Report

Mapping marginal lands in the Khorezm province (Aral Sea basin), prone to soil degradation

Prepared by:
Hayot Ibrakhimov, Inna Rudenko, Murod Sultonov, Alexander Lee, Davran Niyazmetov, Sodiqov Mansur, Ruzmetov Bahodir

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1. Introduction

Agriculture plays an important role in the employment and thus, livelihoods of local population in the Central Asian (CA) countries. Ca. 40 million peasants or 60-70% of the rural population in CA are involved in such agricultural activities as cattle husbandry and production of agricultural crops, fodder, fruits and vegetables for domestic consumption and trade in local markets. Irrigated farming production is mainly cotton and wheat, strategic export crops for national economies of the CA countries. Agricultural sector accounts for ca. 25% of gross domestic product (GDP).

The CA counties are geographically located in the arid and semiarid zone, favorable for agricultural activities and possess sufficient land and water resources. Some 59.1 million ha (38% from the total 154.9 million ha) can be cultivated, but only ca. 10 million ha (6.4 %), generally represented by desert and mountainous pasture is actually cultivated. Of this cultivated area, 7.9 million ha (5.1 %) is under irrigation (SIC ICWC). Non-irrigated area represented by pastures, hay, meadows and fallow land occupies ca. 54 million ha. This area includes rain-fed agricultural fields, but its productivity is extremely low, being on average one tenth of the productivity of irrigated areas.

Aridity of the province dictates high prevalence of evapotranspiration over precipitation. Maximum values of the precipitation (90-450 mm in plains) are recorded in winter-spring periods. During the rest of the year precipitation is negligible, while evapotranspiration may range between 1,300-2,200 mm (Conrad et al. 2012). Such climatic conditions cause formation of salinity build-up in the soil profiles in the vast territory of the province. Saline areas constitute some 47.5 % (Bucknall et al. 2003), which renders them insufficiently low- or even completely non-productive.

Continental arid climate creates the need for artificial irrigation during growing seasons. Irrigation enables leaching of salts from the root zone while substantially increasing land productivity. During Soviet era, extensive irrigation networks and pumping stations delivering water to the remote areas, have been constructed, which allowed to develop new areas for agriculture. By 2000, the overall length of the main and secondary conveyance irrigation network has been 47,750 km, while tertiary farm distribution irrigation networks 268,500 km (SIC ICWC). Ca. 85 % of the water resources from the main arteries of the Central Asia, the Amudarya and Syrdarya Rivers, and their tributaries are used for irrigation purposes.

However, only 20-30 % of the existing canals have been lined; water losses underground, combined with widespread, low-efficient furrow and basin irrigation methods and natural topographic flatness brought about quickly rising groundwater beyond acceptable levels, thus triggering redistribution of salts from deeper horizons. Salts contained in groundwater have been intensively accumulated in the soil profile while pure water evaporated leading to secondary soil salinization. To avoid salinization and waterlogging of the soil profile, drainage networks have been constructed. Some 5 million ha of the total irrigated land requires artificial drainage, which was constructed in 90% of the area. The drainage network requires maintenance; it was severely deteriorated due to weak economic conditions of the CA countries following independence. Land salinization causes a dramatic loss of productivity and the need for freshwater for leaching.

The degradation of the irrigated areas is largely a result of mismanagement of land and water resources. Following independence in 1990s, aiming at water saving, water consumption has been dramatically decreased from ca. 18 m^3 ha-1 to 12 m^3 ha^{-1}. However, this decreased consumption has not been accompanied by improvement of irrigation networks or introduction of water-saving techniques. As a result, further productivity reduction has been observed, while some of the land was taken out of production becoming marginal. Such marginal land is characterized by low biophysical, production and economic potential rendering its use cost-ineffective under natural conditions, management options and agricultural policies.

Rapidly growing population especially in rural areas exerts an increasing pressure on available agricultural land resources. Continuing degradation of the agro-ecosystems further enhanced by

extremes of drought and wet periods due to climate change-related uncertainty render these resources and rural communities even more vulnerable. At the same time arresting land degradation, utilization of marginal land for crop production or grazing has a high potential of reducing the pressure on highly productive land, fighting poverty and enhancing production potential. E.g., producing crops traditionally grown on irrigated areas (fodder, grains, vegetables, etc) or introducing alternative crops (indigo, licorice, etc) on marginal land has a potential to achieve additional food or fodder, enhance food security, receive additional income and hence, provide better livelihoods of rural population, while decreasing dependence on imports. At the same time failure to address poor productivity of the marginal land will result in further land degradation, underproduction of food, increased poverty and thus, social insecurity, inequality and instability.

To address these issues, the CGIAR intends to combine accumulated scientific knowledge and development potential together with partners, farming and rural communities and investors. With the overall aim to improve livelihoods of rural population, while conserving natural resources and empowering farmers and pastoralists to cope with uncertainty of climate change this research program will use innovative and integrated agro-ecosystem approach to improve agricultural productivity of the marginal land. The CGIAR Research program 1.1 led by ICARDA will use two complementary approaches for sustainable conservation and development of the dryland systems: i) increasing their resilience to biophysical and socioeconomic shocks and ii) sustainable intensification of production systems to reduce food insecurity and generate more income.

To achieve the above goals the following steps will be performed:

- Characterize biophysical and socioeconomic conditions of the dryland systems;
- Identify, adapt and test technologies, institutions and policies to better manage risk and sustainably intensify agricultural production systems while conserving the natural resources on which production depends;
- Form better public/private partnerships through innovation platforms that electively deliver technologies to the rural poor in dry areas; and
- Monitoring progress and synthesize knowledge using state of the art tools in modeling and remote sensing.

Integrated system approach including innovative partnership, diverse technologies and appropriate policies is a key to manage dryland systems. Accurate identification and description of the marginal land is a prerequisite for integrated intervention. This report represents a part of the activities of the strategic research theme (SRT) #2 “Reducing vulnerability in agro-ecosystems affected by degradation of natural resources” in the Aral Sea Region. The main goal of this activity is identifying and implementing alternative land use options for a sustainable management of the marginal land resources in the three CA countries (Uzbekistan, Kazakhstan and Turkmenistan) for improving land productivity and livelihood of farmers and agro-pastoral communities and providing eco-systems services. The entire approach and concept for sustainable resource utilization is guided by the principle of efficiency: Making an effective use of marginal land while the resources saved can be more profitably concentrated on the productive croplands.

This SRT includes three target sites, the Dashauz province in Turkmenistan, the Khorezm province and the Republic of Karakalpakstan in Uzbekistan and the Kyzylorda province in Kazakhstan. The current study focuses on the Khorezm province of Uzbekistan. Identification and description of the other sites will follow.

2. Identification and description of agricultural land in the Khorezm province using GIS and remote sensing

2.1 Description of the Khorezm province

The Khorezm province of Uzbekistan is located between 60º - 61º longitude and 41º-42º latitude, in the lower reach of the Amudarya River (Figure 1). It is a lowland with elevation range of 113-138 m above sea level, at a distance of ca. 250 km from the natural depression, the Aral Sea (Figure 2).

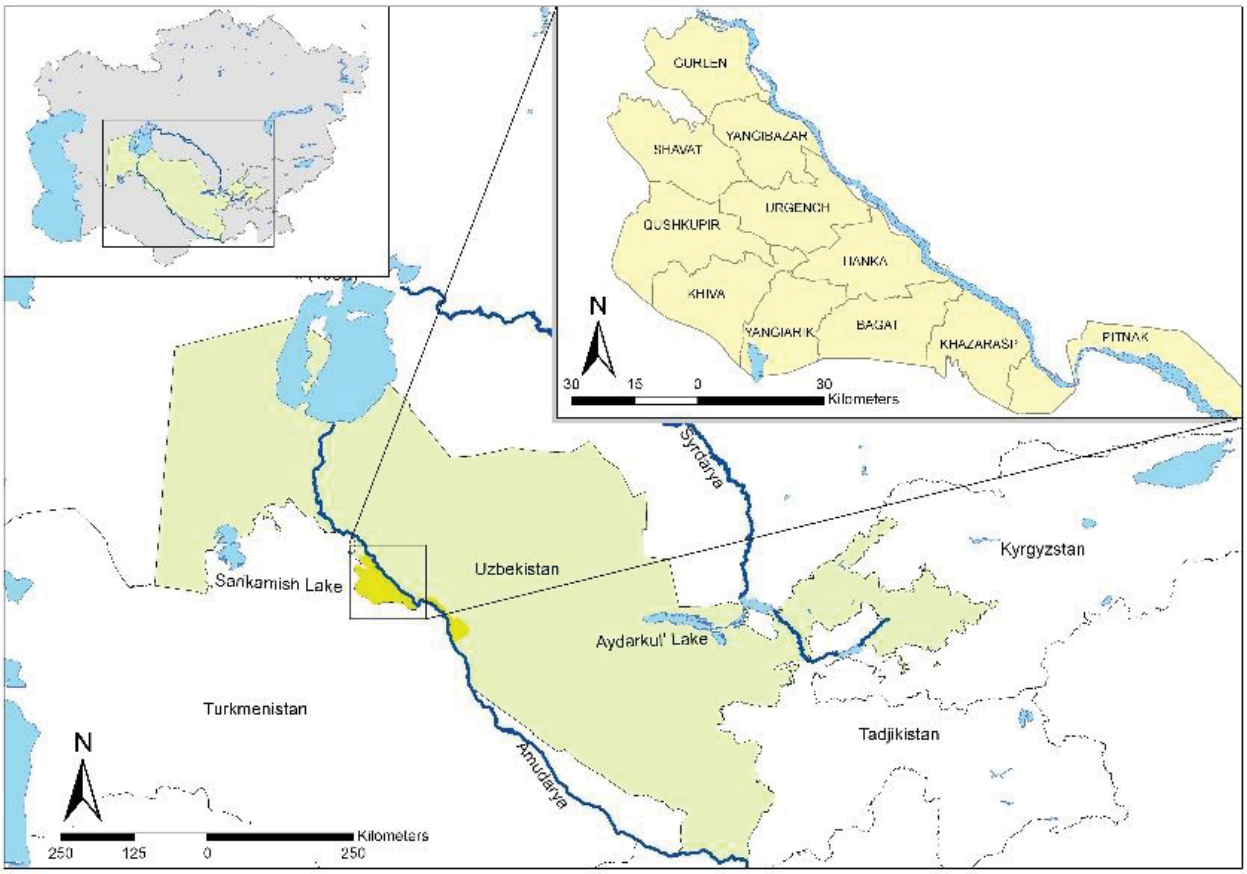


Figure 1. Location of Khorezm province on the Aral Sea basin

The province occupies the territory characterized by arid, continental climate. The total area estimated with help of Geographic Information Systems (GIS) tools from the national administrative maps is 6,250 km^2. Of this area, 4,560 km^2 (73%) is located on the left bank of Amudarya River and 1,690 km^2 (23%) on the right bank. According to the Land and Water Management Institution of the Khorezm province, there are 5,945 ha of irrigated land in the right-bank area, Tuproqqala massif. The total irrigated area in the province is 276,600 ha (44%, Figure 2).

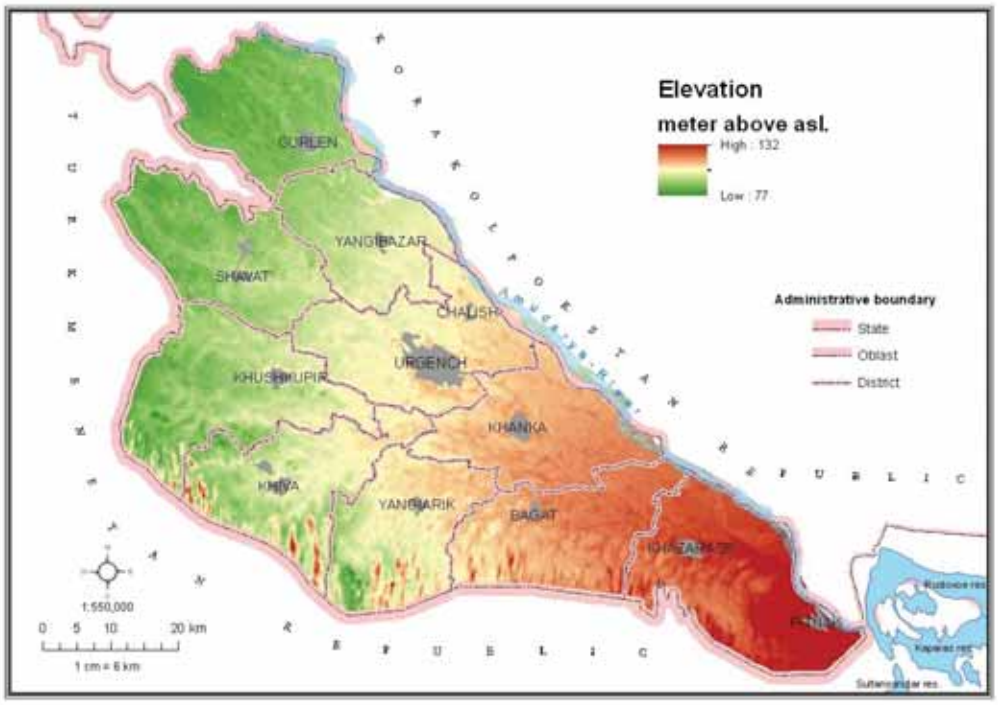


Figure 2. Elevation of the Khorezm province based on the data from Shuttle Radar Topography Mission

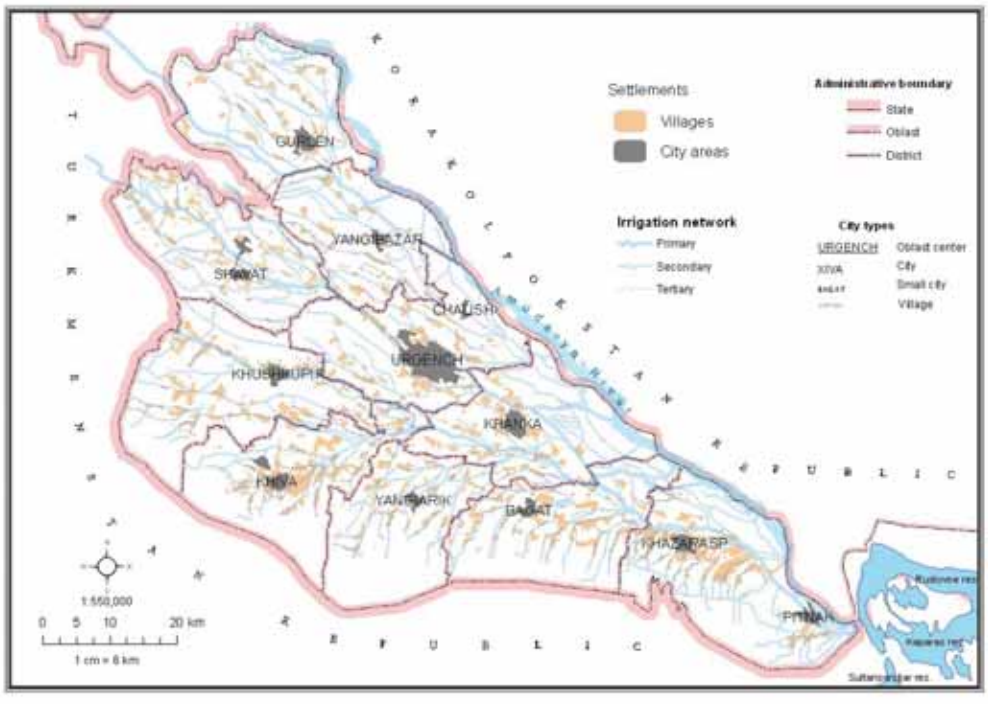


Figure 3. Administrative map of Khorezm with an administrative center and subregional districts

The population of the Khorezm province reached 1,564 million people as of 2010 (ca 1.7 million as of 2013) according to the Statistical Department of the Khorezm province. Urban population constitutes 383.9 people (24.5%), rural – 1,180.2 (75.5%); there are 11 subregional districts with an administrative center Urgench (Figure 3). The population density is 240 people per km^2 (Figure 4) and the growth rate is ca. 2% annually.

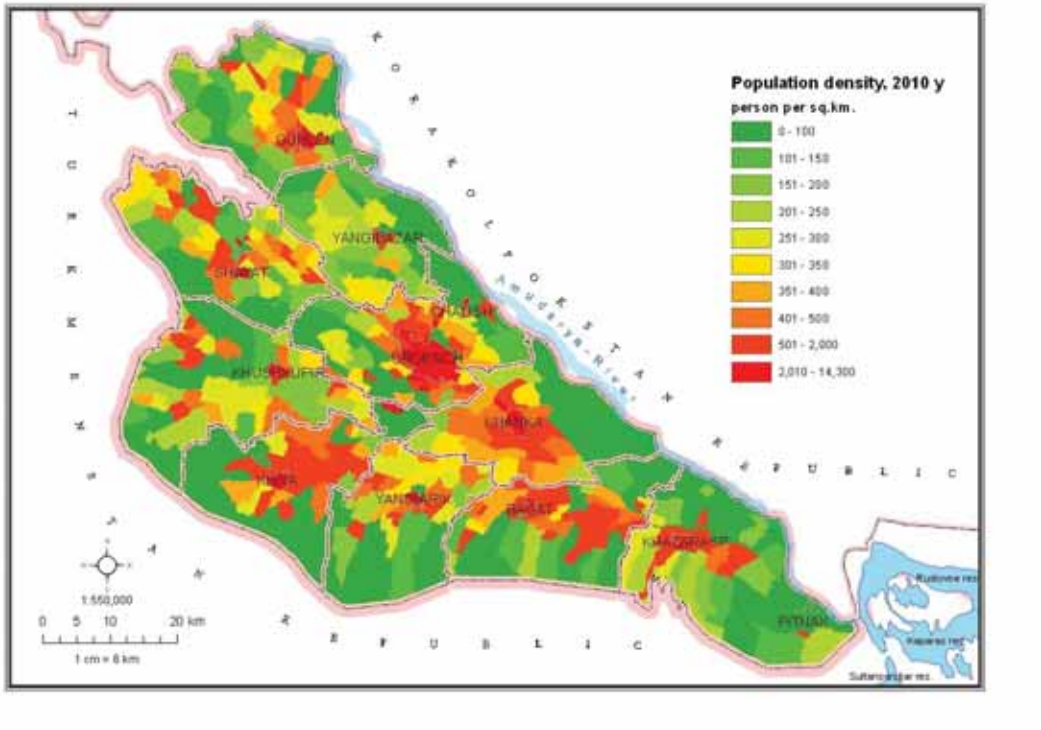


Figure 4. Population density in the Khorezm province in 2010.

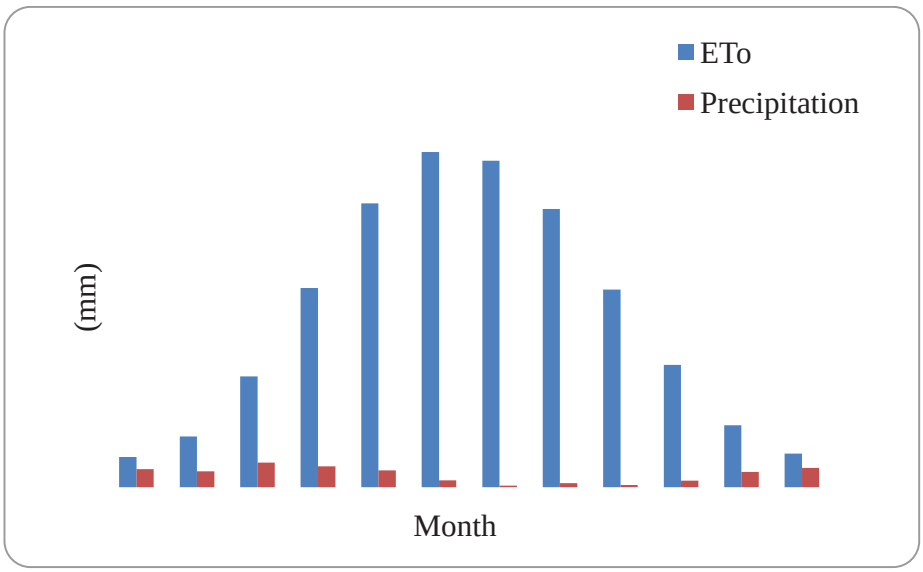


Figure 5. Average monthly values of potential evapotranspiration and precipitation (means from 1985-2007)

Aridity, continental climate in the province with extremely hot summers leads to a substantial prevalence of potential evapotranspiration (ETo,) over precipitation (Conrad et al. 2012). Long-term annual average potential ETo and precipitation for the last 25 years are 1,338 and 94 mm, respectively (Figure 5). The maximum ETo occurs during the months of June (221 mm) and July (215 mm), whereas average rainfall during June and July is 4 and 1 mm, respectively. During the peak growing season of annual crops (April to September) the long-term average ETo is 1,098 mm whereas rainfall is only 33 mm.

Therefore, artificial irrigation is the only way to produce agricultural crops in the province. The irrigated agriculture is of high importance for the regional economy and livelihoods of local population as ca. 90% of regional GDP is generated from the agricultural production, and employs ca. 60% of its labor force (source). The irrigated areas include cropland, orchards, vegetables, and forestry patches.

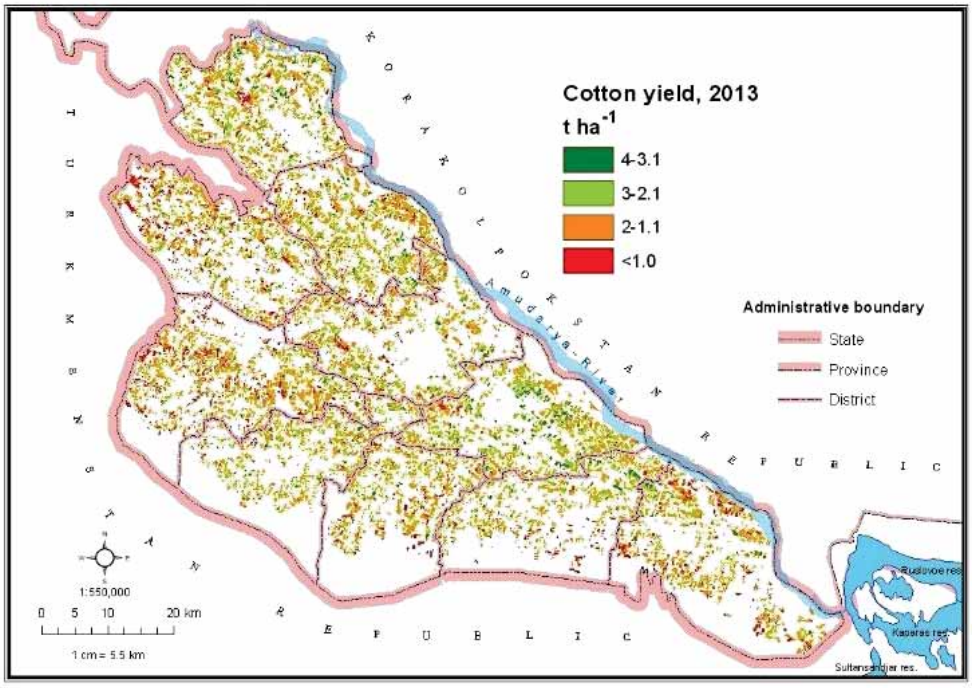


Figure 6. Cotton plantations and yield per hectare in the Khorezm province, 2013

Among the main agricultural crops produced in the irrigated fields are state order cotton (Gossypium hirsutum) and winter wheat (Triticum aestivum). These two crops alone occupy the major share of the irrigated fields. Assessment of the area covered with these crops and their yields using remote sensing tools and Landsat satellite images showed that in 2013 cotton occupied 98,300 ha (37.0%) and its yield ca. 3-4 t ha^{-1}, while winter wheat was sown on 45,500 ha (17.1%), ha with 4-7 t ha^{-1}. (Figures 6 and 7).

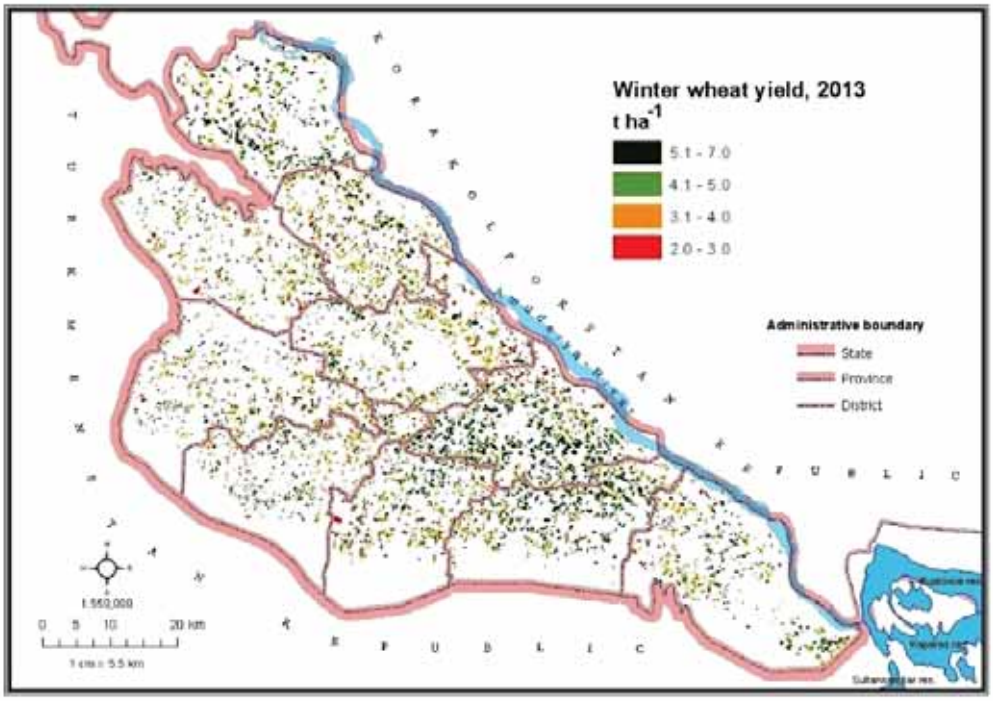


Figure 7. Winter wheat plantations and yield per hectare in the Khorezm province, 2013

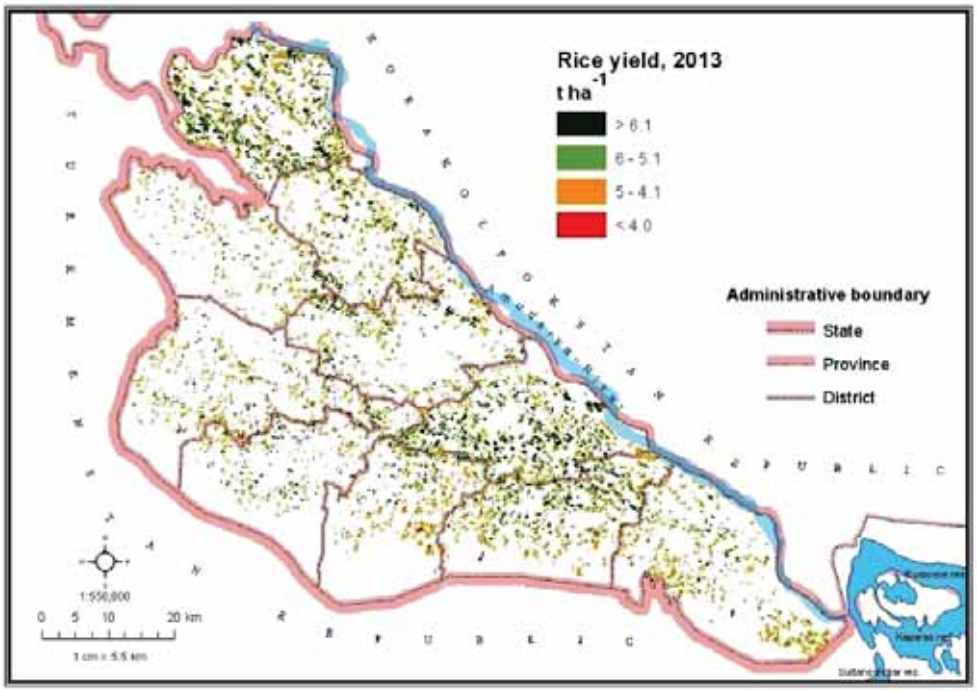


Figure 8. Rice plantations and yield (t ha^{-1}) in the Khorezm province in 2013, including transplanting rice seedlings after winter wheat

Among other crops grown is rice (Oryza sativa) that occupies an area of 49,800 ha in 2013 (including early planted and transplanted rice varieties), which is of high importance to the rural population (Figure 8).

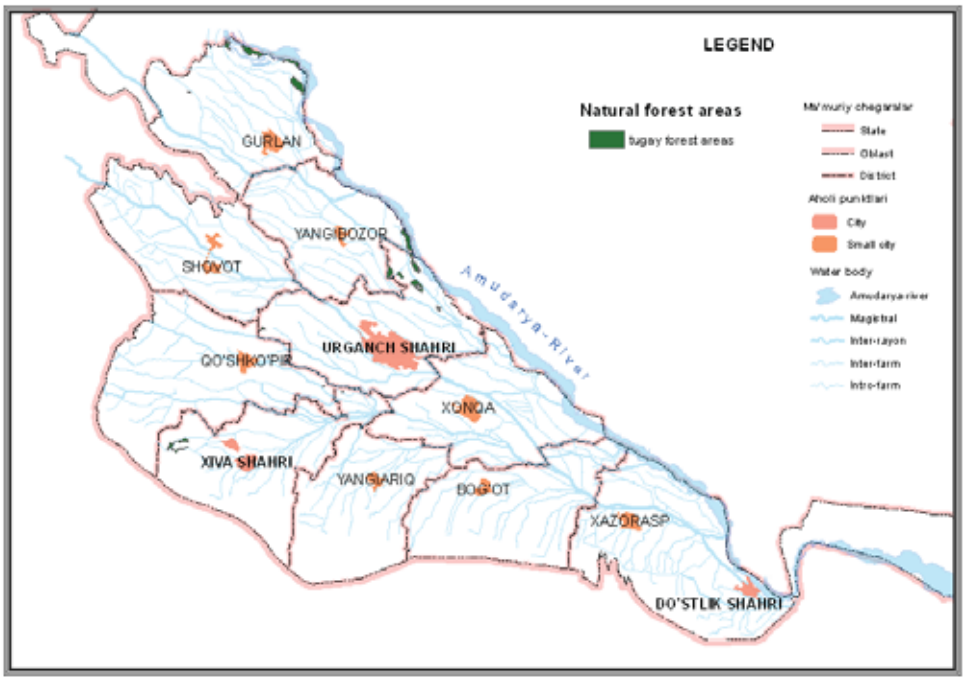


Figure 9. Natural tugai (Populus euphratica) forest areas.

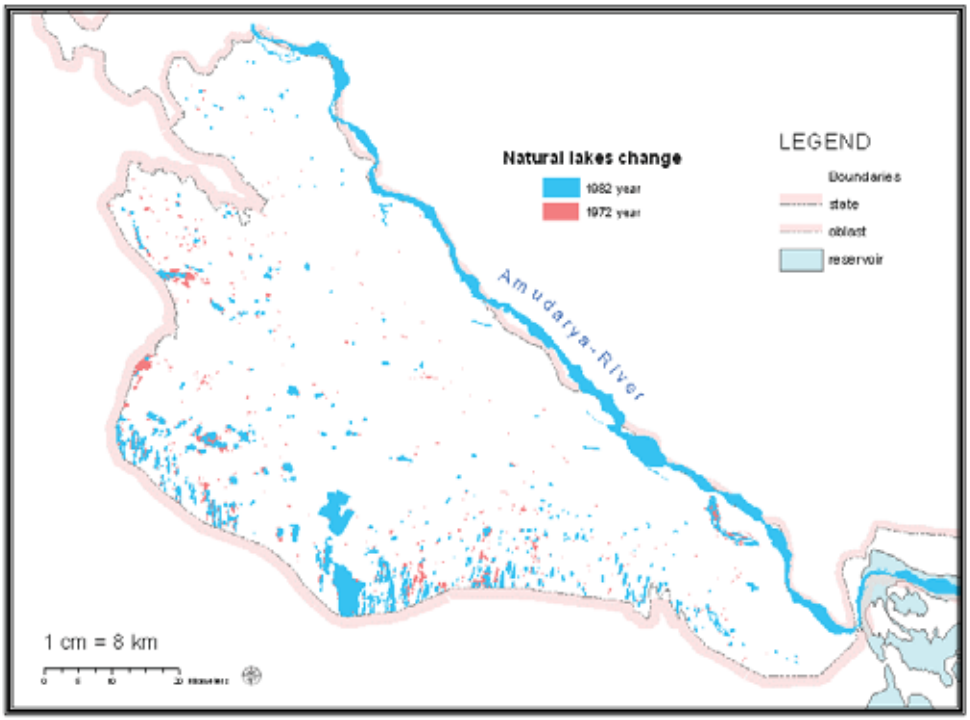


Figure 10. Location and spatial changes of natural lakes over time (1972 and 1982) in the Khorezm province.

Natural vegetation is represented by scarce wild plants and tugai (Populus euphratica) forests (Figure 9). The tugai forests thrived during spills of the Amudarya River before 1930es nowadays cover considerably smaller area of 14,860 ha only. The spring floods of the river served as water sources for numerous natural lakes in the province in the past (Figure 10). However, almost full

usage of river water for agricultural purposes caused drying out of many lakes. The existing lakes are largely fed by drainage discharge.

2.2 Irrigation and drainage infrastructure in the Khorezm province

Artificial irrigation is necessary to bridge the large gap between the crop water demand (as indicated by ETo) and precipitation. Agriculture consumes ca. 95% of Khorezm's total water use of 5 km^3 (Dukhovny and Sokolov 2001). These amounts of water originate from the Amudarya River, the principal source of all water resources in the Khorezm province (Figure 11). The Khorezm province together with neighboring Karakalpakstan receives this water of quality and quantity left from upstream withdrawals and drainage return flows.

Figure 11. The Amudarya River (Wikipedia)

The Amudarya River is fed by the streams from melting snow and glacier on the mountainous region in the Pamir Knot at the eastern end of Afghanistan's Wakhan Corridor. The overall length of Amudarya is 2,400 km. More than 25-30 thousand years ago, the river was oriented east and ended in the Khorezm depressions (Nasonov 2007). Currently, it flows along the eastern 138 km path of the Khorezm province.

Water availability from the Amudarya River varies notably between the years. Statistical records between 1990 and 2011 show that the region frequently experiences insufficient water supply, as evidenced in the period 1999-2001 or in 2008 in the downstream and middle-stream reaches of the irrigation network.

2.2.1 Tuyamuyun reservoir

By 1983, i.e., prior to construction and operation of the Tuyamuyun reservoir, the water flow of the Amudarya River was very high causing flooding every year of the flanking lands when the river

embarked outside its bank. These frequent floods partly explain establishment of facilities regulating the inflow into the irrigation system of Khorezm at a distance of several kilometers from the river bed.

The Tuyamuyun complex of reservoirs is built in the southeast of the Khorezm oasis (Figure 12). This complex was built in the narrowest part of the river, but at the same time it is one of the largest reservoirs in Central Asia occupying an area of 650 km^2. The hydro-engineering complex consists of four separated reservoirs: the Channel Reservoir, Kaparas, Sultansandjar, and Koshbulak. The Tuyamuyun water reservoir includes a dam with the length of 181 m, height of 28 m and a hydroelectric power station. The reservoirs' average depth is 20 m, but at deepest places it may reach 40 m and more. The initial (in 1983) storage capacity was 7.8 km^3, however siltation processes reduced the capacity by 1 km^3 during the period 1983-2001 (Froebrich et al. 2007). The reservoir can supply up to 5 km^3 to Uzbekistan and Turkmenistan.

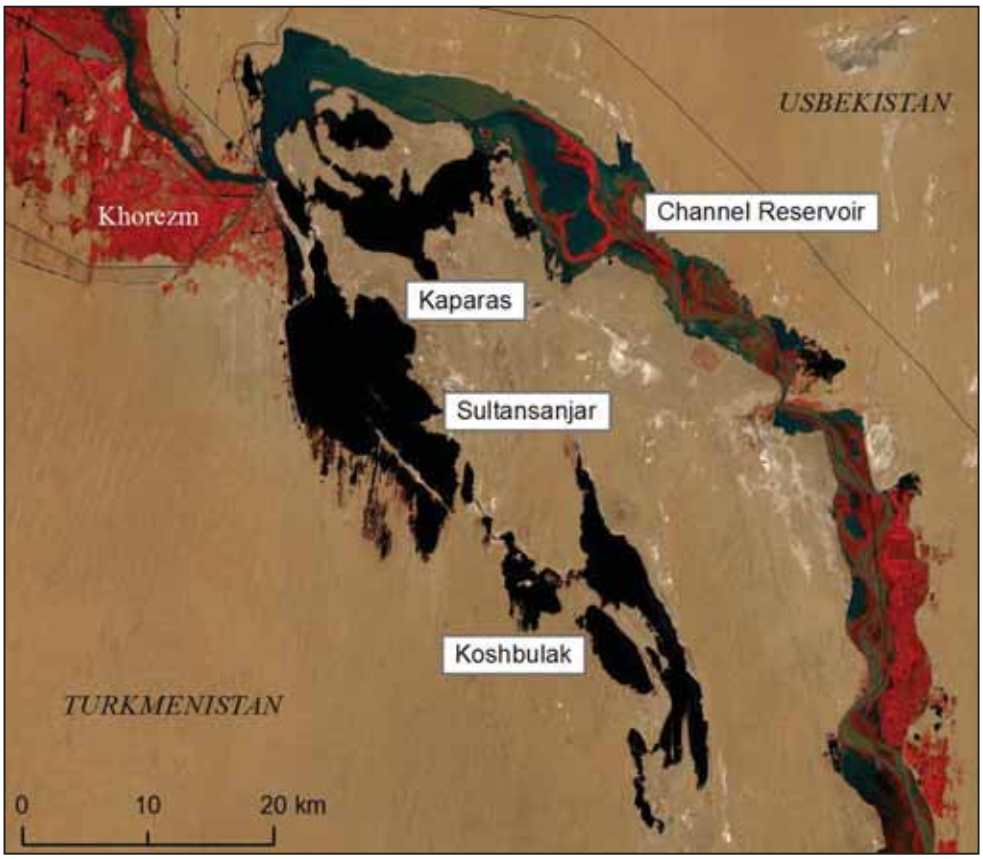


Figure 12. The Tuyamuyun complex of reservoirs (source: Landsat satellite image, August 2010, false color composite)

The capacity of the hydroelectric power station associated with the Tuyamuyun reservoir complex is 150,000 kilowatt per second and includes 6 units. The hydro-junction dam consists of 12 inlet gates, which can let in 54 $m^3\ s^{-1}$ of water. The water distribution unit on the left bank of the reservoir has the hydraulic capacity to carry out 500 $m^3\ s^{-1}$; the one on the right bank to carry out 90 $m^3\ s^{-1}$.

After the construction of the Tuyamuyun reservoir complex, natural discharge of the Amudarya could be regulated to a large extent for the entire delta of the river. However, although this reservoir now cushions floods, in extreme years such as 2004, floods caused by melting of enormous snow volumes had a hazardous impact on agricultural production along parts of the natural riverbed, downstream the dam.

Studies indicated that operation of the Tuyamuyun reservoir caused a drastic reduction of silt contents of the water applied for irrigation in the Khorezm oasis during growing seasons (Table 1).

Table 1. Changes in silt content (g m^{-3}) of Amudarya water in 1985 after the construction of the Tuyamuyun reservoir

Silt measurement point	March	May	June	July	August
Up *Dargan-Ata* reservoir	-	12,800	1,360	1,910	890
Down the *Tuyamuyun* water reservoir	40	30	50	700	120
ПК 34 (*Toshsaka* canal)	80	60	150	740	240
Urgench (*Shovot* canal)	430	480	200	1,250	320
Polvon Gozovot in the direction of Urgench	190	290	820	1,400	340

Source: Fayzullayev, 1985

2.2.2 Irrigation and drainage systems

An extensive irrigation network was established to distribute freshwater from the river to the agricultural fields. The irrigation network is operated partly by gravity; as the canals are dug into the soil in conditions of flat, slightly undulating terrain, numerous pumps were also installed to lift water. As in all irrigation systems located in flat terrain such as is the case in the Khorezm province, a second infrastructural system, the drainage network became necessary. The drainage infrastructure was implemented to manage groundwater levels and control soil salinity for ensuring long-term crop production. The major branches of the irrigation and drainage infrastructure are presented in Figure 13.

