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SUDAN GRASS IN ARID CONDITIONS: PRODUCTIVITY, DROUGHT TOLERANCE, AND FORAGE POTENTIAL

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Abstract

The article discusses Sudanese grass as a potential fodder crop for arid areas, where obtaining a consistent supply of feed is challenging due to a lack of water, high temperatures, and the instability of environmental and climatic conditions. It explores the theoretical foundations for studying the productivity and drought tolerance of this crop, analyzes the characteristics of the arid environment in which it grows, and summarizes data on how moisture availability, agricultural practices, and biological traits of the plant influence crop yield. Special attention is given to assessing Sudanese grass's productivity based on its yield of dry matter and hay, number of harvests, and ability to maintain value in difficult years. Sudanese grass is highlighted as a significant component of forage production in arid regions because of its drought resistance, versatility, rapid regrowth after harvest, and multiple uses. The conclusion is made regarding the high practical significance of the culture in strengthening the forage base of arid areas and enhancing the sustainability of forage production.

Keywords: *Sudanese grass, arid zone, productivity, drought resistance, forage production, green mass, yield, fodder base, multi-crop area, arid territories*

Relevance of the study

The relevance of the research topic stems from the fact that, for arid and semi-arid regions, one of the main challenges remains securing a stable supply of feed in the face of moisture deficiencies and high temperatures. Sudanese grass has been identified as a promising crop precisely because of its drought and heat tolerance, as well as its ability to produce significant biomass under adverse growing conditions.

Scientific and reference materials indicate that crops in the sorghum family, including Sudanese grass and Sudanese-sorghum hybrids, are better suited to warm regions and exhibit greater resistance to drought than corn, which is particularly significant for farms in arid zones.

The practical significance of Sudanese grass increases due to its use as green fodder, hay, and haylage. It also has the advantage of rapid regrowth after being cut, which allows for its multi-faceted use in the feed production system. In arid conditions, according to agronomic and scientific literature, Sudanese grass can provide 2–3 cuts per season. Its economic value is not only related to its yield but also to the flexibility it provides in forming the fodder base during the summer months.

The relevance of the topic increases due to the need to choose varieties and technologies that are ideally suited to the specific climatic conditions of the region. Scientific research explicitly states that for each region, it is necessary to select varieties that can maximize the use of local natural resources. In the conditions of arid steppes, the productivity of sorghum forage crops strongly depends on the water regime and agrotechnical techniques. Therefore, the assessment of the productivity and drought resistance of Sudanese grass in the arid zone has not only theoretical but also practical significance for increasing the sustainability of forage production.

The purpose of the study

The aim of this research is to assess the productivity and drought resistance of Sudanese grass in arid regions and to analyze its potential contribution to sustainable forage production in these areas.

Materials and research methods

The study used open scientific publications, agronomic and reference data, as well as the results of field observations and production indicators related to the cultivation of Sudanese grass in arid conditions.

Various methods were used in the work: analysis of scientific literature, generalization of published information, comparative analysis of productivity indicators, descriptive method, as well as presentation of data in the form of tables and diagrams.

The results of the study

Sudanese grass is an annual cereal forage crop related to sorghum. It is widely used as green fodder, hay, haylage, and for grazing livestock. Sudanese grass is valued in feed production due to its ability to adapt to hot and arid conditions. According to scientists and experts, forage sorghum, including Sudanese grass, is highly resistant to drought. They can grow successfully in places where growing corn is difficult due to high temperatures and lack of moisture. This makes Sudanese grass especially attractive for regions with unstable moisture.

The productivity of Sudanese grass is usually assessed by the yield of green mass, dry matter, and hay, as well as by the plant's ability to grow quickly after mowing. Scientific publications note that this crop forms a significant amount of feed mass and is characterized by high yield, which allows it to be used in a multi-axis system. Studies have shown that in conditions of drought, the productivity of Sudanese grass significantly depends on the availability of moisture and the level of mineral nutrition. This suggests that its yield is influenced not only by the biological characteristics of the crop but also by the specific growing conditions (Khalgaeva K. E., Balinova T. A., Eviev V. A. [et al.] 2021, p. 49).

The drought resistance of Sudanese grass is due to its unique morphological and physiological characteristics. Scientific literature notes that this plant has a powerful root system capable of extracting moisture from deep soil layers. This feature allows Sudanese grass to easily tolerate prolonged periods of drought and continue to grow at high air temperatures. The combination of a well-developed root system, heat resistance, and the ability to quickly restore vegetative mass after mowing makes it an indispensable fodder crop for arid regions.

The key feature of Sudanese grass is that its productivity should not be considered in isolation but in the context of external conditions. Even with the high natural stability of this crop, the actual yield level depends on many factors: moisture regime, agrotechnical techniques, soil conditions, and the period of use of the herbage. In scientific research, the evaluation of Sudanese grass is usually based on comparing its potential productivity with actual yields in specific soil and climatic conditions.

Sudanese grass is a crop that has adapted to growing in environments with high temperatures and low moisture levels. For a better understanding of the natural and climatic conditions in the arid region, it is helpful to see the main indicators in Table 1.

