PRO AGRO LECTORIUM

The scientific basis for increasing fertility of irrigated degraded arid soils

Ministry of Education

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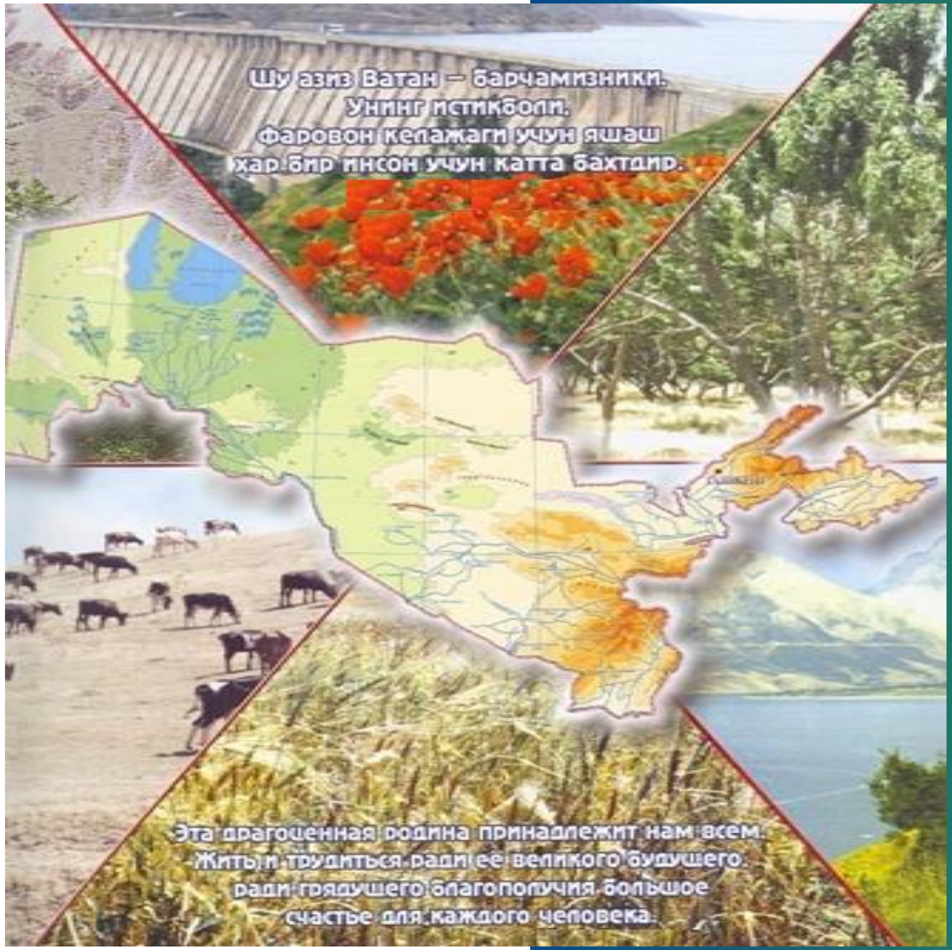
Recently, Uzbekistan has been taking large-scale measures to protect the environment, use natural resources rationally, and preserve biodiversity. These steps reflect the aspiration to harmonize humans' economic activities and the laws of nature.

These measures include rational using and protection of soils, fighting desertification, drought, water and air pollution, rational use and restoration of natural resources.



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Uzbekistan lies in the middle of Asia, right between the rivers of Amu Darya and Syr Darya. It is the most populated country in Central Asia.

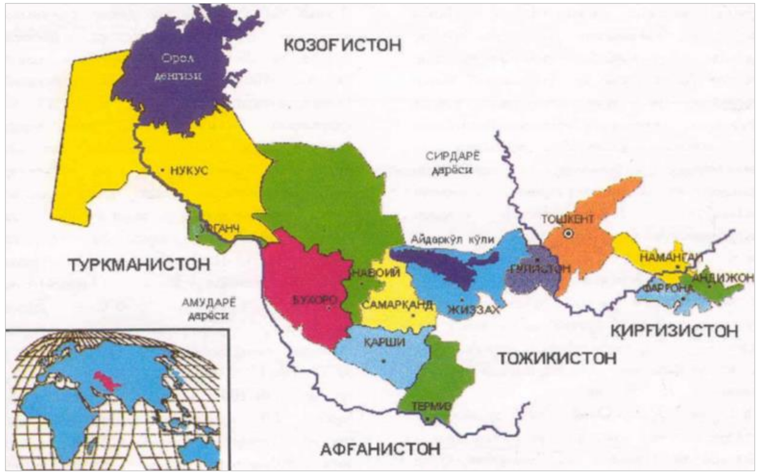
Uzbekistan equals infinite deserts with karakul sheep, green oases with cotton fields, flowering gardens and vineyards, long canals cutting through them, snow-covered mountains, unique monuments and modern industrial sites, gas and oil fields, power stations, new cities, and well-equipped kishlaks.

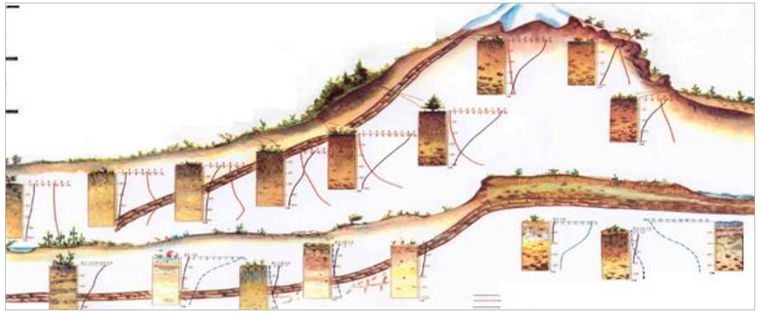




- Uzbekistan is one of the major Central Asian countries with a population of over 36 million people, rich experience in irrigated agriculture, and developing industry. Uzbekistan is a part of the Middle Asian soil and climate zone. It is known for its continental (dry) subtropical climate and particular soils that are different from those in the northern parts of Eurasia. Latitude-wise, Uzbekistan's plains are a part of the southern zone meaning deserts with their grey-brown sandy and takyr soils. .

- Elevational zonation in the eastern part of the country is known for its grey soils in the foothills and low mountains zones, brown and russet soils in middle-height mountains zone, and light russet meadow and steppe soils in high mountains zone. Soils of high-altitude zones in the foothill zone amount up to 43%, while 57% is soils of the plain desert zone.

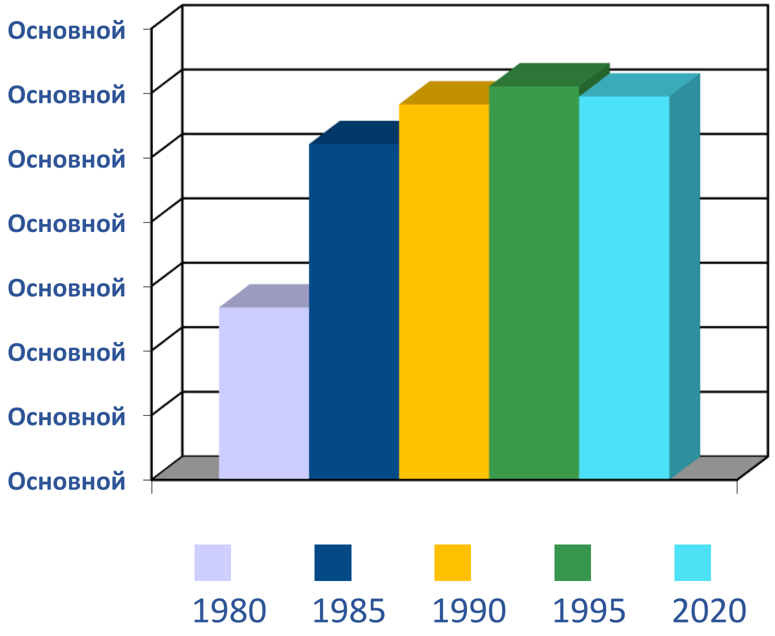




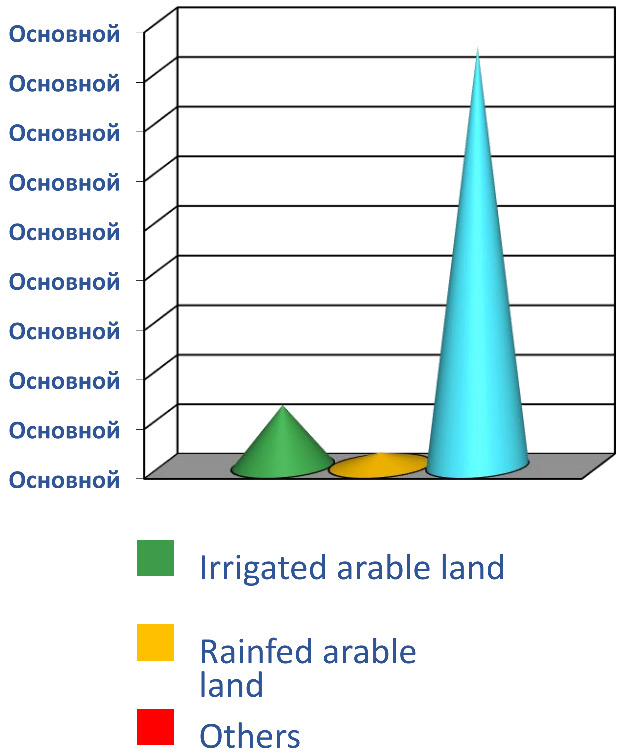
Uzbekistan’s soil types and subtypes

Soil	Surface, thousand ha	% rate
High-altitude zones		
1. Light russet, meadow steppe, high altitude	540	1,2
2. Brown and russet, mountains and forests, middle altitude	1660	3,7
3. Dark grey soils	1050	2,4
4. Conventional grey soils	3050	6,8
5. Light grey soils	2590	5,8
6. Meadow grey soils and grey meadow soils	780	1,8
7. Meadow grey belt	670	1,5
8. Marsh and meadow grey soils	70	0,2
Total:	10410	23,4
Desert zone		
9. Grey russet	11025	24,8
10. Desert sandy	1370	3,1
11. Takyr	1780	4,0
12. Meadow takyr and takyr meadow	460	1,0
13. Meadow in desert zones	1790	4,1
14. Marsh-meadow in desert zones	50	0,1
15. Salt flats	1270	2,9
16. Sands	12100	27,2
Other soils	4155	9,4
Total:	34000	76,6
Total, soils	**44410**	**100,0**

