



Available Online at EScience Press

International Journal of Agricultural Extension

ISSN: 2311-6110 (Online), 2311-8547 (Print)

<https://esciencepress.net/journals/IJAE>

EVALUATION OF YIELD AND NUTRITIONAL VALUE OF FODDER CROPS UNDER PLASTIC GREENHOUSE STRUCTURE IN IRAN

Gholamhassan Ranjbar*, Mohammad J. Babaie-Zarch, Hadis Hatami, Mohammadhassan Rahimian*National Salinity Research Center, Agricultural Research, Education and Extension Organization (AREEO), Yazd, Iran.*

ARTICLE INFO

Article History

Received: March 26, 2024

Revised: July 28, 2025

Accepted: August 11, 2025

Keywords

Crude protein

Fresh and dry weight

Forage crop

Livestock

Water quality

Water scarcity

ABSTRACT

One of the challenges in arid and semi-arid regions, such as Iran, for fodder supply is water scarcity and poor quality. There are various strategies for producing fodder using less water. One of these is forage production under greenhouse conditions (plastic cover). This issue is also significant because the production of common greenhouse plants such as cucumbers and tomatoes is no longer profitable in many greenhouses due to an increase in their irrigation water salinity. To evaluate the feasibility of fodder production under greenhouse conditions, a study was conducted in Yazd, Iran, from 2022 to 2023. Crops were sorghum, corn, pearl millet, guar, amaranth, lathyrus, hairy vetch, fodder beet, and safflower. Fodder fresh and dry weight, plant height, and water productivity, as well as crude protein, starch, acid detergent fiber, and neutral detergent fiber, were measured. Results showed that amaranth could produce about 74.1 Mg ha⁻¹ fresh weight in 35 days. The mean fodder fresh weight for safflower and fodder beet was 93.6 and 238.1 Mg ha⁻¹, respectively. The fresh and dry weight of fodder for sorghum during the year was 650 and 117 Mg ha⁻¹, respectively; at least 5 times more than it in field conditions. The highest fresh weight was obtained for corn, Chavosh cv., by 105 Mg ha⁻¹. The values of crude protein for sorghum, corn, hairy vetch, and amaranth were 10.7, 8.3, 21.9, and 21.0% of dry matter. The water consumption in greenhouse conditions was also about 30-36% of the field conditions. Results of the study showed that in arid and semi-arid areas, it is possible to provide the required fodder in plastic greenhouses with less water consumption.

*Corresponding Author: Gholamhassan Ranjbar**Email: ranjbar71@gmail.com**© The Author(s) 2025.*

INTRODUCTION

The Lack of sufficient water is a limiting factor in arid and semi-arid regions, such as Iran, for producing fodder for livestock. Currently, there are more than 75 million livestock in Iran. Based on the national reports, there is an annual shortage of about 5-7 million tons of dry fodder due to recent drought events in the country. One of the government's policies to address this problem is to move fodder production from fields to indoor spaces to reduce water consumption (Aghashahi, 2022). It is believed that a portion of the required fodder can be produced under

plastic covers, a method commonly used for fruit and vegetables like tomatoes and cucumbers in greenhouse conditions. What is taken from fodder production in the greenhouse is its production in hydroponic systems. The method of hydroponic fodder production dates back to the 1800s or earlier, where European farmers grew cereal grains in greenhouses to feed dairy cows in cold seasons. It is believed that in these systems, compared to open space, total yield is higher, and consumptions of water, energy, and chemical inputs such as fertilizer and poisons, as well as labor costs, are less (Al-Karaki, 2010; Sneath