Figure 12. Overview of the main irrigation and drainage networks in the Khorezm province

The irrigation network in the province consists of three hierarchical types of canals: magistral, inter-farm and on-farm canals[1]. The total length of all canals is 16,377 km (Figure 14). Primary canals are defined as those canals, which are not used to irrigate the agricultural fields directly but supply water to the next hierarchical level of channels, the secondary canals. The primary canals are locally called magistral (trans-boundary) and inter-rayon (district) canals according to the local classification system, and include those canals that supply water to different districts/rayons. The total length of the primary canals in the Khorezm province is 619 km (Figure 15).

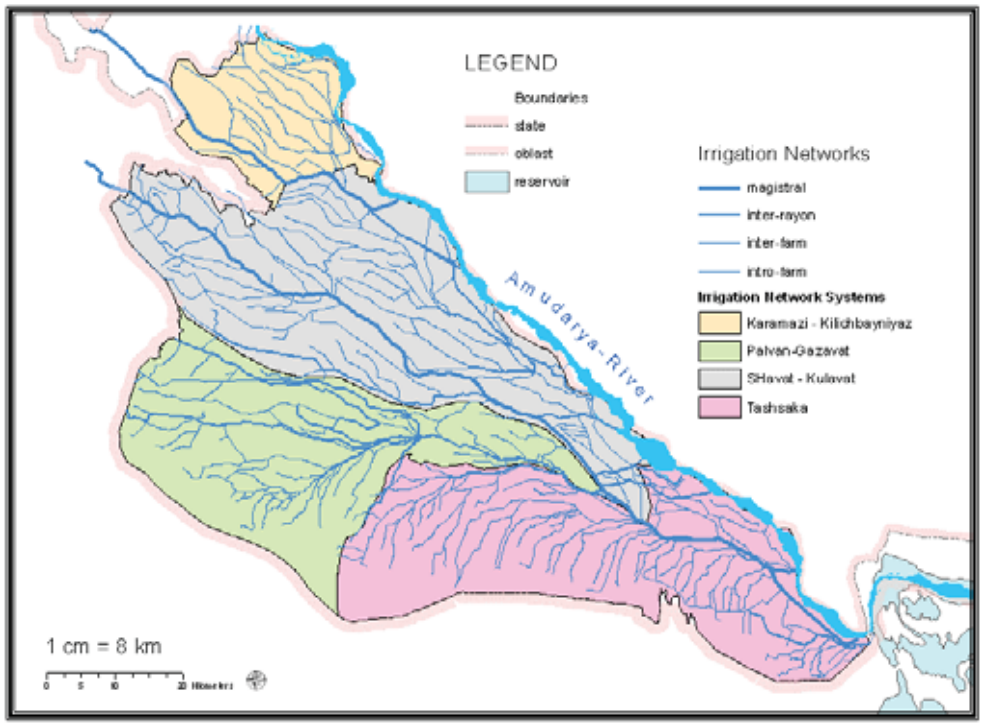
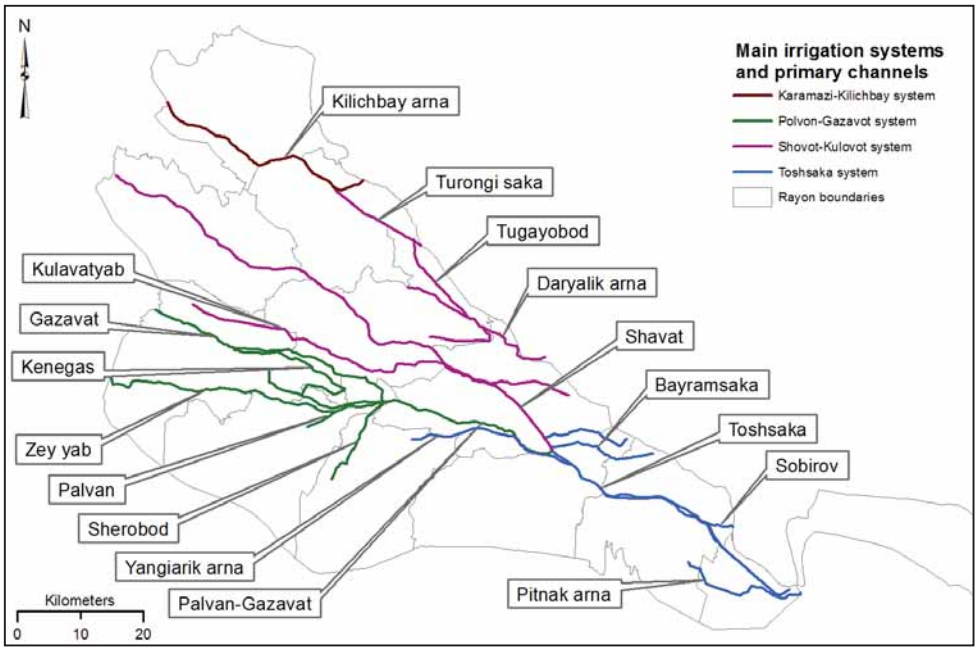


Figure 13. Map of the irrigation system in Khorezm province of Uzbekistan.



[1] The local classification of the irrigation network is “magistral”, “inter-farm” and “on-farm” canals, defining their hierarchy. Primary canals distribute water from the source to the secondary canals, which then supply water to the tertiary canals. Same structure applies for the drainage network

Figure 15. Map of the irrigation system in Khorezm province of Uzbekistan.

Secondary canals, locally called inter-farm canals, are fed by the water from the primary canals. The total length of the secondary canals in the Khorezm province is 1,733.4 km (Figure 16).

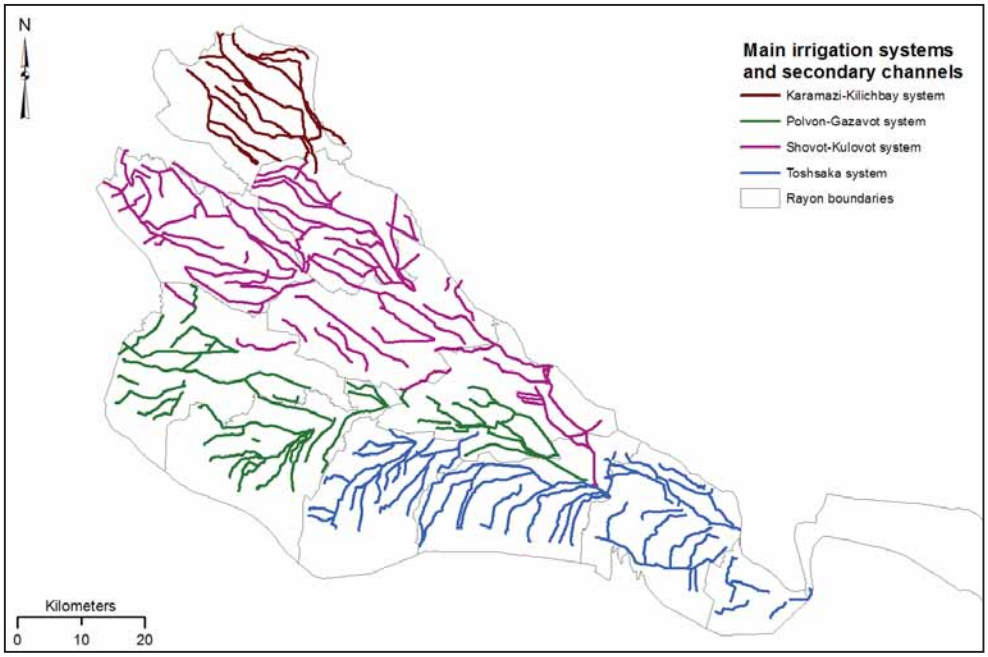


Figure 146. Map of the secondary irrigation canals in the Khorezm province

Tertiary canals are the canals conveying water from the secondary canals to the farm boundaries. The total length of these canals is 14,020 km (Figure 17).

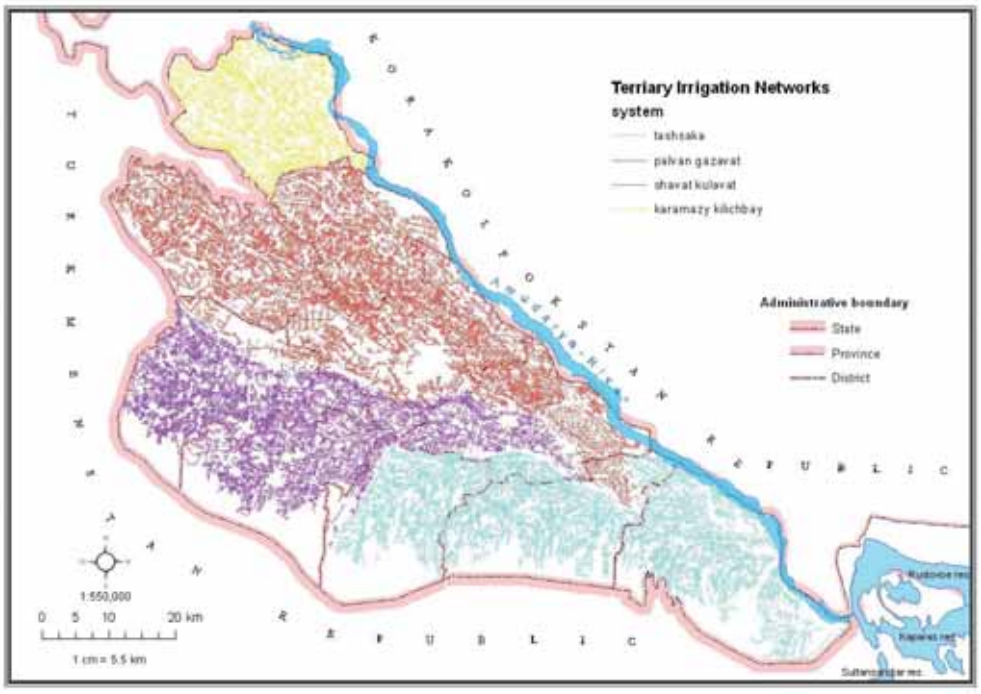


Figure 17. Map of the tertiary irrigation canals in the Khorezm province of Uzbekistan

The density (the length of canal per unit hectare of irrigated land) of the irrigation networks for the primary canals is 2.31 m ha^{-1}, for the secondary canals 6.21 m ha^{-1} and for the tertiary 51 m ha^{-1}. Figure 19 shows the GIS-based spatial representation of the irrigation networks' density in the Khorezm province (Figure 18).

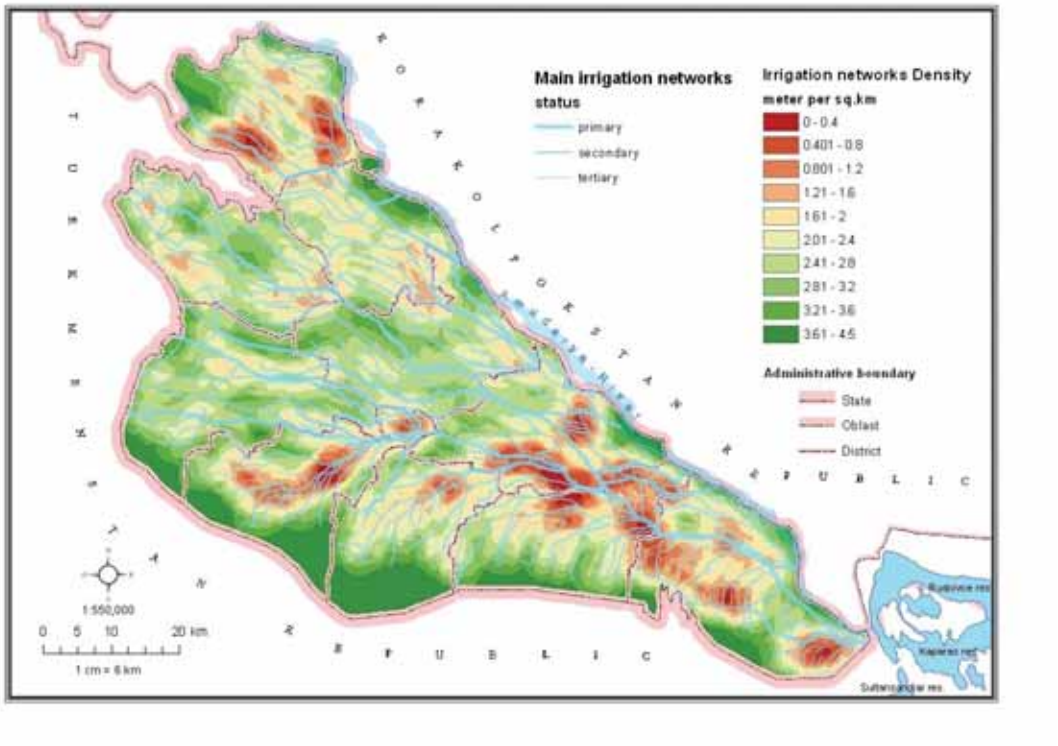


Figure 18. Density of the irrigation systems in the Khorezm province

2.2.3 Legal water management bodies

The National Ministry of Agriculture and Water Management (MAWR) is responsible for the planning of water allocation in Uzbekistan and therefore, intensively collaborates with the Interstate Commission for Water Coordination (ICWC). Transboundary water management between Central Asian (CA) countries and Afghanistan is the responsibility of the BVO (Basin Water Management Organization) 'Amudarya', which is the executive body of the ICWC. The Khorezm oasis and part of neighboring Karakalpakstan are served by the Lower Amudarya River Basin Management, which consists of five Irrigation System Management bodies (Figure 19). The main task of the BUIS (Basin Management Department of Irrigation System) is allocating water to Irrigation Systems and Magistral Canals (UISs); the UISs then delegate tasks to sub-UISs (Irrigation System Management Organization), which ultimately distribute water to Water Consumers Associations (WCA) based on properties of the different canal types (e.g., capacity, conveyance losses).

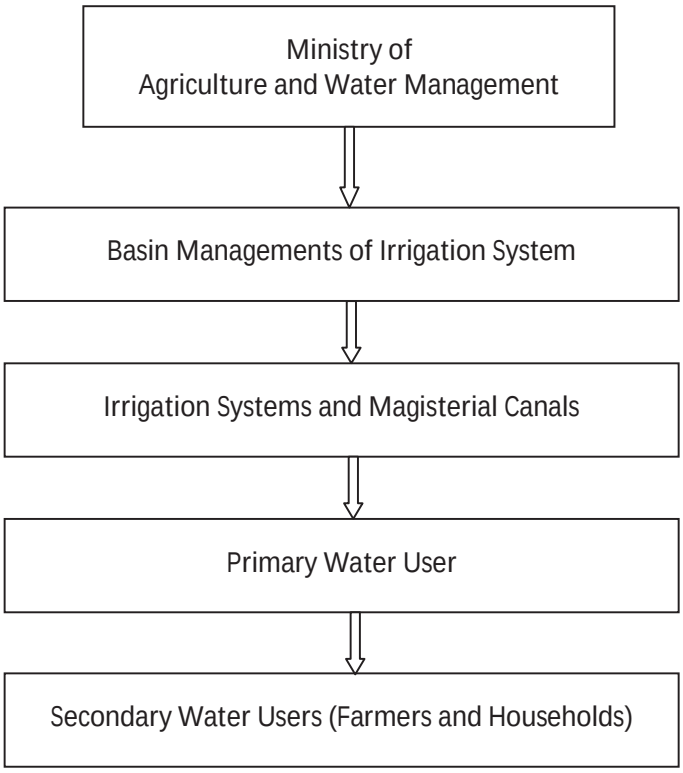


Figure 1915. Water distribution structure in the Khorezm province

2.2.4 Water withdrawal and distribution in Khorezm at a regional level

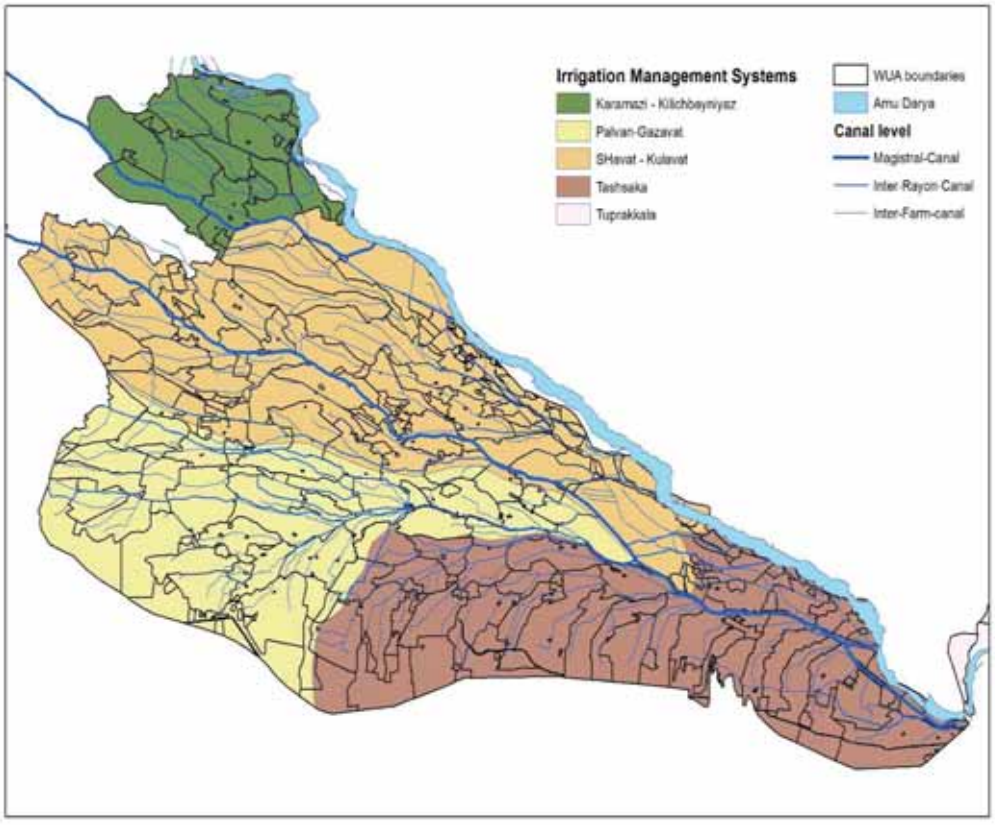


Figure 16. Delineation of the five irrigation management systems in the Khorezm province

The Khorezm province is divided into five irrigation systems based on the location and area served by the primary (magistral) canals. These are Toshsoka, Polvon-Gozovot, Shovot-Kulovot, Koramazi-Kilichbay and Mangit-Nazarhan irrigation systems (Figure 20), which in turn are managed through different subsections (Figure 21).

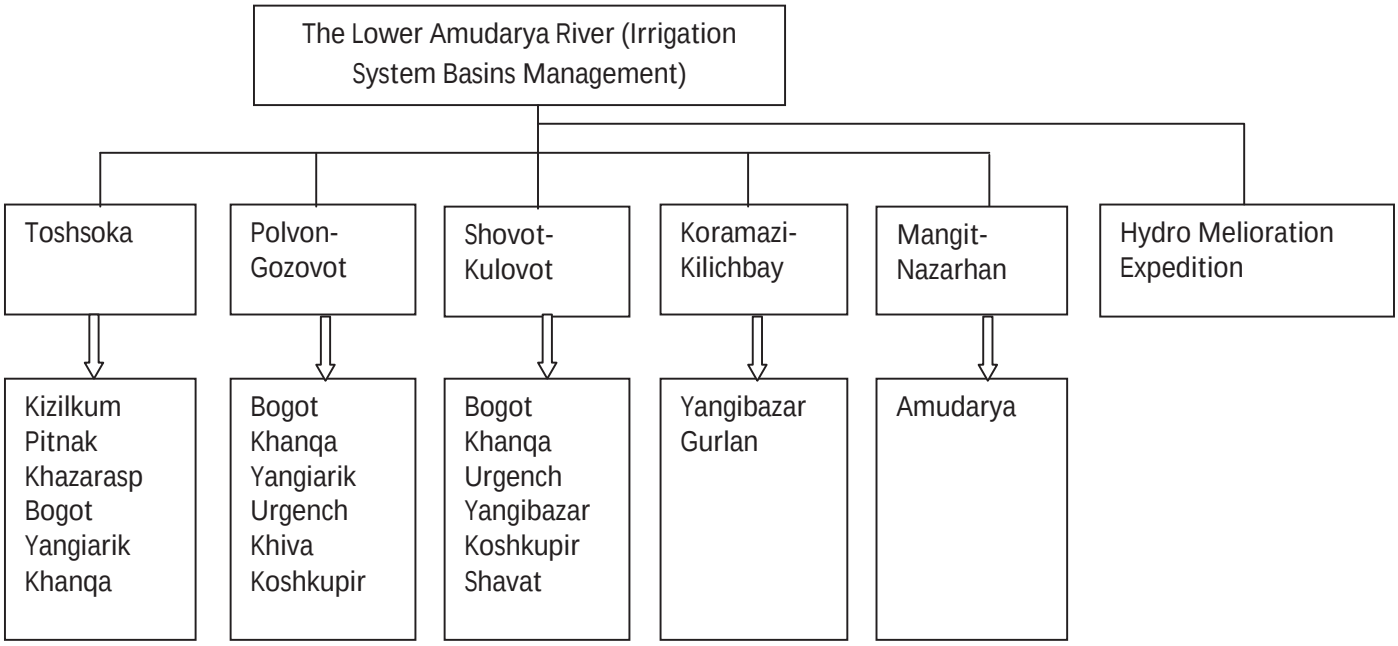


Figure 17. Organizational structure of the Lower Amudarya River Irrigation System Basins Management

The water supply through the primary (magistral) canals is controlled by the BUIS and UPRADIK (Irrigation Canals Division), whereas the secondary (inter-district) canals are controlled by UIS (Irrigation System Authority) through the canal management units, which function as an extended branch of the UISs. The water distribution in the tertiary (on-farm) canals is managed by the Water Consumers' Associations (WCAs).

A major part of water for irrigation into the Khorezm province is taken from the Tuyamuyun reservoir through the Toshsoka, Palvan – Gazavat and Shavat – Kulavat irrigation systems, which serve ca. 90% of the agricultural areas. ca. 10% of the areas receive water directly from the river through pumps via the Karamazi – Kilichniyazbay irrigation system (Table 2). Since these intake points are located downstream of the Tuyamuyun reservoir, they depend on water releases from the reservoir back to the river. The river changes its beds regularly during the year, especially in drought periods and so, direct access to river water is limited.

Table 2. Coverage of the served agricultural areas and water sources of the main irrigation systems in the Khorezm province

Irrigation system	Area, %	Water source
Tashsaka	30	Tuyamuyin Reservoir
Palvan – Gazavat	26	
Shavat – Kulavat	35	
Karamazi – Kilichniyazbay	10	Amudarya River
Total area (% / ha)	100 / 456,000	

2.2.5 Design discharge of canals in different irrigation systems

Water conveyance systems for irrigation, comprising of the primary, secondary and tertiary canals have to be properly designed. The design process comprises defining cross-section parameters, longitudinal slope, length of the canals based on the design discharge for a given command area. The channels are made up of different construction materials. For example, the unlined canals can pass through soils, which are erodible due to high water velocity, while some others may pass through stiff soils, which may relatively be less prone to erosion. Such different conditions would affect the longitudinal design slopes of canals passing in loose or stiff soils. In the following a set of tables is provided with information on the design parameters (length, design discharge) of the main/selected/available canals in the Toshsoka, Polvon-Gozovot, Shovot-Kulovot, and Koramazi-Kilichbay irrigation system.

Table 3. Overview of the design parameters of the irrigation systems in the Khorezm province

#	Main canals	Length, km		Irrigated area, ha	Water intake points	
		Total	Concrete lined		Total	With pump
	Toshsaka irrigation system					
1	MK section	107,67	39,52	6,006	16	
2	R-5 section	175,46	21,75	22,080	98	59
3	Pitnakarna section	37,9	2,1	6,597	19	13
4	R. Sabirov section	186,0	41,27	20,607	148	84
5	R-8 section	159,7	-	16,551	82	53
	Polvon-Gazavot system					
6	R-9 section	50,4	4,5	4,205	53	5
7	Nukus main canal section	90,6	8,6	11,916	77	36
8	Nukus main canal section	201,33	25,58	17,499	226	104
9	Keneges section	544	1,7	4,914	84	41
10	Zey-Yop section	96,3	-	12,760	127	101
11	Tugay-Yop section	81	-	12,491	116	76
	Shovot-Kulovot system					
12	R-7 section	96,2	-	11,459	101	66
13	Urganch-arna section	86,7	15,9	6,700	55	25
14	Daryolik-arna section	237,5	15,8	20,608	90	54
15	Kulovot section	178,8	12,2	12,153	99	43
16	Beg Yop section	52,6	1,5	5,507	25	18
17	Davdon Yop section	26,8	12,4	4,566	23	3
18	Udachi Yop section	45,4	1,7	8,796	56	30
19	Shovot-Kongli section	73	9,9	10,603	60	46
20	Shovot-Begovot section	26,3	4,7	10,115	72	66
21	KDOK section	150,84		14,432	17	10
	Karamazi-Kilichbay					
22	Yangibazar section	11,2		6,660	35	33
23	Alga section	18,8		3,211	28	4
24	Kengesbaev section	27,2		9,541	65	29
25	Gurlan vetka section	36,9		6,225	50	34
26	Toksan arna section	48,53	14,25	3,526	42	20
27	Karakuz section	58,45		6,799	94	12
	Total	**2905,58**	**233,37**	**276,527**	**1,958**	**1,065**

2.2.6 Irrigation network efficiency of the selected primary canals

Irrigation network efficiency is defined as the ratio of the water available at the canal tail to that at the head. It is an indirect measure of the conveyance and distribution losses in the irrigation network. The estimated network efficiencies of various channels are summarized in Table 4.

Table 4. Irrigation network efficiency of selected primary canals

Canal name	District	Efficiency, %	Canal	District	Efficiency, %	Canal	District	Efficiency, %
R - 7b	Bagat	93.6	Kazak - yab	Urgench	93.6	Birlashgan	Khiva	90.4
K.Rovot	Bagat	93.4	sbr Urgancharna	Urgench	93.6	Soyot	Khiva	90.4
K.Yantok	Bagat	93.4	Daryolik arna	Urgench	93.6	Keneges	Khiva	90.4
As – yab	Bagat	93.4	Tugoy obod	Urgench	93.6	Polvon	Khiva	90.4
R - 7 a	Bagat	93.6	sbrDaryolikarn AD	Urgench	100	nas.P.Gazavat	Khiva	90.4
R – 5	Bagat	93.6	Amudarya	Urgench	100	nas.Gozovot	Khiva	90.4
Nukus – yab	Bagat	93.7	nas. Bayram	Khazarasp	94.3	Dovdon	Shavat	90.4
R – 8	Bagat	93.7	R - 3	Khazarasp	93.2	Beg – yab	Shavat	90.1
nas.Tashsaka	Bagat	93.6	XOK	Khazarasp	93.8	Xassa	Shavat	90.2
nas.Bayram	Bagat	94.3	XPK (R - 3a)	Khazarasp	93.8	Udachi	Shavat	90.1
Amudarya	Bagat	100	nas.Tashsaka	Khazarasp	93.2	nas.Shovot	Shavat	90.1
Daryolik arna	Gurlan	93.6	Pitnak arna	Khazarasp	100	nas.T.YArmish	Shavat	90.2
Gurlanvetka	Gurlan	92.5	Amudarya	Khazarasp	100	R – 8	Yangiarik	91.3
Kilichboyvet	Gurlan	92.5	Kulovot	Khanka	94.2	SHerobod	Yangiarik	90.4
Amudarya	Gurlan	100	R - 9	Khanka	93.8	nas.T.YArmish	Yangibazar	90.2
Polvon	Kushkupir	90.4	R - 8	Khanka	93.7	nas.SHovot	Yangibazar	90.5
Keneges	Kushkupir	90.4	R - 7a	Khanka	93.6	Gurlanvetka	Yangibazar	92.5
Gazavat	Kushkupir	90.4	Nukus - yab	Khanka	93.7	Kilichboyvet	Yangibazar	92.5
Kulovot	Kushkupir	90.8	nas.Shovot	Khanka	94.3	Turangi saka	Yangibazar	92.5
Davdon	Urgench	90.4	Madir yab	Khanka	93.8	Daryolik arna	Yangibazar	93.6
Kulovot	Urgench	90.8	Gaybu - yab	Khanka	90.5	Tugoy obod	Yangibazar	93.6
nas.SHovot	Urgench	90.7	nas.P.Gazavat	Khanka	90.8	Urganch arna	Yangibazar	93.6
Gaybu – yab	Urgench	90.5	Urganch arna v/b	Khanka	93.6	Amudarya	Yangibazar	100
nas.Gozovot	Urgench	90.4	Daryolik arna v/b	Khanka	100	nas.LBK	Pitnak	94
Begavat – yab	Urgench	90.7	Amudarya	Khanka	100	Pitnak arna	Pitnak	100
Urganch arna	Urgench	93.6	Irdimzan	Khiva	90.4	Amudarya	Pitnak	100

2.2.7 Lift irrigation schemes in the region

About 55% of the total water supply to farmer's fields is ensured through lift irrigation schemes using pumps (Table 5), whereas the remaining 45% has surface water supply by gravity. The operation and maintenance of the pumping stations supplying water to the fields through tertiary canals is under the jurisdiction of the WCAs. The costs of operation and maintenance are covered from fees collected from farmers. Management Organizations of Pumping Stations are responsible for operation and maintenance of the pumping stations at the level of primary and secondary canals (costs financed by the state).

Table 5. Lift irrigation schemes in the Khorezm province

Districts	Total no. of pump stations	Electric pump stations				Diesel pump stations		
		No. of electric pump stations	No. of installed aggregates (pumps)	Total capacity (kW)	Associated area (ha)	No. of diesel pump stations	Total capacity (horse power)	Associated area (ha)
Bagat	142	118	118	7,183	9,842	24	3,120	1,656
Gurlen	123	117	117	5,959	10,943	6	780	797
Kushkupir	226	170	170	9,972	11,787	56	7,280	3,472
Urgench	209	168	168	9,242	9,023	41	5,330	1,381
Khazarasp	196	166	166	10,679	14,295	30	3,900	1,359
Khanka	77	68	68	5,059	5,988	9	1,170	292
Khiva	125	113	113	7,120	9,849	12	1,560	618
Shavat	156	145	145	9,785	15,485	11	1,430	472
Yangiarik	85	60	60	4,336	5,606	25	3,250	1,748
Yangibazar	191	185	185	11,609	13,233	6	780	148
Regional	**1,530**	**1,310**	**1,310**	**80,944**	**106,051**	**220**	**28,600**	**11,943**

Source: GIS lab of the ZEF/UNESCO project in Urgench

2.2.8 Drainage system in the Khorezm province

An open horizontal drainage network is used to remove excess surface and ground water from the area along with the salts, the latter especially stemming from leaching events conducted prior to the crop growing season. The drainage network consists of field lateral drains and collectors. The overall length of the drains and collectors in the drainage system is 8,790 km and thus, the drainage density amounted to 31.8 m ha^{-1}. A spatial representation of the density of the collector-drainage networks in the Khorezm province is shown in Figure 22.

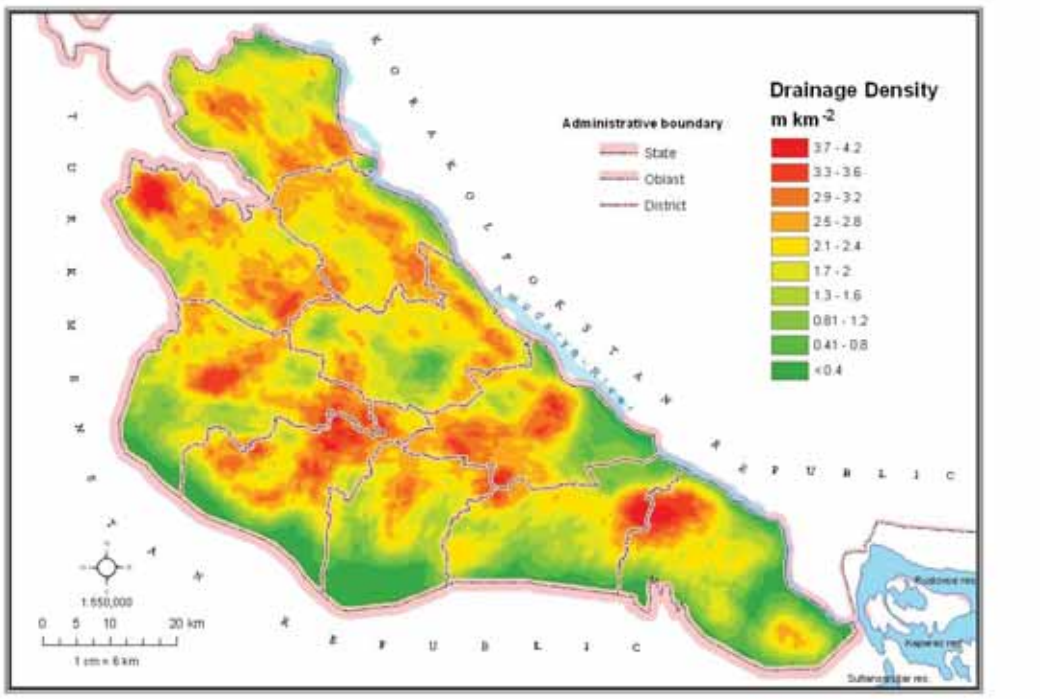


Figure 18. Density of the collector-drainage network in the Khorezm province.

The total length of the collectors (defined as ditches, which receive the drainage discharge directly from the field drains and convey it out of the areas, Figure 23) is 3,290 km, constituting density of 11.89 m ha^{-1}.

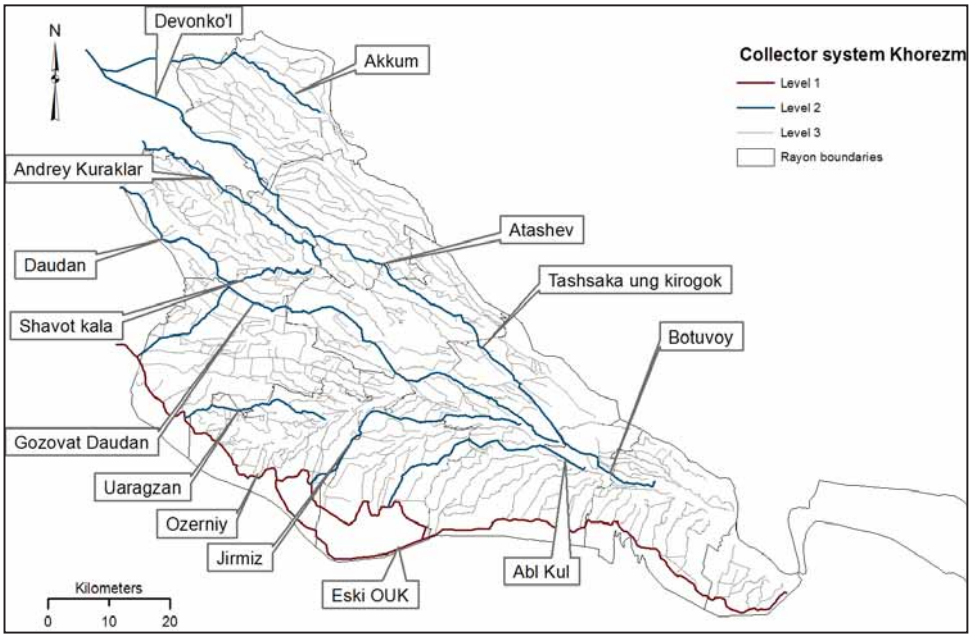


Figure 193. Map of the main collectors in the Khorezm province

The field drains are defined as ditches serving at field level, which collect water from the fields and convey it to the collectors. According to the GIS-based maps (Figure 24), the total length of the drains in the province is 5,500 km, which is equal to a network density of 19.88 m ha^{-1}.

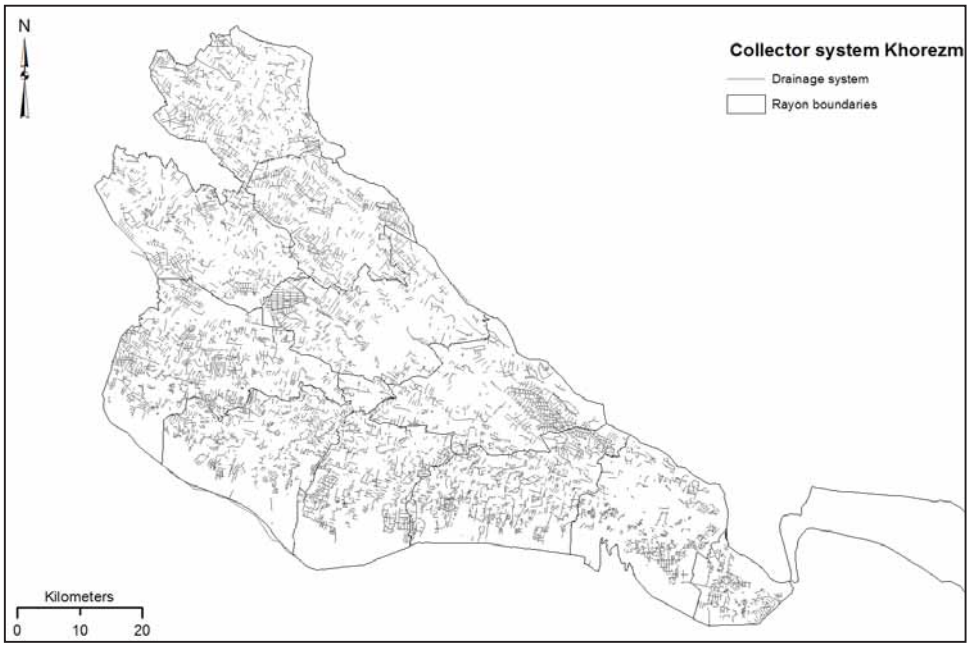


Figure 204. Map of the field drains in the Khorezm province

2.2.9 Evolution of drainage system in the region

At different periods in the history of the Khorezm oasis, the development of the collector and drainage system was deemed necessary due to shallow groundwater levels caused by the intensification of the irrigation system over time, which initially occurred without the installation of a drainage network (Assche and Djanibekov 2011). But despite the construction of a drainage network, land degradation caused by soil salinization continued as evidenced in the increase in soil salinity and a rise of the groundwater tables to unacceptable depths (Ibrakhimov et al. 2007). This has substantially been caused by the dysfunctional on-farm and inter-farm drainage system and severe outlet problems.

The development of the collector and drainage system (CDS) in the Khorezm oasis can be described in three stages of which the first stage lasted for many centuries.

Stage 1: For many centuries and until the middle of the last century, soil salinity control of the irrigated lands in the Khorezm oasis was based on a transition of the agricultural system. This was possible due to the low intensity of land use and slow movement of soluble salts towards the non-irrigated sites (so-called "dry drainage"). In addition, the irrigation system remained unused during the non-growing period (roughly November-February), whilst the irrigated sites were too small and well leveled, and the water level of the canals was lower than the ground surface. Water for irrigation was supplied through a system of so-called chigirs, which carried out defined and tightly controlled irrigation amounts. The measures combined limited the recharge of the groundwater resulting in comparatively deep groundwater tables. In addition, large-scale cultivation of deep rooting crops such as Lucerne contributed to lowering groundwater levels in the root-inhabited layer. Deepened canals played the role of collectors, and effluents from main channels were diverted into adjacent lakes. Therefore, a more developed drainage system was initially not necessary and an organized discharge of drain waters and salt removal out of the Khorezm oasis was not needed during many centuries. The constructed inter-farm and inter-rayon collectors were sufficient to bring the drained water to the lakes and lowlands.

Stage 2: The second stage (1950-1961) in the development of the drainage system was triggered by the increase in irrigated lands, which was followed by an immigration of people. The immigration triggered a rapid increase of natural population growth in the Khorezm oasis. Since the existing irrigation system restricted the intended development of new agriculture land, it was inevitable to introduce a separate irrigation system, which necessitated the reconstruction of the main head works and main canals. As a result of these works, the level of the water in the canals rose considerably, causing on the one hand increased water supply volumes for irrigation but on the other hand the share of the irrigation water losses recharging the groundwater. Sharp increase in the groundwater table and worsening of the land ameliorative conditions took place. These changed conditions necessitated substantial (re)construction of a drainage system.

However, a full-scale construction of the highly necessary drainage system required huge funds, resources and time, which were unaffordable at that time. Therefore, a simplified alternative was chosen. According to the primary scheme, firstly, farm collectors were constructed to discharge the drainage water into peripheral lakes and local lowlands. It was assumed that the discharge of drainage water into lakes and lowlands would be compensated for by the evaporation from the newly established water surface. For that purpose, the Ozerno-Uravnitelniy (Lake-Leveling) collector was constructed as to connect the lakes in the lower lying areas close to the southern border of Khorezm between and near to the irrigated areas.