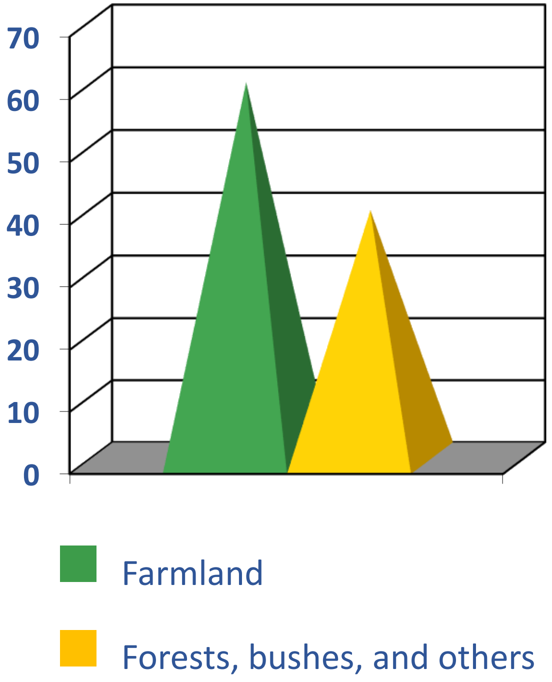
Irrigated soils (thousand ha)



Share of arable land in relation to the total area of farmland (%)



Farmland share in relation to the total area of land (%). Total 44.4 million ha



- The main reasons for land degradation in Uzbekistan, which cause serious concern in terms of providing vital environmental services, are
  - ✓ secondary salinization of irrigated lands
  - ✓ waterlogging, flooding, and overwatering due to irrigated farming
  - ✓ soil depletion (loss of humus and nutrients)
  - ✓ soil over consolidation
  - ✓ water and irrigation erosion of soils in mountainous and foothill areas
  - ✓ deflation and pasture digression in desert areas of nomadic pastoralism
  - ✓ deforestation and loss of biodiversity
  - ✓ soil contamination with agricultural chemicals and industrial chemical pollutants
  - ✓ land desertification in the area of the dried seabed of the Aral
- The geographical, climate, geomorphological, and hydrogeological features of this region made arid ecosystems of the country highly vulnerable to soil degradation and desertification which threaten the economy, agriculture, and living standards.

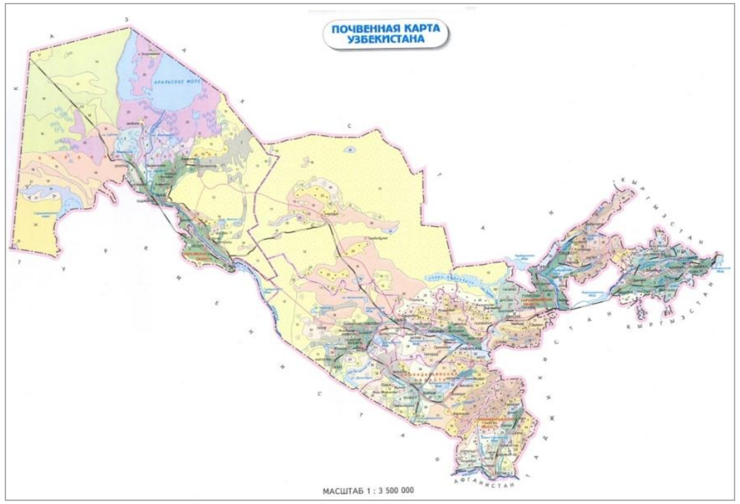
Natural causes of soil degradation in Uzbekistan

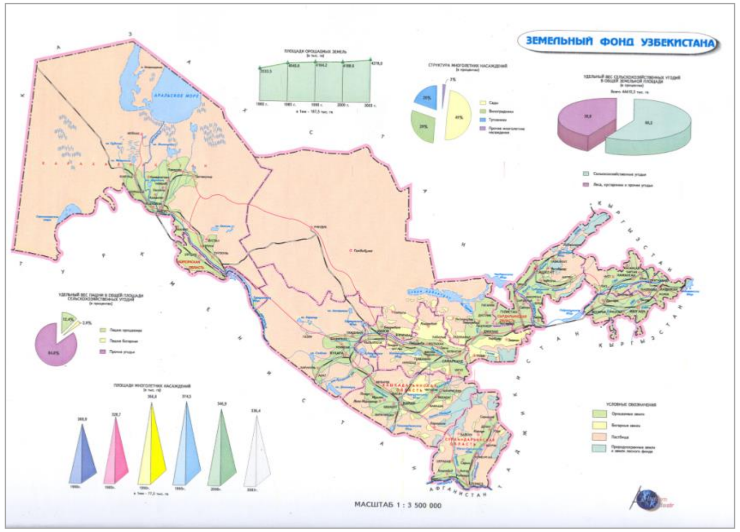
- *climate features* (aridity, continentality, wind activity, etc.) causing such phenomena as drought, dry winds, blowing out of soil particles (deflation), atmospheric transport of sand, salts, and dust;
- *landscape (relief),* steep slopes combined with heavy rains cause water erosions, mudflows, and landslides. At the same time, flat terrains, trenches, and lower grounds are perfect for causing waterlogging and salinization. Orography is responsible for the formation of specific winds (foehn winds, etc.), which play their part in developing wind erosion;
- *parent material features* are responsible for those of the soil (mechanical composition, gypsum content, salinity) and condition soil predisposition to wind erosion, subsidence and karst, form soil buffering (resistance to toxic compounds), etc.;
- *unusual natural phenomena* not caused by human activity, such as forest and steppe fires, floods, etc.

Anthropogenic impact on lands in Uzbekistan

- *intensive farming* leads to the loss of organic matter and nutrients, soil contamination with agrochemicals, the consolidation and destruction of soil structure, etc.;
- *irrigation* with inadequate drainage, wrong management of collector drains cause salinization and waterlogging;
- *unsustainable pasture use* (lack of pasture rotation, violation of its capacities, etc.) leads to overgrazing, bare grounds, the destructions of soil structure, and, in consequence, deflation due to winds and high temperatures;
- *unsustainable forest management* (excessive logging and deforestation) causes erosion of slopes in mountainous areas, soil deflation and sand encroachment on fertile land in the plains;
- soil degradation is connected with the *violation of land improvement measures* related to cotton monoculture, use of high doses of mineral fertilisers and pesticides, insufficient use of organic fertilisers, siderates, and leguminous crops in the past.

- Lack of organic matter supply, moisture, the irregular passage of tillage equipment combined with imperfect agrotechnical methods led to the loss of humus levels, destruction of soil structure, over consolidation, creation of thick plough sole and soil crust in some places, sharp deterioration of agrophysical properties and biological activity of soils, desertification of soil in general.





Humus levels

	Region	Reasearch area, thousand ha	Humus levels , %										Average %
			Too low 0,41-0,8		Low 0,81-1,2		Medium 1,21-1,6		High 1,61-2,0		Very high 2,0<		
			thousand ha	%	thousand ha	%	thousand ha	%	thousand ha	%	thousand ha	%	
1	Karakalpakstan	421,6	158,0	37,5	151,2	35,9	83,0	19,7	24,4	5,8	5,0	1,2	0,46
2	Andijan	177,0	60,3	34,1	58,3	32,9	33,3	18,8	13,1	7,4	12,0	6,8	0,45
3	Bukhara	155,3	126,6	81,5	25,0	16,1	3,7	2,4	0,0	0,0	0,0	0,0	0,54
4	Jizzakh	375,3	120,0	32,0	128,3	34,2	76,2	20,3	25,3	6,8	25,4	6,8	0,45
5	Kashkadarya	426,8	256,9	60,2	70,0	16,4	52,6	12,3	47,3	11,1	0,0	0,0	0,50
6	Namangan	165,3	30,5	18,5	95,7	57,9	32,1	19,4	6,8	4,1	0,2	0,1	0,42
7	Navoiy	76,4	40,6	53,1	27,3	35,7	8,5	11,1	0,0	0,0	0,0	0,0	0,49
8	Samarkand	218,0	81,9	37,6	87,1	39,9	43,3	19,8	5,8	2,7	0,0	0,0	0,46
9	Surkhandarya	217,6	126,6	58,2	72,5	33,3	15,7	7,2	2,8	1,3	0,0	0,0	0,50
10	Syr Darya	251,8	60,7	24,1	152,5	60,6	32,9	13,1	5,6	2,2	0,0	0,0	0,43
11	Tashkent	271,9	64,8	23,8	144,6	53,2	42,3	15,6	14,1	5,2	6,0	2,2	0,43
12	Fergana	251,9	176,0	69,9	49,9	19,8	19,7	7,8	6,3	2,5	0,0	0,0	0,52
13	Khorazm	216,7	132,1	61,0	58,8	27,1	0,0	0,0	19,7	9,1	6,1	2,8	0,50
Total 01.01		**3225,6**	**1435,0**	**44,5**	**1121,1**	**34,8**	**443,2**	**13,7**	**171,2**	**5,3**	**54,7**	**1,7**	**0,47**
As of January 1st, 2008		**2949,7**	**1440,8**	**48,8**	**1030,9**	**34,9**	**297,6**	**10,1**	**142,4**	**4,8**	**38,0**	**1,3**	**0,86**
Difference +,-		**275,9**	**-5,8**	**-4,4**	**90,2**	**-0,2**	**145,6**	**3,7**	**28,8**	**0,5**	**16,7**	**0,4**	**-0,4**

Nutrients levels of irrigated lands in Uzbekistan

thousand ha

№	Soil nutrients	Medium rate mg/kg	As of 2008	As of 2020	Per 3.2 million ha (based on the 2020 data)									
					Very low		Low		Medium		High		Very high	
					ha	%	ha	%	ha	%	ha	%	ha	%
1	**Labile phosphorus**	31-45	25,5	24,2	922,6	29	1323,5	41	762,9	24	178,6	6	50,7	2
2	**Humus**	1,21-1,6	0,86	0,47	1435	44,5	1121,1	34,8	443,2	14	171,2	5	54,7	2
3	**Exchangeable potassium**	201-300	237,8	236	206,9	6	936,4	29	1067,4	33	613,9	19	414,1	13

- One of the main tasks of soil protection is to protect it from erosion. It is an important problem for many countries located in arid areas, including Uzbekistan. Today, out of the total area of Uzbekistan’s 44.4 million ha, agricultural lands account for 26.7 million ha. Only 1.5 million ha or only 5.8% are not subject to erosion.