and McIntosh, 2003). Espinosa-Robles et al. (2009) reported that by planting corn in a hydroponic greenhouse, about 1462 kg per 25 m² could be achieved in 12 days. They estimated 44.5 Mg of fodder obtained from this area in the year. Al-Karaki & Al-Momani (2011) concluded that by using hydroponic systems, it is possible to produce barley forage in 10 days by 207 Mg ha⁻¹. This means that by using this method, it is possible to harvest about 6133 Mg ha⁻¹ with 25 times cultivation. Naik *et al.* (2017) demonstrated that producing 1 kg of hydroponic corn fodder in 7 days requires only 1.5 to 3 liters of water. This method also has significant disadvantages, such as; impossibility of long-term storage, high cost of installing its infrastructure, high consumption of seeds (for example, 4-6 kg m⁻² of seeds for sorghum and wheat and 6.5 to 7.5 kg for corn), decrease in nutritional value and increase in cost of production (Fazaeli et al., 2021; 2011). However, Yurtseven et al. (2020) noted that if the fodder produced in hydroponic conditions is mixed with suitable compounds and ensiled, its quality could be improved. Another method is growing forage crops in the soil bed of the greenhouse as greenhouse vegetables. There are approximately 23,000 hectares of plastic greenhouses in Iran. In many of these greenhouses, the production of common vegetables such as cucumbers and tomatoes is not economically viable due to an increase in water salinity, the spread of pests and diseases, and soil poisoning resulting from their continuous cultivation and excessive use of chemical fertilizers. Meanwhile, during the times when the greenhouse is empty, a suitable forage crop could be cultivated. It appears that farms with limited water for irrigation can produce fodder by utilizing an inexpensive greenhouse structure. The objective of this study was to evaluate the fodder quantity and quality of some forage crops under greenhouse conditions.

METHODOLOGY

Site Description

To evaluate the feasibility of fodder production in greenhouse conditions, a study was conducted at the greenhouse complex of Yazd, Iran, during 2022-2023. To determine the physical and chemical soil properties of the greenhouse, a composite sample of the surface layer of soil (0-30 cm) was collected. The soil at the experimental site had a silty-loam texture with a content of 68.7% sand, 14% silt, and 17.3% clay. A garden rotavator tiller prepared the seedbed.

Fodder Crops Planting

Plant density for each crop is considered similar to the field conditions. Each crop had seven rows, 50 cm row spacing, and 8 m plot length. Seeds were sown by hand with a sowing density of 20, 35, 15, 10, 125, 65, 25, 7, and 30 kg ha⁻¹ for sorghum, corn, pearl millet, guar, lathyrus, hairy vetch, fodder beet, amaranth, and safflower. Seeds of sorghum and pearl millet were sown on 27 April 2022. Seeds of Corn cultivars (Fajr, Taha, Dehghan, and Chavosh) were sown at three planting dates: on 17 April 2022, 27 February, and 29 January 2023. The planting date for amaranth, guar, lathyrus, hairy vetch, fodder beet, and safflower was 26 December 2022.

Prior to each crop planting, a composite surface layer (0-30 cm) soil samples were taken to determine the nutrient level of the field. The required NPK fertilizer was applied as fertigation during the growing season. Nitrogen was added as urea, and mono-potassium phosphate (an inorganic compound with the formula KH₂PO₄) was applied to provide phosphorus and potash.

All other agronomic practices were also kept, as well as the field conditions. During the growing season, weeds, pests, and diseases were closely monitored, and chemical or mechanical control measures were employed as necessary.

Irrigation was done as T-tape irrigation, and the amount of water consumed was measured using a volume meter. The irrigation frequency varied depending on the growing season. Irrigation was done every six days from January to February. The irrigation interval was three days from March to May. Crops were irrigated every other day from June to October. Moreover, finally, the irrigation interval was done every 4 days from November to December. crops were irrigated for 1 hour each time. To determine the amount of water consumption in the greenhouse, the volume of water consumption and water productivity for corn were measured and compared with the field conditions. Figure 1 illustrates the growth status of fodder crops at the harvesting stage in the greenhouse.

Measurements and Analysis

The amount of fodder production for sorghum, pearl millet, guar, lathyrus, hairy vetch, and safflower was measured at the flowering stage. Corn was harvested at the start of the dough stage (about 75 to 80 days after planting), and for the fodder beet, it was at the end of the fourth month. The harvesting area for each crop was a 2-square-meter area, replicated four times. Fodder fresh

and dry weight and plant height were measured for the crops. To measure the nutritional values of crop fodders, shoot samples of sorghum, corn, amaranth, and hairy vetch were prepared. The samples were oven-dried for analyzing fodder quality. The crude protein, starch, acid detergent fiber (ADF), and neutral detergent fiber (NDF)

were determined by following standard methods (AOAC 1990; Van Soest et al., 1991). The collected data were reported as the average of four samples. Data are presented in tables and figures as mean \pm standard deviation (SD), to indicate how spread out the data is around the mean.