Stage 3: In the third stage (1961 till now), the Daryalik, Daudan and Ozerniy collectors were constructed as to discharge drain and excessive water to the Sarikamish depression (now in Turkmenistan). It was planned that the depth of collectors would be 2.5-3.0 m, but due to the sand layers at this depth, it was impossible to reach this objective throughout Khorezm. The depth of the collectors is only 1-1.5 m, in deep places it is 1.75-2 m.

Table 6. Length of the collector drainage system (CDS) of the Khorezm oasis and its estimated network density. The total area taken into consideration is 455,200 hectares (source: Hydromelioration Expedition, OGME).

Year	Irrigated area, 1000‘ ha	Length of CDS (km)			Network density of CDS referring to irrigated area	Network density of CDS referring to total area
		Total	Including			
			Interfarm	Within farm		
1953	143.6	2,500.0	1,210.0	1,290.0	17.40	5.5
1961	146.3	2,610.4	1,385.0	1,225.4	17..84	5.74
1963	151.8	2,774.1	1,548.7	1,225.4	18.27	6.10
1965	151.4	3,227.2	1,889.7	1,337.6	21.32	7.09
1968	150.7	4,269.0	2,250.0	2,019.0	28.33	9.37
1970	151.9	4,571.8.	2,342.2	2,229.6	30.10	10.04
1971	157.9	4,939.4	2,454.9	2,484.5	31.28	10.85
1975	168.1	5,755.4	2,505.6	3,249.8	34.24	12.65
1980	191.8	6,569.1	3,097.2	3,471.9	34.25	14.43
1982	199.44	6,780.1	3,137.8	3,642.3	34.0	14.90
1984	217.61	7,702.1	3,329.7	4,372.4	35.39	16.93
1985	223.8	7,830.5	3,355.1	4,475.4	35.0	17.20
1986	237.4	8,645.5	3,388.2	5,257.3	36.42	19.00
1987	250.2	8,894.0	3,383.0	5,511.0	35.55	19.54
1988	256.33	9,021.6	3,372.1	4,649.5*	35.2	19.83
1989	259.17	9,139.5	3,394.3	5,745.2	35.26	20.08
1990	260.80	9,628.9	3,400.0	6,228.9	36.92	21.16

Source: Fayzullayev, 1985. *The estimated density results do not always match and should therefore in some cases be taken with caution.

Massive over-supply of precious freshwater, virtually complete lack of water-saving technologies and very rare reuse of return water mostly during water-short years, cause enormous inefficient losses of water: 60-85% of supplied water ends up in the drainage discharge.

3. GIS / RS analysis of the current state of productive and marginal irrigated lands in the Khorezm province

3.1 Degraded marginal land in the Khorezm province

The CRP Dryland Systems program targets improving the livelihoods of people in the areas, characterized by high vulnerability and low production potential, with the goal to increase productivity by 10–20 % (CGIAR Strategic Research Theme 2). Prior to define measures to increase productivity of the marginal areas, it is important to identify and map marginal land in the target research areas, provide their characteristics, which will then enable defining possibilities for intervention.

Identification and mapping of the marginal land should be done based on systems approach, which addresses not only qualitative criteria or pure management goals when considering land functions and social-economic impacts. Such an approach will enable proper assessment and management of the land resources. In general, marginal land can be characterized as being low productive and hence, providing a reduced economic return or having severe limitations for agricultural use. Such land is at risk of further degradation. Major driving factors of marginal lands include the demand of food supply and bioenergy, impacts of policies and incentives, and tradeoffs of environment,

ecological services and sustainability. The major assessment factors are physical, production and economic constraints.

Marginal irrigated lands in the Khorezm province include agricultural areas that provide limited economic return or are out of production due to deteriorated soil quality and irrigation management caused by inefficient use, affected by strong salinization, unacceptably shallow and saline groundwater, erosion, poor land and water management and other factors. In the irrigated region, the marginal lands are entire fields or small land patches at the border of cropped areas. Provided that irrigation and drainage measures are implemented, these areas could eventually be recovered and (re)used in agriculture (GKZGK 2009).

Characterization of the marginal land outline soil properties, land use and degradation, water resources, farming systems, as well as economic and institutional information also highlighting major possibilities and constraints, and impact pathways for each regional Action Site. The sections below provide information about the agricultural areas and analysis of marginal land in the Khorezm province.

3.2 Soil properties

The development of soils in Khorezm has, over the millennia, been greatly and primarily influenced by water from a meandering Amudarya River. It is therefore relevant to understand the processes responsible for the spatial distribution of the different soil types.

Central Asian oases, isolated areas of vegetation surrounded by deserts, are among the few regions in the world where irrigation resulted in the development of new anthropogenic soils overlaying the natural formations. Therefore, in particularly the upper layers of soils in the Khorezm province are relatively new formations compared to those soils that developed under natural conditions without human interference.

Irrigated agriculture in Khorezm has a long history (Tolstov 1948; Tsvetsinskaya et al. 2002). Soil evolution has been considerably faster under irrigation than in natural systems, and significant changes in soil properties can occur even within 10–100 years. Furthermore, intensive soil displacements occurred when the irrigation and drainage system was developed. Lithology, geomorphology, hydrochemistry and other local peculiarities such as the very flat terrain provide the background against which this intensive human interference has altered soil formation processes, including the mineralization of soil organic matter and microbiological activity, salt migration, illuviation and clay formation.

Features produced by water flows such as the riverbed, near-bed formations, and depressions can be distinguished and are described in detail by Felitciant (1964) and Tursunov (1981). The latter author explains that the initial relief of the Amudarya river delta in Khorezm was formed by two ancient channels, the so-called Daryalyk and Daudan. These transported large amounts of soil sediments, which were deposited and formed levees. Near-bed levees usually contain coarse-grained material, i.e. sand and silt. However, occasionally these are covered by finer grain material deposited during low-velocity floods. Areas further away from the riverbeds are characterized by layers of fine material that was deposited from suspended loads in slow-flowing waters, or even indicating areas of previously stagnant water that formed loamy and clayey soils. Also, since streams were constantly changing courses and braided the delta region, the vertical and lateral composition of the soils is very varied (Tursunov 1981).

Another factor that affected soil formation during the floodplain-alluvial periods consists in the marshy and meadow-marshy formations on flat areas between intra-bed depressions, which were covered by reeds and often flooded. The interaction of vegetation and floods formed the meadow soils, characterized by groundwater tables deeper than 3 m and a high organic matter accumulation on the surface. Elevated relief areas such as slopes and levees were also under meadow and meadow-marshy soil formation, but occasionally also transformed into solonchaks. These latter

soils have developed mainly under a cover of grass vegetation and with a shallower groundwater table varying between 0.5 and 2.0 m (Kuziev 2006).

Large near-bed levees covered by bush and grass vegetation and experiencing groundwater table depths between 1 and 2.5 m formed meadow Tugai soils which morphologically resemble the features of the soils under Tugai forests (natural floodplain forests along the Amudarya). These soils received litter inputs from the vegetation, explaining why soil organic matter contents often surpass 3%. Today's landscape in Khorezm, however, is significantly altered by human interference. Owing to the intensification of irrigated agriculture over the last 100 years or so, the areas converted into cropland have been traversed by a network of irrigation and drainage canals. Long-term, intensive irrigation formed a layer of uniform topsoil, referred to as the agro-irrigation horizon, which now covers the multi-layered alluvium deposits. Even ridged-hummocky sands, often present in the province, have been leveled and converted into farming land. A large part of the natural Khorezm landscape was transformed into cultured land.

Hydrogeology is another driver of soil formation. The initial hydrogeological conditions disfavored an intensive and widespread irrigated agriculture in Khorezm due to the flat topography, which limits lateral groundwater flow and results in shallow groundwater tables and increased soil salinity, despite the constructed collector-drainage network. The regular occurrence of high groundwater tables, then, in turn, created hydromorphic conditions favorable to formation of solonchaks. The elevated groundwater table enhances vertical water movement, and considerable amounts of water are discharged via evaporation and transpiration rather than via the drainage system, leading to soil and groundwater salinization. According to soil surveys conducted by the State Scientific Research Institute for Soil Science and Agrochemistry (SSRISSA) in 1996 (Kuziev 2006; Ibrakhimov et al. 2007), around 73% of the territory of Khorezm had groundwater tables at 1–2 m.

The area of Khorezm includes a large desert area on the right bank of the Amudarya, which is often excluded from assessments of land resources; the irrigated areas cover only 276,600 ha, the largest share of which is occupied by cropland (Table 7).

Table 7. Land resources in the Khorezm province

	Agricultural land								
	Cropland	Trees	Marginal	Pasture	Household	Forest	Garden	Other	Total
Irrigated	208.6	13.6	4.5	6.4	43.0	0.4	0.1		276.6
Total	208.6	13.6	4.5	6.4	51.0	57.5	0.1	169.9	646.4

The total irrigated area in 2009 was 1.5 times higher than that reported 30 years ago by SSRISSA (Kuziev 2006). More than 95% of the irrigated areas are meadow soils, whilst about 4% are marshy-meadow soils. Meadow soils, developed on alluvial deposits, are considered to be the most fertile land resources and have therefore been brought into cultivation. Soils developed on illuvium are considered less suitable for farming, explaining why only a fraction of these soils is currently cultivated (Kuziev 2006).

3.3 Texture and Soil Horizons

The Khorezm Soil Data Base contains 511 soil profiles and altogether 2,157 soil layers. The Soviet Union system of defining textural fractions differs from the one adopted by FAO where fewer textural fractions are defined (Stolbovoi 2000). However, according to Stolbovoi (2000), who provides a correlation between the Soviet Union and FAO soil classification systems, these differences due to this partial incongruence of the classification systems are mostly irrelevant, and the generalized textural classes can be correlated adequately for practical purposes at a global scale (Table 8).

Table 8. Correlation of particle size distribution between FAO and Soviet Union systems for soil textural classification (Stolbovoi 2000)

Name of texture fraction		Particle size (mm)	
		FAO system (1988)	Soviet Union system (1967)
Gravel, fine gravel		≥2	≥1
Sand	Coarse		–0.5
	Medium	–0.06	–0.25
	Fine		–0.05
Silt	Coarse		–0.01
	Medium	–0.002	–0.005
	Fine		–0.001
Clay		≤–0.002	≤0.001
General classes	Coarse	–0.06	0.05
	Medium	–0.002	–0.001
	Fine	≤–0.002	≤0.001

Out of all layers available in the Khorezm Soil Data Base, 1,884 had a complete set of information, allowing the conversion of soil texture classes into the FAO system (according to a formula provided in Shein 2009). Figure 25 shows the spatial distribution of the soil profiles, indicating a homogenous, representative sampling scheme. The available soil samples from the districts Shavat and Pitnyak (south-east of Khazarasp and not shown in this map) were not geo-referenced.

On average four generic soil horizons per profile are described in the database. For merely 35 soil profiles (~7%) more than 5, at maximum 7, horizons have been identified. Most soils in Khorezm are silt loams (USDA soil texture classification). Silt loam layers together with sandy loams and loams constitute almost 80% of all soil layers (Table 9). Clayey soils are hardly present in Khorezm. Heavy textured soils are frequent at deeper layers (Figure 26). Spatial distribution of the soil texture in Khorezm is shown in Figure 27.

Table 9. Frequency of soil texture classes of the irrigated areas in Khorezm (Khorezm Soil Database, Bairov, personal communication), according to USDA soil classification

Soil texture	N	%
Sand	59	3.1
Loamy sand	86	4.6
Sandy loam	229	12.2
Clay loam	25	1.3
Loam	241	12.8
Sandy clay loam	8	0.4
Silt loam	1,039	55.1
Silt	84	4.5
Silty clay loam	109	5.8
Silty clay	3	0.2
Clay	1	0.1
All	1,884	

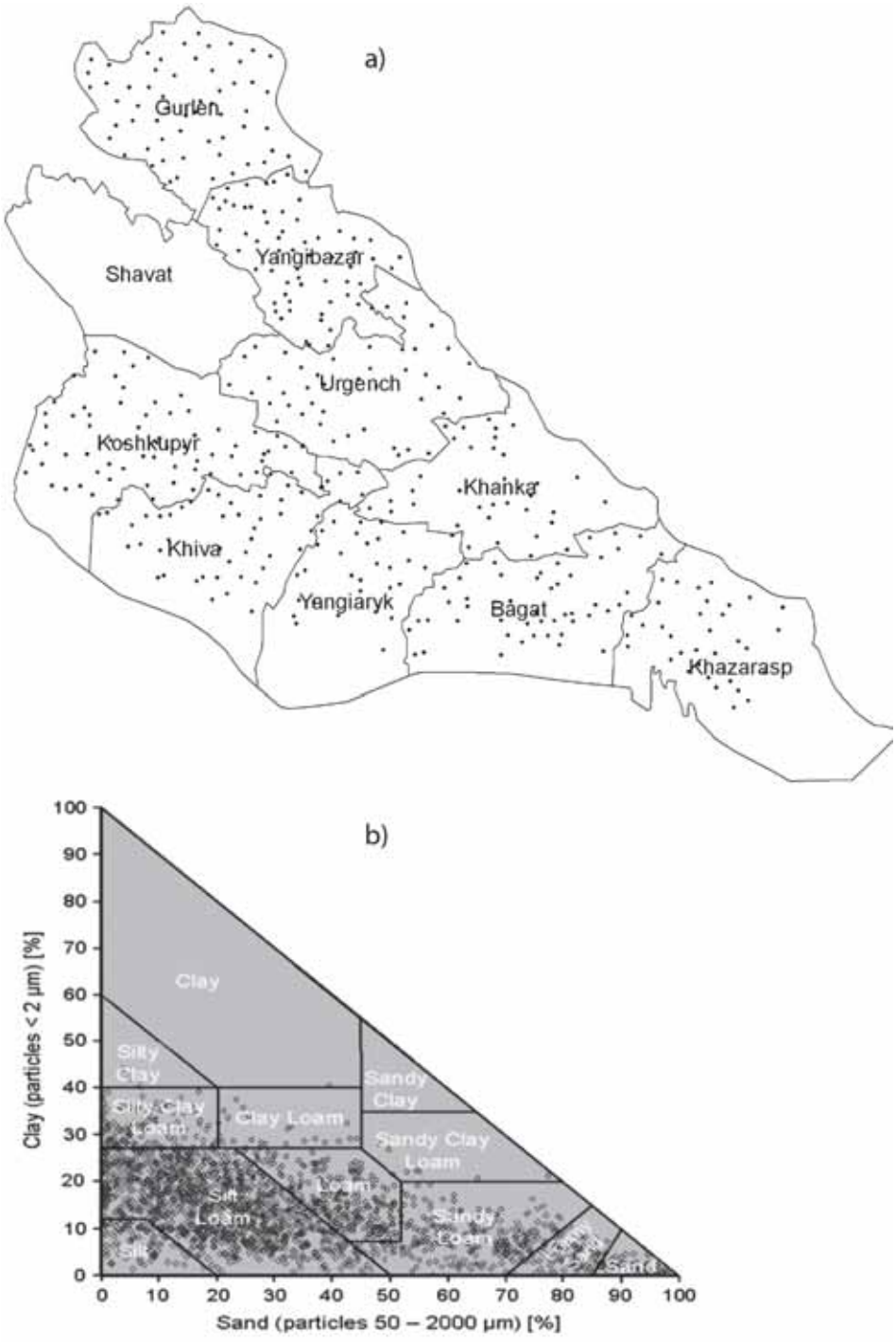


Figure 215. Approximate sampling locations of profiles (a), and USDA soil texture classification of these soil samples and respective distribution for all soil layers described in the Khorezm Soil Data Base (b, Sommer et al. 2010)

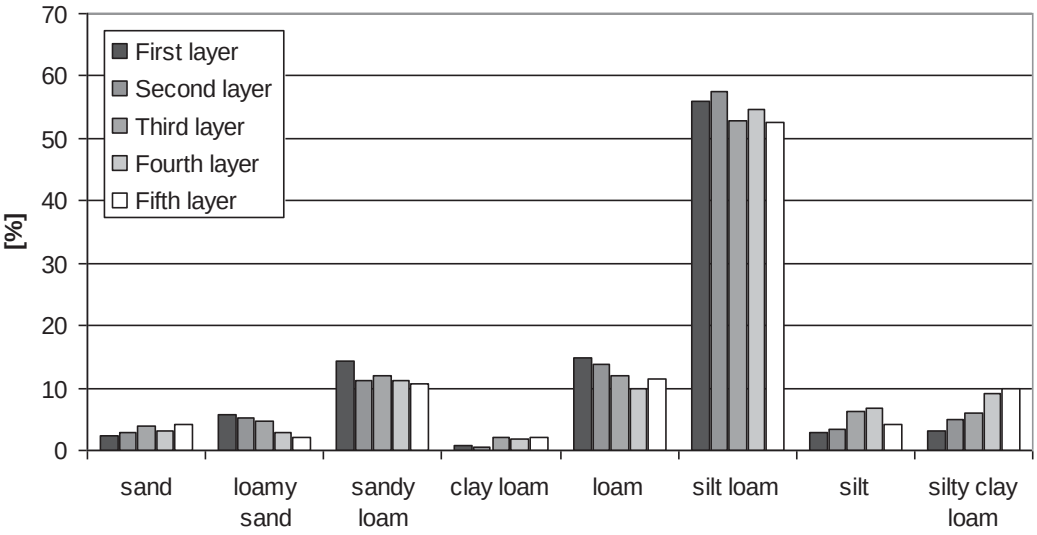


Figure 26. Frequency distribution of eight soil texture classes in the upper five soil layers in Khorezm

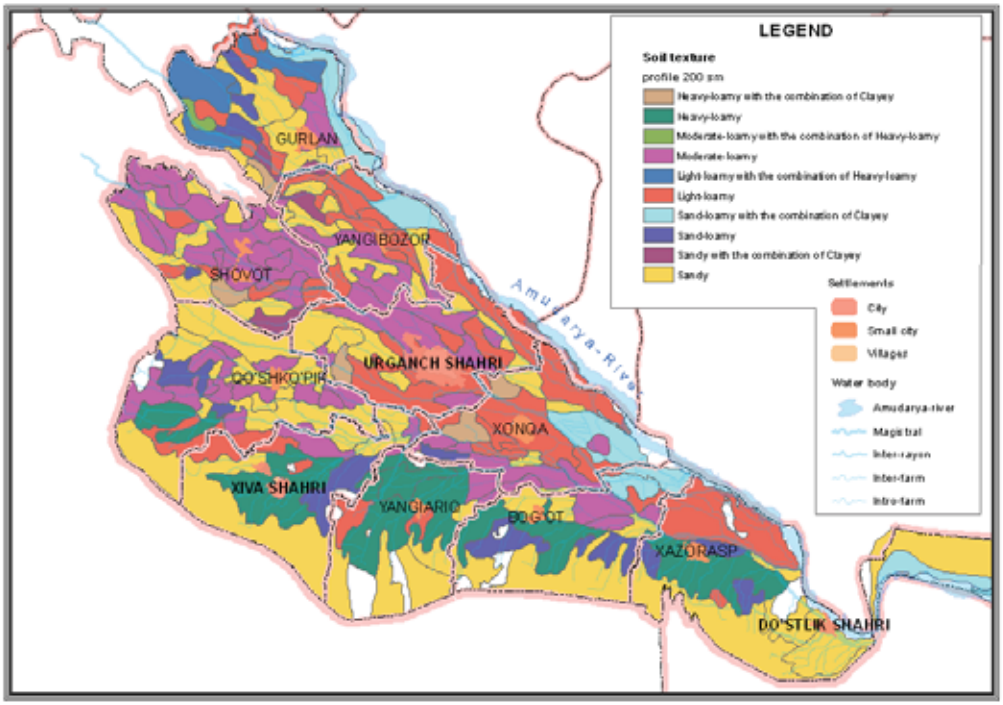


Figure 27. Soil texture to 2-m depth in the Khorezm province

This means that the impact of shallow groundwater and its salinity on crop growth and secondary soil salinization, respectively, is potentially significant, because heavier soils better support capillary rise of groundwater (Brouwer et al. 1985).

There is not much change along the soil profiles in the top 56 cm; profiles are rather homogenous. For instance, altogether 55% of the soils have identical first and second soil layer textural classes. Furthermore, another 33% of all soil profiles had closely matching first and second soil layers (i.e. neighboring soil textural classes in Figure 25). This indicates that only about 12% of all soil profiles show a rather abrupt texture change in the top 56 cm soil. Considering the first four soil layers, this percentage increases to 25%, meaning that still 75% of the soils in the Khorezm Soil Data Base

have a homogenous texture in the top ~129 cm. This is an important aspect, as it allows robust estimations of the vertical distribution of soil texture based only on topsoil data.

Soil parameters that highly correlate with clay content could be estimated with higher precision for monitoring purposes. The importance of monitoring the changes in agricultural land resources is acknowledged by the Government of Uzbekistan, which has introduced guidelines to streamline monitoring of those resources throughout the country in three stages, namely, (1) preparatory works, (2) baseline field studies, and (3) long-term observations. By 2009, the second stage, baseline studies, was completed in most of the regions in Uzbekistan (GKZGK 2009).

3.4 Soil Organic Matter

The Khorezm Soil Data Base contains 1,806 entries for soil organic matter (SOM). Soil organic carbon (SOC) in Uzbekistan is conventionally chemically determined, using a slightly modified form of the Walkley-Black wet-oxidation (potassium dichromate) method (Nelson and Sommers 1982). For the conversion, it is assumed that SOM contains 58% of SOC (Vorobyova 1998).

SOM contents turned out to be low in the soils of Khorezm (Khorezm Soil Data Base). On average, SOM is 7.5 g kg^{-1} (0.75 %) in the topsoil layers, decreasing to 3.9 g kg^{-1} at 156–210 cm depth, with considerable natural variation. The lower quartile of SOM at 0–32 cm was 5.4 g kg^{-1} and the upper quartile 9.4 g kg^{-1} (Figure 29). SOM contents of the data set (n = 148) described by Kuziev (2006) generally concur with those of the Khorezm Soil Data Base. SOM content of heavy- and medium-textured irrigated soils varied from 6–7 to 11–14.5 g kg^{-1}, gradually decreasing with depth. Light-textured soils contained 4.5–8.0 g kg^{-1} SOM, but this decreased to 0.2–0.3 g kg^{-1} at deeper depth. The overall SOM storage of the 0–50 cm layer thus amounts to 16–79 t ha^{-1}. The subsoils of irrigated meadow soils are rich(er) in SOM as compared to the subsoils under natural formations where organic litter contributes to only topsoil (Kuziev 2006). Only due to irrigation, SOM can decrease from 12–20 g kg^{-1} to 7–12 g kg^{-1} (Kuziev 2006).

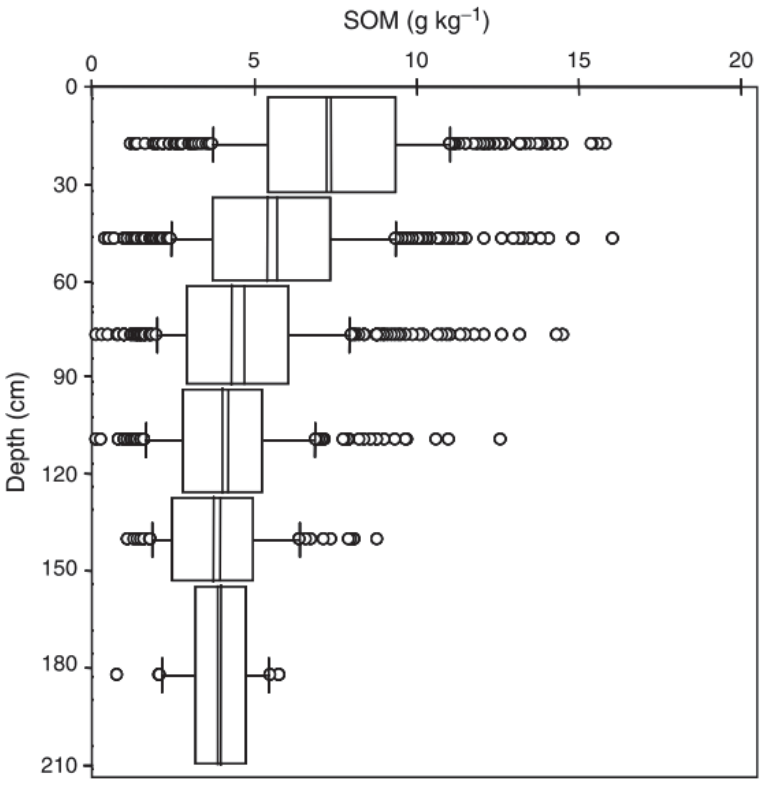


Figure 28. Soil organic matter of soils in the Khorezm soil database; box-whisker plots, bold lines within the box indicate average values

The comparison of the data from 1950 to 1959 for the 0–30 and 30–50 cm layers with those from the 1970s and 1990ies demonstrates a general trend in SOM reduction (Figure 29). Meadow oasis soils located on ancient riverbeds and near-bed deposits had the highest SOM contents, followed by irrigated meadow soils. The lowest SOM content was found on meadow soils developed on recent Amudarya deposits.

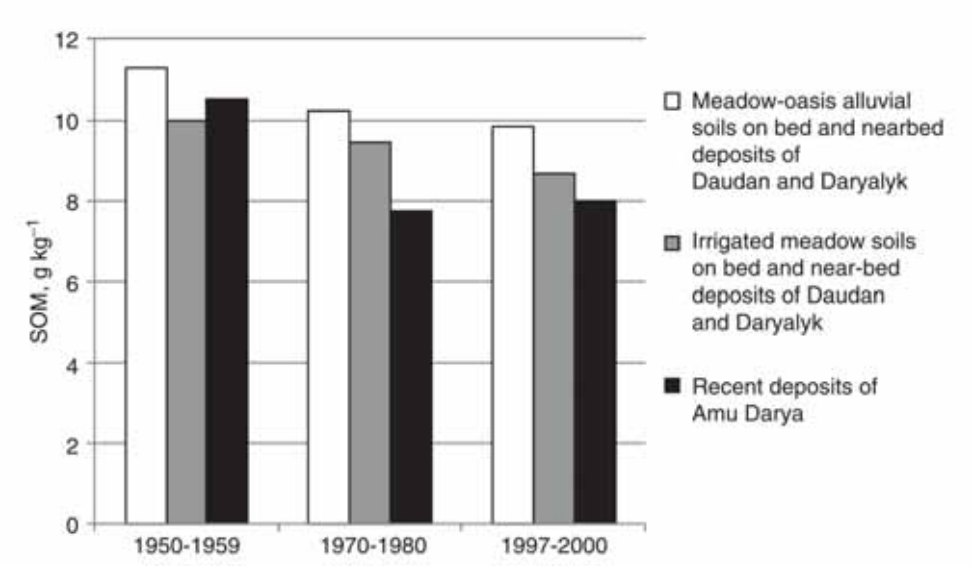


Figure 22. Comparison of soil organic matter content of irrigated topsoil 30 cm from 1950 to 2000 (Adapted from Kuziev 2006)

While irrigation water tends to wash out SOM, it is also one often neglected source of SOM (Kuziev 2006), and deposits suspended sediments rich in nitrogen, phosphorus, potassium, OM and a number of microelements. Irrigation water is a significant source of mineral replenishment of irrigated soils, particularly for automorphic soils of the desert zone, which are prone to enhanced SOM losses compared to soils with hydromorphic or semi-hydromorphic conditions. However, following the construction of the Tuyamuyun reservoir on the Amudarya, located immediately upstream of Khorezm, most suspended solids in the river water are now being retained in this reservoir (Tashkuziev 2003).

3.5 Soil NPK

Due to the low SOM content in Khorezm soils, total soil nitrogen (N) levels are also low, ranging from 0.2–0.8 g N kg^{-1} (0.02–0.08%), with storage of 1.6–4.9 t N ha^{-1} in the 0–50 cm layers. The total N in irrigated soils reaches 4–6 t ha^{-1}, out of which approximately 2 t ha^{-1} are in the topsoil.

Total phosphorus (P) ranges from 450 to 3,000 mg P kg^{-1}. Marshy-meadow soils have usually high (1,000–3,000 mg P kg^{-1}) total P contents, which convert into storage amounts of 8.7–15.2 t P ha^{-1} in 0–50 cm layer. Yet, only 10–20% of the stored amount is available to plants, 50–60% is less available and 20–40% is practically not available to plants (Kuziev 2006).

The soils in the arid region of Khorezm are naturally rich in potassium (K). The total potassium content in the upper horizons ranges from 3,000–31,000 mg K kg^{-1}, however, only 10% of the soils have a total K of over 2,000 mg kg^{-1}. Storage in 0–50 cm layer varies from 71 to 160 t K ha^{-1}.The Khorezm Soil Data Base contains 1,869 entries for soil nitrate. The Soviet Union method to determine soil mineral N (NO_3 and NH_4), is for various reasons (e.g. air-dry soil samples, different chemical analysis) not 1:1 comparable with standard mineral N determinations in other countries. Therefore, also the classification of NO3 contents with regard to optimal crop growth deviates from European norms (Table 10). It appears that the Soviet Union method of chemical analysis of

mineral N gives consistently considerably higher concentrations of NO3 and NH4 than standard "Western" analysis. Hence the following classification was adjusted accordingly.

Table 10. Classification of soil mineral N content with regard to optimal plant growth (WARMAP and EC-IFAS 1998) and its equivalent amounts considering exemplarily 0–30 cm soil depth (Soil bulk density assumed to equal as 1.5 g cm^{-3})

Mineral N content, mg kg^{-1}	Classification	Mass equivalent, kg N ha^{-1} 30 cm^{-1}
<20	Very low	<90
20–30	Low	90–135
30–50	Medium	135–225
50–60	High	225–270
>60	Very high	>270

The NO_3 contents in the Khorezm topsoil alone, with on average 34.5 mg kg^{-1} (median: 19.6), would classify the soil to be medium-rich in mineral N (Figure 31). The heterogeneity of NO_3 contents in 0–30 cm depth was, however, high as evidenced by the range from a lower quartile of 8.5 mg kg^{-1} to an upper quartile of 53.7 mg kg^{-1}. Median NO_3 content decreases from 12.0 mg kg^{-1} in 30–56 cm depth to 6.3 mg kg^{-1} below 156 cm. Interestingly, NO_3 contents below 156 cm vary more than in the three layers above. This may be an additional indication of topsoil nitrate leaching and accumulation in this sub-layer, at least in some soils.

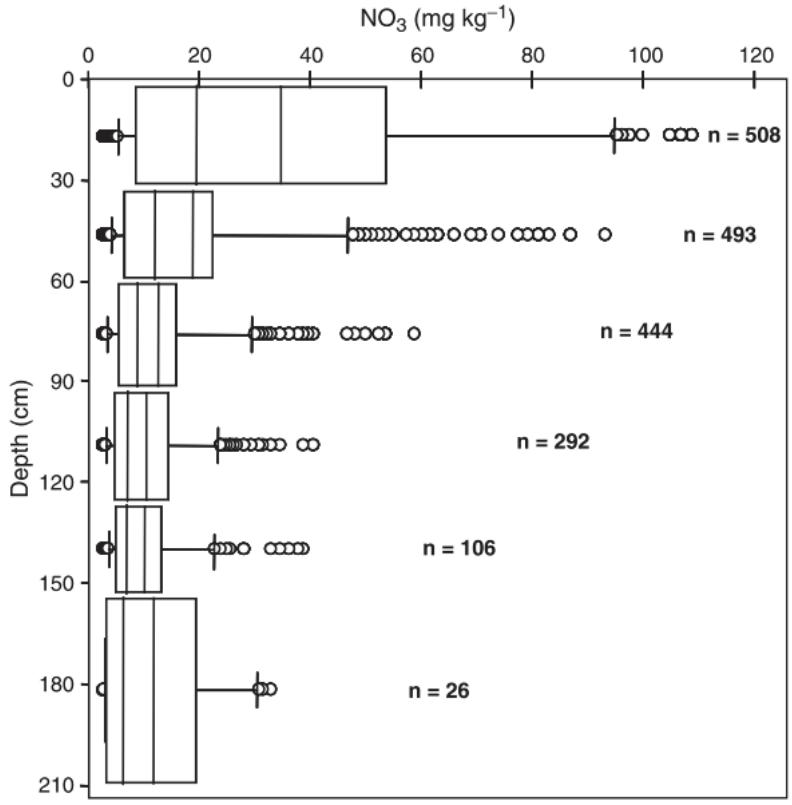


Figure 23. NO_3 contents of soils in the Khorezm soil database; box-whisker plots, bold lines indicate average values

3.6 Soil Microbiological Activity

Soil microbiological activity (Forkutsa 2006) has a key role in the ecological function of soil (decomposition of organic residues, essential soil nutrients for plants, soil quality) and maintenance of soil fertility. Soil micro-organismic activity depends on the presence of moisture, nutrients and organic matter. Soil respiration is known as a biological indicator for microbial decomposition of

organic matter in the soil. Mechanical disturbance causes excessive aeration of soil, while intensity and frequency of disturbance results in a differential distribution and loss of organic matter (Gajri et al. 2002).

The effect of farming practices on soil quality was evaluated at three agricultural sites, which differed in soil management techniques (conventional tillage and zero tillage; with and without mulch), soil texture (loam and sand), and Tugai forest. The carbon dioxide output is consistent with the overall metabolic activity of the soil microflora. Although no pronounced difference between the sites and treatments was found, the respiration rates among the sites decreased in the order: Amir Temur Farm (Loamy) > Khiva Farm Loamy > Tugai forest > Khiva Farm Sandy; i.e. the agriculturally managed loamy soils have a higher microbial activity than the natural Tugai forests and the sandy soils.

Sandy textured soils (Khiva Sandy site) with poor SOC contents (1.7–2.8 g kg^{-1}) had a low range of respiration rates (75.0–390.8 mg CO_2 m^{-2} h^{-1}). In contrast, loamy soils with higher SOC (3.8–6.2 g kg^{-1}) showed respiration ranges from 130.83–949.2 mg CO_2 m^{-2} h^{-1}. Spatial differences across the sites were mostly explained by C % and soil moisture.

Soil microbial biomass-C (Cmic) resulted in similar patterns among all sites. The lowest Cmic was found at the Khiva Sandy site, in the range of 77.9–312.8 mg C g^{-1} dm, and the highest range at the Khiva Loamy site with 765.5–1,430.5 mg C g^{-1} dm. Yet, in spite of the similar soil texture in both Khiva Loamy and Amir Temur sites, the higher Cmic values (765.49 mg C g^{-1} dm or higher) in the Khiva Loamy site, where soil conservation techniques were applied (cf. Pulatov et al. 2011), indicate a better soil quality than in Amir Temur where only 654.17 mg C g^{-1} dm were measured.

Table 11. Soil microbial biomass-C (Cmic), soil organic matter (SOM), microbial quotient and metabolic quotient on four sites in different districts of Khorezm (values followed by the same letter are not significantly different; Tukey test, HSD, P<0.05).

Site	Treatment	C_{mic}, µg C_{mic} g^{-1} dm	SOM, %	Microbial Quotient, C_{mic}/C_{org}, %	Metabolic Quotient, mg CO_2-C g^{-1} C_{mic} h^{-1}
Khiva Loamy	C	970.79 b	0.87 bc	13.8	1.9
	C+	765.49 a	0.69 bc	8.7	4
	Z	1430.48 c	0.79 bc	18.2	2.4
	Z+	837.39 ab	0.79 bc	10.6	3.1
Khiva Sandy	C	195.56 ab	0.37 a	5.3	3.9
	C+	77.92 a	0.35 a	2.2	7.3
	Z	312.82 b	0.33 a	9.4	3.9
	Z+	281.49 b	0.43 a	6.6	1.6
Amir Temur	C	654.17 b	0.99 c	6.6	8.1
Tugai forest	N	549.64 b	0.68 b	2.3	2.5

*C = conventional; Z = zero tillage; N = natural ecosystem; + = with a mulch of plant residues

In this study, the microbial quotient (Cmic/Corg) varied in the range of 2.2–18.2% (Table 11). Often, this value lies in the range of 1–5% (Sparling 1997), however some studies conducted in similar environmental conditions on wheat crop fields have shown a similar wide range of soil microbial ratio values (6.2–2.6%; Insam 1990; Uçkan and Okur 1998). Higher values can be interpreted as a carbon accumulation, whilst lower ones stand for carbon loss. Yet, Insam and

Öhlinger (1996) stated that the soil microbial quotient is highly influenced by climate and thus, arid areas produce higher values than humid (and less hot) environments. Therefore, the microbial quotients in this study indicate that significant carbon accumulation had occurred on sites under zero-tillage treatment. The metabolic quotient (qCO_2) (Table 11) is the rate of soil respiration in terms of the microbial biomass and indicates the qualitative influence on microbial biomass. Lower qCO_2 ratio values stand for more efficient microbial turnover. Based on microbial and metabolic quotients, our study shows a slight positive effect of zero tillage on soil quality.

Results of site comparisons of the mean difference in soil respiration and SOM were in consistency with studies of Conant et al. (2000) and Huxman et al. (2004), who suggest that soil respiration in semiarid ecosystems is mainly controlled by soil C content and moisture, which should also apply for arid regions as Khorezm. In the microbiological analysis, similar to the field measurements, the mulching contribution was not captured; possibly due to the short period of residue management in this field prior to the data collection, and also due to the chosen sampling depth (0–20 cm). However, the average values of soil microbial biomass carbon for conventional fields were lower than those for zero-tillage fields, which indicate that an initial, favourable SOM accumulation takes places under zero-tillage practice.

3.7 Soil Fauna Density and Diversity

For the screening of the soil fauna, Massucati (2006) collected macro- and mesofauna using soil cores of 20 cm diameter and 20 cm depth. Additionally, litter samples were collected from 80 cm diameter areas on the forest floor. The soil macro-invertebrates were then extracted in a heat-moisture gradient in a Berlese apparatus.

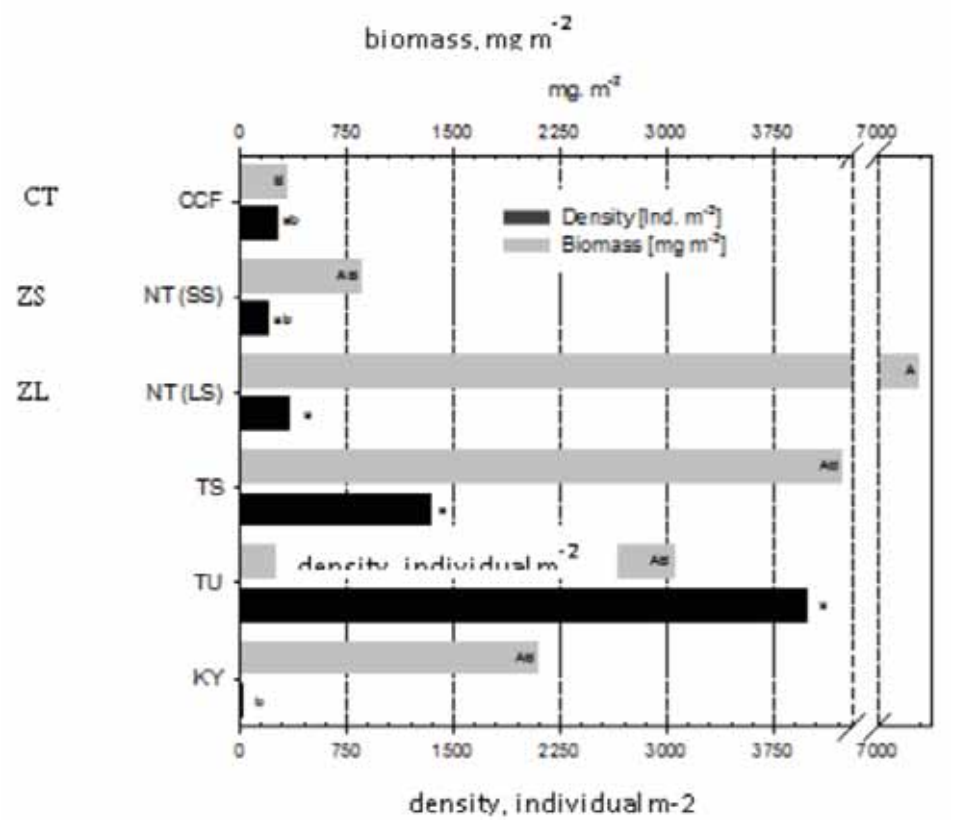


Figure 241. Mean density (individual m^{-2}) and biomass (fresh weight; mg m^{-2}) of the soil fauna at different study sites in Khorezm (CT conventional tillage, ZS zero-tillage (sandy soil), ZL zero- tillage (loamy soil), TS tree strips, TU Tugai forest, KY Kyzylkum desert). Sample sites followed by the same letter are not significantly different (ANOVA, Scheffé, .a = 0.05)

The density of the soil fauna (macro- and mesofauna) in Khorezm ranged between 29 individuals m^{-2} in the desert Kyzylkum and 3,994 individuals m^{-2} in the Tugai forest (Figure 31). The upper level fauna density value in the Tugai forest was caused mainly by the extreme abundance of ants (Hymnoptera: Formicidae), which made up 93% of the total individuals at this site. The abundance of this taxon is high in arid habitats, where soil fauna assemblages are mostly characterized by xerothermal species (Veile 1992). The soil from the Tugai forest served also as habitat for many larvae of flies (Diptera: Asilidae, Sarcophagidae) and beetles (Coleoptera: Chrysomelidae, Cryptophagidae), and a variety of spiders (Arachnida: Gnaphosidae, Lycosidae, Pseudoscorpionida). In tree strips[3] around a cotton field the density was 1,344 individuals m^{-2}, mainly characterized by Formicidae. Both tree strips and forest offer better habitats for social insects such as fire ants (Myrmicinae; Solenopsis sp), to build epigeic nests, since these areas are not used for agriculture. Termites are often found in the desert zones (Abdullaev et al. 2002) but they also affect buildings, often historical ones, e.g. in the ancient city of Khiva, an UNESCO heritage site.