Table 1. *The main natural and climatic indicators of the arid zone, significant for assessing the growing conditions of Sudanese grass*

Indicator	Meaning	Scientific significance for research
Average annual precipitation	250–350 mm	Confirms the lack of moisture in the area
Hydrothermal coefficient	About 0.5	Characterizes the pronounced aridity of the climate
The state of humidification	Evaporation exceeds precipitation	It is the main feature of the arid zone
Dynamics of summer precipitation in arid zones of the Volga region	Reduction by 23–30%	Increases the risk of water shortage during the active growing season
The risk of severe atmospheric droughts in the semi-desert zone	Height from 55% to 82%	It shows an increase in climatic restrictions for feed production
Characteristic soils	light brown	Determine the features of soil moisture accumulation and consumption

A source: (Gubarev D. I., Levitskaya N. G., Derevyagin S. S., 2022; Tashninova A. A., 2020; Shumova N. A., 2021)

These data suggest that moisture availability is the main limiting factor for crop growth in the arid region. Therefore, it is important to assess the productivity of Sudanese grass under these conditions, taking into account not only its total yield but also its ability to maintain growth and development in the face of limited moisture and high temperatures. This highlights the practical significance of studying Sudanese grass, which is one of the most promising forage crops for arid regions.

The productivity of Sudanese grass in the arid zone is primarily estimated by the yield of dry matter, hay yield, number of mowings, and stability of fodder mass production over the years. Field data from Kalmykia show that even in arid conditions, this crop retains practical value for forage production. However, the yield level varies significantly depending on the moisture regime and weather conditions. In particular, at the Bashanti State Variety Site, the average dry matter productivity of Sudanese grass for 2018–2020 ranged from 52.7 c/ha (Kamyshinskaya 51) to 64.7 c/ha (Grazia). There was also a sharp variability across years, with the Grazia variety yielding 68.0, 87.2, and 38.0 c/ha, respectively, in 2018, 2019, and 2020. This highlights the direct dependence of crop yield on moisture availability during the growing season.

In the same materials, it was noted that in the central zone of Kalmykia, during years with a dry period in the second half of summer, the productivity of late crops sharply decreases, and in Sudanese grass, the yield can decrease by 2–3 times. At the same time, production data show that even with these restrictions, the crop provides an economically significant feed yield. In 2020, farms in Kalmykia produced over 6 tons per hectare of hay in the Wormwood SEC, over 7 tons per hectare in the Gagarin SEC, and over 8 tons per hectare in the Pervomaisky SEC. This confirms that Sudanese grass is valuable in the arid zone not only as a potentially productive crop but also as a relatively reliable fodder crop.

The level of agricultural technology has a significant impact on productivity. Open research has shown that Sudanese grass responds well to improved mineral nutrition, particularly nitrogen fertilizers. This is because it removes a significant amount of nutrients from the soil during the formation of a large vegetative mass. Published works emphasize that high yields of this crop can only be achieved when the biological characteristics of the plant are combined with a correct cultivation system (Magomedov K. G., Magomedov M. K., 2005).

The resistance of Sudanese grass to arid conditions is determined not by one indicator, but by a whole complex of biological and economically valuable traits. Scientific and reference literature notes that this crop is adapted to growing in conditions of insufficient moisture, is able to tolerate high temperatures, and has relatively high resistance to drought compared to a number of other forage plants. In addition, the herbage quickly recovers after mowing. However, field studies show that even in drought-resistant crops, the level of productivity largely depends on the severity of water scarcity. To clearly demonstrate the main signs of drought resistance of Sudanese grass, they can be summarized (Table 2).

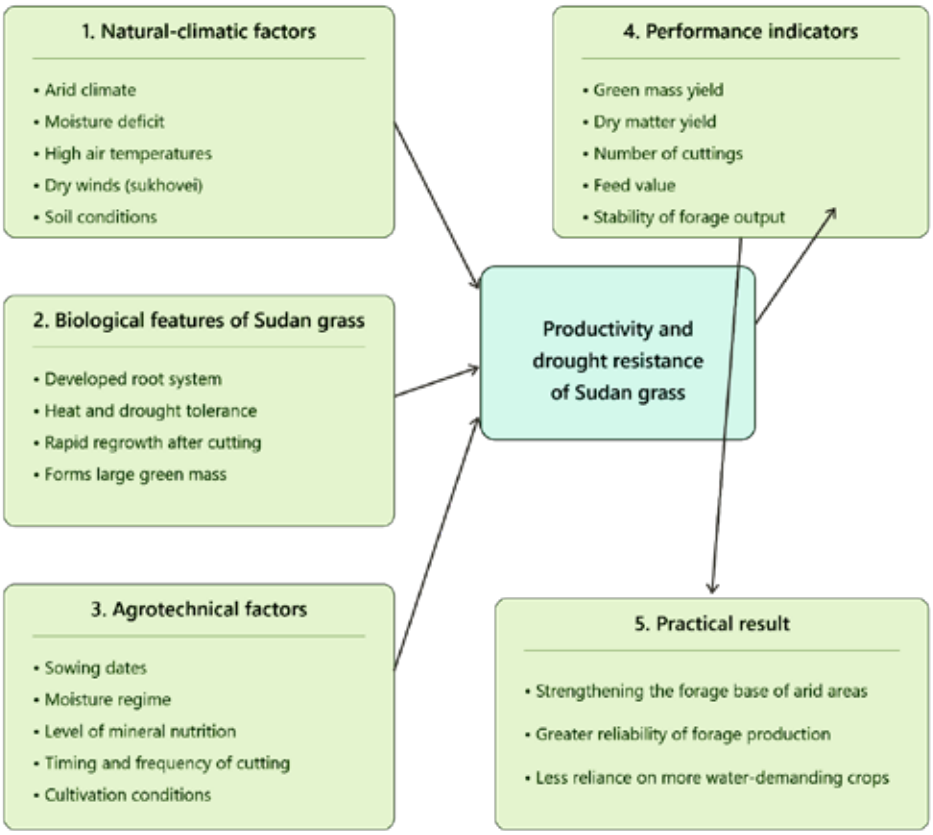
Table 2. *The main signs of drought resistance of Sudanese grass*