Figure 1. Canopy status conditions of the footage crops in the greenhouse conditions, a: corn, b: sorghum, c: fodder beet, and d: safflower.

RESULTS

Results showed that the amount of forage yield was different according to the length of the growth period and crop species (Table 1). Where amaranth could produce about 74.1 Mg ha⁻¹ fresh weight in 35 days, the amounts of fodder fresh weight for lathyrus were not higher than 10.5 Mg ha⁻¹. The yield of crop cultivars was also different at the same growth period length. For safflower, the amount of fodder fresh weight for Golmehr was about 15% higher than that of Parnian in safflower (Table 1). For fodder beet, the yield of the Feldherr (238.1 Mg ha⁻¹) was higher than that of the Timbale cultivar in four months. Total fodder fresh weight (leaves plus root) for Feldherr was 16.9% higher than that of Timbale. For the sorghum crop, the results were interesting. Sorghum plants had vegetative growth throughout the year and were harvested six times during the growing season. The height of the plants was

significantly higher in the greenhouse and varied by cutting times (Figure 2a). Except for the fifth cutting, where the average plant height was 164.2 cm (Coinciding with the cold season), the height of the plant varied from 200.0 to 242.2 cm in the other cutting times. In turn, there was a significant difference between the fresh (Figure 2-b) and dry weight (Figure 2c) of the plant in different cutting numbers. The highest and lowest fodder fresh weight was observed for the third and fifth cutting, respectively.

Mean fodder weight for the fifth cutting was 51.0% lower than that of the third cutting. The highest fodder dry matter was also obtained in the second and third cutting (Figure 2c). The total fodder fresh and dry weight for sorghum during the year was 650 and 117 Mg ha⁻¹, respectively. Generally, about 16.2 to 19.9% (average: 18%) of the plant was dry matter in the greenhouse condition (Figure 2d).

Table 1. Fodder fresh (FFW) and dry weights (FDW) of amaranth, lathyrus, hairy vetch, pearl millet, & guar in greenhouse conditions.

Crop	Scientific name	Cultivar	Growth period length (day)	FFW (Mg/ha)	FDW (Mg/ha)
Amaranth	<i>Amaranthus retroflexus</i>	-	35	74.1	-
Lathyrus	<i>Lathyrus sativus</i>	-	43	10.5	3.2
Hairy vetch	<i>Vicia villosa</i> Roth.	Maragheh	45	42.0	6.2
		Toloo		29.4	3.5
Pearl millet	<i>Pennisetum glaucum</i>	Mehran	72	68.0	-
Guar	<i>Cyamopsis tetragonoloba</i>	-	45	43.8	5.7
Safflower	<i>Carthamus tinctorium</i>	Golmehar	100	93.6	-
		Parnian		79.7	-
Fodder beet	<i>Beta vulgaris</i>	Timbale	120	197.9	-
		Feldherr		238.1	-

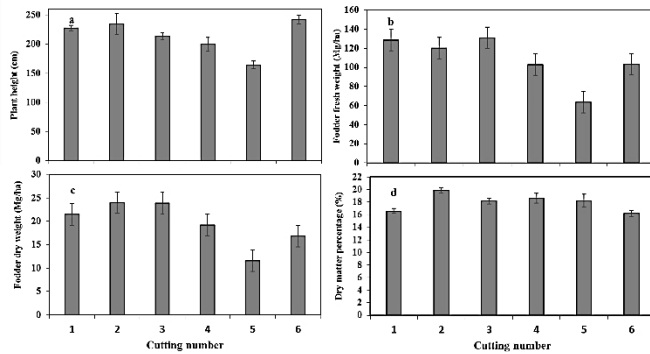


Figure 2. Plant height, fodder fresh and dry weights, and dry matter percentage of the sorghum in different cutting numbers.

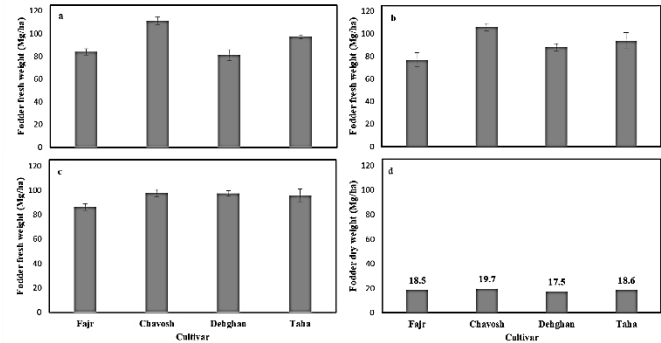


Figure 3. Fodder fresh weights at three planting dates (a, b, and c), and fodder dry weights (d: average of three times) of different corn cultivars in greenhouse conditions.

