Short article

https://revistas.unal.edu.co/index.php/refame

Revista Facultad Nacional de Agronomía

Assessing the influence of cereal-legume mixtures on the productivity of degraded pastures in the Kostanay region of northern Kazakhstan

UNIVERSIDAD NACIONAL DE COLOMBIA

Evaluación de la influencia de las mezclas de cereales y leguminosas en la productividad de pastos degradados en la región de Kostanay, en el norte de Kazajstán

https://doi.org/10.15446/rfnam.v75n1.95199

Almabek Batyrzhanovich Nugmanov[1], Assel Salimzhanovna Tokusheva[1], Asiya Simbaevna Ansabayeva[1]*, Marden Ersainovich Baidalin[2], Almagul Erbatyrovna Kalyaskarova[3] and Aliya Uzbekovna Bugubaeva[1]

ABSTRACT

This study presents the results of some options to restore pastures with low productivity in the arid steppes of the Kostanay region of northern Kazakhstan, describing the effects associated with grass-legume mixtures. The effects of grass-legume mixtures, contribution to the preservation and maintenance of pasture forage crops, and the productivity of pastures were discussed. Mixtures of grasses and legumes were selected that are promising crops for arid regions.The plant density and its condition were determined based on test plots of adjacent rows of 0.5 m each, followed by counting. The plant height was determined before the yield of green mass by measuring 25 plants of each species. The yield of green mass in the maturity phase of the grass was determined by mowing and weighing the green mass in the plots, followed by the analysis of the species composition in the grass mixture and drying until air dry. The density of plants, the height of the plants, and the safety of the forage plants according to the sowing method were the data collected. In addition, the effect of grass mixtures on the productivity of forage crops to improve pastures was compared. According to these results, the highest productivity under experimental conditions was found in the wheat grass-alfalfa-bromegrass variant. This information can contribute to the improvement of the state of the pastures since it is complete and inexpensive food for farm animals.

Keywords:
Fodder production
Grass-legume mixtures
Grasses
Pastures
Perennial plants

RESUMEN

Este estudio presenta los resultados de algunas opciones para restaurar pastos con baja productividad en las tierras áridas de la región de Kostanay (norte de Kazajstán). Se discutieron los efectos de las mezclas de gramíneas y leguminosas, la contribución a la preservación y mantenimiento de los cultivos forrajeros de pastos y la productividad de los mismos. Se seleccionaron mezclas de gramíneas y leguminosas que son cultivos prometedores para las regiones áridas. El estado de la planta y su densidad se determinaron con base en parcelas de prueba de hileras adyacentes de 0.5 m cada una, seguidas de conteo. La altura de la planta se determinó antes del rendimiento de masa verde (masa fresca) midiendo 25 plantas de cada especie. El rendimiento de masa verde en la fase de madurez del pasto se determinó cortando y pesando la masa fresca en las parcelas, seguido del análisis de la composición de especies en la mezcla de pasto y secando las gavillas al aire. La densidad de plantas, la altura de las plantas y la inocuidad de las plantas forrajeras según el método de siembra fueron los datos recogidos. Además, se comparó el efecto de las mezclas de gramíneas sobre la productividad de cultivos forrajeros para mejorar los pastos. Según estos resultados, la mayor productividad en condiciones experimentales se encontró en la variante trigo-alfalfa-hierba-bromo.. Esta información puede contribuir al mejoramiento del estado de los pastos, ya que es alimento completo y económico para los animales de granja.

Palabras clave:
Producción forrajera
Mezclas de hierbas-leguminosas
Pastos
Gramíneas
Plantas perennes

[1] Kostanay Regional University, Kostanay, Kazakhstan. almabeknugmanov@yandex.ru, assel.tokusheva@yandex.ru, asiya.ansabayeva@bk.ru, aliya.bugubaeva@yandex.ru
[2] Sh. Ualikhanov Kokshetau State University, Kokshetau, Kazakhstan. marden.baidalin@bk.ru
[3] Agricultural Experimental Station LPP, Petropavlovsk, Kazakhstan. almagul.kalyaskarova@yandex.ru
* Corresponding author

Received: October 29, 2021; Accepted: November 29, 2021
Rev. Fac. Nac. Agron. Medellín 75(1): 9877-9886. 2022
ISSN 0304-2847 / e-ISSN 2248-7026

The current conditions of pastures in many countries is unsatisfactory due to a strong degradation of vegetation and soil observed worldwide including North and South America, Africa, and Australia (Baethgen *et al*., 2020; Fuglie *et al*., 2021). This is due to the misuse of pastures in farms since continuous and irregular grazing is performed, generating a decrease in vegetation cover and regrowth of weeds and non-food plants. The Republic of Kazakhstan is an agrarian country and ranks sixth in the world in terms of pasture area (Nugmanov *et al*., 2018a). The total land area of pastures is 187 million ha. Currently, due to long-term unsystematic use, 48.0 million ha are degraded, including 26.5 million ha that are destroyed (Nugmanov *et al*., 2018a).

