7. **Ryadchikov V.G. Osnovy' pitaniya i kormleniya selskohozyajstvenny'h zhivotny'h: uchebno-prakticheskoe posobie** [Fundamentals of nutrition and feeding of farm animals: Tutorial]. Krasnodar, KubGAU, 2012, 328 p. (in Russian)

8. **Vahedi S., Ali Alijoo Y., Kazemi-Bonchenar M, Jafari A. Starter protein content and supplemental soybean oil or hydrogenated palm fatty acids in Holstein dairy calves: growth performance, protozoa population, and nitrogen utilization efficiency**. *Animal. The international journal of animal biosciences,* vol. 18, iss. 2, 2024,164 p.

Сведения об авторах:

Папуша Наталья Владимировна – кандидат сельскохозяйственных наук, и.о. ассоциированного профессора кафедры «Продовольственной безопасности и биотехнологии», НАО «Костанайский региональный университет имени Ахмет Байтұрсынұлы», Республика Казахстан, 110000, г. Костанай, ул.Маяковского 99/1. тел. 8-705-411-51-71, e-mail: natali.p82@inbox.ru.

Муратов Досмухамед Куатулы – докторант специальности 8D08201 – «Технология производства продуктов животноводства», НАО «Костанайский региональный университет имени Ахмет Байтұрсынұлы», Республика Казахстан, г. Костанай, 110000, ул. Маяковского 99/1, тел 8-708-577-23-78, E-mail: D_O_S1999@mail.ru.

Мичинский Ян – профессор Варминско-Мазурского университета, доктор PhD, г.Ольштын, Польша, ул. Михала Очаповского, 5, тел. +48/662-377-882, e-mail: micinsk@uwm.edu.pl.

Папуша Наталья Владимировна – ауыл шаруашылығы ғылымдарының кандидаты, Азық-түлік қауіпсіздігі және биотехнология кафедрасы қауымдастырылған профессорының м.а., «Ахмет Байтұрсынұлы атындағы Қостанай Өңірлік университеті», КЕАҚ, Қазақстан Республиқасы, 110000, Қостанай қ, Маяковский көш, 99/1. тел. 8-705-411-51-71 E-mail: natali.p82@inbox.ru.

Мұратов Досмұхамед Қуатұлы – 8D08201 – «Мал шаруашылығы өнімдерін өндіру технологиясы» мамандығының докторанты, «Ахмет Байтұрсынұлы атындағы Қостанай Өңірлік университеті» КЕАҚ, Қазақстан Республикасы, Қостанай қ, 110000, Маяковский көш, 99/1, тел 8-708-577-23-78, E-mail: D_O_S1999@mail.ru.

Ян Мичинский – PhD докторы, Вармин-Мазур университетінің профессоры, Ольштын қ., Польша, Михал Очаповского көш, тел. +48/662-377-882, e-mail: micinsk@uwm.edu.pl.

Papusha Natalya Vladimirovna – Candidate of Agricultural Sciences, acting Associate Professor of the Department of food safety and biotechnology, Akhmet Baitursynuly Kostanay Regional University, Republic of Kazakhstan, 110000, Kostanay, 99/1 Mayakovskiy Str., tel.: 8-705-411-51-71, e-mail: natali.p82@inbox.ru.

Muratov Dosmukhamed Kuatuly – Doctoral student, "8D08201 – Technology of livestock products production" educational program, Akhmet Baitursynuly Kostanay Regional University, Republic of Kazakhstan, Kostanay, 99/1 Mayakovskiy Str., tel.: 8-708-577-23-78, e-mail: D_O_S1999@mail.ru.

Miciński Jan– Professor of the Warmian-Masurian University, PhD, Olsztyn, Poland, Michała Oczapowskiego 5 Str., tel.: +48/662-377-882, e-mail: micinsk@uwm.edu.pl.

MISTI 68.35.47
UDC 633.15
https://doi.org/10.52269/22266070_2024_3_99

PRODUCTIVITY OF FORAGE CROPS IN THE STEPPE ZONE OF THE NORTHERN KAZAKHSTAN

Tynykulov M.K. – Candidate of Agricultural Sciences, Associate Professor of the Department of biotechnology and microbiology, L.N. Gumilyov Eurasian National University, Astana, Republic of Kazakhstan.*

Malitskaya N.V. – Candidate of Agricultural Sciences, Associate Professor of the Department of agronomy and horticultural education, M.Kozybayev North Kazakhstan State University, Petropavlovsk, Republic of Kazakhstan.

Tleppayeva A.A. – Candidate of Agricultural Sciences, Associate Professor of the Department of agriculture and crop production, S. Seifullin Kazakh Agro Technical University, Astana, Republic of Kazakhstan.

Auzhanova M.A. – Candidate of Agricultural Sciences, Associate Professor of the Department of agriculture and bioresources, Sh.Ualikhanov Kokshetau State University, Republic of Kazakhstan.

