



Nutritional Value of Open Medium Grassland and Its Interaction with Year, Season, Ranch, And Grassland Condition

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Abstract

Globally, the value of grasslands has been underestimated; however, they support more than 800 million people. The state of Zacatecas has 5.4 million ha dedicated to livestock production, of which 2.3 million ha have a high level of degradation. To improve grassland condition, it is necessary to dynamically assess the production and nutritional content of biomass and to have technically and economically feasible measurement tools that allow decisions to be made regarding conservation and production through the adjustment of stocking rates. The objective of the study was to evaluate the nutritional contribution of vegetation on three ranches with open medium grassland and its interaction with edaphic and climatic factors. The premise was that the nutritional contribution and production of open medium grassland are at their lowest levels during drought years and are directly related to rainfall, soil, temperature, and livestock management. A total of 120 grass samples were collected from three ranches in May and October of 2024 and 2025. These samples were analyzed for Crude Protein according to the A.O.A.C. technique, 1999; Acid Detergent Fiber (ADF) and Neutral Detergent Fiber (NDF) fractions using the Van Soest method, 1991; and In Vitro Digestibility (IVDMD) using the Tilley and Terry method, 1963. The data were analyzed using a factorial analysis with four factors (year, season, ranch, and grassland condition) with data on Crude Protein (CP), Ash, NDF, ADF, and IVDMD. Significant results were obtained for CP for year, year by season, and season by ranch, $P = (< .0001)$. For Ash, significance was detected for ranch and season by ranch, $P = (< .0001)$. Regarding NDF, year and year by season were significant, $P = (< .0001)$. For ADF, significance was found for year, season, ranch, and condition. Finally, in relation to IVDMD, season and ranch were significant, $P = (< .0001)$. The results show the correlation with the four factors under study and their interaction with edaphic and climatic factors. This method allows livestock producers to determine the nutritional contribution of their grasses, providing basic information for planning supplementation programs during critical drought or winter periods, with better utilization and use of the grassland.

Keywords: Grassland, bromatological analysis, precipitation, soil, stocking rate

Introduction

Grasslands and shrublands in the arid and semi-arid regions of central and northern Mexico are natural resources that comprise approximately 25% of the national territory (SEMARNAT, 2016). The state of Zacatecas has 5.4 million ha dedicated to livestock production, of which 2.3 million ha have a high level of degradation (Echavarría et al., 2009). The most important resources for livestock production in the extensive system in northern Mexico are water and forage. Grassland condition allows decisions to be made to optimize production and protect natural resources (Fariña et al., 2019). Grassland condition is commonly estimated based on species classified according to animal selectivity and ecological attributes (Cerqueria et al., 2003). Regarding quantitative information on grassland condition, it is limited, isolated, and dispersed in Zacatecas; however, knowing the nutritional quality of forage through monitoring grassland condition is key to providing optimal management that allows the sustainability of natural resources and maximizes the productivity and profitability of livestock activity (Medina et al., 2009). The combined effects of overgrazing and climate warming accelerate soil water loss in grassland regions, which has significant implications for grassland management (Xiliang et al., 2017). Traditionally, the evaluation of grassland condition has been based on the present state of vegetation, estimated by the presence and abundance of species classified according to ecological attributes (Dyksterhuis, 1949), and soil protection, in relation to the potential natural community for a given site (Jacoby, 1989; Du Toit, 1995).

Grasslands not only provide essential energy, proteins, vitamins, minerals, and fiber in the diet of ruminants, offering high-quality feed for livestock, but at the same time improve soil quality and reduce greenhouse gas emissions, as mentioned by Akbar and Alam (1991), Ajayi et al. (2005), and Burte et al. (2006). In grasslands, production is important, as is the nutritional value of forage, because there may be good dry matter production while the nutritional content is deficient. The nutritional content of grasslands varies according to the season of the year. In northern Mexico, there are three defined seasons: rainy season (July–September), “nortes” (October–January), and dry season (February–June), which affect the quantity and quality of forage (Gray et al., 1987). On the other hand, the chemical composition of forages varies according to physiological age, harvest time, fraction, species and variety of pastures, degree of contamination, and botanical fraction (Adesogan et al., 2000). Likewise, the nutritional value of forages is strongly related to their chemical composition and digestibility, which vary widely among forages (Fox et al., 1995). The