For the development of animal husbandry in Kazakhstan, it is necessary to create sustainable forage-based food. Given its potential, there are opportunities to introduce highly productive fodder crops and efficient technologies into agricultural production (Baranowski *et al.,* 2020). In Kazakhstan, the sources of plant feed for farm animals are pastures (187 million ha), hayfields (5.0 million ha), and fodder arable land (2.5 million ha) (Popov *et al*., 2017). Within the pasture maintenance of livestock, the rational maintenance of pastures is highly relevant, since the productivity of pasture lands with their correct use increases greatly (Popov *et al*., 2017).

After grazing, fodder cereals and forbs are removed from the grass stand while low-value, poisonous, and weed plants are introduced (Jun Li *et al*., 2007; Vasques *et al*., 2019). Researchers have established criteria and indicators of the degree of degradation of vegetation cover (Ministério da Agricultura e Reforma Agrária Brasil, 2009; Derpsch *et al*., 2010; Asai *et al*., 2018; Sereia *et al*., 2016; Viaud *et al*., 2018; Van Dyke *et al*., 2004; Soares *et al*., 2019; Dymova, 2006; Sizykh, 2007; Bazha *et al*., 2008). They include the low degree, which shows signs of degradation in dry years; moderate degree, which is a decrease in the yield, displacement of rare plants, and the appearance of weeds; high degree, which includes a decrease in productivity, seasonality of use, and displacement of the main types of plants. Very high degree indicators include severe shortages and infestation with undesirable species. The limiting influence of abiotic factors on the productivity of degraded pastures, is considered, as well as the influence of grazing as the most important deflationary process.

In the research of the Humanities and Economics Academy (HEA) member G. V. Blagoveshchensky, the use of a mixture of grass on pastures provided some advantages, such as reducing the incidence of diseases and pests, enriching the soil with organic substances, and leading to a sustainable harvest (Blagoveshchenskiy, 2013; Serekpayev *et al*., 2018). Restoration of degraded pastures in Brazil can improve livestock production and help avoid deforestation and should be a priority strategy for the agribusiness sector (Feltran-Barbieri and Feres, 2021).

The most relevant theoretical and methodological aspects of the biological characteristics of legumes and cereals, their cultivation, adaptation to soil and climatic conditions, and the impact on the productivity and quality of crops have been addressed. Sufficient attention was paid to the peculiarities and problems of the cultivation of perennial grasses, but the issue of the selection of legumes in the composition of pasture mixtures for the arid conditions of the Western Ciscaucasia (Bedilo, 2016).

The formation of grasses and legumes in the pasture due to the replacement of technical nitrogen with a biological source contributes to a decrease in the average annual anthropogenic costs by 40%. The main problems of the feed industry are low yields of pasture forage and a low level of use of pastures and hayfields (Tokusheva and Nugmanov, 2016; Tokusheva *et al*., 2017).

The relevance of the present study is associated with the achievement of high pastures productivity and long-term preservation of grasslands and the supply of food for animals. The main aim of this research was to study the effect of mixtures of grasses and legumes with different sowing methods on the productivity of degraded pastures in the arid steppe of northern Kazakhstan.

MATERIALS AND METHODS

Climatic and soil characteristics

The research location was Zarechnoye Agricultural Experimental Station LLP (AES LLP), which has been a scientific organization and an elite seed farm since 1962. The main activity of the organization has been scientific support of the main activity of the agricultural formations in plant growing and animal husbandry; production of elite seeds of crops, which cover up to 40% of agricultural needs of the local farms in seeds, corresponding to the first class of the sowing standard. The enterprise has introduced more than 40 varieties of oilseeds and potatoes. It stores the gene pool of potatoes, oil flax, spring rape, sunflower, soybeans. Zarechnoye AES LLP closely cooperates with Kazakh and foreign scientific institutions and agricultural producers, also providing training and consulting services to agribusiness entities.

Zarechnoye AES LLP is located in Northern Kazakhstan, between the latitude 53°14'06"N and longitude 63°44'02"E. The region occupies a vast territory, about 114,000 km^2, which is subdivided into three natural and climatic zones (moderately arid steppe and forest-steppe, arid steppe, moderately dry steppe). The research institute is located in the second soil-climatic zone. This zone is represented by an arid steppe mainly with low-humus southern chernozems (Nugmanov *et al.,* 2018b).