The article presents the results of a comparative evaluation of unconventional annual forage crops based on their productivity in the steppe zone of the Northern Kazakhstan. The subjects of the study were varieties and hybrids of Sorghum-sudan grass hybrids, Zea mays, Echinochloa frumentacea and Pennisétum

gláucum. The relevance of the topic lies in the selection and introduction of new, more productive and drought-resistant forage crops for the steppe zone of the Northern Kazakhstan. The objectives of the study are to examine the features of growing forage crops in the steppe zone of the Northern Kazakhstan; conduct a comparative assessment of the productivity of forage crops; and identify the most promising forage crops for cultivation in the steppe zone of the Northern Kazakhstan. The scientific significance of the paper lies in obtaining new data on the comparative productivity of various forage crops in the conditions of the steppe zone of the Northern Kazakhstan. The study used the following research methods: the experimental method by B.A. Dospekhov, the vegetation accounting method by D. Braun, and the soil moisture determination method by N.M. Bakayev; laboratory analyses; and mathematical processing of yield data. The study results showed that the sorghum-sudan grass hybrid had the highest yield: 209.1 c/ha of green mass and 32.6 c/ha of dry matter. Corn and the sorghum-sudan grass hybrid showed a balanced content of crude protein and crude fiber in the forage. The yield of Echinochloa frumentacea and Pennisétum gláucum is lower but still sufficiently high compared to corn and the sorghum-sudan grass hybrid.

***Key words**: Sorghum-sudan grass hybrid, Echinochloa frumentacea, Pennisétum gláucum, yield, green mass, dry matter.*

СОЛТҮСТІК ҚАЗАҚСТАННЫҢ ДАЛА АЙМАҒЫНДАҒЫ ЖЕМШӨП ДАҚЫЛДАРЫНЫҢ ӨНІМДІЛІГІ

Тыныққұлов М.Қ. – ауыл шаруашылығы ғылымдарының кандидаты, Биотехнология және микробиология кафедрасының доценті, Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Астана қ, Қазақстан Республикасы.*

Малицкая Н.В. – ауыл шаруашылығы ғылымдарының кандидаты, Агрономия және орман шаруашылығы кафедрасының доценті, М. Қозыбаев атындағы Солтүстік Қазақстан мемлекеттік университеті, Петропавл қ, Қазақстан Республикасы.

Тлеппаева А.А. – ауыл шаруашылығы ғылымдарының кандидаты, Егіншілік және өсімдік шаруашылығы кафедрасының доценті, С.Сейфуллин атындағы Қазақ агротехникалық университеті, Астана қ, Қазақстан Республикасы.

Аужанова М.А. – ауыл шаруашылығы ғылымдарының кандидаты, Ауыл шаруашылығы және биоресурстар кафедрасының доценті, Ш. Уәлиханов атындағы Көкшетау мемлекеттік университеті, Көкшетау қ, Қазақстан Республикасы.

Мақалада Солтүстік Қазақстанның дала аймағындағы өнімділік бойынша дәстүрлі емес біржылдық жемдік дақылдардың салыстырмалы бағалау нәтижелері ұсынылған. Зерттеу объектілері ретінде сорго-судан шөбі гибридтері, жүгері, пайза және африкалық сұлының сорттары мен гибридтері алынды. Тақырыптың өзектілігі – Солтүстік Қазақстанның дала аймағы үшін жаңа, өнімділігі жоғары және құрғақшылыққа төзімді жемдік дақылдарды таңдап енгізу. Зерттеудің мақсаты: Солтүстік Қазақстанның дала аймағында жемдік дақылдарды өсіру ерекшеліктерін зерттеу; жемдік дақылдардың өнімділігін салыстырмалы бағалау жүргізу; және Солтүстік Қазақстанның дала аймағында өсіру үшін ең перспективті жемдік дақылдарды анықтау. Жұмыстың ғылыми маңызы – Солтүстік Қазақстанның дала аймағындағы әртүрлі жемдік дақылдардың салыстырмалы өнімділігі туралы жаңа мәліметтер алу. Зерттеуде келесі әдістер қолданылды: Б.А. Доспеховтың тәжірибелік әдісі, Д. Браунның өсімдіктерді есепке алу әдісі және Н.М. Бакаевтың топырақ ылғалдылығын анықтау әдісі; зертханалық талдаулар; және өнімділік деректерінің математикалық өңдеуі. Зерттеу нәтижелері бойынша, сорго-судан шөбі гибриді ең жоғары өнімділікке ие екені анықталды: 209,1 ц/га жас массасы және 32,6 ц/га құрғақ зат. Жүгері мен сорго-судан шөбі гибриді жемде шикі протеин мен шикі талшықтың теңгерімді құрамын көрсетті. Пайза мен африкалық сұлының өнімділігі төмен болғанымен, жүгері мен сорго-судан шөбі гибридімен салыстырғанда жеткілікті жоғары.