Figure 3 illustrates a notable difference among corn cultivars under greenhouse conditions. Chavosh cultivar produced the highest fresh weight in all three planting dates. The fodder fresh weight for Chavosh in three planting dates was 111.0, 105.9, and 97.7 Mg ha⁻¹. (Figure 3ac). The highest of fodder dry weight was also observed in the Chavosh cultivar (Figure 3-d). Average height of the plant for the Fajr, Chavosh, Dehghan, and Taha for three planting dates was 3.5, 3.1, 3.0, and 3.2 m, respectively (data not shown). Results of the forage nutritional values showed that the quality indices for

fodder in the crops that were grown in the greenhouse were not different from those in the field conditions. The crude protein content for sorghum and corn was 10.7% and 8.3% of dry matter, respectively, in the greenhouse (Table 2). The results also showed that in comparison to sorghum and corn, hairy vetch and amaranth exhibited a considerably elevated level of crude protein, which was recorded at least 21.0% (Table 2). Additionally, the starch and fiber content (ADF and NDF) of these crops was detected to be low compared to corn and sorghum in greenhouse conditions.

Table 2. Crude protein, starch, acid detergent fiber (ADF), and neutral detergent fiber (NDF) values of sorghum, corn, hairy vetch and amaranth in greenhouse conditions.

Crop	Scientific name	Cultivar	% dry matter			
			Crude protein	Starch	ADF	NDF
Sorghum	<i>Sorghum bicolor</i>	Speedfeed	10.71±0.31	13.38±0.55	30.83±0.79	56.25±1.13
Corn	<i>Zea mays</i>	Dehghan	8.33±0.39	28.38±1.24	23.75±1.30	48.33±0.39
Hairy vetch	<i>Vicia villosa</i> Roth.	Maragheh	21.97±0.85	2.72±0.08	27.92±0.65	37.58±0.94
Amaranth	<i>Amaranthus retroflexus</i>	-	21.00±0.63	2.26±0.03	19.17±0.96	28.17±0.67

The total measured water use in the greenhouse for the corn crop from 17 April to 6 July was about 3,600 m³ ha⁻¹, so the water productivity for the crop (Dehghan cv.) was obtained by 24.5 kg m⁻³ (Table 3). As shown in the table, the water productivity of corn in a greenhouse is remarkably higher than in field conditions. The water productivity for fodder corn was recorded from 18.8 kg

m⁻³ in drip irrigation to 5.9 kg m⁻³ in the plots irrigated as furrow irrigation in the field (Table 3). As shown in Table 3, water saving in the greenhouse condition was approximately 57.3 to 69.2 times higher than that under furrow irrigation and 37.0% higher than under drip irrigation (about 64.0-70.0% higher than the country average).

Table 3. Comparison of water consumption and water productivity of corn (Dehghan cv.) in greenhouse and field conditions.

Experiment conditions	Fodder fresh weight (Mg/ha)	Water consumption volume (m ³ /ha)	Water productivity (kg/m ³)	Reference
Greenhouse	88.1	3600	24.5	Findings of the present research
Field (Furrow irrigation)	68.9	11698	5.9	Ranjbar et al. 2024
Field (Furrow irrigation)	63.1	8423	7.5	Shekholeslami and Naeil, 2010
Field (Drip irrigation)	107.3	5718	18.8	
Country average (Iran)	53.0	10000-12000	5.3-4.4	Anonymous, 2021

