

Morphological and physico-chemical properties of the soil and the forage value of vegetation cover of saline lands on pastures

Field studies on the study of solonetzic soils were carried out in Karaganda, Ulytau, Akmola, Aktope and West Kazakhstan regions at monitoring sites selected using soil, geographical maps and satellite images (Figure 1 and 2).

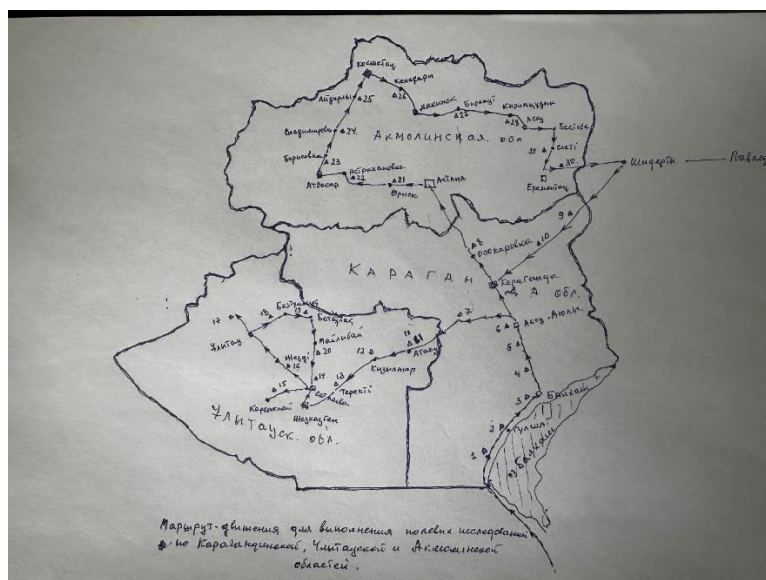


Figure 1 – Location and route of movement for field research in the Karaganda, Ulytau and Akmola regions

In the Aktope and West Kazakhstan regions, 20 landfills were selected (10 in the Aktope and 10 in the West Kazakhstan regions) for the study of solonetz lands on pastures (Figure 2).

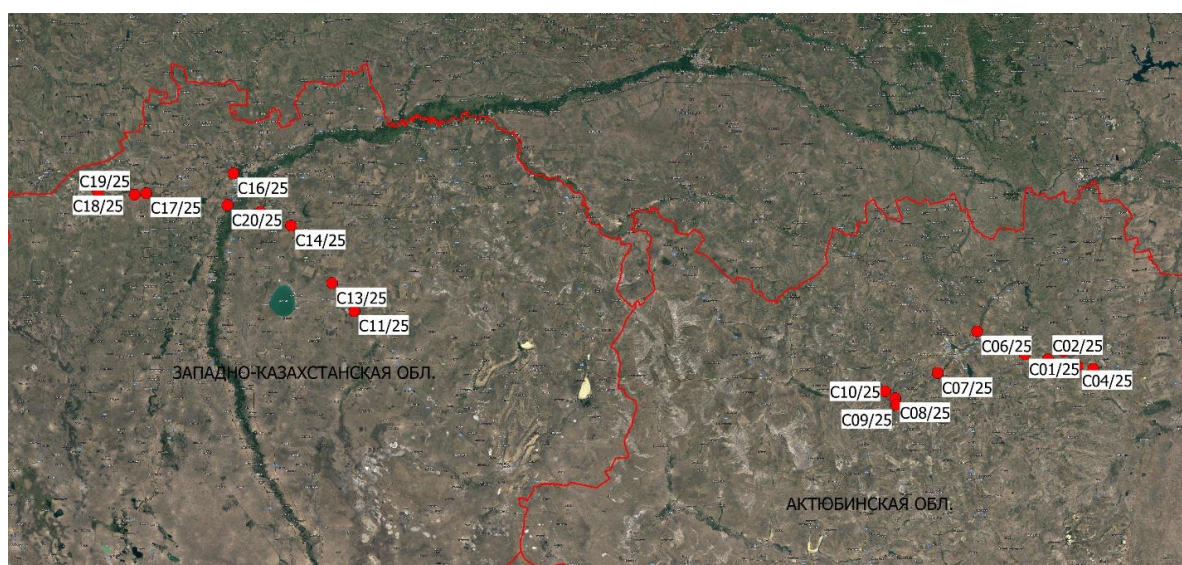


Figure 2 – Location of monitoring sites in Aktope and West Kazakhstan regions

At these sites, landscapes, vegetation, and soil morphological properties were described, and soil samples were selected to study their physicochemical properties. At the same time, photographs of landscapes and soil profiles were taken. After completion of the work, the soil incision was buried to prevent damage to equipment and livestock.

At the same landfills, a forage and botanical examination was carried out, which consisted of determining the projective coverage of vegetation, determining its species composition, taking plant samples from the site 1 m by 1 m, weighing the above-ground mass to determine yield.

Karaganda region

Monitoring site №1 – The study was carried out in the Karaganda region, Aktogay district and is located from the Almaty – Karaganda highway 500 meters in the southeast (Figure 3). Soil type – medium saltbush, relief – plain, landscape aspect – greyish-greenish, water regime – atmospheric. Coordinates N 46° 530' 784", E 074° 146' 130".



A



B

Figure 3 – Structure of the profile (A) of the middle salt licks and surface condition (B)

0-14 cm, light grey, fresh, finely clumped, weakly compacted, pierced by roots, boils violently from HCl, granular loamy, transition sharp in density;

15-33cm, Dark brown with a whitish tint, dry, dense prismatic-columnar, heavy loam, roots, boils violently from HCl transition noticeable;

34-57 cm, Brown with a whitish tint, dry, dense, lumpy, loamy, few roots, boils violently from HCl, the transition is noticeable;

58-85 cm, whitish brown, dry, dense, structureless, loamy, boils violently from HCl, many spots of carbonates, gradual transition;

86-130 cm, light fawn, fresh, dense, structureless, boils violently from HCl, crushed stone.

The middle solonetztes of the Aktogay district of the Karaganda region are characterized by a superficially (0-10 cm) sandy loam and deeper than it (20-50 cm) medium loamy granulometric composition. The physical clay content in the indicated soil strata was 11.23 and 25.13%, respectively (Table 1).

Table 1 – Granulometric composition of mean solonetz

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
1	0-10	0,30	36,409	36,309	16,048	3,210	4,814	3,210	11,234
	20-30	1,36	32,036	32,279	10,543	3,650	8,921	12,571	25,142
	40-50	1,30	20,709	38,359	15,805	4,458	15,805	4,863	25,127
	70-80	2,48	16,756	24,590	46,349	5,332	0,410	6,563	12,305
	120-130	2,22	27,879	28,758	30,272	3,273	0,409	9,409	13,091

A study of the chemical composition of the middle solonetztes of the Aktogay district of the Karaganda region showed that they have a low level of fertility. This is evidenced by the humus content, which amounted to 0.44 and 0.51%, respectively, in the supra-solonetz and solonetz horizons (Table 2).

Table 2 – Chemical composition of medium salt licks

№ cut	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
1	0-10	0,44	0,056	25,2	20	160	9,18
	20-30	0,51	0,042	25,2	4	70	9,42
	40-50	-	-	-	-	-	8,72
	70-80	-	-	-	-	-	8,38
	120-130	-	-	-	-	-	8,36

The half-meter thickness of the middle salt licks of the study point №1 is characterized by a strongly alkaline reaction of the medium (pH 8.72-9.42).

Determination of the salt profile of medium salt licks showed that in them water-soluble salts in concentrations toxic to plants (>0.1-0.3%) occur from a depth of 20 cm. The most superficial humus layer, where the salt content was 0.065%, is favorable with respect to salinity (Table 3). Based on the data of the first half meter, the studied soils can be characterized as slightly saline.

Table 3 – Ionic composition of water extract of medium solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
1	0-10	0,065	0,48	0,00	0,04	0,41	0,09	0,66	0,12	0,06
			0,029	0,000	0,001	0,02	0,002	0,008	0,003	0,002
	20-30	0,329	0,96	0,16	3,29	0,81	0,09	0,09	4,85	0,02
			0,059	0,005	0,117	0,039	0,002	0,001	0,112	0,001
	40-50	0,221	0,40	0,00	3,32	0,15	1,4	1,22	1,24	0,02
			0,024	0,000	0,118	0,007	0,028	0,015	0,028	0,001
	70-80	0,539	0,36	0,00	8,5	0,65	7,01	1,22	1,25	0,02
			0,022	0,000	0,301	0,031	0,14	0,015	0,029	0,001
	120-130	0,859	0,36	0,00	4,99	8,34	10,66	2,16	0,86	0,02
			0,022	0,000	0,177	0,4	0,213	0,026	0,02	0,001

The soils of the monitoring site №1 of the Aktogay district of the Karaganda region are solonetz, since their content of absorbed sodium at a depth of 40-50 cm is 21.42%, and absorbed magnesium in the surface horizons is 29.0 and 54.0% of the sum of absorbed bases (Table 4).

Table 4 – Composition of absorbed bases of middle solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
1	0-10	5,97	2,49	0,02	0,23	8,71
		68,5	29,0	0,2	3,0	
	20-30	4,98	7,46	1,42	0,06	13,92
		36,0	54,0	10,0	0,4	
	40-50	7,96	6,97	21,42	0,06	36,41
		22,0	19,0	59,0	0,2	
	70-80	10,95	17,41	7,84	0,20	36,40
		30,1	47,8	21,5	0,5	
	120-130	12,94	12,44	52,43	0,06	77,87
		17,0	16,0	67,0	0,1	

Characteristics and forage value of land cover. When studying the biological indicators of vegetation, it was revealed that the projective coverage of the surface of solonetzic soils with vegetation is 35–40% of the total area. The type of pasture is scorzonera-sagebrush with the participation of a boy, since when determining the botanical composition of plants, scorzonera occupies – 65%, wormwood – 20% and hawthorn – 15% of the area. On solonetz buds, in addition to them, bluegrass, Tatar rhubarb and kochia are found in small quantities in the vegetation. The yield of pasture mass was –9.2 c/ha. Coordinates of the boundaries of the contour of the research point №1– N 46°20'18.7, E 074°08'47,6''

Research conducted by the laboratory of Kazakh Research Institute of «Animal Husbandry and Feed Production» to study the chemical composition of

feed in solonetzic soils showed that the content of protein in the air-dry state is 13.63%, fat – 5.11%, fiber – 32.74%, NFE -36.09% and ash – 10.30%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.60 per kilogram of feed, and the exchange energy is – 8.71 MJ (appendix).

Monitoring site № 2 is located in the Aktogay district of the Karaganda region, in the southeast 500 meters from the Almaty – Karaganda highway and from the village of Gulshat to the north 18 kilometers (Figure 4). Soil type – medium saltbush, relief – low-wave plain, landscape aspect – greyish, water regime – atmospheric. Coordinates N 46° 721' 132", E 074° 483' 838".



A



B

Figure 4 – Structure of the profile (A) of the middle salt licks and surface condition (B)

0-16 cm, light gray, dry, weakly compacted, dusty-clumpy, loamy, pierced by roots, boiling from HCl, the transition is sharp in density and color;

17-33 cm, Dark brown with whitish spots, dry, dense, heavy loam, roots, boiling from HCl, the transition is noticeable, lumpy-prismatic;

34-58 cm, lighter than the previous one, more spots dense, lumpy, loamy, roots, boils from HCl, dry, the transition is noticeable in mechanical composition;

59-85 cm, brown, fresh, loamy, coarse sand, carbonate spots, weakly compacted, structureless, gradual transition, boiling from HCl;

86-130 cm, light brown, wet, weakly compacted, crushed stone, structureless, boiling from HCl, there are individual gypsum drusen.

The granulometric composition of the solonetz of the middle study points №2 of the Aktogay district of the Karaganda region is characterized by sandy loam in the superficial and heavy loamy solonetz horizons. These had physical clay contents of 16.48 and 33.27%, respectively (Table 5).

Table 5 – Granulometric composition of medium salt licks

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
2	5-15	0,48	30,527	42,946	10,048	5,225	7,235	4,019	16,479
	25-35	1,40	21,542	39,108	6,085	5,274	23,124	4,868	33,266
	40-50	1,68	31,998	31,387	8,950	2,441	19,121	6,103	27,665
	70-80	2,16	24,796	34,730	7,768	22,077	6,541	4,088	32,706
	110-120	3,12	41,969	19,220	9,083	1,652	20,644	7,432	29,727

Table 6 – Chemical composition of medium salt licks

Point №	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
2	5-15	0,37	0,042	22,4	20	200	9,09
	25-35	0,37	0,042	28	8	200	9,25
	40-50	-	-		-	-	8,82
	70-80	-	-	-	-	-	8,66
	110-120	-	-	-	-	-	8,56

The study of the chemical composition of the middle salt licks of the study point №2 of the Aktogay district of the Karaganda region is characterized by a low level of fertility. This proves the humus content in the surface horizons, where it was respectively 0.37%, as well as the very strong alkalinity (pH 9.09-9.25) of the soil environment (Table 6).

The average solonetz of the study point №2 are characterized by the fact that the salinity of the profile increases with depth and at depths of 70-80 and 110-120 cm reaches a maximum (1.092 and 1.218%). The ionic composition is dominated by sulfate and then chlorine ions (Table 7).

Table 7 - Ionic composition of water extract of medium solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
2	5-15	0,141	0,32	0,00	1,00	0,91	0,28	0,84	1,05	0,06
			0,02	0,000	0,035	0,044	0,006	0,01	0,024	0,002
	25-35	0,372	0,56	0,16	5,17	0,45	0,28	0,84	5,04	0,02
			0,034	0,005	0,183	0,022	0,006	0,01	0,116	0,001
	40-50	0,688	0,32	0,00	7,94	3,09	3,27	1,22	6,84	0,02
			0,02	0,000	0,282	0,148	0,065	0,015	0,157	0,001
	70-80	1,092	0,40	0,00	10,71	6,59	4,39	2,06	11,21	0,03

			0,024	0,000	0,38	0,316	0,088	0,025	0,258	0,001
	110-120	1,218	0,32	0,00	10,16	9,08	6,08	2,81	10,64	0,03
			0,02	0,000	0,36	0,436	0,122	0,034	0,245	0,001

Data on the composition of the absorbed bases of the soils of study point №2 showed that they are solonetz. Since in the solonetz horizon (25-35 cm) the proportion of absorbed sodium reaches 43.0% of the sum of absorbed bases (Table 8).

Table 8 - Composition of absorbed bases of middle solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
2	5-15	3,98	1,99	0,92	0,22	7,11
		56,0	28,0	13,0	3,0	
	25-35	3,98	6,47	7,99	0,05	18,49
		22,0	35,0	43,0	0,3	
	40-50	14,43	5,47	11,30	0,22	31,42
		46,0	17,0	36,0	0,7	
	70-80	22,39	9,95	5,88	0,24	38,46
		58,0	26,0	15,0	0,6	
	110-120	11,94	13,93	16,33	0,22	42,42
		28,0	33,0	38,5	0,5	

Characteristics and forage value of land cover. The total projective surface coverage of solonetzic soils with vegetation is only – 45% of the total area. Pasture type – sagebrush – scorzonera with the participation of hawthorn. The botanical composition of the plants consists of wormwood – 40%, scorzonera – 30%, feather grass – 5%, feather grass – 3%, klimokoptera – 10% and hawthorn – 12% of the area. In addition to them, kochia is found in a single specimen in the vegetation cover. The yield of pasture mass is – 10.0 c/ha. Coordinates of the study point contour boundaries №2 – N 46°43'15.7'' E 074°29'037''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 13.41%, fat – 5.23%, fiber – 32.45%, NFE -34.55% and ash – 11.42%. The yield of feed units at natural plant moisture is – 0.50 per kilogram of feed, and the exchange energy is – 6.89 MJ.

Monitoring site № 3 is located 8 kilometers north of the city of Balkhash, Aktogay district, Karaganda region (Figure 5). Soil type – fine saltbush, crushed soil surface, relief – low-wavelength plain, landscape aspect – greyish-greenish, water regime – atmospheric. Coordinates N 46° 949' 820", E 074° 941' 162".



A



B

Figure 5 – Structure of profile (A) of fine solonetz and surface condition (B)

0-11 cm, Light gray, dry, loamy, dusty lumpy, weakly compacted, many roots, boiling from HCl, crushed stone on the surface, sharp transition in density;

12-24 cm, Dark brown, dry, prism-clumpy, dense, heavy loam, roots, boils from HCl;

25-41cm, Brown with carbonate spots, dry, dense, lumpy, loamy, small roots, carbonate spots, gradual transition;

42-69cm, Brown with a whitish tint, fresh, structureless, compacted, noted a lot of gypsum drusen, does not boil from HCl;

70-120 cm, Brown with a reddish tint, wet, clayey, structureless, manganese veins, gypsum drusen, compacted, does not boil from HCl.

An analysis of the content of the fraction of small solonetz of the study point №3 of the Aktogay district of the Karaganda region showed that they have a sandy loam composition in the above-solonetz and heavy loam in the solonetz horizons themselves. In the latter, physical clay contains 14.95 and 33.18%, respectively (Table 9).

Table 9 – Granulometric composition of small salt licks

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
3	0-10	0,98	32,801	35,286	16,966	2,828	6,059	6,059	14,946
	11-21	2,36	32,466	25,748	8,603	10,242	1,639	21,303	33,183
	30-40	1,80	43,829	30,102	6,925	1,222	4,073	13,849	19,145

	50-60	4,38	44,112	26,605	8,785	1,673	2,092	16,733	20,498
	80-90	7,86	8,487	3,386	8,248	4,341	4,775	70,762	79,878

The chemical composition of small salt licks of the study point №3 of the Aktogay district of the Karaganda region shows a low level of their fertility. The humus content of the surface horizons is 0.51% (Table 10).

Table 10 – Chemical composition of fine salt licks

Point №	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
3	0-10	0,51	0,056	19,6	12	220	9,84
	11-21	0,51	0,056	25,2	10	90	8,96
	30-40	-	-	-	-	-	8,61
	50-60	-	-	-	-	-	8,09
	80-90	-	-	-	-	-	6,68

A study of the ionic composition of the water extract and the salt content of the small salt licks of the monitoring site №3 showed that they are superficially practically unsalted. This is clearly shown by the content of water-soluble salts (0.075 and 0.133%) in layers 0-10 and 11-21 cm (Table 11). A sharp increase in the noted indicator to 1.5% is observed deeper than the first half meter in layers of 50-60 and 80-90 cm.

Table 11 - Ionic composition of the aqueous extract of fine salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃	From normal carbonates in CO ₃ ²⁻						
3	0-10	0,075	0,72	0,16	0,07	0,19	0,09	0,28	0,59	0,02
			0,044	0,005	0,003	0,009	0,002	0,003	0,014	0,001
	11-21	0,133	0,64	0,16	1,37	0,02	0,28	0,19	1,52	0,04
			0,039	0,005	0,048	0,001	0,006	0,002	0,035	0,002
	30-40	0,582	0,32	0,00	4,51	4,45	1,78	1,78	5,70	0,02
			0,020	0,000	0,160	0,214	0,036	0,022	0,131	0,001
	50-60	1,237	0,28	0,00	3,84	14,6	11,13	1,41	6,18	0,02
			0,017	0,000	0,136	0,701	0,223	0,017	0,142	0,001
	80-90	1,503	0,36	0,00	24,57	1,14	1,40	3,74	20,91	0,02
			0,022	0,000	0,871	0,055	0,028	0,045	0,481	0,001

A study of the composition of small salt licks of the monitoring site №3 showed that the proportion of absorbed sodium and magnesium in them is high. Thus, for example, in the upper horizon (0-10 cm) the proportion of magnesium absorbed is 36.0%, while at a depth of 30-40 cm the proportion of sodium absorbed reaches 46.0% (Table 12). Moreover, the latter increases even more with depth.

Table 12 - Composition of absorbed bases of small solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
3	0-10	5,47	3,98	1,42	0,12	10,99
		50,0	36,0	13,0	1,0	
	11-21	12,94	2,49	2,09	0,14	17,66
		73,0	14,0	12,0	0,8	
	30-40	21,39	4,48	21,79	0,14	47,80
		45,0	9,0	46,0	0,3	
	50-60	11,94	13,43	26,95	0,05	52,37
		23,0	26,0	51,5	0,1	
	80-90	9,95	12,94	61,06	0,05	84,00
		11,8	15,4	72,7	0,06	

Characteristics and forage value of land cover. Studies of biological indicators of vegetation showed that the projective coverage of the surface of solonetzic soils with vegetation is – 40%. Pasture type – salsola -sagebrush with the participation of hawthorn and feather grass. When studying the botanical composition of plants, it was revealed that scorzonera occupies - 60%, wormwood – 15%, calligonum – 15% and feather grass – 10% of the area. In addition to them, the vegetation contains plants such as kochia, sedge and climocoptera. The yield of pasture mass was - 7.0 c/ha. Coordinates of the study point contour boundaries №3 – N 46°56'59,3''; E 074°56'27,80''.

Analysis of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 11.44%, fat – 6.72%, fiber – 33.42%, NFE -34.65% and ash – 10.53%. At the same time, the yield of feed units at natural plant moisture is – 0.51 per kilogram of feed, and the exchange energy is – 6.96 MJ.

The monitoring site №4 is also located in the Aktogay district of the Karaganda region and is located 500 meters east of the Almaty – Karaganda highway (Figure 6). Soil type – medium saltbush, soil surface - crushed stone, relief – plain, landscape aspect – greyish – yellowish, water regime – atmospheric. Coordinates N 47°19' 14", E 074° 827' 975".



A



B

Figure 6 – Structure of the profile (A) of the middle salt licks and surface condition (B)

0-13 cm, Light gray, dry, dusty-clumpy, weakly compacted, loamy, soil-crushed from the surface, many roots, boiling from HCl, transition clear in density;

14-28 cm, Brown, dry, dense, prism-columnar, heavy loam, roots, salt spots, boiling from HCl, gradual transition;

29-47 cm, Brown with a whitish tint, dry, dense, loamy, lumpy, many roots, boils from HCl, the transition is noticeable in color;

48-68 cm, Lighter than the previous one, dry, compacted, loamy, crushed stone and small stones are found, structureless, boiling transition from HCl is sharp in color;

69-120 cm, Greyish-whitish, fresh, dense, clayey, structureless, a lot of gypsum and carbonates.

A study of the middle salt licks of the study point №4 of the Aktogay district of the Karaganda region showed that in the upper horizon they have a light loamy granulometric composition (physical clay 27.34%). In the underlying horizon, the content of physical clay increases and amounts to 39.55% (Table 13), which indicates severe conditions.

Table 13 – Granulometric composition of medium salt licks

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
4	0-10	1,96	40,147	14,157	18,360	8,568	13,464	5,304	27,336
	15-25	2,90	30,299	15,324	14,830	6,591	11,123	21,833	39,547
	30-40	3,38	30,656	15,111	15,318	7,038	14,490	17,388	38,915
	50-60	2,80	51,749	14,918	9,877	4,938	9,053	9,465	23,457
	80-90	4,06	31,666	23,306	24,599	1,668	0,834	17,928	20,429

Table 14 – Chemical composition of medium salt licks

Point №	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
4	0-10	1,17	0,126	47,6	16	320	8,67
	15-25	0,91	0,112	19,6	2	80	8,46
	30-40	-	-	-	-	-	8,65
	50-60	-	-	-	-	-	8,22
	80-90	-	-	-	-	-	8,15

Compared to previous soils, in the middle salt licks of the study point №4, the humus content in the humus-accumulative horizon (0-10 cm) is slightly higher and amounts to 1.17%. With depth, it gradually decreases to 0.91% (Table 14). From the surface to a depth of 90 cm, the reaction of the soil environment of medium-sized solonetz varies from medium to highly alkaline (pH 8.15-8.67).

From the data of the ionic composition and the content of water-soluble salts of the middle salt licks of the monitoring site №4, it follows that they are not saline in the first half meter (sum of salts <0.1%). However, a high concentration of salts (1.318%) at a depth of 80-90 cm indicates that the noted soils formed on saline source rocks (Table 15).

Table 15 - Ionic composition of water extract of medium solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
4	0-10	0,095	0,44	0,00	0,04	0,87	0,65	0,47	0,14	0,08
			0,027	0,000	0,001	0,042	0,013	0,006	0,003	0,003
	15-25	0,055	0,36	0,00	0,00	0,41	0,28	0,38	0,10	0,02
			0,022	0,000	0,000	0,020	0,006	0,005	0,002	0,001
	30-40	0,078	0,56	0,04	0,00	0,50	0,28	0,38	0,39	0,02

			0,034	0,001	0,000	0,024	0,006	0,005	0,009	0,001
	50-60	0,352	0,28	0,00	0,00	4,86	3,55	0,56	1,01	0,02
			0,017	0,000	0,000	0,233	0,071	0,007	0,023	0,001
	80-90	1,318	0,32	0,00	1,29	17,78	11,87	1,03	6,47	0,02
			0,02	0,000	0,046	0,853	0,237	0,013	0,149	0,001

Data on the composition of the absorbed bases of the middle solonetz of the monitoring site №4 showed that their content of absorbed sodium is quite high (19.5% of the CEC) in the solonetz horizon (Table 16).

Table 16 - Composition of absorbed bases of middle solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
4	0-10	13,43	4,48	0,02	0,22	18,15
		74,0	25,0	0,1	1,0	
	15-25	22,39	6,47	7,02	0,05	35,93
		62,3	18,0	19,5	0,2	
	30-40	20,4	6,97	0,77	0,05	28,19
		72,0	25,0	2,7	2,2	
	50-60	36,82	3,98	2,66	0,05	43,51
		85,0	9,0	6,0	0,1	
	80-90	12,44	14,43	3,66	0,05	30,58
		41,0	47,0	12,0	0,2	

Characteristics and forage value of land cover. The study of soil cover by vegetation showed that projective surface coverage by plants accounts for 45% of the total area. Pasture type – sagebrush - scorzoneraovo - feather grass. The botanical composition of this massif consists of wormwood – 52%, scorzonera – 25%, feather grass – 10%, kochia – 8% and parnell – 5% of the area. Plants such as ferula are also found in the vegetation. The yield of pasture mass was -11.5 c/ha. Coordinates of the study point contour boundaries №4 – N 47°11'56.9''; E 074°49'41.9''.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 12.93%, fat – 6.44%, fiber – 32.22%, NFE -33.38% and ash – 11.84%. At the same time, the yield of feed units at natural plant moisture is – 0.48 per kilogram of feed, and the exchange energy is – 6.74 MJ.

Monitoring site №5 in the Shet district of the Karaganda region and is located 500m northeast of the Karaganda – Almaty highway (Figure 7). Soil type – fine brackish, relief – weakly sloping plain with a southern slope, landscape aspect – greyish, water regime – atmospheric. Coordinates N 47°645' 370", E 074° 365' 029".



A



B

Figure 7 – Structure of profile (A) of fine solonetz and surface condition (B)

0-18 cm, Light grey, dusty-grain, dry, weakly compacted, loamy, many roots, boils violently from HCl, clear transition;

19-31cm, Brown, dry, dense, heavy loam, prism-like lumpy, roots, boiling from HCl, carbonate spots marked towards the bottom, noticeable transition;

32-49 cm, Brown-fawn, a lot of carbonates, dry, dense, lumpy, loamy, few roots, boils violently from HCl;

50-78 cm, Whitish due to carbonates, fresh, dense, structureless, loamy, boils violently from HCl, the transition is noticeable;

79-110 cm, Fawn-buff, fresh, compacted, structureless, manganese dots, iron veins, loamy.

Based on the granulometric composition of the solonetz, small study points №5 of the Shet district of the Karaganda region are characterized as light loamy. Physical clay in the 0-30 cm thickness averages 27.0% (Table 17). Even deeper, starting from 35 cm, the soil becomes heavy clay. Physical clay varies between 43.89 and 55.92%.

Table 17 – Granulometric composition of small salt licks

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
5	5-15	1,52	28,899	28,452	15,435	8,936	12,185	6,093	27,214
	20-30	1,96	42,697	18,543	10,200	6,120	9,384	13,056	28,560
	35-45	2,48	29,717	16,961	9,434	11,075	13,946	18,868	43,888

	60-70	2,16	22,383	19,563	10,221	4,088	38,021	5,724	47,833
	80-90	2,00	18,143	12,878	13,061	4,898	44,490	6,531	55,918

Based on the humus content in the upper horizons of small salt licks, we can state the fact that the soils in question are weakly humidified. The humus content of layers 5-15 and 20-30 cm was 1.75 and 1.36% (Table 18).

Table 18 – Chemical composition of fine salt licks

Point №	Depth, cm	Types of analysis					pH
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			
				Nitrogen	Phosphorus	Potassium	
5	5-15	1,75	0,224	28,0	40	500	7,90
	20-30	1,36	0,098	33,6	2	100	8,56
	35-45	-	-	-	-	-	8,55
	60-70	-	-	-	-	-	8,76
	80-90	-	-	-	-	-	8,31

Data on the ionic composition and water extract salt content of the salt licks of the small monitoring site №5 showed that these soils are not saline at a depth of 0-30 cm (<0.1%). However, within a thickness of 35 to 70 cm, the degree of soil salinity changes to weak (0.298-0.356%) (Table 19).

Table 19 - Ionic composition of fine salt licks aqueous extract, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃	From normal carbonates in CO ₃ ²⁻						
5	5-15	0,086	0,28	0,00	0,04	0,97	0,19	0,94	0,03	0,13
			0,017	0,000	0,001	0,047	0,004	0,011	0,001	0,005
	20-30	0,039	0,44	0,00	0,00	0,07	0,19	0,28	0,03	0,02
			0,027	0,000	0,000	0,003	0,004	0,003	0,001	0,001
	35-45	0,298	0,52	0,00	2,73	1,55	0,47	1,31	3,01	0,02
			0,032	0,000	0,097	0,075	0,009	0,016	0,069	0,001
	60-70	0,356	0,44	0,00	4,62	0,82	0,47	0,75	4,64	0,02
			0,027	0,000	0,164	0,039	0,009	0,009	0,107	0,001
	80-90	0,873	0,36	0,00	4,43	8,78	6,08	1,97	5,51	0,02
			0,022	0,000	0,157	0,421	0,122	0,024	0,127	0,001

The soils of the monitoring site №5 of the Shet district of the Karaganda region are characterized by magnesium solonetzicity. This is evidenced by the proportion of magnesium absorbed, which varies in a noticeable amount within the profile from 37.0 to 42.0% of the cation exchange capacity (Table 20).

Table 20 - Composition of absorbed bases of middle solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
5	5-15	8,46	5,47	0,16	0,65	14,73
		57,0	37,0	1,0	4,0	
	20-30	12,94	2,49	0,16	0,09	15,67
		83,0	16,0	1,0	0,6	
	35-45	12,94	9,95	0,53	0,09	23,50
		55,0	42,0	2,0	0,4	
	60-70	12,94	8,46	1,59	0,09	23,08
		56,0	37,0	7,0	0,4	
	80-90	27,86	6,97	1,72	0,09	36,64
		76,0	19,0	5,0	0,2	

Characteristics and forage value of land cover. The results of the field studies show that the projective covering of the soil surface by plants accounts for – 55% of the total area. Grassland type – sagebrush and feather grass involving *krascheninnikovia ceratoides*. A study of the botanical composition of plants showed that wormwood occupies – 50%, feather grass – 35%, *krascheninnikovia ceratoides* – 10% and *ephedra* – 5% of the area. The plants also contain single plants – Tatar rhubarb. The yield of pasture mass was – 6.0 c/ha. Coordinates of the study point contour boundaries №5 – N 47°38'43.0''; E 074°21'54.2''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 12.52%, fat – 7.00%, fiber – 32.52%, NFE -34.31% and ash – 10.54%. The yield of feed units at natural plant moisture is – 0.53 per kilogram of feed, and the exchange energy is – 7.45 MJ.

Monitoring site № 6 is located 1.5 kilometers from the village. Aksu-Ayuly to the south in the Shet district of the Karaganda region (Figure 8). Soil type – fine saltbush, relief – plain, landscape aspect – yellowish grey, water regime – atmospheric. Coordinates N 48° 756' 219", E 073° 681' 798".



A



B

Figure 8 – Structure of profile (A) of fine solonetz and surface condition (B)

0-10 cm, Dark grey, dry, compacted, dusty lumpy, loamy, plant roots, does not boil from HCl, transition is sharp in density;

11-23cm, Brownish grey, dry, dense, columnar, heavy loam, roots, does not boil from HCl, clear transition;

24-41cm, Brownish, dry, compacted, lumpy, loamy, few roots, veins of carbonates, boils violently from HCl, the transition is gradual;

42-70 cm, Dark brown with carbonate veins, dry, compacted, loamy, few roots, structureless, sharp transition;

71-130 cm, Brown with a whitish tint, fresh, compacted, loamy, accumulation of carbonates and gypsum, individual spots of manganese are found, structureless.

A study of the granulometric composition of small solonetztes of the monitoring site №6 showed that they are superficially light loamy, as well as medium loamy in the solonetz horizon. In the marked strata, the physical clay content was respectively 15.56 and 29.02% (Table 21).

Table 21 – Granulometric composition of small salt licks

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
6	0-10	2,28	14,388	37,720	32,337	6,140	6,140	3,275	15,555
	11-21	2,12	9,931	29,179	31,876	10,217	11,034	7,765	29,015
	30-40	2,00	9,653	36,878	30,612	6,939	8,980	6,939	22,857
	50-60	2,14	6,785	25,772	33,926	9,401	19,620	4,496	33,517

	80-90	1,98	19,547	38,013	29,790	1,224	0,816	10,610	12,650
--	-------	------	--------	--------	--------	-------	-------	--------	--------

Small salt licks of the monitoring site №6 of the Shet district of the Karaganda region contain total humus in the amount of 3.73 and 2.22% in layers 0-10 and 11-21 cm (Table 22). These soils are characterized by a highly alkaline reaction of the medium throughout the profile (pH 8.19-8.64).

Table 22 – Chemical composition of fine salt licks

Point №	Depth, cm	Types of analysis					pH
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			
				Nitrogen	Phosphorus	Potassium	
6	0-10	3,73	0,252	64,4	42	1000	8,64
	11-21	2,22	0,168	50,4	10	680	8,25
	30-40	-	-	-	-	-	8,19
	50-60	-	-	-	-	-	8,22
	80-90	-	-	-	-	-	8,24

According to the ionic composition of the water extract of small salt licks of the monitoring site №6, it is clear that in these soils the salinity increases with depth from a weak to an intense degree. Within the profile, the salt content varies from 0.128 to 1.173% (Table 23).