***Түйінді сөздер:** құмай – судан буданы, пайза, африкалық тары, өнімділік, жасыл масса, құрғақ зат.*

ПРОДУКТИВНОСТЬ КОРМОВЫХ КУЛЬТУР В СТЕПНОЙ ЗОНЕ СЕВЕРНОГО КАЗАХСТАНА

Тыныкулов М.К. – кандидат сельскохозяйственных наук, доцент кафедры биотехнологии и микробиологии, Евразийский национальный университет им. Л.Н. Гумилева, г. Астана, Республика Казахстан.*

Малицкая Н.В. – кандидат сельскохозяйственных наук, доцент кафедры агрономии и лесоводства, Северо-Казахстанский государственный университет им. М. Козыбаева, г. Петропавловск, Республика Казахстан.

Тлеппаева А.А. – кандидат сельскохозяйственных наук, доцент кафедры земледелия и растениеводства, Казахский агротехнический университет им. С. Сейфуллина, г. Астана, Республика Казахстан.

Аужанова М.А. – кандидат сельскохозяйственных наук, доцент кафедры сельского хозяйства и биоресурсов, Кокшетауский государственный университет им. Ш. Уалиханова, г. Кокшетау, Республика Казахстан.

В статье представлены результаты сравнительной оценки нетрадиционных однолетних кормовых культур по урожайности в степной зоне Северного Казахстана. Объектами исследования стали сорта и гибриды сорго-суданскового гибрида, кукурузы, пайзы и африканского проса. Актуальность темы: отбор и внедрение новых, более продуктивных и засухоустойчивых кормовых культур для степной зоны Северного Казахстана. Цель исследования: изучение особенностей выращивания кормовых культур в степной зоне Северного Казахстана; проведение сравнительной оценки урожайности кормовых культур; и выявление наиболее перспективных кормовых культур для выращивания в степной зоне Северного Казахстана. Научная значимость работы заключается в получении новых данных о сравнительной урожайности различных кормовых культур в условиях степной зоны Северного Казахстана. В исследовании использовались следующие методы исследования: экспериментальный метод Б.А. Доспехова, Метод учета вегетации по Д. Брауну и метод определения влажности почвы по Н.М. Бакаеву; лабораторные анализы; математическая обработка данных об урожайности. По результатам исследований установлено, что гибрид сорго и суданской травы дал самую высокую урожайность: 209,1 ц/га зеленой массы и 32,6 ц/га сухого вещества. Кукуруза и гибрид сорго-суданковый гибрид показали сбалансированное содержание сырого протеина и сырой клетчатки в корме. Урожайность пайзы и африканского проса ниже, но все же достаточно высока по сравнению с кукурузой и сорго-суданковым гибридом.

Ключевые слова: *сорго-суданковый гибрид, пайза и африканское просо, урожайность, зеленая масса, сухое вещество.*

Introduction

In a conditions of limited water resources around the world and in Central Asia region [1, p.22], together with adverse weather conditions of Northern Kazakhstan, traditional agricultural methods seeking new adaptive water-saving technologies that can increase the efficiency of agricultural production.

Adaptive water-saving agriculture directed on improving the resistance of production due to unfavourable weather conditions and a decrease in water usage [2, p.37]. This shows, that agricultural methods must be chosen based on the specific characteristics of the region, including precipitation levels, soil types, terrain features, and more.

The advancement of livestock farming, as an essential component of agriculture, and the boost in its efficiency are closely linked to the establishment of a resilient feed source and the enhancement of feed quality [3, p.25; 4, p.57]. The production of superior feed is a critical element in increasing livestock yields.

Foreign researchers indicates that [5, p.341; 6, p.258; 7, p.94; 8, p.1033; 9, p.852], enhancing the variety of forage crops is considered one of the effective ways to address the feed deficit issue. This plan helps to upgrade the resilience of the feed base to adverse environmental factors, ensures more balanced animal nutrition, and enhances livestock productivity. This is because different types of forage crops have different biological characteristics, including resistance to adverse weather conditions, yield, nutritional value, and others.

Traditional forage crops such as maize [10, p.37; 11, p.78; 12, p.40; 13, p.53], sudan grass [14, p.58], and alfalfa have several cons, including their amount of water and cultivation requirements.

Expanding the forage base through non-traditional crops helps address the challenge of providing animals with inexpensive and high-protein feed, thereby increasing their productivity. Incorporating non-traditional crops into animal diets boosts the production of available high-protein feeds, leading to increased livestock productivity [15, p.8; 16, p.15; 17, p.21; 18, p.47; 19, p.85; 20, p.44].

In the field forage production system of Northern Kazakhstan, there is a lack of cold-resistant, drought-tolerant annual forage crops with short growing seasons. Among these uncommon non-traditional forage crops, the cultivation technologies of which are still insufficiently studied, are sorghum-sudangrass hybrids, *Echinochloa frumentacea and Pennisétum gláucum*.