condition and chemical composition of grasslands are influenced by various factors: temperature, season, year, soil, rainfall, stocking rate, vegetation type, and altitude above sea level (Jurado-Guerra et al., 2021). Knowledge of nutritional value offers additional advantages when integrated with information on availability, preference, seasonal variation, and ecophysiological characteristics, which helps to link them with nutritional and physiological aspects, improving the relationship between livestock nutrient demand and grassland supply (Hidalgo et al., 1998). For the producer and nutritionist, it is important to know the chemical composition of grassland plants because it is directly related to the nutritional status of the animals and their body condition (Rodríguez, 2026). Currently, advanced laboratory techniques are available that allow the nutritional value of forages (grasslands) to be evaluated, especially during periods when grass quality decreases. This allows the quantity and quality of forage to be supplemented according to nutritional requirements to be determined (NRC, 1996). There are also other factors to consider in relation to grassland quality, such as desirability, which is measured in terms of agronomic attributes, such as species palatability and livestock selectivity, and in terms of ecological attributes, such as dominance, grazing resistance, and perennality (Du Toit, 2000). With the available information on chemical composition, nutritional value, nutritional requirements, and livestock management, the relationship among plant, animal, and environment is better understood, and this information has been used to make better use of forage by grazing animals (Vásquez-Aguilar et al., 2024).

Materials And Methods

The study was conducted in the state of Zacatecas. The climate corresponds to type B (dry) in 80% of the area, temperate in 19%, and type A (warm humid) in 1% (CONAFOR, 2014). The study was carried out in an open medium grassland located in a dry climate with a warm summer, classified as BS1kw (semi-dry temperate) according to the classification of Koppen (1948), with an annual mean temperature of 15 to 18 °C and precipitation of 355 mm. For the present study, information was obtained from the INIFAP climatic stations in Zacatecas and from the monitoring conducted at each ranch. The study was carried out at three sites (ranches) that differed in terms of soil and were located at different levels of productive suitability of livestock soils in the state of Zacatecas. The ranches were: “Tula” Ranch, “La Jococa” Ranch, and “Nueva Generación” Ranch (Echavarría et al., 2009), with the “Tula” and “Nueva Generación” ranches having high potential and the “La Jococa” ranch having low productive potential, as shown in Figure 1. Table 1 shows the study sites, general information, and their geographic coordinates.

Table 1. Study area and general description of the livestock ranches selected for the research study

Ranch	Municipality	Area (ha)	No. of Paddocks	No. of Head	Coordinates
1) Jococa	Panuco	333	4	66	23° 03'08 N, 102° 32'44 W
2) Nueva Generación	Fresnillo	640	3	189	22° 58'20.2 N, 103° 07'12 W
3) Tula	Zacatecas	1,400	7	129	22° 40'57.6 N, 102° 37'15 W

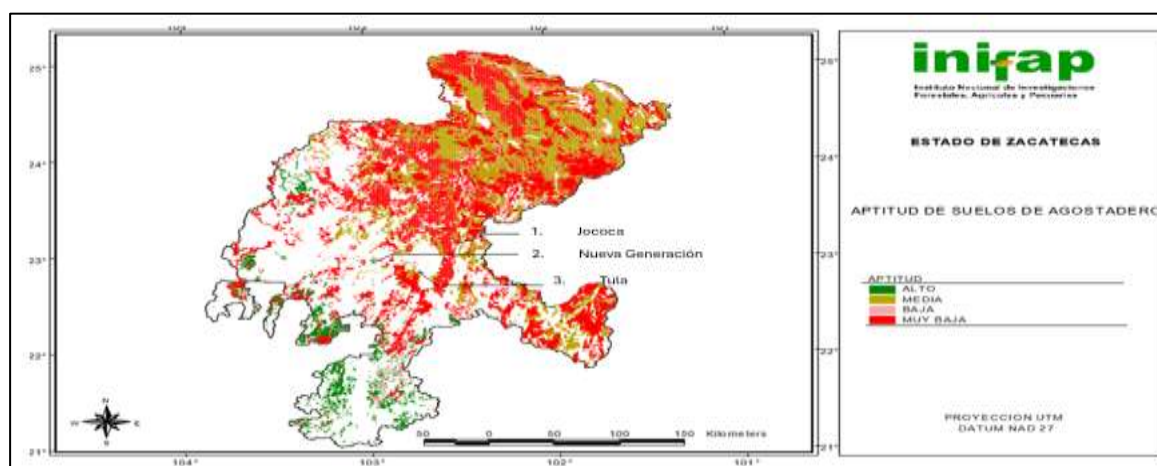


Figure 1. Map of livestock production potential in the state of Zacatecas and location of the three ranches situated at different levels of productive suitability (Echavarría et al., 2009).

A rain gauge was installed at each ranch to record weekly precipitation. Temperature and evapotranspiration data were collected monthly from the climatic stations of the National Institute of Forestry, Agricultural and Livestock Research of Zacatecas (INIFAP) nearest to the experiment. Five soil samples were obtained from each ranch, one from each exclusion site, giving a total of 15 samples, which were analyzed in the INIFAP soil laboratory.