Table 23 - Ionic composition of the aqueous extract of fine salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
6	0-10	0,128	0,48	0,00	0,04	1,26	0,09	0,75	0,66	0,28
			0,029	0,000	0,001	0,061	0,002	0,009	0,015	0,011
	11-21	0,476	0,40	0,00	4,99	2,30	1,78	1,13	4,45	0,33
			0,024	0,000	0,177	0,11	0,036	0,014	0,102	0,013
	30-40	0,766	0,40	0,00	10,16	2,32	4,86	1,69	5,89	0,44
			0,024	0,000	0,36	0,111	0,097	0,021	0,135	0,017
	50-60	1,150	0,36	0,00	10,53	7,85	8,23	3,00	7,23	0,28
			0,022	0,000	0,373	0,377	0,165	0,036	0,166	0,011
	80-90	1,173	0,28	0,00	2,44	15,03	11,03	2,53	4,16	0,02
			0,017	0,000	0,086	0,721	0,221	0,031	0,096	0,001

Study of the composition of the absorbed bases of the middle solonetztes of the monitoring site №6 shows the salinity of the soil from a depth of 30 cm to 60 cm, where the proportion of absorbed sodium is, respectively, 46.0 and 51.8% of the cation exchange capacity (Table 24).

Table 24 - Composition of absorbed bases of middle solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
6	0-10	13,93	4,98	0,89	1,71	21,52
		65,0	23,0	4,0	8,0	
	11-21	14,93	4,98	2,37	0,49	22,77
		66,0	22,0	10,0	2,0	
	30-40	15,42	8,96	21,02	0,45	45,85
		34,0	19,0	46,0	1,0	
	50-60	28,86	7,96	39,60	0,17	76,59
		38,0	10,0	51,8	0,2	
	80-90	12,94	9,95	0,29	0,09	23,27
		55,6	43,0	1,0	0,4	

Characteristics and forage value of land cover. The data obtained when studying the biological indicators of vegetation showed that the projective coverage of the soil with vegetation accounts for 60% of the total area. Pasture type – sagebrush-hazel-cereal. The botanical composition of plants is formed mainly from wormwood – 60%, isene – 30% and cereals – 10% of the area and consists of plants such as wormwood, isene, fescue, chiy, yarrow, cinquefoil and thistle. The yield of pasture mass is 6.5 c/ha. Coordinates of the study point contour boundaries №6 – N 48°45'20,4''; E 073°40'53,8''.

Analysis of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 12.13%, fat – 5.22%, fiber – 32.84%, NFE -34.65% and ash – 12.32%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.50 per kilogram of feed, and the exchange energy is – 7.06MJ.

The monitoring site № 7 is also located in the Shet district of the Karaganda region, east of the Karaganda-Zhezkazgan highway (Figure 9). Soil type – brackish, relief – weakly undulating plain, landscape aspect – greyish-yellowish, water regime – atmospheric. Coordinates N 48° 890' 700", E 072° 333' 273".



A



B

Figure 9 – Structure of the profile (A) of cortical solonetz and surface condition (B)

0-4cm, Light gray, dry, dusty lumpy, loose, loamy, many roots, does not boil from HCl, the transition is sharp in color and density;

5-23cm, Dark brown, dry, very dense, columnar, heavy loam, plant roots, does not boil from HCl, the transition is noticeable;

24-43cm, Gley with brown tint, wet, slightly compacted, light loam, lumpy, boiling from HCl, clear transition in color;

44-62 cm, Gley with brown spots, wet, veins and spots of carbonates, structureless, loamy, weakly compacted, does not boil from HCl, the transition is gradual;

63-120 cm, Gley with pronounced brown spots, wet, structureless, clayey, weakly compacted, does not boil from HCl.

In terms of granulometric composition, the cortical salt licks of the monitoring site №7 are characterized by a sandy loam and light clay composition in the over-solonetz and solonetz horizons. In the latter, the physical clay content was respectively 16.63 and 40.80% (Table 25).

Table 25 – Granulometric composition of cortical solonetz

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physi- cal clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
7	0-7	8,58	28,965	37,782	16,627	7,001	5,688	3,938	16,627
	10-20	1,96	27,458	22,766	8,976	8,160	11,832	20,808	40,800

	25-35	3,08	15,291	23,215	48,700	0,413	0,413	11,969	12,794
	45-55	2,26	12,994	39,943	38,879	2,046	0,818	5,320	8,185
	80-90	1,96	31,089	20,767	17,952	25,296	1,224	3,672	30,192

In the chemical composition of the cortical salt licks of the monitoring site №7 of the Shet district of the Karaganda region, it is clear that their humus content is 2.07, 1.61 and 0.33% in the upper three layers (Table 26). The alkalinity of the soil environment (pH 8.39-9.23) is characterized by almost all genetic horizons of soils, except humus (pH 7.15).

Table 26 – Chemical composition of cortical solonetz

Point №	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
7	0-7	2,07	0,126	25,2	48	290	7,15
	10-20	1,61	0,084	33,6	16	220	8,39
	25-35	0,33	0,084	28,0	6	60	9,23
	45-55	-	-	-	-	-	9,04
	80-90	-	-	-	-	-	8,55

A study of the ionic composition of the water extract of the crust salt licks of the monitoring site №7 showed that these soils are very highly saline within a thickness of 25 to 90 cm. In the latter, the salt content varies from 1.792 to 2.425% (Table 27).

Table 27 - Ionic composition of the aqueous extract of cortical solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃	From normal carbonates in CO ₃ ²⁻						
7	0-7	0,046	0,20	0,00	0,00	0,43	0,09	0,09	0,43	0,02
			0,012	0,000	0,000	0,021	0,002	0,001	0,010	0,001
	10-20	0,355	0,52	0,00	1,40	3,45	0,47	1,40	3,49	0,02
			0,032	0,000	0,050	0,166	0,009	0,017	0,080	0,001
	25-35	2,383	0,28	0,00	6,10	29,13	10,75	3,09	21,64	0,02
			0,017	0,000	0,216	1,398	0,215	0,038	0,498	0,001
	45-55	2,425	0,32	0,00	7,57	28,41	9,63	3,09	23,56	0,02
			0,020	0,000	0,269	1,364	0,193	0,038	0,542	0,001
	80-90	1,792	0,24	0,00	8,50	18,24	5,24	0,47	21,26	0,02
			0,015	0,000	0,301	0,876	0,105	0,006	0,489	0,001

The composition of the absorbed bases of the cortical solonetz of the monitoring site №7 is dominated by absorbed sodium, the share of which in the solonetz horizon was 25.0% of the cation exchange capacity (Table 28). Moreover, with depth, its proportion increases even more and at a depth of 80–90 cm reaches 61.6% of the CEC.

Table 28 - Composition of absorbed bases of cortical solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
7	0-7	6,47	3,48	0,36	0,31	10,62
		61,0	33,0	3,0	3,0	
	10-20	4,48	6,97	3,95	0,11	15,51
		29,0	45,0	25,0	1,0	
	25-35	14,43	9,95	28,29	0,09	52,76
		27,0	18,8	54,0	0,2	
	45-55	12,94	10,95	25,25	0,09	49,22
		26,3	22,2	51,3	0,2	
	80-90	36,82	3,48	64,91	0,09	105,29
		35,0	3,3	61,6	0,09	

Characteristics and forage value of land cover. Analysis of the data obtained from field studies showed that the projective coverage of the soil with vegetation accounts for 60% of the total area. Pasture type – sagebrush-fescue-echium with the distribution of plants such as sagebrush, fescue, feather grass, vostrets, volosnets, echium, statice, camphorosma, reveller and ferula. The botanical composition consists mainly of wormwood – 60%, fescue – 20%, echium– 10%, statice 5% and camphorosm 5% of the area. The yield of pasture mass is at – 5.0 c/ha. Coordinates of the study point contour boundaries №7 – N 48°53'26,4''; E 072°20'00,0''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 11.82%, fat – 6.93%, fiber – 31.93%, NFE -32.58% and ash – 13.42%. The yield of feed units at natural plant moisture is – 0.52 per kilogram of feed, and the exchange energy is – 7.21 MJ.

The monitoring site № 8 is located in the Osakarov district of the Karaganda region and is located 600m from the village. Bakbakty in a northwestern direction, towards Astana (Figure 10). Soil type –shallow, relief – plain, landscape aspect – greenish– greyish, water regime – atmospheric. Coordinates N 50°46' 737", E 072° 687' 368".



A



B

Figure 10 – Structure of the profile (A) of fine solonchoks and surface condition (B)

0-10cm, Dark gray, fresh, dusty lumpy, loose, many plant roots, boils violently from HCl, loamy, the transition is sharp in density;

11-22cm, Dark brown, fresh, dense, columnar-prismoid, heavy loam, roots, boils violently from HCl, gradual transition;

23-36 cm, Lighter than the previous one, fresh, dense, lumpy, loamy, single roots, boils violently from HCl, the transition is gradual;

37-63cm, Brown, wet, compacted, structureless, loamy, carbonate veins, small plant roots, boils violently from HCl, gradual transition;

64-110 cm, Lighter than the previous one, wet, weakly compacted, individual dark spots are noted, clayey, structureless, boils violently from HCl; veins of carbonates.

In small salt licks of the monitoring site №8, Osakarov district, Karaganda region, the content of physical clay in layers 0-10 and 11-21 cm is 33.73 and 44.60%, respectively (Table 29). This suggests that the humus horizon has an average loamy granulometric composition. Deeper, starting from the solonchok horizon, the latter becomes heavy.

Table 29 – Granulometric composition of fine salt licks

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
8	0-10	3,94	5,726	19,738	40,808	9,577	16,240	7,912	33,72 9

	11-21	4,04	3,272	17,528	34,598	11,672	18,341	14,589	44,602
	25-35	3,98	1,458	26,474	14,164	14,580	20,829	22,495	57,905
	50-60	3,92	0,729	10,595	29,142	12,073	22,481	24,979	59,534
	80-90	3,90	0,333	4,766	37,045	13,319	39,958	4,579	57,856

The salt licks of the small monitoring site № 8 in the Osakarov district of the Karaganda region are characterized by a low level of fertility. This is evidenced by the humus content (2.55 and 2.06%) and the medium/strong alkaline reaction of the medium (pH 8.37 and 8.70) (Table 30).

Table 30 – Chemical composition of fine salt licks

№ cut	Depth, cm	Types of analysis					pH
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			
				Nitrogen	Phosphorus	Potassium	
8	0-10	2,55	0,182	81,2	14	500	8,37
	11-21	2,06	0,168	39,2	2	210	8,70
	25-35	1,84	0,098	30,8	2	200	8,64
	50-60	-	-	-	-	-	8,41
	80-90	-	-	-	-	-	8,29

In the small salt licks of the monitoring site №8, the content of water-soluble salts is low, especially in the surface layers, where their sum was 0.115-0.151% (Table 31). However, deeper, the content of toxic salts gradually increases to 0.541%.

Table 31 - Ion composition of water extracts from small salt marshes, mg-eq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
8	0-10	0,115	0,60	0,00	0,22	0,85	0,37	0,66	0,62	0,02
			0,037	0,000	0,008	0,041	0,007	0,008	0,014	0,001
	11-21	0,151	0,76	0,00	0,00	1,35	0,09	0,84	1,16	0,02
			0,046	0,000	0,000	0,065	0,002	0,01	0,027	0,001
	25-35	0,264	0,76	0,00	0,52	2,58	0,19	1,22	2,44	0,02
			0,046	0,000	0,018	0,124	0,004	0,015	0,056	0,001
	50-60	0,504	0,48	0,00	5,73	2,20	1,78	2,06	4,55	0,02
			0,029	0,000	0,203	0,105	0,036	0,025	0,105	0,001
	80-90	0,541	0,40	0,00	7,57	1,28	2,62	1,69	4,93	0,02
			0,024	0,000	0,269	0,061	0,052	0,021	0,113	0,001

Small salt licks of the monitoring site №8 of the Osakarov district of the Karaganda region are characterized by magnesium solonetz. Since the proportion of

absorbed magnesium in the solonetz and sub-solonetz horizons is greater than 30% of the sum of absorbed bases (Table 32).

Table 32 - Composition of absorbed bases of small solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
8	0-10	19,4	6,97	0,94	0,33	27,64
		70,2	25,2	3,4	1,2	
	11-21	15,42	11,44	3,45	0,09	30,39
		50,7	38,0	11,0	0,3	
	25-35	14,93	9,45	0,80	0,09	25,27
		59,1	37,4	3,2	0,3	
	50-60	13,93	17,91	0,78	0,09	32,70
		42,6	54,7	2,4	0,3	
	80-90	11,94	14,43	0,45	0,09	26,90
		44,4	53,6	1,7	0,3	

Characteristics and forage value of land cover. Projective vegetation coverage of this solonetz area accounts for 65% of the total area. Pasture type – wormwood– forge-fescue. The botanical composition of the plants consists of wormwood– 50%, feather grass –30%, fescue– 20% of the area. In addition to the above-mentioned plants, wheatgrass, yellow sweet clover, yarrow and rump are found in a single specimen. The yield of pasture mass is –11.0 c/ha. Coordinates of the study point contour boundaries №8 – N 50°28'10,9''; E 072°41'14,2''.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that in the air-dry state the content of protein is 16.62%, fat – 7.02%, fiber – 32.93%, NFE -33.52% and ash – 7.42%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.58 per kilogram of feed, and the exchange energy is – 8.23 MJ.

Monitoring site № 9 is located in the Osakarov district of the Karaganda region, 400 m west of the Pavlodar highway– Karaganda and in an easterly direction 3 kilometers from the village of Rodnikovskoye (Figure 11). Soil type – fine saltbush, relief – low wavy plain, landscape aspect – greyish– greenish, water regime – atmospheric. Coordinates N 51°040' 035", E 073° 956' 100".



A



B

Figure 11 – Structure of the profile (A) of fine solonetz and surface condition (B)

0-11cm, Dark gray, wet, granular-lumpy, loose, loamy, abundance of roots, boils violently from HCl, the transition is sharp in color and density;

12-24 cm, Dark brown, moist, prism-clumpy, dense, heavy loam, roots, boiling from HCl, transition sharp in color;

24-46 cm, Brown, fresh, lumpy, dense, clayey, boils violently from HCl, single roots, small pebbles are found, the transition is gradual;

47-84 cm, Lighter than the previous one, wet, structureless, carbonate stains, compacted, clayey, boils violently from HCl, gradual transition;

85-120 cm, Brown with a rusty tint, wet, structureless, compacted, clayey, boils violently from HCl.

Small salt licks of the monitoring site № 9 Osakarov district of the Karaganda region were formed on clayey soil-forming rocks. This is indicated by the content of physical clay, which at a depth of 90-100 cm is 57.04% (Table 33). Its maximum value was recorded in layers of 30-40 and 60-70 cm (62.14 and 64.65%). Even the humus horizon has a heavy loamy composition (54.91%).

Table 33 - Granulometric composition of small salt licks

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
9	0-10	3,84	3,702	9,359	32,030	21,631	19,135	14,143	54,908
	12-22	3,98	2,166	4,936	32,910	18,746	25,411	15,830	59,988
	30-40	4,08	2,836	5,004	30,025	18,349	23,353	20,434	62,135
	60-70	4,10	0,792	27,049	7,508	22,106	38,790	3,754	64,651

	90-100	3,92	0,583	34,471	7,910	19,151	33,306	4,580	57,036
--	--------	------	-------	--------	-------	--------	--------	-------	--------

A study of the chemical composition of small salt licks of the monitoring site №9 of the Osakarov district of the Karaganda region showed that they are more fertile compared to previous soils. The humus content in the upper horizons (0-10 and 12-22 cm) was 3.39 and 2.20%, respectively (Table 34). However, in them, the alkalinity of the soil environment is still preserved to an average degree throughout the entire profile.

Table 34 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
9	0-10	3,39	0,210	64,4	28	800	8,40
	12-22	2,20	0,154	53,2	2	190	8,77
	30-40	-	-	-	-	-	8,50
	60-70	-	-	-	-	-	8,31
	90-100	-	-	-	-	-	8,34

Data on the ionic composition of the soil solution of small solonetz showed that in these soils salinity increases with depth and reaches a very strong degree in the parent rock (1.011%). In the ionic composition, chlorine ion dominates among the anions (Table 35).

Table 35 - Ionic composition of the aqueous extract of fine salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
9	0-10	0,135	0,60	0,00	0,00	1,33	0,56	0,75	0,60	0,02
			0,037	0,000	0,000	0,064	0,011	0,009	0,014	0,001
	12-22	0,183	0,96	0,08	0,63	1,02	0,19	0,84	1,45	0,13
			0,059	0,002	0,022	0,049	0,004	0,010	0,033	0,005
	30-40	0,576	0,60	0,00	7,39	1,44	2,15	0,28	6,98	0,02
			0,037	0,000	0,262	0,069	0,043	0,003	0,161	0,001
	60-70	0,820	0,44	0,00	12,01	1,62	1,59	2,72	9,75	0,02
			0,027	0,000	0,426	0,078	0,032	0,033	0,224	0,001
	90-100	1,011	0,40	0,00	12,93	3,61	1,68	2,81	12,43	0,02
			0,024	0,000	0,459	0,174	0,034	0,034	0,286	0,001

A study of the composition of the absorbed bases of small solonetz of the monitoring site №9 of the Osakarov district of the Karaganda region showed that starting from a depth of 30 cm to 100 cm, the share of absorbed sodium occupies more than half (>50% of the ECO) among all cations (Table 36).

Table 36 - Composition of absorbed bases of small solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
9	0-10	16,92	10,95	0,09	0,60	28,56
		59,2	38,3	0,3	2,1	
	12-22	22,39	4,98	2,75	0,06	30,19
		74,2	16,5	9,1	0,2	
	30-40	11,94	14,43	33,52	0,06	59,96
		20,0	24,0	55,9	0,1	
	60-70	10,95	16,42	37,40	0,06	64,83
		16,9	25,0	58,0	0,1	
	90-100	9,45	17,41	32,92	0,06	59,84
		15,8	29,1	55,0	0,1	

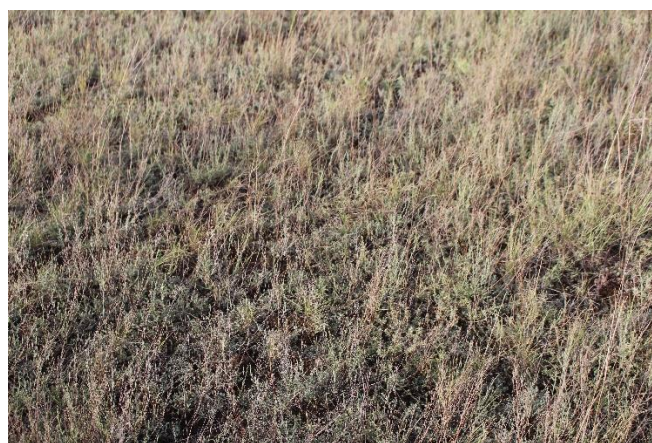
Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 70% of the total area. Pasture type – sagebrush. The botanical composition of the plants in this area consists of sagebrush – 80%, wheatgrass – 10%, feather grass – 5% and fescue – 5% of the area. It is also found in a single specimen of thistle, which belongs to a number of weeds. The yield of pasture mass is – 5 c/ha. Coordinates of the study point contour boundaries №9 – N 51°02'24,2''; E 073°57'22,5''.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 16.00%, fat – 7.20%, fiber – 28.55%, NFE -30.75% and ash – 14.21%. At the same time, the yield of feed units at natural plant moisture is – 0.61 per kilogram of feed, and the exchange energy is – 8.92 MJ.

The monitoring site № 10 is also located in the Osakarov district of the Karaganda region, 400m west of the Pavlodar – Karaganda highway and 70 km in a northeast direction from the city of Karaganda (Figure 12). Soil type – brackish, relief – low-wavelength plain, landscape aspect – greyish– greenish, water regime – atmospheric. Coordinates N 50° 346' 582", E 073° 289' 311".



A



B

Figure 12 – Structure of the profile (A) of cortical solonetztes and surface condition (B)

0-5cm, grey, wet, loose, granular-clumpy, loamy, abundance of plant roots, boiling from HCl, transition noticeable in color and density;

6-17cm, Brown, wet, dense, columnar, heavy loam, roots, boiling from HCl, noticeable transition;

18-27 cm, Lighter than the previous one, wet, lumpy, clayey, roots, boils from HCl, compacted, gradual transition;

28-55 cm, Brown, wet, structureless, clay, boiling from HCl, compacted, noticeable transition;

56-110 cm, Brown with whitish spots of carbonates, wet, structureless, clayey, compacted, boils violently from HCl, gypsum drusen.

The study of the granulometric composition of the small salt licks of the monitoring site №10 showed that they are superficially medium loamy (phys. clay 38.58%). However, the subhumus horizon of the soil acquires a heavy loamy granulometric composition, which is further weighted deeper and reaches maximum values in the layer of 40-50 cm (physical clay 67.80%) (Table 37).

Table 37 – Granulometric composition of cortical solonetztes

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
10	0-5	2,54	7,306	34,004	20,111	10,671	15,596	12,313	38,580

	6-16	3,26	9,944	11,081	27,290	10,750	17,366	23,568	51,685
	18-27	4,80	4,517	24,475	13,445	30,672	20,588	6,303	57,563
	40-50	3,84	4,160	8,070	19,967	55,324	7,903	4,576	67,804
	80-90	4,70	7,807	12,865	67,996	4,197	0,420	6,716	11,333

A study of the cortical solonchets of the monitoring site №10 in the Osakarov district of the Karaganda region showed that they are weakly humous in the upper layer A in terms of humus content (Table 38). The humus value in the marked soil layer is 2.69%.

Table 38 – Chemical composition of cortical solonchets

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
10	0-5	2,69	0,154	47,6	18	410	8,35
	6-16	1,66	0,126	47,6	3	240	8,73
	18-27	1,00	0,098	84,0	10	290	8,82
	40-50	-	-	-	-	-	9,12
	80-90	-	-	-	-	-	8,92

A study of the salt composition of small salt licks of the monitoring site №10 showed that they are superficially weak - (0.250%) and highly saline (0.817%). However, the salt sequence is located in the range from 18 to 90 cm, where the maximum amount of salts (2.6-2.8%) is concentrated. This suggests that the soils studied are deeply saline and formed on saline soil-forming rocks (Table 39).

Table 39 - Ionic composition of the aqueous extract of cortical solonchets, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
10	0-5	0,250	0,52	0,00	0,07	2,90	0,09	0,38	3,01	0,02
			0,032	0,000	0,003	0,139	0,002	0,005	0,069	0,001
	6-16	0,817	0,72	0,00	0,11	10,81	0,94	1,41	9,29	0,02
			0,044	0,000	0,004	0,519	0,019	0,017	0,214	0,001
	18-27	2,555	0,64	0,08	0,78	35,18	6,83	1,97	27,79	0,02
			0,039	0,002	0,028	1,689	0,137	0,024	0,639	0,001
	40-50	2,326	0,56	0,08	2,88	30,16	4,02	1,78	27,79	0,02
			0,034	0,002	0,102	1,448	0,080	0,022	0,639	0,001
	80-90	2,800	0,44	0,00	3,66	37,43	7,29	7,97	26,25	0,02
			0,027	0,000	0,13	1,797	0,146	0,097	0,604	0,001

The soils of the monitoring site №10 of the Osakarov district of the Karaganda region are solonchets, since exchangeable sodium dominates in the composition of absorbed cations (Table 40). Its content in the solonchets horizon is 73.9% of the cation exchange capacity.

Table 40 - Composition of absorbed bases of small solonchets

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
10	0-5	12,44	5,47	51,10	0,06	69,07
		18,0	8,0	73,9	0,1	
	6-16	18,41	5,97	37,58	0,06	62,03
		29,7	9,6	60,6	0,1	
	18-27	11,94	8,46	36,80	0,21	57,41
		20,8	14,7	64,1	0,4	
	40-50	11,94	14,43	19,34	0,06	45,77
		26,1	31,5	42,3	0,1	
	80-90	12,94	14,93	22,87	0,06	50,80
		25,5	29,4	45,0	0,1	

Characteristics and forage value of land cover. Projective vegetation coverage in this area is –70% of the total area. Grassland type – sagebrush-forge-halophyte. The botanical composition of plants in this area consists of wormwood – 60%, feather grass – 15%, echium – 5%, statice - 10%, camphorosma – 5% and wheatgrass – 5% of the area. The yield of pasture mass is 10.5 c/ha. Coordinates of the study point contour boundaries №10 – N 50°20'47,7''; E 073°17'21,4''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 14.41%, fat – 7.52%, fiber – 28.54%, NFE -34.89% and ash – 11.52%. The yield of feed units at natural plant moisture is – 0.57 per kilogram of feed, and the exchange energy is – 7.93 MJ.

Ulytau region.

The monitoring site № 11 is located in the Zhanaarkin district of the Ulytau region, 5500 meters from the village of Atasu in a westerly direction (Figure 13). Soil type – fine saltbush, relief – flat, landscape aspect – greenish, water regime – atmospheric. Coordinates N 48° 639' 417", E 071° 347' 464".



B

A

Figure 13 – Structure of profile (A) of fine solonetz and surface condition (B)

0-11 cm, Dark grey, dry, dusty-lumpy, loamy, weakly compacted, many roots, does not boil from HCl, clear transition;

12-23cm, Brown, dry, lumpy, loamy, dense, roots, does not boil from HCl, the transition is clear in color;

24-43cm, Brown, dry, lumpy, loamy, dense, boils violently from HCl, single roots, noticeable transition;

44-63cm Light brown, fresh, structureless, compacted, clayey, boils violently from HCl, carbonate stains, gradual transition;

64-120 cm, Fawn, wet, structureless, weakly compacted, clayey, carbonates, boils violently from HCl.

In terms of granulometric composition, the small salt licks of the monitoring site №11 of the Zhanaarkin district of the Ulytau region are easily loamy. In the surface horizons, the physical clay content is 19.075 and 23.030% (Table 41). Moreover, as the value deepens, it increases towards weighting.

Table 41 - Granulometric composition of small solonetz

№ cut	Depth, cm	A.S.N % H2O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
11	0-10	1,44	33,604	29,058	18,263	7,305	8,117	3,653	19,075
	10-20	1,00	29,677	30,323	16,970	8,081	10,101	4,848	23,030
	30-40	1,32	35,995	19,416	11,755	5,675	11,755	15,403	32,833
	50-60	1,78	31,562	15,903	8,145	4,887	12,625	26,878	44,390
	80-90	1,02	28,309	28,854	10,507	2,829	15,357	14,144	32,330

In the chemical composition of small salt licks of the monitoring site №11 of the Zhanaarkin district of the Ulytau region, it is clear that these soils contain humus in an amount of 3.98% in the humus horizon (Table 42). As it deepens downward, the humus content sharply decreases, first to 1.88%, and then to 1.31%. The fact that starting from 30 cm to the bottom of the incision, the reaction of the soil medium is very highly alkaline (pH 9.67-9.87) should be noted here.

Table 42 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
11	0-10	3,98	0,238	44,8	49	560	7,60
	10-20	1,88	0,140	22,4	4	520	8,47

	30-40	1,31	-	-	-	-	9,67
	50-60	-	-	-	-	-	9,72
	80-90	-	-	-	-	-	9,87

From the data of the ionic composition of the water extract of the middle salt licks of the monitoring site №11, it follows that these soils are characterized by weak salinity of the soil profile. In the latter, the total salt content varies from 0.167 to 0.355% (Table 43). In the anionic composition, the dominant position is occupied by sulfate and chlorine ions, but in addition to them, soda is present in a content toxic to plants at a depth of 30-90 cm.

Table 43 - Ionic composition of water extract of medium solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
11	0-10	0,167	0,20	0,00	0,00	2,27	1,31	0,66	0,49	0,02
			0,012	0,000	0,000	0,109	0,026	0,008	0,011	0,001
	10-20	0,338	0,16	0,00	0,81	3,93	0,56	0,56	3,40	0,38
			0,01	0,000	0,029	0,189	0,011	0,007	0,078	0,015
	30-40	0,350	1,44	0,80	1,22	2,21	0,19	0,19	4,26	0,23
			0,088	0,024	0,043	0,106	0,004	0,002	0,098	0,009
	50-60	0,355	1,80	1,04	1,66	1,57	0,19	0,38	4,45	0,02
			0,11	0,031	0,059	0,075	0,004	0,005	0,102	0,001
	80-90	0,250	1,20	0,80	1,00	1,30	0,09	0,19	3,20	0,02
			0,073	0,024	0,035	0,063	0,002	0,002	0,074	0,001

The soils of the monitoring site №11 are solonetzic because in them, in the solonetzic horizon, the proportion of sodium absorbed is 29.3% of the sum of the bases absorbed (Table 44). Moreover, as it deepens, the value of the noted indicator increases.

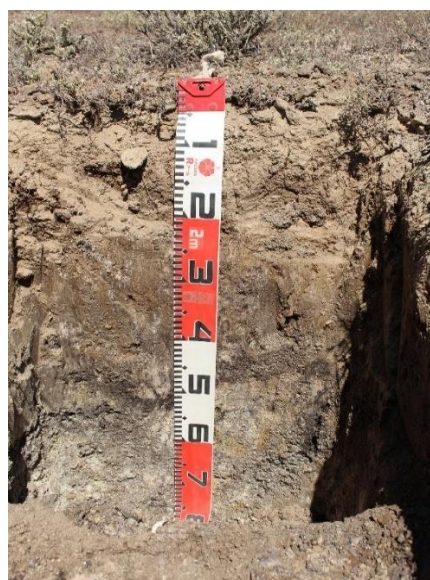
Table 44 - Composition of absorbed bases of middle solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
11	0-10	8,46	2,99	0,30	0,53	12,27
		68,9	24,4	2,4	4,3	
	10-20	13,43	1,49	6,36	0,45	21,73
		61,8	6,8	29,3	2,1	
	30-40	3,48	4,48	4,37	0,04	12,37
		26,1	36,2	35,3	0,3	
	50-60	4,48	7,46	60,36	0,12	72,42
		6,2	10,3	83,3	0,2	
	80-90	3,48	4,48	56,83	0,06	64,85
		5,4	6,9	87,6	0,1	

Characteristics and forage value of land cover. A study of the projective vegetation cover showed that in this area it is no higher than 45% of the total area. Pasture type – sagebrush-wort type with chiya participation. The botanical composition of plants in this area consists of wormwood – 70%, hairwort – 15% and chiya – 15% of the area. It is also found in a single copy of the wostrets, and there is contamination with the sophora. The yield of pasture mass is 6.5 c/ha. Coordinates of the study point contour boundaries №11 – N 48°38'21,9''; E 071°20'51,2''.

A study of the chemical composition of plants growing in solonetzic soils showed that the content of protein in the air-dry state is 14.63%, fat – 6.62%, fiber – 33.50%, NFE -34.03% and ash – 8.20%. The yield of feed units at natural plant moisture is – 0.57 per kilogram of feed, and the exchange energy is – 8.04 MJ.

Monitoring site № 12 is located in the Ulytau district of the Ulytau region, 200 m south of the Karaganda – Zhezkazgan highway (Figure 14). Soil type – fine saltbush, relief – flat, landscape aspect – greenish, water regime – atmospheric. Coordinates N 48° 229' 394", E 069° 306' 406".



A



B

Figure 14 – Structure of profile (A) of fine solonetz and surface condition (B)

0-11 cm, Light grey, dry, weakly compacted, loamy, dusty-lumpy, plant roots, does not boil from HCl, soil surface is crushed stone, transition is sharp in color and density;

12-28cm Solonetzic, dark brown, dry, dense, columnar, heavy loam, does not boil from HCl, few roots, clear transition;

29-42cm, mottled with black, Coal with a large accumulation of carbonate spots mixed with sand, fresh, compacted, lumpy, light clay, boils violently from HCl transition clear;

43-78 cm, Coal with a yellowish-whitish tint, fresh, loose, crushed stone and rocky, structureless, loamy, boiling from HCl, gradual transition;

79-130 cm, Coal with a whitish tint, many spots of carbonate and drusen gypsum, wet, structureless, loamy, coarse sand, crushed stone.

Small salt licks of the monitoring site №12 of the Ulytau district of the Ulytau region have a clay granulometric composition in the solonetz and sub-solonetz horizons. Here, the physical clay content is 61.6 and 42.7%, respectively (Table 45).

Table 45 - Granulometric composition of small solonetz

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
12	0-10	17,30	15,381	8,682	36,276	12,092	26,602	0,967	39,661
	15-25	3,90	12,612	5,390	20,395	10,822	19,563	31,217	61,602
	30-40	2,56	13,218	30,131	13,957	39,409	2,463	0,821	42,693
	60-70	2,02	30,190	30,618	32,660	0,816	1,225	4,491	6,532
	80-90	2,80	45,638	15,679	27,984	1,235	0,412	9,053	10,700

A study of the chemical composition of small solonetz of the monitoring site №12 of the Ulytau district of the Ulytau region showed that as a result of illuvial processes, humus moves into the subhumus horizon, where its content is noticeably higher (2.65%) than in the humus horizon (1.31%) (Table 46).

Table 46 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
12	0-10	1,31	0,098	33,6	42	460	8,13
	15-25	2,65	0,140	39,2	12	200	8,11
	30-40	-	-	-	-	-	8,27
	60-70	-	-	-	-	-	8,14
	80-90	-	-	-	-	-	8,07

Data from small salt licks of the monitoring site № 12 showed that they are slightly saline at a depth of 0-25 cm (0.127-0.424%). However, even deeper (30-90 cm) the degree of salinity rises to a very highly saline level and reaches significant values (1.120-1.749%). In the marked unit, chlorides and sulfates dominate the composition of the anions, and there are no normal carbonates (Table 47).

Table 47 - Ionic composition of the aqueous extract of fine salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						

12	0-10	0,127	0,28	0,00	1,77	0,08	0,28	0,47	1,37	0,02
			0,017	0,000	0,063	0,004	0,006	0,006	0,032	0,001
	15-25	0,424	0,24	0,00	7,02	0,02	0,56	0,75	5,89	0,08
			0,015	0,000	0,249	0,001	0,011	0,009	0,135	0,003
	30-40	1,120	0,24	0,00	19,03	0,30	6,08	1,50	11,97	0,02
			0,015	0,000	0,675	0,015	0,122	0,018	0,275	0,001
	60-70	1,729	0,16	0,00	17,73	10,74	12,81	4,22	11,59	0,02
			0,010	0,000	0,629	0,516	0,256	0,051	0,267	0,001
	80-90	1,749	0,20	0,00	15,89	12,53	13,56	4,22	10,82	0,02
			0,012	0,000	0,563	0,601	0,271	0,051	0,249	0,001

Data on the composition of the absorbed bases of the soils of the monitoring site № 12 showed that they are solonetz. This is evidenced by the proportion of absorbed sodium in solonetz, which exceeds 20% of the sum of absorbed bases (Table 48).

