



## Bromatological chemical composition of Palma Miúda Adensada using two types of organic fertilization

### Composição química bromatológica da Palma Miúda Adensada utilizando dois tipos de adubação orgânica

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#### ABSTRACT

Forage palm is adapted to regions of semiarid climate, constituting an important source of food for herds in the dry season, especially in the Northeast of Brazil. The present work aims to determine the bromatological chemical composition of the offal palm (*Opuntia cochenillifera*) irrigated due to two types of organic fertilization in the county of Santana do Ipanema - AL. The project was carried out in the Serrote dos Braz community, which is located in the county of Santana do Ipanema, mesoregion of the "Sertão Alagoano". The experimental design will be in randomized blocks, with arrangement of subdivided plots. The cladodes will be planted in domino format, testing levels of organic fertilization (cattle, goat, sheep and poultry manure) and chemical fertilization. To determine the bromatological composition, the plant material will be analyzed individually for the contents of dry matter, mineral matter, ether extract, crude protein, organic matter, lignin, neutral detergent fiber and acid detergent fiber. The cutting of the plants will be carried out in the first insertion, leaving only the mother plant. Then it will be made the weighing, in precision scale, of all the cladodes harvested, separating them by plot. The data obtained will be submitted to analysis of variance followed by Tukey's test. Being used the "PROC GLM - General Linear Models", of the Statistical Analysis System - SAS software, considering the significant values of probability lower than 5% ( $P < 0.05$ ).

#### RESUMO

Palma forrageira é adaptada às regiões de clima semiárido, constituindo importante fonte de alimento para os rebanhos no período de estiagem, sobretudo no Nordeste do Brasil. O presente trabalho tem como objetivo determinar a composição química bromatológica da palma miúda (*Opuntia cochenillifera*) irrigada em função de dois tipos de adubação orgânica no município Santana do Ipanema - AL. O projeto foi realizado na comunidade Serrote dos Braz, a qual está localizada no município de Santana do Ipanema, mesorregião do Sertão Alagoano. O delineamento experimental será em blocos casualizados ao acaso, com arranjo de parcelas subdivididas. Os cladódios foram plantados em formato dominó, testando níveis de adubação orgânica (esterco bovinos e aves) e adubação química. Para determinação da composição bromatológica, o material vegetal foi analisado individualmente para os teores de matéria seca, matéria mineral, extrato etéreo, proteína bruta, matéria orgânica, lignina, fibra em detergente neutro e fibra em detergente ácido. O corte das plantas foi realizado na primeira inserção, deixando apenas a planta mãe. Em seguida foi feita a pesagem, em balança de precisão, de todos os cladódios colhidos, separando-os por parcela. Os dados obtidos foram submetidos à análise de variância seguida pelo teste de Tukey. Sendo utilizado o "PROC GLM - General Linear Models", do software *Statistical Analysis System* - SAS considerando como valores significativos de probabilidade inferiores a 5% ( $P < 0,05$ ).

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## Introduction

The north-eastern region is marked by irregular rainfall and low rainfall, which severely damages grassland development. In the semi-arid region, livestock farming has a great economic and social expression, but a poor productive performance, which is partly a consequence of the limitations imposed by local reality and the importation of technologies unsuitable for these conditions (Araújo, 2009).

In terms of fodder production there are periods of high availability, of good quality, followed by periods of extreme scarcity, with nutritional value at low levels, which leads to a drop in the productive indices.

Fodder production is dependent on climatic conditions such as temperature, luminosity and water availability. During the dry season, fodder production is reduced, especially due to the water deficit of the soils. Therefore, the choice of management practices that reduce the problems arising from the stationality in the production of fodder must be consistent, in order to guarantee food throughout the year, particularly in arid and semi-arid regions.

The forage palm has been constituted in one of the bases of the feeding support of the dairy cattle of the Brazilian Northeast, seeing that it remains green and succulent when the majority of the fodder of the semi-arid loses its leaves or dies in the dry period. In this respect, the palma Miute (*Nopalea cochenillifera* Salm Dick) has great productive potential for the semi-arid northeast (Rego et al., 2014).

The soils of the Brazilian semi-arid region have low levels of organic matter, and consequently productivity depends on natural fertility, which sometimes does not meet the nutrition needs of the crops. In the case of dense palm, the literature has shown that the addition of organic matter, more specifically the use of bovine manure, is a soil management practice that makes it feasible to add nutrients, promoting an increase in productivity.

The use of chemical fertilization in the Brazilian semi-arid is reduced due to the high costs and risks of losses due to the irregularity and unpredictability of precipitation. Organic fertilization is one of the resources to increase soil fertility and one of the most efficient ways is the use of animal manure due to its composition, availability, application benefits, and is a common practice in the region (Alencar et al., 2011).

The presence of animal manure, mainly cattle manure, in most agricultural properties is one more tool in maintaining the fertility of the soils of the Brazilian semi-arid region. The animal manure has a variable composition due to the animal species, breed, age, feeding, farming system, animal handling, way of collection and handling. The average values in percentage of nutrients for bovine manure for NPK are 1.1 - 0.65 - 1.44, which corresponds to 76.2% of manure production in the Northeast. Sheep manure is equivalent to 6.0% (Garrido et al., 2008) with a NPK ratio of 1.4- 1.0- 2.1 (Carvalho e Guerra, 2012).