Five exclusion enclosures measuring 15 × 15 m were constructed per ranch using 1.80 m-high sheep fencing, from which grass samples were obtained using the square-meter system, taken inside and outside the exclusion site. A total of 120 samples were collected in May and October of 2024 and 2025, 60 inside the exclusion area and 60 outside the exclusion area. These were identified with information on year, season, ranch, and condition and were dehydrated until

a constant dry weight was obtained. They were then ground in a Wiley mill to obtain the samples used in the bromatological analyses.

The samples were analyzed for Crude Protein according to the A.O.A.C. technique, Acid Detergent Fiber and Neutral Detergent Fiber fractions using the Van Soest method, and In Vitro Digestibility using the Tilley and Terry method. The bromatological analyses of Protein, Ash, Acid Detergent Fiber (ADF), Neutral Detergent Fiber (NDF), and In Vitro Dry Matter Degradability (IVDMD) were carried out in the nutrition laboratory of the Academic Unit of Veterinary Medicine and Animal Science of the UAZ.

The data analysis was performed using a multifactorial design, executed in the SAS system, 2011, version 9.1.

$$y_{ijklm} = \mu + \alpha_i + \beta_j + \alpha\beta + C_k + \alpha C_{ik} + \beta C_{jk} + D_l + D_{il}\alpha + D_{ij}\beta + D_{jk}C + \alpha\beta C_{jk} + \alpha\beta CD_{ijkl} + \varepsilon_{ijklm}$$

Where:

Dependent Variable:

α = Year

β = Site

C = Ranch

D = condición

Protein, Ash, Neutral Detergent Fiber,

Acid Detergent Fiber, Degradability

Dry Matter.

= condición

Results

Table 2. Mean data from the bromatological analysis of grassland samples from La Jococa Ranch (inside and outside the exclusion area) for the years 2024 and 2025. Data expressed as %.

Bromatological Analysis – La Jococa Ranch							
Year	Season	I/O	Protein	Ash	NDF	ADF	IVDMD
2024	May	I	6.17	7.60	83.95*	63.52*	34.87
2024	May	O	7.59	5.71	81.76*	54.90*	34.95
2024	October	I	5.54	6.83	64.91	51.60	40.91
2024	October	O	6.25	7.40	63.48	51.42	42.02
2025	May	I	3.88	6.95*	59.92	50.81	41.44
2025	May	O	3.92	7.78*	60.21	49.12	41.02
2025	October	I	5.08	6.98	56.85	36.76	44.50*
2025	October	O	5.72	7.03	68.18	46.60	44.02*

*Significant at $P < .0001$

Table 2 shows that in May 2024, Crude Protein had its highest level, 7.59, under the condition outside the exclusion area, while the lowest level, 3.92, was recorded under the condition inside the exclusion area in May 2025, with the latter coinciding with the lowest precipitation. With regard to ash, the values were very homogeneous, ranging from 5.71 in May 2024 to 7.60 in May of the same year. On the other hand, the highest NDF and ADF values were recorded in May 2024, with 63.52 and 83.95, respectively, whereas the lowest NDF and ADF values, 56.85 and 36.76, respectively, were recorded in October 2025 for the parameters mentioned above.

Finally, with regard to Dry Matter Digestibility (IVDMD), the lowest values were recorded in May 2024, with 34.87, while the highest value was 44.50 in October 2025, with the latter coinciding with the highest rainfall.

Table 3. Mean data from the bromatological analysis of grassland samples from Nueva Generación Ranch (inside and outside the exclusion area) for the years 2024 and 2025. Data expressed as %

Bromatological Analysis – Nueva Generación Ranch							
Year	Season	Condition	Protein	Ash	NDF	ADF	IVDMD
2024	May	I	5.35	8.13*	77.47*	54.42*	33.95
2024	May	O	5.20	10.14*	81.32*	56.08*	33.15
2024	October	I	7.78*	8.27	65.67	47.85	43.35*
2024	October	O	6.49	7.34	64.96	47.57	42.57
2025	May	I	1.80	7.82	65.03	46.08	32.43
2025	May	O	1.72	8.02	62.63	45.29	35.91
2025	October	I	4.44	7.64	66.78	46.09	38.18
2025	October	O	5.93	7.32	64.89	44.28	40.26

*Significant at $P < .0001$

In Table 3, with regard to Crude Protein, the highest level was recorded in October 2024, with a value of 7.78 under the condition inside the exclusion area, while the lowest level, 1.72, was recorded under the condition outside the exclusion area in May 2025, with the latter coinciding with the lowest rainfall. Regarding Ash, the values ranged from 7.32 in October 2025 to 10.14 in May 2024. On the other hand, the highest NDF and ADF values were recorded in

May 2024, with 81.32 and 56.08, respectively, whereas the lowest NDF and ADF values, 62.63 and 44.28, respectively, were recorded in October 2025 for the parameters mentioned above.