Table 48 - Composition of absorbed bases of middle solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
12	0-10	7,46	2,99	2,09	0,39	12,93
		57,7	23,1	16,2	3,0	
	15-25	13,43	11,44	34,02	0,06	58,95
		22,8	19,4	57,7	0,1	
	30-40	18,91	11,44	54,84	0,06	85,25
		22,2	13,4	64,3	0,1	
	60-70	16,92	10,95	43,56	0,06	71,49
		23,7	15,3	60,9	0,1	
	80-90	16,92	10,95	51,75	0,06	79,68
		21,2	13,7	65,0	0,1	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 50% of the total area. Pasture type – echiumovo-sagebrush-ephemeral. The botanical composition of plants consists of echium – 70%, wormwood – 25% and ephemera – 5% of the area. Also found in a single specimen are bluegrass and statice. The yield of pasture mass is 7, c/ha. Coordinates of the study point contour boundaries №12 – N 48°13'45,3''; E 069°18'22,3''.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 14.73%, fat – 6.82%, fiber – 31.84%, NFE-34.12% and ash – 8.93%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.57 per kilogram of feed, and the exchange energy is – 7.93 MJ.

The monitoring site № 13 is also located in the Ulytau district of the Ulytau region, 200 m north of the Karaganda-Zhezkazgan highway (Figure 15). Soil type – medium saltbush, relief – plain, landscape aspect – grey with a greenish tint, water regime – atmospheric. Coordinates N 48° 122' 130", E 068° 700' 593".



A



B

Figure 15 – Structure of the profile (A) of the middle salt licks and surface condition (B)

0-13cm, Light gray, dry, dusty lumpy, loamy, weakly compacted, does not boil from HCl, many plant roots, the transition is sharp in color and density;

14-33 cm, Brown, dry, loamy, dense, prism-columnar, roots, boiling from HCl, gradual transition;

34-58 cm, Lighter than the previous one, dry, crushed stone present, lumpy, dense, loamy, boiling from HCl, the transition is noticeable;

59-73 cm, Light brown, dry, dense, very crushed, mixed with sand, carbonate stains, boils violently from HCl, the transition is gradual;

74-120 cm, Light brown, dry, structureless, carbonate spots, crushed stone and coarse sand, loamy, dense.

In terms of granulometric composition, the average solonetz of the monitoring site №13 are superficially medium loamy (phys. clay 30.59%) as well as lightly clayey (phys. clay 45.14%) in the solonetz horizon (Table 49).

Table 49 - Granulometric composition of mean solonetz

№ Point	Depth , cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil			
			Fraction sizes in mm			
			Sand	Dust	Silt	Physical clay

			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
13	0-10	1,94	14,216	16,031	39,160	12,237	14,277	4,079	30,594
	20-30	2,52	9,048	9,705	36,110	14,362	17,234	13,541	45,137
	40-50	2,30	12,590	14,534	35,210	11,054	15,558	11,054	37,666
	60-70	1,64	29,565	20,415	23,180	6,507	10,573	9,760	26,840
	80-90	1,90	20,673	17,757	27,319	8,563	13,863	11,825	34,251

The average solonchets of the monitoring site №13 in the Ulytau district of the Ulytau region are characterized by a low level of fertility, as evidenced by the humus content (1.75 and 1.24%), respectively, in the surface horizons (0-10 and 20-30 cm) (Table 50).

Table 50 – Chemical composition of medium salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
13	0-10	1,75	0,126	36,4	54	1000	7,61
	20-30	1,24	0,140	25,2	6	390	7,95
	40-50	-	-	-	-	-	8,57
	60-70	-	-	-	-	-	8,66
	80-90	-	-	-	-	-	8,51

The middle solonchets of the monitoring site №13 are characterized by the unsalinity of the soil profile. Within the latter, the salt content does not exceed 0.1% (Table 51).

Data on the composition of the absorbed bases of the middle solonchets of the monitoring site №13 showed that these soils are characterized by magnesium soloncheticity. Since the proportion of absorbed magnesium in the 20-30 cm layer is quite high and amounts to 35.7% of the sum of absorbed bases (Table 52).

Table 51 - Ionic composition of water extract of medium solonchets, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
13	0-10	0,043	0,36	0,00	0,04	0,21	0,19	0,38	0,03	0,02
			0,022	0,000	0,001	0,010	0,004	0,005	0,001	0,001
	20-30	0,058	0,16	0,00	0,04	0,60	0,09	0,38	0,03	0,30
			0,010	0,000	0,001	0,029	0,002	0,005	0,001	0,012
	40-50	0,050	0,40	0,08	0,00	0,30	0,28	0,38	0,03	0,02
			0,024	0,002	0,000	0,014	0,006	0,005	0,001	0,001
	60-70	0,042	0,32	0,00	0,04	0,25	0,19	0,38	0,03	0,02
			0,020	0,000	0,001	0,012	0,004	0,005	0,001	0,001
	80-90	0,053	0,28	0,00	0,22	0,29	0,47	0,28	0,03	0,02
			0,017	0,000	0,008	0,014	0,009	0,003	0,001	0,001

Table 52 - Composition of absorbed bases of middle solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
13	0-10	12,94	5,97	0,14	2,01	21,06
		61,4	28,4	0,7	9,5	
	20-30	15,92	2,99	0,14	0,04	19,09
		83,4	35,7	0,7	0,2	
	40-50	14,93	4,48	0,14	0,04	19,59
		76,2	22,9	0,7	0,2	
	60-70	8,96	6,97	0,14	0,04	16,11
		55,6	43,3	0,9	0,2	
	80-90	10,95	4,98	0,11	0,04	16,07
		68,1	31,0	0,7	0,2	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 50% of the total area. Pasture type – sagebrush. The botanical composition of plants in this area consists of wormwood – 85%, Persian rose – 10% and wheatgrass – 5% of the area. The yield of pasture mass is 8.1 c/ha. Coordinates of the study point contour boundaries №13 – N 48°07'19,9''; E 068°42'02,0''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 16.23%, fat – 6.74%, fiber – 30.63%, NFE -31.17% and ash – 11.92%. The yield of feed units at natural plant moisture is – 0.60 per kilogram of feed, and the exchange energy is – 8.55 MJ.

Monitoring site № 14 is located in the Ulytau district of the Ulytau region, 6 kilometers west of the city of Satpayev (Figure 16). Soil type – salty light chestnut, relief – hilly, landscape aspect – grey, water regime – atmospheric. Coordinates N 47° 936' 965", E 007° 481' 389".



A



B

Figure 16 – Structure of the profile (A) of saline light chestnut soils and surface condition (B)

0-13cm, Dark grey, dry, loamy, dusty lumpy, loose, does not boil from HCl, many roots, transition sharp in color and density;

14-34cm, Dark brown with brown tint, dry, prism-columnar, dense, loamy, does not boil from HCl, roots, clear transition;

35-58 cm, Brown with whitish spots of carbonates, dry dense, loamy, boiling over from HCl, spots of carbonates, lumpy structure, gradual transition;

59-76 cm, Chestnut, dry, structureless, loamy, chestnut with a whitish tint, abundance of carbonate spots, structureless, boiling from HCl, gradual transition;

77-120 cm, Light brown with a whitish tint, fresh, structureless, dusty-crushed, loamy, compacted.

A study of the granulometric composition of salty light chestnut soils of the monitoring site №14 of the Ulytau district of the Ulytau region showed that they are superficially light loamy. In layer 0-10 cm, the content of physical clay is 20.25%. However, in the underlying solonetz horizon, the indicator value increases to 47.1%, i.e. becomes easily clayey (Table 53).

Table 53 - Granulometric composition of saline light chestnut soils

№ Point	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01

14	0-10	1,24	16,464	39,388	23,896	11,341	3,240	5,670	20,251
	20-30	2,44	10,332	19,557	22,960	9,020	14,760	23,370	47,150
	40-50	2,20	3,967	4,826	37,628	16,360	17,996	19,223	53,579
	60-70	1,98	3,203	33,544	19,588	13,875	15,915	13,875	43,665
	80-90	2,82	5,001	40,667	36,633	2,881	1,235	13,583	17,699

Data on the chemical composition of salty light chestnut soils of the monitoring site №14 of the Ulytau district of the Ulytau region show a low humus content (1.55 and 1.09%) relative to the soil-bioclimatic zone (Table 54).

Table 54 – Chemical composition of saline light chestnut soils

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
14	0-10	1,55	0,098	47,6	60	390	8,19
	20-30	1,09	0,126	25,2	4	140	8,46
	40-50	-	-	-	-	-	8,60
	60-70	-	-	-	-	-	8,52
	80-90	-	-	-	-	-	8,34

The saline light chestnut soils of the monitoring site №14 are characterized by the non-salinity of the first half-meter layer (0-50), where the salt content varies from 0.055 to 0.078% (Table 55). However, from a depth of 60 cm to the bottom of the cut, the degree of soil salinity rises first to weak (0.191%) and then to intense (0.911%).

In terms of the content of absorbed magnesium, the light chestnut soils of the monitoring site №14 are solonetzic, and in terms of absorbed sodium they are residual. The proportion of the former in the upper horizons is 27.0 and 22.0% of the sum of the absorbed bases (Table 56).

Table 55 - Ionic composition of the aqueous extract of solonetzic light chestnut soils, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
14	0-10	0,055	0,32	0,08	0,00	0,47	0,37	0,38	0,03	0,02
			0,020	0,002	0,000	0,023	0,007	0,005	0,001	0,001
	20-30	0,057	0,32	0,00	0,18	0,30	0,37	0,28	0,03	0,12
			0,020	0,000	0,007	0,014	0,007	0,003	0,001	0,005
	40-50	0,078	0,36	0,00	0,18	0,62	0,65	0,47	0,03	0,02
			0,022	0,000	0,007	0,030	0,013	0,006	0,001	0,001
	60-70	0,191	0,24	0,00	0,04	2,57	2,06	0,75	0,03	0,02
			0,015	0,000	0,001	0,123	0,041	0,009	0,001	0,001
	80-90	0,911	0,20	0,00	0,00	13,21	12,9	0,47	0,03	0,02
			0,012	0,000	0,000	0,634	0,258	0,006	0,001	0,001

Table 56 - Composition of absorbed bases of saline light chestnut soils

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
14	0-10	8,96	3,48	0,11	0,34	12,89
		69,5	27,0	0,9	2,6	
	20-30	13,93	3,98	0,11	0,04	18,05
		77,2	22,0	0,6	0,2	
	40-50	14,93	3,48	0,13	0,04	18,57
		80,4	18,7	0,7	0,2	
	60-70	13,93	2,49	0,13	0,04	16,58
		84,0	15,0	0,8	0,2	
	80-90	9,95	9,95	0,14	0,20	20,25
		49,1	49,1	0,7	1,0	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 45% of the total area. Pasture type – sagebrush-ephemeral with the participation of hawthorn. The botanical composition of plants in the solonetz area consists of wormwood – 80%, ephemera -10%, hawthorn – 7% and krascheninnikovia ceratoides – 3% of the area. Also found in vegetation are tulip, bedbug, canopy and a single specimen – hornhead. The yield of pasture mass is 8.4 c/ha. Coordinates of the study point contour boundaries №14 – N 47°56'12,3,’’; E 067°28'52,7’’.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 14.93%, fat – 7.32%, fiber –30.51%, NFE -35.70% and ash – 8.32%. At the same time, the yield of feed units at natural plant moisture is – 0.59 per kilogram of feed, and the exchange energy is – 8.13 MJ.

Monitoring site № 15 is located in the Ulytau district of the Ulytau region, 4 km in a south-eastern direction from the village of Karsakbay (Figure 17). Soil type – fine saltbush, relief – flat, landscape aspect – brownish-greenish, water regime – atmospheric. Coordinates N 47° 822' 188", E 066° 737' 940".



A



B

Figure 17 – Structure of the profile (A) of fine solonetz and surface condition (B)

0-8 cm, Light grey, dry, loamy, dusty lumpy, weakly compacted, many roots, does not boil from HCl, transition is sharp in density;

9-30 cm, Dark brown, dry, columnar, heavy loam, dense, does not boil from HCl, roots, clear transition;

31-52 cm, Brown, fresh, lumpy, loamy, boils violently from HCl, single roots, to the bottom of carbonate spots, gradual transition;

52-84cm, Light brown, fresh, structureless, clayey, compacted, boils violently from HCl, isolated spots of carbonates, the transition is sharp;

85-100 cm, Brown-fawn with whitish tints, fresh, accumulation of carbonates, gypsum drusen, structureless, compacted.

From the granulometric composition data of small solonetz of the monitoring site №15, it follows that the studied soils are heavy loamy. This is evidenced by the content of physical clay, which in the solonetz and supra-solonetz horizons is 27.6 and 62.7%, respectively (Table 57).

Table 57 – Granulometric composition of small solonetz

№ cut	Depth, cm	A.S. N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
15	0-8	1,44	3,531	29,505	39,367	9,740	12,581	5,276	27,597
	15-25	4,36	1,924	5,228	30,113	11,292	23,421	28,022	62,735

	40-50	2,94	1,051	6,635	29,672	9,891	45,333	7,418	62,642
	70-80	2,90	0,680	7,868	38,723	35,427	15,242	2,060	52,729
	90-100	3,10	9,536	14,510	47,884	2,064	23,117	2,890	28,070

In the chemical composition of the small salt licks of the monitoring site №15 of the Ulytau district of the Ulytau region, a very low humus content is observed, only 0.87% in the low-power humus horizon (Table 58). These soils are distinguished by medium and strong alkalinity of the soil environment (pH 8.13-9.48), which makes them unfavorable for many plants.

Table 58 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphoru s	Potassiu m	
15	0-8	0,87	0,070	25,2	70	390	8,28
	15-25	1,41	0,112	25,2	8	210	8,77
	40-50	-	-	-	-	-	9,48
	70-80	-	-	-	-	-	8,52
	90-100	-	-	-	-	-	8,13

From the data on the saline composition of small solonetztes of the monitoring site № 15, it follows that these soils are characterized by practical unsalinity of the upper 0-25 cm layer (0.064-0.155%). Within the profile of the studied soil as a whole, there is a tendency for the salinity of soils to gradually increase with depth (Table 59).

The soils of the monitoring site №15 of the Ulytau district of the Ulytau region are characterized by solonetzicity in exchangeable sodium and solonetzicity in exchangeable magnesium. The share of the latter in the composition of absorbed cations is quite high and amounts to 44.7 and 39.4% in the solonetz and suprasolonetz horizons, respectively (Table 60).

Table 59 - Ionic composition of fine solonetz water extract, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
15	0-8	0,064	0,32	0,08	0,15	0,47	0,19	0,47	0,25	0,03
			0,020	0,002	0,005	0,023	0,004	0,006	0,006	0,001
	15-25	0,155	1,20	0,16	0,11	0,77	0,19	0,56	1,31	0,02
			0,073	0,005	0,004	0,037	0,004	0,007	0,030	0,001
	40-50	0,241	1,72	0,32	0,07	1,36	0,28	0,38	2,48	0,02
			0,105	0,010	0,003	0,065	0,006	0,005	0,057	0,001
	70-80	0,546	0,44	0,00	0,04	7,56	2,43	2,06	3,52	0,02
			0,027	0,000	0,001	0,363	0,049	0,025	0,081	0,001
	90-100	0,878	0,36	0,00	0,07	12,67	10,19	2,34	0,53	0,03
			0,022	0,000	0,003	0,608	0,204	0,029	0,012	0,001

Table 60 – Composition of absorbed bases of small solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
15	0-8	7,46	4,98	0,13	0,08	12,65
		59,0	39,4	1,0	0,6	
	15-25	13,43	14,43	4,44	0,01	32,31
		41,5	44,7	13,7	0,1	
	40-50	6,97	24,38	5,08	0,01	36,45
		19,12	66,9	13,94	0,03	
	70-80	21,39	9,45	0,27	0,01	31,13
		68,7	30,4	0,87	0,03	
	90-100	16,92	12,94	0,15	0,07	30,08
		56,25	43,02	0,5	0,23	

Characteristics and forage value of land cover. Projective vegetation coverage in this area is only 35% of the total area. Pasture type – sagebrush-scorzonera. The botanical composition of plants in this area consists of wormwood – 80% scorzonera-20% of the area and is found in a single specimen of bluegrass. The yield of pasture mass is 6.8 c/ha. Coordinates of the study point contour boundaries №15 – N 47°49'06,9''; E 066°44'55,9''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 16.62%, fat – 6.82%, fiber – 30.40%, NFE -31.79% and ash – 11.10%. The yield of feed units at natural plant moisture is – 0.56 per kilogram of feed, and the exchange energy is – 8.02 MJ.

Monitoring site № 16 is located in the Ulytau district of the Ulytau region, 7 km in a north-eastern direction from the village of Zhezdy towards the regional center of Ulytau (Figure 18). Soil type – brackish fine surface crushed stone, relief – hilly, landscape aspect – greyish-greenish, water regime – atmospheric. Coordinates N 48° 105' 711", E 067° 043' 747".



A



B

Figure 18 – Structure of profile (A) of fine solonetz and surface condition (B)

0-11cm, Light grey, dry, loose, loamy, dusty lumpy, plant roots, does not boil from HCl, transition is sharp in color and density;

12-22cm, Dark brown, dry, prismatic-blocky, heavy loam, very dense, boiling from HCl, roots, clear transition;

23-38 cm, light brown, fresh, lumpy, light loam, single roots, boiling from HCl, gradual transition, compacted;

39-65 cm, lighter than the previous one, fresh, clayey, compacted, boiling from HCl, a layer of light whitish tint is noted across the soil horizon, the transition is sharp in color, structureless;

66-130 cm, yellowish-grey, fresh, structureless, sandy loam, compacted, boiling from HCl.

The study of the granulometric composition of the small salt licks of the monitoring site №16 showed that these soils have a heavy granulometric composition. The content of physical clay in surface horizons is 36.0 and 53.0%, respectively. (Table 61).

Table 61 – Granulometric composition of small solonetz

№ cut	Depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
16	0-10	16,68	18,051	44,023	1,920	11,522	18,243	6,241	36,006

	10-20	5,68	11,578	14,631	20,780	8,906	16,115	27,990	53,011
	25-35	1,70	5,493	23,296	28,077	7,731	15,870	19,532	43,133
	50-60	1,74	4,010	34,928	23,611	4,071	13,841	19,540	37,452
	80-90	2,34	8,007	17,039	26,623	10,240	33,586	4,505	48,331

Like the previous soil in the small salt licks of the monitoring site №16, located in the Ulytau district of the Ulytau region, there is also a very low humus content (0.87%) in the humus over-solonetz horizon (Table 62). However, in the underlying layer of 10-20 cm it increases slightly and amounts to 1.04%. Also noteworthy is the very strongly alkaline reaction of the medium (pH 9.02-9.09) of the surface layers of small solonetz.

Table 62 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
16	0-10	0,87	0,07	22,4	20	260	9,02
	10-20	1,04	0,084	47,6	2	130	9,09
	25-35	0,58	0,042	64,4	4	60	9,08
	50-60	-	-	-	-	-	8,75
	80-90	-	-	-	-	-	8,30

In the soil solution of the small salt licks of the monitoring site № 16, water-soluble salts from the surface are present (Table 63). Moreover, with depth its content increases and reaches a maximum at a depth of 80-90 cm (1.744%). This suggests that the marked soils were formed on saline soil-forming rocks.

Analysis of the composition of the absorbed bases of the soils of the monitoring site №16 showed that these soils are solonetz. This is clearly shown by the percentage of sodium absorbed, which in the solonetz horizon was 30.4% of the cation exchange capacity (Table 64).

Table 63 - Ionic composition of the aqueous extract of fine salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
16	0-10	0,139	0,48	0,00	0,52	1,08	0,19	0,75	1,10	0,04
			0,029	0,000	0,018	0,052	0,004	0,009	0,025	0,002
	10-20	0,315	1,16	0,24	3,10	0,59	0,19	0,56	4,09	0,02
			0,071	0,007	0,110	0,028	0,004	0,007	0,094	0,001
	25-35	0,543	0,76	0,08	8,13	0,25	0,47	1,22	7,39	0,06
			0,046	0,002	0,288	0,012	0,009	0,015	0,170	0,002
	50-60	0,906	0,44	0,00	10,71	3,63	0,84	1,22	12,70	0,02
			0,027	0,000	0,380	0,174	0,017	0,015	0,292	0,001
	80-90	1,744	0,32	0,00	6,46	19,34	7,01	1,22	17,85	0,04
			0,020	0,000	0,229	0,928	0,14	0,015	0,411	0,002

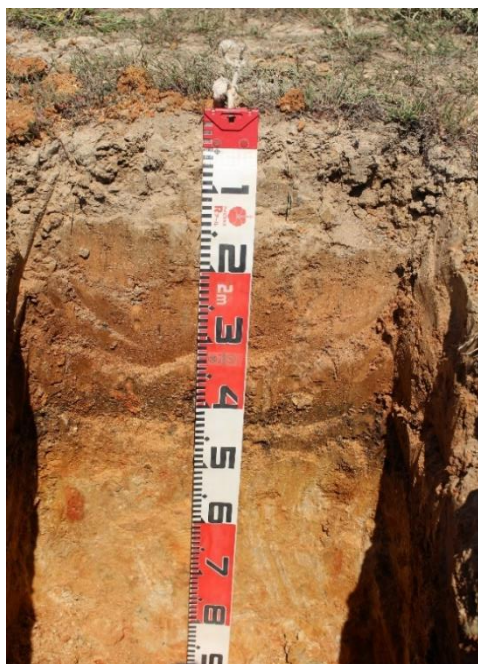
Table 64 – Composition of absorbed bases of small solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
16	0-10	5,97	2,99	0,62	0,03	9,61
		62,1	31,1	6,5	0,3	
	10-20	8,46	6,47	6,54	0,01	21,49
		39,4	30,1	30,4	0,1	
	25-35	5,97	4,48	10,95	0,01	21,42
		27,9	20,9	51,1	0,1	
	50-60	10,45	3,48	2,97	0,01	16,92
		61,8	20,6	17,5	0,1	
	80-90	11,44	9,45	2,36	0,07	23,32
		49,1	40,5	10,1	0,3	

Characteristics and forage value of land cover. Projective vegetation coverage in this area also accounts for - 35% of the total area. Pasture type – echiumovo– sagebrush-scorzonera. The botanical composition of plants in this area consists of echium – 40%, wormwood - 30% and scorzonera – 30% of the area. It is also found in a single specimen of camphorosma. The yield of pasture mass is 7.5 c/ha. Coordinates of the study point contour boundaries №16 – N 48°06'20,7''; E 067°02'36,9''.

A study of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 14.93%, fat – 6.22%, fiber – 30.28%, NFE -33.54% and ash – 12.22%. The yield of feed units at natural plant moisture is – 0.55 per kilogram of feed, and the exchange energy is – 7.72 MJ.

Monitoring site № 17 is located in the Ulytau district of the Ulytau region, 300m north of the Ulytau – Arkalyk highway (Figure 19). Soil type – brackish, relief – saucer-shaped plain, landscape aspect – brownish-greenish, water regime – atmospheric. Coordinates N48°841'375", E 067°061'471".



A



B

Figure 19 – Structure of the profile (A) of cortical solonchets and surface condition (B)

0-5 cm, Light grey, dry, slightly compacted, loamy, dusty-clumpy, pierced by roots, does not boil away from HCl, transition is sharp;

6-22cm, Dark brown, dry, dense, heavy, loam, prismatic-columnar, roots, does not boil from HCl, the transition is clear in color;

23-38 cm, Light brown with a brick tint, fresh, lumpy, dense, loamy, does not boil from HCl, the transition is noticeable;

39-58 cm, Brown with dark interlayer, wet, compacted, clayey, does not boil from HCl, structureless, noticeable transition;

59-130 cm, Brick with an abundance of gypsum accumulations, wet, structureless, does not boil from HCl, weakly compacted, loamy.

In terms of granulometric composition, the cortical solonchets of the monitoring site №17 are medium clay in the solonchets horizon (10-20 cm). It has a physical clay content as high as 62.18% (Table 65).

Chemical composition data from cortical solonchets of the monitoring site №17 of the Ulytau district of the Ulytau region showed that these soils have a low level of fertility, which is confirmed by humus data (1.73 and 1.38%) in surface horizons (0-5 and 10-20 cm) (Table 66).

Table 65 - Granulometric composition of cortical solonetz

№ Point	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
17	0-5	1,46	14,492	30,302	26,791	12,178	11,772	4,465	28,415
	10-20	2,86	4,303	17,048	16,471	14,000	19,354	28,824	62,178
	25-35	2,22	10,841	37,206	14,727	4,091	9,409	23,727	37,226
	40-50	3,04	9,653	37,541	31,353	18,564	0,413	2,475	21,452
	100-110	1,40	15,396	50,527	26,369	0,811	6,491	0,406	7,708

Table 66 – Chemical composition of cortical solonetzes

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
17	0-5	1,73	0,112	33,6	40	240	7,48
	10-20	1,38	0,084	39,2	14	80	5,68
	25-35	0,77	0,056	33,6	4	80	5,45
	40-50	-	-	-	-	-	6,45
	100-110	-	-	-	-	-	7,59

The cortical salt licks of the monitoring site №17 in solution contain easily soluble salts from a depth of 10 cm, i.e. starting from the solonetz horizon. The salt horizon is located at a depth of 40-50 cm, where the salt content is 1.117% (Table 67).

Table 67 - Ionic composition of the aqueous extract of cortical solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
17	0-5	0,037	0,24	0,00	0,11	0,17	0,09	0,09	0,31	0,02
			0,015	0,000	0,004	0,008	0,002	0,001	0,007	0,001
	10-20	0,110	0,28	0,08	1,22	0,24	0,09	0,19	1,45	0,02
			0,017	0,002	0,043	0,012	0,002	0,002	0,033	0,001
	25-35	0,192	0,12	0,00	3,07	0,05	0,09	0,09	3,01	0,04
			0,007	0,000	0,109	0,002	0,002	0,001	0,069	0,001
	40-50	1,117	0,12	0,00	8,31	9,34	3,93	2,81	11,01	0,02
			0,007	0,000	0,295	0,448	0,079	0,034	0,253	0,001
	100-110	0,590	0,12	0,00	5,73	3,61	0,56	0,94	7,94	0,02
			0,007	0,000	0,203	0,173	0,011	0,011	0,183	0,001

The study of the composition of the absorbed bases of the soils of the monitoring site №17 showed that they are solonetz, since the content of absorbed sodium in a layer of 10-20 cm reaches 26.1% of the sum of the absorbed bases (Table 68).

Table 68 - Composition of absorbed bases of cortical solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
17	0-5	8,96	3,48	0,46	0,00	12,91
		69,4	27,0	3,6	0,00	
	10-20	11,94	9,45	7,61	0,18	29,18
		40,9	32,4	26,1	0,6	
	25-35	7,46	5,47	24,30	0,04	37,26
		20,0	14,7	65,2	0,1	
	40-50	11,44	10,95	27,51	0,04	49,93
		22,9	21,9	55,1	0,1	
	100-110	9,95	6,47	35,04	0,04	51,50
		19,3	12,6	68,0	0,1	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 55% of the total area. Pasture type – echiumovo-scorzoneraovo-sagebrush. The botanical composition of plants in this area consists of echium – 60%, scorzonera -35%, wormwood– 15%, knotweed -5% and bluegrass - 5% of the area. Wild onions are also found in a single specimen. The yield of pasture mass is 6, c/ha. Coordinates of the study point contour boundaries №17 – N 48°50'23,7''; E 067°03'41,1''.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 13.63%, fat – 7.00%, fiber – 30.50%, NFE -34.89% and ash – 10.72%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.56 per kilogram of feed, and the exchange energy is – 7.78 MJ.

Monitoring site № 18 is located in the Ulytau district of the Ulytau region, 30 km east of the village of Ulytau, towards the village of Boztumysyk – Shubarkol (Figure 20). Soil type – brackish, relief – inter-hill valley, landscape aspect – greenish-brown, water regime – atmospheric. Coordinates N 48° 689' 067", E 067° 344' 075".



A



B

Figure 20 – Structure of the profile (A) of cortical solonchets and surface condition (B)

0-6 cm, Light brown, dry, lumpy, loamy, weakly compacted, plant roots, boiling from HCl, the transition is sharp in structure;

7-22cm, Dark brown, dry, prism-columnar, clayey, dense, roots, boiling from HCl, clear transition in color;

23-34cm, Brown, wet, lumpy, compacted, gypsum stains, clayey, does not boil from HCl, the transition is clear in color;

35-56 cm, Lighter than the previous one with a high gypsum content, wet, compacted, clayey, structureless, does not boil from HCl, the transition is gradual;

57-130 cm, brown with a gley tint, wet, compacted, clayey, structureless, does not boil, large accumulation of gypsum.

The cortical salt licks of the monitoring site №18 are characterized by a light clay heavy granulometric composition in a layer of 10-20 cm, where the content of physical clay was 41.14% of the cation exchange capacity (Table 69).

The cortical solonchets of the monitoring site №18 of the Ulytau district of the Ulytau region are also characterized by a low level of fertility, as evidenced by the humus content in its upper horizons (0.48 and 1.51%) (Table 70).

Table 69 - Granulometric composition of cortical solonetz

№ Point	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
18	0-6	2,52	13,480	17,993	29,134	11,900	18,876	8,617	39,393
	10-20	1,80	23,544	18,208	17,108	8,554	14,257	18,330	41,141
	20-30	5,98	10,891	8,275	59,562	14,040	0,425	6,807	21,272
	40-50	6,78	6,179	7,144	35,615	47,200	0,429	3,433	51,062
	90-100	6,88	4,167	0,258	9,880	6,443	11,168	68,729	86,340

Table 70 – Chemical composition of solonetz cortices

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
18	0-6	0,48	0,056	14,0	19	260	8,21
	10-20	1,51	0,098	33,6	12	80	7,13
	20-30	0,48	0,056	33,6	1	110	7,88
	40-50	-	-	-	-	-	7,58
	90-100	-	-	-	-	-	7,28

In the soil solution of the cortical solonetz of the monitoring site № 18, water-soluble salts are present in maximum amounts (1.069-1.607%) within a thickness of 20 to 100 cm (Table 71). In a low-power humus horizon (0-6 cm), the salt content is 0.095%, i.e. is not unsalted.

Table 71 - Ionic composition of the aqueous extract of cortical solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
18	0-6	0,095	0,16	0,00	1,40	0,03	0,09	0,19	1,29	0,02
			0,010	0,000	0,050	0,001	0,002	0,002	0,030	0,001
	10-20	0,358	0,16	0,00	5,91	0,10	0,37	0,66	5,12	0,02
			0,010	0,000	0,210	0,005	0,007	0,008	0,118	0,001
	20-30	1,607	0,24	0,00	15,52	10,58	9,35	4,03	12,93	0,02
			0,015	0,000	0,550	0,508	0,187	0,049	0,297	0,001
	40-50	1,423	0,24	0,00	18,29	5,05	2,06	1,78	19,73	0,02
			0,015	0,000	0,648	0,243	0,041	0,022	0,454	0,001
	90-100	1,069	0,08	0,00	16,81	1,28	0,56	0,94	16,66	0,02
			0,005	0,000	0,596	0,061	0,011	0,011	0,383	0,001

The composition of the absorbed cations of the cortical solonetz of the monitoring site № 18 is dominated by exchangeable sodium. Its share in relation to other cations is 26.7 and 52.5%, respectively, in the solonetz and suprasolonetz horizons (Table 72).

Table 72 - Composition of absorbed bases of cortical solonetz

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
18	0-6	8,96	4,98	5,09	0,04	19,07
		47,0	26,1	26,7	0,2	
	10-20	10,45	9,45	22,04	0,04	41,97
		24,9	22,5	52,5	0,1	
	20-30	14,93	17,41	12,01	0,04	44,39
		33,6	39,2	27,1	0,1	
	40-50	19,4	15,92	19,10	0,04	54,45
		35,6	29,2	35,1	0,1	
	90-100	30,35	9,95	31,90	0,04	72,23
		42,0	13,8	44,1	0,1	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 45% of the total area. Pasture type – sagebrush-scorzoneraov-echiumovy. The botanical composition of plants in this area consists of wormwood – 60%, scorzonera - 25% and echium –15% of the area. Also found in a single specimen are bluegrass, sagebrush, tas-scorzonera, calligonum, statice, parmella. The yield of pasture mass is 6.0 c/ha. Coordinates of the study point contour boundaries №18 – N 48°41'20,8''; E 067°20'39,1''.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 16.32%, fat – 6.13%, fiber –32.74%, NFE-34.11% and ash – 11.52%. At the same time, the yield of feed units at natural plant moisture is – 0.56 per kilogram of feed, and the exchange energy is – 8.21 MJ.

Monitoring site № 19 is located in the Ulytau district of the Ulytau region, from the Boztumysk highway towards the village of Betbulaka, 200 meters from the grader highway (Figure 21). Soil type – fine saltbush, relief – flat, landscape aspect – greenish-dark grey, water regime – atmospheric. Coordinates N 48° 838' 903", E 067° 932' 118".



A



B

Figure 21 – Structure of the profile (A) of fine solonetz and surface condition (B)

0-10cm, Dark gray, dry, dusty lumpy, loamy, loose, many roots, boiling from HCl, KIK crushed stone surface, sharp transition in density;

11-28 cm, Dark brown, dry, heavy loam, very dense, columnar, roots, fine crushed stone, boiling from HCl, gradual transition;

29-40 cm, lighter than the previous one, dry, loamy, lumpy-prismatic, dense, sparse spots of carbonates, boiling from HCl, the transition is sharp in color;

41-57 cm, whitish with brown tint, carbonate layer, fresh, loamy, structureless, compacted, boils violently from HCl, the transition is noticeable;

58-110 cm, Greenish with a brown tint, fresh, clayey, a lot of gypsum, there are gypsum drusen, some spots of manganese.

The granulometric composition data of the small salt licks of the monitoring site №19 showed that the indicated soils have a heavy granulometric composition in the solonetz horizon. Here the physical clay content reaches 71.6% (Table 73).