The soil fauna density under conventional tillage was 267 individuals m^{-2}, showing no significant difference from the density in the Tugai forest, tree strips and in zero tillage fields. Analogous to the forest site and tree strips, ants were also the most important component of the soil fauna assemblage at this study site. This may primarily be explained by the favorable environmental conditions of adjacent tree strips, where social insects find refuge to build long-lasting nests. Secondly, ants have a wide diet spectrum (Martius et al. 2001), enabling them to colonize many different systems.

Under zero-tillage in the ZS and ZL sites (zero-tillage on sandy and loamy soil, respectively, Figure 31) isopods (woodlice; Isopoda: Oniscidea) were the most dominant taxon, accounting for 41% of the total soil fauna. Isopods (and myriapods) belong to a suitable indicator group for soil disturbance, since they are sensitive to soil tillage, and as a consequence are rare in cultivated soils (Paoletti 1999; Holland 2004). This group, which was observed across the tree strips too, enhances nutrient cycling by decomposing organic detritus and transporting it to moister microsites in the soil. Other two important taxa for soil structure and formation were observed under zero-tillage, earthworms (Oligochaeta; Lumbricidae) and myriapods (Diplopoda; millipedes). Earthworm and myriapod assemblages can positively be affected by conservation agriculture as observed in previous studies (e.g. Chan 2001; Holland 2004). For isopods and myriapods in particular, the retention of surface mulch modifies the physical soil properties (e.g. prevention of water evaporation), increasing the architectural complexity of the soil surface environment, and as consequence facilitating their movements (Holland 2004). However, the residues left on the soil surface did not affect the population of generalist predators, such as ground beetles and spiders, as previously concluded (e.g. Szendrei and Weber 2009). Thus, both conservation agriculture and tree strips may improve the environ-mental sustainability of irrigated arable lands in Khorezm, by offering refuge, shelter over the irrigation and cultivation season, overwintering grounds, and food reservoirs, especially in springtime, for many soil taxa.

Biodiversity, calculated by the Shannon-Wiener-Index, was the highest (1.3) under conventional tillage (CT), although it was not significantly different from Tugai and zero-tillage fields. The high diversity of invertebrates seems to be linked to the very specific soil fauna community under cultivated soils.

3.8 Soil quality assessment (Bonitet)

Soil fertility is estimated using a Soviet system of soil quality appraisal, so-called soil bonitet. Bonitet is the comparative evaluation of the soil quality (natural and gained) at an average level of farm equipment and machineries and farming intensity, defined via a 100-point (soil of 100 points has the best possible quality) scale applied to cotton (GKZGK 2009). Bonitet is an aggregate of several parameters ranging from field characteristics (morphology, etc.) to results of laboratory

analyses for various soil properties (fertility, chemistry, etc.). Since cotton is the major crop in irrigated agriculture of Uzbekistan, it is used as the reference crop in soil bonitet assessments. When assessing the soil bonitet, preference is given to the criteria, which are more conservative, but at the same time more closely correlated with crops, like soil texture and groundwater levels. Correction coefficients of quality influencing factors such as salinity, humus contents, groundwater levels, etc are applied during an evaluation of the soil quality at the fields and farms.

Table 12 presents data on estimates of soil bonitet scores for the agri-cultural land resources of about 233,000 ha in Khorezm, which includes cropland, trees, marginal land, and pasture. The average soil bonitet of these land resources is 53.

Table 12. Soil bonitet and area size (ha) according to land cadastre groups and soil classes of the agricultural land resources in Khorezm based on an assessment in 2005 (GKZGK 2009).

Land cadastre group	Bad		Below average		Average		Good		Very good	
Soil class	I	II	III	IV	V	VI	VII	VIII	IX	X
Bonitet	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100
Hectares	n.a.	625	8 839	46 296	34 932	82 052	49 291	11 848	102	n.a.

n.a. = not available

The final qualification of the soil fertility is estimated by multiplying the original value (see the basic scale in Table 13), with the decreasing coefficients such as for example of humus content (Table 13, a) and salinity (Table 13, b) using the following formula:

$$Bonitet\ value = original\ value * K1 * K2 * \ldots * Kn$$

Table 13. Soil fertility assessment coefficients based on humus contents and soil salinity

a) humus content

Humus content T ha^{-1}	%	Decreasing coefficient K_1
<30	0.46	0.5
30-45	0.46-0.65	0.55
46-65	0.66-0.9	0.65
66-85	0.91-1.25	0.75
86-105	1.26-1.5	0.85
106-125	1.51-1.8	0.95
>125	>1.8	1.00

b) soil salinity

Salinity degree	Decreasing coefficient K_2
Non-saline	1.0
Slightly saline	0.85
Moderately saline	0.60
Strongly saline	0.3
Very strongly saline	0.2

**) salinity contents within 0-50 cm soil profile*

Nine soil fertility groups, from extremely low to very high, can be determined for Khorezm (Table 14). The map and classification of the soil bonitet over the land use types in the Khorezm province are provided in the Figure 32 and Table 15.

Table 14. Soil fertility groups for the Khorezm province

Group	Points	Fertility characteristics
1	0-20	Extremely low
2	21-30	Very low
3	31-40	Low
4	41-50	Reduced
5	51-60	Average
6	61-70	Good
7	71-80	Increased
8	81-90	High
9	91-100	Very high

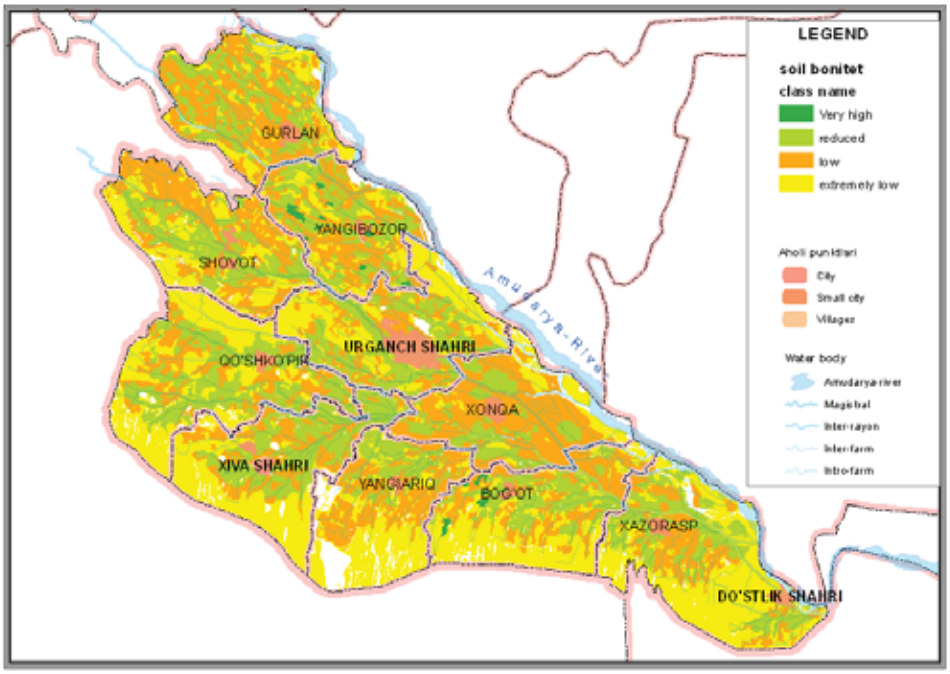


Figure 252. Map of the soil bonitet classification of the Khorezm province.

Table 15. Classification of the soil bonitet over the land use types in the Khorezm province.

Agriultural land

Name	Extremely low				Low		Reduced		Very high		Sum
Bonitet for group	<40				41-60		61-80		81-100		
Bonitet	0-10	11-20	21-30	31-40	41-50	51-60	61-70	71-80	81-90	91-100	
Area [ha]	**0**	**0**	**23791**	**63100**	**68669**	**75016**	**100356**	**30510**	**2089**	**0**	
Area for group [ha]	86891				143685		130866		2089		363531

Non agricultural land

Name	non evaluated	nonused	urban areas	flood plane	sand	nonsuitable land	water	Sum
Class	100	101	102	103	104	105	106	
Area [ha]	**11558**	**4513**	**2189**	**6785**	**51452**	**2304**	**17126**	95927

Sum of all areas

Name	Agriultural land	Non agricultural land	Sum
Area [ha]	**363531**	**95927**	459458

3.9 Soil Salinity and C Stock

Soil salinization is one of the critical indicators of the land degradation in Khorezm. Salinization reduces crop yields and threatens environmental sustainability of the arable land. The Khorezm Soil Data Base contains 2,053 entries for soil salinity expressed in percentages of total dissolved solids (% TDS). These values were converted into electrical conductivity, ECe, using the relationship suggested by Abrol et al. (1988): ECe (dS m^{-1}) = %TDS / 0.064. Using this conversion, the findings showed that the median ECe decreases from 10.1 dS m^{-1} in 0–32 cm to roughly half of this value (4.7 dS m^{-1}) in 32–60 cm depth. Below 60 cm depth, the median soil salinity is basically constant at around 3.8 dS m^{-1}. As with NO_3, heterogeneity of salinity is high in the topsoil, where ECe ranged from a lower quartile of 3.3 dS m^{-1} to an upper quartile of 25.8 dS m^{-1} (Figure 33).

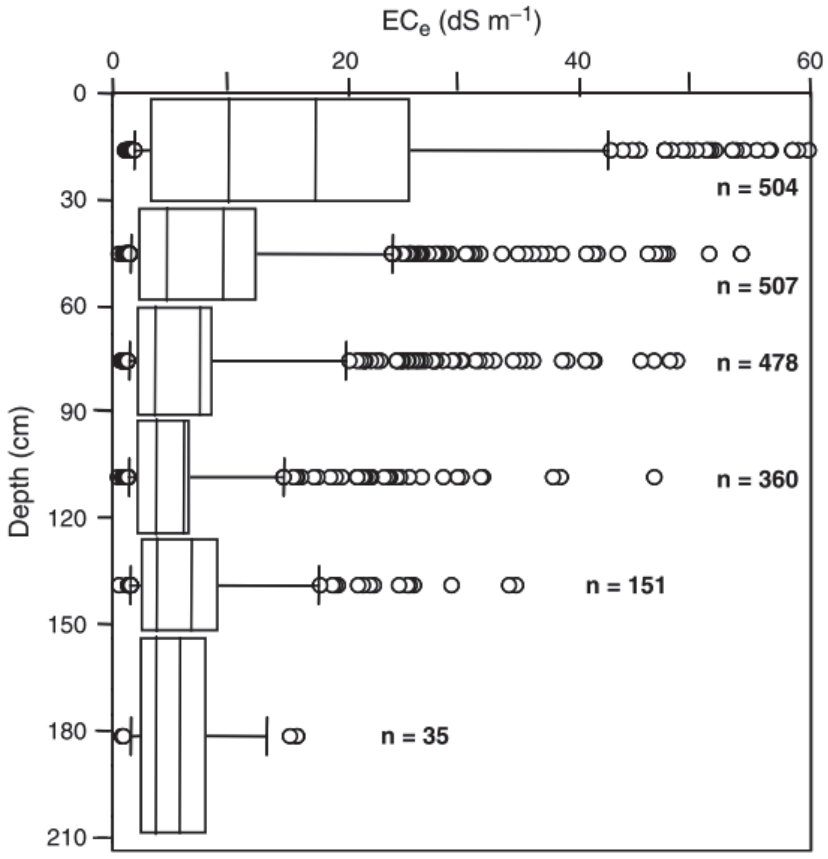


Figure 263. Salinity of soils in the Khorezm soil database; box-whisker plots, bold lines indicate average values

The snapshot survey of soil salinity conducted by Hbirkou et al. (2011) suggests that the ECe increased in the order Tugai forest < desert site < long-term afforestation sites < fallow land (Table 16). However, their data also shows that carbon stocks (total carbon Ct and SOC) were highest on long-term (80 years) afforestation sites, and lowest in the desert ecosystem, suggesting that long-term afforestation had led to an increase of the SOC stock in the topsoil (0–20 cm) to levels even above those in the native Tugai forest.

Table 16. Selected soil ecology parameters of different land use systems in the Khorezm region.

	[a]C_{tot}, t ha^{-1}	[a]SOC, t ha^{-1}	[a]EC_e, dS m^{-1}	[b]Soil fauna biodiversity (Hs')	[b]Soil fauna biodiversity (Hs'Max)	[c]Respiration, mg CO_2 m^{-2} h^{-1}	[c]Microbial biomass, µg C_{mic} g^{-1} dm
Tugai	72.5	21.4	9.4	0.97	1.34	257.5	549.64
Desert	42.7	6.6	10.4	0.14	0.14	N/A	N/A
Tree strip	92.6	29.9	13.8	0.52	0.88	N/A	N/A
Conventional fields	77.8	21.5	17.1	1.12	1.25	419.2	654.17
NT loam				0.93	1.17	376.0	1001.04
NT sandy				0.72	0.78	241.0	216.95

Source: a = Hbirkou et al. (2011); b = Massucati (2006); c = Forkutsa (2006)

According to the classification of soil salinity by Abrol et al. (1988), most subsoils in Khorezm are slightly- to moderately-saline , whereas the majority of topsoils above 60 cm are strongly saline (Figures 33 and 34). Non-saline areas constitute 29.5 thousand ha (11.1%), slightly saline 19.9 thousand ha (7.1%), moderately saline 157.2 thousand ha (59.1%) and highly and very saline areas 60.3 thousand ha (22.7 %, Figure 35).

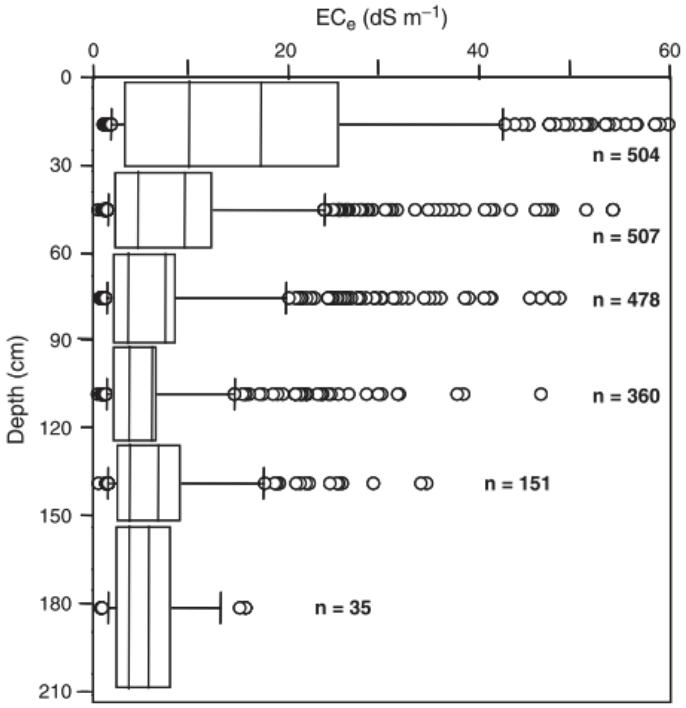


Figure 27. Soil salinity in the Khorezm soil database; box-whisker plots, bold lines indicate average values

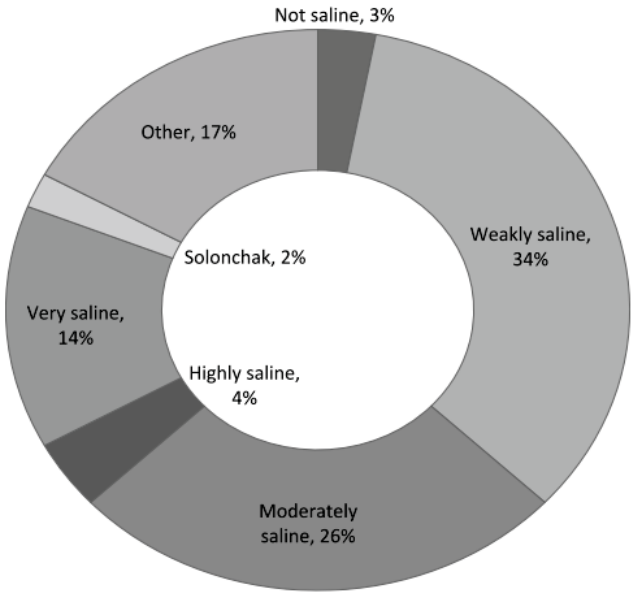


Figure 28. Share of soil salinity classes in the Khorezm region according to the classification by Abrol et al. (1988)

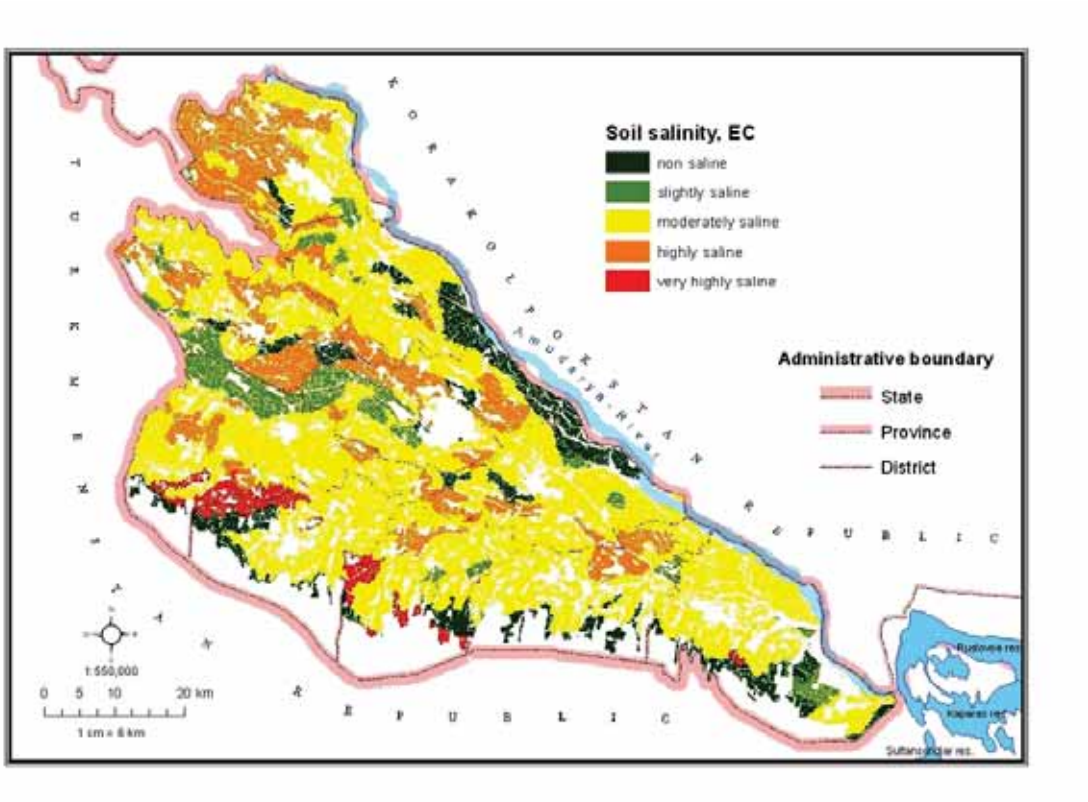


Figure 29. Soil salinization map (EC, dS m-1) in the Khorezm province

According to Kuziev (2006), the area of solonchaks had decreased from 10.8% to 1.6% between the 1960s and 1990s, due to ameliorative measures and after having been used for farming. Non- and slightly saline areas have decreased from 74% in 1960 to 48% 1990. In the same period,

moderately saline soils have increased from 21% to 31%, and highly saline soils, from 6% to 21%.

Input of salts into the root zone is mainly caused by irrigation water and capillary rise from shallow groundwater. The salt content of the irrigation water drawn from the Amudarya River is in the range of 0.8^{-1} g l^{-1} (Ikramov 2004), whereas that of the groundwater averages 1.75 g l^{-1} (Ibrakhimov et al. 2007). According to the FAO classification (Ayers,Westcot 1985), under such salinity levels a slight to moderate restriction on groundwater use should be exerted. Analyses from various locations showed that salt input from shallow groundwater with a salinity of 2.5 to 3.5 gl^{-1} was 40% higher than that from irrigation water (Ibrakhimov et al. 2007).

3.10 Strategies of salinity management

Current soil salinity management strategies by farmers mainly include pre-season leaching, which is typically conducted in late February – March. Depending on the coarse assessment of the soil salinity, which is classified as "low", "medium" or "high", the freshwater application from 3,000 till 7,500 m^3 ha^{-1} by 2–3 leaching events is recommended (Zaidelman 2003; SIC–ICWC 2004). On the regional scale, riverwater supply according to these static leaching norms accounts for around 25% of the total annual water input of 4.5 km^3 in Khorezm (Tischbein et al. 2012). Considering such a large share of the leaching demand in the regional water consumption, the options for increasing water use efficiency need to include improved leaching practices that can be implemented by land managers and lead to water savings.

3.10.1 Efficiency of current soil salinity management strategies

The high water input for pre-season leaching does not successfully deliver the desired desalination effects given the limited decrease in soil salinity evident in a comparison of the soil salinity before and after leaching events. For this comparison, two approaches were used: (a) high spatial resolution monitoring with the electromagnetic induction meter EM38 (Geonics Limited, Canada) on a 30-ha land area divided into four fields (Figure 37), and (b) analysis of soil profiles.

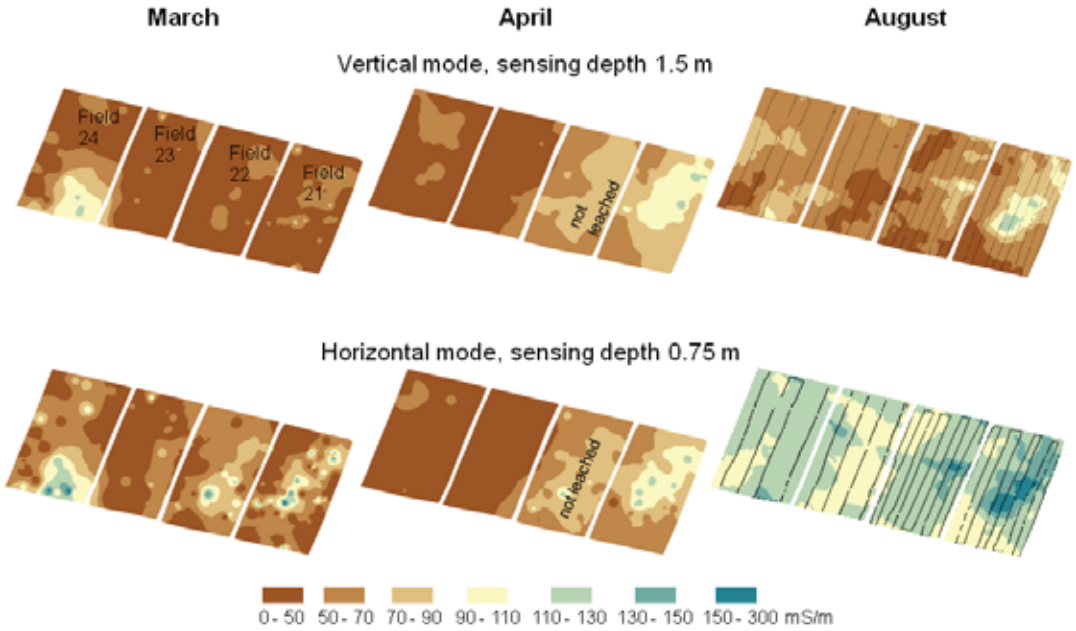


Figure 30. Soil salinity before (March) and after leaching (April), and towards the end of the cotton vegetation period on four selected fields (numbered 21, 22, 23, 24)

(a) Monitoring the spatial distribution of soil salinity (represented as apparent electric conductivity ECa) before and after leaching events was performed at the selected fields (numbered 21, 22, 23, 24) before and after leaching, and towards the end of the cotton vegetation period in 2008. The sensing depth of the EM in the vertical and horizontal mode allows monitoring salinity changes at 1.5 and 0.75 m soil depths. The ECa measured by the EM is represented in mSm^{-1}. For loamy soils, values below 70 mSm^{-1} indicate non-saline soils, slightly saline soils range from 70-110 mSm^{-1}, and with values above 110 mSm^{-1} soils can be considered as moderately saline. Readings above 150 mSm^{-1} indicate highly saline soils.

The monitoring results show that leaching events mainly diluted the salts in the 0.75 m soil layer. Moreover, under the present practices applied by land managers, soil salinity increased towards the end of the cotton vegetation period (August), indicating the movement of salts back to the upper layer. Field 22 was not leached, and showed an increased average soil salinity level in the 1.5 m layer after the leaching events on the neighbouring fields. This could be attributed to a migration of dissolved salts from these fields and to the rise of the groundwater table.

(b) The impact of leaching on the vertical distribution of soil salinity was analyzed by examining soil profiles in a farmer-managed field (ca. 7 ha). This field (No. 21; Figure 37) was selected because of its representativeness regarding size, soil, irrigation and drainage infrastructure. Soil salinity, expressed by the electrical conductivity of the saturation extract (ECe), was monitored before and after leaching. A lowering of the ECe (and thus of soil salinity) was observed in the upper soil layer (0-45 cm) only, whereas the ECe did not change in the 45-75 cm layer, and even increased in the deeper soil layers (Figure 38).

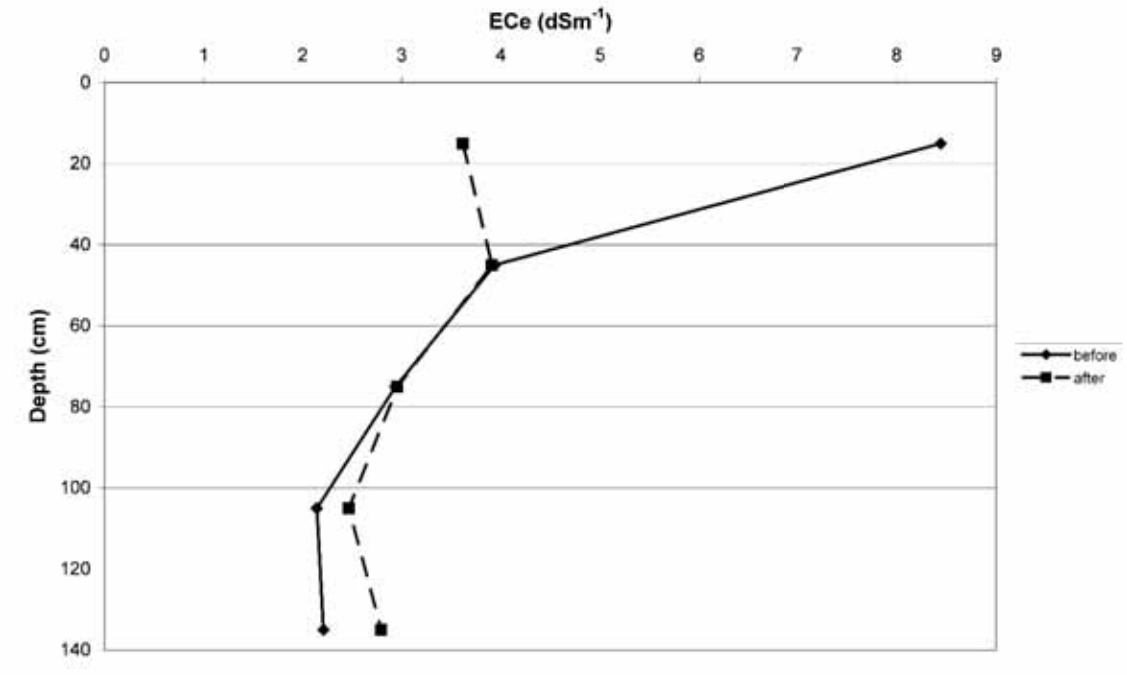


Figure 38. Vertical profile of soil salinity (expressed by ECe) before and after pre-season leaching on a farmer-managed field

Although a total of 510 mm of leaching water had been applied during two events by the farmer, leaching did not affect soil salt content in the entire crop root zone. This observation is in line with

previous model simulations (Forkutsa et al. 2009), suggesting rather a relocation of salts from upper to lower layers than their removal from the profile. Furthermore, the observed shifting of salts within the soil profile supports the results of the EM monitoring, which also showed only a small change in soil salinity at a 1.5 m depth.

The low effectiveness of the current leaching practices also becomes obvious when using the FAO concept of leaching fractions (Ayers and Westcot 1985). Considering, for instance, 400 mm of leaching water and assuming that 100 mm of this water is required to raise the actual soil moisture to field capacity before the percolation can be initiated for leaching, and taking into account the seasonal evapotranspiration of 800 mm (Conrad et al. 2007), the actual leaching fraction would be in the range of 35-40%. This is far above the fraction of 7% that is needed to avoid salt accumulation at levels exceeding the salt tolerance of cotton according to the FAO approach parameterized for the conditions in Khorezm (Awan et al. 2011).

3.10.2 Groundwater levels and salinity

Since the breakdown of the Soviet Union, the investments into the irrigation and drainage infrastructure decreased sharply. The tertiary irrigation canals and drainage ditches, maintained by farmers/Water Consumers' Associations received considerably little attention due to weak financial capacities of the farmers (Rudenko and Lamers 2006). As a result, the groundwater tables are persistently shallow beyond acceptable levels virtually in the entire province (Ibrakhimov 2007).

The average groundwater tables in the province are shallow all the year round with a long-term annual average of 1.75 ± 0.46 m (Ibrakhimov et al. 2007) below land surface during growing seasons both spatially and temporally (Figures 39 and 40). The levels fluctuate between about 2.3 m below the ground at the end of the irrigation-free period in January, about 1.4 m after the pre-seasonal leaching in April, and about 1.2 m during the irrigation season in August. Of the total area, in ca. 340.5 thousand ha (74.6%) the groundwater levels are critically shallow beyond 1.5 m during growing seasons, causing waterlogging and salinization. The groundwater levels are at the favorable depths only in 14.8 thousand ha (3.2%). As a consequence, capillary rise from the shallow groundwater is a major driver of secondary soil salinization.

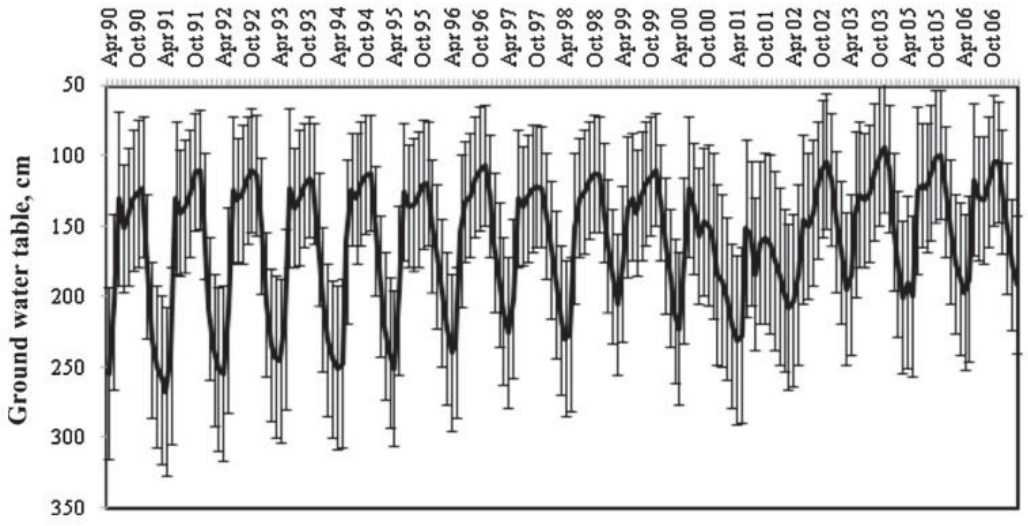


Figure 3931. Dynamics of monthly-average groundwater levels (m) in the Khorezm province in 1990-2006

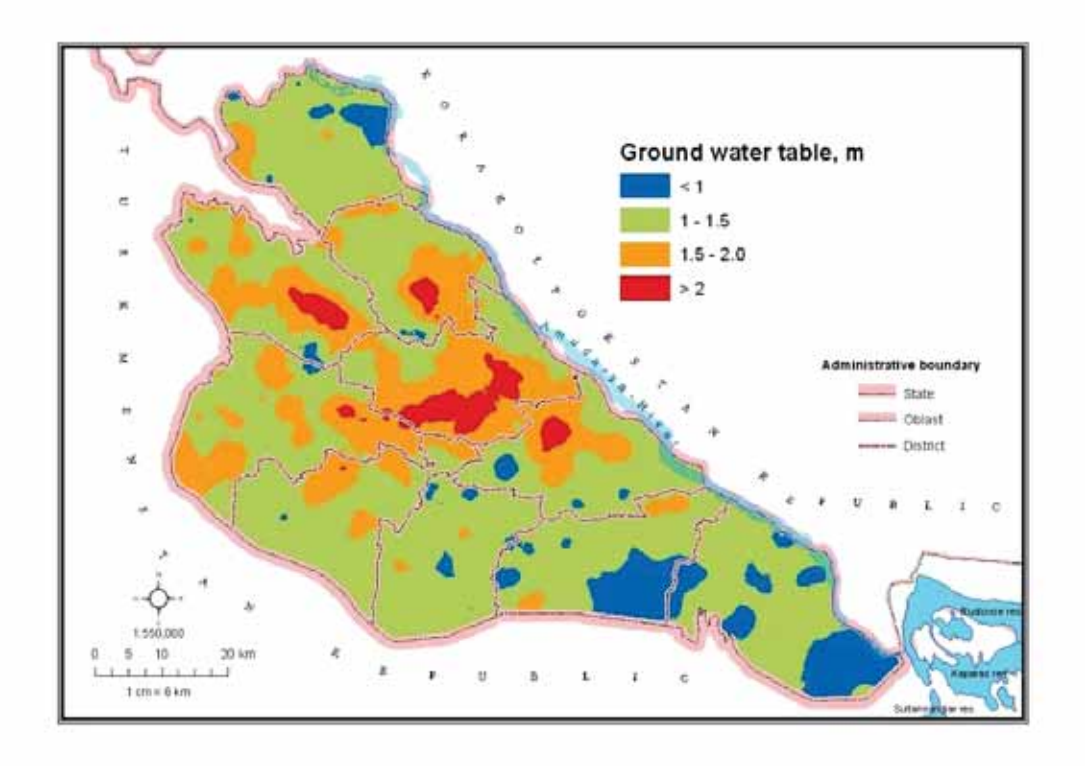


Figure 320. Typical distribution of the spatial groundwater levels (m) below land surface in the Khorezm province

Shallow groundwater contributes to the growth and development of plants by increasing soil moisture in the root zone through capillary rise (Hillel 2000). However, salts contained in groundwater and lifted into the root zone remain there while pure water evaporates. Groundwater in Khorezm is slightly-saline in 29.2 ha (6%) only. It is largely moderately and highly saline with the areal coverage of 234.8 ha (52%) and 188.1 ha (42%), respectively.

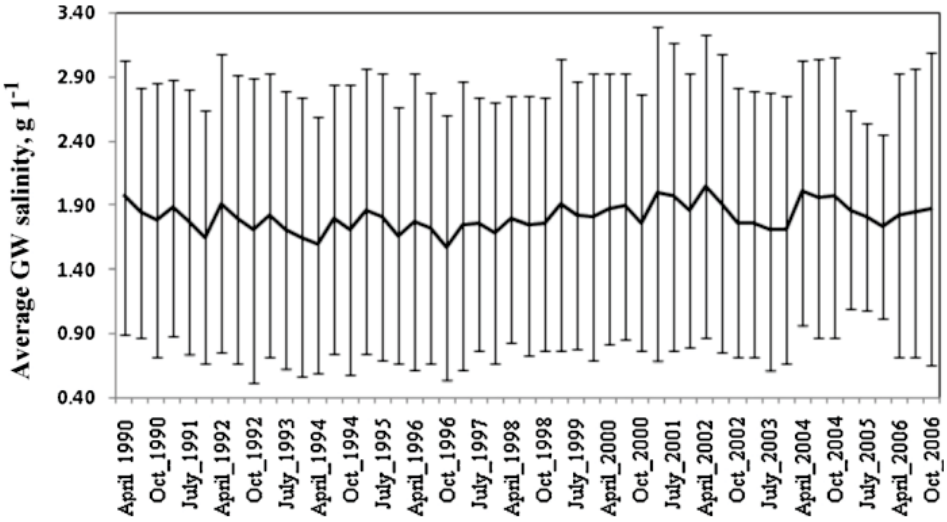


Figure 33. Dynamics of groundwater salinity (g l^{-1}, measured in April, July and October) in the Khorezm province in 1990-2006

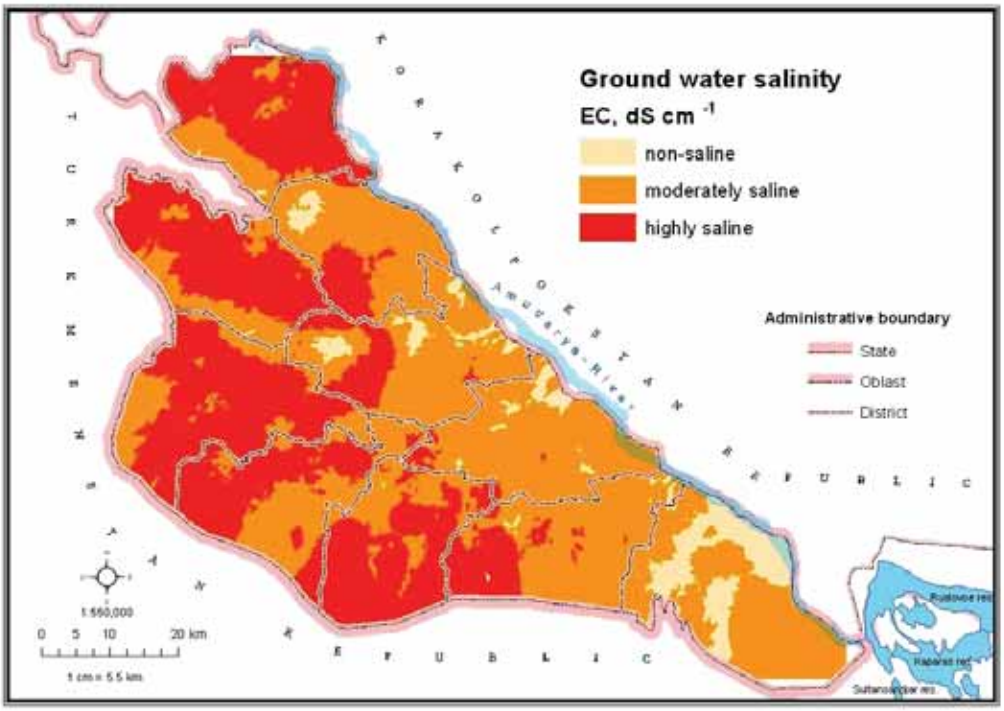


Figure 342. Spatial groundwater salinity, dS cm^{-1} in the Khorezm province

3.11 Distance to agricultural fields

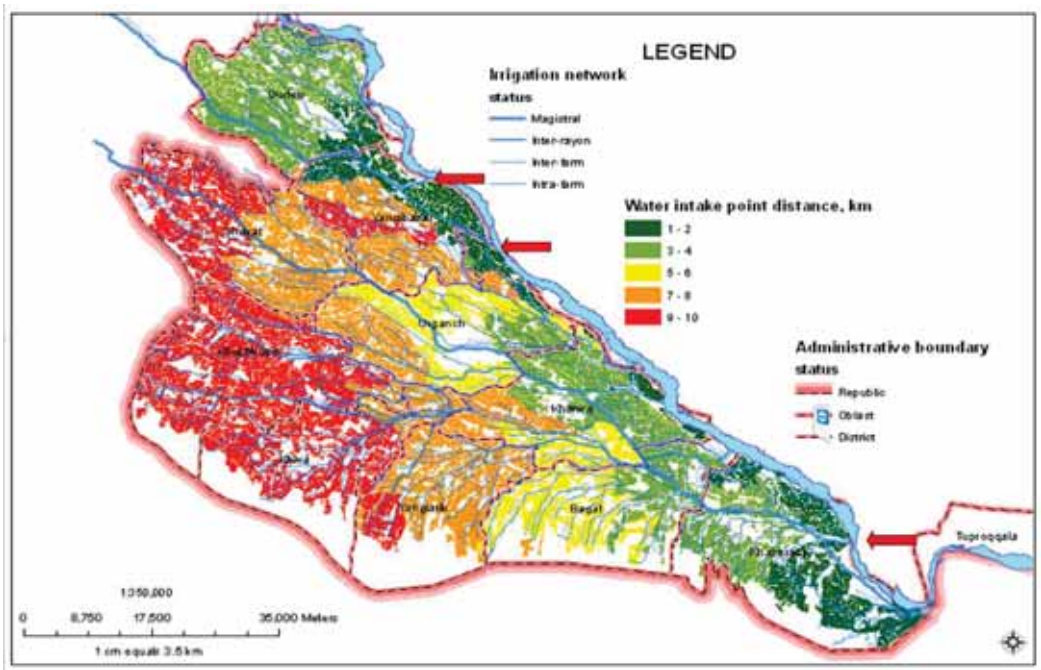


Figure 353. Distance (km) from the water intake points to the irrigated areas in the Khorezm region. The distant areas and water intake points (arrows) are shown in red.