The climate in the research area is sharply continental with hot and dry summers and cold winters with little snow. The annual amplitude of air temperature is on average 75 °C, and in some years, it has reached 88 °C. In winter, the minimum air temperature often drops to 35-40 °C, and in rare cases, the temperature drops to 45-50 °C. In summer, the absolute temperature rises to +41-43 °C. The warm period with an average daily temperature above 0 °C lasts 195-200 days (from April to October). The duration of the frost-free period ranges from 108 to 130 days. The average annual air temperature is 0.3-2.3 °C, and in some years, it rises to 4.5-5.0 °C or drops to 0-1.2 °C. The duration of the growing season increases from north to south and is 166 to 174 days. A characteristic feature of the continental climate is the predominance of precipitation during the warm period (May to October) when 60-80% of the annual rate falls. The maximum precipitation occurs in the second half of summer, most often in July. The moisture index (HTC) in the region varies from 0.9 in the north to 0.5 in the south. Prolonged cold in spring, an earlier cold snap in autumn, and rainfall in late summer are typical of the region's climate and distinguish it from other arid regions. High insolation, a sharp temperature difference between day and night, low air humidity, low cloudiness, and frequent winds cause intensive evaporation of moisture 2 to 5 times higher than the amount of precipitation.

The meteorological conditions in 2016 showed favorable conditions for the growth and development of perennial crops. The annual amount of precipitation in 2016 exceeded the average annual normal and amounted to 559.9 mm. In 2017, the annual precipitation exceeded the average annual precipitation rate and amounted to 425.9 mm, which favorably influenced the growth and development of perennial grasses. In 2018, the annual precipitation rate slightly exceeded the average annual precipitation rate and reached 382.2 mm, which also positively influenced the formation of the yield of pasture crops (Table 1).

Table 1. Distribution of precipitation by periods of the year in comparison with the long-term normal (2016-2018).

Year	Amount of precipitation (mm)			
	Total for the year (October to September)	Cold period (November to March)	Warm period (April to October)	During the growing season (May to August)
Long-term normal	340.0	98.0	242.0	162.0
2016	559.9	183.6	338.3	205.9
2017	425.9	123.5	285.7	234.4
2018	382.2	116.6	324.5	239.2

Snow precipitation represents 30-40% of the total annual amount, but the maximum precipitation falls in July and amounts to 55-70 mm. There are years when precipitation during the growing season is practically absent, and in some years, it is 2-3 times higher than usual.

However, even a low temperature, compared to the long-term average norm, and an almost complete absence of precipitation, caused intensive evaporation of moisture from plants and the soil surface, which eventually influenced a reduction in the period of plant development phases and a decrease in their growing season (Table 2).

Table 2. Average monthly air temperature during the growing season for the 2016-2018 period, Kostanay region.

Months	**Air temperature (°C)**			
	2016	**2017**	**2018**	**Long-term norms**
May	13.8	13.5	11.9	13.7
June	18.3	18.7	16.6	20.0
July	20.3	19.7	22.1	20.9
August	22.9	20.3	18.1	18.9

When analyzing the air temperature in July, no strong deviations from the long-term norm were observed (-0.6, -1.2 and +1.2 °C), which can also be said about August (+4, +1.4 and -0.8 ℃ from the average annual rate). The soil of the experimental site is southern thin chernozem in a complex with solonetz up to 10%. The thickness of the humus horizon (A+B) equals 41 to 45 cm. Effervescence from HCl from 85 cm, release of carbonates from the same depth. The humus content is 3.0-3.2%. Soil sampling was carried out using a drill. Soil samples taken for laboratory analysis were prepared. Each sample was placed on paper, scattered in a thin layer, and dried. After that, the samples were sent to a chemical laboratory. According to the analyses carried out by the agrochemical laboratory of the Institute, the soil of the experimental plot contains 0.15-0.16% of total nitrogen (in the 0-20 cm layer) and 0.10-0.13% of phosphorus.

Mobile forms of nitrogen (NO_3) were measured in the soil using the Grandval-Lyazh method (22.5-25.5 mg kg^{-1} soil – average). This method is based on the interaction of nitrates with disulfophenolic acid with the formation of trinitrophenol (picric acid). In an alkaline environment, it gives a color yellow due to the formation of potassium trinitrophenolate (or sodium, depending on the alkali used) in the amount equivalent to the content of nitrates (23). Mobile compounds of phosphorus and potassium were determined using the Chirikov method. This method is based on the extraction of P_2O_5 and K_2O from the soil with a solution of acetic acid at a concentration of 1:2.5 (soil to solution) and the subsequent determination of phosphorus in the form of a blue phosphorus-molybdenum complex on a photoelectric colorimeter and potassium on a flame photometer (24). The phosphorus content was 114-136 mg kg^{-1} of soil (high) and potassium content – more than 200 mg kg^{-1} of soil (high). There is a small amount of exchangeable sodium and potassium. The reaction of the aqueous suspension within the first meter is slightly alkaline.