Sign	Confirmed information
General characteristics of drought resistance	Sudanese grass is a drought-resistant forage crop
Comparative stability	Sorghum crops, including Sudanese grass, are more drought-tolerant than corn
Adaptation to the conditions of semi-arid and arid territories	The crop is well-suited for cultivation in stressful and arid regions
Ability to recover after mowing	After mowing or bleaching, Sudanese grass regrows quickly
Reaction to increased drought	In dry years, productivity can decrease by 2–3 times

A source: author's development based on open data

To better understand what factors affect the yield and resistance of Sudanese grass to drought in the arid zone, they can be presented in the form of a diagram (Figure).

Figure 1. *Factors affecting the productivity and drought resistance of Sudanese grass in the arid zone [author's development]*



Sudanese grass plays an important role in forage production in arid regions, as it offers economic versatility, high productivity, and adaptability to growing in conditions with insufficient moisture. In these areas, the ability to use this crop for various purposes is particularly significant: for green feed, hay, silage, and pasture management. This versatility allows farmers to more flexibly build their feed base based on weather conditions, land use, and animal husbandry needs.

In the arid zone of Sudan, grass has practical value as an agricultural crop that can provide nutrition during periods when other plants are experiencing difficulties due to high temperatures and lack of moisture. Its inclusion in the feeding system helps to maintain the stability of green feed intake, as it germinates quickly after mowing and can be harvested several times. Thanks to this, Sudanese grass helps to prolong the production period of green fodder during the season, which is especially valuable for regions with unpredictable climates.

The forage value of Sudanese grass is significant. It forms a nutritious green mass, but its quality depends on the plant's stage of development and timing of harvest. As the plants age, their nutrient content decreases. Therefore, it is important to cut the grass at the right time to ensure proper nutrient content.

Sudanese grass has the ability to produce multiple cuttings per season, which is especially useful in arid areas. This increases the reliability of forage production and allows for more feed even in conditions of limited water. The multiple cuttings also contribute to more efficient use of land and make Sudanese grass a valuable component of the field forage system.

It is equally important to consider Sudanese grass as a crop that is more adapted to water scarcity than a number of traditional forage plants. This makes it more significant in regions where moisture availability is the main limiting factor for crop yield. In these conditions, Sudanese grass plays not only an industrial but also an adaptive role, allowing farmers to maintain the stability of their feed base during adverse weather conditions.

To better understand the role of Sudanese grass in forage production in arid areas, it is helpful to present its major economic benefits in Table 3.

Table 3. *The role of Sudanese grass in the forage production of arid territories*

Indicator	Characteristic	Importance for feed production
Directions of use	Green fodder, hay, haylage, silage, pasture	Provides multi-purpose use of culture
Adaptability to arid conditions	It is capable of growing and yielding crops in conditions of moisture deficiency	Increases the stability of the food supply in the arid zone
Participation in the green pipeline	It can be used at any time of the year	Increases the period of receipt of fresh herbs
The ability to regrow	It recovers quickly after mowing	Makes it possible to get multiple mows
Feed value	Forms a nutritious green mass	It is an important component of the animal diet
Importance in case of water shortage	It is less dependent on a high level of moisture compared to crops that require more water	Reduces the risk of feed shortages in dry years

A source: author's development based on open data

Conclusions

The results of the analysis allow us to conclude that Sudanic grass is one of the most promising fodder crops for arid areas. Its value is due to a combination of characteristics such as drought resistance, the ability to form

a significant amount of green mass, rapid recovery after mowing, and versatility in use.

It was found that the productivity of this crop largely depends on the availability of moisture, weather conditions during the year, and the level of agricultural technology. However, even in arid regions, Sudanese grass retains its high economic value. Its cultivation helps to strengthen the feed base, prolong the period of green mass intake, and reduce the dependence of farms on more moisture-consuming crops.

Thus, the cultivation of Sudanese grass in the arid zone is of both theoretical and practical importance for increasing the sustainability of feed production.

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