Regarding Dry Matter Degradability (IVDMD), the minimum value was recorded in May 2025, with 32.43, while the highest value was 43.35 in October 2024, with the latter coinciding with the highest rainfall recorded.

Table 4. Mean data from the bromatological analysis of grassland samples from Tula Ranch (inside and outside the exclusion area) for the years 2024 and 2025. Data expressed as %

Bromatological Analysis – Tula Ranch							
Year	Season	Condition	Protein	Ash	NDF	ADF	IVDMD
2024	May	I	7.84*	5.99	69.16*	50.32	45.60*
2024	May	O	7.59*	7.48	79.02*	51.29	46.50*
2024	October	I	4.84	8.29*	73.42	59.96*	37.26
2024	October	O	4.64	10.13*	67.44	54.73*	36.03
2025	May	I	2.73	8.28	68.14	47.69	36.88
2025	May	O	2.67	7.17	65.66	50.73	42.97*
2025	October	I	4.29	9.24*	69.19	48.46	39.09
2025	October	O	4.89	9.87*	61.28	39.08	39.15

*Significant at $P < .0001$

7.84 and 7.59, which were significant for year and season, $P < .00$, whereas the minimum value was 2.67 in May 2025. Regarding Ash content, the lowest value was 5.99 in May 2024 (inside), while the highest value was 10.13 in October 2024 (outside). In relation to NDF and ADF content, the highest values were 79.02 in May 2024 and 59.96 in October 2024, respectively. The highest value of Dry Matter Degradability (IVDMD), 46.50, was recorded outside the exclusion area in May 2024; in contrast, the lowest value was 36.03 in October 2024.

Table 5. Results of the statistical analyses of the dependent variables

Protein	Year × Season	Season × Ranch
Ash	Year × Season × Ranch × Condition	
NDF	Year × Season	
ADF	Year × Season × Ranch × Condition	
IVDMD	Year × Ranch	Season × Ranch

The data reflecting the highest Crude Protein content were recorded at Tula Ranch in May 2024, with values of 7.84 and 7.59 for the conditions inside and outside the exclusion area, respectively.

Table 6. Soil fertility values for La Jococa, Nueva Generación, and Tula Ranches, year 2024

Soil Reaction and Fertility				
Data	pH	O.M. %	Inorganic Nitrogen mg/kg	Olsen Phosphorus mg/kg
Nueva Generación	6.73	2.87	26.57	9.58
Tula	7.14	1.59	7.92	2.7
Jococa	8.2	1.22	20.98	7.4

Table 6 shows the pH data, where Jococa Ranch had the most alkaline pH of 8.2, while Nueva Generación had the most neutral pH of 6.73. Regarding the percentage of organic matter, Nueva Generación showed the highest value at 2.87, while Jococa had 1.22. Finally, with regard to Nitrogen and Phosphorus, Nueva Generación had the highest contents, with 26.57 and 9.58 for Nitrogen and Phosphorus, respectively. In contrast, Tula Ranch had the lowest values, with 7.92 and 2.7, respectively. On the other hand, Tula Ranch had the intermediate pH value of 7.14, with a greater balance between acidic and alkaline conditions.

Table 7. Soil texture values for La Jococa, Nueva Generación, and Tula Ranch. Year 2024

Texture					
Data	% Sand	% Clay	% Silt	Textural Class	Bulk Density g/cm ³
Nueva Generación	44.84	27.16	28	Clay Loam	1.42
Tula	38.92	31.112	29.96	Clay Loam	1.414
Jococa	46.37	25	28.62	Sandy Clay Loam	1.17

Table 7 shows the results for soil texture. For Nueva Generación Ranch and Tula Ranch, the textural classification was clay loam, while for Jococa Ranch it was sandy clay loam. Regarding bulk density, Nueva Generación Ranch had the highest bulk density value of 1.42, whereas the lowest value was recorded at La Jococa Ranch, with 1.17.