Research methods

Research and observations were carried out following generally accepted methods and state standards (GOSTs). These methods were the methodology of field experiment (Dospekhov, 1985) and methodological guidelines for conducting field experiments with forage crops (All-Russian Williams Fodder Research Institute) (Podgot *et al*., 1983). According to these methods, standing density accounting was performed twice: after germination, before harvesting on designated areas in the 1st and 3rd replicates. Plant density and safety were determined on test plots of adjacent rows of 0.5 m with subsequent counting. According to the technique for studying the grass height, measurements were made at five points on each replica, located at a distance of 1 m from each other (20 measurements). A rail with a centimeter scale was placed vertically among the plants, a bunch of plants was attached to it, and the height of the highest part of the plants was measured. The height of the plants was determined before accounting for the green mass yield by measuring 25 plants of each species.

The botanical composition of the herbage was determined by analyzing plant samples weighing 1 kg with the isolation of legumes, cereals, and herbs, followed by weighing each component. To determine the botanical composition of the herbage, 100-250 g of air-dried mass or 500-1000 g of freshly harvested green forage mass were used. In a species analysis, each sample was disassembled into separate types of herbs. The fractions were weighed and the botanical composition of the herbage was determined as a percentage of the sample weight. The botanical composition of the herbage was determined before each grazing.

The yield of green mass in the maturity phase of pasture was determined by mowing and weighing the green mass in the log plots with an analysis of the species composition of the grass mixture and drying the sheaves until air dry. Experiments were performed in the field (Table 3). Plot area was set by SKP-2.7 seeder (anchor opener) — 97.2 m^2 and Wintersteiger machine (disc opener) — 60.0 m^2. The experiment was repeated 4 times.

Table 3. Experiment setup.

		Sowing methods	
1	Degraded pasture land (control)	-	-
2	Wheatgrass (*Agropyron pectiniforme* Roem.et Schult.) — alfalfa (*Medicago sativa* L.) — bromegrass *(Bromus inermis* Leyss.*)*	Wide-row sowing — 27 cm	Ordinary sowing — 15 cm
3	Wild rye (*Elymus junceus* Fisch.) — alfalfa (*Medicago sativa* L.) -bromegrass (*Bromus inermis* Leyss.)		
4	Slender wheatgrass (*Elymus trachycaulus* Get.S.) — alfalfa (*Medicago sativa* L.) — wheatgrass (*Agropyron pectiniforme* Roem.et Schult.).		

In the spring, on the degraded site where the experiments were laid, a survey of the vegetation cover and the soil cover was carried out. In the summer, after the vegetation regrowth, a repeated survey was carried out, and the species composition of the vegetation was determined. After that, the rate of consumption of the continuous herbicide was calculated. A continuous herbicide was applied for 8-10 days before sowing perennial grasses. Then, as soon as the vegetative mass dried up and the weeds died, the BZTs-12 tooth harrow machine was used at the site of the experiments without disturbing the soil sod. In the presence of moisture at a sowing depth of 2-3 cm, perennial grasses were sown directly onto the lawn with SKP-2.7 seeders (anchor opener) using the wide-row sowing method and Wintersteiger (disc opener) using the ordinary row sowing method.

The varietal composition of the perennial grasses when the experiments were performed was Batyr wheatgrass, Akmolinsky 91 bromegrass, Shortandinsky wild rye, Arman slender wheatgrass, Raikhan alfalfa.

Static data processing was performed by analysis of variance using Microsoft Excel and AGROS 2.11. This method is used to assess the significance of differences between several groups of observations.

RESULTS AND DISCUSSION

The density of plants is influenced by factors such as weather conditions, soil fertility, biological characteristics of plants, seeding rate. According to Tiscornia *et al.* (2019), more arid pastures, as a rule, depend on the climatic conditions. The development and observation phases are carried out depending on the crops. The plant density of grass-legume mixtures during the evaluating period with wide-row and ordinary sowing methods is shown in Table 4. In the course of the standing plants density studies, in the degraded pasture control plot, herbs such as fescue, feather grass, and cold wormwood were noticed. In addition, in each variant of the experiment, natural vegetation was found, which was not counted in the calculation of the number of plants.

Table 4. The standing density of grass-legume mixtures of the first year of life (2016-2018).