Ca. 30% of the irrigated areas are located at the distance of more than 80 km away from the water intake points (Figure 43). The surface water, conveyed a long distance to the remote farms is subject to evaporation and infiltration into drains and deeper soil horizons, and thus only reduced water amounts are available for irrigation.

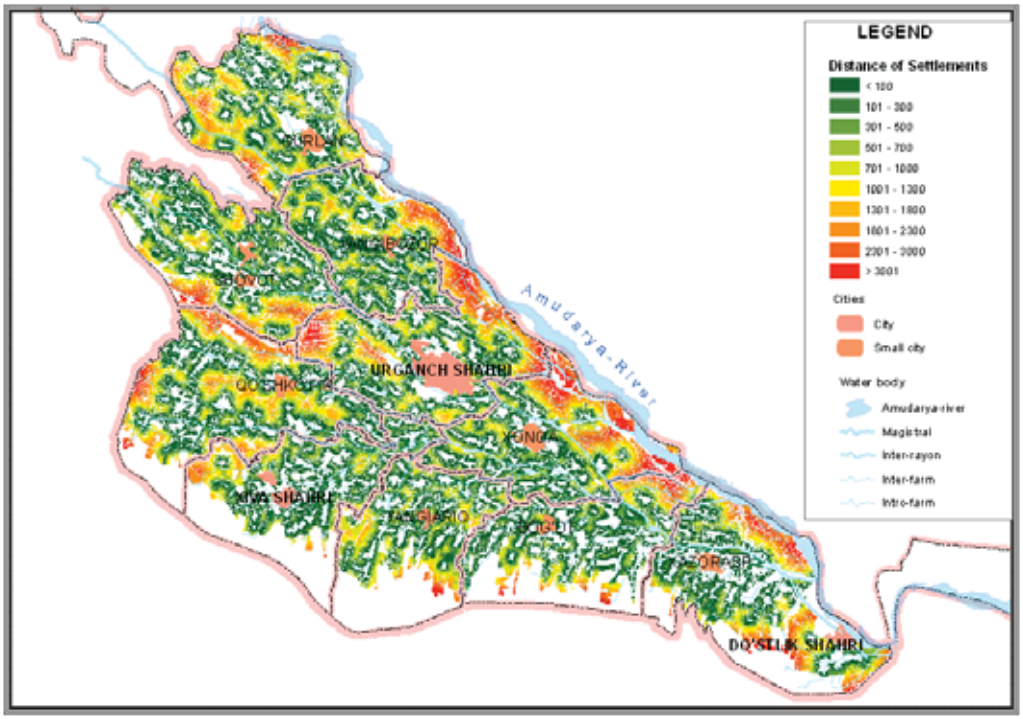


Figure 44. Distance (km) to the crop fields from settlements.

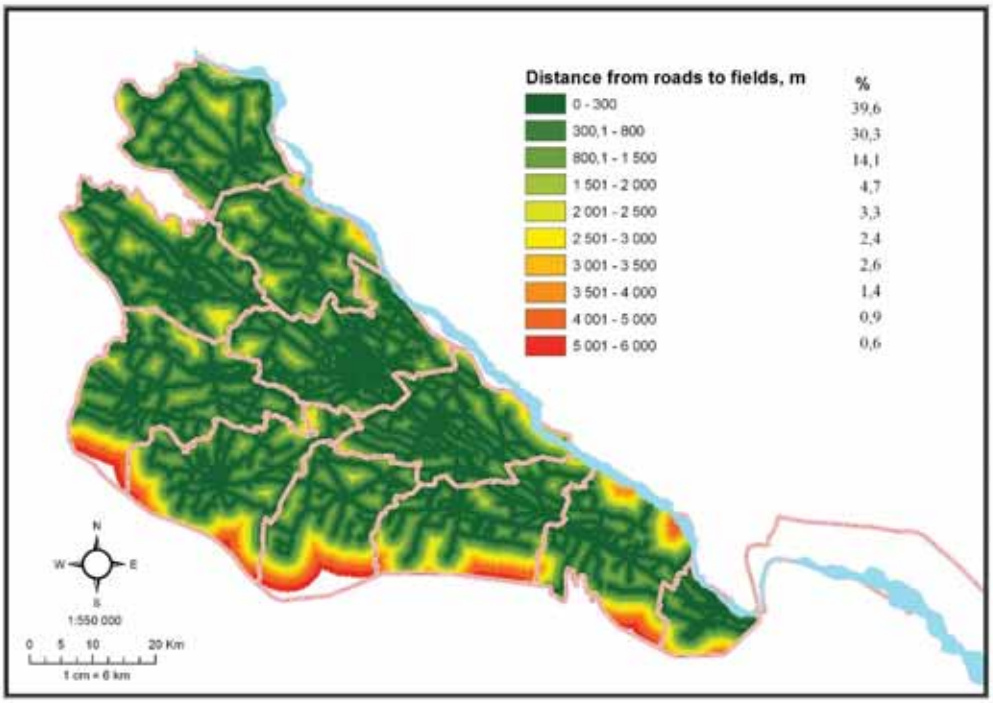


Figure 45. Distance from the agricultural fields to roads

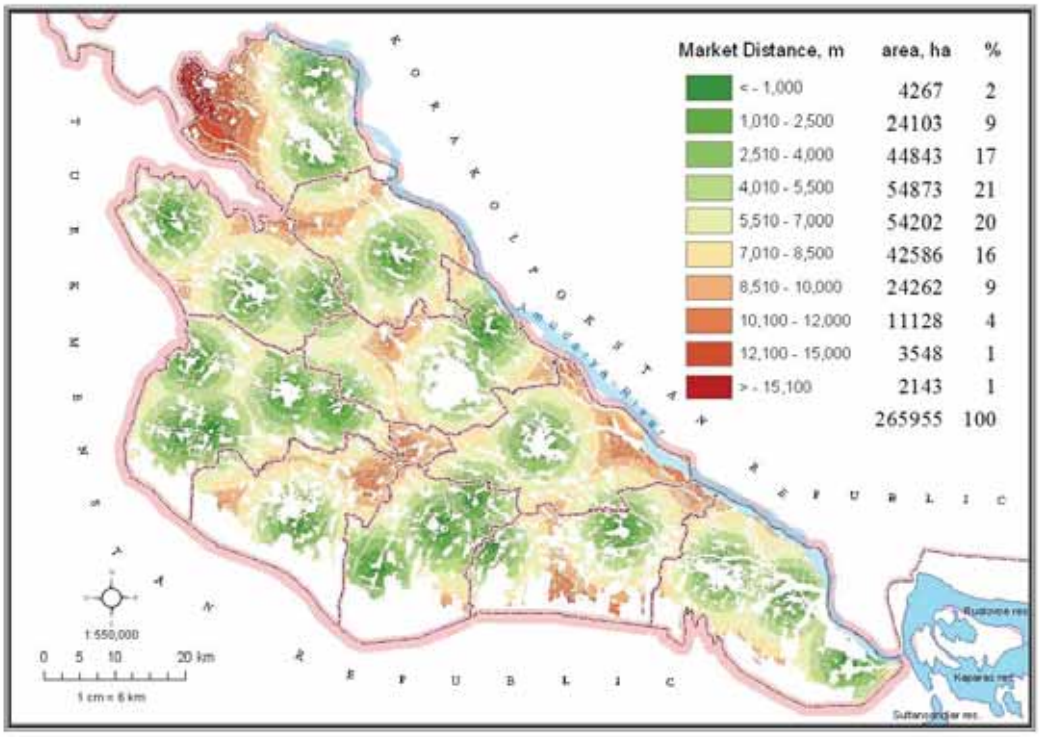


Figure 46. Distance from the agricultural fields to local markets

The distance of the agricultural fields from the settlements (Figure 44) and roads (Figure 45) plays an important role in terms of ease of (heavy) agricultural machinery and labor to reach them and to deliver products to the local markets. The distance from the cropland to the settlements varies from less than 100 m till >3 km (Figure 44).

The distance to the local markets is an important indicator of the economic sustainability and costs of the farmers (Figure 46).

3.12 Identification of agricultural marginal land in the Khorezm province

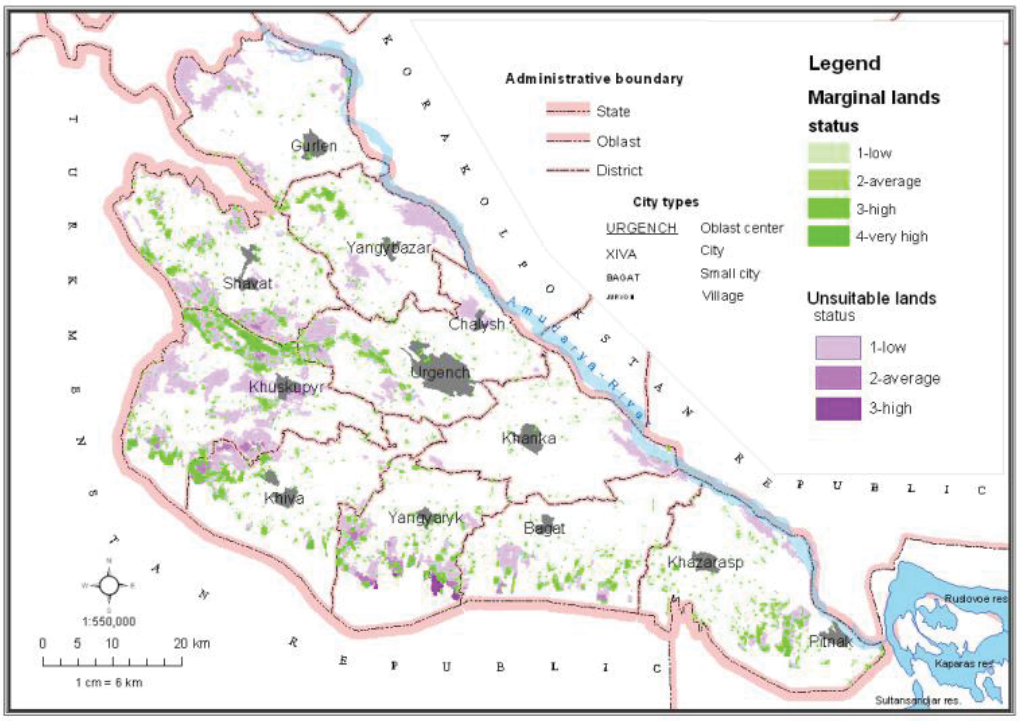


Figure 36. Marginal agricultural land in the Khorezm province

Several specific indices were estimated and applied to classify and map agricultural marginal land in Khorezm (Figure 47). These indices were combined effects of biophysical and socioeconomic constraints such as low soil fertility, poor drainage, shallow and saline groundwater, unfavourable climatic conditions, difficult accessibility to markets, poor infrastructure, unfavourable management and low yields.

4. Socio-economic survey of households in the selected districts

Socio economic survey of the selected villages/mahallas was undertaken in the framework of the DS CRP Activity "Improving the productive use of marginal lands in mixed farming and pastoral systems" in the Aral Sea Action Site.

The survey was conducted stepwise and included data collection (structured interviews); data arrangement (cleaning/entry); data processing (statistical and graphical analyses); and description of findings.

In total 70 households living in the immediate vicinity to the lake have been randomly selected during transect walks and interviewed. The report summarizes the main findings of the socio-economic survey with regards to general information about the surveyed households; livestock practices; opinion on access and availability of fodder; household's sources of fuel for heating and cooking; access to fuel sources; crop cultivation practices; perception of households on the vegetation around the lake; household income structure; household expenditure structure.

4.1 Methodology

Socio-economic survey of households in the vicinity of the selected degraded areas for determining the present perceptions on degraded land, intentions of land users with respect to further activities was conducted stepwise and included data collection (structured interviews); data arrangement (cleaning/entry); data processing (statistical and graphical analyses); and description of findings.

4.1.1 Data collection

The survey was carried out in selected districts, respective villages and *mahalla*s in the Khorezm region of Uzbekistan. The selection of districts and villages was based on the soil degradation assessment maps, prepared by the GIS specialists of KRASS and UrDU prior to socio-economic survey (Figure 1). The survey was carried out in particular in the Urgench district (Navruz town; village Bekobod: *mahalla*s Oq-yop, Zargarlar, Rovot); Yangiarik district (village Qo'riqtom, *mahalla*s: Yangiyer, Fursat, Shirsholi); and Kushkupir district (village Yangilik, *mahalla*s: Yangilik, Ayronkol, Xaydarobod, Nasofat) (Figure 47 above).

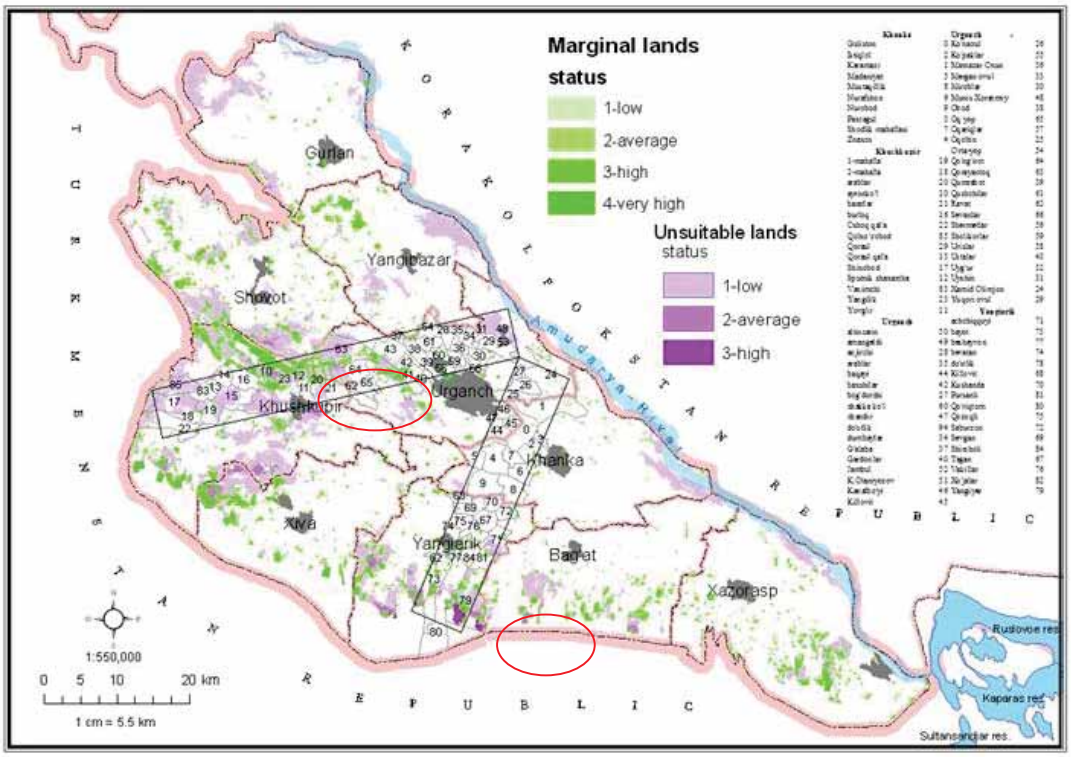


Figure 48. Soil assessment map with transect boundaries, villages and *mahalla*s for household survey

A semi-structured questionnaire (annexes 1 and 2) consisted of 10 pages, 12 major sections, including: General information about the surveyed household (family members, age, educational level, occupation, involvement in agricultural production); Land resources (area, soil quality, reasons for low quality, land reclamation measures, knowledge on soil); Agricultural production (types and inputs used); Livestock practices (opinion on access and availability of fodder); Crop

cultivation practices; Energy resources for cooking and heating; Property; Expenditure structure; Income structure; Social problems of the households (access to education, health care, living conditions, job opportunities); Environmental problems in the view of households; Livelihood improvement strategies; Willingness to participate in research and experimentation on land improvement options.

The structured interviews focused in detail on the location of the households (e.g., location of the village), socio-economic factors (e.g., increasing population, sex ratio, etc.), agricultural production factors (e.g., agricultural inputs, agricultural knowledge). Furthermore, the survey collected information on household demographics, land access and cropping patterns, and activities that contributed to household wellbeing. The survey also requested respondents to rank their most important livelihood sources (i.e. those that generated the most "income"—cash or in-kind—for their households). Livelihood activities were divided between those derived from agricultural production, including livestock production, and from "nonfarm" options.

The questionnaire was prepared by the specialists of NGO "KRASS" in the local languages (Russian and Uzbek). Predominantly individual interviews (with several exceptions when the whole family participated in the discussions) have been applied when collecting the data.

The interviews were conducted during transect walks through the selected *mahalla*s; the selection of interviewees was random, meaning all villagers who were present and willing to talk were included. The 70 interviewees included male and female household members (not necessarily the head of the household) of different age groups. Particularly with elder people, interviews included oral history accounts of the characteristics of the land resources in the past as well as of memories of their own experiences and past activities in relation to agricultural practices.

4.1.2 Data arrangement and data processing

Data from the filled-in questionnaires was entered and stored in Excel. The established database was used for statistical analysis of survey responses. Statistical analysis of the data included: descriptive statistics (means, maximum, averages, etc.), identification of frequencies and percentage/distribution of answers, proportion of respondents with various thematic feedback. Modern Excel program allowed for conducting also the graphical analysis and description of findings for a better visualization of the survey results.

4.1.3 Description of findings

All graphs created in Excel were transferred to Word document of a certain structure for further description of findings. Each graph got its caption with a concise and catchy wording. A short description was provided to each graph explaining in a couple of sentences the main findings (Chapter 4 of the report) with regards to a corresponding section and question.

4.2 Key findings of socio-economic survey

4.2.1 General information about surveyed households

Households located in the vicinity of the selected degraded areas (in Urgench, Kushkupir and Yangiarik districts of the Khorezm region) have been surveyed. The general information about the surveyed household included information about the family members, their gender, age, educational level, occupation, involvement in agricultural production be it animal and poultry keeping or cropping activities, and the location of their houses with regards to local market.

There are markets in every district of Khorezm region, including those surveyed. However, these markets work once a week, whereas central markets in administrative center – Urgench city – work every day. With regards to the location of surveyed households to markets it was observed that surveyed households in Urgench district are located in the vicinity of 5 to 27 km, with an average distance of 18 km. Households in Kushkupir district are located from 1 to 7 km, and in Yangiariq district from 2 to 15 km away from their local market.

Households' family size

Family size in rural areas of Uzbekistan has been decreasing in the last decades, albeit at slower rate compared to the urban families. 20-40 years ago it was normal to have many children and thus large families of more than 10 family members. Nowadays, the general trend is to have 2-3 children both due to life conditions and due to state birth control regulations. Likewise, in the prevailing majority of surveyed households (63%) there are 4-6 family members, in one fifth of households there are 7-9 family members (in most cases these would include elderly members – grandparents). On the extreme edges 4% of households reported to have more than 10 family members and 11% of households have up to 3 members only (few cases of divorced families or families with widows) (Figure 49).

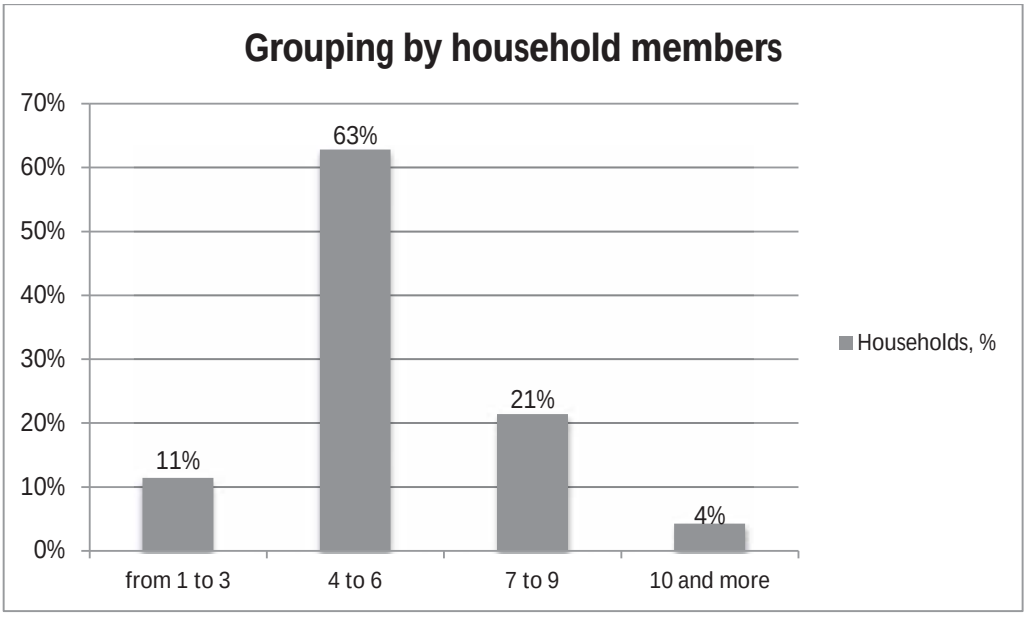


Figure 49. Family members in the surveyed households

Educational level of household members

Literacy rate in Uzbekistan is reported to be 99%. Virtually all citizens throughout the country do have school education. In order to increase educational level of the population and access to education numerous colleges, lyceums, etc. have been built in the country including rural areas. However, higher educational institutions are located in regional centers (Urgench in our case) or and most of them in the capital city – Tashkent. Not that many people from the remote rural areas thus have possibilities to continue with higher education.

About half of the surveyed households reported to have either school education (Figure 50) or to have currently family members attending schools and half of households have members with a bachelor's degree, i.e. who have graduated or are about to graduate from one of the Uzbek Universities. Currently, after the reformation of the educational system of Uzbekistan, youngsters aged 16-18 study at colleges, academic lyceums after completing a 9-year school study. In

virtually all surveyed households (96%) there are family members with secondary education, i.e. college, lyceums or technical schools. These could be both parents with only secondary education or teenager children who are currently attending secondary educational institutions.

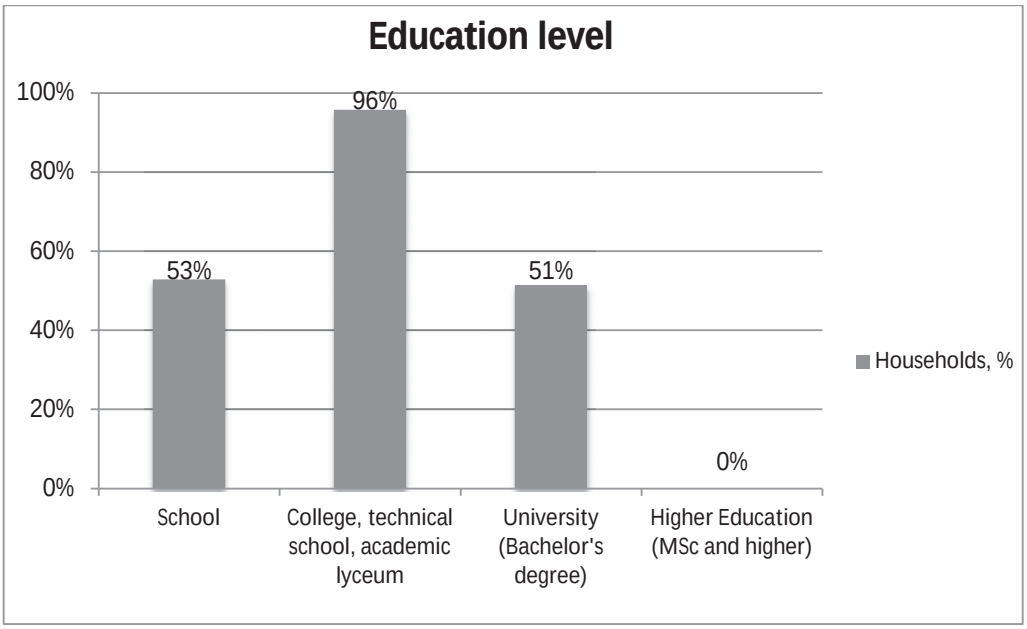


Figure 50. Educational level of the members of surveyed households

Occupation of household members

Uzbek families consist of family members of various ages from grandparents enjoying their retirement to kids attending kindergartens. Around 40% of the surveyed households have children of pre-school age, whereas 67% of households have teenagers attending school, college or lyceum (Table 17) and only 3% of the respondents have university students. Grandparents who are on pension live in 39% of the households. According to the Uzbek culture usually most of the rural families will have at least one housewife. In the framework of the survey it was interestingly enough to find only 19% of households with a housewife (unemployed female family members). At the same time around 80% of households reported to have family members working in educational sphere. This is possibly due to the fact that in the course of the survey, enumerators had difficulties with quality answers by randomly selected households and had to alter the selection strategy – the enumerators were seeking (still randomly through transect walks) the households with members with at least secondary education and somebody working in the educational sphere (schools, colleges, etc.) and which would be able to understand and to answer the questions.

In 57% of the surveyed households there are unemployed family members with no employment opportunity in the local area. Some respondents from this category as well as from those 13% of employment in 'other spheres' are seasonal migrants to the neighbouring countries, which would work half a year (usually spring-summer) and return home during autumn-winter. Among the surveyed households there were no with disabled family members, no households (predominantly poor) have farm business, very few have own business (shops, barber shop, taxi drivers, etc.). Several surveyed households have family members working outside agricultural sector: public

health service (hospitals, rural medical centers, etc.) – 3% of the respondents and in local administration – 24% of the respondents.

Table 17. Occupation of the household members

Occupation	number	share, %
He/she is a child and goes to kindergarten or stays at home	28	40%
He/she studies at school, at technical college, lyceum	47	67%
He/she goes to institute, university	2	3%
On pension	27	39%
Housewife and sits at home	13	19%
Disabled, does not have capacity to work	0	0%
Unemployed and doesn't receive a salary	40	57%
Runs own private farm business	0	0%
Runs own business	5	7%
Employed as a worker at another farm	1	1%
Works in MTP, association of private farms, water user association	3	4%
Works in commercial / private firm	3	4%
Works in education sector, including kindergartens	56	80%
Works in public health service, in hospital, in poliklinika	2	3%
Works in the administrative bodies/ in government, for instance in Khokimiat	17	24%
Other	9	13%

In general, average low level of education of surveyed households (secondary and not higher) limits their occupation opportunities at well-paid jobs. Many households are doing subsistence agriculture, i.e. cultivate crops or keep cattle and poultry at their plots. Both male and female family members, which are not officially occupied at jobs are involved is such agricultural activities with the exception of small children or teenagers, attending colleges outside the village.

Involvement of household members in agricultural production

In total surveyed households reported to consist of 376 family members, of which more than half (54%) are females and 46% are males of various age groups. When it comes to agricultural production, the survey showed that crop production on small land plots (mostly vegetables) is the prerogative of female family members, whereas both females and males evenly participate in animal keeping in their households. Females are busy with such activities as milking and feeding the animals, whereas males are in charge of keeping fodder stocks, purchasing fodder and cleaning the stables.

4.2.2 Land resources

All land resources in Uzbekistan are the property of the state, which regulates and monitors land use. Most of the available arable land resources are devoted to agricultural production either by the farmers (registered legal entities) or by *dehqon*s (rural households). Whereas the farmers lease

the land from the state for the period of up to 50 years, *dehqon*s get the land for life-time inheritable use. According to the land legislation *dehqon*s may lease land of the maximum size of 0.12 ha for house buildings/dwellings and additional 0.12 ha for cultivating agricultural crops, which however depends on the availability of 'free' land in the given district or region. Households mainly use land plots as backyard kitchen gardens or a specified area within the main farmland of the farmers, and are free to choose their crops to plant and to sell at their own discretion.

In the surveyed group of households the same trend of land size was observed. Usually the houses in rural area are large and occupy half of the land plots. Thus from the 0.12 ha of land around 600 square meters would be occupied by the house and other buildings (stables, storage rooms), the remaining around 600 square meters would be used as backyard orchards (Figure 51). Despite many rural households are predominantly poor, most of them like to have additional land plots in particular for production of fodder crops within the main farm land (usually leased from big farmers on some kind of agreements). In general such land plots would be 0.12 ha large (as prescribed by the legislation), in other cases and in particular when a household has enough labor and financial resources to manage larger land plots, the household would lease larger plots. Some surveyed households reported to have land plots in the farm land of up to 1 ha in special cases.

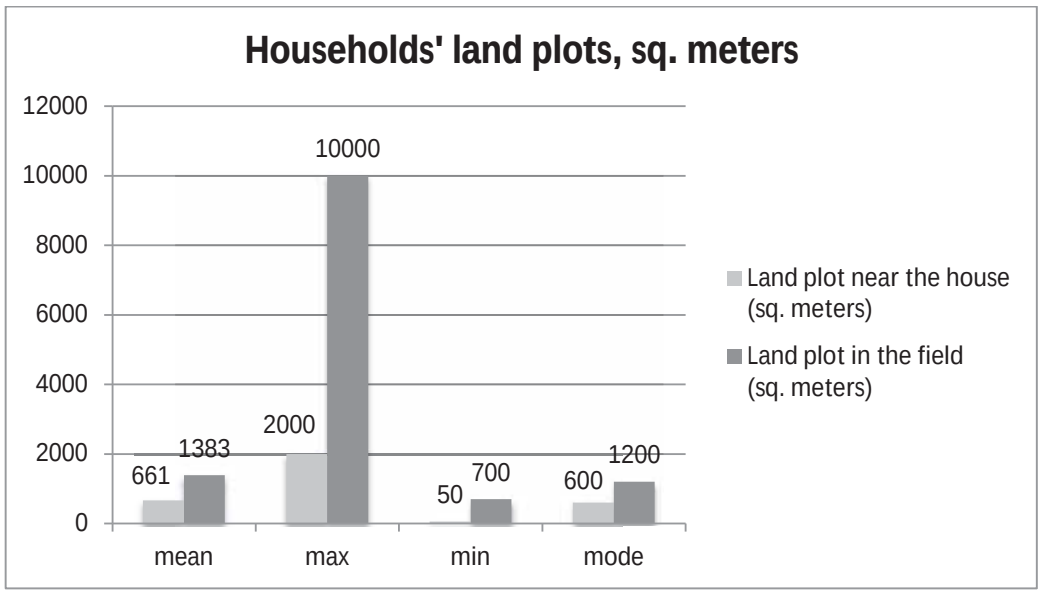


Figure 51. Land plots of the surveyed households

During the survey special attention was paid to the quality of land of the surveyed households. They were asked to rate their land plots, both near the house and within the farm land, and to distinguish the share of land of good or satisfactory quality (not degraded land). The majority of the surveyed households consider their land plots near the houses of better quality than plots in the farmland – 16% of the respondents think that more than half of their land plots are of good quality and 49% of households think all their land near the houses is of good quality. Still a quarter of the respondents reported to have no land of good quality near the houses. 44% of the households consider all farm land of poor quality, 25% consider the farm land to be partly ok, and only one third of the households is satisfied with the quality of their land plots within the main farmland (Figure 52).

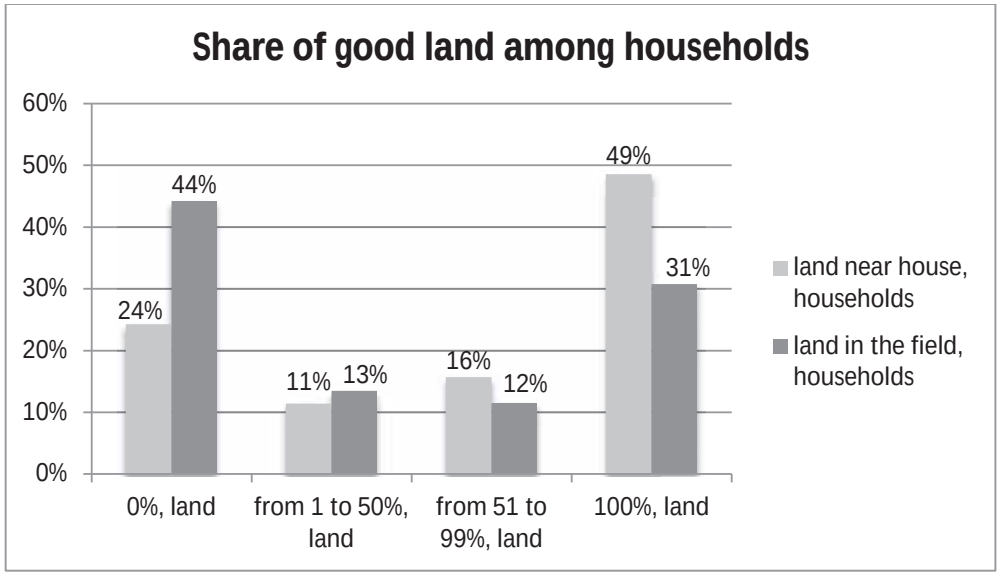


Figure 52. Land plots of good quality

Closely related to the quality of land was the question on soil salinization. The households were asked to classify their land plots, both near the house and in the farm land, for soil salinity (Figure 53). 70% of the respondents consider their land plots near the house to be saline to various degree, whereas 85% of households are not satisfied with salinity level of their land plots in the farm land. So, in general, land plots in the farm land are considered by the households, the direct land users, to be of lower quality and with higher level of soil salinization compared to the land plots near the houses.

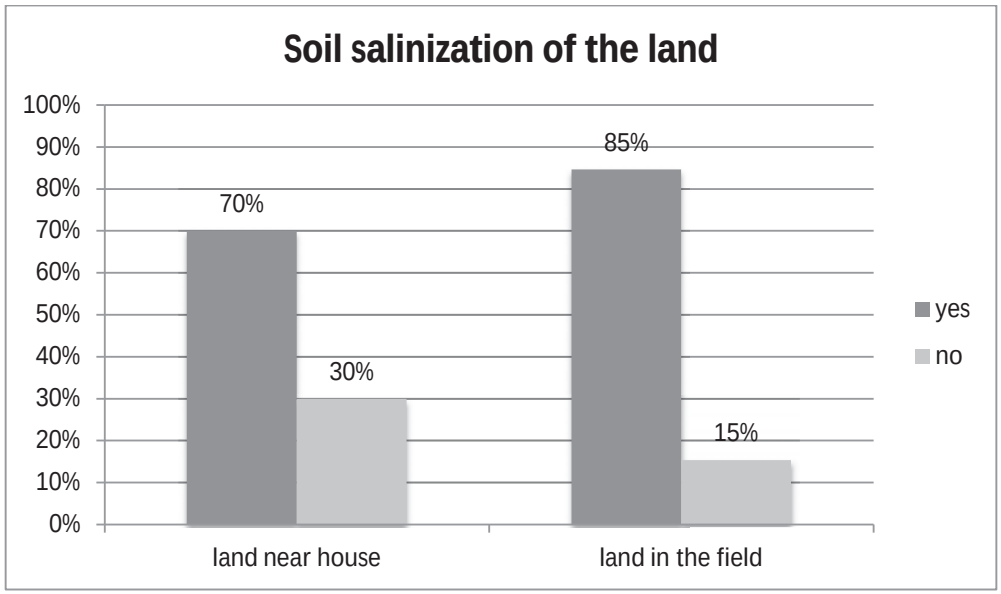


Figure 53. Soil salinization in the land plots of the surveyed households

Soil quality indicator used widely in agriculture of Uzbekistan is called *bonitet*. It is an aggregate of several parameters ranging from field characteristics (morphology, etc.) to results of laboratory analyses for various soil properties (fertility, chemistry, etc.). It is a measuring score ranging from 0 to 100, the closer the indicator is to 100, the better land quality it stands for. The average *bonitet* in the Khorezm region is around 70, whereas it is not economically and officially rational to grow

cotton for example on land with the *bonitet* of 40 or below. This indicator, however is more familiar to the farmers, professional land users, whose agricultural output and quotas for state crops production directly depend on *bonitet*.

Rural households rarely know the average *bonitet* of their land plots. Likewise during the survey, only 1 household among the 70 interviewed ones had an idea of *bonitet* score of his land. Instead, rural households can judge or measure the quality of their land based on other parameters, signs. During the survey, households were asked to name some of the factors or parameters according to which they consider their land plots to be of good, moderate or low quality (Figure 54). Among the factors used to determine the quality of land the households named: (1) visual appearance of the land, white salty cover, the colour of soil in general – 37% of the respondents; (2) yields of planted crops – 49% of the respondents; (3) the groundwater table – 21% of the surveyed households; (4) other factors. A few respondents could not give clear suggestions on the factors for determining the quality of their land.

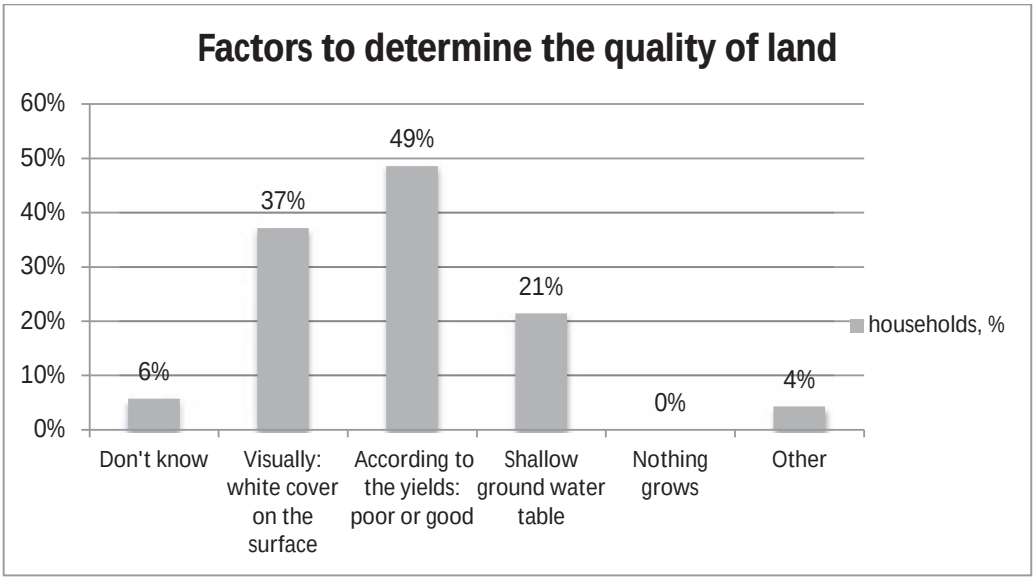


Figure 54. Households' methods used to determine the quality of their land

During the survey, households especially those with elderly household members could name the possible underlying reasons for poor quality of their land plots. The majority (around 40%) of the households consider practicing monoculture and absence of crop rotation to be the main reason for poor quality and in general for land degradation processes in the region (Figure 55). One fifth or respondents recall that there used to be a lake or a swamp on the territory of their land plots. Few households mentioned the excess use of mineral fertilizers as the underlying reason for land degradation. One tenth considers the poor condition and lack of adequate maintenance of the drainage system to be causing soil degradation processes. Still one third of the respondents could not present a clear reason for the poor quality of their land.