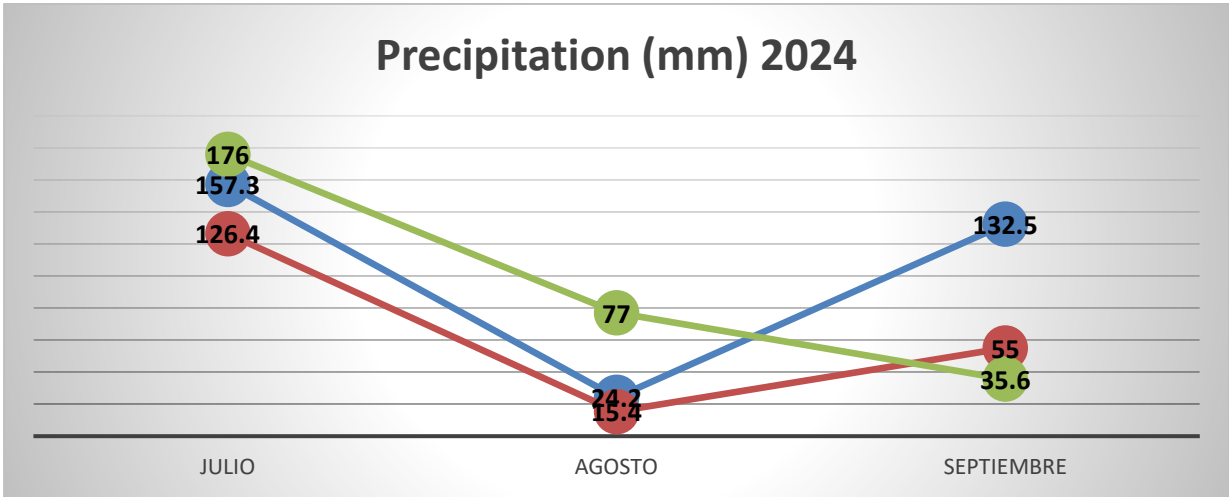


Figure 2. Annual rainfall at La Jococa, Nueva Generación, and Tula Ranches in 2024. Expressed in annual mm.

Figure 2 presents the annual rainfall data for 2024 for the three ranches, where Tula Ranch had a rainfall of 314 mm, followed by Jococa Ranch with 288.6 mm, and finally Nueva Generación Ranch with 196.8 mm.

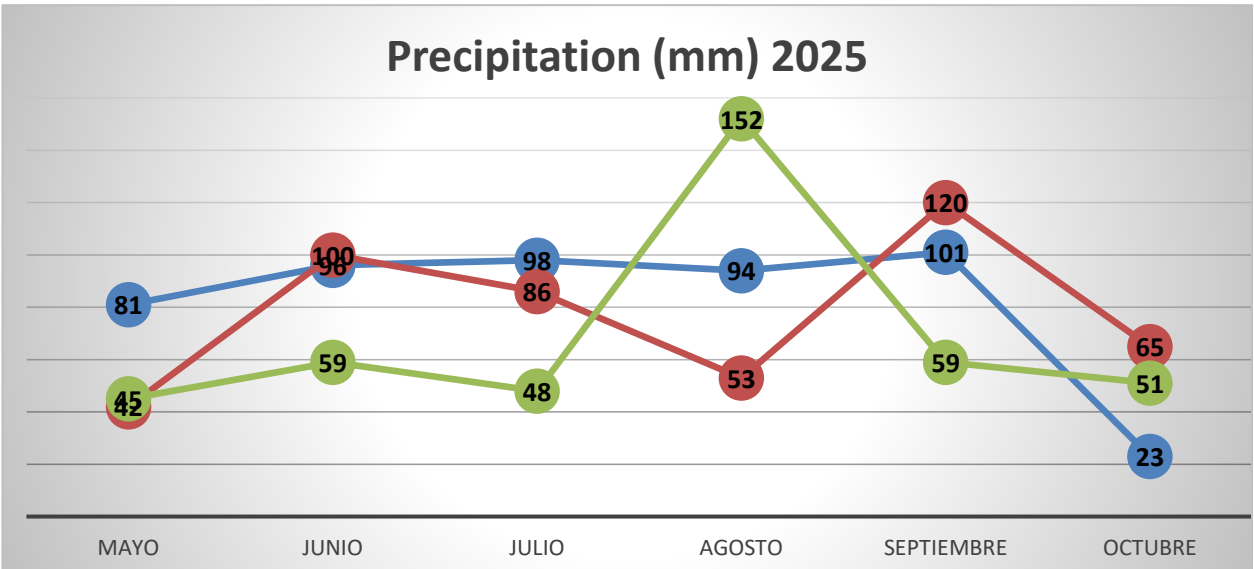


Figure 3. Annual rainfall at La Jococa, Nueva Generación, and Tula Ranches in 2025.

Figure 3 presents the annual rainfall data for 2025 for the three ranches, where Tula Ranch had a rainfall of 493 mm, followed by Nueva Generación Ranch with 466 mm, and finally La Jococa Ranch with 414 mm. Compared with the previous year, rainfall was 79% higher.