The small salt licks of the monitoring site №19 in the Ulytau district of the Ulytau region contain 1.17% humus in their surface horizon, which increases slightly in the solonetz horizon (1.25%) (Table 74).

Table 73 – Granulometric composition of small solonetz

№ Point	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil			
			Fraction sizes in mm			
			Sand	Dust	Silt	Physical clay

			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
19	0-10	4,58	3,186	6,686	23,056	8,384	38,566	20,122	67,072
	15-25	4,52	3,687	4,985	19,690	9,636	23,041	38,961	71,638
	30-40	3,92	4,996	14,654	60,366	6,661	1,249	12,073	19,983
	45-55	4,62	2,118	1,426	75,068	8,807	2,097	10,484	21,388
	80-90	1,02	2,324	5,941	10,911	75,571	1,212	4,041	80,824

Table 74 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
19	0-10	1,17	0,112	50,4	8	440	8,49
	15-25	1,25	0,098	25,2	2	270	8,72
	30-40	-	-	-	-	-	8,20
	45-55	-	-	-	-	-	8,17
	80-90	-	-	-	-	-	8,15

In the soil solution of small solonetztes of the monitoring site № 19 water-soluble salts in the maximum amount (1.576-2.014%) are present in the range from 30 to 90 cm, i.e. these soils are salty and very highly saline (Table 75). The most favorable are surface horizons, where the salt content is 0.096 and 0.126%, respectively.

Table 75 - Ionic composition of the aqueous extract of fine salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
19	0-10	0,096	0,56	0,08	0,11	0,68	0,28	0,47	0,58	0,02
			0,034	0,002	0,004	0,033	0,006	0,006	0,013	0,001
	15-25	0,126	1,04	0,16	0,59	0,09	0,19	0,19	1,33	0,02
			0,063	0,005	0,021	0,004	0,004	0,002	0,031	0,001
	30-40	1,576	0,44	0,00	6,10	17,56	11,78	2,63	9,67	0,02
			0,027	0,000	0,216	0,843	0,236	0,032	0,222	0,001
	45-55	1,808	0,40	0,00	9,24	18,30	11,31	2,91	13,7	0,02
			0,024	0,000	0,328	0,878	0,226	0,035	0,315	0,001
	80-90	2,014	0,36	0,00	10,71	19,83	7,39	2,63	20,88	0,02
			0,022	0,000	0,38	0,952	0,148	0,032	0,48	0,001

Small solonetztes of the monitoring site №19 in the Ulytau district of the Ulytau region in the soil-absorbing complex of the solonetz horizon (15-25 cm) contain 19.0% absorbed sodium (Table 76).

Table 76 - Composition of absorbed bases of small solonetztes

Point №	Depth, cm	Absorbed bases in mEq/%				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
19	0-10	25,87	8,95	0,71	0,10	35,63
		72,6	25,1	2,0	0,3	
	15-25	23,38	8,95	7,60	0,04	39,96
		58,5	22,4	19,0	0,1	
	30-40	16,92	13,43	2,99	0,02	33,36
		50,7	40,2	9,0	0,1	
	45-55	16,92	11,94	4,11	0,04	33,00
		51,3	36,2	12,4	0,1	
	80-90	19,9	12,94	59,19	0,04	92,06
		21,6	14,0	64,3	0,1	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 60% of the total area. Pasture type – sagebrush. The botanical composition of plants in this area consists of wormwood – 80%, scorzonera – 10%, feather grass –5% and climacopter –5% of the area. Also found in a single specimen are ruminus hairwort and tulip. The yield of pasture mass is 8.0 c/ha. Coordinates of the study point contour boundaries №19 – N 48°50'20,0''; E 067°55'55,6''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 17.30%, fat – 6.82%, fiber – 30.12%, NFE -34.48% and ash – 8.12%. The yield of feed units at natural plant moisture is – 0.57 per kilogram of feed, and the exchange energy is – 8.23 MJ.

Monitoring site № 20 is located in the Ulytau district of the Ulytau region from the village of Malshybay towards the city of Satpayev, 5 kilometers in a southwestern direction (Figure 22). Soil type – fine saltbush, relief – undulating plain, landscape aspect – greyish-greenish, water regime – atmospheric. Coordinates N 48° 374' 403", E 067° 854' 285".



A



B

Figure 22 – Structure of the profile (A) of fine solonetztes and surface condition (B)

0-8cm, Light gray, dry, loose, loamy, dusty lumpy, small plant roots, boils violently from HCl, the transition is sharp in color and density;

9-22 cm, Dark brown, dry, dense, heavy loam, prism-columnar, roots, boils violently from HCl, gradual transition;

23-37 cm, Brown with single carbonate spots, dry, dense, lumpy, loamy, carbonate spots, boiling from HCl, the transition is sharp in color;

38-54cm, Brown with whitish tints, large accumulation of carbonates, loamy, dense, structureless, boiling from HCl, clear transition;

55-100 cm, light brown, dry, loamy, dense, structureless, found in sand and crushed stone, gypsum and carbonate drusen, abundance of sand and crushed stone, boils violently from HCl.

From the granulometric composition data of small solonetztes of the monitoring site №20 it follows that these soils have a heavy composition. The latter can be traced in the solonetz horizon, where physical clay reaches 48.5% (Table 77).

Examination of the chemical composition of the small salt licks of the monitoring site №20 shows a low humus content (2.05 and 1.72%) in the surface horizons (0-8 and 10-20 cm) (Table 78).

Table 77 – Granulometric composition of small solonetz

№ Point	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01

20	0-8	2,44	10,209	20,500	33,620	18,450	11,480	5,740	35,670
	10-20	3,56	9,146	12,049	30,278	10,784	21,153	16,591	48,528
	25-35	3,40	7,019	12,236	33,540	12,008	20,704	14,493	47,205
	40-50	3,06	11,162	22,406	12,379	8,253	21,869	23,932	54,054
	80-90	2,76	17,359	20,527	39,079	2,879	9,461	10,695	23,036

Table 78 – Chemical composition of salt licks of small

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
20	0-8	2,05	0,154	28,0	60	620	7,31
	10-20	1,72	0,112	30,8	6	240	7,92
	25-35	1,34	0,098	22,4	4	130	8,76
	40-50	-	-	-	-	-	8,62
	80-90	-	-	-	-	-	8,16

The ionic composition of the water extract of small salt licks of the monitoring site № 20 is shown by the fact that, according to the data of the first half meter, these soils are slightly saline (sum of salts 0.136-0.204%). The anionic composition lacks normal carbonates and sulfates dominate (Table 79).

Table 79 – Ionic composition of fine solonetz water extract, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
20	0-8	0,204	0,28	0,00	0,07	2,69	1,68	1,13	0,06	0,17
			0,017	0,000	0,003	0,129	0,034	0,014	0,001	0,007
	10-20	0,074	0,40	0,00	0,07	0,64	0,19	0,84	0,06	0,02
			0,024	0,000	0,003	0,031	0,004	0,010	0,001	0,001
	25-35	0,152	0,56	0,00	0,07	1,70	0,37	1,78	0,16	0,02
			0,034	0,000	0,003	0,081	0,007	0,022	0,004	0,001
	40-50	0,136	0,52	0,00	0,07	1,47	0,47	1,41	0,17	0,02
			0,032	0,000	0,003	0,071	0,009	0,017	0,004	0,001
	80-90	0,949	0,28	0,00	0,22	13,63	12,16	1,78	0,17	0,02
			0,017	0,000	0,008	0,654	0,243	0,022	0,004	0,001

The soils of the monitoring site №20 are characterized by magnesium solonetz. Its share is significantly high in the solonetz horizon and amounts to 29.78% of the sum of absorbed bases (Table 80).

Table 80 – Composition of absorbed bases of small solonetz

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
20	0-8	16,42	3,48	0,17	0,24	20,31
		80,85	17,13	0,84	1,18	

10-20	17,41	7,46	0,17	0,01	25,05
	69,5	29,78	0,68	0,04	
25-35	18,91	6,47	0,02	0,01	25,41
	74,42	25,46	0,08	0,04	
40-50	15,42	6,97	0,01	0,01	22,42
	68,8	31,1	0,05	0,05	
80-90	13,43	12,94	0,05	0,01	26,44
	50,79	49,0	0,18	0,03	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 60% of the total area. Pasture type – sagebrush. The botanical composition of the plants in this area consists of wormwood – 90%, hay – 5%, feather grass – 2% and climate copters - 3% of the area. The yield of pasture mass is 78 c/ha. Coordinates of the study point contour boundaries №20 – N 48°22'27,8''; E 067°51'15,7''.

A study of the chemical composition of plants growing in solonetzic soils showed that the content of protein in the air-dry state is 17.22%, fat – 4.63%, fiber – 30.44%, NFE-31.57% and ash – 12.82%. The yield of feed units at natural plant moisture is – 0.50 per kilogram of feed, and the exchange energy is – 7.14 MJ.

Akmola region

The monitoring site № 21 is located in the Astrakhan district of the Akmola region, south of 300 m from the Astana – Atbasar highway and from the village of Ornek, 600 m to the north (Figure 23). Soil type – brackish, relief – flat, landscape aspect – greyish-greenish, water regime – atmospheric. Coordinates N 51° 313' 935", E 070° 209' 884".

0-4 cm, Dark grey, dry, loamy, layered-lumpy, weakly compacted, rootlets, does not boil from HCl, transition clear in density and structure;

5-22cm, Dark brown, dry, heavy loam, dense, columnar, roots, does not boil from HCl, the transition is clear in color;

23-40 cm, Lighter than the previous one, brown, wet, lumpy, compacted, separated carbonate spots, boils violently from HCl, gradual transition;

41-74 cm, dark brown, wet, structureless, compacted, carbonate stains, clay, boils violently from HCl;



A



B

Figure 23 – Structure of the profile (A) of cortical solonchoks and surface condition (B)

75-120 cm, Dark brown with a whitish tint, wet, compacted, structureless, clayey, many spots of carbonates and gypsum drusen.

The cortical salt licks of the monitoring site №21 have a heavy granulometric composition, starting from the solonchok horizon. In the latter, the physical clay content is 74.4% (Table 81).

Table 81 – Granulometric composition of cortical solonchok

№ Point	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
21	0-4	1,82	8,800	38,236	30,964	5,704	11,000	5,296	22,000
	10-20	3,80	4,262	17,152	4,158	31,185	24,948	18,295	74,428
	25-35	4,16	3,255	11,603	30,885	29,633	21,703	2,922	54,257
	50-60	3,72	2,555	11,446	75,197	5,816	1,246	3,739	10,802
	90-100	3,24	9,115	21,848	59,115	4,134	1,654	4,134	9,921

Data on the chemical composition of the cortical salt licks of the monitoring site №21 of the Astrakhan district of the Ak-mola region show a humus content of 2.20% in the humus and 1.64% in the subhumus horizons (Table 82). Starting from

a depth of 10 cm deep, the reaction of the soil environment varies from medium to highly alkaline.

Table 82 – Chemical composition of cortical solonetz

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
21	0-4	2,20	0,140	50,4	62	600	7,70
	10-20	1,64	0,098	36,4	20	330	8,32
	25-35	0,93	0,070	25,2	6	250	8,83
	50-60	-	-	-	-	-	8,63
	90-100	-	-	-	-	-	8,50

The cortical salt licks of the monitoring site №21 are both salt marshes and salt marshes. The maximum mass of easily soluble salts is concentrated in the underlying layers in an amount of 1.2-1.8% (Table 83). The anionic composition is dominated by both chlorides and sulfates.

Table 83 - Ionic composition of the aqueous extract of cortical solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃	From normal carbonates in CO ₃ ²⁻						
21	0-4	0,133	0,52	0,00	0,30	1,08	0,28	0,56	0,91	0,14
			0,032	0,000	0,010	0,052	0,006	0,007	0,021	0,005
	10-20	0,755	0,56	0,00	6,65	4,75	0,09	1,59	10,25	0,02
			0,034	0,000	0,236	0,228	0,002	0,019	0,236	0,001
	25-35	1,779	0,56	0,08	11,45	15,88	4,96	4,69	18,23	0,02
			0,034	0,002	0,406	0,762	0,099	0,057	0,419	0,001
	50-60	1,517	0,40	0,08	7,02	15,88	7,67	2,91	12,7	0,02
			0,024	0,002	0,249	0,762	0,153	0,035	0,292	0,001
	90-100	1,222	0,36	0,00	3,14	14,81	5,80	2,44	10,06	0,02
			0,022	0,000	0,111	0,711	0,116	0,03	0,231	0,001

The cortical salt licks of the monitoring site №21 of the Astrakhan district of the Akmoła region are distinguished by a high proportion of absorbed sodium and magnesium. As follows from the table, the share of the latter in layers 10-20 and 25-35 cm is 18.03 and 56.67%, respectively, as well as 41.65 and 16.94% (Table 84).

Table 84 – Composition of absorbed cortical solonetz bases

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
21	0-4	8,96	3,98	0,20	0,47	13,61
		65,8	29,4	1,4	3,4	
	10-20	6,47	14,43	4,60	0,01	25,51
		25,36	56,57	18,03	0,04	

25-35	21,89	8,96	22,03	0,01	52,89
	41,39	16,94	41,65	0,02	
50-60	11,94	9,95	18,37	0,01	40,27
	29,65	24,71	45,62	0,02	
90-100	9,95	10,95	9,79	0,01	30,70
	32,41	35,67	31,89	0,03	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 65% of the total area. Pasture type –sagebrush-forge-fescue. The botanical composition of the plants in this area consists of wormwood – 60%, feather grass –20%, fescue – 10% and hay - 10% of the area. Also found in a single specimen is the wheatgrass, gimlet, and statice. The yield of pasture mass is 6.1 c/ha. Coordinates of the study point contour boundaries №21 - N 51°18'50,2''; E 070°12'35,7''.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 12.52%, fat – 6.32%, fiber – 32.23%, NFE -34.04% and ash – 12.21%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.51 per kilogram of feed, and the exchange energy is – 8.23 MJ.

The monitoring site № 22 is also located in the Astrakhan district of the Akmola region, from the Astana – Atbasar highway to the southwest, 400 meters and from the regional center of Astrakhanovka to the south, 5 km (Figure 24). Soil type – brackish, relief – low-wave plain, landscape aspect – light greyish, water regime – atmospheric. Coordinates N 51° 600' 993", E 069° 850' 032".

0-5cm, Dark gray, dry, lumpy, loamy, slightly compacted, plant roots, boiling from HCl, transition noticeable in density;

6-17 cm, Brown, fresh, columnar, heavy loam, light veins of salts noted, dense, roots, boiling from HCl, transition noticeable in color;

18-34 cm, brown with whitish spots of carbonates, fresh, slightly compacted, loamy, boils violently from HCl, lumpy, gradual transition;



B

A

Figure 24 – Structure of the profile (A) of cortical solonetz and surface condition (B)

35-62 cm, Brownish, moist, loamy, weakly compacted, structureless, carbonate stains, boils violently from HCl, gradual transition;

63-130 cm, Dark brown, wet, loamy, structureless, boiling from HCl, weakly compacted.

The granulometric composition data of the cortical solonetz of the monitoring site №22 show that they are heavy in the solonetz and easily loamy in the suprasolonetz horizons. In the latter, the physical clay content reached 30.4 and 39.7%, respectively (Table 85).

Table 85 – Granulometric composition of cortical solonetz

Sampling location	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
22	0-5	2,66	12,739	41,648	15,204	6,164	11,095	13,150	30,409
	7-17	3,20	4,773	36,550	19,008	11,570	11,157	16,942	39,669
	20-30	2,12	8,132	40,785	36,780	4,495	4,904	4,904	14,303
	50-60	2,82	9,117	62,070	14,818	9,467	1,646	2,881	13,995
	80-90	2,02	11,615	67,973	8,981	2,449	6,532	2,449	11,431

The chemical composition of the cortical salt licks of the monitoring site №22 of the Astrakhan district of the Akmoła region shows a relatively low level of their fertility. This is due not only to the humus content, but also to the alkaline reaction of the soil environment throughout the soil profile. If the first in the surface horizons is 1.97 and 1.76%, then the second (pH) in the indicated places is 8.71 and 8.76, respectively (Table 86).

Table 86 – Chemical composition of cortical solonetz

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
22	0-5	1,97	0,196	56,0	50	330	8,71
	7-17	1,76	0,154	64,4	12	80	8,76
	20-30	0,82	0,070	36,4	11	70	8,83
	50-60	-	-	-	-	-	8,63
	80-90	-	-	-	-	-	8,63

In the soil solution of the crust salt licks of the monitoring site № 22 there are easily soluble salts in concentrations toxic to plants, starting from the surface, i.e.

are salt marshes and very highly saline (Table 87). Salt content above 1.0% is accumulated within depths of 7 to 60 cm.

Table 87 – Ionic composition of the aqueous extract of cortical solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
22	0-5	0,707	0,96	0,16	5,73	4,23	0,19	0,84	9,87	0,02
			0,059	0,005	0,203	0,203	0,004	0,010	0,227	0,001
	7-17	1,965	0,48	0,00	14,22	15,87	3,37	2,16	25,03	0,02
			0,029	0,000	0,504	0,762	0,067	0,026	0,576	0,001
	20-30	2,106	0,52	0,08	12,01	19,72	5,89	2,06	24,27	0,02
			0,032	0,002	0,426	0,947	0,118	0,025	0,558	0,001
	50-60	1,194	0,36	0,00	4,25	13,3	4,68	1,41	11,81	0,02
			0,022	0,000	0,151	0,638	0,094	0,017	0,272	0,001
	80-90	0,643	0,24	0,00	0,89	8,38	4,68	0,94	3,88	0,02
			0,015	0,000	0,031	0,402	0,094	0,011	0,089	0,001

The soils of the monitoring site №22 are solonetzic, since the percentage of sodium absorbed in the solonetzic and supra-solonetzic horizons is 20.13 and 23.82%, respectively (Table 88).

Table 88 – Composition of absorbed solonetz bases

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
22	0-5	10,95	3,98	4,69	0,07	19,69
		55,61	20,21	23,82	0,36	
	7-17	23,88	12,94	9,30	0,07	46,19
		51,7	28,02	20,13	0,15	
	20-30	9,95	12,44	7,82	0,07	30,28
		32,86	41,08	25,83	0,23	
	50-60	12,44	11,94	1,12	0,07	25,57
		48,65	46,7	4,38	0,27	
	80-90	36,32	4,98	2,28	0,07	43,65
		83,21	11,41	5,22	0,16	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 65% of the total area. Pasture type – sagebrush-fescueovo-covy. The botanical composition of plants in this area consists of wormwood – 64%, fescue – 15%, feather grass – 15% and echium – 6% of the area. The yield of pasture mass is 7.0 c/ha. Coordinates of the study point contour boundaries №22 – N 51°36'03,6''; E 069°50'59,6''.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 13.00%, fat – 6.52%, fiber – 32.73%, NFE -32.66% and ash – 11.82%. At the same time, the yield of feed units at natural plant moisture is – 0.49 per kilogram of feed, and the exchange energy is – 6.88 MJ.

The monitoring site № 23 is located in the Atbasar district of the Akmola region and is located from the Atbasar – Kokshetau highway in the eastern direction, 700 km and from the village. Borisovki to the southwest at 500 m (Figure 25). Soil type – meadow saltbush shallow, relief – flat, landscape aspect – greenish, water regime – ground. Groundwater lies close to the soil surface. Coordinates N 51° 883' 090", E 068° 529' 880".

0-10 cm, Dark grey, dry, granular-lumpy, loamy, compacted, abundance of roots, boiling from HCl, transition sharp;

11-27 cm, Dark brown, moist, nutty-prismatic, dense, heavy loam, roots, boils from HCl, gradual transition;

27-42 cm, Brown, wet, lumpy, slightly compacted, single roots, clayey, boiling from HCl, the transition is noticeable in color;

43-72cm, Brown, wet, structureless, weakly compacted, clayey, boiling from HCl, sharp in color transition;

72-120 cm, Brown with a yellowish tint, wet, clayey, structureless, weakly compacted, boiling from HCl.



A



B

Figure 25 – Structure of the profile (A) of meadow salt licks and surface condition (B)

Analysis of the granulometric composition of the meadow solonetz of the monitoring site №23 showed that the studied soils have a heavy composition in the solonetz horizon, where the physical clay content is 72.3% (Table 89).

Table 89 – Granulometric composition of meadow salt licks

№ Point	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil
			Fraction sizes in mm

			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
23	0-10	1,24	8,364	4,557	3,645	5,670	46,983	30,782	83,435
	15-25	0,90	7,326	18,406	2,018	13,724	20,585	37,941	72,250
	30-40	1,10	14,156	3,741	14,965	12,942	13,347	40,849	67,139
	60-70	1,18	30,662	4,574	12,143	10,929	10,524	31,168	52,621
	90-100	3,00	37,505	1,052	7,423	6,186	8,247	39,588	54,021

Data on the chemical composition of the meadow salt licks of the study point № 23 in the Atbasar district of the Akmola region show a relatively high humus content in the upper horizon (4.02%), which is associated with the conditions of the meadow soil-forming process (Table 90). However, a limiting factor in their fertility is the salinity of the entire profile and soloneness. The presence of the latter demonstrates not only absorbed sodium, but also a high level of alkalinity of the soil environment (pH 8.46-9.22).

Table 90 – Chemical composition of meadow salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
23	0-10	4,02	0,280	50,4	40	500	7,92
	15-25	2,91	0,196	36,4	2	260	8,46
	30-40	-	-	-	-	-	8,98
	60-70	-	-	-	-	-	9,10
	90-100	-	-	-	-	-	9,22

Salt content data from the over-salt and solonetz horizons (0.405 and 0.996% respectively) of the monitoring site's meadow salt licks № 23 showed that these soils are medium - and intensively saline (Table 91). The anionic composition contains sulfates and chlorides in toxic concentrations, but also bicarbonates and normal carbonates. It is known that the presence of the latter (>0.8 and 0.03 mEq per 100 g of soil) causes high alkalinity of the soil environment.

Table 91 - Ionic composition of the water extract of meadow salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
23	0-10	0,405	0,52	0,00	3,55	2,39	1,12	1,22	4,09	0,03
			0,032	0,000	0,126	0,115	0,022	0,015	0,094	0,001
	15-25	0,996	0,72	0,16	5,73	8,80	1,40	1,88	11,95	0,02
			0,044	0,005	0,203	0,422	0,028	0,023	0,275	0,001
	30-40	0,829	1,28	0,40	5,91	5,52	0,28	1,41	11,00	0,02
			0,078	0,012	0,210	0,265	0,006	0,017	0,253	0,001
	60-70	0,716	1,16	0,32	5,73	4,13	0,09	0,84	10,06	0,02
			0,071	0,010	0,203	0,198	0,002	0,010	0,231	0,001

	90-100	0,653	1,04	0,32	5,73	3,40	0,09	0,94	9,11	0,02
			0,063	0,010	0,203	0,163	0,002	0,011	0,210	0,001

The meadow salt licks of the monitoring site № 23 contain in noticeable quantities not only absorbed sodium, but also magnesium. Their proportion in the 15-25 cm layer is 19.10 and 30.66% of the sum of the absorbed bases (Table 92).

Table 92 – Composition of absorbed bases of grassland solonetz

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
23	0-10	23,88	8,96	3,84	0,14	36,82
		64,86	24,33	10,43	0,38	
	15-25	24,38	14,93	9,30	0,07	48,68
		50,1	30,66	19,10	0,14	
	30-40	8,96	10,95	14,49	0,07	34,47
		25,99	31,77	42,04	0,2	
	60-70	6,47	8,46	9,30	0,07	24,30
		26,63	34,81	38,27	0,29	
	90-100	4,98	9,95	14,55	0,07	29,55
		16,85	33,67	49,24	0,24	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 80% of the total area, which is due to the close occurrence of groundwater. Pasture type – grass-wormwood. The botanical composition of plants in this area consists of wheatgrass – 30%, rump – 25%, ratite – 15% and wormwood - 10% of the area. Also found in a single specimen is elecampane, knotweed, plantain, and fescue. The yield of pasture mass is 16.5 c/ha. Coordinates of the study point contour boundaries №23 – N 51°53'06.8''; E 068°31'03.9''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 12.63%, fat – 5.64%, fiber – 32.62%, NFE -34.76% and ash – 11.63%. The yield of feed units at natural plant moisture is – 0.51 per kilogram of feed, and the exchange energy is – 7.31 MJ.

The monitoring site № 24 is located in the Sandyktau district of the Akmola region and is located from the Atbasar – Kokshetau highway to the southeast, 4 km and from the village of Vladimirovka, 1.5 km to the southeast (Figure 26). Soil type – fine brackish meadow, relief – low wave plain, landscape aspect – green, water regime –ground. Coordinates N 52° 323' 206", E 068° 611' 116".

0-12 cm, brown, wet, loamy, granular-lumpy, compacted, abundance of plant roots, boiling from HCl, transition clear in color and density;

13-32cm, Dark brown, fresh, heavy loam, columnar, dense, salt spots, boiling from HCl, roots, gradual transition;

33-56 cm, Darker than the previous one with a grayish tint, wet, loamy, lumpy, compacted, roots, individual salt spots noted, boiling from HCl, gradual transition;



A



B

Figure 26 – Structure of the profile (A) of the salt licks of small meadow and surface condition (B)

57-78 cm, Greyish-dark, moist, loamy, structureless, compacted, boiling from HCl, individual roots, salt spots, transition sharp in color;

79-120 cm, Light brown, wet, clayey, structureless, boils violently from HCl, weakly compacted.

Analysis of the granulometric composition of the soils of the monitoring site №24 showed that small meadow salt licks have a heavy composition. The physical clay content in the solonetz horizon reaches 62.01 and 64.29% (Table 93).

Table 93 – Granulometric composition of small grassland solonetz

№ cut	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
24	0-10	8,50	4,481	5,027	28,415	13,115	16,612	32,350	62,077
	20-30	3,56	3,837	6,159	25,715	14,102	24,886	25,301	64,289
	40-50	3,66	3,633	5,024	20,345	11,625	26,157	33,216	70,999
	70-80	3,56	3,567	21,775	11,613	10,369	18,664	34,011	63,044
	90-100	3,52	6,198	4,664	18,242	22,803	15,755	32,338	70,896

If compared with previous soils, the meadow small salt licks of the monitoring site №24 in the Sandyktau district of the Akmolra region are characterized by a high

level of humus, which in the upper horizons was 5.03 and 4.66%, respectively (Table 94).

Table 94 – Chemical composition of small meadow salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
24	0-10	5,03	0,336	53,2	62	1000	8,24
	20-30	4,66	0,322	39,2	6	260	8,22
	40-50	-	-	-	-	-	8,45
	70-80	-	-	-	-	-	8,34
	90-100	-	-	-	-	-	8,34

The small meadow salt licks of the monitoring site №24 are practically not saline. Since the salt content in the first half meter varies from 0.090 to 0.143% (Table 95). These soils practically lack normal carbonates.

Table 95 - Ionic composition of the water extract of small meadow salt licks, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
24	0-10	0,109	0,60	0,00	0,04	0,90	0,47	0,75	0,16	0,16
			0,037	0,000	0,001	0,043	0,009	0,009	0,004	0,006
	20-30	0,090	0,56	0,00	0,11	0,65	0,28	0,84	0,17	0,02
			0,034	0,000	0,004	0,031	0,006	0,01	0,004	0,001
	40-50	0,143	0,64	0,00	0,11	1,40	0,19	1,50	0,44	0,02
			0,039	0,000	0,004	0,067	0,004	0,018	0,01	0,001
	70-80	0,179	0,64	0,04	0,85	1,30	0,47	1,41	0,89	0,02
			0,039	0,001	0,03	0,062	0,009	0,017	0,021	0,001
	90-100	0,205	0,52	0,00	0,96	1,79	0,37	1,97	0,91	0,02
			0,032	0,000	0,034	0,086	0,007	0,024	0,021	0,001

The soils of the monitoring site №24 of the Sandyktau district of the Akmola region are characterized by magnesium solonetz. This is due to the high content of absorbed magnesium, which in the solonetz and supra-solonetz horizons amounted to 44.2 and 22.3% of the ECO total (Table 96).

Table 96 – Composition of absorbed solonetz bases

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
24	0-10	24,88	7,46	0,09	1,06	33,49
		74,3	22,27	0,27	3,16	
	20-30	26,87	21,39	0,03	0,07	48,36
		55,56	44,2	0,1	0,14	
	40-50	24,88	18,41	0,71	0,07	44,07

		56,46	41,77	1,61	0,16	
	70-80	25,37	20,4	1,68	0,07	47,52
		53,39	42,93	3,53	0,15	
	90-100	19,4	11,44	1,60	0,07	32,51
		59,67	35,19	4,92	0,22	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 85% of the total area. Pasture type – cereal-grass. The botanical composition of plants in this area consists of wheatgrass - 30%, ratite - 16%, rump –15%, yarrow – 10%, wormwood – 10%, knotweed – 10% and fescue – 9% of the area. The yield of pasture mass is 17.0 c/ha. Coordinates of the study point contour boundaries №24 – N 52°19'23,4''; E 068°36'40,1''.

A study of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 16.63%, fat – 3.93%, fiber – 32.72%, NFE -33.42% and ash – 10.14%. The yield of feed units at natural plant moisture is – 0.50 per kilogram of feed, and the exchange energy is – 6.91 MJ.

The monitoring site № 25 is located in the Zerendinsky district of the Akmola region from the Atbasar – Kokshetau highway to the west, 800 m, and from the village of Aidarly to the southeast, 600 m (Figure 27). Soil type – fine saltbush, relief – flat, landscape aspect – yellowish– light grey, water regime – atmospheric. Coordinates N 53° 046' 727", E 069° 140' 717".

0-9cm, Dark gray, wet, granular-clumpy, loamy, slightly compacted, many roots, does not boil from HCl, the transition is sharp in density;

10-21cm, Dark brown, fresh, columnar-prismatic, dense, heavy loam, roots, does not boil from HCl, the transition is gradual;

22-43 cm, Lighter than the previous one, fresh, lumpy, loamy, small roots, does not boil from HCl, the transition is noticeable;

44-78 cm, Light brown with whitish veins, fresh, structureless, loamy, fine sand, dense, does not boil from HCl;

79-120 cm, Brown, fresh, structureless, veins of salts and spots of carbonates, loamy, dense, boils violently from HCl.



A



B

Figure 27 – Structure of the profile (A) of fine solonetz and surface condition (B)

The small salt licks of the monitoring site №25 are characterized by a heavy granulometric composition, since the physical clay content of the 10-20 cm layer is 56.4% (Table 97).

Table 97 – Granulometric composition of small solonetz

№ cut	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01
25	0-9	3,52	7,898	11,671	29,022	13,267	18,657	19,486	51,410
	10-20	3,60	5,207	8,071	30,290	13,278	18,257	24,896	56,432
	30-40	3,52	9,660	10,323	25,290	14,925	19,486	20,315	54,726
	50-60	3,52	19,196	14,055	48,093	7,048	6,633	4,975	18,657
	90-100	3,32	19,963	41,560	9,930	2,482	21,101	4,965	28,548

From the data on the chemical composition of small salt licks of the monitoring site №25 of the Zerendinsky district of the Akmola region it follows that they are low-humus. In them, the humus content is 4.22% in the supra-solonetz humus and 3.93% in the solonetz horizons proper (Table 98).

Table 98 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
25	0-9	4,22	0,280	61,6	70	990	6,88
	10-20	3,93	0,238	25,2	16	330	7,86
	30-40	-	-	-	-	-	8,50
	50-60	-	-	-	-	-	8,33
	90-100	-	-	-	-	-	8,19

A study of the salt composition of the small salt licks of the monitoring site № 25 showed that their surface horizons (0-9 and 10-20 cm) are practically unsalted (0.083 and 0.106%). However, deeper than the above horizons, soil salinity increases to 0.909% (Table 99).

Table 99 - Salt composition of small solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
25	0-9	0,106	0,24	0,00	0,00	1,27	0,37	0,56	0,39	0,18
			0,015	0,000	0,000	0,061	0,007	0,007	0,009	0,007
	10-20	0,083	0,52	0,16	0,00	0,60	0,19	0,28	0,62	0,03
			0,032	0,005	0,000	0,029	0,004	0,003	0,014	0,001
	30-40	0,264	0,72	0,00	2,07	1,28	0,47	0,66	2,91	0,03
			0,044	0,000	0,073	0,061	0,009	0,008	0,067	0,001
	50-60	0,909	0,44	0,00	3,66	9,93	5,05	3,00	5,95	0,03
			0,027	0,000	0,130	0,477	0,101	0,036	0,137	0,001
	90-100	0,813	0,36	0,00	2,70	9,11	3,93	2,25	5,09	0,90
			0,022	0,000	0,096	0,438	0,079	0,027	0,117	0,035

Table 100 – Composition of absorbed bases of small solonetz

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
25	0-9	21,39	10,95	0,03	1,17	33,54
		63,77	32,65	0,09	3,49	
	10-20	24,38	11,44	1,29	0,07	37,18
		65,57	30,77	3,47	0,19	
	30-40	21,89	11,44	2,80	0,07	36,20
		60,47	31,60	7,73	0,2	
	50-60	10,95	22,89	1,68	0,07	35,59
		30,77	64,31	4,72	0,2	
	90-100	11,44	21,89	1,94	0,07	35,34
		32,37	61,94	5,49	0,2	

Like the soils of the previous point, the small solonetztes of the monitoring area № 25 are also characterized by magnesium solonetization. Among the cations, its proportion in the upper horizons varies from 30.77 to 32.65% of the sum of the bases absorbed (Table 100).

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 75% of the total area. Grassland type – sagebrush-type grassland. The botanical composition of plants in this area consists of wormwood – 70%, fescue - 20% and wheatgrass – 10% of the area. Also found in a single specimen is calligonum, cinquefoil, and reveler. The yield of pasture mass is 8.5 c/ha. Coordinates of the study point contour boundaries №25 – N 53°02'48,4''; E 069°08'26,5''.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 15.81%, fat – 4.41%, fiber – 30.22%, NFE -34.46% and ash – 11.32%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.58 per kilogram of feed, and the exchange energy is – 7.51 MJ.

The monitoring site № 26 is located in the Burabay district of the Akmola region and is located from the Kokshetau - Astana highway 600 m to the north-east and from the village of Kenesary 500 m to the north (Figure 28). Soil type – southern chernozem solonetzic, relief – plains, landscape aspect – green, water regime – atmospheric. Coordinates N 53° 116' 890", E 069° 859' 629".