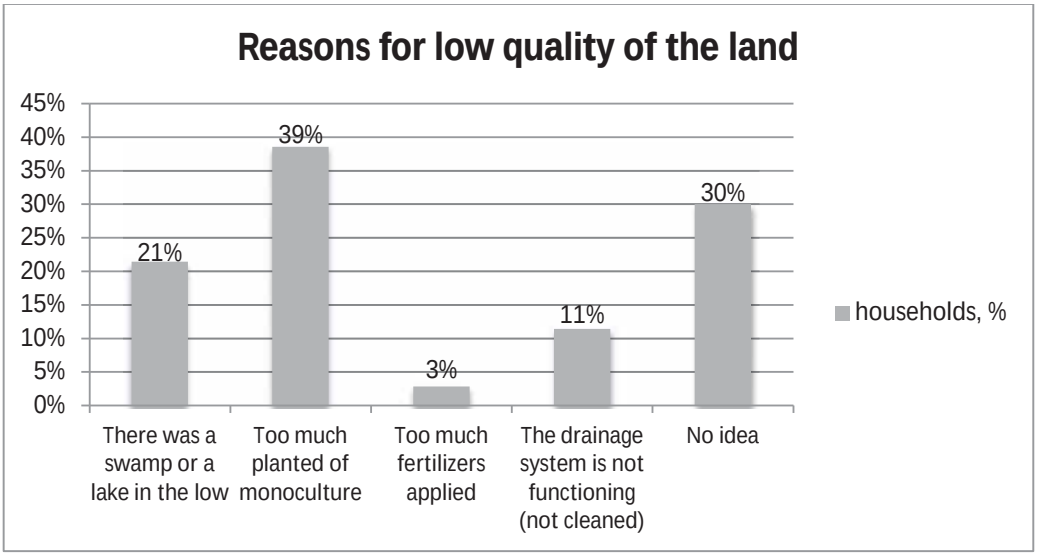


Figure 55. Households' view on the underlying reasons for low quality of their land
*Some households pointed at more than one reason, thus the total is over 100%

With regards to land reclamation practices in order to improve the land and to bring the degraded parts back to agricultural production, all households reported to undertake some activities. About half of the households apply more manure (organic fertilizer) in order to restore productivity of land; 44% do practice crop rotation (usually maize or sorghum for forage after winter wheat); 14% of households practice more leaching events in order to reduce albeit only temporally soil salinity level in their fields. Few households mentioned the positive effects of planting legumes as a soil productivity restoring plant. Some households practice more than one land improvement strategy (Figure 56) .

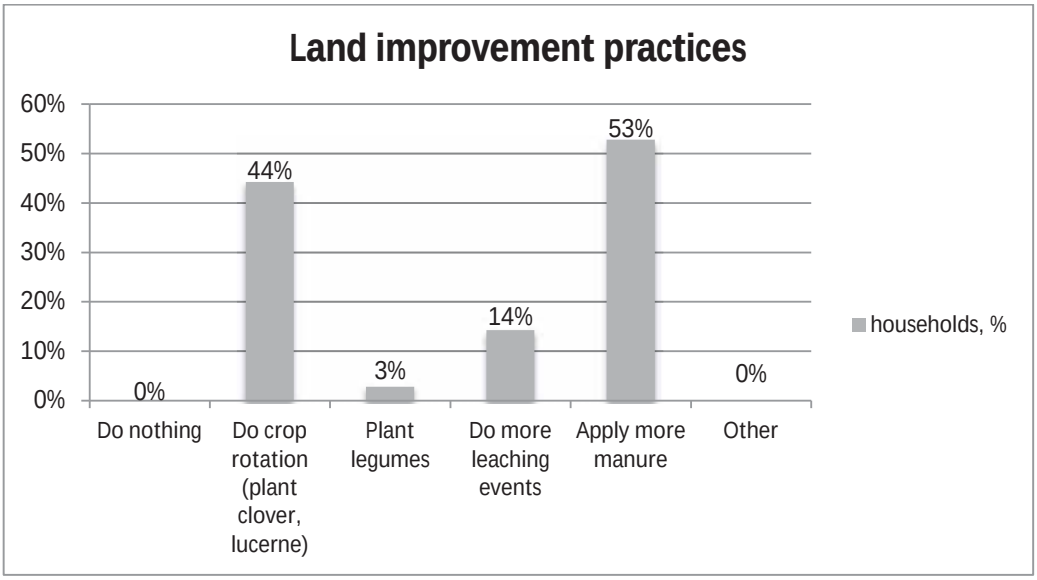


Figure 56. Land reclamation practices of the surveyed households

The official organization in Uzbekistan responsible for land classification, monitoring of land use and other land management issues – Land Cadastre office – distinguishes the following categories of land: saline soil, swampy land with reed cover, pasture with bush cover, irrigated abandoned land and irrigated abandoned land with bush cover. It appeared during the survey that rural

households are partly familiar with such land classification. The households were asked to assign the named land categories to their land plots and as a result, the prevailing majority (59% of the households) could distinguish saline soil and irrigated abandoned land. Logically, there is no pasture land in the Khorezm region and almost no irrigated abandoned land with bush cover (tree plantations) since local population knows little on agroforestry practices or on planting specific salt tolerant trees on abandoned and highly degraded land plots (Figure 57).

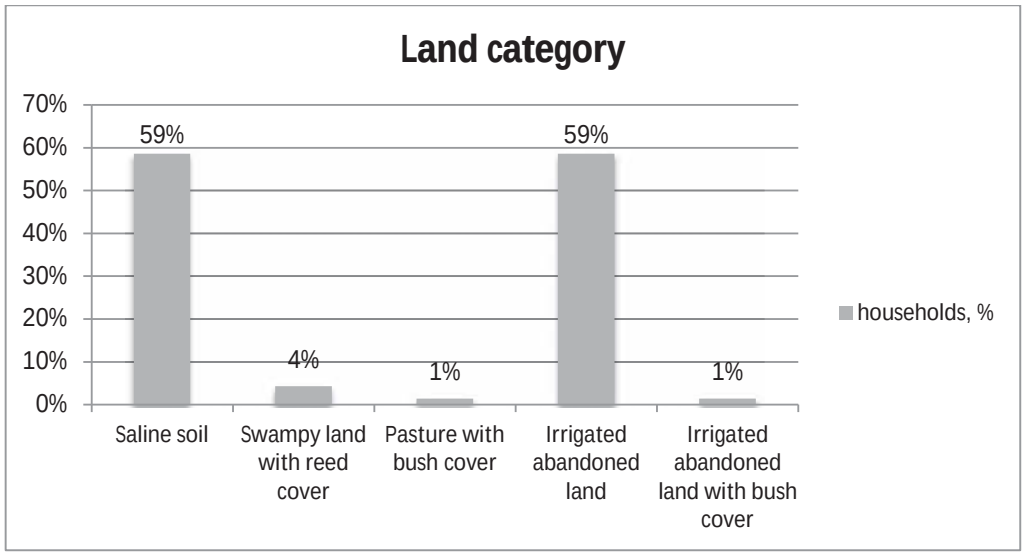


Figure 57. Land categories of the surveyed households' plots

Local population does recognize the existing land degradation problems and does understand that there is a high need to reverse this negative trend and to do something to restore the degraded land. From 30-40% of the surveyed households consider that it is possible to achieve satisfactory yields of crops on saline soils and on irrigated abandoned land after some soil reclamation measures (Figure 58). The question remains how to find the most suitable, affordable and practical (not too scientific or difficult for the agricultural workers to apply) land improvement practices to be implemented in the region on a wider scale.

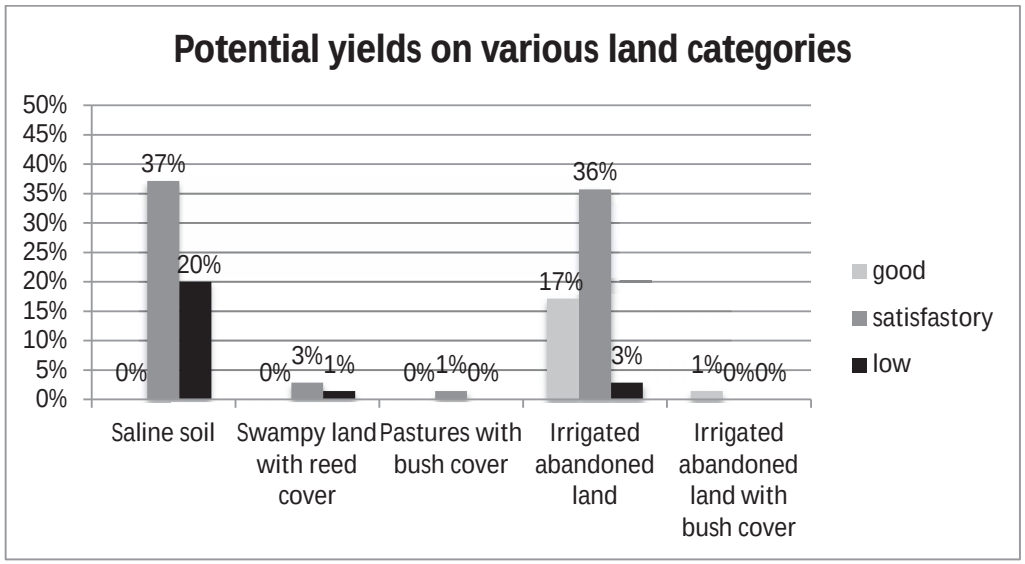


Figure 58. Potential yields by land categories

4.2.3 Agricultural production

Households in rural areas survive on subsistence agriculture, i.e. cultivate crops or keep cattle and poultry at their plots mostly for own consumption, very rarely they grow cash crops (cotton or rice) or sell dairy products. Survey showed that almost all interviewed households (94%) grow vegetables and 73% of the respondents keep cattle, poultry and other animals. Since wheat is of a high importance to the rural households for bread, pastry and fodder for animals (wheat bran), 64% of the surveyed households distinguished growing wheat among other agricultural practices (Figure 59). Half of the respondents have fruit trees in their back yard gardens, providing essential fruits for own consumption. Fish keeping and bee keeping is not the types of agricultural activities widely practiced in the Khorezm region – there were no respondents in the survey, which would grow fish or keep bees.

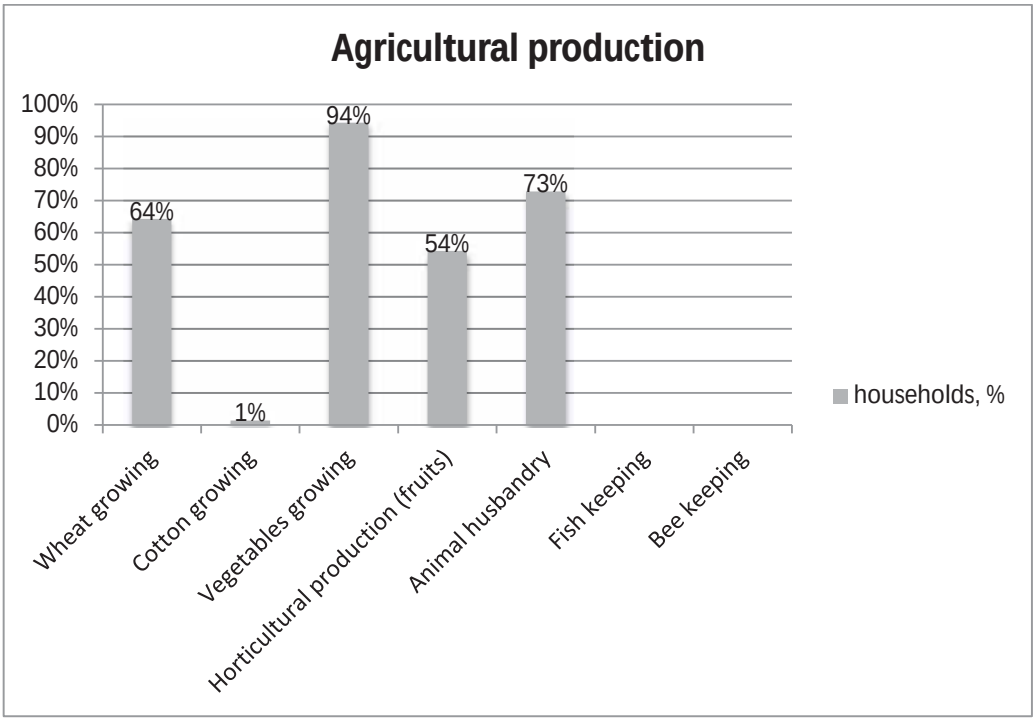


Figure 59. Types of agricultural production by the surveyed households

Intensive type of agricultural production in the Khorezm region calls for heavy use of both mineral and organic fertilizers. Over 90% of the surveyed households reported to apply either mineral fertilizers, organic fertilizers, or in most cases the combination of both. Due to the high costs of agricultural chemicals as pesticide and herbicide, their use has been reducing in the aftermath of independence of Uzbekistan. Instead of pesticides a bio pest control method has been introduced and widely spread in the region. The survey also showed that only 6% of the respondents sometimes apply pesticides and mostly on fruit trees in the blooming period. One fifth of the surveyed households reported to apply herbicides, mostly on wheat (Figure 60).

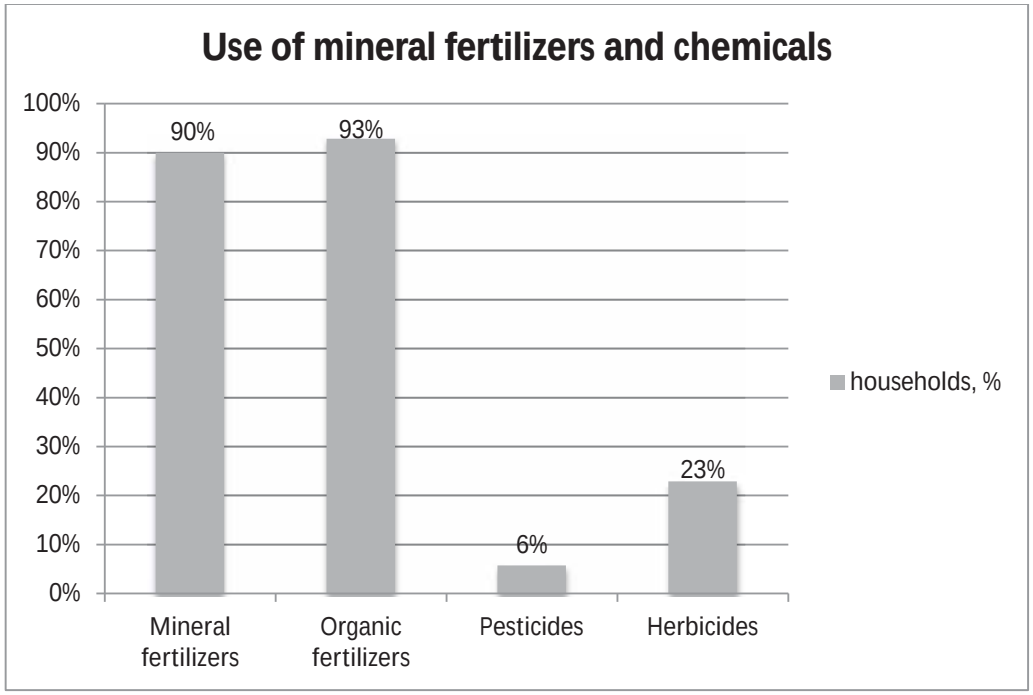


Figure 60. Use of fertilizer and agricultural chemicals by the surveyed households.

Since virtually all households in the survey use organic fertilizer, the outcoming question was on the source of manure they apply on their plots. The majority of households (79%) have enough or close to enough manure produced by their own cattle, whereas still half of the respondents have to purchase manure at various amounts, depending on the availability of manure in their own stables (Figure 61). Usually manure is bartered or purchased from the neighbors, which have more cattle head.

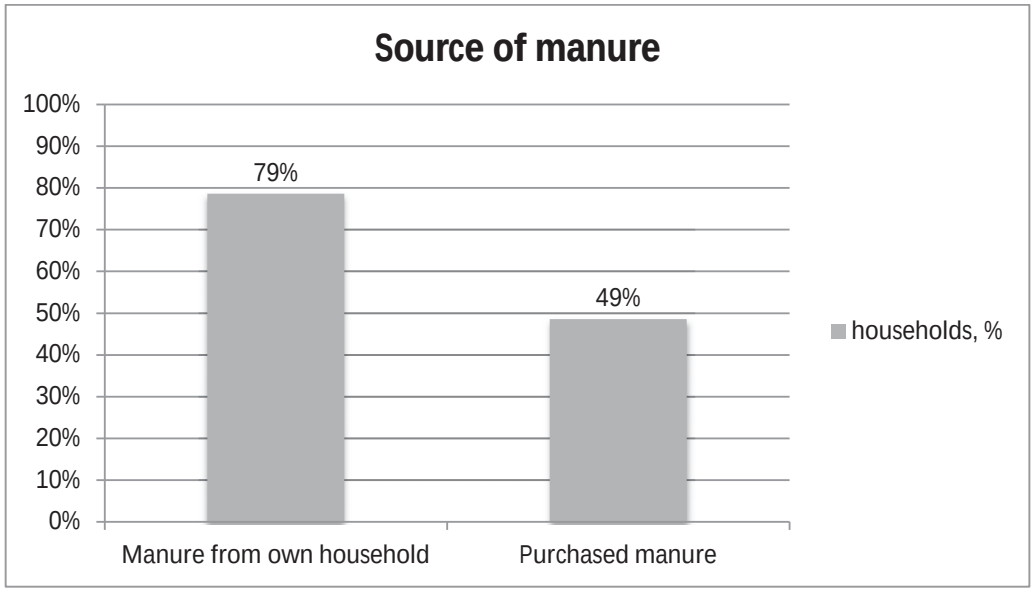


Figure 61. Source of organic fertilizer by the surveyed households

4.2.4 Livestock

Households with livestock and livestock availability

Because of subsistence type of agricultural production of the surveyed households, many of the surveyed households (74% of the respondents) possess poultry (chicken, turkey), while none of them has horse. Having a goat is in general also very rare in the surveyed areas (Figure 62). 16% of households reported to have at least 1 donkey for cart transportation means and to keep some sheep (also 16% of the respondents). Whereas virtually all households do keep cattle, the majority of the respondents mentioned keeping cows for own consumption of dairy products, 63% keep calf for later sale in the market and 24% have grown bulls as a source of investment. Traditionally, bulls and calves are considered to be a good, reliable and fast paying off investment option. Many rural households, which plan to have weddings or other big celebrations or if the household has teenagers ready to attend or already enrolled at universities, the family can fast sell the cattle and get the required funds to cover expenses for celebrations or educational fees. Thus, livestock for households is one of the essential sources of food and income. However, for most of them the number of livestock and their variety is constrained by the income and the fodder availability.

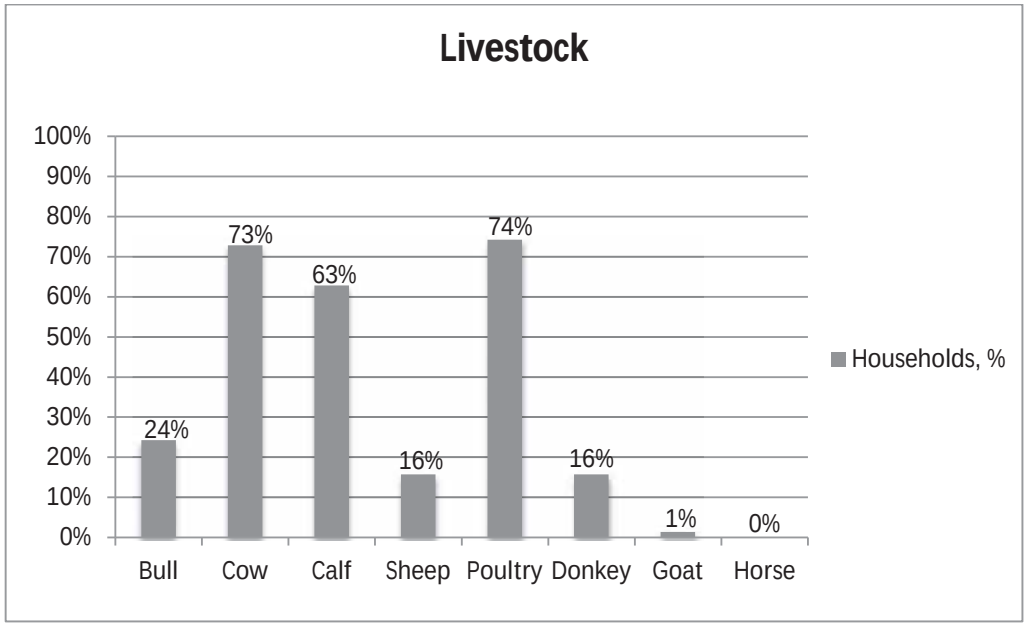


Figure 62. Livestock ownership of the surveyed households

Sources of fodder for domestic animals

There is a variety of fodder sources available in the rural area. During the survey the following 2 main sources have been identified by households, which keep cattle. Primary and most important fodder source for bulls, cows and calves (100%, 86% and 84% of those respondents keeping cattle respectively, Table 18) is crops, produced at households' plots. Own produced crops (including green forage as cover crop) are also the source of fodder for donkeys, goats and sheep Around half of the households use own crops to feed their calf, sheep and poultry. It happens, however, that in the off-season (winter and early spring) households experience fodder shortage, and have to buy the required amount and type of fodder at local markets. This happens more with poultry (77% of the respondents), but also with cattle, since the households have to buy cotton husk and meal for supplying their cattle with protein fodder type. In rare cases, households members

working in big farm fields get some fodder (wheat barn, wheat straw) as labour remuneration. No households reported to graze their cattle or poultry on the natural vegetation (grass) in the fields or near the canals, with the exception of sheep, which should be occasionally grazed in the open flat land.

Table 18. Main fodder sources for the surveyed households

Sources	Bull	Cow	Calf	Sheep	Poultry	Donkey	Goat
Grazing near canals and in the fields	0%	0%	0%	0%	0%	0%	0%
Grazing in the flat land	0%	0%	0%	9%	0%	0%	0%
Give crops produced at own household plots	100%	86%	84%	82%	21%	82%	100%
Give crops received for working in farm fields	6%	2%	2%	0%	0%	0%	0%
Give purchased crops	12%	10%	11%	9%	77%	18%	0%
Other	0%	2%	0%	0%	0%	0%	0%

Reason for keeping livestock

Two major reasons for keeping livestock have been reported during the survey. First and most important in conditions of subsistence agricultural production is breeding livestock for home consumption. This concerns mainly cows (94% of the respondents) for dairy products, sheep and poultry (each 100%) for supplying households with meat and eggs (poultry). Second reason is breeding livestock for sale at local markets. This reasoning concerns mainly bulls (82%). Calves are kept for both future selling (in case of male calves) and for keeping in the household (for female calves) (Figure 63).

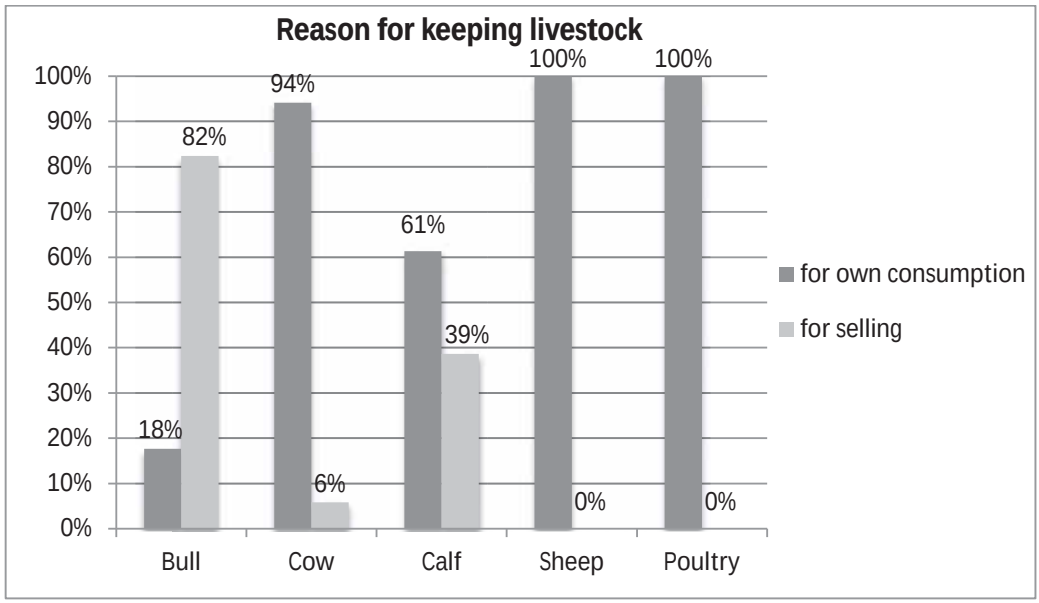


Figure 63. Reasons for breeding cattle and other livestock

4.2.5 Access to fodder

Many types of fodder were reported to be used to feed the animals by the surveyed households. Such fodder types as wheat straw and bran, rice straw and husk, green maize and sorghum, maize and sorghum grain, cotton seed husk and cake, and finally grass were among the mentioned fodder types. It has to be stressed that all rural households including the surveyed ones use a combination of fodder types and not only one type.

Wheat is a very important crop in Uzbekistan. Despite it was introduced on a large scale recently (since independence) in the framework of the state program of self sufficiency in grains and for the reasons of food security in the country, agricultural producers learned very quickly the technology of its cultivation. Wheat is widely grown throughout the country and especially by rural households for 2 reasons: to feed the family (wheat grain) and to feed the animals (cattle - wheat straw, poultry – wheat bran).

In many occasions during the survey it was reported that the small land plots of the rural households on the one hand and low quality of land (saline soil, water logging, low fertility) lead to the insufficient production of fodder crops and as a result fodder shortages. Whereas 67% of surveyed households reported to experience fodder shortages to various degrees, 58% stressed to have frequent fodder shortages during the year (Figure 64). Shortages usually occur late winter – early spring. No problems with fodder were reported in summer (when animals can graze) and autumn (immediately after fodder crops harvesting).

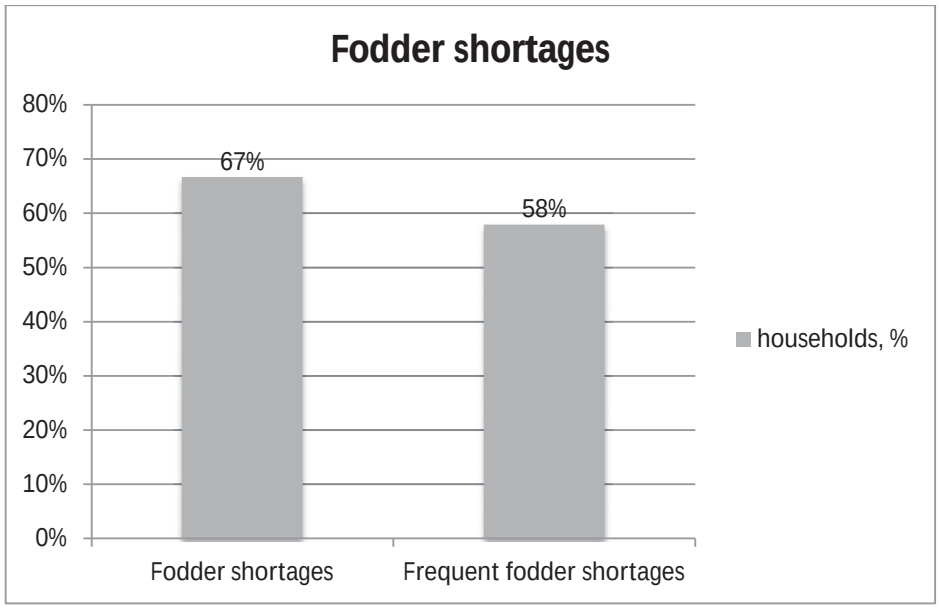


Figure 64. Respondents experiencing fodder shortages

To cope with fodder shortages the households have no other choice as to buy the required amounts of fodder at local market. Interesting trend was observed with regards to how often households buy fodder. The poorer the family the more frequently it needs to buy fodder, because only limited financial resources can immediately be spent on purchasing fodder. Better-to-do families can set aside more funds for purchasing fodder and thus do not buy frequently and little amounts, but buy occasionally and bigger amounts. Among the surveyed households 69% have to buy fodder frequently (more than once a month, Figure 65), and less than one third of the surveyed households have to buy fodder less frequently – less than once a month.

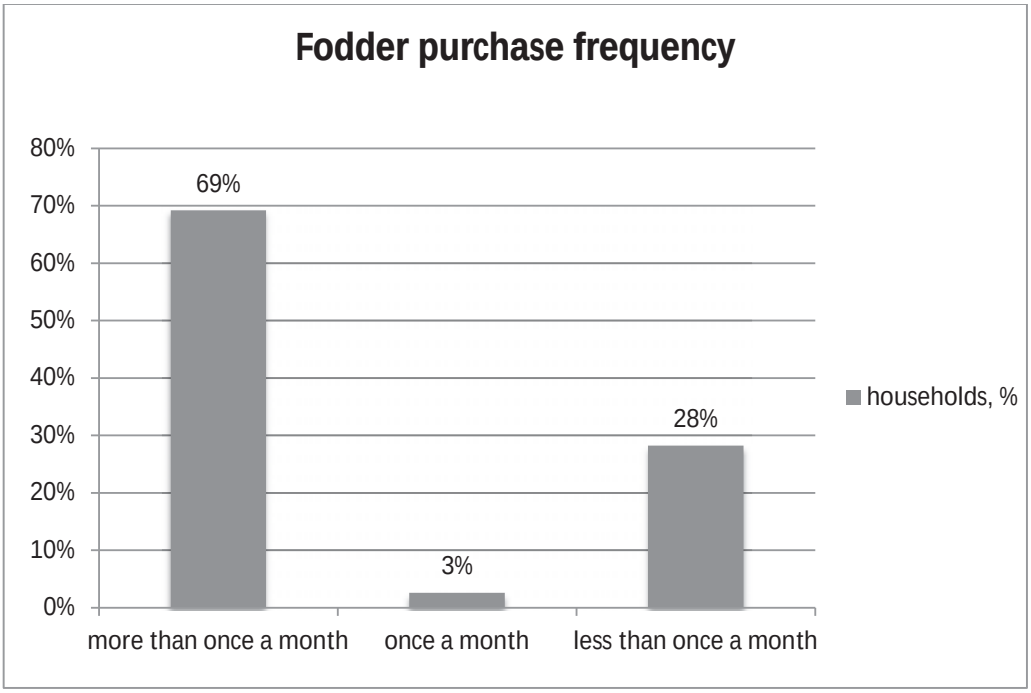


Figure 65. Frequency of fodder purchasing

4.2.6 Households' energy sources for heating and cooking

The general trend in the country is towards decreasing the use of non-renewable energy resources especially by the population, including in rural areas. Supply of natural gas has been decreasing, became very unstable and is expected to be reduced to the minimum in the coming future. The cases of energy supply deficits became widespread and the population is forced to look for alternative energy sources for cooking and heating the houses. In many if not all the cases, the households use several energy sources in order to diversify the risk of no energy supply and to lower the costs (Table 19). The use of alternative energy sources such as solar energy or biogas is not yet practiced in rural areas of Uzbekistan (no respondents mentioned these energy sources), though there have been some initiatives in the capital or big cities to spread the idea and the corresponding technologies to population. The reason may lie in quite high costs of these technologies, in most cases still unbearable for rural population, in insufficient knowledge and availability of such technologies for open sale. Neither do surveyed households use power generators.

Available energy sources

Several types of energy resources somehow available and used by the surveyed households have been identified and grouped in Table 19. While none of the respondents reported to use kerosene, diesel and gasoline for cooking or heating purposes, cotton stems were reported to be used by 84% of the households, 93% of households rely on natural gas when it is centrally supplied, half of the respondents use mostly fuelwood, 16% use liquid gas as an alternative energy source for cooking purposes. Few respondents reported to use charcoal (4% only - since the quality of available charcoal is very low) and 7% of the surveyed households, those who have cattle, use manure (dried) for heating their houses (Table 19).

Table 19. Available energy resources for the surveyed households

Households	LPG	Natural gas	Charcoal	Fuelwood	Cotton stem	Manure	Kerosene	Diesel	Gasoline
number, yes	11	65	3	34	59	5	0	0	0
share, %	16%	93%	4%	49%	84%	7%	0%	0%	0%

It has to be mentioned once more that one household can use several energy sources for different purposes, for example, cotton stems are used a lot for cooking, whereas the same household would use charcoal for heating, etc.

Primary sources of energy separately for cooking and heating

Table 20 reflects the use of the above mentioned energy sources specifically for cooking purposes. All respondents who have reported to be using liquid gas, natural gas, and cotton stems do use these for cooking purposes. Other stand-by energy sources for cooking, especially in cases of insufficient natural gas supply, reported to be fuelwood and dried manure. In many, if not all, cases households use the mixture of energy sources.

Table 20. Energy sources used for cooking

Households	LPG	Natural gas	Charcoal	Fuelwood	Cotton stem	Manure
number	11	65	0	22	59	2
share, %	100%	100%	0%	65%	100%	40%

With regards to the use of energy sources for heating purposes, surveyed households reported to be using natural gas, charcoal, and fuelwood.

Where does energy come from and how much does it cost

Each type of energy has its own source. Natural gas is of course supplied centrally via gas pipes (corresponds to ‘other source’ in Table 21 with regards to natural gas), all liquid gas is purchased by the respondents at special gas stations either in the city, so only those households which have transportation means can afford using liquid gas. Manure is not traded, so those households (really poor ones) which use manure for heating have it produced by own cattle or in several cases bartered with the neighbours. Cotton stems and fuelwood are either collected/harvested by the respondents themselves either from the street, from the farmers’ fields or from own land plots. In many cases respondents buy fuelwood or cotton stems from the small traders walking in the street with the carriages or carts.

Table 21. Supply of energy resources

Source	LPG	Natural gas	Charcoal	Fuelwood	Cotton stem	Manure
Produced on own household plot	0%	0%	0%	29%	0%	80%
From neighbors/relatives	0%	0%	0%	6%	2%	0%
From local farmers	0%	0%	0%	15%	46%	0%
Purchased in the local market	0%	0%	33%	18%	7%	0%

Purchased from retailers	100%	0%	67%	26%	12%	0%
Other	0%	100%	0%	6%	34%	20%

In order to offset and alleviate energy shortages, households purchase energy resources for cooking and heating. Most of the households buy them for cooking and heating only once a year. They buy fuelwood and cotton stems in bulk from local farmers and sellers. In contrast to purchasing fodder, the frequency of which depends on the financial capacities of the surveyed households and is quite frequent (for many households every week for example), purchasing of energy resources for cooking or heating happens once or twice in a year (because households buy a bulk of stems or fuelwood at once). Those households, that use LPG, have to go to the city several times a year (up to 3 times) to fill their gas tanks.

In summary, all energy sources used by the surveyed households for cooking or heating, besides cotton stems (which partly can be produced by the households) and fuelwood (which can be, and in some cases illegally, collected in the street) are purchased for money.

Table 22. Share or purchased energy resources by households

Households	LPG	Natural gas	Charcoal	Fuelwood	Cotton stem
number	11	65	3	20	39
share	100%	100%	100%	59%	66%

During the survey not many respondents could clearly recall and report on the expenditures they spent for energy resources. The expenses for energy resources depend on the size of the house (heating requirements), the size of the family (cooking requirements), and the availability of energy resources (manure, cotton stems or fuelwood) at households' own plots. It was identified via the survey, that annually one average rural household in the surveyed villages spends on average around 1.3 mln. UZS (Uzbek soum – local currency in Uzbekistan) on liquid gas, 560 thousand UZS on natural gas, 552 thousand UZS on fuelwood and 289 thousand UZS on cotton stems (Table 23). In general, there is a problem with energy supply not only for surveyed households, but also for the whole communities. And this problem becomes extremely acute during winter. So, households have to reserve significant amount of cash (if available) for purchasing of alternative sources of energy to survive in cold months.

Table 23. Annual costs for purchasing energy by the surveyed households

Indicator	LPG	Natural gas	Charcoal	Fuelwood	Cotton stem
average	1 265 455	560 520		552 500	289 744
max	3 960 000	810 000		2 400 000	500 000
min	150 000	162 000		200 000	15 000

Access to energy resources

Access to energy resources is a critical issue in rural areas. Households were asked to assess the level of energy resources availability for them. 74% of the respondents are satisfied with the availability of energy resources for cooking and 69% of respondents for heating. Slightly less than half of the households (43%) experience shortages with energy supply (Figure 66).

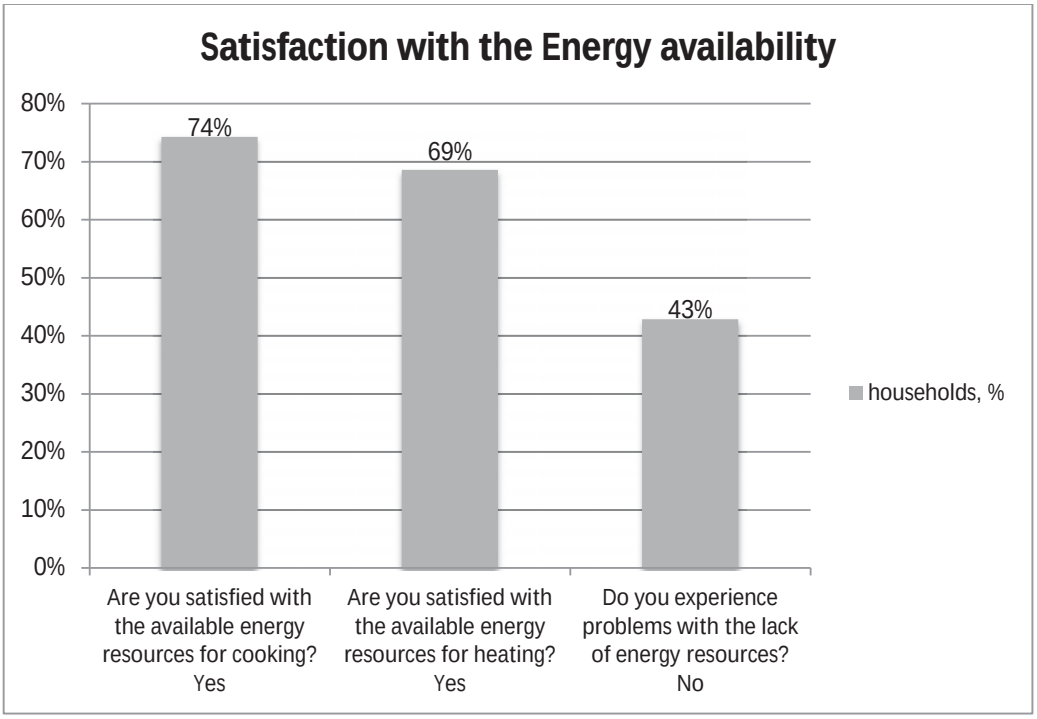


Figure 66. Satisfaction of households with the availability of energy resources

Children are not involved in procuring energy resources. In most of the households male adults are responsible for buying and fetching energy resources both for cooking (80%) and heating (97%), since it is a rather laborious task (Table 24). Women in some households (20% of the respondents) are in charge of energy resources for cooking.

Table 24. Responsible members of households for energy resources supply

Household member	**cooking** share, %	**heating** share, %
Female children	0%	0%
Male children	0%	0%
Female adults	20%	3%
Male adults	80%	97%

4.2.7 Crop cultivation

Crops are vital for households to survive in rural areas. Households were asked various questions regarding types of cultivated crops, importance level of these crops for their households, harvests and the degree of satisfaction with their harvest, etc.

Cultivated crops

Data shows that almost all households (93% of the respondents) cultivate table vegetables on their allocated plots for home consumption (Table 25). Over two thirds of the respondents grow melons (66%), fruits (61%), and wheat (61% of the surveyed households). Surprisingly for the survey 43% of households reported to cultivate rice on additional land plots, usually 1200 sq meters (basically in Kushkupir district of Khorezm), since rice is not allowed in general due to water shortages. Maize and sorghum are cultivated on the same land plots right after wheat (cover crops). Sunflower and alfalfa are rarely cultivated by the surveyed households in the surveyed

districts. It needs to be stressed once more, that almost all surveyed households produce crops for home consumption and not for sale.

Table 25. Crops grown by the surveyed households

Households	Wheat	Rice	Maize	Sorghum	Sun-flower	Vegetables	Melons	Fruit trees	Alfalfa	Cotton
number	43	30	18	21	1	65	46	43	7	0
share, %	61%	43%	26%	30%	1%	93%	66%	61%	10%	

Reason for crops cultivation, harvests, satisfaction with harvests

There are two main reasons, which respondents indicated, for cultivation of certain crops. Naturally, households cultivate wheat, rice, vegetables, melons and fruits for own consumption. Maize and sorghum and alfalfa are cultivated for feeding animals. As mentioned already hardly any cash crops are grown neither for sale at markets, nor for exchange with neighbours or relatives (Table 26). It has to be stressed that land reclamation or land improvement was rarely among the reasons for cultivation certain crops by the surveyed households.