- Over 4.7 million ha are subject to water erosion which can be found in mountain slopes, foothill areas, and adyry. This type of erosion is particularly dangerous on sloping lands occupied by rainfed arable land or pastures.

Type of land	**Total (million ha)**	**Thousand ha**			
		Not subject to erosion	**Subject to water (irrigation) erosion**	**Subject to water erosion**	Subject to water and wind erosion
Total surface	44.4	-	-	-	-
including farmlands	26.7	1551	2700	20478	2005
Subtypes					
Irrigated	3.7	791	341	2262	341
a) Arable land	3.3	569	341	2057	341
b) Others	0.425	212	-	213	-
Non-irrigated (including pastures)	23	760	2359	18218	1664

- 2.9 million, or 75% out of 3.73 million ha of used irrigated lands, are eroded to various degrees.

✓ irrigation erosion on the area of 682.000 ha or 20% of irrigated lands;

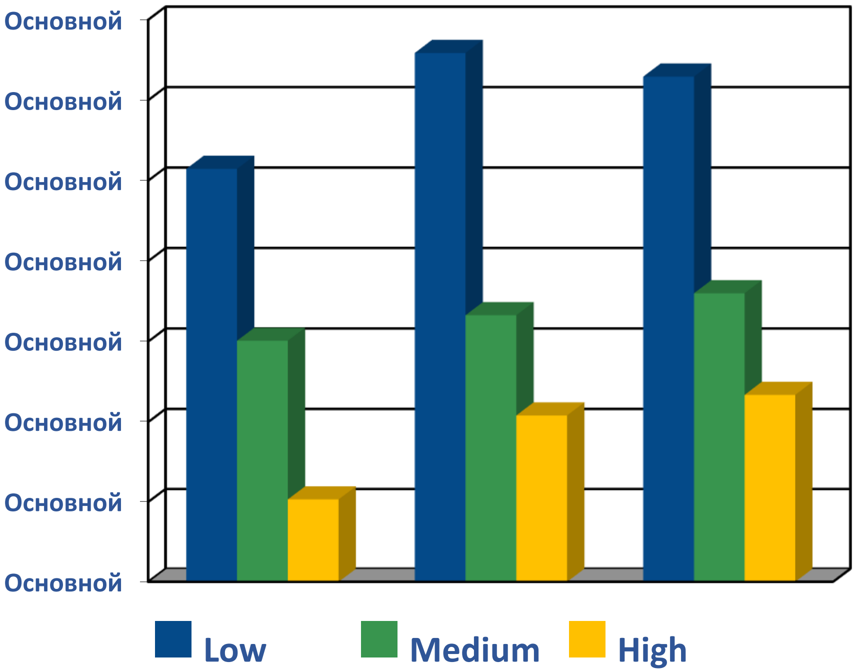
✓ as a result of irrigation erosion alone, soil removal can reach 100-500 tonnes/ha, and annual losses of humus can amount to up to 500-800 kg/ha, nitrogen 100-120 kg/ha, phosphorus 75-100 kg/ha, and more.

- Erosion can affect the amount of used solar energy in the biomass of ecosystems in soils. As a result of erosion processes up to 30-60% and more of the solar energy used in phytomass, humus, and microorganisms is lost. Taking into account that the intensity of biological processes and nitrogen regime in soils is related to the reserves of the solar energy, we can imagine the damage caused to the ecosystem by erosion.

Soil salinization

Soil salinization is a major environmental problem for Uzbekistan. The surface of salinized land has been growing in the last 30 to 50 years.

Salinization of irrigated lands in 1990, 2000-2016



In recent years, the area of irrigated saline soils has increased by 608.000 ha and reached 2.4 million ha in 2010, or 65.9% of the irrigated area. Medium and highly saline soils amount to up to 1,2 million ha or 32.04%. The Aral Sea catastrophe led to increased salinization in the region. Nowadays, saline lands in irrigated conditions occupy 49% of the territory thanks to large-scale land improvement work.

Climate change and its impact on soil

- Climate change and its impact on the environment is one of the major problems in the XXI century. One of the key aspects here is to preserve soils and biodiversity.
- In Uzbekistan, regional climate changes will contribute to the increasing number of unusual natural phenomena, droughts, high temperatures, changes in the creation of water resources, and soil degradation.

Climate predictions for the area

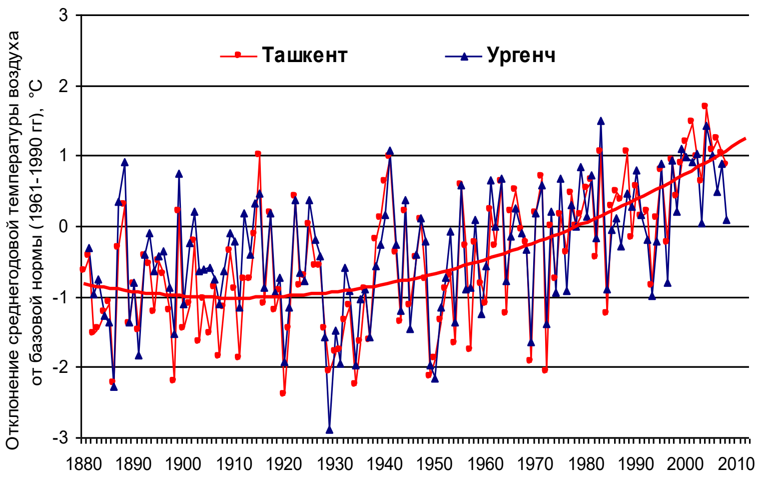
- An increase of the mean annual temperature by 1,9-2,4°C by 2050 with regional differences. Winter and spring will show major warming.
- Average annual precipitations will grow by 15-18% with the biggest increase during the summer season.
- Agricultural production conditions will deteriorate and become riskier.
- There will be an increase in evapotranspiration on agricultural lands due to rising temperatures.
- There will be compensation for the projected increase in precipitation and bringing agricultural production to drier conditions, increasing its dependence on already inadequate water resources.
- Water scarcity in the Aral Sea basin will go up. It will happen because the water demand increases and the existing volume decreases guarantee water withdrawals from the Amu Darya and Syr Darya rivers. Water scarcity will exceed 500%, increasing from 2 km^3 per year from 2005 to 11-13 km^3 in 2050.
- Rising length of the growing season, especially in northern regions, will allow new crops to be planted.

Climate change impact

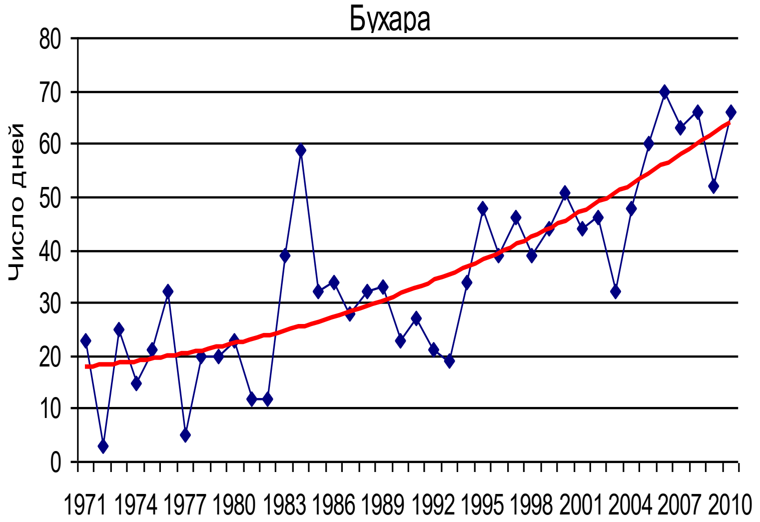
- Climate change represents a problem not only for our future but also for our present. Modern agriculture should take it into account. Rational use and protection of soils in Uzbekistan have a special place in the strategy of rational use and protection of natural resources.
- Soil is limited in space and quality. Its modern state is of concern as in the last 30-50 years humus and nutrient levels have decreased. Besides, it was affected by salinization, water and wind erosion, contamination with heavy metals, fluorides, and agrochemicals.
- About 76.6% of the country lies in the desert zone. That is why any risk of aridity, extended periods of very high temperatures, droughts, and lack of water will lead to a decrease in crop yields.
- 23.4% of soils lie in mountainous areas. Climate change may elevate the risk of frost for fruit crops, and droughts, as well as accelerate and change the time of snow melting. All of which will trigger erosion and landslides.