Experiment variants	Number of plants (pieces m^{-2})											
	Wide-row sowing method						Ordinary row sowing method					
	2016		2017		2018		2016		2017		2018	
	by crop	total	by crop	total	by crop	total	by crop	total	by crop	total	by crop	total
Degraded pasture land (control)	50		56		53		50		56		53	
Wheatgrass-alfalfa-bromegrass	47 36 42	125	46 34 40	120	44 32 37	113	98 77 95	262	94 72 92	258	90 65 86	241
Wild rye-alfalfa-bromegrass	45 31 43	119	43 28 41	112	40 26 39	105	95 75 92	259	92 73 90	255	89 68 84	241
Slender wheatgrass-alfalfa-wheatgrass	46 28 45	119	45 26 44	115	43 24 42	109	94 68 97	270	92 64 95	251	89 58 91	238

In 2017, the density on the wheatgrass-alfalfa-bromegrass variant equaled 46, 34, and 40 pieces m^{-2} and in grass mixtures 120 pieces m^{-2}. These values are similar to the previous year, which suggests that the meteorological conditions did not differ much. In 2018, the highest value was also noted for the wheatgrass-alfalfa-bromegrass variant (44, 32, and 37 pieces m^{-2}), while the grass mixtures were 113 pieces m^{-2}.

The conservation of perennial grasses after the winter period in mixed legumes and cereals crops differed in the variants with wide-row and ordinary row sowing methods. The preservation of perennial forage grasses depends primarily on how the crop wintered. As shown in Table 5, data on the safety of perennial grasses for 2016-2018 are given with ordinary row sowing methods, where the results showed significantly good values in comparison with the wide row sowing method. The greatest indicator of the safety of grass-legume plants was noted in the wheatgrass-alfalfa-bromegrass variant (91%) and the wild rye-alfalfa-bromegrass variant (90%). The highest preservation rate of grass-legume mixtures of the first year of life on average for 3 years (2016-2018) was observed for wheatgrass-alfalfa-bromegrass with 85% for the wide-row sowing method and 91% for the ordinary row sowing method. With this method of sowing, the plots showed good preservation, since the plants were located at a distance of 15 cm and this had the advantage of preserving the plants from the winter cold.

The height of plants is influenced by agrometeorological conditions, soil fertility, and agricultural cultivation techniques. To measure the height of plants, the start and end dates of the measurement must be observed. For annual perennial sown grasses, as well as grass mixtures, it was necessary to perform measurements at the beginning of the term when a height of 5 cm was reached in spring, and after cutting when young shoots 5 cm long appear.

Table 5. Preservation of grass-legume mixtures after the winter period (2016-2018)

Experiment variants	With a wide-row sowing method							With an ordinary row sowing method						
	2016		2017		2018		Preservation (2016-2018)	2016		2017		2018		Preservation (2016-2018)
	%													
Degraded pasture land (control)	25		28		27		27	25		28		27		27
Wheatgrass-alfalfa-bromegrass	94 90 84	89	92 85 80	86	88 80 74	81	85	98 96 95	96	94 90 92	92	90 81 86	86	91
Wild rye-alfalfa-bromegrass	90 77 86	84	86 70 84	80	80 65 78	74	80	95 94 92	94	92 91 90	91	89 85 84	86	90
Slender wheatgrass-alfalfa-wheatgrass	92 70 90	84	90 65 88	81	86 60 84	77	81	94 85 97	92	92 80 95	90	89 73 91	85	89

The last measurement of the height was necessary to carry out the beginning of haymaking in the study area or at the beginning of grazing (cessation of growth).

The height of grass-legume mixtures in 2016 varied from 7 to 91 cm depending on the sowing method, as shown in Table 6. On the control plot of degraded pasture land, the plant height was 9 cm in 2016, 10 cm in 2017, 12 cm in 2018, on the variants of grass mixtures with a wide-row sowing method the wheatgrass-alfalfa-bromegrass variant had the following plant height parameters during 2016: 11 cm for cereals, 8 cm for legumes, and 9 cm for natural vegetation. On the experimental site, natural vegetation was found, namely fescue, feather grass, and cold glade. For the wild rye-alfalfa-bromegrass variant, the height of cereal plants was 12 cm, 14 cm for legumes, and 10 cm for natural vegetation; for the slender wheatgrass-sainfoin-wheatgrass variant, the height of cereal plants equaled 11 cm, 13 cm for legumes, and 10 cm for natural vegetation. The plant height was also considered for the plot with the ordinary sowing method in 2016 (Table 6).

Table 6. Height of grass-legume mixtures of the first years of life, depending on the method of sowing.