A



B

Figure 28 – Structure of the profile (A) of the saline salt marshes of the southern chernozems and surface condition (B)

0-6 cm, Dark grey, wet, loamy, granular-lumpy, loose, abundance of roots, boiling from HCl, transition clear in density;

7-21cm, Dark brown, wet, heavy loam, columnar, dense, roots, boils from HCl, the transition is noticeable in color;

22-37 cm, Dark brown, moist, heavy loam, compacted, lumpy, marked with individual spots of carbonates, single roots, boiling from HCl, clear transition;

38-66 cm, Brown, wet, heavy loam, compacted, structureless, abundance of carbonate stains, boils violently from HCl, clear transition;

67-120 cm, Dark brown, wet, heavy loam, compacted, structureless, interspersed with carbonates, boils violently from HCl.

From the data of the fraction of small solonetztes of the monitoring site № 26, it is clear that they have a heavy composition of the solonetz horizon, where the content of physical clay is 38.5 and 32.4% (Table 101).

Table 101 – Granulometric composition of small salt licks

№ cut	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
26	0-6	3,42	9,236	14,144	38,103	18,223	12,011	8,283	38,517
	10-20	3,60	5,041	23,174	39,419	10,373	13,278	8,714	32,365
	25-35	3,60	10,809	27,780	34,855	11,618	9,544	5,394	26,556
	50-60	3,44	4,805	26,429	21,955	17,813	20,713	8,285	46,810
	80-90	3,14	5,369	18,645	42,123	14,454	13,215	6,195	33,863

From the data on the chemical composition of the solonetzic salt marshy southern chernozems of the monitoring site № 26 of the Burabay district of the Akmola region, it follows that these soils are weakly humidified. This is evidenced by the humus content in the humus horizon, which is 3.51% (Table 102). With depth, the noted value decreases first to 2.21%, and then to 1.52%.

Table 102 – Chemical composition of solonetzic saltmarsh southern chernozems

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
26	0-6	3,51	0,238	95,2	66	1000	8,29
	10-20	2,21	0,210	44,8	10	240	8,14
	25-35	1,52	0,196	25,2	8	170	8,27
	50-60	-	-	-	-	-	8,21
	80-90	-	-	-	-	-	8,19

From the data on the content of water-soluble salts of the saline-like saline-like southern chernozems of the monitoring site № 26, it appears that these soils are superficially weakly and highly saline. In the topsoil the salt content is 0.170 and 0.789% (Table 103). From 25 to 90 cm, the salt concentration varies from 1.118 to 1.610%.

Table 103 - Saline composition of solonetzic salt marshes of southern chernozems, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
26	0-6	0,170	0,52	0,00	0,33	1,59	0,65	0,66	0,92	0,20
			0,032	0,000	0,012	0,076	0,013	0,008	0,021	0,008
	10-20	0,789	0,52	0,00	3,29	8,25	4,21	1,88	5,95	0,03
			0,032	0,000	0,117	0,396	0,084	0,023	0,137	0,001
	25-35	1,118	0,44	0,00	4,10	12,59	6,64	3,09	7,37	0,03
			0,027	0,000	0,145	0,604	0,133	0,038	0,17	0,001
	50-60	1,610	0,48	0,00	6,83	17,45	7,01	4,50	13,22	0,03
			0,029	0,000	0,242	0,838	0,140	0,055	0,304	0,001
	80-90	1,506	0,48	0,00	7,76	15,2	6,73	4,41	12,27	0,03
			0,029	0,000	0,275	0,730	0,135	0,054	0,282	0,001

The southern chernozems of the monitoring site № 26 have not only salt marshes, but also medium saltiness. Since the latter shows the proportion of sodium absorbed, which in the solonetz horizon is 12.01% of the sum of the bases absorbed (Table 104).

Table 104 – Composition of absorbed bases of solonetzic saltmarsh southern chernozems

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
26	0-6	25,37	6,97	1,31	2,01	35,66
		71,14	19,55	3,67	5,64	
	10-20	34,33	10,95	6,19	0,06	51,53
		66,62	21,25	12,01	0,12	
	25-35	12,94	19,9	2,07	0,06	34,97
		37,0	56,90	5,9	0,2	
	50-60	14,43	19,9	3,21	0,06	37,60
		38,38	52,92	8,54	0,16	
	80-90	15,42	18,41	3,59	0,06	37,48
		41,14	49,12	9,58	0,16	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 70% of the total area. Pasture type – wheatgrass-swan-fescue. The botanical composition of plants in this area consists of wheatgrass – 70%, quinoa – 15%, fescue – 10% and bedbug – 5% of the area. Also found in a single specimen is ruminaceae hairwort. The yield of pasture mass is 9.0 c/ha. Coordinates of the study point contour boundaries №26 – N 53°07'00,2''; E 069°51'20,9''.

A study conducted to study the chemical composition of feed on solonetzic salty soils showed that the content of protein in the air-dry state is 12.13%, fat –

5.44%, fiber –33.00%, NFE -37.96% and ash – 8.73%. At the same time, the yield of feed units at natural plant moisture is – 0.54 per kilogram of feed, and the exchange energy is – 7.49 MJ.

The monitoring site № 27 is located in the Enbekshil district of the Akmola region and is located from the highway of the city of Makinsk – Aksu to the northwest, 400 m and from the village of Birsuat to the south, 10 km (Figure 29). Soil type – fine saltbush, relief – flat, landscape aspect –greyish-green, water regime – atmospheric. Coordinates N 52° 667' 836", E 070° 861' 389".



A



B

Figure 29 – Structure of the profile (A) of fine solonetztes and surface condition (B)

0-6 cm, Dark grey, dry, granular-lumpy, loamy, weakly compacted, abundance of roots, does not boil from HCl, transition is sharp in density;

7-22 cm, Dark brown, wet, heavy loam, dense, nutty-clumpy, roots, does not boil from HCl, the transition is noticeable in color;

22-41cm, Dark brown, wet, clayey, lumpy, single spots of carbonates, boiling from HCl, single small roots, gradual transition;

42-59 cm, Brown, wet, clayey, structureless, carbonate stains, boils violently from HCl, gradual transition, compacted;

60-120 cm, Lighter than the previous one, wet, clayey, structureless, compacted, boils violently from HCl.

The granulometric composition data of the small salt licks of the monitoring site № 27 showed that they have a heavy composition, especially in the solonetz horizon. Here the physical clay content is 65.5% (Table 105).

Table 105 – Granulometric composition of small salt licks

№ cut	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
27	0-6	3,64	12,848	22,395	22,001	13,699	17,850	11,208	42,756
	10-20	1,64	10,960	4,860	18,707	13,827	24,400	27,247	65,474
	30-40	3,50	7,088	4,207	62,176	20,725	3,731	2,073	26,528
	45-55	3,26	7,608	6,802	72,359	9,097	1,240	2,894	13,231
	80-90	3,16	6,939	3,015	21,066	9,500	43,784	15,696	68,980

In the chemical composition of small salt licks of the monitoring site № 27 of the Enbekshil district of the Akmola region, it is clear that the humus content in the low-power humus horizon is 3.11%, and in the subhumus horizon 1.33% (Table 106). The peculiarity of the studied soils also lies in the alkalinity of the soil environment (pH 8.89-9.03) starting from the solonetz horizon.

Table 106 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
27	0-6	3,11	0,182	64,4	50	770	7,56
	10-20	1,33	0,112	47,6	2	350	8,89
	30-40	-	-	-	-	-	8,57
	45-55	-	-	-	-	-	8,61
	80-90	-	-	-	-	-	9,03

A study of the content of water-soluble salts of small salt licks of the monitoring site №27 showed that they are slightly saline in the low-power humus horizon (sum of salts 0.197%). While in the underlying horizon the indicator value increases to 0.536%, which indicates average salinity (0.536%). Even deeper, the salt concentration rises to 1.4% (Table 107).

Table 107 - Salt composition of small solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
27	0-6	0,197	0,64	0,16	0,26	1,86	0,09	0,56	1,96	0,14
			0,039	0,005	0,009	0,089	0,002	0,007	0,045	0,005
	10-20	0,536	1,20	0,24	2,11	4,55	0,47	0,94	6,42	0,03
			0,073	0,007	0,075	0,218	0,009	0,011	0,148	0,001
	30-40	1,173	0,56	0,04	2,29	14,49	4,39	2,16	10,76	0,03
			0,034	0,001	0,081	0,695	0,088	0,026	0,247	0,001

	45-55	1,379	0,48	0,04	2,03	17,65	6,55	1,31	12,27	0,03
			0,029	0,001	0,072	0,847	0,131	0,016	0,282	0,001
	80-90	0,702	1,04	0,24	2,29	6,88	0,28	0,66	9,24	0,03
			0,063	0,007	0,081	0,330	0,006	0,008	0,213	0,001

The soils of the monitoring site №27 of the Enbekshil district of the Akmola region are solonetz. In them, the proportion of absorbed sodium and magnesium in a layer of 10-20 cm reaches 19.36 and 45.47%, respectively (Table 108).

Table 108 – Composition of absorbed bases of small solonetz

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
27	0-6	13,43	8,46	1,41	1,08	24,38
		55,09	34,7	5,78	4,43	
	10-20	9,95	12,94	5,51	0,06	28,46
		34,96	45,47	19,36	0,21	
	30-40	14,43	9,45	2,81	0,06	26,75
		53,94	35,33	10,51	0,22	
	45-55	14,43	8,46	2,82	0,01	25,72
		56,10	32,9	10,96	0,04	
	80-90	8,46	10,45	19,27	0,06	38,24
		22,12	27,33	50,39	0,16	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 55% of the total area. Type of pasture – isene-wormwood with the participation of sweet clover. The botanical composition of plants in this area consists of isene – 70%, wormwood – 20% and sweet clover – 10% of the area. Also found in a single specimen are feather grass, horse sorrel, quinoa, wormwood, skerda, dandelion and statice. The yield of pasture mass is 7.6 c/ha. Coordinates of the study point contour boundaries №27 – N 52°40'04.0''; E 070°51'40.4''.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 15.53%, fat – 5.62%, fiber – 31.60%, NFE -34.39% and ash – 9.92%. The yield of feed units at natural plant moisture is – 0.56 per kilogram of feed, and the exchange energy is – 7.89 MJ.

The monitoring site № 28 is located in the Akkol district of the Akmola region and is located from the highway of the city of Makinsk – Aksu, 1 km to the west and from the village of Kyrykuduk, 400 m to the east (Figure 30). Soil type – fine saltbush, relief – flat, landscape aspect –greyish-green, water regime – atmospheric. Coordinates N52°51'532", E071°651'485".



A



B

Figure 30 – Structure of the profile (A) of fine solonchets and surface condition (B)

0-7 cm, Dark grey, dry, granular-lumpy, loamy, loose, abundance of roots, does not boil from HCl, the transition is noticeable in color;

8-22 cm, Dark brown, dry, nutty-columnar, heavy loam, dense, roots, does not boil from HCl, the transition is noticeable in color;

23-38 cm, Light brown, dry, lumpy, dense, isolated spots of carbonates, boiling from HCl, clayey, gradual transition;

39-58 cm, Brown, fresh, structureless, dense, clayey, carbonate spots and individual gypsum drusen, boils violently from HCl, the transition is gradual;

59-120 cm, Darker than the previous one, wet, structureless, compacted, clayey, carbonate spots, abundance of gypsum drusen, boils violently from HCl.

Analysis of the fraction of small salt licks of the monitoring site № 28 showed that these soils are heavy loamy. This is evidenced by the physical clay content, which reaches 36.9% in the solonchetz horizon (Table 109).

Table 109 – Granulometric composition of small solonchetz

№ cut	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
28	0-7	1,46	21,514	32,616	20,702	8,119	9,336	7,713	25,167
	10-20	1,60	16,850	19,736	26,423	10,569	16,667	9,756	36,992
	25-35	1,62	13,661	19,252	8,538	10,978	22,769	24,802	58,548
	40-50	1,36	16,342	24,858	6,083	8,921	28,792	15,004	52,717

	80-90	1,50	18,071	6,686	40,203	12,995	0,812	2,437	16,244
--	-------	------	--------	-------	--------	--------	-------	-------	--------

The chemical composition of the salt licks of the small monitoring site № 28 of the Akkol district of the Akmola region showed that they are relatively highly enriched with organic matter in the surface horizon, where the humus content was 4.78% (Table 110).

Table 110 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
28	0-7	4,78	0,308	75,6	110	870	8,21
	10-20	2,36	0,210	36,4	6	600	8,90
	25-35	0,92	0,084	47,6	2	240	9,25
	40-50	-	-	-	-	-	8,99
	80-90	-	-	-	-	-	8,59

Data on the ionic composition and salt content of the small salt licks of the monitoring site №28 showed that they were slightly saline from the surface to a depth of 40 cm. In the noted interval, the salt concentration varies from 0.084 to 0.158% (Table 111). Account should be taken here of the fact that, as it deepens downwards, the degree of salinization of the small salt licks increases to an intensive (0.877%).

Table 111 - Salt composition of small solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
28	0-7	0,106	0,36	0,00	0,00	1,10	0,37	0,47	0,37	0,25
			0,022	0,000	0,000	0,053	0,007	0,006	0,009	0,010
	10-20	0,084	0,44	0,00	0,00	0,70	0,19	0,19	0,73	0,03
			0,027	0,000	0,000	0,034	0,004	0,002	0,017	0,001
	25-35	0,158	1,56	0,24	0,00	0,45	0,28	0,38	1,32	0,03
			0,095	0,007	0,000	0,021	0,006	0,005	0,030	0,001
	40-50	0,426	0,84	0,16	0,78	4,53	0,28	1,03	4,81	0,03
			0,051	0,005	0,028	0,218	0,006	0,013	0,111	0,001
	80-90	0,877	0,52	0,08	1,96	10,44	4,68	0,84	7,37	0,03
			0,032	0,002	0,069	0,501	0,094	0,010	0,170	0,001

Small salt licks of the monitoring site № 28 of the Akkol district of the Akmola region are characterized by a high content of absorbed magnesium and sodium. Moreover, a significant share of them is observed in a layer of 25-35 cm and amounts to 46.46 and 21.82% (Table 112).

Table 112 – Composition of absorbed bases of small solonetz

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
28	0-7	18,91	4,48	0,96	2,36	26,71
		70,8	16,77	3,59	8,84	
	10-20	15,92	10,45	3,03	0,89	30,29
		52,56	34,5	10,0	2,94	
	25-35	9,45	13,93	6,54	0,06	29,98
		31,52	46,46	21,82	0,2	
	40-50	10,45	9,95	8,69	0,06	29,15
		35,85	34,13	29,81	0,21	
	80-90	14,43	7,96	11,35	0,06	33,80
		42,69	23,55	33,58	0,18	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 75% of the total area. Pasture type –sagebrush-fescue-wheatgrass. The botanical composition of plants in this area consists of wormwood – 60%, wheatgrass - 35% and fescue – 5% of the area. Also found in a single specimen are hiccups, wheatgrass, bedbugs and thistles. The yield of pasture mass is 7.5 c/ha. Coordinates of the study point contour boundaries №28 – N 52°30'41,7''; E 071°39'05,4''.

A study of the chemical composition of plants growing in solonetzic soils showed that the content of protein in the air-dry state is 13.11%, fat – 7.42%, fiber – 30.93%, NFE -33.50% and ash – 11.92%. The yield of feed units at natural plant moisture is – 0.55 per kilogram of feed, and the exchange energy is – 7.62 MJ.

The monitoring site № 29 is located in the Ermentau district of the Akmola region and is located from the highway to the south of the 200 m grader highway Bestobe – Seleti and from the village of Seleti to the north 12 km (Figure 31). Soil type – brackish, relief – flat, landscape aspect –greyish-greenish, water regime – atmospheric. Coordinates N 52° 223' 521", E 072° 742' 756".



A



B

Figure 31 – Structure of the profile (A) of cortical solonetzes and surface condition (B)

0-4 cm, Dark grey, dry, dusty-lumpy, loose, loamy, plant roots, boiling from HCl, individual coarse crushed stone noted, soil surface crushed, transition clear;

5-18 cm, Dark gray, dry, nutty-columnar, loamy, dense, plant roots, boiling from HCl, isolated spots of carbonates, crushed stone found, clear transition in color;

19-35 cm, Light brown, fresh, clumpy, loamy, compacted, individual root species, carbonate spots found, isolated accumulation of gypsum drusen, boiling from HCl, gradual transition;

36-65 cm, Lighter than the previous one, fresh, structureless, loamy, compacted, boils violently from HCl, large spots of carbonates and gypsum drusen, the transition is gradual;

66-120 cm, Brown, fresh, structureless, compacted, clayey, boils violently from HCl, accumulation of gypsum drusen and individual spots of carbonates.

The cortical salt licks of the monitoring site №29 are distinguished by their light and medium loamy granulometric composition. This is evidenced by the physical clay content, which reaches 23.5% in the solonetz layer (Table 113).

Table 113 – Granulometric composition of cortical solonetz

№ cut	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0 -0,25	0,25- 0,05	0,05- 0,01	0,01- 0,005	0,005- 0,001	<0,001	< 0,01

29	0-4	2,22	24,443	29,740	13,091	6,545	14,318	11,863	32,727
	5-15	1,38	27,317	36,990	12,168	4,056	10,951	8,518	23,525
	20-30	2,88	31,734	25,021	30,066	2,471	5,354	5,354	13,180
	40-50	2,06	44,456	10,619	17,153	12,252	13,886	1,634	27,772
	80-90	3,12	36,705	12,097	29,315	14,864	4,129	2,890	21,883

Data on the chemical composition of cortical salt licks of the monitoring site №29 of the Ermentau district of the Akmola region showed a low humus content in the surface horizons, only 1.81 and 1.17%, respectively (Table 114). These soils are also characterized by a very high and high alkalinity of the soil environment (pH 9.15-8.42) throughout the studied profile.

Table 114 – Chemical composition of cortical solonetz

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
29	0-4	1,81	0,14	25,2	30	410	9,15
	5-15	1,17	0,14	39,2	6	80	8,79
	20-30	0,90	0,08	33,6	6	170	8,52
	40-50	-	-	-	-	-	8,61
	80-90	-	-	-	-	-	8,42

In the soil solution of the cortical solonetz of the monitoring site № 29 water-soluble salts in a noticeable amount (0.295%) are present starting from the solonetz horizon (5-15 cm). The maximum salts are kept at a depth of 20-30 cm, where it reaches 1.116% (Table 115).

Table 115 - Salt composition of cortical solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
29	0-4	0,095	0,56	0,04	0,07	0,66	0,09	0,28	0,89	0,03
			0,034	0,001	0,003	0,031	0,002	0,003	0,02	0,001
	5-15	0,295	0,40	0,00	0,96	2,99	0,65	0,47	3,20	0,03
			0,024	0,000	0,034	0,143	0,013	0,006	0,074	0,001
	20-30	1,116	0,36	0,00	6,83	10,68	6,73	4,78	6,33	0,03
			0,022	0,000	0,242	0,512	0,135	0,058	0,146	0,001
	40-50	0,799	0,28	0,00	6,65	5,86	4,77	1,41	6,58	0,03
			0,017	0,000	0,236	0,281	0,095	0,017	0,151	0,001
	80-90	0,921	0,28	0,00	6,10	8,30	6,17	2,81	5,66	0,03
			0,017	0,000	0,216	0,398	0,123	0,034	0,13	0,001

A study of the composition of the absorbed bases of the cortical solonetz of the monitoring site №29 of the Ermentau district of the Akmola region showed that they have magnesium solonetzicity. However, the proportion of sodium absorbed is

also high. If the proportion of absorbed magnesium in the 5-15 cm layer reaches 31.7%, then absorbed sodium – 9.83% (Table 116).

Table 116 – Composition of absorbed cortical solonetz bases

Point №	Depth, cm	Absorbed bases in mg-eq/100 g soil				CEC, mEq per 100g of soil
		Calcium	Magnesium	Sodium	Potassium	
29	0-4	11,44	4,98	2,01	0,81	19,24
		59,46	25,88	10,45	4,21	
	5-15	10,95	5,97	1,85	0,06	18,83
		58,15	31,7	9,83	0,32	
	20-30	13,93	14,43	2,55	0,05	30,96
		44,99	46,61	8,24	0,16	
	40-50	12,94	10,95	2,84	0,03	26,76
		48,36	40,92	10,61	0,11	
	80-90	15,92	9,95	1,02	0,07	26,96
		59,05	36,91	3,78	0,26	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 65% of the total area. Pasture type – sagebrush-fescue-covy. The botanical composition of plants in this area consists of wormwood – 70%, feather grass – 15%, fescue - 10%, and thin-legged – 5% of the area. Also found in a single specimen are wheatgrass, cloves, yellow alfalfa and statice. The yield of pasture mass is 6.6 c/ha. Coordinates of the study point contour boundaries №29 – N 52°13'24,7''; E 072°44'34,1''.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 14.13%, fat – 6.93%, fiber – 33.41%, NFE -33.46% and ash – 9.13%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is – 0.55 per kilogram of feed, and the exchange energy is – 7.75 MJ.

The monitoring site № 30 is also located in the Erementau district of the Akmola region and is located from the Astana – Pavlodar highway, 400 m and from the city of Ermentau, 25 km to the northeast (Figure 32). Soil type – fine saltbush, relief – flat, landscape aspect – greyish-green, water regime – atmospheric. Coordinates N 51° 683' 408", E 073° 408' 963".



A



B

Figure 32 – Structure of the profile (A) of fine solonchets and surface condition (B)

0-9 cm, Dark grey, dry, granular-lumpy, loamy, loose, root-permeated, HCl-free, transition sharp in density;

10-21cm, Greyish-brown, dry, prismatic-columnar, there is an accumulation of salts, dense, heavy loam, does not boil from HCl, permeated with roots, the transition is noticeable in color;

22-36 cm, Dark brown with a pronounced lumpiness of the humus horizon, fresh, lumpy, loamy, boiling from HCl, interspersed with carbonates, compacted, gradual transition;

37-65 cm, Brown, wet, structureless, weakly compacted, clayey, carbonate stains, boiling from HCl, gradual transition;

66-120 cm, Light brown, wet, structureless, clayey, weakly compacted, carbonates and druse of gypsum, sand and crushed stone are found.

The granulometric composition data of the small salt licks of the monitoring site № 30 showed that they are heavy loam in the first half of the profile. In the upper horizons, the physical clay content is 43.3 and 50.1% (Table 117).

Table 117 – Granulometric composition of small solonchets

№ cut	Sample depth, cm	A.S.N % H ₂ O	Fraction content in % on absolute dry soil						
			Fraction sizes in mm						
			Sand		Dust			Silt	Physical clay
			1,0-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	< 0,01
30	0-9	4,82	19,500	13,259	23,955	11,767	21,433	10,086	43,286
	10-20	3,40	19,752	9,441	20,704	13,665	25,259	11,180	50,104
	25-35	3,70	17,217	5,109	19,938	9,138	40,291	8,307	57,736

	50-60	3,68	16,445	2,575	15,365	19,934	40,698	4,983	65,615
	80-90	3,70	20,104	13,853	57,736	3,323	1,661	3,323	8,307

The chemical composition of the small salt licks of the monitoring site № 30 of the Erementau district of the Akmola region shows a comparatively high humus (5.09%) in a low-power humus horizon (Table 118).

Table 118 – Chemical composition of fine salt licks

№ Point	Depth, cm	Types of analysis					
		Total humus, %	Gross nitrogen, %	Movable forms, mg/kg			pH
				Nitrogen	Phosphorus	Potassium	
30	0-9	5,09	0,294	44,8	20	810	8,26
	10-20	3,20	0,238	33,6	4	420	8,57
	25-35	1,00	0,154	19,6	4	190	8,88
	50-60	-	-	-	-	-	8,97
	80-90	-	-	-	-	-	8,79

Table 119 – Salt composition of small solonetz, mEq/%

№ cut	Sample depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ²⁻	Ca ²⁺	Mg ²⁺	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
30	0-9	0,132	0,48	0,00	0,11	1,26	0,28	0,47	1,00	0,11
			0,029	0,000	0,004	0,061	0,006	0,006	0,023	0,004
	10-20	0,758	0,48	0,00	1,33	9,33	3,27	1,22	6,61	0,04
			0,029	0,000	0,047	0,448	0,065	0,015	0,152	0,002
	25-35	1,782	0,52	0,04	4,40	21,39	2,81	2,72	20,76	0,03
			0,032	0,001	0,156	1,027	0,056	0,033	0,477	0,001
	50-60	1,338	0,48	0,08	6,28	13,40	2,71	1,22	16,2	0,03
			0,029	0,002	0,223	0,643	0,054	0,015	0,373	0,001
	80-90	1,736	0,40	0,04	12,19	14,61	6,92	2,53	17,72	0,03
			0,024	0,001	0,432	0,701	0,138	0,031	0,408	0,001

A study of the saline composition of the soil solution of small salt licks of the monitoring site № 30 showed that they are saline from a depth of 10 cm to 90 cm. A sharp increase in salt content to 1.78% is observed in the thickness from 25 to 90 cm (Table 119).

The small salt licks of the monitoring site №30 are characterized by salinity throughout the entire profile. It is especially evident from 25 to 60 cm, where the proportion of absorbed sodium and magnesium is, respectively, 24.73-45.39% and 33.28-37.45% of the sum of absorbed bases (Table 120).

Table 120 – Composition of absorbed solonetz bases

Point №	Depth, cm	Absorbed bases in mg-eq/%				ЕКО, мг- экв на 100г почвы
		Calcium	Magnesium	Sodium	Potassium	
30	0-9	19,4	6,47	1,75	1,27	28,89
		67,15	22,39	6,06	4,4	
	10-20	25,87	11,44	5,13	0,17	42,61
		60,71	26,85	12,04	0,4	
	25-35	19,4	15,42	11,46	0,06	46,34
		41,86	33,28	24,73	0,13	
	50-60	7,46	16,42	19,9	0,06	43,84
		17,02	37,45	45,39	0,14	
	80-90	16,42	6,97	3,57	0,08	27,04
		60,72	25,78	13,20	0,3	

Characteristics and forage value of land cover. Projective vegetation coverage in this area accounts for 65% of the total area. Pasture type –sagebrush-fescue- saltwort. The botanical composition of plants in this area consists of wormwood – 60%, aescue – 30% and saltwort – 10% of the area. Also found in a single specimen is ratite, nanea, slender-legged, and borage. The yield of pasture mass is 7.3 c/ha. Coordinates of the study point contour boundaries №30 –N 51°41'00.2''; E 073°24'31.7''.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 12.52%, fat – 6.24%, fiber –32.74%, NFE -35.53% and ash – 9.43%. At the same time, the yield of feed units at natural plant moisture is – 0.56 per kilogram of feed, and the exchange energy is – 7.75 MJ.

Aktobe Region

Monitoring site № 31. Soil: Steppe deep salt marsh heavy loamy on loam. Located in the Khromtau district of the Aktobe region (Figure 33). Coordinates: N 50.280431°, E 57.736493°. Height above u.m. = 334 m. Wavy plain within the floodplain terrace. Vegetation of forbs-forge fescue-wormwood: blue wormwood sp, fescue sol, feather grass sol, caragana sol, yarrow sol, onion sol. Closure 50 %, Height 15-30 cm. Depth 65 cm. A+B = 55 cm. Boiling from 40 cm. Carbonates – sharply defined spots from 55 cm. Plaster sand from 55 cm. Horizons A1 0-5, AB 5-18, B₁^{CH} 18-35, B₂^{CH} 35-55, C₁ 55-bottom.

0-5 cm, Dark brown, greyish, dry, slightly compacted, strongly radicate, powdery-clumpy, medium loamy

5-18 cm, Dark brown, dry, compacted, with roots granular-clumpy, medium loamy

18 - 35 cm, Dark brownish, dry, dense, blocky-nutty, clayey

35 - 55 cm, Brown, dry, dense, clayish with single roots, sharply costose-clumpy

55-bottom, Inhomogeneously coloured, fresh, dense, brown with whitish spots of carbonates and gypsum, unstructured, heavy loamy



Figure 33 – Deep steppe saltbush heavy loamy on loam

Table 121 – Chemical and physico-chemical properties of steppe solonetztes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
31	0-5	4,41	0,28	0,32	19,8	6,44	0,4	0,78	27,42	7
	7-17	2,46	0,21	0,19	16,34	7,92	0,13	0,19	24,58	7,24
	21-31	1,94	0,21	0,16	13,37	18,32	2,21	0,21	34,11	8,24
	40-50	1,22	0,112	1,84	8,42	18,32	2,9	0,21	29,85	8,82
	55-65			1,71						8,36

Table 122 - Granulometric composition of steppe solonetztes

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
31	0-5	7,35	19,94	31,63	9,45	21,36	10,27	41,08
	7-17	6,44	17,22	29,96	10,67	24,63	11,08	46,38
	21-31	4,57	9,41	25,35	12,47	28,26	19,95	60,67
	40-50	4,03	11,66	24,80	10,33	23,56	25,63	59,52
	55-65	4,27	17,26	54,10	18,17	3,72	2,48	24,37

Table 123 – Composition of water-soluble salts in steppe salt licks, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃	From normal						

			-	carbonates in CO ₃ ²⁻						
31	0-5	0,034	0,015	0,000	0,005	0,005	0,004	0,002	0,001	0,003
			0,24	0,00	0,15	0,1	0,19	0,19	0,04	0,07
	7-17	0,105	0,01	0,000	0,004	0,065	0,009	0,011	0,004	0,002
			0,16	0,00	0,11	1,36	0,47	0,94	0,17	0,05
	21-31	0,17	0,046	0,002	0,005	0,074	0,007	0,013	0,024	0,001
			0,76	0,08	0,15	1,55	0,37	1,03	1,03	0,02
	40-50	0,29	0,051	0,005	0,009	0,147	0,006	0,014	0,063	0,001
			0,84	0,16	0,26	3,06	0,28	1,13	2,73	0,02
	55-65	1,211	0,022	0,000	0,017	0,849	0,137	0,093	0,091	0,002
			0,36	0,00	0,48	17,68	6,83	7,69	3,95	0,06

The profile is powerful (up to 65 cm), the humus horizon is pronounced (A+B $\approx$ 55 cm). In the upper horizons, exchangeable Na is low (0.13–0.40 mEq/100 g), but increases sharply in the illuvial part (to 2.2–2.9) (Table 121). The proportion of physical clay increases from 41–46 % at the top to 60 % at the B horizons, then decreases in the parent rock (Table 122). Salinisation is observed from 55 cm (Table 123). This is a typical salt licorice with a pronounced sodium and clay maximum.

Characteristics and forage value of land cover. Relief – wavy-hilly plain point located above the floodplain terrace, landscape aspect – grayish-green, water regime – atmospheric. At the monitoring site, when studying the biological indicators of vegetation, it was revealed that the projective coverage of the soil surface with vegetation does not exceed 50% of the total area. Pasture type – sagebrush-forge-typchak, botanical composition of plants showed that sagebrush occupies – 65%, feather grass – 20% and fescue – 15%. In the composition of the grass stand, the dominant plant is wormwood, feather grass and fescue are subdominant, and the presence of plants such as, canopy, onion, yarrow, sweet clover and gulthemia is also noted. At the same time, the yield of pasture mass was 9.5 c/ha.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 14.73 %, fat – 5.64 %, fiber – 33.26 %, NFE – 36.32 % and ash – 9.42%. At the same time, the yield of feed units at natural plant moisture is 0.53 per kilogram of feed, and the exchange energy is – 6.94 MJ.

Monitoring site №32. Soil: Chestnut, slightly salty, light loamy on the sand. Located in the Khromtau district of the Aktobe region (Figure 34). Coordinates: N 50.254651°, E 57.953029°. Height above u.m. = 416 m. Wavy high plain. Vegetation of forbs-wormwood-fescue: fescue sp, wormwood sp, yarrow sol, poppy-leg sol, silene sol, cinquefoil sol, feather grass sol, erythematous sol, field bindweed sol, gypsophila. Closedness 60 %. Height 20-25 cm. Depth 75, A+B = 40 cm. Boiling from 20 cm. No visible carbonates – were found. Horizons A 0-5, AB 5-20, B₂^{CH} 20-40, C₁ 40-60, C₂ 60-bottom

0-5 cm, Greyish-brown, dry, compacted, radicate powdery-clumpy, light loamy

5-20 cm, Brown, grayish, dry, compacted with roots, weakly lumpy, light loamy

20-40 cm, Brown (brownish), dense, dry, nutty, sandy loam

40-60 cm, Cream sand with gypsum crystals

60-bottom, Slightly darker than the previous coarse sand

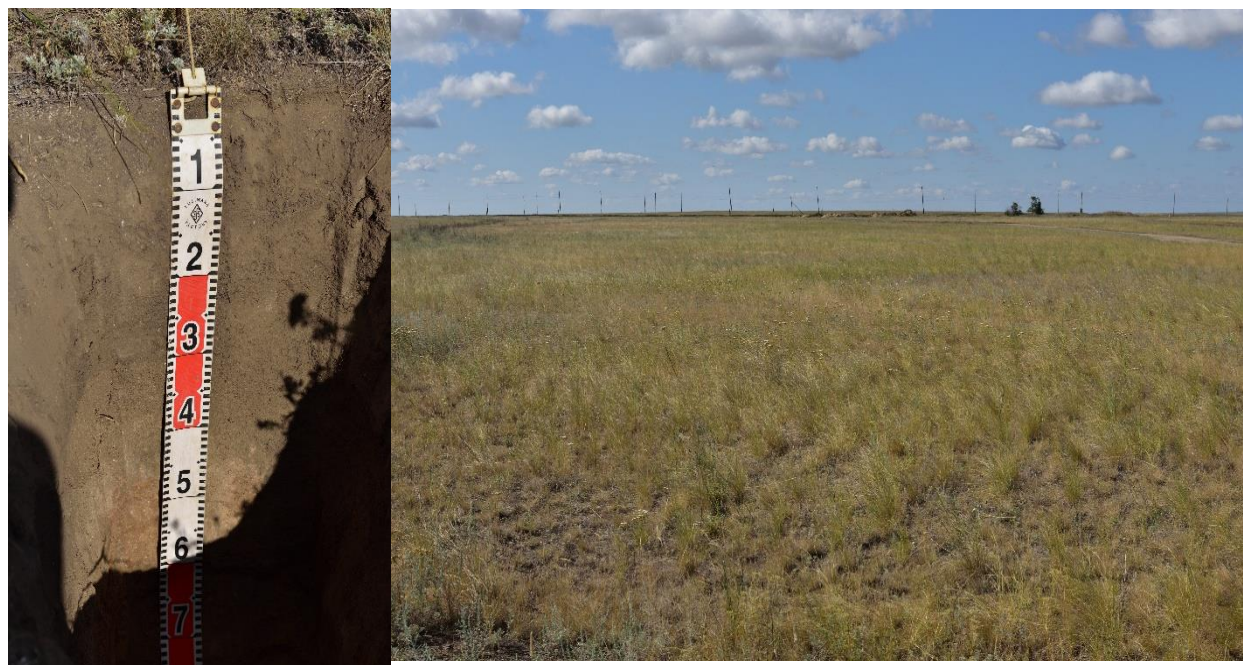


Figure 34 – Chestnut slightly saline medium loamy on sand

Table 124 – Chemical and physico-chemical properties of chestnut weakly saline soil

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
32	0-5	4,15	0,224	0,23	11,88	2,48	0,4	0,05	14,81	7,04
	7-17	1,93	0,14	0,16	9,9	2,48	0,4	0,1	12,88	7
	25-35	0,84	0,126	0,16	6,44	0,99	0,4	0,21	8,04	7,12
	45-55	0,51	0,126	0,49	6,93	1,98	0,4	0,21	9,52	7,03
	65-75			0,16						7

Table 125 - Granulometric composition of chestnut weakly saline soil

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
32	0-5	60,14	9,60	12,51	4,84	10,49	2,42	17,75
	7-17	70,07	5,74	6,85	3,23	10,88	3,23	17,33
	25-35	71,70	11,42	4,82	1,61	6,83	3,62	12,06

	45-55	66,69	16,43	4,82	2,01	4,02	6,03	12,05
	65-75	68,70	18,05	3,61	0,40	4,82	4,42	9,64

Table 126 – Composition of water-soluble salts in chestnut slightly saline soil, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
32	0-5	0,103	0,01	0,000	0,005	0,064	0,004	0,016	0,001	0,004
			0,16	0,00	0,15	1,33	0,19	1,31	0,04	0,09
	7-17	0,105	0,007	0,000	0,003	0,069	0,007	0,014	0,001	0,004
			0,12	0,00	0,07	1,44	0,37	1,13	0,04	0,09
	25-35	0,016	0,005	0,000	0,004	0,003	0,002	0,001	0,001	0,001
			0,08	0,00	0,11	0,06	0,09	0,09	0,04	0,02
	45-55	0,045	0,01	0,000	0,004	0,021	0,002	0,007	0,001	0,001
			0,16	0,00	0,11	0,44	0,09	0,56	0,04	0,02
	65-75	0,068	0,005	0,000	0,004	0,043	0,004	0,01	0,001	0,001
			0,08	0,00	0,11	0,9	0,19	0,84	0,04	0,02

Humus content in the upper horizon is 4.15%, rapidly decreasing downwards. Underlain by sand with gypsum with 40 cm The soil is slightly alkaline (pH about 7) (Table 124). Light particle size distribution (up to 70% of sand fraction) (Table 125). The exchangeable Na throughout the profile is consistently low (0.4 mEq). at the top the physical clay is about 18%, down it decreases to 10%. The soils are practically unsalted (Table 126). The soloneticity is weakly expressed in the surface horizon.