Regional indicators of climate change

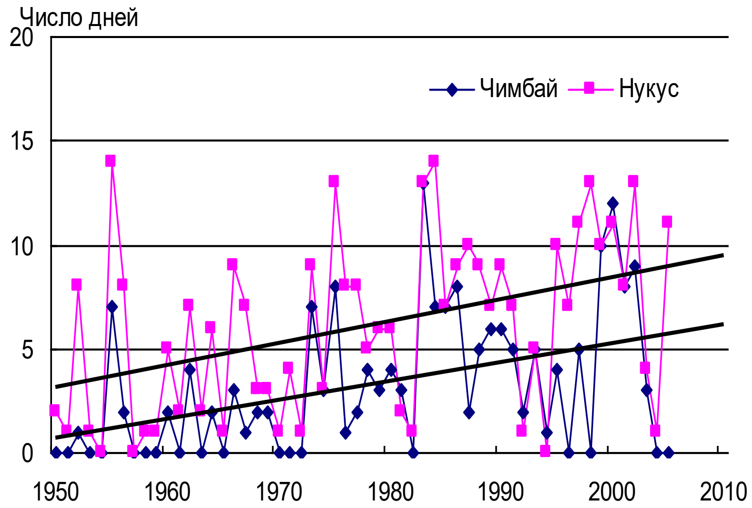
Temperature growth°C



Number of days with temperature over 40 °C

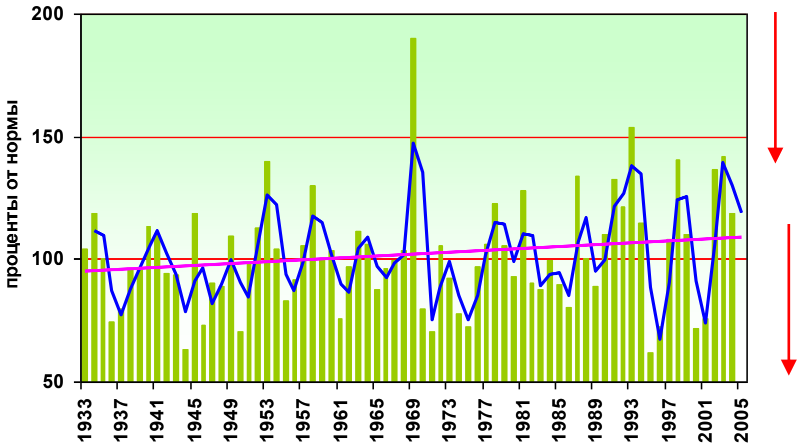


Number of days with dry winds

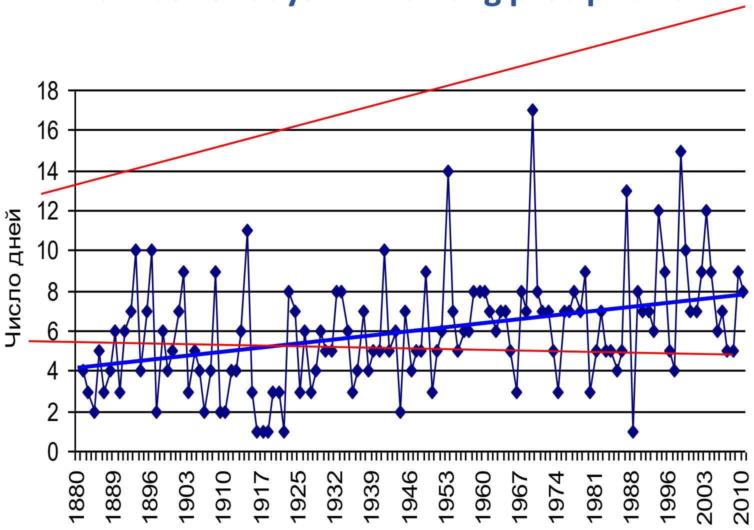


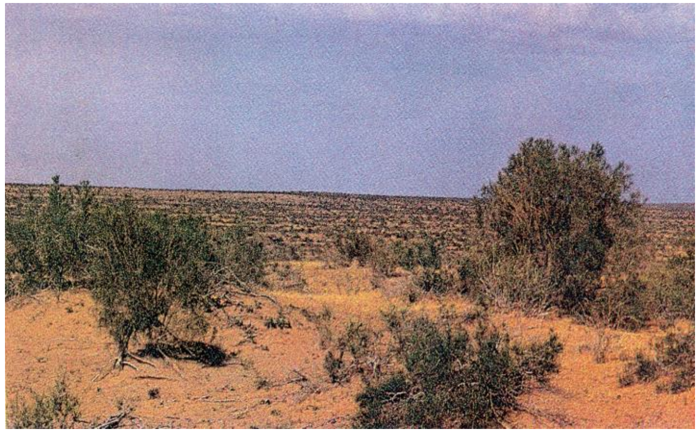
Regional climate change indicators

Change in annual precipitation totals in Uzbekistan

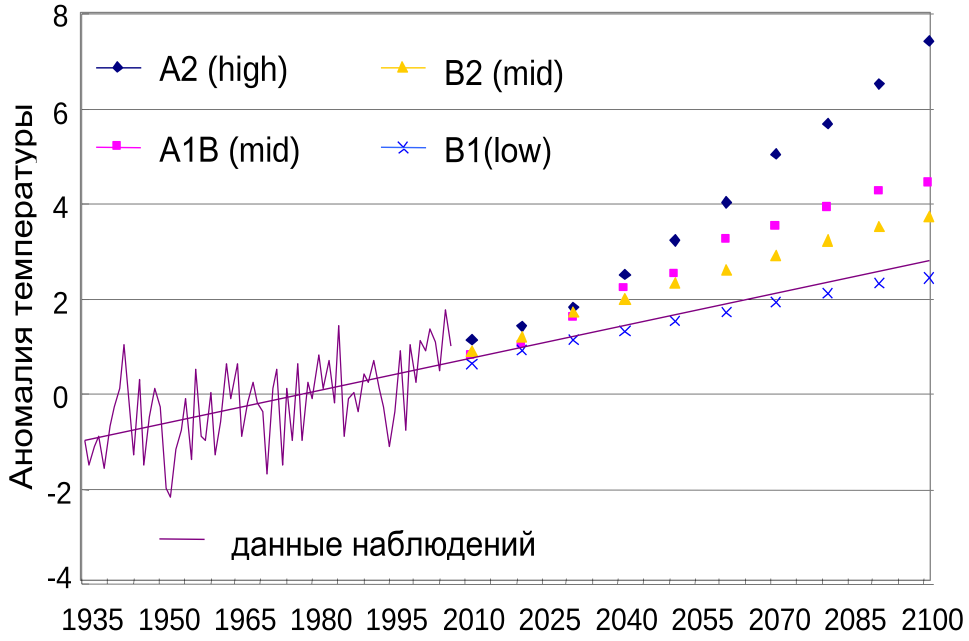


Number of days with strong precipitations





Expected changes



Expected rise of temperature(°C)

scenario		A2	B2
by 2030	about	1.0-1.5	1.6-1.8
by 2050	about	2.0-2.6	2.3-2.6
by 2080	about	3.9-4.5	3.2-3.6

The catastrophe of the Aral Sea is a great example of how big ecological, social, and economic consequences can be if we use incorrectly our natural resources.

- Until 1960, the Aral Sea was one of the biggest endorheic lakes in the world. Its surface was 68.900 km^2 and it had 1.083 km^3 of water. Its deepest place was 68 m. Due to the flow of the Syr Darya and Amu Darya rivers, the Aral Sea annually received an average 50-55 km^3 of water.

1964
surface 64.800 km^2

100%

2001
surface 21.100 км^2

32,5%

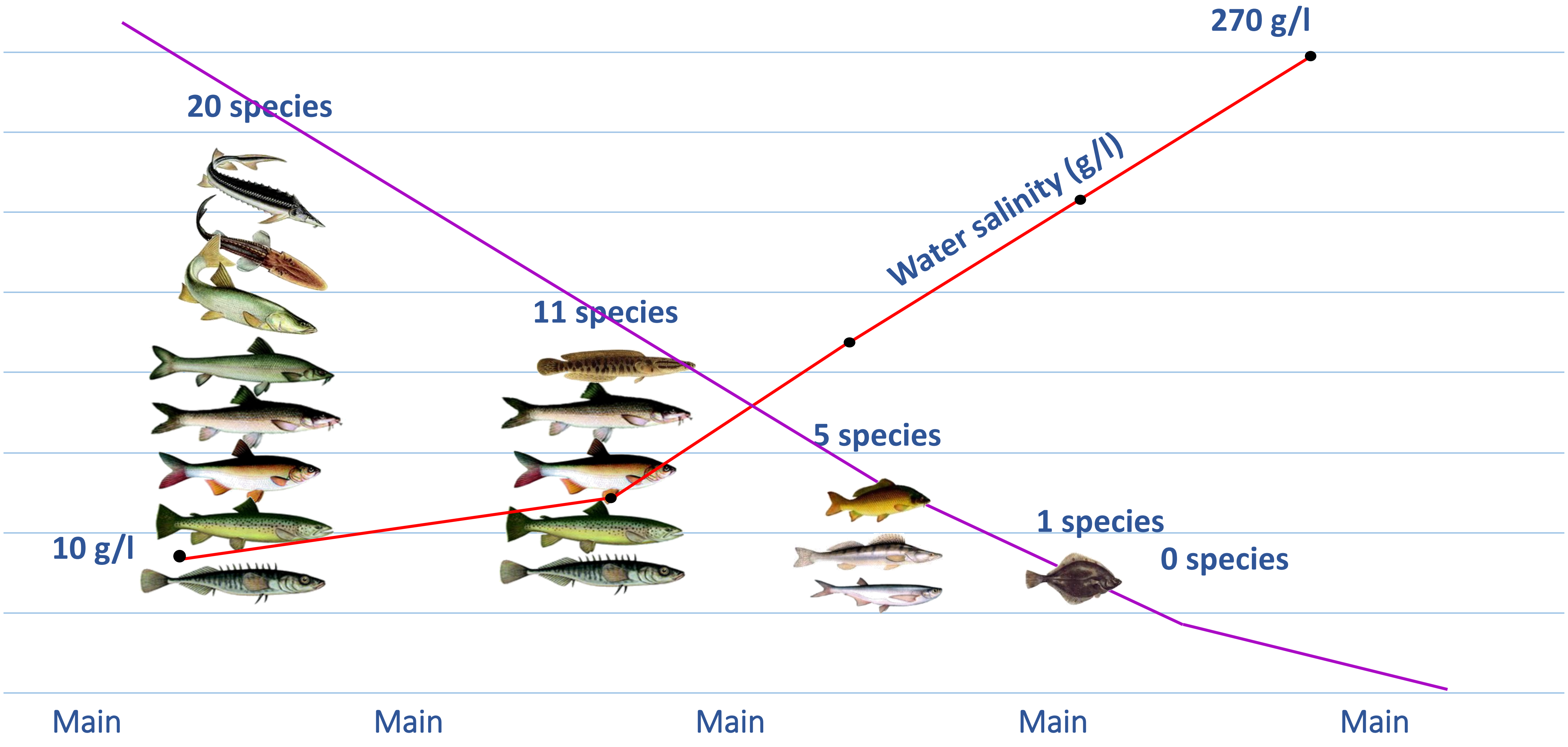
2020
surface 8.730 km^2

13,5%

The sea helped to regulate the climate and mitigated sharp changes in weather conditions in the region. It had a positive effect on living standards, agricultural production, and the environment.