Experiment variants	Plant height (cm)					
	Wide-row sowing method			Ordinary row sowing method		
	2016	2017	2018	2016	2017	2018
Degraded pasture land (control)	9	10	12	9	10	12
Wheatgrass-alfalfa-bromegrass	C-11 L-8 N-9	C-15 L-10 N-9	C-13 L-11 N-10	C-8 L-7 N-10	C-16 L-9 N-10	C-15 L-12 N-11
Wild rye-alfalfa-bromegrass	C-12 L-14 N-10	C-13 L-11 N-10	C-12 L-13 N-10	C-9 L-7 N-13	C-17 L-12 N-11	C-16 L-14 N-11
Slender wheatgrass-alfalfa-wheatgrass	C-11 L-13 N-10	C-12 L-9 N-11	C-10 L-11 N-9	C-10 L-11 N-11	C-16 L-10 N-12	C-13 L-10 N-8

C: cereals, L: legumes, N: natural vegetation (fescue, feather grass, cold wormwood).

With the ordinary row sowing method, there was a positive growth of the grass-and-legume mixture in height. In 2018, the growth and development indicators of grass-legume mixtures were moderate, since forage crops provide a good vegetative mass in subsequent years of life.

To determine the yield of grass-legume mixtures, a selection was carried out according to the medium sheaf samples selection method (1 kg of each plot). The yield of the evaluating period of life is shown in Table 7 with both methods, The productivity of perennial grasses of moderately winter-hardy grass-legume mixtures with different sowing methods in 2016 had insignificant differences since the amount of precipitation during the growing season was 205.9 mm, which is several times higher than the long-term norm. The favorable air temperature contributed to this result. With an ordinary method of sowing in 2016, the wheatgrass-alfalfa-bromegrass obtained a yield of 440 kg ha^{-1}, and the yield of slender wheatgrass-alfalfa-bromegrass was 420 kg ha^{-1}.

Table 7. The average productivity of grass-legume mixtures during 2016-2018.

Experiment variants	kg ha^{-1}							
	wide-row sowing method				ordinary row sowing method			
	2016	2017	2018	Average (2016-2018)	2016	2017	2018	Average (2016-2018)
Degraded pastureland (control)	100	150	180	140	100	150	180	140
Wheatgrass-alfalfa-bromegrass	480	500	470	480	440	480	460	460
Wild rye-alfalfa-bromegrass	480	490	450	470	420	460	440	440
Slender wheatgrass-alfalfa-wheatgrass	440	460	420	440	400	440	400	410
Least significant difference$_{05}$				14				12

These results show that concerning the productivity of the air-dry mass of perennial grasses, the highest yield in 2017 was obtained on variants such as wheatgrass-alfalfa-bromegrass (500 kg ha^{-1}), wild rye-alfalfa-bromegrass (490 kg ha^{-1}), and slender wheatgrass-alfalfa-wheatgrass (460 kg ha^{-1}). The yield of perennial crops was slightly different. Comparing the variants of the experiment with the control of degraded pastureland, it can be seen that the variants are twice superior to the rest. With ordinary sowing methods in 2017, the productivity of the air-dry mass in the variant wheatgrass-alfalfa-bromegrass with 480 kg ha^{-1}, wild rye-alfalfa-bromegrass amounted was 460 kg ha^{-1} and 440 kg ha^{-1} for slender wheatgrass-alfalfa-wheatgrass. Although that year, according to meteorological data, it did not differ much from the long-term norms. Nevertheless, it can be assumed that the productivity of grass mixtures depends not only on climatic conditions but also on crop safety.

According to the data obtained, the yield of grass-and-legume mixtures with a wide-row sowing method in 2018 had the following values for the following variants: wheatgrass-alfalfa-bromegrass — 470 kg ha^{-1}, wild rye-alfalfa-bromegrass — 450 kg ha^{-1}, slender wheatgrass-alfalfa-wheatgrass — 420 kg ha^{-1}, compared with the control plot.

On average for 2016-2018 the highest yield was observed on the wheatgrass-alfalfa-bromegrass variant (480 kg ha^{-1}). With an ordinary row sowing method, the productivity of grass-legume mixtures on average for 2016-2018 showed an insignificant difference, which was observed on the wheatgrass-alfalfa-bromegrass variant (460 kg ha^{-1}). The wide-row sowing method is used for plants that require a large area of nutrition and are heavily clogged with weeds and grow slowly after sowing. Ordinary row sowing methods are the most ideal ones since the seeds are embedded in the soil at the same time. The advantage of these methods is that the seeds are placed in optimal and uniform conditions, which ensures uniform germination and uniform emergence of seedlings. This is used in the development of a resource-saving technology for the surface improvement of pastures, which is achieved by selecting crops of perennial cereals and legumes of forage grasses, as well as direct sowing of their mixtures into the sod, which allows to reduce energy costs and provides in the steppe zone the receipt of up to 1500 kg ha^{-1} of pasture mass (Serekpaev *et al.*, 2016). Havilah, (2011) found that pasture and annual forage grasses can provide animals with high-yielding and high-quality forage. Australian scientists (Fulkerson *et al.*, 2011) stated that alfalfa mixtures create and maintain pastures for long-term use. In a Mediterranean setting (Bathgate *et al.,* 2009), new annual legume grasses can affect farm profits and land use and result in a 26% increase in farm profits. Thus, cereal-legume grass mixtures can increase the productivity of degraded pastures.