Research objectives:

1. To determine the agronomic characteristics and requirements for the conditions of growing forage crops in the steppe zone of Northern Kazakhstan.
2. Conducting a comparative assessment of the yield of forage crops in the conditions of the steppe zone.
3. To determine the nutritional value of forage crops.
4. Identification of the most promising forage crops in the steppe zone of Northern Kazakhstan.

Materials and methods of the research

Research on the development of basic cultivation practices for forage crops was conducted in the steppe zone of Northern Kazakhstan at "Novorybinsky and K" LLP during the years of 2015-2016. The soil of the experimental field consisted of ordinary chernozem of a carbonate heavy loamy texture. The predecessor crop

was a perennial grass layer (winter wheat). Different forage crops were compared by yield production during the experiment, with maize being used as the control. The sowing was done on May 25 th. The experimental setup and mathematical processing of yield data were conducted using the methodology of experimental agriculture by B.A. Dospekhov [21]. Yield recording was performed using a continuous method on all plots of the experiment. The plot area for recording was 42 m^2, with a fourfold repetition, and the placement of repetitions was sequential.

The following varieties were sown: maize – Turgayskaya 5/87, sorghum-sudangrass hybrid – Solaris, *Pennisétum gláucum* – Sogur, *Echinochloa frumentacea* – Krasava. During the winter, the height and density of the snow cover were determined (Picture 1).

a) densitometer

b) measuring stick

Picture 1 – Defining the thickness and hight of snow covering with help of densitometer and measuring stick

The following data of the experiment was received: snow density – 0.23 g/cm³, snow coverage height – 35.6 cm. Soil samples were taken at 35 sites at the experimental site for the content of nutrients and humus. Based on the conducted analyses in the soil-agrochemical laboratory, the following data on the content of humus, macronutrients and micronutrients in the soil were obtained (Table 1).

Table 1 – Agrochemical characteristics of soil in experimental zone (average of 2 years) (the data from the State Enterprise "Republican Centre for Quarantine and Plant Protection" of the Ministry of Agriculture of the Republic of Kazakhstan)

№	Soil horizone	Agrochemical parameters				
		Humus, %	Phosphorus, мг/кг	Potassium, мг/кг	Nitrogen, мг/кг	pH
1	2	3	4	5	6	7
1	0-20	3,14	3,82	660	34,7	7,54
2	0-20	2,71	2,89	546	34,7	7,58
3	20-40	1,87	2,02	469	30,2	7,62
4	20-40	1,87	2,40	389	37,0	7,61
5	0-20	2,68	8,66	630	34,7	7,65
6	20-40	1,74	1,99	318	38,1	7,60
7	20-40	2,71	2,67	307	31,4	7,57
8	20-40	1,70	1,58	273	32,5	7,57
9	0-20	2,26	7,22	475	35,8	7,61
10	0-20	2,21	7,94	468	35,8	7,63
11	Control treat 1	1,8	0,79	318	354	7,58
12	Control treat 2	1,93	1,93	351	35,1	7,60
13	A/m	11,35	214,75	2361	32,5	6,88
14	A/m	11,72	198,8	2450	30,2	6,70

According to the Table 1, the humus content in the 0-20 cm layer is at a low level, starting from 2.68% to 3.19%, while in the 20-40 cm horizon, it is at critical level, ranging from 1.74% to 1.87%. Regarding the content of available phosphorus in the soil, the experimental plot shows extremely low levels (less than 10 mg/kg), with values from 2.89 to 8.66 mg/kg in 0-20 cm layer. The potassium exchange capacity in soil ranges from high (401-600 mg/kg) to very high (over 600 mg/kg), indicating a sufficiency of element. The content of readily hydrolysable nitrogen in the soil is low, and the soil solution reaction in the salt extract is weakly alkaline.

Thus, the soils of the experimental plot have low sulfur and zinc content, average copper content, and high manganese and cobalt content. They also exhibit very low levels of available phosphorus, low humus and

readily hydrolyzable nitrogen content, and high potassium content. Regarding micronutrients, the soil is deficient in sulphur and zinc.

During the pre-sowing period, affecting optimal seed swelling and germination factor is a soil density. Its determination in the plowed layer was conducted at three points across the experimental plot (Table 2).

Table 2 – Dense of control area during the pre-sowing period (average of 2 years)

Horizon	Soil humidity (W), %	Completely dry soil mass (M), г	The volume of samples, (V) см^2	Bulk density mass, (d) г/см^2
Sample 1				
0-10	19,1	251,7	237,5	1,1
10-20	21,2	267,1	237,5	1,1
20-30	15,7	299,2	237,5	1,3
Average – 1,1				
Sample 2				
0-10	15,5	229,4	237,5	1,0
10-20	22,3	238,6	237,5	1,0
20-30	46,9	231,1	237,5	1,0
Average – 1,0				
Sample 3				
0-10	23,9	221,7	237,5	0,9
10-20	20,1	289,3	237,5	1,2
20-30	27,3	256,4	237,5	1,1
Average – 1,1				
Average of control area- 1,1				

It is seen from Table 2, that the mass of completely dry soil is minimal in the 0-10 cm layer, ranging from 221.7 to 251.7 g, and in the 10-30 cm layer, it varies from 238.6 to 299.2 g. Soil humidity in the soil layer of 0-30 cm varied between 15.5 and 46.9%. In terms of compaction, specifically the bulk density, the soil of the experimental plot is loose, averaging 1.1 g/cm^3 from 3 samples across the plot.