- In the 1930s, large-scale construction of irrigation canals began in Central Asia. It intensified from the 1950-1960s. Since the 1960s the sea started to become shallow. Between 1960 and 1990, the surface of irrigated lands in Central Asia grew from 4,5 million ha to 9.1 million. The region's water demand increased from 60 to 120 km^3 per year. 90% was used for irrigation.
- Since 1961, the sea level has been falling at an increasing rate. In less than half a century, the total flow of rivers into the Aral Sea has decreased almost 4.5 times, the water level by 29 metres, and the volume of water in the sea more than 15 times. Water salinity has grown to 125-300 g/l, exceeding more than 10 times the average salinity level of the world ocean.

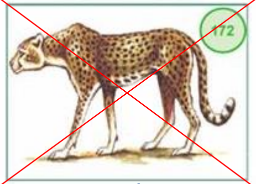
Decrease in species diversity of the Aral Sea ichthyofauna as water salinity increases



Extinct and endangered species of flora and fauna of the Priaralie under the negative impact of the Aral Sea desiccation

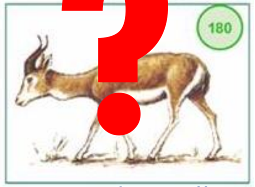
Extinct

Endangered

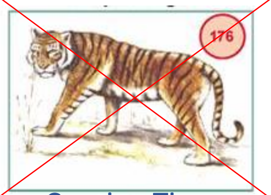


Asiatic Cheetan

Brandt’s Hedgehog (Hemiechinus hypomelas)



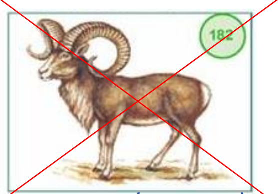
Goitred Gazelle



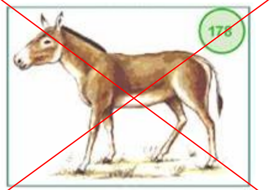
Caspian Tiger

Thick-tailed Pygmy Jerboa

Honey Badger (Ratel)



Transcaspian (Ustyurt) Uria



Kulan

Turkmen Caracal (Desert Lynx)

Bactrian (Bukhara) Deer

The Aralkum desert

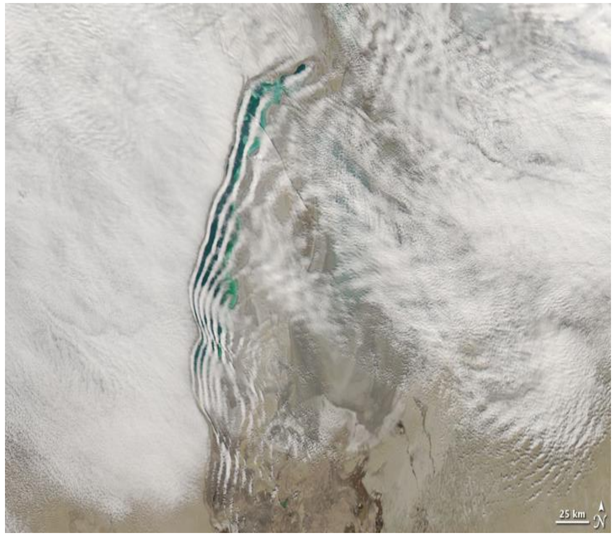
Vast areas of white salt fields covered with sand appeared on the dried seabed thus creating the new Aralkum desert with a surface of 5.5 million ha.

It has become a perfect place for dust and salt storms which transport millions of tonnes of salt, dust, and sand across hundreds of kilometres.

- These catastrophic changes resulted in the loss of more than half of the flora and fauna gene pool. Land resources degraded, the area of saline lands has increased, and their condition has worsened. In general terms, the biological productivity of the Aral Sea region decreased by 10 times.
- Endemic species such as the Caspian tiger, Asiatic cheetah, Ustyurt uria, striped hyena, and others became extinct or endangered. Saiga antelopes came to the verge of extinction. 11 species of fish, 12 species of mammals, 26 bird species, and 11 plant species were added to the Red List of Endangered Species.
- The number of days with temperatures above 40°C has doubled in the Priaralie region. Recently there has been an increased number of days with extremely cold winter temperatures below -30°C.

- Vast areas of white salt fields covered with sand appeared on the dried seabed thus creating the new Aralkum desert with a surface of 5.5 million ha. It has become a perfect place for dust and salt storms which last for more than 90 days per year and transport 100 million tonnes of dust across 300 km.

- The sea helped to regulate the climate and mitigated sharp changes in weather conditions in the region. This had a positive effect on living standards, agricultural production, and the environment.



Innovative methods and technologies for increasing and reproducing fertility of irrigated degraded arid soils

(best methods)

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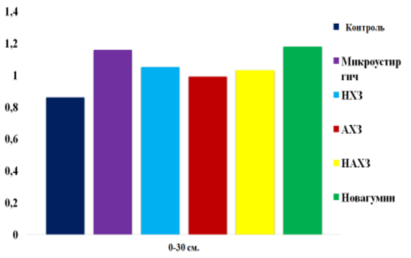
Eco-friendly agro-biotechnologies for increasing productivity of saline soils in the Priaralie region

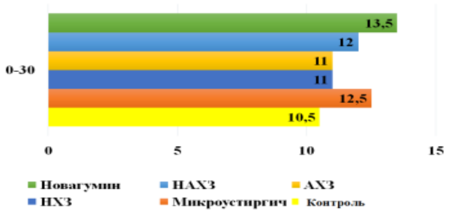
An agrobiotechnology to restore and increase the fertility of degraded meadow-alluvial soils of the Priaralie region, improve the environment, increase crop yields and quality in the context of climate change, and prevent desertification and droughts in the area was developed. All these tasks were defined in the Decree of the President of the Republic of Uzbekistan dated 4th October 2019 (No. 4477 "On the approval of the strategy for the transition of the Republic of Uzbekistan to a "green" economy in 2019-2030"); PP-4973 on 2 February 2021 ("On the measures for further development of rice cultivation"), and PK-277 on 10th October 2022 ("On the measures to create an effective system to combat land degradation" and other relevant regulatory and legal documents. This technology seeks to improve agrochemical, agrophysical, and biological properties of saline-degraded soils using phytomeliorant (Nukus-2 rice variety) and bio and nano compounds (Novagumin, Mikroustirgich, Nanochitosan-NXZ, Chitosan ascorbate-AXZ, Chitosan nano ascorbate-NAXZ).

Effect of bio and nano substances use on growth, development and yield of rice on irrigated meadow-alluvial soils

1	Compounds	Amount of plants, pieces	Average plant height, cm	Ear length, cm	Number of seed per ear	Seed weight, g	Crop yield, centners /ha
1	Nazorat	152	68,7	12,6	96,2	2,01	54
2	Novagumin 1	231	91,4	14,1	107,8	2,15	58
3	Mikroustirgich 1	220	84,5	13,2	102,5	2,10	57
4	Nanochitosan 1	189	76,6	12,9	98,5	2,06	56
5	Chitosan ascorbate 1	168	74,5	12,9	97,8	2,05	56
6	Chitosan nano ascorbate 1	152	73,3	12,8	97,5	2,05	56
7	Novagumin 2	253	98,9	14,7	115,9	2,21	59
8	Mikroustirgich 2	238	90,5	14,3	110,4	2,16	58
9	Nanochitosan 2	207	85,8	13,3	100,8	2,09	57
10	Chitosan ascorbate 2	203	78,2	13,0	99,7	2,08	57
11	Chitosan nano ascorbate 2	201	76,4	12,9	99,2	2,06	57
		HCP_{05}					3,88

Compound impact on the humus levels of the soil





Substances' effect on labile phosphorus in saline meadow-alluvial soils

Bio and nano substances' effect on microorganism levels in irrigated meadow-alluvial soils

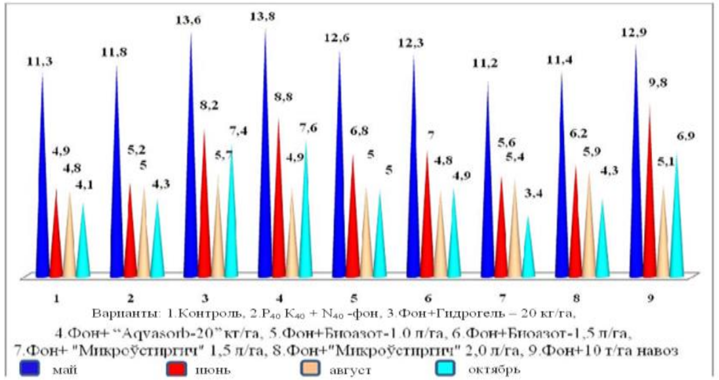
New highly effective bio substances for improving soil fertility and crop yields

- The technology focuses on using new agricultural and biotechnological approaches to increase and restore the fertility of low-productive saline soils.
- Application of new generation microbial composition allows for improved properties of particular saline soils and optimizes biological basis of the rational use and protection of the desert zone soils. The bio compound has growth-activating and antagonistic properties and increases the biological activity of the soil.
- The technology provides a 4-6% increase in crop yields and can be used for growing cotton, cereals, vegetables, and other crops. The technology is recommended for saline lands, for increasing and reestablishing soil fertility, and for raising the quality and yield of crops while preserving the biological diversity of soils in arid areas.