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – greenish grey, water regime – atmospheric. The total projective covering of the soil surface with vegetation was 55% of the total area. Grassland type – fescue-wormwood-variegated. The botanical composition of plants consists of fescue – 50%, wormwood – 35% and forbs – 15%. In addition to them, there are: yarrow, cinquefoil, eryngium, feather grass, thin-legged grass, rock and resin. The yield of pasture mass is 10.5 c/ha

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 13.91 %, fat – 5.82 %, fiber – 34.00 %, NFE – 35.20 % and ash – 8.52%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is 0.60 per kilogram of feed, and the exchange energy is – 8.96 MJ.

Monitoring site № 33. Soil: Meadow-desert salt marsh clayey saltbush on heavy loam. Located in the Khromtau district of the Aktobe region (Figure 35). Coordinates: N 50.297157°, E 58.080788°. A complex surface, a tumbled-wavy plain, part plowed. Among sunflower crops, bald spots – solonetz spots. Vegetation wormwood-forge-comforosm: comforosm sp, cop, feather grass sp-sol, scorzonera sol, volos sp, izen sol, parmelia sol. Closedness 75-80 %. Height 10-15 cm. Depth 70 cm. A+B = 30 cm. Boiling 15 cm. Gypsum with 50 sand. Carbonates – from 30 to 50 cm whitish spots. Horizons A₁^{CH} 0-5, B₁^{CH} 5-15, B₂ 15-30, C₁^K 30-50, C₂ 50-bottom.



Figure 35 – Meadow-desert salt marsh saltbush clayey on heavy loam

0-5 cm, Light grey, radiculate, dry, dense, clumpy-hazelous, clayey
 5-15 cm, Brown, dry, very dense, nutty, clayey
 15-30 cm, Greyish-bright brown, fresh, dense, cingulate-clumpy, heavy loamy
 30-50 cm, Bright brown, fresh, compacted, heavy loamy
 50-bottom, Reddish brown, fresh, compacted with gypsum inclusion, heavy loamy.

Table 127 – Chemical and physico-chemical properties of meadow-desert salt marshes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
33	0-5	3,16	0,238	0,16	17,33	6,44	1,63	0,36	25,76	7,52
	5-15	2,35	0,21	0,16	20,3	12,38	5,82	0,21	38,71	7,96
	17-27	1,92	0,126	1,00	11,39	13,86	14,62	0,21	40,08	8,48
	35-45	0,90	0,098	4,59	12,38	15,35	18,18	0,21	46,12	8,47
	60-70			1,46						8,18

Table 128 - Granulometric composition of meadow-desert salt marshes

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
33	0-5	10,87	16,56	22,68	12,78	25,57	11,55	49,90
	5-15	7,18	3,66	22,60	10,05	27,21	29,30	66,56
	17-27	9,65	1,74	25,86	9,75	27,14	25,86	62,75
	35-45	5,75	9,19	34,61	13,76	33,35	3,34	50,45
	60-70	8,16	11,09	65,27	4,18	4,18	7,11	15,48

The upper horizons are brownish grey, heavy loamy and fissured. Humus 4.2 % in the upper horizon, reduced to 1 %. Carbonates and gypsum are developed with 30–50 cm. The soil is alkaline (pH 7.5–8.5) (Table 127). Physical clay increases to 66 % in B1, remaining high (50–62 %) and deeper (Table 128). Severe salinity in the lower horizons (up to 1.7 % of salts) (Table 129). Upper humus layer with Na $\approx$ 1.6, below — sharp increase: 5.8–14.6–18.2 in horizons B. This is a salt licorice with pronounced sodium accumulation in the illuvial horizon.

Table 129 – Composition of water-soluble salts in meadow-desert salt marshes, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
33	0-5	0,127	0,02	0,000	0,008	0,065	0,002	0,011	0,019	0,001
			0,32	0,00	0,22	1,36	0,09	0,94	0,85	0,03
	5-15	0,094	0,034	0,002	0,014	0,017	0,002	0,001	0,025	0,001
			0,56	0,08	0,41	0,34	0,09	0,09	1,11	0,02
	17-27	0,530	0,037	0,002	0,288	0,011	0,013	0,011	0,168	0,002
			0,6	0,08	8,13	0,22	0,65	0,94	7,31	0,05
	35-45	1,292	0,032	0,000	0,675	0,147	0,036	0,084	0,319	0,001
			0,52	0,00	19,03	3,05	1,78	6,94	13,87	0,02
	60-70	1,715	0,017	0,000	0,766	0,366	0,125	0,107	0,332	0,001
			0,28	0,00	21,61	7,63	6,26	8,81	14,43	0,02

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – greenish grey, water regime – atmospheric. Projective coverage of the soil surface with vegetation is 80%. Type of pasture – comphorosmic-sagebrush-quaff. When studying the botanical composition of plants, it was revealed that komforosma occupies – 40%, wormwood – 35, and feather grass – 25% of the

total area. In addition to them, the grass stand contains: hairsucker and canopy in a single specimen. The yield of pasture mass was 11.0 c/ha.

A study of the chemical composition of plants growing in solonetzic soils showed that the content of protein in the air-dry state is 17.00%, fat – 7.13%, fiber – 30.25%, NFE– 35.20% and ash – 8.52 %. The yield of feed units at natural plant moisture is 0.61 per kilogram of feed, and the exchange energy is – 8.55 MJ.

Monitoring site №34. Soil: Chestnut medium salty heavy loamy on clay. Located in the Khromtau district of the Aktobe region (Figure 36). Coordinates: N 50.219143°, E 58.194353°. Height above u.m. = 407 m. Gently undulating plain. Cut on the gentle slope 3° of the northern exposition. Vegetation of forbs and forbsbill wormwood is fescue: fescue cop, feather grass sol, sp, wormwood sp, crown vetch sol. Closedness 90-95 %. Height 25-30 cm. The soil surface is broken by deep cracks up to 10 cm wide, 30-40 cm deep. Depth 60 cm. A+B = 40 cm. Boiling with 40 slight swelling. Carbonates – small veins with 40 cm No salt. Horizons A₁^D 0-5, B₁^{CH} 5-20, B₂^{CH} 20-40, C₁^K 40-bottom.

0-5 cm, Brownish-grey, dry, compacted, strongly radiate, dusty-clumpy, heavy loamy

5-20 cm, Darkish brown, dry, dense, lumpy, clayey

20-40 cm, Brown, dry, very dense, blocky, clayey

40-bottom, Chocolate, fresh, dense, structureless, clay.



Figure 36 – Chestnut medium saline heavy loamy on clay

Table 130 – Chemical and physico-chemical properties of chestnut medium saline soil

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	

34	0-5	4,22	0,266	0,16	26,73	4,95	0,25	1,04	32,97	7,41
	7-17	2,58	0,182	0,16	27,23	8,91	0,08	0,21	36,43	7,49
	25-35	1,49	0,126	0,16	23,76	8,42	2,32	0,21	34,71	8,15
	50-60	1,08	0,14	0,19	20,3	13,37	2,73	0,21	36,61	8,16

Table 131 - Granulometric composition of chestnut medium saline soil

№ cut	Depth, cm	Fraction content in % on dry soil							
		fraction size in mm							
		Sand		Dust			Silt	Physical clay	
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01	
34	0-5	7,20	3,92	22,12	7,93	25,04	33,80	66,76	
	7-17	4,80	4,57	16,71	10,44	20,46	43,02	73,92	
	25-35	4,90	5,53	17,58	10,88	27,21	33,91	72,00	
	50-60	3,51	7,34	10,93	10,93	60,56	6,73	78,22	

Table 132 – Composition of water soluble salts in chestnut medium saline soil, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃	From normal carbonates in CO ₃ ²⁻						
34	0-5	0,074	0,02	0,000	0,007	0,028	0,009	0,006	0,002	0,003
			0,32	0,00	0,18	0,59	0,47	0,47	0,08	0,08
	7-17	0,065	0,017	0,000	0,005	0,026	0,006	0,006	0,005	0,001
			0,28	0,00	0,15	0,55	0,28	0,47	0,21	0,02
	25-35	0,129	0,032	0,000	0,046	0,011	0,006	0,007	0,027	0,001
			0,52	0,00	1,29	0,23	0,28	0,56	1,18	0,02
	50-60	0,378	0,027	0,000	0,21	0,007	0,028	0,011	0,095	0,001
			0,44	0,00	5,91	0,14	1,4	0,94	4,13	0,02

Humus 4.2% in the upper horizon, reduced to 1%. The soil is dense, carbonates with 40 cm Alkaline reaction (pH 7.4–8.1). Above, the sodium content is low (0.08–0.25), but rises to 2.3–2.7 in B2–C1 (Table 130). The proportion of physical clay is very high (67–78 %), increasing with depth (Table 131). The soils are practically weakly saline from a depth of 50 cm (Table 132). Soloniteness is expressed in the middle part of the profile, the soil is heavy in terms of grain composition.

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – straw-greenish-grey, water regime – atmospheric. Projective coverage of the soil surface with vegetation is 90%. Grassland type – fescue-forge-wormwood-variegated. Determination of the botanical composition of plants showed that fescue occupies – 45%, feather grass – 25%, wormwood – 20%, and forbs – 10% of the total area. In addition to them, grass stands include; zopnik,

yarrow, breast, eryngium with the participation of meadowsweet. The yield of pasture mass was 14.5 c/ha.

Determination of the chemical composition of plants growing in solonetzic soils showed that the content of protein in the air-dry state is 18.53%, fat – 6.82%, fiber – 31.52%, NFE – 30.87 % and ash – 9.63 %. The yield of feed units at natural plant moisture is 0.57 per kilogram of feed, and the exchange energy is – 8.23 MJ.

Monitoring site №35. Soil: Steppe salt marsh salt marsh heavy loamy on crushed loam. Located in. Abay in the Khromtau district of the Aktobe region (Figure 37). Coordinates: N 50.205311°, E 58.325471°. Wavy plain. Vegetation wormwood-fescue with crushed stone: fescue sp, wormwood sp, parmelia sol, sallow-capped moss sp, izen sp. Closedness 45-50 %. Depth 50 cm. A+B = 35 cm. Boiling from 20 cm. Crushed stone from 35 cm is strong. Horizons B^P 0-5, B₁^{CH} 5-20, B₂^{CH} 20-35, C 35-bottom

0-5 cm, Gray, dry, dense, radiculate, dusty-clumpy, light loamy

5-20 cm, Brown (darkish), dry, very dense, blocky with vertical columnar, clayey

20-35 cm, Bright brown, dry, compacted, dusty-clumpy, medium loamy

35-bottom, Whitish-yellow-brown fresh with a lot of stones, medium loamy.



Figure 37 – Steppe saltmarsh saltmarsh heavy loamy on crushed loam

Table 133 – Chemical and physico-chemical properties of steppe salt marshes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
35	0-5	1,27	0,126	0,16	8,42	1,98	0,13	0,19	10,72	6,83
	7-17	1,84	0,126	0,32	19,31	3,96	6,47	0,21	29,95	7,98

	23-33	1,57	0,112	4,79	18,32	7,92	11,81	0,21	38,26	8,75
	40-50	1,12	0,07	5,69	18,32	6,93	8,43	0,21	33,89	8,63

Table 134 - Granulometric composition of steppe salt marshes

№ cut	Depth, cm	Fraction content in % on dry soil							
		fraction size in mm							
		Sand		Dust			Silt	Physical clay	
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01	
35	0-5	7,59	43,74	23,53	8,92	14,20	2,03	25,15	
	7-17	4,06	27,29	18,72	4,99	14,56	30,37	49,93	
	23-33	7,33	21,88	17,07	9,16	22,07	22,49	53,72	
	40-50	9,69	26,80	22,00	9,55	19,93	12,04	41,51	

Table 135 – Composition of water-soluble salts in salt licks of steppe salt marshes, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
35	0-5	0,062	0,012	0,000	0,005	0,027	0,004	0,005	0,007	0,002
			0,20	0,00	0,15	0,57	0,19	0,38	0,30	0,05
	7-17	0,151	0,046	0,007	0,045	0,016	0,002	0,011	0,03	0,001
			0,76	0,24	1,26	0,34	0,09	0,94	1,31	0,02
	23-33	0,505	0,037	0,002	0,275	0,01	0,017	0,014	0,151	0,002
			0,6	0,08	7,76	0,22	0,84	1,13	6,56	0,05
	40-50	0,592	0,039	0,000	0,334	0,002	0,039	0,013	0,162	0,003
			0,64	0,00	9,42	0,04	1,96	1,03	7,03	0,08

Humus is low (1.3–1.8%). With 35 cm crushed stone, salinity (0.5–0.6% salts in the lower horizons). The soil is alkaline (pH to 8.7) (Table 133). Physical clay increases from 25% at the top to 54% at the mid-horizons (Table 134). The soils are saline from a depth of 20 cm, where the sum of the salts is 0.5 % (Table 135). In soil with 7 cm, the solonetz horizon is well defined.

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – straw grey, water regime – atmospheric. The total projective coverage of the soil surface with vegetation is 45-50%. Grassland type – sagebrush-fescue-senic. In percentage terms, wormwood – 50%, fescue – 25% and hay – 15-10% of the total area participate in grass. Among the grass stand there are: goiter, yarrow, breast, eryngium with the participation of meadowsweet. The yield of pasture mass was 7.5 c/ha.

A study of the chemical composition of plants growing in solonetzic soils showed that the content of protein in the air-dry state is 16.33%, fat – 7.30%, fiber – 32.82%, NFE– 31.52% and ash – 9.42%. The yield of feed units at natural plant

moisture is 0.55 per kilogram of feed, and the exchange energy is – 8.24 MJ. Height above cm. 385 m.

Monitoring site № 36. Soil: Meadow-chestnut strongly saline salt marsh heavy loamy on loam. Located in the Karagalinsky district of the Aktobe region (Figure 38). Coordinates: N 50.400845°, E 57.37545°. Height above u.m. = 262 m. Floodplain terrace of the river. Zhaksa Kargaly. Vegetation of forbs-fescue-wormwood: wormwood sp, fescue sp, feather grass sol, bedstraw, breastplate sl, silene, yellow alfalfa, limonium un. Closedness 65-70 %. Height 20-25 cm. Depth 65 cm, A+B = 35, Boiling 35. Carbonates – with 15 cm of vein, 35-50 whitish coating. Horizons A_1^S 0-3, B_1^{CH} 3-15, B_2 15-35, C_1^K 35-50, C_2^K 50-bottom

0-3 cm, Greyish darkish brown, dry, weakly compacted, strongly radiculate, clumpy-powdery, medium loamy

3-15 cm, Dark brown grayish, fresh, dense, sharply ribbed-clumpy, heavy loamy

15-35 cm, Grayish dirty brown, fresh, dense, blocky, heavy loamy

35-50 cm, Whitish-dirty-brown, fresh, compacted, with carbonates, structureless, heavy loamy

50-bottom, Dirty yellow-brown with dark smudges, compacted, with carbonates, structureless, heavy loamy.



Figure 38 – Meadow-chestnut strongly saline heavy loamy on loam

The top is greyish-brown with humus content up to 3.9% (Table 136). Below are carbonate inclusions. The soil is heavy loamy and clayey (Table 137). The salt content rises sharply from 37 cm (to 1.2% and above) (Table 138). The soil solution reaction is slightly alkaline (pH 7.5–8.6). Physical clay increases from 45% to 66% in B₂, then subsides. The soils are already saline from a depth of 35 cm. Clear illuvial-solonetz differentiation is characteristic.

Table 136 – Chemical and physico-chemical properties of meadow chestnut highly saline salt marsh soil

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
36	0-3	3,92	0,266	0,16	18,32	9,9	0,15	0,69	29,06	7,49
	4-14	3,18	0,238	0,16	19,31	10,89	0,62	0,38	31,2	7,45
	20-30	2,24	0,224	3,62	12,38	15,35	4,25	0,21	32,19	8,63
	37-47	0,79	0,112	11,64	17,32	10,89	3,17	0,21	31,59	8,52
	55-65			16,17						8,66

Table 137 - Granulometric composition of meadow-chestnut highly saline salt marsh soil

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
36	0-3	10,35	13,81	31,33	10,72	23,08	10,72	44,52
	4-14	7,56	11,30	31,46	9,94	27,74	12,01	49,68
	20-30	8,14	7,73	17,82	17,41	23,21	25,69	66,31
	37-47	7,00	5,21	24,21	24,21	36,10	3,28	63,59
	55-65	3,26	0,68	55,83	27,92	10,26	2,05	40,23

Table 138 – Composition of water-soluble salts in meadow chestnut highly saline salt marsh soil, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
36	0-3	0,089	0,02	0,000	0,007	0,039	0,006	0,008	0,006	0,004
			0,32	0,00	0,18	0,81	0,28	0,66	0,27	0,11
	4-14	0,103	0,017	0,000	0,007	0,052	0,004	0,009	0,013	0,001
			0,28	0,00	0,18	1,08	0,19	0,75	0,57	0,04
	20-30	0,158	0,056	0,002	0,035	0,021	0,002	0,01	0,032	0,001
			0,92	0,08	1,00	0,44	0,09	0,84	1,41	0,02
	37-47	1,247	0,024	0,000	0,151	0,704	0,174	0,056	0,138	0,001
			0,4	0,00	4,25	14,66	8,7	4,59	6,00	0,02
	55-65	1,156	0,02	0,000	0,21	0,583	0,118	0,068	0,157	0,001
			0,32	0,00	5,91	12,14	5,89	5,63	6,84	0,02

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – greyish green, water regime – atmospheric.

Projective coverage of the soil surface with vegetation is 45-50% of the total area. Pasture type – sagebrush-variegated-cereal. In percentage terms, wormwood – 60%, forbs – 20%, fescue and feather grass – 10% of the total area participate in grass stand. Among the grass stand there are: bedstraw, yarrow, breast, resin, yellow alfalfa, statice, witwort and meadowsweet. The yield of pasture mass was 15.1 c/ha. Chemical analysis of the feed showed that the content of protein in the air-dry state was 12.20%, fat – 8.23%, fiber – 33.81%, NFE – 35.87% and ash – 6.83%. The yield of feed units at natural plant moisture is 0.57 per kilogram of feed, and the exchange energy is – 7.74 MJ.

Monitoring site №37. Soil: Steppe saltbush heavy loamy. Located in the Alginsky district of the Aktobe region (Figure 39). Coordinates: N 50.182491°, E 57.049101°. Wavy plain. The cut is on a gentle descent to the river. Vegetation is ishen-sagebrush with bluegrass: wormwood cop, izen sol-sp, feather grass, onion bluegrass sol, statice sol. Closedness 50-60%. Height 15-20 cm. Depth 60. A+B = 27. Boiling 27. Carbonates – white-eye 27-43 cm. Horizons A₁ 0-3, A 3-15, B^{CH} 15-27, C₁^K 27-43, C₂ 43-bottom.



Figure 39 – Steppe saltbush (chestnut solonetzic) heavy loamy

0-3 cm, Brown greyish layered strongly radiate powdery lumpy medium loamy

3-15 cm, Brown, dry, compacted, powdery-clumpy, medium loamy

15 - 27 cm, Dark rachis, dry, very dense, blocky-nutty, clayey

27-43 cm, Dirty dark brown, dry, with white eyes, very dense blocky, clayey

43-bottom, Yellow-brown, dry, dense, blocky, heavy loamy.

Table 139 – Chemical and physico-chemical properties of steppe solonetzses

№		Humus , %		CO ₂ , %	Absorbed bases, mg-eq/100 g	
---	--	--------------	--	------------------------	--------------------------------	--

cut	Sample depth, cm		Total nitrogen, %		Ca	Mg	Na	K	Amount	pH of water.
37	0-3	3,18	0,224	0,16	13,86	6,44	0,28	0,65	21,23	7,31
	4-14	1,76	0,182	0,23	13,86	7,43	0,15	0,21	21,65	7,4
	16-26	1,67	0,14	0,32	14,85	10,89	3,41	0,21	29,36	8,5
	30-40	1,23	0,14	1,52	4,46	3,96	5,94	0,21	14,57	8,94
	50-60			1,84						8,99

Table 140 - Granulometric composition of steppe solonetz

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
37	0-3	16,53	26,60	24,55	11,05	14,32	6,96	32,32
	4-14	16,05	24,59	21,29	13,10	17,61	7,37	38,08
	16-26	15,91	18,88	13,71	8,72	19,52	23,26	51,51
	30-40	13,73	20,93	12,82	9,10	18,61	24,81	52,52
	50-60	15,17	18,17	17,28	5,35	22,22	21,81	49,38

Table 141 – Composition of water-soluble salts in steppe salt licks, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
37	0-3	0,033	0,02	0,000	0,004	0	0,004	0,001	0,001	0,004
			0,32	0,00	0,11	0	0,19	0,09	0,06	0,09
	4-14	0,089	0,01	0,000	0,007	0,05	0,007	0,009	0,006	0,001
			0,16	0,00	0,18	1,04	0,37	0,75	0,25	0,02
	16-26	0,108	0,063	0,005	0,012	0,001	0,002	0,001	0,027	0,001
			1,04	0,16	0,33	0,02	0,09	0,09	1,18	0,03
	30-40	0,231	0,076	0,005	0,026	0,06	0,002	0,005	0,063	0,001
			1,24	0,16	0,74	1,24	0,09	0,38	2,73	0,02
	50-60	0,301	0,063	0,005	0,073	0,068	0,002	0,009	0,084	0,001
			1,04	0,16	2,07	1,42	0,09	0,75	3,67	0,02

Humus to 3.2% in the upper horizon, reduced to 1.2% (Table 139). Physical clay increases from 32–38% to 52% in BC horizons (Table (Table 140). The soil is dense and salinity is noticeable from 15 cm (Table 141) pH 7.3 to 8.9. Above Na 0.15–0.28, in the middle part of the profile it reaches 3.4–5.9. The solonetz structure is clearly defined from a depth of 15 cm.

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – greyish, water regime – atmospheric. Projective covering of the soil surface with vegetation accounts for 55% of the total area. Pasture type – sagebrush-hazel-mint. Wormwood – 75%, slough – 10%, bluegrass – 10% of the

total area takes part in the grass stand. In the botanical composition, grass stands include; yarrow, Fescue, statice, wheatgrass, and feather grass. The yield of pasture mass was 11.0 c/ha.

Determination of the chemical composition of plants growing on solonetzic soils showed that the content of protein in the air-dry state is 13.82%, fat – 6.82%, fiber – 32.44%, NFE – 33.22% and ash – 10.42%. The yield of feed units at natural plant moisture is 0.52 per kilogram of feed, and the exchange energy is – 7.37 MJ.

Monitoring site № 38. Soil: Saltmarsh saltmarsh heavy loamy on crushed-sandy sediment. Located in the Temir district of the Aktobe region (Figure 40). Coordinates: N 50.050770°, E 58.702365°. High floodplain terrace of the river. Karaobda. Vegetation complex, sagebrush-comforosmic, feather grass, section under sagebrush-comforosmic vegetation. There are bare spots: comforosma cop, wormwood sp, feather grass sol, fescue sol, keireuk ip. Closedness 40-50%.



Figure 40 – Saltmarsh saltmarsh heavy loamy on crushed-sand sediment

Height 5-15 cm. Depth 55. A+B = 33 cm No boiling. Salts with 20 cm crust on crushed stone, Crushed stone with 20 cm. Horizons A₁ 0-5, B₁^{CH} 5-20, B₂^{CH} 20-33, C₁^{SH} 33-bottom.

0 - 5 cm, Light grey, strata iridescent-clumpy, with medium loamy pores, with rootlets

5-20 cm, Brown, dry, dense, nutty, clayey

20-33 cm, Reddish-brown, dry, compacted, heavy loamy, blocky with salts

33-bottom, Lighter than the previous one, crushed stone-sandy sediment

Humus is low (2.4% above, below <1%). The soil is saline (0.5% salts per 20-30 cm) pH up to 9.2. At the top, Na is low (0.23), but in B1–B2 rises to 3.6-4.1, then falls again (1.3–0.3) (Table 142). The soil is practically not saline (Table 143). Physical clay grows up to 33% in the average horizon, but decreases lower (Table 144). The solonetest is pronounced and there is a salt marsh effect.

Table 142 – Chemical and physico-chemical properties of salt marshes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
38	0-5	2,44	0,168	0,16	7,92	5,94	0,23	0,16	14,25	7,34
	7-17	1,3	0,126	0,16	12,87	7,92	3,56	0,15	24,5	8,58
	21-31	0,72	0,042	0,26	11,39	4,46	4,05	0,15	20,05	8,03
	45-55	0,24	0,028	0,32	7,43	4,95	1,32	0,15	13,85	9,22
	60-70	1,6	0,056	0,16	7,92	5,94	0,31	0,22	14,39	7,44

Table 143 - Granulometric composition of salt marshes

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
38	0-5	38,58	26,28	18,58	3,23	8,89	4,44	16,56
	7-17	34,11	21,12	11,40	2,04	16,69	14,65	33,37
	21-31	49,09	18,71	6,93	2,45	6,52	16,30	25,27
	45-55	46,59	25,82	7,71	3,25	11,77	4,87	19,88
	60-70	32,91	30,60	16,62	3,65	10,54	5,68	19,86

Table 144 – Composition of water-soluble salts in salt marshes, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
38	0-5	0,042	0,012	0,000	0,001	0,016	0,002	0,001	0,008	0,001
			0,2	0,00	0,04	0,34	0,09	0,09	0,37	0,02
	7-17	0,112	0,032	0,005	0,001	0,045	0,002	0,001	0,03	0,001
			0,52	0,16	0,04	0,95	0,09	0,09	1,30	0,02
	21-31	0,565	0,017	0,000	0,007	0,366	0,022	0,008	0,145	0,001
			0,28	0,00	0,18	7,62	1,12	0,66	6,29	0,02
	45-55	0,168	0,027	0,002	0,007	0,086	0,013	0,006	0,029	0,001
			0,44	0,08	0,18	1,79	0,65	0,47	1,28	0,02
	60-70	0,018	0,007	0,000	0,001	0,004	0,002	0,001	0,001	0,001
			0,12	0,00	0,04	0,09	0,09	0,09	0,04	0,02

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – grey, water regime – atmospheric. The point is on the floodplain terrace.

Projective coverage of the soil surface with vegetation is 50%. Wormwood-camphorosmo-Fescue grass stand with meadowsweet. When studying the botanical composition of plants, it was revealed that it occupies wormwood – 55%, camphorosma – 30% and Fescue – 15% of the total area. In addition to them, the grass stand contains; bluegrass, thin-legged, yarrow, isen, lalemantia, meadowsweet, reveler and feather grass. The yield of pasture mass was 11.3 c/ha.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 16.83%, fat – 6.92%, fiber – 31.26%, NFE – 33.09% and ash – 8.93%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is 0.58 per kilogram of feed, and the exchange energy is – 8.17 MJ.

Monitoring site №39. Soil: Chestnut, slightly salty, light loamy on sandy loam. Located in the Temir district of the Aktobe region in the Kiikbulak tract (Figure 41). Coordinates: N 50.014829°, E 57.701498°. Wavy plain. Vegetation of wormwood: wormwood shrenka cop, wormwood estrogen sol, bluegrass meadow yip, fescue sol, wheatgrass sol. Closedness 40%. Height 15-25. Depth 65. A+B = 27. No boiling. There are no carbonates. Horizons A₁ 0-3, B₁^{CH} 3-16, B₂^{CH} 16-27, C₁ 27-45, C₂ 45-bottom

0 - 3 cm, Light grey, dry, weakly compacted, sparsely rooted, not strongly clumpy dusty, light loamy, sandy loam

3-16 cm, Dark brown, dry, dense, with sparse roots, coarsely lumpy, light loamy

16-27 cm, Brown, dry, dense, sharply ribbed-clumpy, light loamy

27-45 cm, Bright brown, dry, dense, dusty-blocky, sandy loam

45-bottom, Brown, with dark deposits, dry, dense, structureless, medium loamy, sandy loam



Figure 41 – Chestnut, slightly salty, light loamy on sandy loam

Humus is low (about 1%), Na is consistently low (0.31 at all depths) (Table 145). Physical clay fluctuates around 20–23 %, drops to 16–19 % at the bottom (Table 146). Salts not available (Table 147). The profile is light, slightly salty.

Table 145 – Chemical and physico-chemical properties of chestnut lightly saline soil

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
39	0-3	1,05	0,112	0,16	7,92	4,95	0,31	0,15	13,33	7,51
	5-15	0,99	0,084	0,19	9,41	4,46	0,31	0,15	14,33	7,51
	16-26	0,96	0,07	0,16	7,43	1,98	0,31	0,15	9,87	7,03
	30-40	0,58	0,07	0,16	6,93	2,48	0,31	0,15	9,87	7,47
	55-65			0,81						7,73

Table 146 - Granulometric composition of chestnut weakly saline soil

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
39	0-3	31,38	30,43	16,25	0,81	11,38	9,75	21,94
	5-15	36,32	26,75	14,21	0,81	10,96	10,96	22,73
	16-26	36,99	26,08	14,61	0,41	10,55	11,36	22,32
	30-40	45,56	30,12	8,51	0,41	4,46	10,94	15,81
	55-65	44,83	26,39	10,13	2,03	4,46	12,16	18,65

Table 147 – Composition of water-soluble salts in chestnut lightly saline soil, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
39	0-3	0,028	0,005	0,000	0,001	0,014	0,004	0,002	0,001	0,001
			0,08	0,00	0,04	0,3	0,19	0,19	0,02	0,02
	5-15	0,028	0,005	0,000	0,001	0,014	0,004	0,002	0,001	0,001
			0,08	0,00	0,04	0,3	0,19	0,19	0,02	0,02
	16-26	0,077	0,002	0,000	0,000	0,054	0,013	0,006	0,001	0,001
			0,04	0,00	0,00	1,13	0,65	0,47	0,02	0,02
	30-40	0,016	0,005	0,000	0,001	0,005	0,002	0,001	0,001	0,001
			0,08	0,00	0,04	0,11	0,09	0,09	0,02	0,02
	55-65	0,042	0,01	0,000	0,000	0,021	0,007	0,002	0,001	0,001
			0,16	0,00	0,00	0,44	0,37	0,19	0,02	0,02

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – grey, water regime – atmospheric.

Projective coverage of the soil surface with vegetation is 40-45% of the total area. Pasture type – sagebrush. In percentage terms, Shrenk's sagebrush – 90% and tarragon – 10% of the total area participate in grass stand. The following are found in single quantities as part of the grass stand: bluegrass, cinquefoil, wheatgrass, feather grass, yarrow, resin grass. The yield of pasture mass was 6.0 c/ha.

Determination of the chemical composition of plants growing on solonchic soils showed that the content of protein in the air-dry state is 16.73%, fat – 5.82%, fiber – 31.12%, NFE – 32.12% and ash – 11.10%. The yield of feed units at natural plant moisture is 0.59 per kilogram of feed, and the exchange energy is – 8.35 MJ.