Meteorological conditions during the study period allowed for the examination of the patterns of crop formation under the influence of various climatic factors, some of which were extreme. However, the hydrothermal conditions, as shown in Tables 3 and 4, were generally typical for the climatic characteristics of the steppe zone and slightly deviated from the multi-year averages.

In terms of precipitation, the study period was close to the multi-year average in terms of the amount of rainfall (Table 3).

Table 3 – Precipitation measurements during the whole experiment

Months	Precipitation amount, мм		Errors from average of multiple years
	Average in 2 years	Average for multiple years	
January	18,5	19	- 0,5
February	6,9	14	-7,1
March	16,6	18	-1,4
April	34,1	20	+ 14,1
May	53,3	31	+ 22,3
June	28,7	41	- 12,3
July	30,7	52	-21,3
August	10,7	41	-30,3
September	31,8	17,5	+14,3
May-August	123,4	165,0	-41,6

However, compared to the distribution of precipitation throughout the year, the exact studied year significantly differed from the norm. The amount of precipitation during the cold period was considerably higher than the multi-year average with total of 123.4 mm from May to August compared to 165 mm according to the multi-year average.

Uneven or error values also emerged concerning temperature parameters (Table 4).

Table 4 – Temperature measurement during the whole experiment

Month	Температура воздуха, ^{0}C		Errors from average of multiple years
	Average in 2 years	Average for multiple years	
January	- 25,4	- 15,3	- 10,1
February	- 17,6	- 11,3	- 6,3
March	- 6,6	- 10,7	+ 4,1
April	3,9	1,5	+ 1,4
May	12,0	12,5	- 0,5
June	21,5	18,1	+3,4
July	21,6	20,4	+1,6
August	18,7	17,9	+0,8
September	+8,8	+10,2	+1,4

The temperature medium during the winter period was significantly warmer than usual, except for January, which was colder than average. Summer period had an extremely uneven precipitation. From May to August, 123.4 mm of precipitation was recorded, which is 41.6 mm less than the multi-year average. The highest amount of precipitation occurred in May, with 53.3 mm. There was also an excess above the multi-year average in April – 14.4 mm, and in September – 14.3 mm. In the other months of the summer period, precipitation was below the multi-year average. In terms of temperature conditions, the summer turned out to be slightly warmer than usual. July and June were particularly hot, with the average monthly temperature being 3.4 and 1.6 degrees higher than the multi-year average, respectively. Overall, the weather conditions during the analysed period were close to the climatic conditions of the region.

Results

During the pre-sowing period the germination and purity of seeds of annual forage crops were analysed in laboratory conditions. (Tables 5 and 6).

Table 5 – Laboratory germination of forage crop seeds

№	Type	Laboratory germination, %
1	Zea mays	92
2	Sorghum-sudangrass hybrid	87
3	*Pennisétum gláucum*	89
4	*Echinochloa frumentacea*	85

Table 6 – Identification of annual forage crop seeds purity

№	Type	Variety	Seeds purity, %
1	Zea mays	Turgai 5/87	99,63
2	Sorghum-sudangrass hybrid	Solaris	97,3
3	*Echinochloa frumentacea*	Krasava	98,5
4		Sogur	97,9

During the phase of full emergence, the field germination of plants was determined (Table 7).

Table 7 – Field germination of forage crops

Type	Germinated on		Amount of plants, pieces		Field germination, %
	1division	On 1 square meter	1м^2	On 1 division area.	
Zea mays	147	7	3	63	42,86
Pennisétum gláucum	210	10	5	105	50,0
Echinochloa frumentacea	210	10	5	105	50,0
Sorghum-sudangrass hybrid	210	10	6	126	60,0

During the field period, phenological observations were conducted in order to see the growth and development of plants.

Phenology. Recording of plant development stages including germination, tillering, shooting (branching), 5th leaf, 8-9 leaves, ear emergence, flowering, ear formation (for maize), ear flowering (for maize), seed ripening (milk, milk-wax, and full maturity).

Harvesting and yield assessment of forage crops were observed in August. The climatic conditions during the plant growth period contributed to the yield formation of forage crops (Table 8).