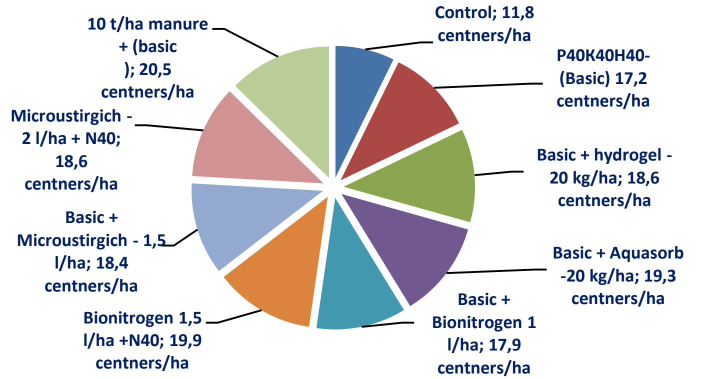
The scientific basis for increasing fertility of rainfed degraded grey soils

An agricultural technology for the efficient use of rainfed lands in crop cultivation, raising soil fertility, and getting high-quality winter wheat yields was developed. All these tasks were defined in the Decree of the President of the Republic of Uzbekistan № PF-5742 of 17 June 2019 ("On measures for the effective use of land and water resources in agriculture"), № 4477 of 4 October 2019 ("On approval of the strategy for the transition of the Republic of Uzbekistan to a "green" economy in 2019-2030"), and PP № 277 of 10 June 2022 ("On measures to create an effective system of combating land degradation") and other regulatory legal documents. Application of this technology allowed us to scientifically explain ways to improve the agrophysical, agrochemical, and biological properties of soils, accumulation of additional moisture, and increase in productivity under climate change conditions.

Effect of mineral, organic fertilisers and absorbents use in ploughland on soil moisture levels



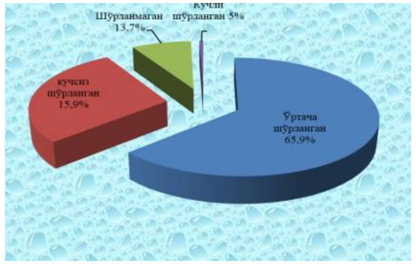
Effect of fertilisers, biocompounds and absorbents applied to clean tillage on wheat yields



- Application of 10 t/ha of manure and 40 kg/ha of phosphorus fertilisers, 20 kg/ha of hydrogel on rainfed soils of hilly plains before autumn ploughing reduces evaporation of natural moisture by 170.0-171.3 m^3/ha.
- Subplough application of 20 kg/ha of hydrogel, 10 t/ha of manure and 40 t/ha of phosphorus fertilisers, 40 kg/ha of nitrogen fertilisers during tillering of the winter wheat variety Bakhmal-97 provided a yield increase of 3.9-5.4 centners/ha compared to the control levels.
- Subplough of nitrogen, phosphorus, and potassium fertilisers in the amount of 30 kg/a is recommended when precipitation is less than perennial norms (300-320 mm), and when precipitation falls within limits (360 mm) it is recommended to apply 40 kg/ha. When precipitations are abundant (over 360 mm) the levels of fertilisers should be increased to 40-50 kg/ha and additionally apply 10 t/ha of manure.

The biological bases of fertility restoration and increase in saline soils of the Hungry Steppe

- A technology for improving the agricultural properties of soils was developed to preserve and restore the fertility of irrigated saline meadow grey soils. The biological basis of land improvement was recommended, and bio substances that are effective in conditions of weak and medium salinity degrees and also for optimising winter wheat yield were determined.



Saline soils, Xovos district

Effect of bio substances on winter wheat yield

Salt levels in irrigated meadow grey soils

Layer thickness, cm	Dry residue	HCO_3^-	CL^-	SO_4^{--}	Ca^{++}	Mg^{++}	Na^++K^+
Soil cross section 1							
0-60	2,417	0,045	0,556	0,716	0,118	0,039	0,478
60-120	2,458	0,048	0,643	0,782	0,376	0,034	0,450
120-190	2,508	0,043	0,600	0,778	0,248	0,036	0,462
Soil cross section 8							
0-62	1,912	0,062	0,600	0,750	0,130	0,045	0,512
62-128	2,022	0,031	0,342	0,782	0,410	0,040	0,507
128-190	1,908	0,027	0,378	0,768	0,212	0,051	0,522

Agrochemical properties of saline irrigated meadow grey soils

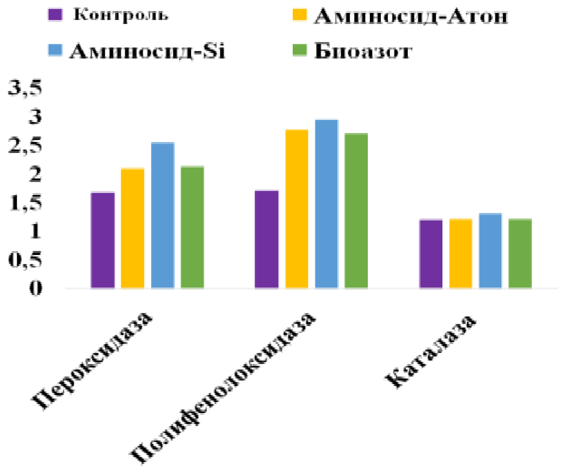
Cross section №	Soil layer, см	Humus ,%	Nitrogen		Phosphorus		Potassium	
			Total, %	$N\text{-}NO_3$ mg/kg	Total, %	P_2O_5, mg/kg	Total, %	K_2O mg/kg
1	0-15	0,830	0,04	12,1	0,21	32	0,964	186
	15-30	0,634	0,03	6,44	0,15	26	0,723	160
	30-50	0,467	0,02	4,48	0,07	14	0,723	126
8	0-15	0,995	0,05	11,7	0,17	26	0,964	265
	15-30	0,804	0,04	6,44	0,12	20	0,723	160
	30-50	0,519	0,03	4,87	0,08	10	0,723	120

№	Options	Total number of stems per 1м², pieces	Number of productive stems per 1м², pieces	Seed weight per ear, g	Seed yield, centners/ha
1	Control	311,4	198,5	0,98	17,98
2	$N_{180}P_{90}K_{60}$	327,8	207,8	1,31	18,97
3	Maxim +N_{180} P_{90} K_{60}	345,4	221,6	1,33	21,09
4	Azospirillum +N_{180} P_{90} K_{60}	348,2	225,8	1,34	23,62
5	Biohumus + N_{180} P_{90} K_{60}	365,9	228,4	1,32	22,36
6	Rizokom 2 +N_{180} P_{90} K_{60}	372,3	268,6	1,35	23,45
7	Novostil + N_{180} P_{90} K_{60}	357,7	232,6	1,29	22,14
8	Microzym1+N_{180} P_{90} K_{60}	369,9	266,8	1,34	22,39

New highly effective compounds for increasing degraded soils fertility

An environmentally friendly resource-saving technology for the restoration and increase of degraded saline soils has been developed. This task was defined in the Decree of the President of the Republic of Uzbekistan № PF-5742 of 17 June 2019 ("On measures for the effective use of land and water resources in agriculture"), 4477 on 4 October 2019 ("On approval of the strategy for the transition of the Republic of Uzbekistan to a "green" economy in 2019-2030"), PP № -277 on 10 June 2022 ("On measures to create an effective system to combat land degradation") and other regulatory and legal documents. It has been established that new highly effective compounds Biosolvent (Institute of Bioorganic Chemistry, Academy of Sciences of Uzbekistan), Aminosid-Aton, and Aminosid-Si (LLC Rasayana) and Bioazot (Institute of Microbiology ASUz) increase the productivity of degraded soils, improve agrochemical, physical and biological properties of the soil. They also have a positive effect on the activity of biochemical processes, including antioxidant enzymes, which are important for developing and adapting responses to abiotic and biotic influence.

Substance effect on enzymatic soil activity



Substance effect on biological soil activity, thousand per 1g of soil

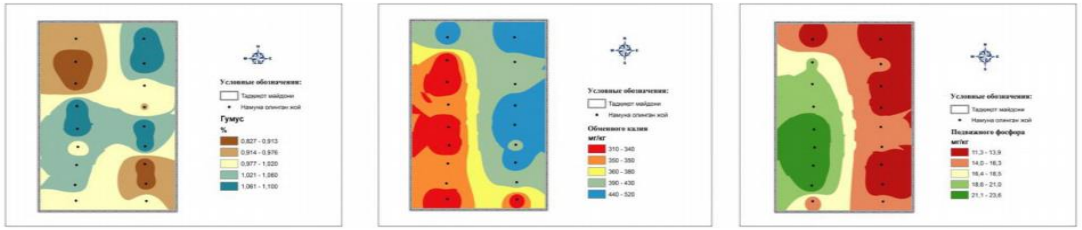
Cotton variety	Bukhara-8											
Enzymes	Control	Aminosid-Aton	Aminosid-Si	Bioazot	Control	Aminosid-Aton	Aminosid-Si	Bioazot	Control	Aminosid-Aton	Aminosid-Si	Bioazot
POX	130,85	137,1	253,9	134,36	111,08	84,63	91,4	120,5	74,5	130,85	137,1	253,9
PFO	141,05	203,12	272,54	146,16	110,02	17,43	118,2	105,6	85,2	141,05	203,12	72,54
FAI	69,82	75,78	109,82	75,32	69,48	72,66	101,1	88,7	76,5	89,82	95,78	89,82
Flavanoidlar	117,45	145,86	181,25	133,54	117,72	134,29	153,3	145,2	97,6	137,45	195,86	138,25

Biosolvent proved to be effective in carrying out harmful salts, saving water, and maintaining soil properties in optimal condition. Aminosid-Aton, Aminocid-Si, and Bioazot showed great results in field conditions on the Bukhara-8 cotton variety. On saline soils, Aminosid-Si scored the highest, as it increased the adaptive properties of cotton to salinity.