DISCUSSION

The results show that forage crops could produce more yield in greenhouse conditions than in field conditions in a shorter growing period. For example, while the fodder beet yield in this experiment was about 218 Mg ha⁻¹, the mean yield of fodder beet under suitable conditions in the field is almost 80 Mg ha⁻¹ (Shalaby et al. 1989). In Turkey root yield for Feldherr cultivars was reported as 109.7 to 135.5 Mg ha⁻¹ (Ozkose, 2013). Khogali et al. (2011) in a field experiment reported total green fodder yield for Voroshenger (Hungarian), Anisa (Italian), and Polyproductiva (Polish) cultivars of fodder beet by 146.2, 139.1, and 149.9 Mg ha⁻¹, respectively, at Khartoum, Sudan. In Iran, a field experiment conducted in two regions revealed that Kyros produced the highest fodder fresh weight, at 101.2 Mg ha⁻¹, surpassing both foreign varieties (Brunium, Jamon, Rigour) and local varieties (SBI 050, SBI 051, SBI 052). It should be noted that the length of the growth period of the fodder beet in the field condition is usually about 200 days (Taleghani et al. 2019). The total fresh weight of fodder for safflower was reported to be 28.5 Mg ha⁻¹ in the coastal zone of northwest Turkey (Arsalan et al., 2012).

In turn, according to the literature review, the amount of sorghum yield in the greenhouse (current study) is at least 5 times higher than the reported forage yields in

the field conditions. Ayub et al. (2012) compared seven forage sorghum varieties under irrigated conditions in Faisalabad, Pakistan. They found that they harvested about 54.6 and 17.3 Mg ha⁻¹ of shoot fresh and dry weight, respectively, in 70 days. The highest mean fresh yield for sorghum, Speedfeed cv., was reported by 249.7-298.4 Mg ha⁻¹ and 80.29 to 92.06 tha⁻¹ in the studies of Eshraghi-Nejad et al. (2022) and Varmazyari et al. (2012).

In another experiment in a rain-fed agriculture region of China with precipitation of 590.1 and 472.1 mm, Gao et al. (2022) reported the highest above-ground dry matter yield for sorghum by 22.3 and 18.0 Mg ha⁻¹ at the milk stage, respectively. Marsalis et al. (2010) also indicated that maximum dry matter yield (24.6 Mg ha⁻¹) for sorghum could be achieved with an optimum condition. Although dry matter reported by 33-36% of fresh weight (Yusriani et al., 2023), it seems the dry matter content of sorghum that has grown in greenhouse conditions (about 18%) is lower than in the field conditions.

Generally, the average field yield for fodder corn between 2015 and 2021 was reported as 85-104 Mg ha⁻¹ (FAO, 2024), but the highest fresh weight varies globally. Ranjbar et al. (2024) obtained about 70 Mg ha⁻¹ fresh weight for corn, SC-704 under field conditions at Yazd, Iran (The location of the present experiment). Ahmad et

al. (2023) obtained 62.4 to 67.8 kg of fodder fresh weight with a dry weight of 17.3 to 23.4 Kg ha⁻¹ in a field study at Khyber Pakhtunkhwa, Pakistan. Yilmaz et al. (2007) reported a mean of 55.9 to 69.5 and 21.6 to 27 Mg ha⁻¹ for corn fresh and dry weight in Turkey, respectively. The highest fresh and dry forage yields of 77.8 and 32.7 Mg ha⁻¹ were reported for Isfahan, Iran, respectively, in optimum situation (Esfahani et al., 2014).

Results of the forage nutritional values also showed that the quality indices for fodder in the crops that were grown in the greenhouse were not different from those in the field conditions. The crude protein for sorghum and corn by 10.7 and 8.3% of dry matter is similar to the protein content of these crops in field conditions. For example, where Varmazyari et al. (2012) reported the highest protein percent of 11.07% for sorghum (Speedfeed cv.) at the optimum condition, Rana et al. (2014) obtained a mean crude protein for different sorghum varieties of 3.9 to 6.6%. The mean crude protein for the corn was reported by 5.2% of dry matter (Rehman et al., 2023).

CONCLUSION

Limited water resources availability is becoming the main challenge for sustainable crop production in semiarid regions such as Iran. To address this issue, improving water productivity must be a key approach. Results of the present study showed that it is possible to achieve an acceptable fodder yield by growing forage crops in the greenhouse.

Safflower and fodder beet, which have been successfully used as sole food or silage in the diet of dairy cows and sheep, as well as corn and sorghum, are suitable options for fodder production in the greenhouse. When the vegetable greenhouse is empty for a period of continuous three months, growing fodder corn is so appropriate. Meanwhile, a high level of nutrient availability in the soil after greenhouse fruit vegetables is usually ensured, allowing for an optimal yield without the need for additional fertilizer.