Monitoring site №40. Soil: Chestnut, slightly salty on sandy loam. Located in the Khobdin district of the Aktobe region (Figure 42). Coordinates: N 50.086763o, E 56.618554o. A wavy, almost flat plain. Vegetation ephemeral sagebrush: sagebrush cop1, bluegrass sol, feather grass un. Closedness 35-40 %. Height 20-25 cm. Depth 65 cm. A+B = 30 cm. No boiling. There are no carbonates. Horizons A₁ 0-3, AB 3-15, B₁^{CH} 15-30, C₁ 30-50, C₂ 50-bottom

0-3 cm, Gray, dry, loose, layered, dusty-clumpy, radiculate, light loamy

3-15 cm, Greyish dark brown, dry, compacted, dusty-clumpy, medium loamy

15-30 cm, Dark brown, dry, dense, not strongly lumpy, medium loamy

30-50 cm, Brown, dry, compacted, dusty-blocky, light loamy

50-bottom, Brown almost like the previous sandy loam



Figure 42 – Chestnut slightly salty on sandy loam

Table 148 – Chemical and physico-chemical properties of chestnut lightly saline soil

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
40	0-3	1,70	0,14	0,16	5,94	0,99	0,31	0,38	7,62	7,65
	4-14	1,21	0,112	0,19	7,92	1,49	0,31	0,22	9,94	7,56
	17-27	0,94	0,098	0,16	7,92	3,96	0,31	0,15	12,34	6,79
	35-45	0,56	0,098	0,16	9,41	2,97	0,31	0,15	12,84	7,23
	55-65			0,32						7,44

Table 149 - Granulometric composition of chestnut weakly saline soil

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
40	0-3	39,64	34,49	12,12	3,64	6,06	4,04	13,74
	4-14	35,20	36,88	10,12	4,05	8,91	4,86	17,81
	17-27	35,90	31,28	11,75	2,84	8,91	9,32	21,07
	35-45	46,31	26,50	6,90	3,25	6,49	10,55	20,29
	55-65	51,62	23,66	7,70	5,67	2,03	9,32	17,02

Table 150 – Composition of water-soluble salts in chestnut lightly saline soil, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
40	0-3	0,024	0,012	0,000	0,000	0,005	0,002	0,001	0,001	0,004
			0,2	0,00	0,00	0,11	0,09	0,09	0,02	0,09
	4-14	0,035	0,007	0,000	0,000	0,017	0,006	0,001	0,001	0,003
			0,12	0,00	0,00	0,36	0,28	0,09	0,02	0,08
	17-27	0,052	0,005	0,000	0,000	0,034	0,007	0,005	0,001	0,001
			0,08	0,00	0,00	0,71	0,37	0,38	0,02	0,02
	35-45	0,052	0,002	0,000	0,000	0,036	0,007	0,005	0,001	0,001
			0,04	0,00	0,00	0,75	0,37	0,38	0,02	0,02
	55-65	0,052	0,005	0,000	0,001	0,032	0,007	0,005	0,001	0,001
			0,08	0,00	0,04	0,68	0,37	0,38	0,02	0,02

The top is gray, loose sandy loam, then light loamy horizons. The soil is low humus (1.7%), exchangeable Na is low (0.15-0.31) throughout, but its relative content reaches 3-4% of the sum of the bases (Table 148). The mechanical composition is light (up to 50% sand) (Table 149). There is no salinity (Table 150).

Physical clay increases from 14 to 21% in the middle part, then decreases. The soil is classified as slightly saline.

Characteristics and forage value of land cover. Relief – undulating plain, landscape aspect – greyish green, water regime – atmospheric. The total projective coverage of the soil surface with vegetation is 35-40%. Pasture type – sagebrush-ephemeral. Participation in wormwood grass – 90%, bluegrass – 10% of the total area. The grass stand contains ragweed, feather grass, yarrow and tarragon wormwood in a single specimen. The yield of pasture mass was 9.0 c/ha.

A study of the chemical composition of plants growing in solonetzic soils showed that the content of protein in the air-dry state is 16.32%, fat – 3.62%, fiber – 30.61%, NFE – 38.25% and ash – 8.71%. The yield of feed units at natural plant moisture is 0.59 per kilogram of feed, and the exchange energy is – 7.92 MJ.

West Kazakhstan region

Monitoring site №41. Soil: Saltmarsh saltmarsh heavy loamy on clay. Located in the Syrymsky district of the West Kazakhstan region (Figure 43). Coordinates: N 50.506914°, E 52.26408°. Flat plain with microrelief. Vegetation wormwood with feather grass: wormwood cop1, feather grass sol, limonium sol, fescue sol, breastplate un. Closedness 50-60 %. Height 15-25 cm. Depth 60 cm. A+B = 30 cm. Boiling from 30 cm. No carbonate. Salts veins at 30 – bottom. Horizons A₁ 0-5, AB 5-15, B₁^{CH} 15-30, C₁^{SH} 30-45, C₂^{SH} 45-bottom.

0-5 cm, Greyish-light brown, dry, compacted, radiculate, dusty-clumpy, light loamy.

5-15 cm, Light brown, dry, compacted, dusty-clumpy, medium loamy.

15-30 cm, Brown, fresh, dense, lumpy-blocky, heavy loamy

30-45 cm, Light brown, light, compacted, obscurely blocky, heavy loamy

45-bottom, Brightly light brown, fresh, compacted, structureless, clayey



Figure 43 – Saltmarsh saltmarsh heavy loamy on clay

Table 151 – Chemical and physico-chemical properties of salt marshes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
41	0-5	2,19	0,168	0,23	7,43	5,45	0,21	0,88	13,97	7,56
	5-15	1,07	0,112	0,19	9,9	14,85	1,54	0,24	26,53	7,66
	17-27	1,73	0,084	4,85	19,8	12,87	2,33	0,15	35,15	8,12
	33-43	0,69	0,056	6,27	2,97	8,42	4,85	0,15	16,39	8,55
	50-60			0,16						8,53

Table 152 - Granulometric composition of salt marshes

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
41	0-5	2,16	13,65	55,32	10,58	13,83	4,47	28,88
	5-15	1,42	11,68	57,26	10,15	14,62	4,87	29,65
	17-27	1,08	5,54	36,27	10,84	23,76	22,51	57,11
	33-43	0,64	4,12	39,34	24,43	29,81	1,66	55,90
	50-60	1,04	7,93	74,07	11,59	4,14	1,24	16,97

Table 153 – Composition of water-soluble salts in salt marshes, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
41	0-5	0,045	0,012	0,000	0,009	0,009	0,004	0,002	0,003	0,005
			0,20	0,00	0,26	0,19	0,19	0,19	0,14	0,14
	5-15	0,099	0,005	0,000	0,038	0,023	0,007	0,006	0,016	0,003
			0,08	0,00	1,07	0,48	0,37	0,47	0,71	0,08
	17-27	0,487	0,020	0,000	0,282	0,005	0,015	0,011	0,153	0,001
			0,32	0,00	7,94	0,11	0,75	0,94	6,67	0,02
	33-43	1,376	0,024	0,002	0,472	0,406	0,118	0,022	0,333	0,001
			0,40	0,08	13,3	8,47	5,89	1,78	14,48	0,02
	50-60	1,557	0,020	0,000	0,4	0,649	0,178	0,07	0,241	0,001
			0,32	0,00	11,27	13,52	8,88	5,72	10,49	0,02

The top is grayish-brown and light loamy, followed by heavy horizons. Humus 2.2%, reduced to < 1%, pH 7.5-8.6. Na from a surface of 0.2, then rises to 1.5-2.3 and reaches 4.9 in a horizon of 33-43 cm (Table 151). The soil is dense, the physical clay rises to 57% and 56% in the middle part of the profile, then falls (Table

152).salination is strong (up to 1.5% dense residue) (Table 153). The soloneness is pronounced, with a sodium maximum in the middle horizons.

Characteristics and feed value of the vegetation cover . The relief is a flat plain, with a gray landscape aspect and an atmospheric water regime. The total projective cover of the soil surface by vegetation is 50%. The pasture type is wormwood–feather grass–fescue. In the plant community composition: wormwood accounts for 60%, fescue for 25%, and feather grass for 15% of the total area. Other species found in the herbage include bluegrass, statice (Limonium), Grudnitsa (possibly Lactuca tatarica or related species), couch grass, and meadow grass. The pasture yield is 7.5 c/ha.

A study conducted to study the chemical composition of feed on solonetzic soils showed that the content of protein in the air-dry state is 16.53 %, fat – 5.72 %, fiber – 28.66 %, NFE – 37.13 % and ash – 8.72%. At the same time, the yield of feed units at natural plant moisture is 0.53 per kilogram of feed, and the exchange energy is – 7.63 MJ.

Monitoring Site No. 42. Soil: Meadow-steppe solonetz, solonchak type, on heavy loam. Located in the Syrym District of the West Kazakhstan Region (Figure 44). Coordinates: N 50.506914°, E 52.264068°. Flat low plain. Vegetation: wormwood–camphorosma — camphorosma cop1, saltwormwood sol, keireuk sol, stipa sol, limonium un. Canopy density 40–45%. Height 5–20 cm. Depth 60 cm. A + B = 30 cm. Effervescence from 30 cm. Carbonates – none. Salts from 30 cm – white veins, moderate; from 45 cm – spots to the bottom.. Horizons A₁0-3, AB 3-10, B^{CH} 10-20, B₂^{CH} 20-30, C₁^{SH}30-45, C₂^{SH} 45-bottom.



Figure 44 – Meadow-steppe saltmarsh saltbush on heavy loam

0-3 cm, Brownish-light grey, dry with roots, not strongly clumpy-dusty, light loamy

3-10 cm, Light brown dry, radiculate, fragile, lumpy-dusty, light loamy

10-20 cm, Dirty dark brown, fresh with very dense, blocky, divided vertically separately, clayey

20-30 cm, Brown, fresh, compacted, obscurely blocky, heavy loamy

30-45 cm, Dark brown with white veins of salts, fresh, compacted, structureless, heavy loamy

45-bottom, Yellow-brown, fresh with whitish salt spots, heavy loamy.

Table 154 – Chemical and physico-chemical properties of meadow-steppe salt marshes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
42	0-3	1,72	0,14	0,19	6,44	2,97	0,23	0,81	10,45	7,27
	3-10	1,29	0,098	0,49	6,93	9,41	0,66	0,55	17,55	7,98
	10-20	1,47	0,126	0,19	3,47	11,88	8,99	0,15	24,49	8,38
	20-30	0,98	0,07	0,68	7,42	8,41	13,66	0,15	29,64	8,55
	32-42	0,51	0,042	5,72	8,42	4,95	17,21	0,15	30,73	8,57
	50-60			0,16						8,68

Table 155 - Granulometric composition of meadow-steppe salt marshes

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
42	0-3	1,95	24,52	49,16	8,94	10,56	4,88	24,38
	3-10	0,20	36,52	37,32	8,92	11,76	5,27	25,96
	10-20	0,70	25,13	25,69	7,87	15,75	24,86	48,48
	20-30	0,44	9,03	41,94	7,89	17,44	23,26	48,59
	32-42	0,29	8,95	60,78	22,07	5,83	2,08	29,98
	50-60	0,17	16,33	70,63	6,23	2,08	4,57	12,88

Table 156 – Composition of water-soluble salts in meadow-steppe salt marshes, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						

42	0-3	0,026	0,012	0,000	0,005	0	0,002	0,001	0,001	0,004
			0,20	0,00	0,15	0,01	0,09	0,09	0,06	0,1
	3-10	0,044	0,012	0,000	0,007	0,012	0,002	0,001	0,01	0,001
			0,20	0,00	0,18	0,24	0,09	0,09	0,42	0,02
	10-20	0,313	0,051	0,005	0,118	0,034	0,004	0,002	0,103	0,001
			0,84	0,16	3,32	0,71	0,19	0,19	4,49	0,02
	20-30	0,649	0,037	0,002	0,262	0,116	0,004	0,006	0,224	0,001
			0,60	0,08	7,39	2,42	0,19	0,47	9,73	0,02
	32-42	1,731	0,027	0,002	0,328	0,829	0,159	0,055	0,333	0,001
			0,44	0,08	9,24	17,27	7,95	4,5	14,48	0,02
	50-60	1,662	0,024	0,002	0,321	0,79	0,155	0,051	0,32	0,001
			0,40	0,08	9,05	16,45	7,76	4,22	13,91	0,02

The upperparts are brownish grey and light loamy. From a depth of 10 cm – dense heavy loamy horizons. Humus 1.7%, pH slightly alkaline (7.3-8.6). Na 0.23-0.66 on top, then a sharp increase: 9-13.7-17.2 mEq in B and BC horizons (Table 154). The physical clay increases to 48–49% in the middle of the profile, then decreases. from 30 cm (Table 155). There is strong salinity up to 1.7%, including soda (Table 156). A classic example of a solonetz.

Characteristics and feed value of the vegetation cover. The relief is a flat plain, with a gray landscape aspect and an atmospheric water regime. The projective cover of the soil surface by vegetation is 50%. The herbage is of the wormwood–Camphorosma–statice type. The botanical composition analysis showed that wormwood accounts for 60%, fescue for 25%, and feather grass for 15% of the total area. Other species present in the herbage include bluegrass (Poa), Koeleria, statice (Limonium), Grudnitsa (possibly Lactuca tatarica), wheatgrass (Agropyron), and couch grass (Elytrigia repens). The pasture yield amounts to 8.0 c/ha.

Analysis of the data obtained, when determining the chemical composition of growing plants on solonetzic soils, shows that the content of protein in the air-dry state is 15.52%, fat – 6.00%, fiber – 27.89%, NFE – 38.25% and ash – 9.22%. Moreover, on these types of pastures, the yield of feed units at natural plant moisture is 0.56 per kilogram of feed, and the exchange energy is – 7.88 MJ.

Monitoring Site No. 43 Soil: Steppe solonetz, solonchak type, heavy loam. Located in the Syrym District of the West Kazakhstan Region (Figure 45). Coordinates: N 50.585831°, E 52.170676°. Flat plain with a complex vegetation cover. The soil profile was studied under wormwood vegetation. Vegetation: common wormwood cop1, green wormwood sol, feather grass (stipa tirsia) sol, fescue sol, statice (limonium) un. Canopy density: 40–50%. Height: 10–15 cm (feather grass up to 30 cm). Depth: 60 cm. A + B horizons: 35 cm. Effervescence begins at 35 cm. Salts: from 35 cm — fine specks. Horizons: A₁ 0–3, AB 3–10, B^{CH} 10–20, B₂ 20–35, C₁^{SH} 35–50, C₂ 50–bottom.

0-3 cm, Grayish-light brown, dry, loose, radiculate, dusty-unusual-clumpy, light loamy

3-10 cm, Brown, dry, lamellar-clumpy with roots, medium loamy

10-20 cm, Dirty dark brown, dry, very dense, columnar-blocky, clayey

20-35 cm, Brown, fresh, compacted, blocky-clumpy, heavy loamy

35-50 cm, Brown, bright, fresh, compacted, obscurely lumpy, heavy loamy
 50-bottom, Yellow-brown, weakly moistened with salt veins, compacted, structureless, heavy loamy.



Figure 45 – Steppe saltbush heavy loamy

Table 157 – Chemical and physico-chemical properties of steppe salt marshes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
43	0-3	1,68	0,112	0,16	9,41	3,47	0,25	0,54	13,67	6,85
	3-10	1,24	0,098	0,19	6,93	10,4	0,12	0,42	17,87	7,25
	10-20	1,68	0,098	0,36	3,96	14,85	6,22	0,15	25,18	8,23
	22-32	0,93	0,098	4,85	6,93	7,17	15,39	0,15	29,64	8,67
	37-47	0,43	0,056	7,92	12,87	7,92	3,88	0,15	24,82	8,48
	50-60			0,23						8,56

Table 158 - Granulometric composition of steppe salt marshes

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
43	0-3	1,71	49,50	19,52	10,98	13,82	4,47	29,27
	3-10	0,96	43,37	23,17	11,38	16,66	4,47	32,51
	10-20	0,68	8,52	33,17	12,02	14,93	30,68	57,63
	22-32	0,31	32,57	14,09	7,04	18,65	27,35	53,04
	37-47	1,72	17,64	51,70	20,27	5,79	2,90	28,95
	50-60	1,51	5,60	47,07	33,86	10,32	1,65	45,83

Table 159 – Composition of water-soluble salts in steppe saline soils, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
43	0-3	0,042	0,007	0,000	0,003	0,019	0,004	0,002	0,002	0,005
			0,12	0,00	0,07	0,4	0,19	0,19	0,08	0,14
	3-10	0,042	0,005	0,000	0,003	0,021	0,002	0,002	0,005	0,003
			0,08	0,00	0,07	0,44	0,09	0,19	0,23	0,08
	10-20	0,216	0,049	0,010	0,068	0,026	0,004	0,002	0,066	0,001
			0,8	0,32	1,92	0,54	0,19	0,19	2,87	0,02
	22-32	0,42	0,056	0,005	0,164	0,05	0,002	0,002	0,145	0,001
			0,92	0,16	4,62	1,05	0,09	0,19	6,29	0,02
	37-47	1,05	0,022	0,000	0,197	0,505	0,118	0,039	0,169	0,001
			0,36	0,00	5,54	10,53	5,89	3,19	7,33	0,02
	50-60	1,083	0,024	0,000	0,295	0,413	0,108	0,035	0,206	0,001
			0,4	0,00	8,31	8,61	5,42	2,91	8,97	0,02

The top layer is grayish-brown, light loam, with dense, heavy horizons below. Humus content is low (1.2-1.7%). pH 6.8-8.7. Na increases from 0.25 to 6.2 and 15.4 in horizons B1–B2 (maximum), then decreases (Table 157). Physical clay reaches 57% in the middle of the profile (Table 158). Strong salinity in the lower part of the profile (up to 1.0-1.1% salts) (Table 159). Strong salinity and heavy mechanical composition.

Characteristics and forage value of the vegetation cover. Relief – undulating plain, aspect of the landscape – grey, water regime – atmospheric. The projective cover of the soil surface by vegetation is 40–45%. The grass stand is wormwood–bluegrass. During the study of the botanical composition of plants, it was revealed that wormwood occupies – 60%, camphorosma – 25%, statice – 15%, and salsola–10% of the total area. Also present in the grass stand are: bluegrass, fescue, feather grass, wheatgrass, and couch grass. The pasture biomass yield amounted to 9.6 c/ha.

Determination of the chemical composition of plants growing on saline soils showed that the protein content in the air-dry state is 16.00%, fat – 6.93%, fiber – 29.63%, NFE – 32.26%, and ash – 12.50%. The yield of feed units at natural plant moisture content is 0.62 per kilogram of feed, and the metabolic energy is 9.06 MJ.

Monitoring site No. 44. Soil: Steppe clay loam. Located in the Terekta district of West Kazakhstan region (Figure 46). Coordinates: N 50.652015°, E 52.081550°. Flat plain. Sown with rye grass with patches of solonetz under gray-polyn vegetation with feather grass. Vegetation: gray wormwood cop1, feather grass sol, rye grass sol. Closure 40%. Height 25-35 cm. Depth 60 cm, A+B = 25 cm. Boiling from 40 cm. No visible carbonates. No salts. Horizons A₁^K 0-4, AB 4-14, B₁^{CH} 14-25, BC^{CH} 25-40, C₁ 40-bottom.

0-4 cm, grayish light brown, dry, loose, layered crust, medium loam
 4-14 cm, brownish gray, dry, compacted, granular, heavy loam
 14-25 cm, dirty dark brown, dry, very dense, columnar lumpy, clayey
 25-40 cm, dark brown, dry, dense, slab-like lumpy, clayey
 40- bottom, yellowish-brown, dry, dense, unstructured, clayey.



Figure 46 – Steppe clayey solonetz

Table 160 – Chemical and physicochemical properties of steppe solonchaks

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
44	0-4	2,44	0,154	0,16	31,19	5,94	0,29	0,98	38,4	7,41
	4-14	1,95	0,14	0,16	12,87	12,38	0,12	0,55	25,92	7,48
	15-25	1,29	0,098	0,32	7,92	14,85	2,29	0,15	25,21	7,88
	27-37	0,84	0,07	4,20	12,87	7,43	3,83	0,15	24,28	8,81
	50-60			0,16						8,99

Table 161 - Granulometric composition of steppe solonchaks

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
44	0-4	3,47	11,67	45,10	10,66	22,96	6,15	39,77
	4-14	2,41	35,90	20,56	6,99	22,62	11,52	41,13
	15-25	2,30	14,56	28,13	11,17	23,58	20,27	55,02

	27-37	3,95	21,66	23,97	11,16	22,73	16,53	50,42
	50-60	4,48	21,93	20,56	8,63	23,84	20,56	53,03

Table 162 – Composition of water-soluble salts in steppe solonchaks, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃	From normal carbonates in CO ₃ ²⁻						
44	0-4	0,042	0,017	0,000	0,001	0,010	0,004	0,001	0,003	0,006
			0,28	0,00	0,04	0,22	0,19	0,09	0,11	0,14
	4-14	0,049	0,01	0,000	0,003	0,022	0,002	0,002	0,008	0,002
			0,16	0,00	0,07	0,46	0,09	0,19	0,36	0,06
	15-25	0,068	0,044	0,000	0,005	0,000	0,002	0,002	0,013	0,001
			0,72	0,00	0,15	0,00	0,09	0,19	0,56	0,03
	27-37	0,120	0,054	0,005	0,01	0,020	0,002	0,001	0,032	0,001
			0,88	0,16	0,3	0,42	0,09	0,09	1,37	0,03
	50-60	0,227	0,059	0,005	0,03	0,066	0,002	0,002	0,066	0,001
			0,96	0,16	0,85	1,38	0,09	0,19	2,88	0,03

The top layer is grayish-brown, medium loamy. Below are dense clay horizons. Humus content is about 2.4% in the top layer, decreasing to 0.8%, pH 7.4-8.8. Na is low at the top (0.12-0.29), then increases to 2.3-3.8 (Table 160). The physical clay content is high (40-55%), increasing towards the bottom (Table 161). Salinity is moderate (Table 162).

Characteristics and forage value of the vegetation cover. Relief – plain, aspect of the landscape – greenish-grey, water regime – atmospheric. The projective cover of the soil surface by vegetation is 35–40%. The grass stand is wormwood–grass. During the study of the botanical composition of plants, it was revealed that wormwood occupies – 80%, bluegrass – 20% of the total area. The grass stand also includes limonium, izen, and knotgrass. The pasture biomass yield amounted to 7.5 c/ha.

Analysis of the data obtained when determining the chemical composition of plants growing on saline soils shows that the protein content in an air-dry state is 15.17%, fat – 5.44%, fiber – 33.71%, NFE – 35.82%, and ash – 6.93%. At the same time, on these types of pastures, the yield of feed units at natural plant moisture content is 0.57 per kilogram of feed, and the metabolic energy is 8.12 MJ.

Monitoring site No. 45. Soil: Lightly solonetzic chestnut, medium loamy. Located in Terekti District, West Kazakhstan Region (Figure 47). Coordinates: N 51.020283°, E 51.495817°. Flat plain. Field with wheatgrass and scattered trees of elm (karagach) and oleaster. Solonetz spots make up 20–25% of the area. Vegetation: grey wormwood – cop1, narrow-leaved wormwood – sol, feather grass (tyrsa) – sol, yarrow – sol, yellow alfalfa – sol, introduced wheatgrass – sol, bedstraw – sol. Canopy closure 40–50%. Height 25–35 cm. Depth 60 cm. A+B = 32.

Effervescence from 32 cm. Carbonates – from 45 cm, sharply defined spots.
Horizons: A₁ 0–4, AB 4–15, B₁^{CH} 15–32, C₁ 32–45, C₂^K 45–bottom.



Figure 47 – Chestnut slightly saline medium loamy soil

0-4 cm, brownish-gray, dry, layered, crust with roots, medium loam
4-15 cm, brown, dry, dense, lumpy, with vertical cracks
15-32 cm, dirty brown, dry, dense, lumpy-nutty, heavy loam
32-45 cm, light brown, dry, dense, lumpy, heavy loam
45-bottom, Yellow-brown, with sharply defined carbonate spots, dry, dense, clayey.

Exchangeable Na is low (0.2) throughout the profile, but magnesium content is high (Table 163). Physical clay increases from 35% to 45% down the profile (Table 164). The soil is not saline – the total salt content barely reaches 0.05% (Table 165). The soil can be classified as slightly saline magnesium soil.

Table 163 – Chemical and physicochemical properties of chestnut slightly saline soils

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
45	0-4	2,27	0,196	0,32	14,85	7,43	0,2	1,12	23,6	7,49
	4-14	1,58	0,126	0,23	13,86	7,43	0,2	0,51	22,00	7,48
	18-28	1,24	0,098	5,66	13,37	8,42	0,2	0,02	22,01	7,48
	33-43	0,94	0,056	6,02	17,82	5,45	0,2	0,02	23,49	8,54
	50-60			0,49						8,78

Table 164 - Granulometric composition of chestnut slightly saline soils

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
45	0-4	7,57	32,55	24,61	8,61	20,51	6,15	35,28
	4-14	5,57	29,51	25,48	11,92	18,08	9,45	39,45
	18-28	5,82	23,43	27,97	13,58	14,81	14,40	42,78
	33-43	2,02	19,84	32,90	6,99	21,39	16,86	45,24
	50-60	3,07	10,92	44,24	10,24	23,35	8,19	41,78

Table 165 – Composition of water-soluble salts in chestnut slightly saline soils, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
45	0-4	0,03	0,017	0,000	0,004	0,000	0,002	0,001	0,002	0,004
			0,28	0,00	0,11	0,00	0,09	0,09	0,09	0,11
	4-14	0,043	0,029	0,000	0,003	0,000	0,004	0,002	0,003	0,002
			0,48	0,00	0,07	0,00	0,19	0,19	0,13	0,06
	18-28	0,021	0,007	0,000	0,003	0,005	0,002	0,001	0,002	0,001
			0,12	0,00	0,07	0,11	0,09	0,09	0,09	0,02
	33-43	0,051	0,029	0,002	0,001	0,008	0,007	0,002	0,002	0,001
			0,48	0,08	0,04	0,16	0,37	0,19	0,09	0,02
	50-60	0,051	0,032	0,002	0,001	0,006	0,006	0,003	0,002	0,001
			0,52	0,08	0,04	0,12	0,28	0,28	0,09	0,02

Characteristics and forage value of the vegetation cover. Relief – plain, aspect of the landscape – grayish-green, water regime – atmospheric. The projective cover of the soil surface by vegetation is 40–45%. Pasture type – wormwood. Analysis of the botanical composition of plants showed that wormwood accounts for 85%, couch grass – 10%, and feather grass – 5% of the total area. The grass stand also includes bluegrass, yarrow, brome, cinquefoil, toadflax, knotweed, wheatgrass, and kochia. The pasture biomass yield amounted to 8.0 c/ha.

A study of the chemical composition of plants growing on saline soils showed that the protein content in an air-dry state is 16.62%, fat – 6.00%, fiber – 31.44%, NFE – 33.79%, and ash – 9.33%. The yield of feed units at natural plant moisture content is 0.55 per kilogram of feed, and the metabolic energy is 7.82 MJ.

Monitoring site No. 46. Soil: Lightly solonetzic chestnut heavy loam. Located in Zelenovsky District, West Kazakhstan Region (Figure 48). Coordinates: N 51.218016°, E 51.272661°. Low flat plain. Vegetation: tall wormwood–grass – cop, mixed herbs–bluegrass–wormwood – sp, narrow-leaved wormwood – sol, bulbous bluegrass – sp, kochia – sol, annual saltwort. Depth 60 cm. A+B = 30. Effervescence from surface to 47 cm, none deeper. No carbonates. Horizons: A₁^{CH} 0–10, B₁C10–30, BC 30–47, B₁^{middle} 47–bottom

0-10 cm, Dirty dark brown, dry, very dense, lumpy, heavy loam

10-30 cm, Dark brown with dark gray streaks,

30-47 cm, Similar to the previous one, but with a large amount of clay seepage

47-bottom, grayish-dark brown, fresh, dense, lumpy, clayey buried horizon.



Figure 48 – Chestnut slightly saline heavy loam

Table 166 – Chemical and physicochemical properties of chestnut slightly saline soils

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
46	0-10	1,88	0,112	0,52	18,81	3,96	0,2	1,18	24,15	8,42
	15-25	1,49	0,098	0,23	21,29	7,92	0,18	0,02	29,41	8,37
	33-43	2,17	0,112	0,29	15,35	8,91	0,12	0,02	24,40	7,81
	50-60			0,16						7,91

Table 167 - Granulometric composition of chestnut slightly saline soils

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
46	0-10	1,24	8,23	42,39	9,88	40,74	19,34	48,15
	15-25	0,52	7,41	39,22	8,26	47,07	28,90	52,85
	33-43	0,37	19,18	21,98	13,27	47,69	26,13	58,47
	50-60	0,69	16,74	23,65	12,03	49,38	28,22	58,92

Table 168 – Composition of water-soluble salts in chestnut slightly saline soils, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
46	0-10	0,061	0,029	0,000	0,001	0,013	0,007	0,002	0,002	0,006
			0,48	0,00	0,04	0,28	0,37	0,19	0,09	0,14
	15-25	0,044	0,024	0,000	0,001	0,007	0,007	0,001	0,002	0,001
			0,40	0,00	0,04	0,14	0,37	0,09	0,09	0,02
	33-43	0,059	0,024	0,000	0,001	0,017	0,009	0,001	0,005	0,001
			0,40	0,00	0,04	0,35	0,47	0,09	0,21	0,02
	50-60	0,075	0,029	0,000	0,004	0,021	0,011	0,002	0,006	0,001
			0,48	0,00	0,11	0,45	0,56	0,19	0,26	0,02

The soil is shallow (A+B = 30 cm), heavy loam, very dense. Humus content is about 1.9-2.2%. The soil is alkaline (pH up to 8.4). Despite the low exchangeable sodium content (1.18 mg-eq/100 g), a large amount of exchangeable magnesium (7.9-9.0 mg-eq/100 g) has been noted, which allows us to conclude that the soil is magnesium-saline (Table 166). The physical clay content is high (48–59%) and increases towards the bottom (Table 167). There is no salinity (Table 168).

Characteristics and forage value of the vegetation cover. Relief – flat plain, aspect of the landscape – gray, water regime – atmospheric. The projective cover of the soil surface by vegetation is 65%. Pasture type – wormwood–forb. The botanical composition of plants showed that wormwood accounts for 65%, bluegrass – 25%, and forbs – 10% of the total area. The grass stand includes couch grass, kochia, bassia, and annual saltwort. The pasture biomass yield amounted to 18.0 c/ha.

Determination of the chemical composition of plants growing on saline soils showed that the protein content in the air-dry state is 14.93%, fat – 6.61%, fiber – 34.21%, crude protein – 32.84%, and ash – 8.23%. The yield of feed units at natural

plant moisture content is 0.55 per kilogram of feed, and the metabolic energy is 7.77 MJ.

Monitoring site No. 47. Soil: Steppe solonetz saline heavy loam. Located in Zelenovsky District, West Kazakhstan Region (Figure 49). Coordinates: N 51.116833°, E 50.557786°. Undulating plain. Complex vegetation, feather grass–grudnitsa, grudnitsa–feather grass with fescue: feather grass (*stipa pennata*) cop1, grudnitsa sol, fescue sol, bulbous bluegrass sol, izen sol. Canopy closure 70%. Height 25–35 cm. Depth 60–70 cm. A+B = 35. Effervescence from 25 cm. Carbonate spots from 25 cm to bottom. Horizons: A₁^D 0–4, B₁^{CH} 4–12, B₂^{CH} 12–25, B₃^{CH} 25–35, C₁^K 35–50, C₂^K 50–bottom.

0-4 cm, gray, dry, compacted, dusty and lumpy, medium loamy

4-12 cm, brownish-gray, dry, finely lumpy, with roots, heavy loamy

12-25 cm, brown, dry, very dense, lumpy, clayey

25-35 cm, slightly lighter, dry, dense, with carbonate spots, nutty, clayey

35-50 cm, brown with spots, dry, dense, lumpy, heavy loam

50- bottom, yellowish-brown, dry, compacted, unstructured, heavy loam



Figure 49 – Steppe saline heavy loam solonetz

Table 169 – Chemical and physicochemical properties of steppe salt marshes

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
47	0-4	1,59	0,168	0,16	11,88	9,41	0,01	0,02	21,32	7,07
	4-12	1,27	0,112	0,16	20,3	10,4	0,48	0,02	31,2	7,29
	13-23	1,2	0,112	0,23	15,35	12,38	3,94	0,02	31,69	7,77
	25-35	1,18	0,098	0,81	12,87	12,38	6,12	0,02	31,39	8,67

	37-47	0,86	0,098	2,49	23,76	7,92	5,23	0,02	36,93	8,77
	60-70			3,72						8,32

Table 170 – Granulometric composition of steppe salt marshes

№ cut	Depth, cm	Fraction content in % on dry soil							
		fraction size in mm							
		Sand		Dust			Silt	Physical clay	
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01	
47	0-4	8,04	30,16	14,01	15,66	34,61	12,77	47,80	
	4-12	11,42	29,42	15,61	11,50	34,51	15,20	43,55	
	13-23	7,61	17,08	22,05	9,57	46,18	22,47	53,26	
	25-35	5,24	10,58	19,69	7,96	59,06	31,00	64,50	
	37-47	3,99	19,14	17,87	9,14	52,36	29,50	59,01	
	60-70	2,65	22,74	17,00	7,05	53,06	2,07	57,62	

Table 171 – Composition of water-soluble salts in steppe saline soils, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
47	0-4	0,042	0,005	0,000	0,001	0,023	0,002	0,001	0,009	0,001
			0,08	0,00	0,04	0,47	0,09	0,09	0,38	0,02
	4-12	0,044	0,007	0,000	0,003	0,021	0,002	0,001	0,01	0,001
			0,12	0,00	0,07	0,44	0,09	0,09	0,42	0,02
	13-23	0,090	0,017	0,002	0,004	0,041	0,002	0,001	0,024	0,001
			0,28	0,08	0,11	0,86	0,09	0,09	1,04	0,02
	25-35	0,165	0,063	0,005	0,034	0,015	0,002	0,001	0,048	0,001
			1,04	0,16	0,96	0,31	0,09	0,09	2,10	0,02
	37-47	0,323	0,051	0,002	0,059	0,107	0,004	0,003	0,097	0,001
			0,84	0,08	1,66	2,23	0,19	0,28	4,24	0,02
	60-70	0,783	0,027	0,000	0,089	0,422	0,065	0,018	0,16	0,001
			0,44	0,00	2,51	8,8	3,27	1,5	6,96	0,02

The entire profile is heavy loam, with carbonates appearing at 25 cm. The humus content is low (1.6%), pH 7.0-8.8. Na increases from 0.5 to 3.9-6.1 in horizons B2-B3 and remains high (5.2) (Table 169). Physical clay also increases from 44-53% to 65%, then decreases slightly (Table 170). Salinization is noted from 35 cm (0.3-0.8%) (Table 171), which allows the soil to be classified as saline. Classic saline differentiation.