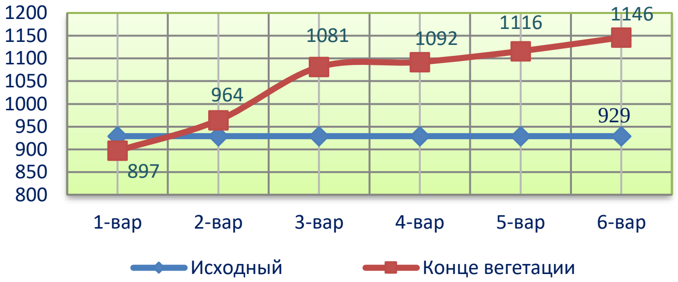
Technology of organic carbon conservation and preservation in arid degraded soils

- An environmentally friendly resource-saving technology for the restoration and increase of fertility of degraded arid soils has been developed by the Decree of the President of the Republic of Uzbekistan № PF-5742 on 17 June 2019 ("On measures for the effective use of land and water resources in agriculture"), № 4477 on 4 October 2019 ("On approval of the strategy for the transition of the Republic of Uzbekistan to a "green" economy in 2019-2030"), PP № -277 on 10 June 2022 ("On measures to create an effective system of combating land degradation") and other regulatory and legal documents. The role and efficiency of cultivation of legume resowed crops, bio-organic fertilisers, and green fertilisers in preserving and increasing the fertility of irrigated light grey soils, as well as improving the productivity and quality of crops have been scientifically proved.

Cartographic models of humus, potassium and phosphorus levels in the upper soil layer



Water permeability of soils, m³/ha



Effect of organic fertilisers and sowing legume crops on soil water permeability

Effect of organic fertilisers and sowing leguminous crops on soil agrochemical properties

№	Experiment	Yield, centners/ha							
		Seed			Average	Straw			Average
		Year				Year			
		2017	2018	2019		2017	2018	2019	
1	$N_0P_0K_0$	13,4	12,8	12,0	12,7	16,9	13,4	14,8	15,0
2	Basic – $N_{180}P_{90}K_{60}$	56,3	55,7	52,9	55,0	42,9	41,9	41,7	42,2
3	Basic + mung bean	56,6	59,2	63,4	59,7	43,0	43,6	43,5	43,4
4	Basic+mung bean 20 t/ha organic fertiliser	57,8	60,3	68,5	62,2	43,7	44,0	44,8	44,2
5	Basic+medick+$N_{180}P_{90}K_{60}$	56,4	48,4	70,8	58,5	30,0	28,3	45,0	34,4
6	Basic+medick 20 t/ha organic fertiliser	58,6	50,8	74,6	61,3	31,2	28,9	45,4	35,0


MA'LUMOTLAR BAZASINING RASMIY RO'YXATDAN O'TKAZILGANLIGI TO'G'RISIDAGI
GUVOHNOMA
СВИДЕТЕЛЬСТВО ОБ ОФИЦИАЛЬНОЙ РЕГИСТРАЦИИ БАЗЫ ДАННЫХ


O'ZBEKISTON RESPUBLIKASI QISHLOQ XO'JALIGI VAZIRLIGI

The role of legumes in improving soil fertility

- All crops enrich the soil with nitrogen, macro and micro elements, biologically active substances, and are a good precursor for cereals and other crops. The technology was developed in cooperation with ICARDA, the World Vegetable Center, the Institute of Plant Industry, the Institute of Vegetable, Melon and Potato Production of the Republic of Uzbekistan.
- This technology is aimed at implementing comprehensive measures to save resources, protect and increase soil fertility, and improve its ecological conditions.




Vegetable and legume crops as a mean to improve soil fertility

The technology is resource-saving, soil-protective, aimed at carrying out comprehensive measures to increase soil fertility and improve the ecological conditions of lands.

Cultivation of new vegetable and legume crops is recommended on arid, low fertile degraded soils. Biological basis of restoration and preservation of its productivity, introduction of new bio substances, implementation of new soil protection measures have been developed. Changes in soil properties and yield at spring and summer sowing of vegetable and leguminous crops are shown. Various varieties of vegetable soyabean, mung bean, and asparagus bean are recommended taking into account soil and climate conditions.





Nematode distribution on saline meadow grey soils and ways of its optimisation

The study of phytonematode fauna on irrigated meadow grey soils with different degrees of salinity showed that the composition of their species and ecological and trophic groups depend on the type and degree of soil salinity, chemical composition, agrophysical properties, and soil humus levels. For non-saline soils, the nematode fauna can be assessed as relatively diverse. The Shannon Diversity index is 1.4 - 2.55, and the Bongers Maturity index (MI) is 2.75 - 4.3. For moderately saline soils the Shannon index is characterised by slightly lower values of 1.2 - 1.6, and the Bongers nematode maturity index (MI) is 2.0 - 3.5. For highly saline soils, the Shannon diversity index shows the lowest levels of 0.6 - 1.2, and the Bongers maturity index (MI) is 1.8 - 2.2, which is due to the state of the soil, lack of vegetation, and presence of large amounts of salts. These indices reflect the state of the environment and indicate disturbance and deterioration of soil properties. The diversity and maturity indices (along with humus, NPK levels, soil density, mechanical composition, degree, and type of soil salinity) can serve as indicators of soil degradation.




Bacteriotrophs prevailed in all biotopes, which were up to 85.7 % in virgin and non-saline areas, and up to 95.8 % in highly saline areas. The nematode predominance was distributed in the following order: on virgin land bacteriotrophs > mycotrophs (phytotrophs); on non-saline bacteriotrophs > mycotrophs (phytotrophs) > polytrophs; on saline bacteriotrophs > mycotrophs > (phytotrophs).

Nematode distribution on saline meadow grey soils and ways of its optimisation

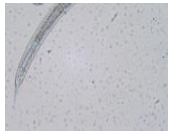
Cotton agrocenosis (spring)

№	Nemadote species	Depth, cm			Total
		0-10	10-20	20-30	
1	Plectus parietinus	4	6		10
2	Prismatolaimus intermedius		10		10
3	Mesodoraylaimus bastian	7			7
4	Rhabditis filiformis	5		2	7
5	Cephalobus oryzae	3	4		7
6	Eucephalobus oxyuroides	3		2	5
7	Acrobeloides labiatus		10		10
8	Negolaimus brachyuris	10		4	14
9	Negolaimus intermedius	8	4		12
10	Helicotylenchus multicinctus	104	120	32	256
11	Eudoraylaimus labiatus		25		25
12	Eudoraylaimus monohustera			6	6
13	Eudoraylaimus obtusicaudatus	4		4	8
13	Eudoraylaimus pratensis			4	4
14	Eudoraylaimus parvus	6	25		31
15	Cephalobus persegnis		16		16
16	Eucephalobus laevis	24			24
17	Aphelenchus avenae		31		31
18	Aphelenchoides limberi		6		6
19	Aphelenchoides parietinus	22			22
20	Aglenchus agricola	56	16	10	82
21	Tylenchus davaini	20	18	8	46
22	Fylenchus filiformus	20	14		34
23	Bitylenchus dubius	34	44	12	90
24	Ditylenchus dipsaci	12	20	8	40
Total amount		346	379	96	803

Rhabditis filiformis
Microscope XPS-500E
China, 2019 --(cir 10 x 20)

Eudoraylaimus labiatus
Microscope XPS-500E
China, 2019 --(cir 10 x 20)

Mesodorylaimus pseudobastiani
Microscope XPS-500E
China, 2019 --(cir 10 x 20)



Mesodorylaimus pseudobastiani
Microscope XPS-500E
China, 2019 --(cir 10 x 20)

Ditylenchus dipsaci
Microscope XPS-500E
China, 2019 --(cir 10 x 20)

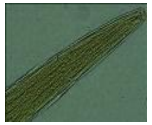
Salt flat (solonchak)

№	**Nematode species**	**Depth, cm**			**Total**
		0-10	10-20	20-30	
1	Mesorhabditis monhystera		2		2
2	Eucephalobus oxyuroides		3	4	7
3	Aporselaimellus obtusicaudatus	2		3	5
4	Acrobeloides emarginatus		2	2	4
5	Acrobeloides nanus	3	1	4	8
6	Rhabditis filiformis	2		10	12
7	Cephalobus oryzae			6	6
8	C. persegnis		4	3	7
9	Aphelenchus avenae		7		7
10	Aglenchus Agricola	2		8	10
11	Tylenchus filiformis	3	6		9
12	Ditylenchus dipsaci		10	20	30
Total amount					107

Efficiency of compounds Novagumin, Ecogumin, Aminosid-Si, Vayomil, An-bio for optimizing nematodes on saline meadow grey soils.

Helicotylenchus multicinctus
Microscope XPS-500E
China, 2019 --(cir 10 x 20)

Nygolaimus intermedius
Microscope XPS-500E
China, 2019 --(cir 10 x 20)



Nygolaimus intermedius
Microscope XPS-500E
China, 2019 --(cir 10 x 20)

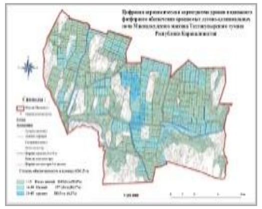
Nygolaimus intermedius
Microscope XPS-500E
China, 2019 --(cir 10 x 20)

Development of the information and analysis system of agrochemical survey and soil fertility monitoring using GIS technologies

It’s all about creating digital agrochemical cartograms of irrigated soils using modern GIS technologies and establishing optimal rates and timing of fertiliser application for crops, as well as developing the information and analysis system of agrochemical survey of soils. "Information and analysis system of agrochemical survey of soils" has high capabilities when it’s about storage, quick update, search, and provision of data. These data include an electronic database on the agrochemical state of irrigated soils, scientific proof of the high and effective potential of the GIS technologies in the creation of digital agrochemical cartograms compared to the traditional methods, as well as the distribution of agrochemical properties of soil and variogram of mathematical structure.