Table 8 – Harvest of the green mass and dry matter of crops and one year forage crop hybrids

№	Type	Variety (hybrid)	Green mass, c/ha	Dry matter, c/ha
1	Zea mays	Turgai 5/87	195,2	25,4
2	Sorghum-sudangrass hybrid	Solaris	209,1	32,6
3	*Pennisétum gláucum*	Krasava	185,6	21,7
4	*Echinochloa frumentacea*	Sogur	175,5	20,8

In terms of yield production, the sorghum-sudangrass hybrid produced a yield of green mass at 209.1 t/ha and dry matter at 32.6 t/ha. *Pennisétum gláucum* and *Echinochloa frumentacea* produced slightly lower yields of dry matter compared to maize, at 21.7% and 20.8%, respectively, compared to 25.4% for maize. In the steppe zone conditions, it had an earlier onset and a longer duration of maximum biomass growth compared to other hybrids.

During the post-harvest period, selected plant samples were sent to the agrochemical laboratory of "Agrokomplex-expert" LLP to determine the productivity of forage crops (Table 9).

Table 9 – Chemical analysis of forage crop mass of one year crop varieties (data from "Agrokomplex-expert" LLP)

Variety/ Nutrition of green mass	Zea mays			Sorghum-sudangrass hybrid		
	stems	leaves	overall	stems	leaves	overall
1 кg of dry matter consist, %						
Carotene, mg/kg	20,5	21,2	41,7	19,6	21,9	41,5
Starch	4,1	1,8	5,9	6,7	0,6	7,3
Sugar	6,5	2,8	9,3	5,2	4,7	9,9
Digestible protein	1,99	6,54	8,53	2,09	7,25	9,34
Phosphorus	0,2	0,26	0,46	0,17	0,25	0,42
Calcium	0,5	0,34	0,84	0,49	0,46	0,95
Metabolizable energy, MJ	4,9	4,73	9,63	6,26	4,97	11,23
Moisture	4,7	3,7	8,4	7,5	4,2	11,7
Dry matter	95,3	96,3	191,6	92,5	95,8	188,3
Crude protein	4,9	10,8	15,7	5,5	11,7	17,2
Crude fat	0,1	2,6	2,7	0,4	1,5	1,9
Crude ash	9,8	7,1	16,9	6,0	6,5	12,5
Crude fiber	59,6	60,9	120,5	49,8	59,1	108,9
NEM	-	-	-	-	-	-
Digestibility coefficient	0,19	0,18	0,37	0,38	0,20	0,58

Note: NEL – non azotic extractive matters

At the end of August, samples were taken to determine the sugar content in the biomass of plants (Table 10).

Table 10 – Sugar Content in the Green Mass of Forage Crops

№	Type	Sugar content amount, %
1	Zea mays (control)	14,41
2	Sorghum-sudangrass hybrid	19,63
3	*Echinochloa frumentacea*	12,91
4	*Pennisétum gláucum*	11,66

Table 10 indicates, that the highest sugar content was provided by the sorghum-sudangrass hybrid – 19.63%, while *Echinochloa frumentacea* and *Pennisétum gláucum* accumulated sugars at 12.91% and 11.66%, respectively, compared to 14.41% in the control.

Conclusion

Among the studied non-traditional annual forage crops, the sorghum-sudangrass hybrid become the most productive crop of all. It produced a yield of green mass equal to 209.1 tons/ha and dry matter of 32.6 tons/ha. This is 12.9 % and 22.7% more than the Turgai 5/87 maize. Maize and the sorghum-sudangrass hybrid Solaris are the most balanced feeds in terms of raw protein and crude fiber amount. Raw protein content in maize is 11.7%, while in the sorghum-sudangrass hybrid it equals to 12.6%. The crude fiber content in maize is 29.2 %, which is insignificantly higher than in sorghum-sudangrass hybrid which is 27.4%. The sorghum-sudangrass hybrid is the most saccharine culture of all studied – 19.63 %, which is 33.2 % more than in maize. *Echinochloa frumentacea* and *Pennisétum gláucum* have lower yields compared to maize and sorghum-sudangrass hybrid. Based on the research results, it can be concluded that non-traditional annual forage crops may be promising for cultivation in the steppe zone of Northern Kazakhstan. They are characterized by high yields, resistance to adverse conditions, and good forage qualities.

REFERENCES:

1. **Medeu A.R., Malkovskij I.M., Toleubaeva L.S. Vodny'e resursy' Kazahstana: ocenka, prognoz, upravlenie (koncepciya)** [Water resources of Kazakhstan: assessment, forecast, management (concept)]. Almaty, 2008, TOO «Institut geografii i vodnoj bezopasnosti, vol.1, 94 p. (In Russian)
2. **Reutskih N.A., Pulnikov K.V. Vliyanie sostava pochvogruntov na agrofizicheskie harakteristiki** [The influence of soil composition on agrophysical characteristics]. Sbornik trudov LIX Studencheskoj nauchno-prakticheskoj konferencii «Uspehi molodezhnoj nauki v agropromy'shlennom komplekse», Tyumen'. Gosudarstvenny'j agrarny'j universitet Severnogo Zaural'ya, 2022, pp. 196-206. (In Russian). https://www.elibrary.ru/item.asp?id=50280551.
3. **Gossen E.F. Pochvozashchitnoe zemledelie i ustojchivost' proizvodstva zerna** [Conservation agriculture and sustainability of grain production]. Poligrafiya, Kokshetau, 2014, 135 p. (In Russian)
4. **Dvurechenskij V.I., Gilevich S.I. K voprosu obosnovaniya neobhodimosti perekhoda na novy'e resurso- i vlagosberegayushchie tehnologii pri vozdely'vanii zernovy'h kul'tur** [On the issue of substantiating the need to switch to new resource- and moisture-saving technologies in the grain crops cultivation]. *Vestn. s.-h. nauk Kazahstana*, 2005, no.10, pp. 37-41. (In Russian)
5. **Husnain R.S., Sutriadi T., Nassir A., Sarwani M. Improvement of soil fertility and crop production through direct application of phosphate rock on Made in Indonesia**. *Procedural Engineering*, 2014, 83, pp. 336-343. DOI: 10.1016/j.proeng.2014.09.025.
6. **Wilkinson J.M., Hill J. Effect on yield and dry-matter distribution of the stay-green characteristic in cultivars of forage maize grown in England**. *Grass and Forage Science*, 2003, no.58, pp. 258-264.
7. **Hong Fls S.P., Ronse Decraene Fls L.P., Smets Fls E. Systematic significance of tepal surface morphology in tribes Persicarieae and Polygoneae (Polygonaceae)**. *Botanical Journal of the Linnean Society,* 2008, no.127, pp. 91-116.
8. **Akande M.O., Makinde, E.A., Adetunji, M.T. Response of maize and cowpea grown sequentially to application of phosphate rock in the humidtropics**. *Communications in Soil Science and Plant Analysis,* 2011, 42 (9), pp. 1027-1037. DOI: 10.1080/00103624.2011.562584.
9. **Bilalis D.J., Karamanos, A.J. Organic maize growth and mycorrhizal root colonization response to village and organic fertilization**. *Journal of Sustainable Agriculture*, 2010, 34(8), pp. 836-849. DOI: 10.1080/10440046.2010.519197.
10. **Ilin B.S., Ilin I.V. et al. Rannespelaya kukuruza: sostoyanie i perspektivy': monografiya** [Early-maturing corn: status and prospects: monograph]. Omsk, Izd-vo OmGAU, 2001, 172 p. (In Russian)
11. **Kostikov I.F. Zonal'ny'e osobennosti konvejernogo proizvodstva silosa** [Zonal features of silos flow production production]. *Sovremenny'e problemy' razvitiya krest'yanskih i fermerskih hozyajstv*, 2001, pp.78-79. (In Russian)
12. **Murzhanov I.T., Kostikov I.F. Sovershenstvovanie tehnologii proizvodstva kukuruzy' na silos** [Improving the technology of producing corn for silage]. *Materialy' Respublikanskoj nauchno-prakticheskoj konferencii*, Kokshetau, 2000, pp. 84-86. (In Russian)
13. **Ospanov E.D., Kostikov I.F. Ustojchivost' silosny'h kul'tur k e'kstremal'ny'm usloviyam**. [Resistance of silage crops to extreme conditions]. *Problemy' razvitiya agrarnogo sektora v XXI veke: Materialy' Mezhdunarodnoj nauchno-prakticheskoj konferencii*, Kokshetau, 1999, vol.1, pp.84-85. (In Russian)
14. **Drozd D.A. Organizaciya sy'r'evogo konvejera iz razlichny'h po skorospelosti sortov klevera lugovogo** [Organization of forage flow production from red clover varieties of various ripening stages] *Melioraciya*, 2020, (1), pp. 71-77. (In Russian)

15. **Kostikov I.F., Tynykulov M.K. Ot monokul'tury' k silosnomu konvejeru** [From monoculture to silo flow production]. *Nauchno-prakticheskij mezhdunarodny'j e'lektronny'j zhurnal «Adaptivnoe kormoproizvodstvo»*, Moscow, 2016, no.1, pp.14-26. (In Russian)

16. **Saeed M.F. Productivity and Forage Quality of Different Forage Crops under Semi-Arid Conditions**. *Agronomy*, 2023, 13(5), 1104 p. https://doi.org/10.3390/agronomy13051104.

17. **Sharma R.K. Effect of Different Forage Crops on Soil Fertility and Productivity in Semi-Arid Regions**. *Field Crops Research*, 2022, 272, 108263 p. https://doi.org/10.1016/j.fcr.2021.108263.

18. **Gómez M. Assessment of Forage Crop Productivity in Arid and Semi-Arid Regions**. *Agricultural Systems*, 2021, 190, 103136 p. https://doi.org/10.1016/j.agsy.2021.103136.

19. **Ali R., Ahmed S**. **Sorghum-Sudan Grass Hybrids: A Potential Forage Crop for Drought-Prone Areas.** *Journal of Agronomy and Crop Science*, 2020, 206(4), pp. 486-496. https://doi.org/10.1111/jac.12462.