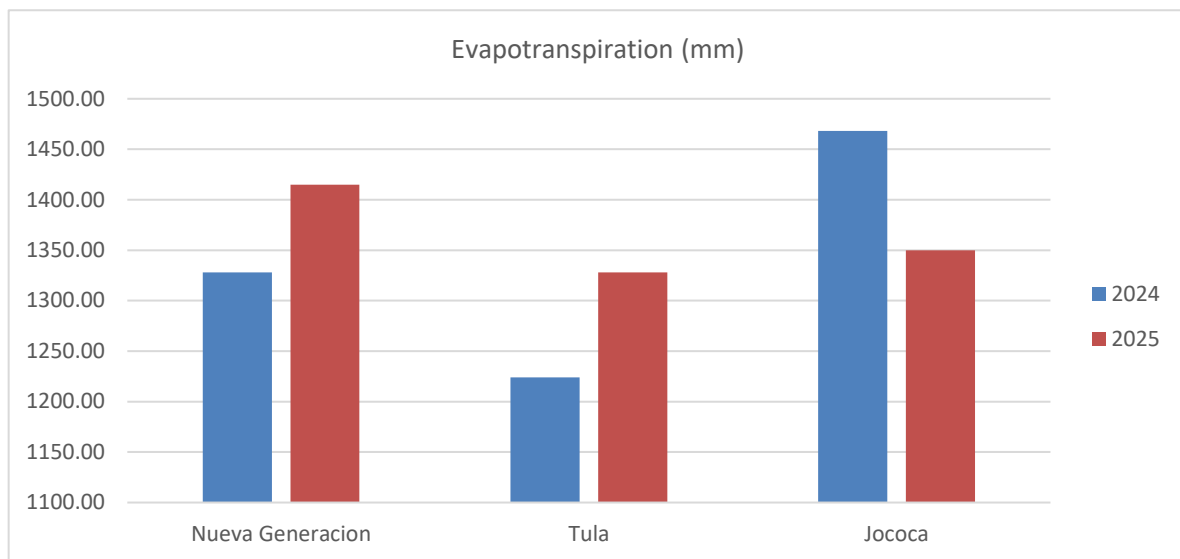


Figure 4. Mean evapotranspiration values for La Jococa, Nueva Generación, and Tula Ranches for the years 2024 and 2025. Source: INIFAP climatic stations, Zacatecas.

Figure 4 shows that the highest evapotranspiration values in 2024 were recorded at Jococa Ranch, with 1460 mm, while the lowest were recorded at Tula Ranch, with 1215 mm. In 2025, the amount of evapotranspiration decreased, with Nueva Generación Ranch recording the highest value at 1410 mm and Tula Ranch the lowest at 1320 mm.

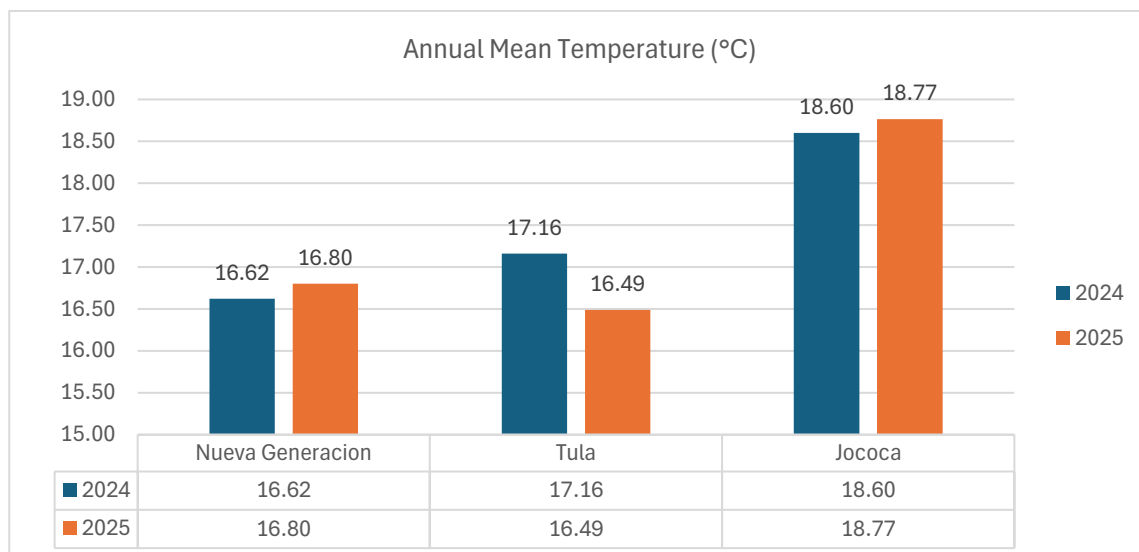


Figure 5. Mean temperature values for La Jococa, Nueva Generación, and Tula Ranches for the years 2024 and 2025. Source: INIFAP climatic stations, Zacatecas.