CONCLUSIONS

As a result of the research, it can be concluded that the productivity of grass-legume mixtures of the first years of life with wide-row and ordinary row sowing methods, the highest result was noted on the average (2016-2018) for the wheatgrass-alfalfa-bromegrass variant (480 kg ha^{-1}, 460 kg ha^{-1}). The use of resource-saving methods allows preventing the degradation of pasture herbage and will also help to improve the quality of forage, yield, and soil fertility. In comparison with the control, the experimental variants showed high productivity. Future scope of research could include monitoring of the study area, assessing the safety of cereal-legume grass mixtures, and improving degraded pastures.

ACKNOWLEDGMENTS

This research was funded by the Science Committee of the Ministry of Education and Science of the Republic of Kazakhstan (Grant No. AP09562508).

REFERENCES

Asai M, Moraine M, Ryschawy J, Wit J, Hoshide AK and Martin G. 2018. Critical factors for crop-livestock integration beyond the farm level: A cross analysis of worldwide case studies. Land Use Policy 73: 184-194. https://doi.org/10.1016/j.landusepol.2017.12.010

Baethgen W, Parton W, Rubio V, Kelly R, Lutz M. 2020. Ecosystem dynamics of crop-pasture rotations in a fifty-year field experiment in southern south America: Century model and field results. Soil Science Society of American Journal: https://doi.org/10.1002/saj2.20204

Baranowski E, Thevs N, Khalil A, Baibagyssov A, Iklassov M, Salmurzauli R, Nurtazin S and Beckmann V. 2020. Pastoral Farming in the Ili Delta, Kazakhstan, under Decreasing Water Infow: An Economic Assessment. Agriculture 10(7): 281: https://doi.org/10.3390/agriculture10070281

Bathgate A, Revell C, Kingwell R. 2009. Identifying the value of pasture improvement using wholefarm modeling. Agricultural Systems 102(1-3): 48-57. https://doi.org/10.1016/j.agsy.2009.06.008

Bazha SN, Bayasglan D, Gunin PD, Danzhalova EI, Drobyshev YuI, Kazantseva TI, Prischepa AV and Harbater S. 2008. Features of pasture digression of steppe ecosystems of Central Mongolia. Botanical Journal 5(93): 657-681.

Bedilo NA. 2016. Productivity, feed value and symbiotic activity of legume species and their mixtures on leached Chernozem of the Western. (Ph.D. Thesis). Krasnodar.

Blagoveshchenskiy GV. 2013. Advantages of cereal-legume grass mixtures for mowing use. In: SD Group Company, https://sdexpert.ru/news/company/preimushchestva-bobovo-zlakovykh-travosmesey-ukosnogo-ispolzovaniya/. Accessed: December 2021.

Derpsch R, Friedrich T, Kassam A and Hongwen L. 2010. Current status of adoption of no-till farming in the world and some of its main benefits. International Journal of Agricultural and Biological Engineering 3(1): 1-26. https://doi.org/10.3965/j.issn.1934-6344.2010.01.001-025

Dospekhov BA. 1985. Method of field experience (with the basics of statistical processing of research results). 5th ed., add. and revised. Agropromizdat, Moscow.

Dymova TV. 2006. Pasture as a factor of anthropogenic influence on natural vegetation in the conditions of the Volga Delta. Journal of Kabard-Balk. State University. Series of Biological Sciences 8: 8-9.

Feltran-Barbieri R and Feres JG. 2021. Degraded pastures in Brazil: improving livestock production and forest restoration. Royal Society Open Science 8: 201854. https://doi.org/10.1098/rsos.201854

Fuglie K, Peters M and Burkart S. 2021. The Extent and Economic significance of cultivated forage crops in developing countries. Frontiers in sustainable food systems 5: 1-8. https://doi.org/10.3389/fsufs.2021.712136

Fulkerson W J, Lowe KF, Hume DE. 2011. Forages and pastures: Perennial forage and pasture crops—establishment and maintenance. Encyclopedia of Dairy Sciences: 586-593. https://doi.org/10.1016/B978-0-08-100596-5.21852-0

Havilah EJ. 2011. Forages and pastures: Annual forage and pasture crops – species and varieties. Encyclopedia of Dairy Sciences: 552-562. https://doi.org/10.1016/B978-0-08-100596-5.21855-6

Jun Li W, Ali SH and Zhang Q. 2007. Property rights and grassland degradation: A study of the Xilingol Pasture, Inner Mongolia, China. Journal of Environmental Management 85(2): 461-470. https://doi.org/10.1016/j.jenvman.2006.10.010

Ministério da Agricultura e Reforma Agrária Brasil. 2009. “Regras para análise de sementes”. SNDA/DNDV CLAV, Brasília.