Characteristics and forage value of the vegetation cover. Relief – gently undulating plain, aspect of the landscape – grayish-green, water regime – atmospheric. The projective cover of the soil surface by vegetation is 70%. Pasture type – fescue-feather grass-grudnitsa. The study of the botanical composition of plants revealed that fescue accounts for 45%, feather grass – 30%,

and grudnitsa – 25% of the total area. The grass stand includes wormwood, feather grass, izen, and bluegrass. The pasture biomass yield amounted to 11.5 c/ha.

Analysis of the data obtained when determining the chemical composition of plants growing on saline soils shows that the protein content in an air-dry state is 13.52%, fat – 6.93%, fiber – 29.62%, NFE – 33.53%, and ash – 12.92%. At the same time, on these types of pastures, the yield of feed units at natural plant moisture content is 0.55 per kilogram of feed, and the metabolic energy is 7.82 MJ.

Monitoring site No. 48. Soil: Strongly solonetzic chestnut clay. Located in Taskalinsky District, West Kazakhstan Region (Figure 50). Coordinates: N 50.126092°, E 50.161923°. Hilly undulating plain. Section on gentle eastern slope 2–3. Vegetation feather grass–wormwood: wormwood sp, feather grass sp, fescue sp, brome sol. Canopy closure 70 %. Height 25–30. Depth 60 cm. A+B = 40 cm. Effervescence – swelling from surface, vigorous from 5 cm. Carbonates – whitish horizon from 50 cm. Horizons A 0–5, B₁^{CH} 5–20, B₂ 20–40, BC 40–bottom.

0-5 cm, Dark grayish brown, dry, loose, unusually lumpy and powdery, medium loam

5-20 cm, dirty dark brown, dry, dense, lumpy, clayey

20-40 cm, dark brown, dry, less dense, lumpy, clayey

40-bottom, brown with dark wedges, lumpy, clayey



Figure 50 – Chestnut strongly saline clay

The soil is low in humus, with 2.2% humus content. Violent bubbling occurs at a depth of 5 cm. The soil is heavy in terms of its mechanical composition. The reaction of the environment is alkaline (pH 8.3-8.8). Na is low at the top (0.2-0.12), increasing to 1.0-4.3 at the bottom (Table 172). The physical clay content is very high (56-67%), increasing towards the lower horizons (Table 173). Salinity is moderate (up to 0.14% salts) (Table 174). The soil is strongly saline.

Table 172 – Chemical and physicochemical properties of chestnut saline clay soil

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
48	0-5	2,24	0,168	0,55	25,25	4,95	0,2	0,51	30,91	8,38
	7-17	1,58	0,154	0,84	21,29	9,9	0,12	0,02	31,33	8,3
	25-35	1,5	0,168	1,94	16,83	9,9	0,97	0,02	27,72	8,53
	50-60	1,22	0,098	3,91	17,33	2,48	4,25	0,02	24,08	8,83

Table 173 - Granulometric composition of chestnut strongly saline clay soil

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
48	0-5	2,59	14,34	27,13	9,18	49,26	27,55	55,94
	7-17	2,32	9,81	27,20	11,72	51,46	33,47	60,67
	25-35	1,55	5,68	27,16	8,78	59,34	38,45	65,61
	50-60	2,24	8,79	22,14	8,35	60,99	39,68	66,83

Table 174 – Composition of water-soluble salts in chestnut strongly saline clay soil, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃	From normal carbonates in CO ₃ ²⁻						
48	0-5	0,049	0,027	0,000	0,004	0,004	0,007	0,001	0,002	0,003
			0,44	0,00	0,11	0,08	0,37	0,09	0,09	0,08
	7-17	0,058	0,022	0,000	0,003	0,017	0,009	0,001	0,005	0,001
			0,36	0,00	0,07	0,36	0,47	0,09	0,21	0,02
	25-35	0,095	0,041	0,002	0,003	0,025	0,004	0,002	0,02	0,001
			0,68	0,08	0,07	0,51	0,19	0,19	0,87	0,02
	50-60	0,142	0,071	0,007	0,003	0,028	0,004	0,001	0,035	0,001
			1,16	0,24	0,07	0,58	0,19	0,09	1,51	0,02

Characteristics and forage value of the vegetation cover. Relief – gently rolling plain, aspect of the landscape – grayish-green, water regime – atmospheric. The projective cover of the soil surface by vegetation is 35–40%. The grass stand type is wormwood–grass. The study of the botanical composition of plants showed that wormwood occupies 60%, feather grass – 35%, and limonium – 5% of the total area. The grass stand includes fine grass (*Stipa*), bluegrass, yarrow, brome, grudnitsa, catchfly, knapweeds, couch grass, and yellow alfalfa. The pasture biomass yield amounted to 16.0 c/ha.

A study of the chemical composition of plants growing on saline soils showed that the protein content in an air-dry state is 16.83%, fat – 6.82%, fiber – 28.62%, NFE – 29.94%, and ash – 14.63%. The yield of feed units at natural plant moisture content is 0.54 per kilogram of feed, and the metabolic energy is 7.68 MJ.

Monitoring site No. 49.

Soil: Steppe solonetz saline. Located in Taskalin District, West Kazakhstan Region (Figure 51). Coordinates: N 51.108436°, E 50.462800°. Undulating plain. Vegetation fescue–wormwood with feather grass and grudnitsa: wormwood sp, fescue sp, feather grass sol, grudnitsa sol, bluegrass sol, onion un. Canopy closure 40–50%. Height 15–25 cm. Depth 60 cm, A+B = 60. Effervescence vigorous from 35 cm. Carbonates – whitish horizon from 35 cm. Horizons: A₁^D 0–4, AB 4–15, B₁^{CH} 15–35, C₁^K 35–bottom.

0-4 cm, Light gray, dry, heavily rooted, loose and dusty, medium loam

4-15 cm, Grayish light brown, dry, compacted, with roots, dusty and lumpy, medium loam

15-35 cm, bright brown, dry, very dense, nutty, with columnar divisions, clayey

35-bottom, whitish-yellow brown, fresh, lumpy, medium loamy.



Figure 51 – Steppe saline heavy loam

Table 175 – Chemical and physicochemical properties of steppe saline soils

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
49	0-4	3,05	0,21	0,16	16,34	4,46	0,2	0,53	21,53	6,68
	5-15	1,63	0,14	0,19	18,81	11,39	0,2	0,02	30,42	6,63
	20-30	1,05	0,112	0,26	15,35	10,4	2,6	0,02	28,37	7,94
	50-60	0,77	0,056	3,2	16,83	3,47	3,25	0,02	23,57	8,21

Table 176 - Granulometric composition of steppe saline soils

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
49	0-4	12,11	32,55	26,65	8,61	22,55	5,74	28,69
	5-15	16,27	33,05	20,03	6,95	26,16	8,99	30,66
	20-30	7,44	29,48	11,28	6,27	48,05	30,50	51,81
	50-60	10,97	31,88	12,84	8,28	38,51	7,87	44,31

Table 177 – Composition of water-soluble salts in steppe saline soils, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
49	0-4	0,031	0,015	0,000	0,003	0,004	0,002	0,001	0,002	0,005
			0,24	0,00	0,07	0,09	0,09	0,09	0,09	0,12
	5-15	0,022	0,007	0,000	0,003	0,006	0,002	0,001	0,002	0,001
			0,12	0,00	0,07	0,12	0,09	0,09	0,09	0,03
	20-30	0,106	0,037	0,000	0,01	0,026	0,002	0,001	0,028	0,001
			0,60	0,00	0,3	0,55	0,09	0,09	1,24	0,02
	50-60	0,878	0,024	0,000	0,347	0,198	0,065	0,014	0,226	0,003
			0,40	0,00	9,79	4,12	3,27	1,13	9,84	0,08

The top layer is gray, with a humus content of 3.0%. Below are dense horizons with a whitish carbonate horizon at 35 cm. Na is low at the top (0.2), with a sharp maximum (2.6-3.3) in the middle of the profile (Table 175). Physical clay increases from 29-31% to 52%, then decreases to 44% (Table 176). Salinity is moderate (up to 0.9%) from a depth of 50 cm, which allows the soil to be classified as saline (Table 177). Salinity is pronounced in the middle part of the profile.

Characteristics and forage value of the vegetation cover. Relief – undulating plain, aspect of the landscape – grayish-green, water regime – atmospheric. The projective cover of the soil surface by vegetation is 50%.

Pasture type – wormwood–fescue–feather grass– saltwort. The determination of the botanical composition of plants revealed that wormwood occupies 60%, fescue – 25%, feather grass – 10%, saltwort – 5% of the total area. The grass stand includes fine grass, limonium, catchfly, cinquefoil, and betony. The pasture biomass yield amounted to 13.1 c/ha.

Determination of the chemical composition of plants growing on saline soils showed that the protein content in the air-dry state is 15.22%, fat – 6.44%, fiber – 30.31%, NFE – 31.41%, and ash – 13.84%. The yield of feed units at natural plant moisture content is 0.55 per kilogram of feed, and the metabolic energy is 7.78 MJ.

Monitoring plot No. 50. Soil: Chestnut weakly solonetzic medium loam. Located in Zelenov district, West Kazakhstan region (Figure 52). Coordinates: N 51.054148°, E 51.222784°. Flat surface. Vegetation dominated by wormwood, trampled near the settlement, pasture trails. Cover density 35-40%. Height 20-25 cm. Depth 60 cm, A+B = 30 cm. Swelling from 17 cm. Carbonates – spots from 17 cm. Horizons A_1^K 0-5, AB 5-17, B_1^{CH} 17-30, BC 30-43, C_1^K 40-bottom.



Figure 52 – Chestnut slightly saline medium loam

- 0-5 cm, brownish-gray, lumpy with roots, medium loam
- 5-17 cm, dark brown, dry, compacted, coarse-grained and lumpy, medium loam
- 17-30 cm, brown, very dense, dry, lumpy, medium loam
- 30-43 cm, light brown, dry, dense, lumpy, medium loam
- 43-bottom, whitish light brown, dry, dense, lumpy, medium loam

Table 178 – Chemical and physicochemical properties of chestnut slightly saline soils

№ cut	Sample depth, cm	Humus, %	Total nitrogen, %	CO ₂ , %	Absorbed bases, mg-eq/100 g					pH of water.
					Ca	Mg	Na	K	Amount	
50	0-5	2,42	0,196	0,26	15,35	6,44	0,2	1,2	23,19	7,85
	6-16	1,16	0,196	0,49	14,85	5,94	0,2	0,02	21,01	8,48
	18-28	1,02	0,126	0,68	14,36	5,45	0,2	0,02	20,03	8,5
	32-42	0,99	0,14	1,46	19,8	6,44	0,12	0,02	26,38	8,63
	50-60			6,82						9,2

Table 179 - Granulometric composition of chestnut slightly saline soils

№ cut	Depth, cm	Fraction content in % on dry soil						
		fraction size in mm						
		Sand		Dust			Silt	Physical clay
		1-0,25	0,25-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	<0,01
50	0-5	2,26	26,72	37,77	7,80	27,92	9,85	33,25
	6-16	0,70	26,52	30,43	5,76	39,06	20,56	42,35
	18-28	0,27	27,82	30,82	8,63	34,93	15,62	41,09
	32-42	0,41	37,63	26,26	9,85	28,31	11,90	35,70
	50-60	0,22	34,92	26,51	11,42	29,37	14,28	38,34

Table 180 – Composition of water-soluble salts in chestnut slightly saline soils, %/mg-eq

№ cut	Depth, cm	Sum of salts, %	Alkalinity		Cl ⁻	SO ₄ ⁻²	Ca ⁺²	Mg ⁺²	Na ⁺	K ⁺
			General in HCO ₃ ⁻	From normal carbonates in CO ₃ ²⁻						
50	0-5	0,057	0,024	0,000	0,004	0,010	0,006	0,001	0,002	0,01
			0,40	0,00	0,11	0,21	0,28	0,09	0,09	0,25
	6-16	0,039	0,024	0,000	0,004	0,000	0,006	0,001	0,002	0,002
			0,40	0,00	0,11	0,00	0,28	0,09	0,09	0,04
	18-28	0,051	0,029	0,000	0,003	0,005	0,009	0,001	0,002	0,001
			0,48	0,00	0,07	0,11	0,47	0,09	0,07	0,03
	32-42	0,069	0,032	0,001	0,003	0,016	0,006	0,002	0,01	0,001
			0,52	0,04	0,07	0,34	0,28	0,19	0,44	0,02
	50-60	0,107	0,051	0,007	0,003	0,023	0,004	0,001	0,025	0,001
			0,84	0,24	0,07	0,47	0,19	0,09	1,08	0,02

The soil is shallow (A+B = 30 cm), medium loamy, and very dense. Humus content is about 2.4%. The soil is alkaline (pH up to 9.2). Despite the low exchangeable sodium content, a large amount of exchangeable magnesium (5.4-6.2

mg-eq/100 g) was noted, which allows for the diagnosis of magnesium salinity (Table 178). In terms of mechanical composition, the soil is medium loamy with an increase in physical clay content in the middle part of the profile (Table 179). There is no salinity (Table 180). Salinity is weak.

Characteristics and forage value of the vegetation cover. Relief – undulating plain, landscape aspect – grayish-green, water regime – atmospheric. The projective vegetation cover of the soil surface is 35–40%. Pasture type – wormwood-dominated. When determining the botanical composition of the vegetation, it was found that wormwood occupies 100% of the total area. In the grass stand, single specimens of bluegrass, horsemint, alyssum, schismus, and stellaria were found. The yield of pasture biomass amounted to 12.0 c/ha.

Determination of the chemical composition of plants growing on saline soils showed that the protein content in the air-dry state is 16.12%, fat – 6.231%, fiber – 29.44%, NFE – 31.56%, and ash – 13.52%. The yield of feed units at natural plant moisture content is 0.55 per kilogram of feed, and the metabolic energy is 7.82 MJ.

Table A.1 – Results of chemical analysis of feed based on natural moisture content

Point No.	NAME OF SAMPLE	PW	HW	TM	DM	In air-dry condition, %										Feed unit per 1 kg	DP, g	ME, MJ	FEU
						Protein	Fat	Fiber	NFE	Sugar	Starch	ash	Ca	P	Carotene, mg				
22	Wormwood-feather grass-feather grass steppe	8,42	3,27	11,41	88,59	11,91	5,97	29,97	25,33	0,35	1,09	15,40	1,40	0,47	19,87	0,49	71,43	6,88	0,69
20	Wormwood	8,53	3,32	11,57	88,43	13,01	4,24	30,59	28,88	0,27	0,87	11,73	1,56	0,48	13,72	0,50	78,04	7,14	0,71
1	Anabasis = wormwood with the participation of salsola	8,19	3,13	11,06	88,94	14,02	3,77	28,22	32,97	1,54	0,17	9,95	0,84	0,28	12,71	0,60	108,13	8,71	0,87
2	Wormwood- anabasis with the participation of salsola	8,49	2,94	11,18	88,82	10,53	4,79	29,69	32,53	1,10	-	11,28	0,65	0,38	11,29	0,50	57,16	6,89	0,69
3	Anabasis = wormwood with the participation of salsola and salsola orientalis	7,85	3,24	10,84	89,16	10,70	6,19	29,80	31,93	0,48	2,24	10,55	1,12	0,48	8,41	0,51	52,19	6,96	0,70
4	Wormwood– anabasis – feather grass community	8,18	3,19	11,11	88,89	10,95	5,91	29,58	30,06	0,65	1,70	12,38	1,58	0,49	6,68	0,48	65,72	6,74	0,67
5	Wormwood-feather grass community with inclusion of krascheninnikovia	7,48	3,11	10,36	89,64	11,58	6,48	30,09	31,74	0,57	1,64	9,75	1,60	0,31	14,12	0,53	69,50	7,45	0,74
6	Wormwood=kochia grass=grass	7,95	2,84	10,56	89,44	11,17	4,81	28,39	30,97	0,65	1,57	14,10	1,31	0,38	3,68	0,50	66,99	7,06	0,71
7	Wormwood=feather grass–atriplex cana community	8,16	3,32	11,21	88,79	11,86	6,36	29,32	29,92	0,57	2,46	11,32	1,74	0,48	10,86	0,52	65,13	7,21	0,72
11	Wormwood–carex community with inclusion of chia	8,37	3,02	11,14	88,86	14,32	6,07	30,70	31,18	0,74	2,41	6,60	1,76	0,49	15,51	0,57	85,93	8,04	0,80
12	Atriplex cana–wormwood–ephemeral community	7,94	3,56	11,22	88,78	13,56	6,28	29,31	31,41	0,38	2,49	8,22	1,80	0,48	19,74	0,57	81,36	7,93	0,79
13	Wormwood	8,11	3,31	11,15	88,85	17,67	6,19	24,01	30,02	0,10	0,96	10,95	1,89	0,51	17,02	0,60	106,02	8,55	0,85
14	Wormwood-ephemeral	8,64	3,22	11,58	88,42	13,64	6,69	27,87	32,62	0,38	3,89	7,60	1,68	0,47	18,27	0,59	81,84	8,13	

	with the participation of salsola																		0,81
17	Atriplex cana– anabasis – wormwood community	8,19	3,26	11,18	88,82	12,51	6,43	28,00	32,03	0,86	2,30	9,84	1,72	0,39	18,21	0,56	75,08	7,78	0,78
18	Wormwood= anabasis – atriplex cana community	7,75	3,18	10,68	89,32	17,82	5,65	28,36	26,85	0,75	4,01	10,63	1,78	0,47	17,84	0,56	106,9 4	8,21	0,82
19	Artemisia glauca	7,50	3,16	10,42	89,58	16,00	6,31	30,64	29,12	0,20	3,50	7,51	1,63	0,49	20,82	0,57	96,02	8,23	0,82
21	Wormwood–feather grass– feather grass (or fescue) community	8,11	2,69	10,58	89,42	17,02	5,81	33,29	22,08	0,47	3,33	11,22	1,94	0,51	22,82	0,51	102,1 1	7,65	0,76
16	Atriplex cana– wormwood– biyurgun community	8,57	2,81	11,14	88,86	13,65	5,69	27,69	30,67	0,48	2,48	11,17	1,99	0,58	14,41	0,55	81,90	7,72	0,77
15	Wormwood– anabasis community	8,28	3,27	11,28	88,72	15,24	6,26	27,88	29,16	0,29	0,96	10,18	2,02	0,48	16,66	0,56	91,46	8,02	0,80
8	Wormwood–feather grass– fescue community	8,65	2,49	10,92	89,08	15,18	6,41	30,08	30,62	0,26	0,29	6,78	0,85	0,48	20,38	0,58	91,09	8,23	0,82
31	Wormwood–feather grass– fescue community	9,11	3,44	12,24	87,76	4,30	0,83	30,23	51,19	1,13	0,00	1,22	0,76	0,19	-	0,53	25,79	6,94	0,69
23	Grass–wormwood community	8,71	2,72	11,19	88,81	11,53	2,41	35,26	36,30	0,47	3,43	3,31	1,60	0,68	-	0,51	69,18	7,31	0,73
24	Grass–mixed herbaceous community	8,35	3,66	11,70	88,30	16,99	0,85	34,57	34,84	0,21	4,74	1,04	1,21	0,47	-	0,50	41,96	6,91	0,69
25	Wormwood–fescue community	8,22	3,28	11,23	88,77	15,33	2,21	27,74	34,28	2,87	0,77	9,21	1,29	0,30	-	0,58	31,99	7,51	0,75
26	Wheatgrass–goosefoot– fescue community	8,65	2,74	11,15	88,85	11,08	4,97	30,15	34,68	1,95	0,37	7,97	1,48	0,47	15,53	0,54	66,48	7,49	0,75
27	Kochia = wormwood community with inclusion of sweet clover	8,92	2,94	11,60	88,40	14,14	5,12	28,78	32,23	0,57	1,45	8,12	1,71	0,56	18,77	0,56	84,87	7,89	0,79
28	Wormwood-fescue- ryegrass community	8,23	3,12	11,09	88,91	12,03	6,81	28,38	30,74	0,32	1,95	10,94	1,60	0,56	15,34	0,55	72,19	7,62	0,76
29	Wormwood-fescue-feather grass community	8,36	2,94	11,05	88,95	12,95	6,35	30,62	30,66	0,68	2,30	8,37	1,49	0,57	17,62	0,55	77,69	7,75	0,78
9	Wormwood	8,53	3,29	11,54	88,46	14,04	7,50	26,46	29,47	0,39	-	11,00	1,93	0,87	14,05	0,61	126,2 3	8,92	0,89
30	Wormwood–fescue– saltwort community	7,87	3,54	11,13	88,87	9,69	6,67	31,08	32,58	0,44	1,84	8,85	1,96	0,47	17,26	0,56	58,15	7,55	0,75
	Wormwood	8,23	3,11	11,08	88,92	10,76	5,34	31,31	36,82	1,04	0,95	4,68	1,07	0,56	25,90	0,56	64,59	7,74	0,77
10	Wormwood-feather grass- halophytic community	9,03	3,12	11,87	88,13	13,11	6,84	25,96	31,74	0,28	1,32	10,48	1,38	0,40	15,57	0,57	78,65	7,93	0,79

32	Fescue-wormwood-forb community	9,56	2,55	11,87	88,13	16,62	5,26	29,13	29,31	0,00	1,47	7,80	1,75	0,65	17,58	0,60	129,7 5	8,96	0,90
33	Camphorosma-wormwood-feather grass community	8,79	2,91	11,44	88,56	15,51	6,50	27,59	31,27	0,00	3,76	7,68	1,66	0,67	22,09	0,61	93,03	8,55	0,86
34	Fescue-feather grass-wormwood-forb community	9,27	2,63	11,66	88,34	16,81	6,19	27,60	29,01	1,05	3,19	8,74	1,61	0,67	18,98	0,57	100,8 7	8,23	0,82
35	Wormwood-fescue- kochia community	9,03	2,61	11,40	88,60	15,40	6,64	28,59	30,40	0,00	1,19	8,57	1,90	0,76	16,83	0,55	116,4 2	8,24	0,82
36	Wormwood-forb-fescue community	9,74	3,06	12,50	87,50	11,01	7,43	30,52	32,38	0,43	1,93	6,16	2,04	0,73	14,73	0,57	66,07	7,74	0,77
37	Wormwood- kochia - meadow grass community	7,54	3,28	10,57	89,43	12,78	6,31	27,69	33,02	0,33	2,60	9,63	1,43	0,58	16,27	0,52	76,67	7,37	0,74
38	Wormwood=camphorosma-fescue community	8,84	2,97	11,55	88,45	15,34	6,31	28,50	30,16	0,37	2,40	8,14	1,59	0,56	20,00	0,58	92,05	8,17	0,82
39	Wormwood	7,57	3,24	10,56	89,44	15,28	5,29	26,49	34,32	1,52	0,99	8,06	1,33	0,39	25,82	0,59	91,67	8,35	0,83
40	Wormwood-ephemeral community	7,40	3,13	10,30	89,70	10,67	5,56	29,82	35,12	1,79	2,29	8,54	0,78	0,49	15,68	0,59	64,01	7,92	0,79
41	Wormwood-feather grass-fescue community	9,23	2,68	11,66	88,34	14,52	6,29	28,62	29,56	0,99	2,03	9,35	1,34	0,55	20,33	0,53	87,14	7,63	0,76
42	Wormwood-camphorosma-limonium community	8,61	2,93	11,29	88,71	13,86	4,97	30,81	32,74	2,11	3,72	6,33	1,11	0,65	16,45	0,56	83,18	7,88	0,79
43	Wormwood-meadow grass community	9,14	2,49	11,40	88,60	14,28	3,29	27,81	34,75	1,80	3,44	8,46	1,55	0,29	26,91	0,62	121,6 8	9,06	0,91
44	Wormwood-grass community	8,21	2,62	10,61	89,39	15,44	5,51	28,86	31,02	1,11	3,41	8,56	1,49	0,58	19,48	0,57	92,63	8,12	0,81
45	Wormwood	8,16	3,18	11,08	88,92	13,71	6,07	31,42	30,16	0,75	2,56	7,56	1,57	0,48	20,40	0,55	82,27	7,82	0,78
46	Wormwood-forb community	7,15	3,48	10,38	89,62	12,55	6,43	28,07	31,13	0,29	2,63	11,43	1,54	0,57	22,94	0,55	75,32	7,77	0,78
47	Fescue-feather grass-cerastium vegetation	9,00	3,16	11,88	88,12	15,32	6,21	28,59	27,25	1,07	2,83	10,76	1,53	0,56	18,60	0,55	91,89	7,87	0,79
48	Wormwood-grass community	7,81	2,78	10,37	89,63	14,03	5,94	27,94	28,96	1,48	1,91	12,76	1,67	0,57	9,97	0,54	84,19	7,68	0,77
49	Wormwood-fescue-feather grass community	8,24	3,13	11,11	88,89	14,79	5,72	27,01	28,96	2,51	-	12,41	1,76	0,57	2,32	0,55	88,75	7,78	0,78
50	Wormwood	8,16	3,18	11,08	88,92	13,71	6,07	31,42	30,16	0,75	2,56	7,56	1,57	0,48	20,40	0,55	82,27	7,82	0,78

Note: **PW** – Initial moisture, **HW** – Hygroscopic moisture, **TM** – Total moisture, **DM** – Dry matter, **NFE** – Nitrogen-free extractives, **Ca** – Calcium, **P** – Phosphorus, **Feed unit** – Feed unit, **DP** – Digestible protein **ME** – Metabolizable energy, **FEU** – Feed energy unit.

Table A. 2 – Results of chemical analysis of feed in air-dry condition

No. Points	NAME OF SAMPLE	PW	HW	TM	DM	In air-dry condition, %									
						Protein	Fat	Fiber	NFE	Sugar	Starch	ash	Ca	P	Carotene, mg
22	Wormwood-fescue-feather grass community	8,42	3,27	11,41	88,59	13,00	6,52	32,73	32,66	0,38	1,19	11,82	1,53	0,51	21,70
20	Wormwood	8,53	3,32	11,57	88,43	17,22	4,63	30,44	31,57	0,30	0,95	12,82	1,71	0,52	15,00
1	Anabasis = wormwood community with participation of calligonum	8,19	2,13	11,06	88,94	13,63	5,11	32,74	36,09	1,68	0,18	10,30	0,92	0,31	13,84
2	Wormwood- anabasis community with presence of calligonum	8,49	2,94	11,18	88,82	13,41	5,23	32,45	34,55	1,20	-	11,42	0,71	0,42	12,34
3	Wormwood= anabasis community with participation of calligonum and salsola arbuscula	7,85	3,24	10,84	89,16	11,44	6,72	33,42	32,65	0,52	2,43	12,53	1,21	0,52	9,13
4	Wormwood– anabasis –feather grass community	8,18	3,19	11,11	88,89	12,93	6,44	32,22	33,38	0,71	1,85	11,84	1,72	0,53	7,28
5	Wormwood=feather grass community with participation of krascheninnikovia	7,48	3,11	10,36	89,64	12,52	7,00	32,31	34,52	0,62	1,77	10,54	1,73	0,33	15,26
6	Wormwood= kochia =grass community	7,95	2,84	10,56	89,44	12,13	5,22	32,84	34,65	0,71	1,71	14,32	1,42	0,41	4,00
7	Wormwood=fescue– atriplex cana community	8,16	3,32	11,21	88,79	11,82	6,93	31,93	32,58	0,62	2,68	13,42	1,89	0,52	11,82
11	Wormwood–needlegrass community with participation of chia	8,37	3,02	11,14	88,86	14,63	6,62	33,50	34,03	0,81	2,63	8,20	1,92	0,54	16,93
12	Atriplex cana –wormwood–ephemeral community	7,94	3,56	11,22	88,78	14,73	6,82	31,84	34,12	0,41	2,71	8,93	1,96	0,52	21,44
13	Wormwood	8,11	3,31	11,15	88,85	16,23	6,74	30,63	31,17	0,11	1,05	10,92	2,06	0,55	18,52
14	Wormwood-ephemeral community with participation of calligonum	8,64	3,22	11,58	88,42	14,93	7,32	30,51	35,70	0,42	4,26	8,32	1,84	0,51	20,00
17	Atriplex cana – anabasis –wormwood community	8,19	3,26	11,18	88,82	13,63	7,00	30,50	34,89	0,94	2,51	10,72	1,87	0,42	19,83
18	Wormwood– anabasis – atriplex cana community	7,75	3,18	10,68	89,32	16,32	6,13	32,74	34,11	0,81	4,35	11,52	1,93	0,51	19,34
19	Artemisia glauca	7,50	3,16	10,42	89,58	14,30	6,82	33,12	34,48	0,22	3,78	8,12	1,76	0,53	22,51
21	Wormwood–feather grass–fescue community	8,11	2,69	10,58	89,42	16,52	6,32	30,23	32,03	0,51	3,62	12,21	2,11	0,56	24,83
16	Atriplex cana –wormwood– anabasis community	8,57	2,81	11,14	88,86	14,93	6,22	30,28	33,54	0,53	2,71	12,22	2,18	0,63	15,76
15	Wormwood– anabasis community	8,28	3,27	11,28	88,72	16,62	6,82	30,40	31,79	0,32	1,05	11,10	2,20	0,52	18,16

8	Wormwood–feather grass–fescue community	8,65	2,49	10,92	89,08	16,62	7,02	32,93	33,52	0,29	0,32	9,42	0,93	0,52	22,31
31	Wormwood–feather grass–fescue community	9,11	3,44	12,24	87,76	14,73	5,02	33,26	36,32	1,24	0,00	11,34	0,84	0,21	-
23	Grass–wormwood community	8,71	2,72	11,19	88,81	12,63	5,64	32,62	34,76	0,51	3,76	11,63	1,75	0,74	-
24	Grass–forb (mixed herbaceous) community	8,35	3,66	11,70	88,30	16,63	3,93	32,72	33,92	0,23	5,17	11,14	1,32	0,51	-
25	Wormwood–fescue pastures	8,22	3,28	11,23	88,77	15,81	4,41	30,22	34,96	3,13	0,84	11,32	1,41	0,33	-
26	Couch grass–goosefoot–fescue community	8,65	2,74	11,15	88,85	12,13	5,44	33,00	37,96	2,14	0,41	8,73	1,62	0,51	17,00
27	Kochia-type = wormwood community with participation of sweet clover	8,92	2,94	11,60	88,40	15,53	5,62	31,60	34,39	0,63	1,59	9,92	1,88	0,62	20,61
28	Wormwood–fescue–couch grass community	8,23	3,12	11,09	88,91	13,11	7,42	30,93	33,50	0,35	2,13	11,92	1,74	0,61	16,72
29	Wormwood–fescue–feather grass community	8,36	2,94	11,05	88,95	15,13	5,93	33,41	33,46	0,74	2,51	9,13	1,63	0,62	19,23
9	Wormwood	8,53	3,29	11,54	88,46	16,00	7,20	28,55	32,75	0,43	0,00	12,21	2,11	0,95	15,36
30	Wormwood–fescue–saltwort community	7,87	3,54	11,13	88,87	12,52	6,24	32,74	35,53	0,48	2,00	9,43	2,13	0,51	18,73
39	Wormwood	8,23	3,11	11,08	88,92	16,73	5,82	31,12	32,12	1,13	1,04	11,10	1,17	0,61	28,22
10	Wormwood–feather grass–halophytic community	9,03	3,12	11,87	88,13	14,41	7,52	28,54	34,89	0,31	1,45	11,52	1,52	0,44	17,12
32	Fescue–wormwood–mixed herbaceous community	9,56	2,55	11,87	88,13	13,91	5,82	34,00	35,20	0,00	1,63	8,52	1,94	0,72	19,44
33	Camphorosma–wormwood–feather grass community	8,79	2,91	11,44	88,56	17,00	7,13	30,25	34,48	0,00	4,12	8,23	1,82	0,74	24,22
34	Fescue–feather grass–wormwood–mixed herbaceous community	9,27	2,63	11,66	88,34	18,53	6,82	31,52	30,87	1,16	3,52	9,63	1,77	0,74	20,92
35	Wormwood–fescue–kochia community	9,03	2,61	11,40	88,60	16,33	7,30	32,82	31,52	0,00	1,31	9,42	2,09	0,84	18,50
36	Wormwood–mixed herbaceous–fescue community	9,74	3,06	12,50	87,50	12,20	8,23	33,81	35,87	0,48	2,14	6,83	2,26	0,81	16,32
37	Wormwood–kochia–bluegrass community	7,54	3,28	10,57	89,43	13,82	6,82	32,44	33,22	0,36	2,81	10,42	1,55	0,63	17,60
38	Wormwood = camphorosma–fescue community	8,84	2,97	11,55	88,45	16,83	6,92	31,26	33,09	0,41	2,63	8,93	1,74	0,61	21,94
41	Wormwood = feather grass–fescue community	7,57	3,24	10,56	89,44	16,53	5,72	28,66	37,13	1,64	1,07	8,72	1,44	0,42	27,93
42	Wormwood–camphorosma–limonium community	7,40	3,13	10,30	89,70	15,52	6,00	27,88	38,25	1,93	2,47	9,22	0,84	0,53	16,93
43	Wormwood–bluegrass community	9,23	2,68	11,66	88,34	16,00	6,93	29,63	32,26	1,09	2,24	12,50	1,48	0,61	22,40
44	Wormwood–grass community	8,61	2,93	11,29	88,71	15,17	5,44	33,71	35,82	2,31	4,07	6,93	1,22	0,71	18,00
40	Wormwood–ephemeral community	9,14	2,49	11,40	88,60	16,32	3,62	30,61	38,25	1,98	3,79	8,71	1,71	0,32	29,62

45	Wormwood	8,21	2,62	10,61	89,39	16,82	6,00	31,44	33,79	1,21	3,71	9,33	1,62	0,63	21,22
46	Wormwood–mixed herbaceous community	8,16	3,18	11,08	88,92	14,93	6,61	34,21	32,84	0,82	2,79	8,23	1,71	0,52	22,21
47	Fescue-feather grass-cerastium vegetation	7,15	3,48	10,38	89,62	13,52	6,93	29,62	33,53	0,31	2,83	12,92	1,66	0,61	24,71
48	Wormwood–grass community	9,00	3,16	11,88	88,12	16,83	6,82	28,62	29,94	1,18	3,11	14,63	1,68	0,62	20,44
49	Wormwood–fescue–feather grass community	7,81	2,78	10,37	89,63	15,22	6,44	30,31	31,41	1,61	2,07	13,84	1,81	0,62	10,81
50	Wormwood	8,24	3,13	11,11	88,89	16,12	6,23	29,44	31,56	2,73	-	13,52	1,92	0,62	2,53