Table 26. Reasons for cultivation of certain crops by the surveyed households

Reason	Wheat	Rice	Maize	Sorghum	Vegetables	Melons	Fruit trees	Alfalfa
For own consumption	100%	100%	6%	5%	95%	93%	93%	0%
For feeding own animals	0%	0%	94%	90%	2%	0%	0%	86%
For using as energy resource	0%	0%	0%	0%	0%	0%	0%	0%
To earn money from selling	0%	0%	0%	5%	3%	7%	7%	0%
For exchanging with neighbors	0%	0%	0%	0%	0%	0%	0%	0%
For improving land quality	0%	0%	0%	0%	0%	0%	0%	0%
My household has no other alternatives/no other crop suits the quality of land	0%	0%	0%	0%	0%	0%	0%	14%
Other	0%	0%	0%	0%	0%	0%	0%	0%

With regards to the yields of cultivated crops, very diverse responses have been reported during the survey. Many respondents failed to give precise values. Since households cultivate rather small land plots and thus could hold better control or better management, their reported harvests may seem a bit exaggerated. Yields ranged:

- Wheat – 1.2 to 8 tons per ha, on average 3.9 tons per ha;
- Rice – 1.8 to 8 tons per ha, on average 4.9 tons per ha;

- Vegetables – 2.5 to 40 tons per ha, on average 10.2 tons per ha;
- Melons – 2.5 to 30 tons per ha, on average 9.7 tons per ha;
- Fruits – 0.7 to 15 tons per ha, on average 5.2 tons per ha.

What is more important is the degree of satisfaction of households with their crop harvests. Households do not consider their harvests as excellent for none of the crops, with a small exception for some horticultural producers (Table 27). Melons and alfalfa yields are considered good by around 40% of the respondents. The widely reported level of yields of all crops is 'satisfactory'. The main reason for this dissatisfaction is a low quality of available land - it is usually highly saline and almost all households do acknowledge this problem.

Table 27. Rating* of harvests

Rating indicator	Wheat	Rice	Maize	Sorghum	Vegetables	Melons	Fruit trees	Alfalfa
Very poor	2%	7%	0%	0%	0%	0%	0%	0%
Poor	14%	7%	22%	0%	5%	4%	2%	0%
Satisfactory	58%	57%	56%	71%	69%	54%	63%	57%
Good	26%	30%	22%	29%	26%	41%	33%	43%
Excellent	0%	0%	0%	0%	0%	0%	2%	0%

*Share of the respondents who grow corresponding crops

Crops for sale, purchased crops

Very few households reported to sell little amounts of their produced crops, except for some households selling larger amounts of rice (Table 28). Wheat, rice, maize, and sorghum are sold primarily in a local market. Vegetables, melons, and fruits are sold in a local market as well as to local shops (retailers).

Table 28. Crops for sale by the surveyed households

Households	Wheat	Rice	Maize	Sorghum	Vegetables	Melons	Fruit trees	Alfalfa
number	3	9	1	1	3	3	2	0
share, %	7%	30%	6%	5%	5%	7%	5%	0

*Share of the respondents who grow corresponding crops

Since cultivated crops are not enough to meet households' demands, they have to purchase necessary amounts and varieties of crops. Almost all respondents buy additional wheat, rice, vegetables, fruits, melons, some vegetables and maize (Table 29). The share of the purchased crops in total consumption is given below.

Table 29. Crops purchased by the surveyed households

Households	Wheat	Rice	Maize	Sorghum	Vegetables	Melons	Fruit trees	Alfalfa
number	32	43	17	9	14	25	38	1
share, %	46%	61%	24%	13%	20%	36%	54%	1%

Those respondents who purchase crops, primarily buy 100% of wheat, rice, maize, melons, and fruits. Half of corresponding respondents purchase 50% of their demand in vegetables, and the other half purchase 100% of demand in vegetables (Table 30).

Table 30. Where households buy additional crops

Households	Wheat	Rice	Maize	Sorghum	Vegetables	Melons	Fruit trees	Alfalfa
Purchase in the local market	100%	100%	94%	100%	100%	80%	97%	0%
Purchase from sellers in the street	0%	0%	6%	0%	0%	20%	3%	100%

In summary, surveyed households complained mostly about low quality of the cropland and most of them don't know how to improve it. Some households tried to use manure and fertilizers but without significant positive result. Though, there are few households that managed to receive higher yields in their cropland applying combination of fertilizers and land treatment (more machinery services), but it requires cash investments, which most of the households can't afford. Another major complain regarding crop cultivation is water supply shortage.

4.2.8 Households' property and food stocks

With regards to the property, one of the useful socio-economic indicators, rural households in general and surveyed households in particular, have TV sets (100% of the respondents), refrigerators (97%), laundry machines (40%). Over one third of the surveyed households can afford having cars and computers and only 10% of households consider air conditioners the necessary items in their households. Since the survey was conducted among the rural households and not the farmers, very few reported to possess agricultural machinery (tractors) or trucks (Figure 67).

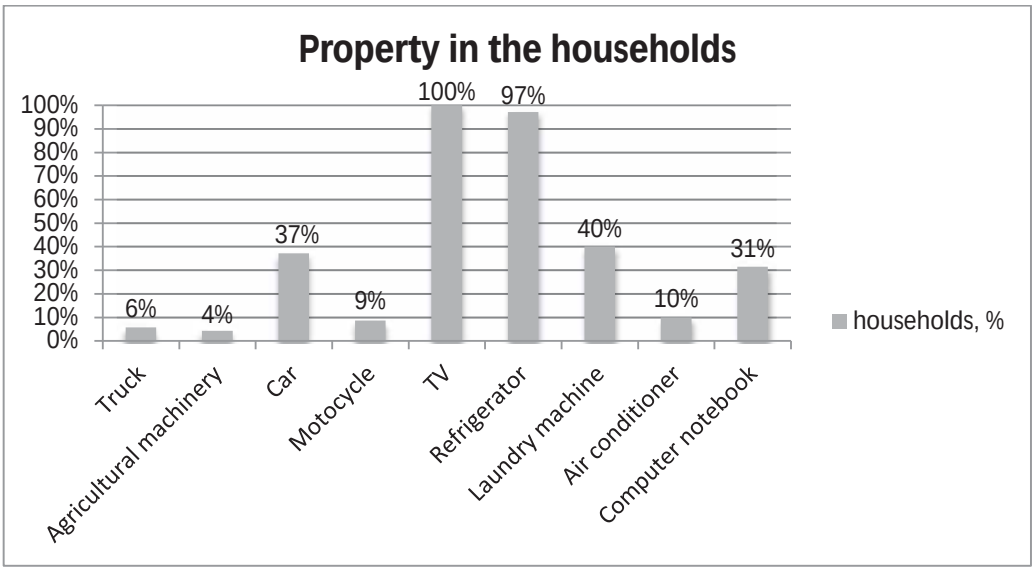


Figure 67. The common property items of the surveyed households

The general 'food security' habit of the population and the more so of the rural population (due to the availability of storage facilities compared to urban population living in apartments) is to prepare/store sufficient amounts of the main food items (wheat, potato, other vegetables, fruits,

processed/canned/dried fruits and vegetables, flour, Figure 68) for the winter-spring seasons. The underlying reasons are price fluctuations – price increase for many products during winter and early spring, the lack of good quality products in winter at the market place and the reluctance of family members to go to markets during the cold winter days. Above 90% of the surveyed households prepare vegetables and fruits, both fresh and processed. It is natural for the Uzbek families to bake their own bread, thus 80% of the surveyed households do store sufficient, in some cases own produced wheat and then turn it into flour upon the requirement of the household in flour and still 73% of respondents buy sufficient amounts of ready flour to provide families with bread products during the winter.

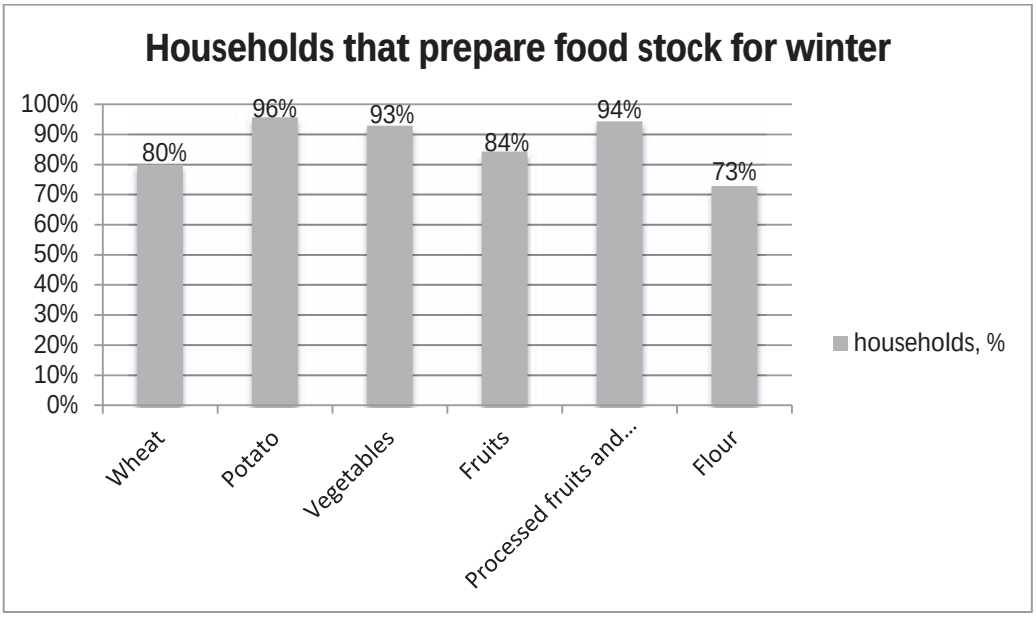


Figure 68. Food stocks of the surveyed households

On average (but of course depending of family size), households store for winter time 542 kg of wheat, 153 kg of potato, 188 kg of other vegetables (carrot, cabbage, turnip, etc.), 130 kg of fruits (usually locally available and durable fruits such as apple, pear or grapes), 121 kg of processed fruits and vegetables and finally 178 kg of wheat flour (Table 31).

Table 31. Amount of food stock in kg, by surveyed households

	Wheat	Potato	Vegetables	Fruits	Processed fruits and vegetables	Flour
average	542	153	188	130	121	178
max	1500	600	800	400	500	600
min	150	50	50	30	30	50
mode	500	100	100	100	100	100

As household income depends to a large extent on agricultural production and also as the largest share of the budget is spent on food consumption price fluctuations will have a strong effect on the level of both production and consumption, and thus on the households' overall welfare.

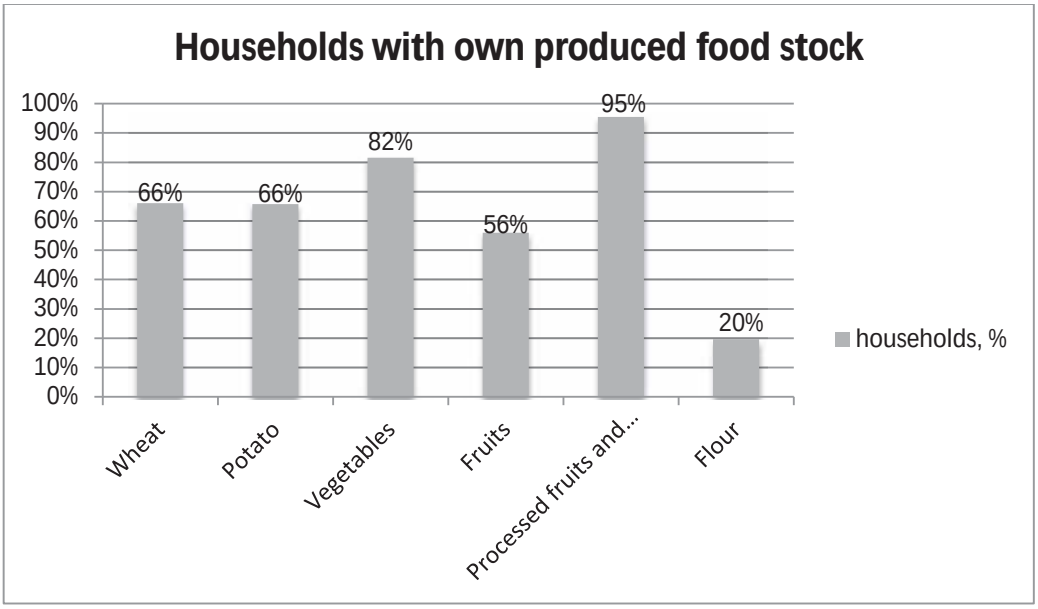


Figure 69. Food stock produced by the surveyed households

The food items which households store during the winter are either home produced (Figure 69) or purchased from local markets (Figure 70) in autumn, right after the harvest (for vegetables and fruits) or in July (for winter wheat). Again, almost all households do both strategies – produce certain amount themselves and purchase the missing amounts from the markets. Vegetables and processed fruits and vegetables are more home produced than purchased, fruits are half grown at own plots and the remaining required half comes from markets, wheat and potato is also more home produced, whereas flour comes in most cases from the traders.

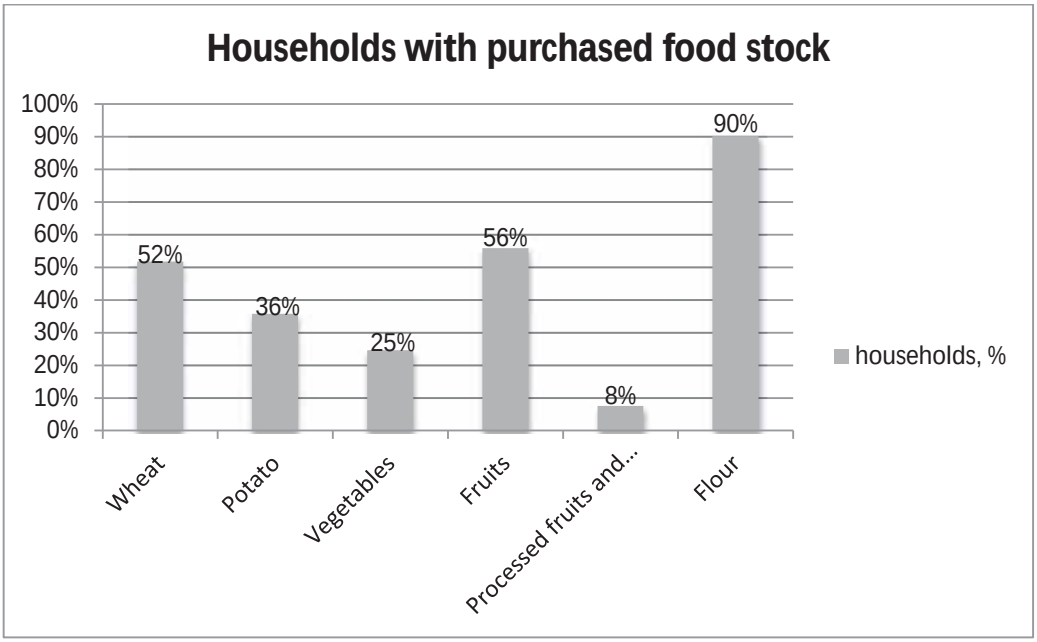


Figure 70. Food stocks purchased by the surveyed households

4.2.9 Households expenditure structure

Analysis of the expenditures shows that 83% of the surveyed households spend the largest share (from 40% to 70%) of their income on food consumption (Table 32). Expenditures on energy resources are the second largest item (up to 20%) in the budget of 85% of households. Clothing also consumes up to 20% of the family budgets of 29% of households, whereas half of the households try to spend only 10% of the family budgets on clothing. In general it has to be noted, that Uzbek families are not spoilt in terms of clothing and the trend is that younger children would wear the remaining clothes and food wear from the elder sisters or brothers. Costs for cultivating land vary on average from 1 to 5% for most households (77%); the same is true for costs on taking care of the livestock. Expenditures on education include costs for children studying at schools, colleges and university: on average these costs take up to 5% for 59% of the respondents and up to 10% of the annual family budgets for one tenth of the surveyed households. Costs on hygiene (soap, laundry powder, etc) and other (medicine, primarily) costs usually don't exceed 5% of the budgets of the surveyed households (Table 32).

Table 32. Expenditure structure of the surveyed households

Share of budget, %	0	1 to 5	6 to 10	11 to 20	21 to 30	31 to 40	41 to 50	51 to 60	61 to 70
Food consumption (at home and outside)	0%	0%	0%	3%	6%	9%	30%	30%	23%
Purchasing and repairing clothes	1%	16%	53%	29%	0%	1%	0%	0%	0%
Buying things for hygiene	1%	96%	3%	0%	0%	0%	0%	0%	0%
Money spent for education	27%	59%	10%	3%	0%	1%	0%	0%	0%
Energy resources for heating and cooking	0%	1%	41%	44%	10%	1%	1%	0%	0%
Expenditures for cultivating crops on own plots	9%	77%	11%	3%	0%	0%	0%	0%	0%
Expenditures for feeding and taking care of own livestock	24%	59%	14%	3%	0%	0%	0%	0%	0%
Other important expenditure (medicine)	26%	70%	4%	0%	0%	0%	0%	0%	0%

From the analysis of the income and expenditures structure we can see that, surveyed households hardly make any savings due to low income.

4.2.10 Households' income structure and sources of income

This section describes income structure of the surveyed households. It should be noted, that most respondents unwillingly answered questions related to their income both absolute amounts and the source. Following Table 33 provides information on the available sources of income and their importance for households.

Table 33. Income sources of the surveyed households

Income source	Income sources, % of households	Primary income source, % of households
Selling own produced crop products	27%	9%
Selling own produced animal products	41%	19%
Salaries from work in other farm fields and employment in farms	10%	1%
Pensions	36%	21%
Stipend	3%	1%
Remittances from household members working abroad	19%	1%
Salaries from work in governmental organizations	34%	10%
Salaries from work in MTP, WUA or farmers association	4%	3%
Salaries from employment in educational sector, including kindergartens	74%	27%
Salaries from employment in public health service, in hospital, in poliklinika	4%	4%
Income from own private business not related to agriculture (private worker in construction)	11%	4%
Income from running own farm	1%	1%

There are various sources of income for the surveyed households. Since many of the respondents work in educational sphere, 74% reported that salaries received in educational organizations are the main and most important income sources for family budgets (Table 33). 41% of the respondents receive income from selling own produced animal products (meat or cattle in life weight), however this income source is of primary importance for 19% of the surveyed households. More than one third of the respondents relies on salaries of family members working in some kind of administrations, and also one third of the households get cash in the form of pensions of the retired family members – this is the important and primary source of income for one fifth of the respondents. Other income sources of the rural families include (in descending order): income from sales of own produced crops; remittances from household members working abroad; salaries from non-agricultural sectors (construction, etc.); salaries of households members working in big farm fields; salaries of family members working in public health sectors and agricultural service providing centers; stipends of the teenagers studying at university (Table 33). Unofficial surveys reveal that rural households depend almost entirely on the remittances from family members working in neighbouring CIS countries, which however was not evident from the current socio-economic survey. Many households do not share this information due to many reasons.

The main budget managers in the surveyed households are husband or wife, or the respondents (Figure 71). 99% of households reported to be receiving enough financial resources (budget) for food and other important expenditures, but not for making reserves. The remaining 1% or very few respondents do not get enough funds even for food.

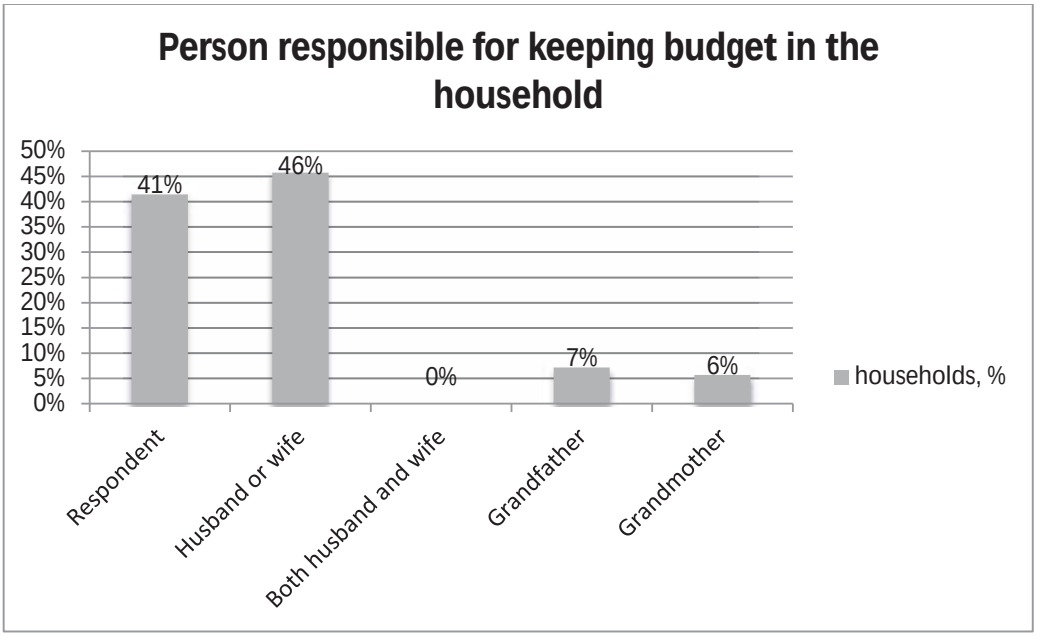


Figure 71. Budget managers in the surveyed households

4.2.11 Socio-economic problems of households

With regards to problems, drawbacks for the wellbeing and development of living conditions of the rural households, respondents listed a range of options from several socio-economic spheres (Table 34). The respondents also were asked to rate the listed problems as important and not important. The respondents had the possibility to mark more than one problem, while some respondents had difficulties to mention any of the listed problems. The largest group of respondents (though only 13%) agree that there is lack of human capacity improving or developing options in the rural or closely located areas, more than half of this group considers this particular problem an important one (Table 34). Furthermore, lack of kindergartens in rural area, high expenses for education, low level of professional education and experience and finally lack of machinery and equipment were accepted as problems by groups of 9% each.

Table 34. The list of socio-economic problems and their importance for the surveyed households

Problems	Yes	Not important	Important
High expenses for education of my children	9%	49%	11%
Absence of educational institutions near the house	4%	63%	10%
No possibility to improve human capacities near the house	13%	56%	27%
Absence of kindergartens near the house	9%	60%	19%
No access to financial resources, credits	7%	60%	33%
Too much work around the house	1%	66%	26%
No access to appropriate jobs near the house	7%	57%	29%

Good jobs are available only at province centers or abroad	3%	69%	20%
The low level of education and experience	9%	69%	24%
Little help for development of own business	1%	73%	7%
Not enough machinery and cars for own business	9%	61%	24%
Not enough labor resources	7%	59%	26%
Legal barriers for own business development	0%	40%	3%
Delays in pensions and other social payments	1%	59%	19%
Insufficient health curing services	3%	57%	27%
Delayed delivery of irrigation water	4%	26%	63%

In addition to socio-economic problems the households were asked to name (open question, list of ecological problems created by the households) ecological/environmental problems they face in their everyday lives (Figure 72). Soil degradation and in particular exceeding soil salinization was reported by 59% of the respondents, availability and access to clean drinking water is acknowledged by one third of the surveyed households. This reflects the fact, that not all districts have tap water supply, whereas groundwater which they pump for their households consumption is in most cases saline and of low quality. 14% of the respondents consider lack of irrigation water due to climate change and other reasons as the main constraint for the development in rural areas. Still 10% of respondents named other problems connected with the dust in atmosphere, poor condition of transportation roads, lack of energy resources supply (natural gas, electricity) as the outcome of ecological or environmental problems.

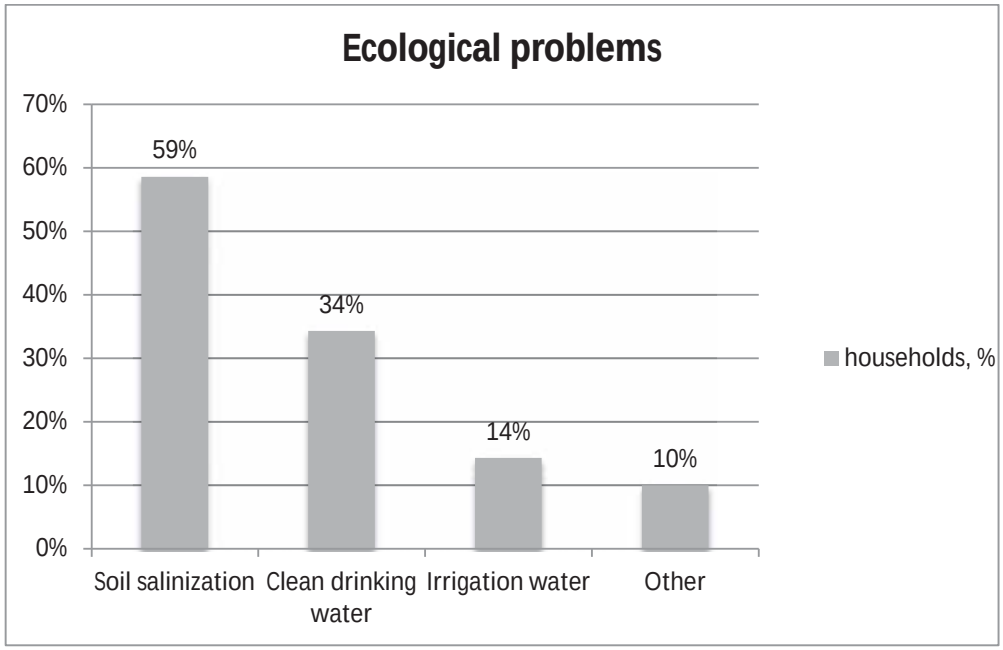


Figure 72. Households' view on the existing ecological/environmental problems

4.2.12 Livelihood improvement strategies of households

Final section of the socio-economic survey dealt with strategies or options which households consider would improve their living conditions and wellbeing in general. The mentioned strategies have been grouped around educational options, agriculture related and non-agricultural business strategies. Most important education or capacity building strategy considered by 91% of the households is the provision of good education for their children. About two thirds of the respondents think that improving qualifications of grown-up family members and finding corresponding or appropriate well paid jobs in the local area are the right wellbeing improvement strategies (Figure 73).

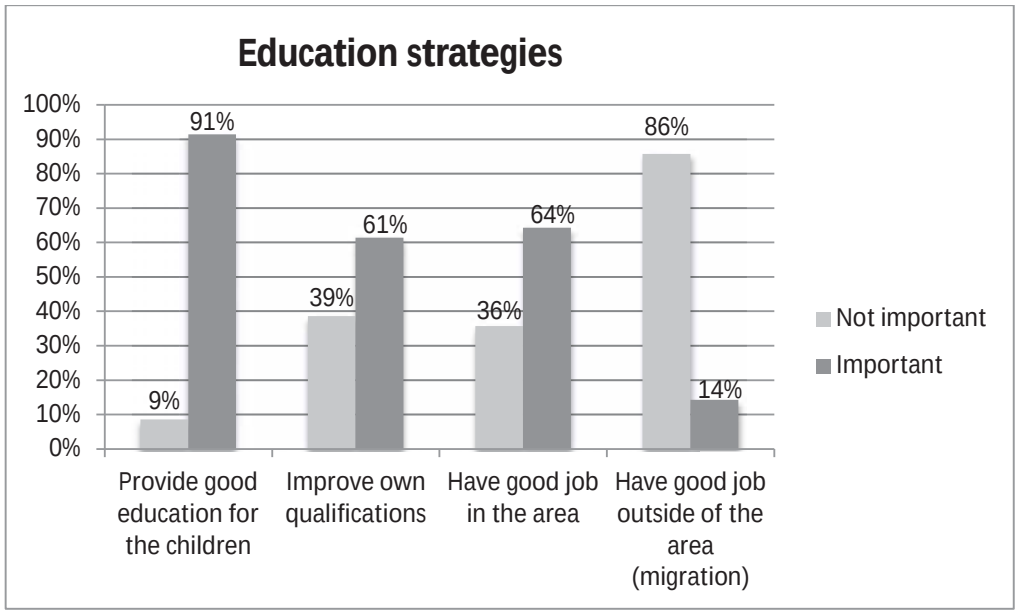


Figure 73. Livelihood improvement strategies in the sphere of education and capacity building

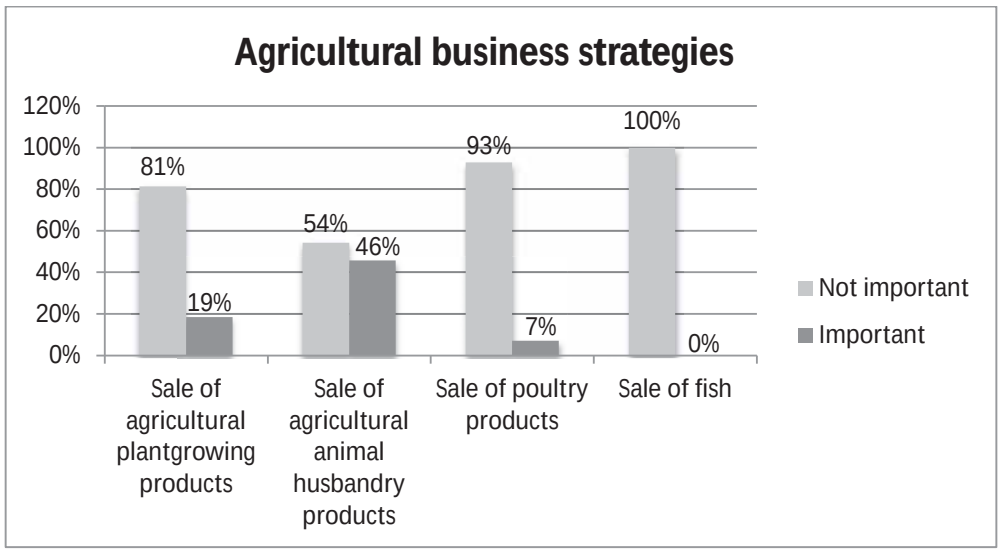


Figure 74. Trading of agricultural products as livelihood improvement strategies for the surveyed households

With regards to agricultural production, increase in trading of crops is considered a suitable strategy by 81% of the respondents, increase in trading of animal husbandry products (meat) is important to 54% of the respondents (Figure 74). Trade of poultry products is not an option for 93% of the households, since as the survey showed poultry is kept for home consumption purposes, while none of the households have the opportunity of keeping and selling fish.

About one fifth of the respondents hopes to improve the wellbeing via non-agricultural business strategies such as doing and trading handicraft products, trading of various products or providing various services to local population (sewing, barbers, taxi drivers). This rather low business initiatives is closely related or even is an outcome both of the lack of financial resources – starting capital and of lack of capacity development options (learning jobs) (Figure 75).

Figure 75. Options to improve wellbeing through business initiatives for the households

4.3 Summary of socio-economic survey findings

Family size in rural areas of Uzbekistan has been decreasing in the last decades and the general trend is to have 2-3 children both due to life conditions and due to state birth control regulations. The average family size in the surveyed rural areas comprises 4-6 people.

Literacy rate in Uzbekistan is reported to be 99%. Virtually all citizens throughout the country do have school education. In order to increase educational level of the population and access to education numerous colleges, lyceums, etc. have been built in the country including rural areas. However, higher educational institutions are located in regional centers (Urgench in our case) or and most of them in the capital city – Tashkent. Not that many people from the remote rural areas thus have possibilities to continue with higher education. In virtually all surveyed households (96%) there are family members with secondary education, i.e. college, lyceums or technical schools. These could be both parents with only secondary education or teenager children who are currently attending secondary educational institutions.

Uzbek families consist of family members of various ages from grandparents enjoying their retirement to kids attending kindergartens. In 57% of the surveyed households there are

unemployed family members with no employment opportunity in the local area. Some respondents from this category as well as from those 13% of employment in 'other spheres' are seasonal migrants to the neighbouring countries, which would work half a year (usually spring-summer) and return home during autumn-winter. In general, average low level of education of surveyed households (secondary and not higher) limits their occupation opportunities at well-paid jobs. Many households are doing subsistence agriculture, i.e. cultivate crops or keep cattle and poultry at their plots. Both male and female family members, which are not officially occupied at jobs are involved is such agricultural activities with the exception of small children or teenagers, attending colleges outside the village.

All land resources in Uzbekistan are the property of the state, which regulates and monitors land use. Most of the available arable land resources are devoted to agricultural production either by the farmers (registered legal entities) or by *dehqon*s (rural households). According to the land legislation *dehqon*s may lease land of the maximum size of 0.12 ha for house buildings/dwellings and additional 0.12 ha for cultivating agricultural crops, which however depends on the availability of 'free' land in the given district or region. In general, land plots in the farm land are considered by the households, the direct land users, to be of lower quality and with higher level of soil salinization compared to the land plots near the houses. With regards to soil quality indicators, rural households rarely know the average *bonitet* of their land plots. Instead rural households can judge or measure the quality of their land based on other parameters such as: visual appearance of the land, white salty cover, the colour of soil in general; yields of planted crops; the groundwater table; and other factors. With regards to the reasons for low quality of the land, households named: practicing monoculture and absence of crop rotation; there used to be a lake or a swamp on the territory of their land plots; the excess use of mineral fertilizers; the poor condition and lack of adequate maintenance of the drainage system. With regards to land reclamation practices in order to improve the land and to bring the degraded parts back to agricultural production, all households reported to undertake some activities, such as: applying more manure (organic fertilizer) in order to restore productivity of land; practicing crop rotation (usually maize or sorghum for forage after winter wheat); practicing more leaching events; planting legumes as a soil productivity restoring plant. Local population does recognize the existing land degradation problems and does understand that there is a high need to reverse this negative trend and to do something to restore the degraded land.

Since households in rural areas rely on subsistence agriculture, rural households do vegetable growing, animal husbandry, wheat cultivation and horticultural production. No fish or bee keeping is possible in the area with degraded land or lack of water resources. Intensive type of agricultural production in the Khorezm region calls for heavy use of both mineral and organic fertilizers. Due to the high costs of agricultural chemicals as pesticide and herbicide, their use has been reducing in the aftermath of independence of Uzbekistan. Instead of pesticides a bio pest control method has been introduced and widely spread in the region.

Two major reasons for keeping livestock have been reported during the survey. First and most important in conditions of subsistence agricultural production is breeding livestock for home consumption but also for selling. The general trend observed during the survey with regards to livestock is that rural households keep bulls as an economic asset or income source, easily marketable in case of necessity (social events like weddings, or funerals, or for supporting educational (university) fees of the children in the household). However, for most of the households the number of livestock and their variety is constrained by the income and the fodder availability. Fodder shortages occur frequently and especially in winter and early spring.

The cases of energy supply deficits became widespread throughout the country and the population is forced to look for alternative energy sources for cooking and heating the houses. The use of alternative energy sources such as solar energy or biogas is not yet practiced in rural areas of Uzbekistan (no respondents mentioned these energy sources), though there have been some initiatives in the capital or big cities to spread the idea and the corresponding technologies to population. In many if not all the cases, the households use several energy sources in order to diversify the risk of no energy supply and to lower the costs. Very rarely households use power generators. In summary, all energy sources used by the surveyed households for cooking or heating, besides cotton stems (which partly can be produced by the households) and fuelwood (which can be, and in some cases illegally, collected in the street) are purchased for money.

Crop cultivation is an essential part of the rural lifestyle. Major crops cultivated by the surveyed households are vegetables, melons, fruits and wheat, maize and sorghum as cover crops after winter wheat. There are two main reasons, which respondents indicated, for cultivation of certain crops. Naturally, households cultivate wheat, rice, vegetables, melons and fruits for own consumption. Maize and sorghum and alfalfa are cultivated for feeding animals. As mentioned already almost no cash crops are grown neither for sale at markets, nor for exchange with neighbours or relatives. Households do not consider their harvests as excellent for none of the crops, with a small exception for some horticultural producers. Since cultivated crops are not enough to meet households' demands, they have to purchase necessary amounts and varieties of crops. Almost all respondents buy additional wheat, rice, vegetables, fruits, melons, some vegetables and maize.

With regards to property, rural households possess first-need items, such as TV sets, refrigerators, laundry machines. Few have computers or air conditioners. No households have agricultural machinery or equipment (due to small land plots and due to lack of financial capital).

The general 'food security' habit of the population and the more so of the rural population (due to the availability of storage facilities compared to urban population living in apartments) is to prepare/store sufficient amounts of the main food items (wheat, potato, other vegetables, fruits, processed/canned/dried fruits and vegetables, flour) for the winter-spring seasons. As household income depends to a large extent on agricultural production and also as the largest share of the budget is spent on food consumption price fluctuations will have a strong effect on the level of both production and consumption, and thus on the households' overall welfare.

Analysis of the expenditures shows that surveyed households spend their budgets in descending order on: food consumption; energy resources; clothing; agricultural inputs; education; hygiene; and other (medicine, primarily).

With respect to income values and sources, most households were unwilling to respond. Analysis of income structure shows that there are various sources of income for the surveyed households including: salaries received in educational organizations; income from selling own produced animal products (meat or cattle in life weight); salaries of family members working in some kind of administrations; pensions of the retired family members; income from sales of own produced crops; remittances from household members working abroad; salaries from non-agricultural sectors (construction, etc.); salaries of households members working in big farm fields; salaries of family members working in public health sectors and agricultural service providing centers; stipends of the teenagers studying at university.

With regards to problems, drawbacks for the wellbeing and development of living conditions of the rural households, respondents listed: lack of human capacity improving or developing options

in the rural or closely located area; lack of kindergartens in rural area; high expenses for education; low level of professional education and experience; lack of machinery and equipment.

Among the ecological/environmental problems households mentioned: soil degradation and in particular exceeding soil salinization; availability and access to clean drinking water; lack of irrigation water due to climate change and other reasons; other problems connected with the dust in atmosphere, poor condition of transportation roads, lack of energy resources supply (natural gas, electricity) as the outcome of ecological or environmental problems.

Rural households do think of strategies or options to improve their living conditions and wellbeing in general. The mentioned strategies have been grouped around educational options (provision of good education for the children; improving qualifications of grown-up family members and finding corresponding or appropriate well paid jobs in the local area); agriculture related business strategies (increase in trading of crops; increase in trading of animal husbandry products (meat)); and non-agricultural business strategies (doing and trading handicraft products, trading of various products or providing various services to local population (sewing, barbers, taxi drivers)). This rather low business initiatives is closely related or even is an outcome both of the lack of financial resources – starting capital and of lack of capacity development options (learning jobs).

5. System approach for efficient utilization of the marginal land – proposal for actions

Between 1950 and 1990, the irrigated croplands of the dryland ecosystems of CA, have expanded from 2.0 to ca. 8 Million ha (Mha). This development of the land use for agriculture increased the value of land. Although still less than 3% of the total CA area became arable due to the constructed irrigation and drainage facilities, this region has since become one of the largest irrigated zones worldwide. Irrigated agriculture in the region is the centerpiece for the livelihoods of about 70% of rural population of 63 million inhabitants. However, the combined impact of regional population growth, expansion of the irrigated cropland, and the tripling of water consumption, has prompted land degradation of the irrigated dryland ecosystems. In some parts, this degradation reached critical levels and hence caused a loss of the land productivity.

Among the most severe factors of the on-going land degradation is a secondary soil salinization, caused primarily by over-application of irrigation water into ill-levelled fields. Such over-application and ill-functioning drainage result in quickly rising saline groundwater to unacceptably shallow levels. This is exemplified in the case of the Khorezm province in northwest Uzbekistan, where bio-physical and socio-economic factors enhance the degradation of the agricultural cropland.

Due to this complexity, a search for solutions must follow a system approach and should be based on a thorough knowledge and understanding of these factors. A mapping of the degraded croplands in the Khorezm region allowed for an inventory and a classification of the irrigated marginal land, including those areas that can benefit from mitigation actions.

Options for reclaiming of marginal irrigated land

Functional drainage is of undisputable importance in agriculture with artificial irrigation. Traditionally, narrow measures of coping with salinization in Khorezm consisted of pre-season leaching and maintaining magistral and inter-farm drains. However, maintaining the drainage network is expensive and even when conducted it does not warrant a sufficient removal of salts

from the root zone: Hence present leaching efforts consuming ca. 25% of all freshwater resources are ineffective for salt removal, which however is often out of control of the farming population. On the other hand, land salinization is enhanced due to unleveled fields, water over-application, shallow saline groundwater, which can be tackled by farmers. Further research and the dissemination of findings for effective land reclamation and maintenance of irrigated lands in the Khorezm province are urgently necessary. In this respect, analyses of the efficiency of existing drainage networks (e.g., using DRAINMOD computer simulation model) allows for assessing the necessity of maintaining or reconstructing the drainage facilities.