Figure 5 shows that the highest temperatures corresponded to La Jococa Ranch for the years 2024 and 2025. In contrast, the minimum values observed were recorded at Nueva Generación Ranch for the same years, while Tula Ranch remained at an intermediate level. The maximum mean values were 18.75 °C and the minimum values were 16.50 °C.

Discussion

Grassland condition is commonly estimated based on species classified according to animal selectivity and ecological attributes (Cerqueria et al., 2003); however, knowing the nutritional quality of forage through monitoring grassland condition is key to providing optimal management that allows the sustainability of natural resources and maximizes the productivity and profitability of the activity.

Regarding Crude Protein (CP), Tula Ranch had the results with the highest percentage of protein, with 7.84 in May 2024, followed by Nueva Generación Ranch with 7.78 in October 2024, and finally La Jococa Ranch with 7.59 in May 2024. These results are related to the precipitation and temperature patterns observed in 2023. In this regard, Chang et al. (2018) mention that in arid and semi-arid regions, there is interannual variability in precipitation. Recently, it has been demonstrated that annual grassland condition largely depends on precipitation in the current year and the previous year (Chang et al., 2018; Martiny et al., 2005). The dependence of vegetation variation on precipitation is referred to

as “time-lag effects.” It is commonly known that vegetation variation is correlated not only with precipitation in the current year but also with the vegetation itself in previous years (Taosuo et al., 2019). This would partly explain the variation in nutritional content, but there are other factors such as soil quality, stocking rate, and livestock management. However, the results are very similar to those found by Rodríguez (2026), Echavarría et al. (2007), Medina et al. (2009), and Gutiérrez et al. (2018). Although there is variation among species in CP values, the grassland did not exceed the minimum crude protein level of 8% required by ruminants for optimal growth and multiplication of rumen microorganisms (Machen, 2012). In this regard, Chávez et al. (1986) mention that on 40% of ranches, grassland forage does not meet livestock requirements throughout the year. This deficit occurs at the end of the dry season due to two factors: grasslands are used with an inadequate grazing system, and the stocking rate employed exceeds the capacity of the ranch.

On the other hand, the lowest Crude Protein values were observed in samples from May 2025 for all ranches, which were 3.88, 1.72, and 2.73. These data are directly related to rainfall, evapotranspiration, and stocking rate during 2024 and January–June 2025, which were associated with below-average precipitation (Jiménez and Cantú, 2008). Similar data were found by Rodríguez et al. (2014), with 3.14% Crude Protein in a grassland in Sombrerete, Zac. Jurado et al. (2021) mention that CP decreases to 4.4% during the dry season in medium grasslands without shrub invasion, with the amount of Crude Protein being comparatively very low during this period. However, these values are lower than those reported by Bryant et al. (1980), Chávez et al. (1986), Sánchez et al. (2020), and Cerqueria et al. (2003).

Regarding Ash content, the highest levels were recorded in October 2024 and 2025, with percentages of 10.13, 10.14, and 7.40%, values similar to those reported by Rodríguez et al. (2014), with 13.9 in autumn. In other studies, such as that conducted by Jurado et al. (2021), the chemical composition of grasses was determined on three ranches sampled in the state of Zacatecas, with Ash values of 12.5, 13.43, and 9.82, respectively.

Neutral Detergent Fiber (NDF) showed significance for the year $\times$ season interaction ($P < .0001\%$). The highest NDF values for the three ranches were 83.95, 81.32, and 79.02, respectively, in May 2024, similar to the 82.7 obtained by Rodríguez et al. (2014) in spring. The lowest values were 56.85, 62.63, and 61.28 in October 2025, lower than the 79.7 reported by Rodríguez et al. (2014) in autumn. Similar results have been reported by Villalobos (1983). Barde et al. (2014), when conducting a chemical analysis of forage on rangeland, reported that all forage plants met the 8% crude protein and minimum 20% NDF requirements for optimal growth and multiplication of ruminal microbiota, as well as for adequate forage digestion in ruminants.

Regarding Acid Detergent Fiber (ADF), the data obtained showed significant differences ($P < .0001\%$) in relation to year, season, ranch, and condition. In general, the values tended to be higher during the rainy season and lower during the dry season (May 2024 and 2025), in contrast to rangeland (Jiménez and Cantú, 2008). When evaluating the effect of precipitation level on forage quality, it was concluded that there were no significant differences in Acid Detergent Fiber content and that fiber normally fluctuates in direct relation to the protein content of the forage.