In summary, by planting appropriate cultivars of fodder crops in the greenhouse, it is possible to produce about 105, 93.6, and 238.1 Mg ha⁻¹ corn, safflower, and fodder beet forage in a period of 3 to 4 months. The amount of sorghum fodder in the greenhouse could be at least five times that of field conditions in a year. Water consumption in greenhouse conditions is approximately

30-36% of that in field conditions. Further studies with different cultivars of fodder crops and economic evaluation of forage production in greenhouses are recommended.

REFERENCES

- Ahmad, H., Ahmed, U., Ullah, I. and Masud, H. 2023. Comparing fodder production of maize varieties under varied nitrogen levels. *Journal of Applied Life Sciences & Environment*, 56(4): 551-562.
- Aghashahi, A.R. 2022. Strategic document of using potentials and improving productivity for self-reliance in livestock and poultry feed production. *Iranian Institute of Animal Sciences Research, Agricultural Research, Education and Extension Organization (AREEO)*, 166 p.
- Al-Karaki, G.N. 2010. Hydroponic green fodder: alternative method for saving water in dry areas. In *Proceedings of the "Second Agricultural Meeting on Sustainable Improvement of Agricultural and Animal Production and Saving Water Use*. September 2010, Sultanate of Oman.
- Al-Karaki, G.N. and Al-Momani, N. 2011. Evaluation of some barley cultivars for green fodder production and water use efficiency under hydroponic conditions. *Jordan Journal of Agricultural Sciences*, 7(3): 448-456.
- Anonymous. 2021. *Agriculture Statistics of Iran, 2021*. Ministry of Agriculture. Tehran, Iran.
- AOAC. 1990. *Official methods of analysis*, 15th Edition. Association of Official Analytical Chemists, Washington, DC, USA
- Arslan, B., Ates, E. and Coskuntuna, L. 2012. Forage yield and some quality properties of safflower (*Carthamus tinctorius* L.)-fodder pea (*Pisum arvense* L.) mixtures, as affected by sowing rates in Thrace region, Turkey. *Romanian Agricultural Research*, 29: 255-260.
- Ayub, M. A. N. M., Khalid, M., Tariq, M., Elahi, M. and Nadeem, M. A. 2012. Comparison of sorghum genotypes for forage production and quality. *The Journal of Animal & Plant Sciences*, 22(3): 733-737.
- Esfahani, H. Z., Aminpanah, H. and Gandomani, H. D. 2014. Effect of planting date and nitrogen rate on yield and quality of forage corn. *Poljoprivreda i Sumarstvo; Titograd*, 60: 193-206.