Conservation agriculture practices in combination with laser-guided land leveling have been successfully tested in Khorezm. These practices showed promising results from both an economic and productivity prospective. Moreover, considerable water saving can be achieved, while groundwater tables can be kept at the favorable depth. Saved water may be used for more remote fields. This approach is rather new in the region and would need a further development in close collaboration with farmers and the local administration.

Cropping pattern, timing and amounts of water application are typically influencing factors of on-going salinization. Flexible irrigation scheduling based on scientific principles, but easy-to-implement by farmers, should be developed and tested in participation with them.

Afforestation and the use of vegetation, such as halophytes in the highly saline, difficult to reclaim land has received wide attention not only of scientific community, but also from the farmers and the governmental land and water management organizations. In Uzbekistan, irrigated abandoned and highly saline land is now widely used for reclamation using Glycyrrhiza glabra (licorice). Research of the possibility to obtain increased yields with genetically modified, salt-tolerant wheat species in the saline land is being tested. There are also examples of the use of vegetation as bio-drainage and fodder for domestic animals.

System approach considers not only testing different approaches, but should necessarily concentrate on the acceptance of these approaches by farmers and land and water management organizations. Numerous research findings including those highly effective ones remain unaccepted. Therefore, participatory approach with the farmers as main actors is of paramount necessity. Only this approach can assure success and wide acceptance of the technologies.

Institutional frame conditions are important to study and consider since a change in land use policies of marginal land may be necessary to implement some options. The institutional settings must be screened for their role in providing direct economic benefits to rural households, income for the government via taxes, and lead to an overall improvement in ecological conditions in the region.

With regards to site selection, the following issues, both derived from surveys and from the discussion with experts' group, have to be taken into consideration:

- Research sites/demo plots should not be located too far away from the scientific and office infrastructure. Otherwise logistics becomes cumbersome.
- On the other hand, as much impact should be reached as possible, thus the demo plot should be located in the vicinity of populated areas
- Since it is planned to test and demonstrate a complex set of technologies on water and land management it will make sense to select a rather large unit – a farm, a Water Consumer Association, etc.
- On the other hand such a large unit must have land of various degradation degrees and should have highly marginalized patches of land in order to test the complex set of technologies.

With regards to technologies to be tested, implemented and disseminated, the following issues have to be considered:

- First of all, the technology should aim at altering the reasons of land and other resource degradation, but not always for mitigating or coping with consequences.
- The root of problems should be identified and set as a basis
- Secondly, technologies should be grouped according to the land degradation degrees – classes, so site specific technological packages should be developed, which would include the set of measure instead of standalone technological recommendations
- Technologies for dissemination should also include aspects for improvement of land, water, farm management, since in many cases the poor management capacities of the land users are at the root of the problems
- The recommended technological packages should be not worse compared to the current practices and should not negatively affect other aspects of wellbeing of the rural population. For example, land improvement options through planting salt tolerant crops should not threaten the food security or income opportunities for the local population
- Stakeholders should be involved from the very beginning – research site selection, shaping technological packages, since the land users as the target stakeholders should be the clients of the project and should help in shaping the best solutions for land improvement and such
- Technological packages should not necessarily be comprised of new technologies, innovations, but should rather be selected from the available and tested technologies by other development organizations and institutions active in the area through exchange of ideas. However, with caution, since the technologies should be close to reality, that is suitable for Khorezm or later on to Karakalpakstan conditions.

In general, since the project is going to deal with synthesis of the existing packages, a very good coordination efforts are needed.

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Annex 1. Questionnaire in the Russian language

ОПРОСНИК ДЛЯ ИЗУЧЕНИЯ ДОМОХОЗЯЙСТВ

Текущая практика использования деградированных земель, их влияние на социально-экономическое положение домохозяйств и потенциал для улучшения

Имя респондента: _____ Район: _____

Дата проведения интервью: _____ Кишлак: _____

Имя интервьюера: _____ Махалля/Адрес : _____

I. ОБЩАЯ ИНФОРМАЦИЯ О ДОМОХОЗЯЙСТВЕ

1) Какое расстояние от вашего дома (участка) до ближайшего дехканского рынка (км, м) _____

2) Сколько человек у вас в семье, включая временно отсутствующих? _____

3)

N	Имя члена домохозяйства	Пол **(Ж, М)**	Возраст **(лет)**	Образование **(Код 1)**	Род занятий в настоящее время **(Код 2)**	Занят ли этот член домохозяйства в производстве с\х культур на вашем участке?	Занят ли этот член домохозяйства в уходе за животными (КРС или МРС) на вашем участке?
	1	2	3	4	5	6	7
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							

II. ЗЕМЕЛЬНЫЕ РЕСУРСЫ

4)

Хозяйство	Общая площадь, га	Из них земля хорошего качества, га или %	Из них земля плохого качества, га или %	Средний балл бонитета	Засоленность, есть или нет
Приусадебный участок (около дома)					
Дехканское хозяйство (тамарка)					
Фермерское хозяйство					

5) Как вы оцениваете состояние/качество ваших земельных участков?

5.a Не знаю ничего

5.b Визуально: земля покрыта белым слоем

5.c По урожаю: низкий или высокий урожай

5.d Грунтовые воды близко к поверхности

5.e Ничего не растет

5.f Другое_____

6) Почему качество ваших земель низкое? Что привело к этому?

6.a Раньше здесь было болото, озеро

6.b Слишком много сажали (монокультура)

6.c Слишком много удобряли

6.d Плохо работает дренаж (коллектор не чистят)

6.e Другое_____

7) Что вы делаете для улучшения состояния ваших земельных участков?

7.a Ничего не делаю

7.b Делаю севооборот (сажаю люцерну, кукурузу или клевер)

7.c Сажаю определенные культуры (бобовые)

7.d Делаю больше промывку

7.e Вношу больше удобрений (навоза)

7.f Другое_____

III. СЕЛЬСКОХОЗЯЙСТВЕННОЕ ПРОИЗВОДСТВО

8) Занимаетесь ли Вы следующими видами сельскохозяйственной деятельности?

Вид деятельности	Да	Нет
Зерноводство		
Хлопководство		
Овощеводство		
Садоводство		
Животноводство		
Рыбоводство		
Пчеловодство		

9) Используете ли вы в своем домашнем хозяйстве удобрения и сельскохозяйственные химикаты?

Вид деятельности	Да	Нет	Не знаю
Минеральные удобрения			
Органические удобрения (навоз)			
Пестициды			
Гербициды			

10) Навоз вы получаете от домашнего скота? **(Да, Нет)**_____

11) Покупаете ли вы навоз для использования на своем зем участке? **(Да, Нет)**_____

IV. ЖИВОТНОВОДСТВО

12)

N	Домашние животные	У вас в домохо-зяйстве есть эти животные ?	Сколько **(кол-во)?**	Какой у вас основной источник корма? **(Код 3)**	Вы содержите это животное для своего потребления или для продажи его и продукции из него? **(свое потребление; продажа)**	Где вы продаете продукцию животновод ства? **(Код 4)**
1	Быки					
2	Коровы					
3	Телята					
4	Овцы					
5	Козы					
6	Птица					
7	Ослы					
8	Лошади					

Код 3 Источник корма для животных

3.a Пасутся около каналов и в поле
3.b Пасутся на пустыре
3.c Корм выращенный в домохозяйстве
3.d Корм, заработанный на других фермерских хозяйствах
3.e Приобретенный корм на рынке
3.f другое (уточните _____)

Код 4 Реализация сельхоз продукции

4.a Продажа около дома
4.b Продажа соседям
4.c Продажа через местный магазин
4.d Продажа через местный рынок
4.e Продажа скупщикам (розничным торговцам) на улице
4.f другое (уточните _____)

V. МНЕНИЯ ОТНОСИТЕЛЬНО ДОСТУПА К КОРМАМ

13) Испытывает ли ваше домохозяйство нехватку кормов для животных? (Да, Нет)_____

14) Случается ли нехватка корма в течение года? (Да, Нет)_____

15) В какие месяцы года случается такая нехватка чаще всего? _____

16) Как часто в течение года вы покупаете корм животным?_____

17) Кто является ответственным за доставку корма в вашем домохозяйстве? **(Код 5)**_____

Код 5

5.a Дети женского пола
5.b Дети мужского пола
5.c Взрослые женского пола
5.d Взрослые мужского пола

VI. ИСТОЧНИК ЭНЕРГОРЕСУРСОВ ДЛЯ ОБОГРЕВА И ПРИГОТОВЛЕНИЯ ПИЩИ

18)

N	Источник энергоресурсов	Какой из энергоресурсов вы используете? (**Да, Нет**)	Для приготовления пищи? (**Поставьте 1**)	Для обогрева? (**Поставьте 1**)	Где вы берете этот энергоресурс? (**Код 6**)	Какая единица измерения энергоресурсов?	Какое количество энергоресурсов вы используете в год?	Какую часть энергоресурсов вы покупаете в год? (**%**)	По какой цене вы покупаете энергоресурс? (**сум за единицу**)
	1	2	3	4	5	6	7	8	9
1	Сжиженный газ								
2	Керосин								
3	Дизел (салярка)								
4	Бензин								
5	Природный газ								
6	Уголь								
7	Дрова								
8	Гузапая								
9	Навоз								
10									

Код 6. Источник энергоресурсов

7.a Произведен на своем зем участке
7.b Приобретен у соседей/родственников
7.c Приобретен у местных фермеров
7.d Куплен на местном рынке
7.e Куплен у розничных торговцев
7.f Другое _____

Код 7. Гендер

8.a Дети женского пола
8.b Дети мужского пола
8.c Взрослые женского пола
8.d Взрослые мужского пола

19) Вы довольны имеющимся количеством энергоресурсов для приготовления пищи? (Да, Нет)_____

20) Вы довольны имеющимся количеством энергоресурсов для отопления? (Да, Нет _____

21) В какие месяцы обычно случаются проблемы с недостатком топлива? (название месяцев)_____

22) Кто в вашем домохозяйстве ответственный за доставку топлива для приготовления пищи? (**Код 7**)_____

23) Кто в вашем домохозяйстве ответственный за доставку топлива для отопления? (**Код 7**)_____

24) Использует ли ваше домохозяйство электрогенератор? _____

VII. СЕЛЬСКОХОЗЯЙСТВЕННЫЕ КУЛЬТУРЫ

25)

N	Культуры	Какие культуры вы выращиваете?	Какие три культуры самые важные? **(1-3)**	Посевная площадь (га, **м^2**)	Почему вы выращиваете данную культуру? **(Код 8)**	Какой урожай вы собираете? **(кг)**	Как вы оцениваете урожай? **(Код 9)**	Какие культуры вы продаете?	Какую часть урожая вы продаете? **(%)**	Где Вы продаете? **(Код 10)**	Какие культуры вам необходимо покупать?	Какую часть культуры вы покупаете? **(%)**	Где вы покупаете эти культуры? **(Код 11)**
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Пшеница												
2	Рис												
3	Кукуруза												
4	Сорго												
5	Подсолнечник												
6	Овощи												
7	Бахчевые												
8	Фруктовые деревья												
9	Люцерна												
10	Хлопок												

Код 8. Причины для выращивания

9.a Для собственного потребления
9.b На корм домашнему скоту
9.c Для использования как топливо
9.d Для получения дохода от продажи
9.e Для обмена с соседями
9.f Для улучшения качества земли
9.g Другие культуры невозможно выращивать (низкое качество земли)
9.h Другое _____

Код 9. Удовлетворение урожайностью

10.a Очень плохо
10.b Плохо
10.c Удовлетворительно
10.d Хорошо
10.e Отлично

Код 10. Реализация урожая

11.a Продаем около своего дома
11.b Посещаем соседей и продаем им
11.c Даем местному магазину для продажи
11.d Везем для продажи на местном рынке
11.e Продаем торговцам с улицы
11.f Другое _____

Код 11. Источник дополнительного количества с\х культур

12.a Соседи / родственники
12.b Местные фермеры
12.c Местный рынок
12.d Торговцы на улице
12.e Другое _____

VIII. ИМУЩЕСТВО И ЗАПАСЫ

26) Имеется ли в вашем домашнем хозяйстве следующее имущество?

Вид имущества	Да	Нет
Грузовая машина		
Сельхоз техника		
Легковой автомобиль		
Мотоцикл		
Телевизор		
Холодильник		
Стиральная машина		
Кондиционер		
Компьютер/ноутбук		

27)Делают ли обычно в вашем домашнем хозяйстве продовольственные запасы на зимний период?

Наименование	Да	Нет	Количество	Собственного производства	Куплено
Зерно					
Картофель					
Овощи					
Фрукты					
Консервированные продукты					
Мука					

IX. СТРУКТУРА РАСХОДОВ ДОМОХОЗЯЙСТВА

28) Какова доля расходов на топливо в общем бюджете Вашего д/х? (%)_____

29) Какова доля расходов на питание в общем бюджете Вашего д/х? (%)_____

N	**Расходы**	**%**
1	Потребление пищи (дома и вне)	
2	Одежда и ее ремонт (пошив)	
3	Средства гигиены	
4	Деньги потраченные на образование (школа, лицей/колледж универ и т.д.)	

5	Покупка топлива для приготовления пищи и отопления	
6	Расходы на выращивание культур на собственной земле	
7	Содержание и корм домашнего скота	
8	Другое (важное)_____	

X. СТРУКТУРА ДОХОДОВ ДОМОХОЗЯЙСТВА

30)

N	Источник дохода	Имеет ли Ваше д/х эти источники дохода **(Да; Нет)**	Какой самый важный источник дохода для Вашего д/х? **(поставьте 1)**	Какой источник дохода второй по степени важности для Вашего д/х? **(поставьте 1)**	Каков примерный размер годового дохода от этих источников? **(сум)**	Какова доля этих источников в общем доходе д/х? **(%)**
1	Доход от продажи собственного урожая					
2	Доход от продажи продуктов от домашнего скота					
3	Зарплата за работу на ф/х					
4	Пенсия					
5	Стипендия					
6	Денежные переводы из-зарубежа					
7	Зарплата за работу в госорганизациях					
8	Зарплата за работу на МТП, АВП, т.д.					
9	Зарплата за работу в сфере образования					
10	Зарплата за работу в сфере здравоохранения					
11	Доход от частного бизнеса вне сферы с/х (такси, парикмахерская, магазин)					
12	Доход от собственного ф/х					

31) На что хватает доходов всех членов Вашего домашнего хозяйства?

29.a Достаточно на питание и другие расходы
29.b Достаточно только на питание
29.c Если ограничиваться, то только на питание
29.d Не достаточно на питание

30) Кто из членов Вашего домашнего хозяйства является ответственным за финансовые вопросы?

30.a Вы 30.b Муж/жена
30.c Оба супруга 30.d Дедушка
30.e Бабушка 30.f Другие

XI. СОЦИАЛЬНО-ЭКОНОМИЧЕСКИЕ ПРОБЛЕМЫ ДОМОХОЗЯЙСТВА

32) Как вы оцениваете следующие проблемы?

Проблемы	Оценки			
	Не важно	Менее важно	Важно	Очень важно
Высокие затраты на образование для детей	1	2	3	4
Отсутствие профессиональных учебных заведений вблизи от места жительства	1	2	3	4
Нет предложений для повышения квалификации вблизи от места жительства	1	2	3	4
Отсутствие детских дошкольных учреждений вблизи от места жительства	1	2	3	4
Отсутствие финансовых средств/кредитов	1	2	3	4
Занятость делами в домашнем хозяйстве	1	2	3	4
Отсутствие подходящей работы в пределах досягаемости от места жительства	1	2	3	4
Подходящая работа есть только за пределами региона/страны	1	2	3	4
Недостаточный уровень вашего образования и профессиональной квалификации	1	2	3	4
Поддержка собственного бизнеса (см. инструкцию)	1	2	3	4
Нехватка машин и оборудования для ведения вашего хозяйства	1	2	3	4
Нехватка рабочей силы в вашем хозяйстве	1	2	3	4
Наличие бюрократических и законодательных барьеров при ведении бизнеса	1	2	3	4
Задержки с получением пенсий, пособий и др.	1	2	3	4
Недостаточный уровень обеспечения услугами здравоохранения	1	2	3	4
Задержки с подачей оросительной воды	1	2	3	4

33) Назовите самые значительные **экологические проблемы** в вашем регионе?

33.a

33.b

33.c

XII. СТРАТЕГИИ К УЛУЧШЕНИЮ УСЛОВИЙ ЖИЗНЕДЕЯТЕЛЬНОСТИ

34) Как вы планируете улучшить положение своего домохозяйства?

Возможности	Оценки			
	Не важно	Менее важно	Важно	Очень важно
Образование				
Дать хорошее образование для детей	1	2	3	4
Повысить собственную профессиональную квалификацию	1	2	3	4
Иметь работу в родном регионе	1	2	3	4
Иметь работу за пределами родного региона (миграция)	1	2	3	4
Основание предприятий вне сферы сельского хозяйства				
Открыть ремесленное производство	1	2	3	4
Начать частную торговлю	1	2	3	4
Основать собственное предприятие по услугам	1	2	3	4
Продажа сельскохозяйственной продукции				
Реализовывать продукцию растениеводства	1	2	3	4
Реализовывать продукцию животноводства	1	2	3	4
Реализовывать продукцию птицеводства	1	2	3	4
Реализовывать продукцию рыбоводства	1	2	3	4
Другое				

ЭТО КОНЕЦ ОПРОСА

ЕЩЕ РАЗ БОЛЬШОЕ СПАСИБО ЗА ВАШИ ОТВЕТЫ И ЗА УДЕЛЕННОЕ ВРЕМЯ!

Качество ответов (**Код 12**) _____

Код 12.

17.a. очень низко
17.b низко
17.c удовлетворительно
17.d хорошо
17.e отлично

Annex 2. Questionnaire in the Uzbek language

ОПРОСНИК ДЛЯ ИЗУЧЕНИЯ ДОМОХОЗЯЙСТВ

Текущая практика использования деградированных земель, их влияние на социально-экономическое положение домохозяйств и потенциал для улучшения

Респондент Исми Шарифи: _____ Район: _____

Интервью ўтказадиган сана: _____ Қишлоқ: _____

Интервью олувчи: _____ Маҳалла/Манзил : _____

I. УЙ ХЎЖАЛИК ҲАҚИДА УМУМИЙ МАЪЛУМОТ

1) Уйингиздан (участкадан) якин орадаги деҳқон бозоригача бўлган масофа (км, м) _____

2) Уйда йўкларни ҳисобга олганда оилангизда нечта одам бор? _____

3)

N	Уй хўжалик аъзосининг исми	Жинси **(Ж, М)**	Ёш **(йил)**	Маълумоти(**Код 1)**	Хозирги кунда иш фаолияти **(Код 2)**	Бу одам сизнинг ер майдонингизда қишлоқ хўжалик экинлари экиш билан машғулми?	Бу одам ер майдонингизда уй ҳайвонлари боқишда машгулми (йирик ёки майда орамол)?
	1	2	3	4	5	6	7
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							

II. ЕР РЕСУРСЛАРИ

4)

Хўжалик	Умумий майдон, га	Шундан яхши сифатга эга ер майдон, га еки %	Шундан ёмон сифатга эга ер майдон, га еки %	Ўртача балл бонитет	Шўрланиш (бор, йўқ)
Томорқа (уй ёнида)					
Деҳқон хўжалиги (томорка)					
Фермер хўжалиги					

5) Ер майдонларингиз сифати/ҳолатини қандай баҳолайсиз?

5.a Ҳеч нарса билмайман

5.b Кўринишдан: ер устида ок рангли коплам бор

5.c Ҳосилга қараб: паст ёки юқори ҳосилдорлик

5.d Ер ости сувларининг сатҳи ер устига якин

5.e Ҳеч нарса усмайди

5.f Бошқа_____

6) Ер сифати йўқолишига сабаб?

6.a Аввал бу ерда кўл, ботқоқ бўлган

6.b Бир хил экин кўп экилган (монокультура)

6.c Кўп миқдорда ўғитланган

6.d Дренаж яхши ишламайди (коллекторни тозаламайдилар)

6.e Бошқа_____

7) Ер майдонингиз сифати яхшилаш учун нима қиласиз?

7.a Ҳеч нарса

7.b Алмашлаб экишни жорий қиламан (маккажўхори ёки беда)

7.c (дукакли экинлар)

7.d Кўпроқ туздан ювиш (промывка) жорий қиламан

7.e Кўпрок табиий ўғит (гўнг) ишлатаман

7.f Бошқа_____

Қуйидаги ер турлари мавжудми ва нима экилади?				
№	Ер холати	Экин тури	Майдони, га	Ҳосил-дорлик
1	Шўрхок ер			
2	Ботқоқлашган қамишзор			
3	Бутазор ўсган яйловлар			
4	Суғориладиган партов бўз ер			
5	Бутазор ўсган суғориладиган партов бўз ер			

III. ҚИШЛОҚ ХЎЖАЛИК ИШЛАБ ЧИҚАРИШ

8) Қишлоқ хўжалик фаолиятнинг қўйидаги қайси турларидан фойдаланасиз?

Фаолиятнинг тури	Ҳа	Йўқ
Галлачилик		
Пахтачилик		
Сабзавотчилик		
Боғдорчилик		
Чорвачилик		
Баликчилик		
Асалчилик		

9) Уй хўжаликингизда ўғит ва қишлоқ хўжалик химикатлардан фойдаланасизми ?

Фаолиятнинг тури	Ҳа	Йўқ	Билмайман
Минерал ўғитлар			
Органик ўғитлар (гўнг)			
Пестицидлар			
Гербицидлар			

10) Уй ҳайвонларидан маҳаллий ўғитларни оласизми? **(Ҳа, Йўқ)**_____

11) Ер майдонингизда ишлатиш учун маҳаллий ўғитларни сотиб оласизми? **(Ҳа, Йўқ)**_____

IV. ЧОРВАЧИЛИК

12)

N	Уй ҳайвонлари	Уй хўжаликингизда қуйидаги ҳайвонлар бор ми?	Нечта ()?	Ем-хашакнинг асосий манбаи? (**Код 3**)	Бу ҳайвонни ўзингиз ишлатиш учун сақлайсизми ёки ушбу ҳайвонни ўзини ва унинг маҳсулотини сотиш учун? (**Ўз истъемоли; сотиш**)	Чорва маҳсулотларини қаерда сотасиз? (**Код 4**)
1	Буқалар					
2	Сигирлар					
3	Бузоқлар					
4	Қўйлар					
5	Эчкилар					
6	Парранда					
7	Эшаклар					
8	Отлар					

Код 3 Ем хашакнинг асосий манбаи

3.a Канал ва далада ўзлари озиқланади
3.b Бўш майдонларда
3.c Уйда етиштирган ем-хашак3.d Бошқа фермер хўжаликларда ишлаб топилган
3.e Бозордан сотиб олинган
3.f Бошқа (аниқлаб беринг _____)

Код 4 Қишлоқ хўжалик маҳсулотларни сотиш

4.a Уй олдидан сотиш
4.b Қўшниларга сотиш
4.c Маҳаллий дукон орқали сотиш
4.d Маҳаллий бозорда сотиш
4.e Кўчадаги олиб сотувчиларга сотиш
4.f Бошқа (аниқлаб беринг _____)

V. ЕМ -ХАШАК ТЎҒРИСИДА ФИКРЛАРИ

13) Уй хўжаликингизда ем- хашакнинг етишмаслигини сезасизми? (Ҳа, Йўқ)_____

14) Ем-хашакнинг етишмовчилиги йил давомида такрорланиб турадими ? (Ҳа, Йўқ)_____

15) Йилнинг қайси ойларида бундай етишмовчилик кўпроқ бўлади ? _____

16) Йил давомида ем-хашакни қанчалик тез сотиб оласиз ?_____

17) Уй хўжаликингизда ем-хашакни етказиб беришга ким маъсул? (**Код 5**)_____

Код 5

5.a Ёш қиз болалар
5.b Ёш ўғил болалар
5.c Аёллар
5.d Эркаклар

VI. ИССИТИШ ВА ОВҚАТ ТАЙЁРЛАШ УЧУН ЭНЕРГИЯ РЕСУРСЛАРИ

18)

N	Энергия ресурсларнинг манбаи	Қайси энергия ресурсларидан фойдаланасиз? (Ҳа, Йўқ)	Овқат тайёрлаш учун? (**1 ёзинг**)	Исситиш учун? (**1 ёзинг**)	Бу энергия ресурсини қаердан оласиз? (**Код 6**)	Энергия ресурсининг ўлчов бирлиги?	Энергия ресурсининг йилда ишлатилиш миқдори?	Ушбу энергия ресурслардан қайси қисмини сотиб оласиз? **(%)**	Энергия ресурсини қанчага сотиб оласиз? **(бирлик учун сўм)**
	1	2	3	4	5	6	7	8	9
1	Суюқ газ								
2	Керосин								
3	Дизел (салярка)								
4	Бензин								
5	Табиий газ								
6	Кўмир								
7	Ўтин								
8	Ғўза поя								
9	Гўнг								
10									

Код 6. Энергия ресурсларнинг манбаи

6.a Ўз ер майдонидан
6.b Қўшни/қариндошлардан сотиб олинган
6.c Маҳаллий фермерлардан сотиб олинган
6.d Маҳаллий бозордан сотиб олинган
6.e Чакана савдодан сотиб олинган
6.f Бошқа _____

Код 7. Гендер

7.a Ёш қиз болалар
7.b Ёш ўғил болалар
7.c Аёллар
7.d Эркаклар

19)Сиз овқат тайёрлаш учун энергия ресурсларнинг миқдоридан қоникасизми? (Ҳа, Йўқ)_____

20)Исситиш учун энергия ресурслар миқдоридан қоникасизми? (Ҳа, Йўқ _____

21)Қайси ойларда ёқилғи материаллар етишмаслиги билан боғлиқ бўлган муаммолар туғилади? (ойларни номланг)_____

22)Овқат тайёрлаш учун ёқилғи материаллар етказиш учун ким маъсул? (**Код 7**)_____

23)Исситиш учун ёқилғи етказиш учун ким маъсул? (**Код 7**)_____

24)Уй хўжаликингизда электрогенератор ишлатиладими? _____

VII. ҚИШЛОҚ ХЎЖАЛИК ЭКИНЛАРИ

25)

N	Экинлар	Етиштира етган экин тури?	Энг муҳим экинларда н учта қайси? **(1-3)**	Экилад иган ер майдон и (га, **м^2**)	Шу экинни етиштири ш сабаблари ? (**Код 8**)	Ҳосилдор лик? (**кг**)	Ҳосилдо рликни қандай бахолайс из? (**Код 9**)	Қайси экинларн и сотасиз?	Ҳосилнин г қайси қисмини сотасиз? **(%)**	Қаерда сотасиз ? (**Код 10**)	Қайси экин сотиб олишингиз керак?	Экинларни нг қайси қисмини сотиб олишингиз керак? **(%)**	Шу экинлар ни қаерда сотиб оласиз? (**Код 11**)
	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Галла												
2	Шоли												
3	Маккажўхори												
4	Жўхори												
5	Кунгабоқар												
6	Сабзавотлар												
7	Полиз экинлари												
8	Мева дарахт												
9	Беда												
10	Пахта												
11													

Код 8. Етиштиришнг сабаблари

8.a Ўз истеъмоли учун
8.b Ем-хашак сифатида
8.c Ёқилғи сифатида
8.d Сотишдан даромад олиш
8.e Қўшнилар билан алмошиш
8.f Ер сифатини яхшилаш
8.g Бошқа экинларни етиштиришни имкони йўқ (ернинг паст сифати туфайли)
8.h Бошқа _____

Код 9. Ҳосилдорликдан қоникиш

9.a Жуда ёмон
9.b Ёмон
9.c Қоникарли
9.d Яхши
9.e Аъло

Код 10. Ҳосил сотиш

10.a Уй ёнида сотамиз
10.b Қўшниларга бориб уларга сотамиз
10.c Маҳаллий дўконга сотиш учун берамиз
10.d Маҳаллий бозорда сотиш учун олиб кетамиз
10.e Кўчадаги олиб сотувчиларга сотиш
10.f Бошқа _____

Код 11. Қишлоқ хўжалик экинларнинг қўшимча миқдорнинг манбаи

11.a Кушнилар / кариндошлар
11.b Махаллий фермерлар
11.c Махаллий бозор
11.d Кўчада сотиб оламиз
11.e Бошқа _____

VIII. МОЛ-МУЛК ВА ҒАМЛАШ

26) Уй хўжаликингизда қуйидаги мол-мулк мавжудми?

Шахсий мол-мулк тури	Ҳа	Йўқ
Юк машина		
Қишлоқ хўжалик техника		
Енгил автомобиль		
Мотоцикл		
Телевизор		
Холодильник		
Кир ювиш машина		
Кондиционер		
Компьютер/ноутбук		

27) Қиш фаслида истъемол қилиш учун хўжалигинзда озиқ-овқат (запас) ғамлайсизми?

Наименование	Ҳа	Йўқ	Миқдор	Ўзи қилган	Сотиб олинган
Дон					
Картошка					
Сабзавотлар					
Мевалар					
Консерваланган маҳсулот					
Ун					

IX. УЙ ХЎЖАЛИК САРФ-ХАРАЖАТЛАРНИНГ ТАРКИБИ

28) Уй хўжаликингизда ёқилғи учун умумий бюджетнинг неча фоизи ишлатилади? (%)_____

29)Овқатланишга харажатлари учун умумий бюджетнинг неча фоизи ишлатилади? (%)_____

N	**Сарф-харажатлар**	**%**
1	Овкатланиш (уйда ва уй ташқарида)	
2	Кийим-кечак ва уларнинг таъмирлаш (тиктириш)	
3	Гигиена маҳсулотлари	
4	Таълимга сарф қилинган пул (мактаб,лицей/коллеж, университет ва ҳоказо)	
5	Ёқилғи овқат тайёрлаш ва исситиш учун сотиб олиш	

6	Ўз ерингизда экин етиштириш учун сарф-харажатлар	
7	Уй ҳайвонларнинг парвариши ва ем-хашак учун	
8	Бошқа (муҳим)_____	

X. УЙ ХЎЖАЛИК ДАРОМАДНИНГ ТАРКИБИ

30)

N	Даромаднинг манбаи	Қуйидаги даромад манбалардан қайси бири уй хўжаликингизда мавжуд **(**Ҳа, Йўқ**)**	Уй хўжаликингиз учун қуйидагилардан қайси бири энг муҳими? **(1 ёзинг)**	Уй хўжаликингиз учун қуйидагилардан қайси бири муҳимлиги буйича 2нчи ўринда туради? **(1 ёзинг)**	Қуйидагиларда н даромаднинг йиллик Ўртача миқдори? **(сўм)**	Умумий бюджетдаги қуйидагиларнинг фоиз миқдори? **(%)**
1	Ўз етиштирилган ҳосилни сотишдан олинган даромад					
2	Ўз чорва маҳсулотларини сотишдан олинган даромад					
3	Фермер хўжаликда ишлаб олинган ойлик маоши					
4	Нафака					
5	Стипендия					
6	Чет давлатлардан пул ўтказмалари					
7	Давлат ташкилотларда ишлаб олинган иш маоши					
8	МТП, АВП ва ҳоказо ишлаб олинган иш маоши					
9	Таълим соҳасида ишлаб олинган иш маоши					
10	Соғлиқни сақлаш соҳасида ишлаб олинган иш маоши					
11	Қишлоқ хўжаликдан ташқари хусусий тадбиркорликдан олинган даромад (такси, сартарошхона, дўкон)					
12	Ўз фермер хўжаликдан даромад					

31) Уй хўжаликингиздаги хамма аъзоларининг даромадлари нималарга етарди?

31a Овқатланиш ва бошқа харажатлар учун етарли

31.b Фақатгина овқатланиш учун етарли

31.c Овқатланиш учун етарли эмас

32) Уй хўжаликингизнинг хамма аъзоларининг молиявий /пул маблағлари учун ким маъсул?

32.a Сиз 32.b Эр/Хотин

32.c Иккиласи 32.d Бува 32.e Буви 32.f Бошқалар

XI. УЙ ХЎЖАЛИКДАГИ ИЖТИМОИЙ ИҚТИСОДИЙ МУАММОЛАРИ

33) Қўйидаги муаммоларни қандай баҳолайсиз?

Муаммолар	Ҳа/Йўқ	Муҳим эмас	Муҳим
Болаларимнинг таълим олиш учун кўп сарфланади			
Яшаш жойи яқинида ўқув муассасаларнинг йўқлиги			
Яшаш жойи яқинида малака оширишга имконият йўқлиги			
Яшаш жойи яқинида мактабгача тарбия муассасаларининг йўқлиги			
Маблағ/кредит йўқлиги			
Уй хўжалигини бошқариш туфайли бандлиги			
Яшаш жойи яқинида мос келадиган иш жой йўқлиги			
Мос келадиган иш жойи фақат вилоят/мамлакат ташқарида мавжуд			
Сизнинг таълим ва малакангиз етарли эмас			
Ўз бизнесга ёрдам			
Хўжаликингиз бошқариш учун машина ва асбобларнинг етишмаслиги			
Иш кучи етишмаслиги			
Бизнес фаолияти юритишда бюрократик ва қонунчилик тўсикларнинг мавжудлиги			
Нафака, пособие ва ҳоказо вақтида берилмайди			
Соғликни сақлаш хизматлари етарли даражада эмас			
Суғориш учун сув вақтида берилмайди			

34) Ўз худудингиздаги энг муҳим **экологик муаммоларни** номлаб беринг?

34.a

34.b

34.c

XII. ҲАЁТ ВА ФАОЛИЯТИНИНГ ЯХШИЛАШНИ СТРАТЕГИЯСИ

35) Ўз хўжаликингизни қандай қилиб яхшилашни режаллаштирасиз?

Имкониятлар	Баҳолаш			
	Муҳим эмас	Анча муҳим эмас	Муҳим	Жуда муҳим
Таълим				
Болаларга яхши таълимни таъминлаб бериш	1	2	3	4
Ўз мутахассислик малакасини ошириш	1	2	3	4
Яшаш жойимда яхши иш жойига эга булиш	1	2	3	4
Яшаган ерим ташқарида иш топиш (миграция)	1	2	3	4
Қишлоқ хўжалик ташқари фаолият юритиш				
Ҳунармандчиликни ташқил қилиш	1	2	3	4
Хусусий савдони ташқил қилиш	1	2	3	4
Хусусий маиший хизматларни ташқил қилиш	1	2	3	4
Қишлоқ хўжалик маҳсулотларни сотиш				
Ўсимликчилик маҳсулотни сотиш	1	2	3	4
Чорвачилик маҳсулотни сотиш	1	2	3	4
Паррандачилик маҳсулотни сотиш	1	2	3	4
Баликчилик маҳсулотни сотиш	1	2	3	4
Бошқа				

Бу суровноманинг

ВАҚТИНГИЗНИ АЖРАТИБ САВОЛЛАРГА ЖАВОБ БЕРГАНИНГИЗ УЧУН ЯНА БИР МАРТА КАТТА РАҲМАТ!

Жавоблар сифати (**Код 12)** _____

Код 12.

12.a. Жуда паст 12.b Паст
12.c Қоникарли 12.d Яхши
12.e Аъло

Annex 3. The list of the interviewed households

#	Household	District	Village	Mahalla
1	Aminov A	Urganch	Bekobod	Oq yop
2	Saparov Rasulbek	Urganch	Bekobod	Oq yop
3	Qurbonov Jasurbek	Urganch	Bekobod	Oq yop
4	Hayitboyev Jumanazar	Urganch	Bekobod	Oq yop
5	Bekchanov Ravshanbek	Urganch	Bekobod	Oq yop
6	Yoqubov Jumaniyoz	Urganch	Bekobod	Oq yop
7	Karimov R	Urganch	Bekobod	Oq yop
8	Erkinova Nafisa	Urganch	Bekobod	Oq yop
9	Masharipova Muqaddas	Urganch	Bekobod	Oq yop
10	Avezov Bahtiyor	Urganch	Bekobod	Oq yop
11	Ruzmetov Bahodir	Urganch	Bekobod	Oq yop
12	Inoyatova Dildora	Urganch	Bekobod	Oq yop
13	Matkarimova Shodmon	Urganch	Bekobod	Rovot
14	Qutlimurodova Qublibika	Urganch	Bekobod	Rovot
15	Avezova Muqaddas	Urganch	Bekobod	Rovot
16	Otajanova Chamangul	Urganch	Bekobod	Rovot
17	Rahimov Toirjon	Urganch	Bekobod	Rovot
18	Karimov Uktamboy	Urganch	Bekobod	Rovot
19	Rahimov Qahramon	Urganch	Bekobod	Rovot
20	Sharipov Qodirbergan	Urganch	Bekobod	Zargarlar
21	Abdullayeva Oqiljon	Urganch	Bekobod	Zargarlar
22	Sapayev Komiljon	Urganch	Bekobod	Zargarlar
23	Jumaniyozova Zamira	Urganch	Bekobod	Zargarlar
24	Ibragimova Qurbonjon	Urganch	Bekobod	Zargarlar
25	Yusupov Faxriddin	Urganch	Bekobod	Zargarlar
26	Jumaniyozova Malika	Urganch	Bekobod	Zargarlar
27	Madaminova Alima	Urganch	Bekobod	Zargarlar
28	Rajabova Poshsha	Urganch	Bekobod	Zargarlar
29	Xudayberganov G	Urganch	Bekobod	Zargarlar
30	Sapayev Otavoy	Urganch	Navroz	Navro'z ko'cha uy №13 proyezd 3
31	Hasanov N	Urganch	Navroz	Navro'z ko'cha uy №16 proyezd 3
32	Turayeva Sharofat	Urganch	Navroz	Navbahor №3 proyezd 5

33	Ibodullayev Maqsud	Urganch	Navroz	
34	Karimov Shuhrat	Urganch	Navroz	
35	Sobirova Shukurjon	Urganch	Navroz	
36	Allamurodov Tuyin	Qoshkupir	Yangilik	Ayronkul
37	Shomurotova S	Qoshkupir	Yangilik	Ayronkul
38	Xudayberganova Y	Qoshkupir	Yangilik	Ayronkul
39	Tillayeva Shahodat	Qoshkupir	Yangilik	Ayronkul
40	Rahimov Yoqubboy	Qoshkupir	Yangilik	Ayronkul
41	Yoqubova Nazira	Qoshkupir	Yangilik	Ayronkul
42	Qurbonov Sanat	Qoshkupir	Yangilik	M.Rahimov
43	Sultonov Sarvarbek	Qoshkupir	Yangilik	Nasofat 4
44	Boltayeva Olmajon	Qoshkupir	Yangilik	Xaydarobod
45	Matchanova Nargiza	Qoshkupir	Yangilik	Yangilik
46	Gayibov Yaqubbay	Qoshkupir	Yangilik	Yangilik
47	Qoraboyeva Muyassar	Qoshkupir	Yangilik	Yangilik
48	Qodirov Tohir	Qoshkupir	Yangilik	Yangilik
49	Norboyeva Nazokat	Qoshkupir	Yangilik	Yangilik
50	Qurbonov G	Qoshkupir	Yangilik	Yangilik
51	Qalandarov Shonazar	Qoshkupir	Yangilik	Yangilik
52	Matyoqubova Oysulton	Qoshkupir	Yangilik	Yangilik
53	Ismoilova Sevara	Qoshkupir	Yangilik	Yangilik
54	Davletov Rustam	Qoshkupir	Yangilik	Yangilik
55	Xasanova Sadoqat	Qoshkupir	Yangilik	Yangilik
56	Ismoilov O	Qoshkupir	Yangilik	Yangilik
57	Shomuratov Dilmurod	Yangiariq	Quriqtom	Fursat
58	Masharipov Rashid	Yangiariq	Quriqtom	Shirrice
59	Jumaniyazov Nuriddin	Yangiariq	Quriqtom	Yangiyer
60	Baxtiyorov Ulugbek	Yangiariq	Quriqtom	Yangiyer
61	Eshchanova Darmon	Yangiariq	Quriqtom	Yangiyer
62	Otajanov Jasur	Yangiariq	Quriqtom	Yangiyer
63	Shermetov Hasanboy	Yangiariq	Quriqtom	Yangiyer
64	Bobojonov Q	Yangiariq	Quriqtom	Yangiyer
65	Matniyozov Bahrom	Yangiariq	Quriqtom	Yangiyer
66	Jumaboyev Rashid	Yangiariq	Quriqtom	Yangiyer

67	Jumaniyozov Ulugbek	Yangiariq	Quriqtom	Yangiyer
68	Qurbonboyev Bahrom	Yangiariq	Quriqtom	Yangiyer
69	Xojayev Farxod	Yangiariq	Quriqtom	Yangiyer
70	Jumaniyozov N	Yangiariq	Quriqtom	Yangiyer