With reference to Degradability (IVDMD), significant differences were observed in relation to year by ranch and season by ranch ($P < .0001\%$). Lignin content is negatively correlated with feed digestibility; therefore, the higher the lignin content in the sample, the lower its nutritional value (Khan et al., 2003). In general, the values tended to be higher during the rainy season and lower during the dry season (May 2024 and 2025) for the three ranches.

Cerqueria et al. (2003) evaluated two 24-ha grassland plots for each contrasting condition (fair and good), which were grazed at a low stocking rate during autumn, winter, and spring for two consecutive years. The results allowed the inference that, although absolute total biomass was similar between conditions, the good condition provided 2.5 times more biomass for animal categories requiring IVDMD equal to or greater than 40%. The inclusion of nutritional parameters improved the estimation of the condition of these grasslands for livestock purposes. According to López-Pérez et al. (2012), as the growing season progresses and the plant reaches maturity, fibrous components develop and increase, significantly reducing protein content, dry matter digestibility, and crude protein digestibility. For this reason, the highest digestibility values were recorded in October for the Jococa and Nueva Generación ranches and, to a lesser extent, at Tula Ranch.

Grassland communities are characterized by having a well-defined growing season, which begins with the onset of the rainy season from June to October. During winter, vegetation dynamics are reduced (López-Pérez et al., 2012). Rainfall effectiveness is determined by soil type and slope; runoff in shallow soils and on steep slopes occurs because of their reduced infiltration capacity (Jiménez and Cantú, 2008). On the other hand, Huss and Aguirre (1987) consider that shallow soils are associated with mountainous topography and hills with steep slopes. These soils reduce the capacity of a site to produce forage because of the limited space available for root development.

Echavarría et al. (2015) conducted a study on the health of grasslands in Zacatecas and showed that most of them are in a moderate state of health because, although soil properties are acceptable, the vegetation shows a high degree of deterioration.

Livestock production systems in semi-arid areas are vulnerable because of the recurrence of droughts, the presence of soils with low vegetation cover, and low organic matter content (Kéfi et al., 2007). Soils are products of the interaction of several factors, including parent material, climate, topography, time, and organisms, which interact interdependently (Honorato, 2000). Soil quality is related to its ability to sustain biological productivity, ecosystem functionality, and maintain a biophysical environmental balance (Navarrete et al., 2001).

One factor that improves the physical conditions of the soil to increase and conserve moisture after rainfall is the use of soil cover (Sharma et al., 2019; Herssaín et al., 2022).

The results indicate that, due to trampling and stocking pressure, bulk density values increased from 1.41 to 1.53 g cm, whereas under rotational grazing the parameters remained almost unchanged. These data are very similar to those obtained in the present study, ranging from 1.17 to 1.42. Likewise, soil penetration resistance values at the sites

increased from 14.6 to 17.9 Jcm, whereas under rotational grazing they remained stable, from 15 to 16.1 Jcm (Echavarria et al., 2007). On the other hand, grazing modifies the physical, chemical, and biological properties of the soil and affects hydrological processes, nutrient cycling, and plant production (Tate et al., 2004).

Moya et al. (2003) applied fourteen nitrogen (N) and phosphorus (P) fertilizer treatments in an overgrazed communal grassland in northern Mexico during 1990 and 1991, with a pH of 6.1. The results showed a significant improvement in dry matter production and Crude Protein, but there was no difference between nitrogen sources. On the other hand, Jarillo et al. (2011) investigated the effect of season and stocking rate on forage yield, Crude Protein, Neutral Detergent Fiber, and Acid Detergent Fiber in native grasses of Veracruz, concluding that the main factor affected was forage yield and nutritional quality. Stem density and length, as well as leaf length, were greater with a lower stocking rate during the rainy season.

Conclusion

Regarding Crude Protein content for the three ranches in 2024 and 2025, no value of 8% or higher was recorded, which is the recommended requirement for maintenance and optimal functioning of the physiological systems of ruminant livestock. This may have occurred because the samples were collected in May and October of each year, excluding grass harvesting in July and August, when the quantity and quality of nutrients are greater. With regard to the study variables, the factor with the greatest influence was season, which is related to precipitation and evapotranspiration. The second most important factor was year, followed by ranch, which was influenced by several factors, including stocking rate, soil condition, forage species, and general livestock management. Finally, the inside/outside exclusion condition was significant only for NDF and ADF in relation to ranch.

This method allows livestock producers to determine the nutritional contribution of their grasses, providing basic information for planning supplementation programs during critical drought or winter periods, with better utilization and use of the grassland. It is recommended to supplement the livestock diet with a source of non-protein nitrogen for all three ranches and also to provide energy through grains during the dry season. Finally, for Nueva Generación and La Jococa ranches, the stocking rate should be reduced, while at Tula Ranch, water distribution should be improved in order to increase the utilization and better use of the grassland.

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