- Digital agrochemical cartograms with the amount of humus and nutrients in the arable horizon of irrigated soils for farms with the use of the GIS technologies and based on the current methodological guidelines were compiled;
- Scientifically based optimal rates and timing of fertiliser application for the main types of crops grown on the arable land of farms have been developed based on the digital agrochemical cartograms created;
- The difference and efficiency of fertiliser rates based on the digital agrochemical cartograms created with a focus on the fertiliser rates were calculated;
- It has been proved that the use of geoinformation technologies while organizing digital agrochemical services saves time and manual labour.

№	Experiment parts	Time, minutes	
		Traditional methods	Information and analysis system
1.	Field research	600	310
2.	Lab tests	600	500
3.	Office work	540	20
4.	Calculating fertiliser application	720	60
5.	Agrochemical monitoring of lands	600	30
	Total	3060 (51 hours)	845 (15 hours 16 minutes)



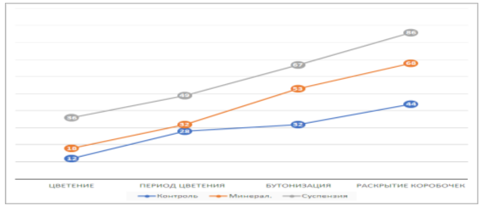
Liquid suspension complex fertilisers for cotton crop

The application of liquid suspension complex fertilisers (LSCF) combined with mineral fertilisers proved to have a positive effect on the growth and development of cotton.

Phenological observation showed that during the flowering period of cotton with the use of liquid suspension complex fertilizers the stem length was 6-9 cm longer than in the control group and 3-4 cm longer than with mineral fertilizers. Also the number of leaves formed on 1 bush was higher when liquid suspension complex fertilisers were used (31-32 pieces). In cotton, which by this period of vegetation had entered the flowering phase, the control group formed 8-9 flowers, the one with mineral fertilisers 14-15, and those with suspension application 24-27.

The research carried out at the end of summer (30.08.2022) showed a big difference between variants in terms of buds formed. Fertilised plants developed 1.5-3.0 buds more than the control group.

Different fertilisers and number of cotton bolls



Options	Depth, cm	Humus, %	Totals of nitrogen, %	Totals of phosphorus, %	Totals of potassium, %
Control	0-30 30-45	1,18 0,92	0,093 0,074	0,145 0,115	1,47 1,35
N250 P180 K150	0-30 30-45	1,20 0,95	0,101 0,080	0,169 0,130	1,52 1,39
N250P180K150 + LSCF 2,5 l	0-30 30-45	1,25 0,96	0,120 0,085	0,175 0,135	1,60 1,40

Change of agrochemical properties depending on soil conditions

Use of liquid suspension complex fertilisers (LSCF) combined with mineral fertilisers has a positive effect on cotton's growth and development

№	Options	Yield, centners/ha	Profit, total/ha		Profitability, %	
			total	±	%	±
1	Control	20,9	16121260		330,1	
2	N250 P180 K150	30,1	23520754	7399494	349,5	19,4
3	N250P180K150 +LSCF 2,5 l	38,2	30343468	14222208	377,1	46,9

Economic efficiency and profitability of liquid suspension complex fertilisers

Production and application of bio-organic fertiliser “Universal" from wastes

- The technology of obtaining a highly effective bio-organic fertiliser "Universal" from agricultural and solid domestic waste using local species of earthworms is resource-saving and environmentally friendly. It also helps to improve soil properties and increase crop yields.
- The use of bio fertiliser "Universal" creates an opportunity to provide crops with macro and microelements, improve the qualitative and quantitative composition of humus, optimise water, physical, agrochemical properties, the biological activity of the soil, reduce weeds, and increase crop yields. The technology of vermicomposting with modifications in short periods allows effective processing of agricultural and solid domestic wastes into vermicompost which is an effective fertiliser for agriculture, and worm biomass, a high-protein feed for poultry and fish farming. Worm biomass is also an effective biological ameliorant and can improve the physical properties of soils (structure, porosity, air and water properties, etc.). Recommendations on the implementation of this technology have been developed. The technology was developed by scientists of the Karaganda State University.

Yield of cotton variety C-6524 with the use of bioorganic fertilisers on meadow grey soils

№	Option	Yield, centners/ ha	Increase, centners/ha ***	№	Option	Yield, centners/ ha	Increase, centners/ha
1	N_{150} P_{105} K_{75} Control	32,1	5,1/-	4	Basic +1,5 t/ha BTW**	36,7	4,6/9,7
2	N_{100} P_{70} K_{50} Basic	27,0	-/-5,1	5	Basic +2,5 t/ha BTW	43,6	11,5/16,6
3	Basic + 2t/ha PHF*	34,8	2,7/7,8	6	Basic +2,5 t/ha vermicompost	40,3	8,2/12,7

* PHF – Phosphate and humic acid fertilisers
** BTW – Biogas technology waste
*** Increase in relation to full fertiliser rate - Control/Increase with reduced fertiliser rate by 30% - Basic

Effect of vermicompost on soil properties

- Effect of vermicompost on agrochemical properties of soil was analyzed by different options: 1 - control, 2 – application of vermicompost “Universal” (obtained thanks to earthworms Eisenia fetida processing solid domestic waste), 3 – bio-organic fertilizer “Unumdor” (obtained as a result of anaerobic digestion at a biogas plant), 4 – use of earthworms Eisenia fetida. One plot of 30 m^2 needs “Universal", 200 litres of "Unumdor", and 700 earthworms.
- Agrochemical properties of “Universal” vermicompost: humus 25.05%, nitrogen 1.032%, phosphorus 2.108%, labile variants of $N\text{-}NH_4$ 36.3 mg/kg, P_2O_5 66 mg/kg, K_2O 217mg/kg. Agrochemical properties of “Unumdor” bio-organic fertiliser: per dry weight of organic carbon 64.01%, humic acids 13.2%, fulvic acid 20.3%, nitrogen 7.47%, potassium 2.41%, phosphorus 2.90%, Fe_2O_3 0.04%, Al_2O_3 0.1%, Na 0.41%.
- Agrochemical properties of soils got better after using fertilisers. “Universal” (option 2) showed the best results in terms of humus and nutrient levels. Up next is option 3 with “Unumdor” and 4 with earthworms.




Training farmers in soil fertility improvement techniques

- Training farmers in resource-saving environmentally friendly technologies for increasing and restoring soil fertility is aimed at improving their ecological condition and sharing best practices for sustainable use of land resources. Taking into account soil and climatic conditions when determining the factors limiting fertility, a special training programme is developed for farmers, and topics and content are determined. The training production base is demonstration plots. Theory classes are held on the premises of the scientific centre AgroEcoBiotechnology of the Mirzo Ulugbek National University of Uzbekistan, as well as in field stations, experimental stations, and agricultural colleges. It is also planned to do field training in basic farms. Recommendations, brochures, and other information materials have been made for farmers.

Farmers’ Day

Qibray district,
Tashkent region

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INNOWEEK 2022

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Анализ почвы
Анализ минеральных удобрений
в центре проводятся лабораторные работы по 4 направлениям
Таксологический анализ
Радиологический контрольный анализ
Услуги, предоставляемые в центре агрохимических анализов
Проведение агрохимических анализов почвы на договорной основе сельскохозяйственным предприятиям агрокластерам, фермерским хозяйствам, частным подворьям, теплицам; определение уровень обеспеченности почвы элементами питания и на основании этого разработать агрохимический карт послойного дифференцированного применения минеральных удобрений под вид сельскохозяйственных культуры и в каждый контур;
разработка научно обоснованной потребности в минеральных удобрениях в зависимости от уровня обеспеченности почвы питательными веществами;
проведение лабораторных анализов и выдача заключений о качестве всех видов минеральных удобрений, поставляемых в сельское хозяйство (зернистость, влажность, количество действующих веществ в составе и другие);
проведение радиологического и токсикологического мониторинга в установленных контрольных точках, определение уровней накопления остатков нитратов, токсичных пестицидов, солей тяжелых металлов и радионуклидов в почве и сельскохозяйственной продукции и принятие мер по их устранению;
1. Составляется договор и проводится подготовка почвы к анализу
2. Специалист берет пробу почвы и отправляет в лабораторию
3. Результаты агрохимического анализа почвы вносятся в электронную платформу «Uzagrolab.uz»
4. Результаты анализа будут представлены вам с картами на основе рекомендации
5. Вы можете правильно распределить минеральные удобрения, основываясь на рекомендациях
O'ZBEKISTON RESPUBLIKASI QISHLOQ XO'JALIGI VAZIRLIGI HUZURIDAGI O'SIMLIKLAR KARANTINI VA HIMOYASI AGENTLIGI
Республиканский центр агрохимичиского анализа
Агрохимический анализ почвы – залог обильного урожая и высокого дохода

Conclusions

- Tasks in the development and implementation of innovative technologies to improve the fertility of degraded soils:
  - ✓ to study how the process of irrigated soil formation changes given the adaptive character of modern agriculture to climate change;
  - ✓ to develop a theoretical basis and efficient methods to fight salinity, erosion, destruction of humus, over consolidation, and pollution with heavy metals, fluorides, and agrochemicals;
  - ✓ to study and optimize the biological activity of soils, their pedofauna in different soil and climate conditions, and agrocenosis;
  - ✓ to develop biological methods of increasing soil fertility;
  - ✓ to develop and implement agricultural eco-technologies, nano y biotechnologies, the GIS technologies in the field of rational use and preservation of soil resources;
  - ✓ to study carbon balance in soils and agricultural landscapes, carbon emission and precipitation by arable soils, improvement of productivity of agrocenoses, and possibilities to manage all of it;
  - ✓ to plan measures to preserve and use rationally forest resources (in mountains, deserts, or tugay) as well as to improve lands and defend them from erosion, salinity, and the negative impact of climate change;
  - ✓ to research how the dried Aral seabed and the territory nearby can be used;
  - ✓ to study the correlation between fertilisers' efficiency and environmental conditions;
  - ✓ to study how different crops get nutrients, to develop a new system of applying fertilisers in terms of a new adaptational system of agriculture;
  - ✓ to develop an adaptive landscape and eco-friendly farming systems.

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Thank you!