Nugmanov AB, Kikebaev NA, Tokusheva AS, Agibaeva ZK, and Dzidra Kreismane. 2018a. Productivity of grass stands of perennial grasses depending on the method of recovery of pastures. News of the National Academy of Sciences of the Republic of Kazakhstan. 4(46):13-16.

Nugmanov AB, Tulayev YV, Tulkubayeva SA and Somova SV. 2018b. Developing a system of organic farming technologies to obtain environmentally clean agricultural products (organic food) in the steppe zone of the Kostanay region. OnLine Journal of Biological Sciences 18(2): 130-137. https://doi.org/10.3844/ojbsci.2018.130.137

Podgot Yu and Novoselov K. 1983. Methodological guidelines for conducting field experiments with forage crops. V. R. Williams Institute of forage research. VIC, Moscow.

Popov V, Serekpayev N, Zharlygasov Z, Stybayev G and Ansabayeva A. 2017. Adaptive technology of environmentally–friendly production of legumes in the dry steppe zones. Journal of Central European Agriculture 18(1): 73-94. https://doi.org/10.5513/JCEA01/18.1.1869

Sereia RC, Ensinas SC, Neto ALN, Alovisi AMT, Marchetti ME and Cortez JW. 2016. Agricultural management systems affect on physical, chemical and microbial soil properties. Australian Journal of Crop Science 10(5): 683-692. https://doi.org/10.21475/ajcs.2016.10.05.p7410

Serekpaev NA, Mozhaev NI, Stybaev GZh, Nogaev AA, Khurmetbek O and Bahralinova AS. 2016. Saving technology for surface improvement of natural hayfields and pastures for the steppe zone. Patent № 24 KZ (22) A (11) 30913 (in Russian).

Serekpayev N, Stybayev G, Nogayev A, Baitelenova A, Ansabayeva A, Yessenzholov D and Ashirbekova I. 2018. Method for chickpea cultivation in a steppe zone for obtaining an environmentally safe product. Patent No. WO2018231037-A1 (in Russian). https://patentscope.wipo.int/search/en/detail.jsf?docId=WO2018231037

Sizykh AP. 2007. On the issue of digression of plant communities and environments under the influence of anthropogenic factors. Siberian Journal of Ecology 3(14): 441-447.

Soares AB, Finkler da Silveira AD, Assmann TS and Schmitt D. 2019. Herbage production, botanical and plant-part composition of mixed black oat (*Avena strigosa* Scherb.) annual ryegrass (*Lolium multiflorum* Lam.) pastures under different management strategies. Australian Journal of Crop Science 13(11): 1826-1832. https://doi.org/10.21475/ajcs.19.13.11.p1855

Tiscornia G, Jaurena M, Baethgen W. 2019. Drivers, process and consequences of native grasslands degradation: insights from a literature review and a survey in Río de la Plata Grasslands. Agronomy 239: https://doi.org/10.3390/agronomy9050239

Tokusheva AS and Nugmanov AB. 2016. The Problem of feed production development. Izvestiya NAS RK. Almaty 4: 41-43.

Tokusheva AS, Nugmanov AB and Melnikov VA. 2017. Degraded pastures improvement using no-till technology in Northern Kazakhstan. Ecology, Environment and Conservation. India 23(2): 1242-1248.

Van Dyke F, Van Kley SE, Page CE and Van Beek JG. 2004. Restoration efforts for plant and bird communities in tallgrass prairies using prescribed burning and mowing. Restoration Ecology 12(4): 575-585. https://doi.org/10.1111/j.1061-2971.2004.00352.x

Vasques ICF, Souza AA, Morais EG, Benevenute PAN, da Silva LCM, Homem BGC, Casagrande DR and Silva BM. 2019. Improved management increases carrying capacity of Brazilian pastures. Agriculture, Ecosystems & Environment 282(1): 30–39. https://doi.org/10.1016/j.agee.2019.05.017

Viaud V, Santillàn-Carvantes P, Akkal-Corfini N, Guillou CL, Prévost-Bouré NC, Ranjard L and Menasseri-Aubry L. 2018. Landscape-scale analysis of cropping system effects on soil quality in a context of crop-livestock farming. Agriculture, Ecosystems & Environment 265(1): 166–177. https://doi.org/10.1016/j.agee.2018.06.018