20. **Kumar R., Sharma P. Yield and Nutrient Dynamics of Forage Crops in Semi-Arid Areas: A Review.** *Grass and Forage Science*, 2019, 74(3), pp. 407-421. https://doi.org/10.1111/gfs.12413.

21. **Dospehov B.A. Metodika polevogo opy'ta: uchebnik dlya vuzov** [Methodology of field experience: manual for the higher educational institutions]. Moscow, Agropromizdat, 1985, 351 p. (In Russian)

Information about the authors:

Tynykulov Marat Karganbekovich – Candidate of Agricultural Sciences, Associate Professor of the Department of biotechnology and microbiology, L.N. Gumilyov Eurasian National University, Republic of Kazakhstan, 010000, Astana, 2 Satpayev Str., tel.: +77078835166; e-mail: tynykulov@list.ru.*

Malitskaya Natalya Vladimirovna – Candidate of Agricultural Sciences, Associate Professor of the Department of agronomy and horticultural education, M. Kozybayev North Kazakhstan State University, Republic of Kazakhstan, 150000, Petropavlovsk, 86 Pushkin Str., tel.: +77774210235; e-mail: natali_gorec@mail.ru.

Tleppayeva Aigul Aldabergenovna – Candidate of Agricultural Sciences, Associate Professor of the Department of agriculture and crop production, S. Seifullin Kazakh Agro Technical University, Republic of Kazakhstan, 010000, Astana, 62 Zhenis Str., tel.: +77782895530, e-mail: tleppaeva@mail.ru.

Auzhanova Mariya Asylkhanovna – Candidate of Agricultural Sciences, Associate Professor of the Department of agriculture and bioresources, Sh. Ualikhanov Kokshetau State University, Republic of Kazakhstan, 020000, Kokshetau, 76 Abai str., tel.: +77015425375; e-mail: auzhanovam@bk.ru.

Тынықұлов Марат Қарғанбекұлы – ауыл шаруашылығы ғылымдарының кандидаты, Биотехнология және микробиология кафедрасының доценті, Л.Н. Гумилев атындағы Еуразия ұлттық университеті, Қазақстан Республикасы, 010000, Астана қ., Сәтбаев көш, 2., тел.: +77078835166; e-mail: tynykulov@list.ru б.*

Малицкая Наталья Владимировна – ауыл шаруашылығы ғылымдарының кандидаты, Агрономия және орман шаруашылығы кафедрасының доценті, М. Қозыбаев атындағы Солтүстік Қазақстан мемлекеттік университеті, Қазақстан Республикасы, 150000, Петропавл қ, Пушкин көш, 86., тел.: +77774210235; e-mail: natali_gorec@mail.ru.

Тлеппаева Айгүл Алдабергенқызы – ауыл шаруашылығы ғылымдарының кандидаты, Егіншілік және өсімдік шаруашылығы кафедрасының доценті, С. Сейфуллин атындағы Қазақ Агротехникалық университеті, Қазақстан Республикасы, 010000, Астана қ, Жеңіс көш, 62, тел.: +77782895530, e-mail: tleppaeva@mail.ru.

Аужанова Мария Асылхановна – ауыл шаруашылығы ғылымдарының кандидаты, ауыл шаруашылығы және биоресурстар кафедрасының доценті, Ш.Уәлиханов атындағы Көкшетау мемлекеттік университеті, Қазақстан Республикасы, 020000, Көкшетау қ, Абай к-сі, 76, тел.: +77782895530, email: auzhanovam@bk.ru.

Тыныкулов Марат Карганбекович – кандидат сельскохозяйственных наук, доцент кафедры биотехнологии и микробиологии, Евразийский национальный университет им. Л.Н. Гумилева, Республика Казахстан, 010000, Астана, ул. Сатпаева, 2, тел.: +77078835166, e-mail: tynykulov@list.ru.*

Малицкая Наталья Владимировна – кандидат сельскохозяйственных наук, доцент кафедры агрономии и лесоводства, Северо-Казахстанский государственный университет им. М. Козыбаева, Республика Казахстан, 150000, Петропавловск, ул. Пушкина, 86, тел.: +77774210235, e-mail: natali_gorec@mail.ru.

Тлеппаева Айгуль Алдабергеновна – кандидат сельскохозяйственных наук, доцент кафедры земледелия и растениеводства, Казахский агротехнический университет им. С. Сейфуллина, Республика Казахстан, 010000, Астана, ул. Женис, 62, тел.: +77782895530, email: tleppaeva@mail.ru.

Аужанова Мария Асылхановна – кандидат сельскохозяйственных наук, доцент кафедры сельского хозяйства и биоресурсов, Кокшетауский государственный университет им. Ш. Уалиханова, Республика Казахстан, 020000, Кокшетау, ул. Абая, 76, тел.: +77782895530, email: auzhanovam@bk.ru.