- Eshraghi-Nejad, M., Alavi Siney, S.M., and Aien, A. 2022. Investigation and comparison of the forage sorghum genotypes yields under water stress conditions in the southern region of Kerman. *Environmental Stresses in Crop Science*, 15(1): 31-41.
- Espinosa-Robles, P., Espinosa-Mendoza, L., Pérez-Mercado, C. and Agustin-Martinez, J. 2009. Hydroponics maize forage production. *Acta Horticulture*, 843: 283-286.
- Fazaeli, H., Golmohammadi, H.A. and Tabatatbaei, S.N. 2021. Effect of Replacing dietary corn silage with hydroponic barley green fodder on Holstein Dairy Cows Performance. *Iranian Journal of Applied Animal Science*, 11(1): 47-57.
- Gao, W., Shou, N., Jiang, C., Ma, R. and Yang, X. 2022. Optimizing N application for forage sorghum to maximize yield, quality, and N use efficiency while reducing environmental costs. *Agronomy*, 12(12): 2969.
- Khogali, M. E., Dagash, Y. M. and EL-Hag, M. G. 2011. Productivity of fodder beet (*Beta vulgaris* var. *Crassa*) cultivars affected by nitrogen and plant spacing. *Agriculture and Biology Journal of North America*, 2(5): 791-798.
- Marsalis, M.A., Angadi, S.V. and Contreras-Govea, F.E. 2010. Dry matter yield and nutritive value of corn, forage sorghum, and BMR forage sorghum at different plant populations and nitrogen rates. *Field Crops Research*, 116: 52-57.
- Naik, P.K., Swain, B.K., Chakurkar, E.B. and Singh, N.P. 2017. Effect of seed rate on yield and proximate constituents of different parts of hydroponics maize fodder. *Indian Journal of Animal Sciences*, 87: 109-112.
- Özköse, A. 2013. Determination of yield and yield components of fodder beet (*Beta vulgaris* L. var. *rapacea* Koch.) cultivars under the Konya region conditions. *International Journal of Agricultural and Biosystems Engineering*, 7(12): 1157-1160.
- Rana, A. S., Ahmad, A. H., Saleem, N., Nawaz, A., Hussian, T. and Saad, M. 2014. Differential response of sorghum cultivars for fodder yield and quality. *Journal of Global Innovations in Agricultural and Social Sciences*, 2(1): 6-10.
- Ranjbar, G.H., Beyrami, H., Tabatabaiei, S.A., Shiran-Tafti, M. and Anoshe, H.P. 2024. Effect of conservation tillage methods in comparison with conventional tillage on on water holding capacity and soil organic matter amount (case study: Yazd). *Journal of Agricultural Science and Sustainable Production*, 34(2): 299-313.
- Rehman, S., Nizam, S., SaimaRubab, S. B. and Wei, X. 2023. Evaluation of Protein Content in Some Fodder Crops. *Hamdard Medicus*, 66(1): 14.
- Shalaby, A. S., Rammah, A. M., Abdul-Aziz, G. M. and Beshay, M.G. 1989. Fodder beet, a new forage in Egypt. 1. Productivity and the chemical analysis of some Fodder beet (*Beta vulgaris* L.) cultivars sown at different locations in Egypt. In proceedings of the third Egyptian British Conference on Animals, fish and poultry production. Alexandria, Egypt, 13: 133-143.
- Sheykholeslami, M.B., and Naeil, M.K. 2010. The National Conference on Water Crisis Management. Azad University, Marvdasht, Iran [In Farsi].
- Sneath, R. and McIntosh, F. 2003. Review of hydroponic fodder production for beef cattle. Queensland Government, Department of Primary Industries, Dalby, Queensland
- Taleghani, D., Sadeghi-Shoa, M., Moharamzadeh, M., Aghashahi, A.R., Sadeghzadeh-Hemayati, S., Mohammadian, R. Urazizadeh, M.R., and Hamdi-Holasou, F. 2019. Comparison of biomass and water use efficiency of fodder beet cultivars. *Agricultural Research, Education and Extension Organization (AREEO)*. 38 P [In Farsi].
- Van Soest, P.J., Robertson, J.B. and Lewis, B.A. 1991. Methods for dietary fiber, neutral detergent fiber and non-starch polysaccharides in relation to animal nutrition. *Journal of Dairy Science* 74: 3583-3597.
- Varmazyari, A., Khalili-Mahaleh, J., Roshdi, M. and Kharazmi, K. 2012. Effects of nitrogen application and Time on fodder yield and some characteristics of Forage Sorghum var. Speed-Feed. *Advances in Environmental Biology*, 6(2): 587-593.
- Yilmaz, S., Gozubenli, H., Konuskan, O., & Atis, I. (2007). Genotype and plant density effects on corn (*Zea mays* L.) forage yield. *Asian Journal Plant Science*, 6(3), 538-541.
- Yurtseven, S., Guler, A. and Sakar, E. 2020. Effects of hydroponic media on forage and silage quality of barley (*Hordeum vulgare*). *Applied Ecology and Environmental Research*, 18(1): 1601-1610.

Yusriani, Y., Usrina, N., Fitriawaty, Haiqal, N., Hayanti, S.Y., Qomariyah, M., Bakar, B.A., Idawanni, Nathania, N.M. and Sabri, M. 2024. Potential and

utilization of sorghum in dry land as animal feed. In IOP Conference Series: Earth and Environmental Science, 1297: 012023.

Publisher's note: ESscience Press remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Open Access This article is licensed under a Creative Commons Attribution 4.0 International License, which permits use, sharing, adaptation, distribution and reproduction in any medium or format, as long as you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license and indicate if changes were made. The images or other third-party material in this article are included in the article's Creative Commons license, unless indicated otherwise in a credit line to the material. If material is not included in the article's Creative Commons license and your intended use is not permitted by statutory regulation or exceeds the permitted use, you will need to obtain permission directly from the copyright holder. To view a copy of this license, visit <http://creativecommons.org/licenses/by/4.0/>.