The benefits of applying dung relate both to the physical, chemical and biological properties of the soil. Physically improves soil structure, permeability, aggregate stability, aeration and water retention in the soil. Chemically, it tends to improve the pH and the levels of N, P, S, Ca, Mg, and to reduce Al in the surface layer, bringing about an increase in the population of macro and micro-organisms, whose action in the decomposition of organic matter makes the plants nutrients available. Studies carried out with forage palm show that there is a correlation between increased productivity, nutrient levels and dry matter in cladodes when there is an increase in organic fertilization (Ramos, 2012).

The choice of the spacing of the fodder palm is a function of the producer's production system and is directly related to light interception. However, in addition to these factors it's important to consider the availability of cladodes for planting, soil type, cultural management practices such as weeding, mowing, fertilizer application and consortium with other crops. Spacing, as a management strategy, is important in the establishment of palm because it defines the plant population, varying according to the fertility of the soil, amount of precipitation, exploration purpose and with the consortium to be used (Ramos et al., 2011).

Techniques such as planting spacing, harvesting management and fertilizing have been indicated as having a major influence on the productivity of forage palm. (Consoli et al., 2013) obtained yields of 12.9 t ha<sup>-1</sup> year<sup>-1</sup> with the palma Mivem (Lima et al., 2015) reported a PMS of 23.04 t ha<sup>-1</sup>yr<sup>-1</sup> with irrigated Chicken palm, at the density of 50 thousand plants, preserving secondary cladodes and with chemical and organic fertilization. The level of fertilization is a determining factor in the production of green mass. Phosphorus deficiency has reduced the total number of cladodes per palm plant, a limiting factor being the productive capacity of this forage plant. On the other hand, they found that the increase in nitrogen brought about an increase in the total number of cladodes per plant. The nutritional characteristics of the food are related to its chemical composition, which indicates the amount of nutrients potentially available to the animal. In general, there is variation in the chemical composition of the different foods, so that a single food does not provide all the nutrients in quantity and proportions perfectly adjusted to the animal's nutritional requirements. The present study aims to determine the chemical composition of the bromatological palm (*Opuntia cochenillifera*) irrigated according to two types of organic fertilization in Santana do Ipanema - AL.

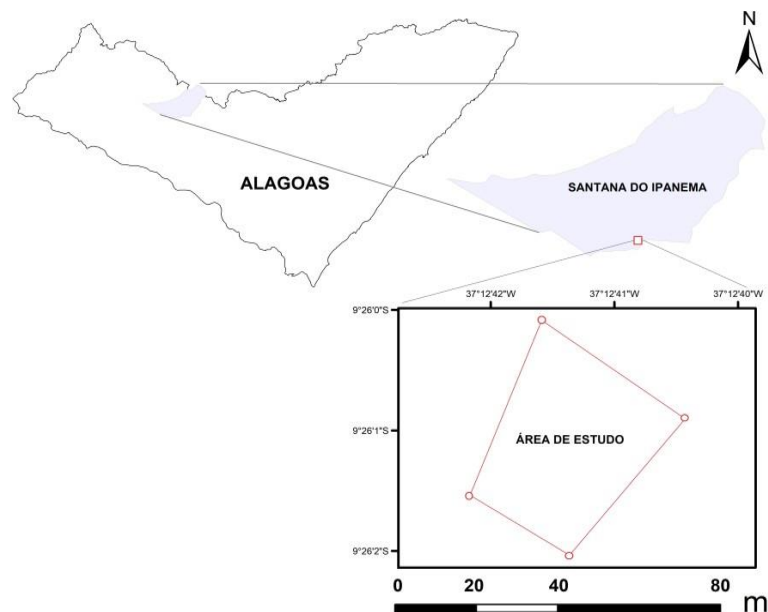
## Material and Methods

The project was carried out in the experimental area of the Serrote dos Braz community, which is located in the municipality of Santana do Ipanema, a mesoregion of the “*Sertão Alagoano*”, with an average altitude of 250 meters. The climate of the region, according to the Köppen classification, is of type Aw, tropical climate, marked by a dry and rainy season. The average annual rainfall is around 693 mm, the rainy season. The experiment was conducted

with a drip irrigation system. For the control of the weeds in the areas between parcels and streets, only grazing was carried out without any movement of the soil and the maintenance of the vegetal remains. The planting of the palm Mivem was carried out in August 2020, and the finalization was in July, with linear markings. the experimental design was done in blocks randomly cased, with arrangement of subdivided parcels. The experimental blocks were made up of five rows of five linear meters. The cladodes were planted in a domino format, with spacing 1.0 m x 0.25 m., levels of organic fertilization (cattle and poultry manure) and chemical fertilization were tested. The factors tested were levels of organic fertilization (0, 10, 20, 30 and 40 t of MO ha<sup>-1</sup> year<sup>-1</sup>, using bovine manure and birds), nitrogen levels (0, 120, 240 and 360 kg of N ha<sup>-1</sup> year<sup>-1</sup>, using urea).

**Figure 1.**

*Area of study.*



For the assessment of the vegetative development of forage palm, morphometric aspects of cladodes and plants were observed. The characteristics analyzed in the cladodes were width, length and circumference, determined with the aid of a tape measure, according to Andrade et al. (2009). With a mechanical pachimeter will be determined to the thickness of the cladode. After cutting the morphometric evaluation, the samples will be sent to the Laboratory of the State University of Alagoas, to determine the bromatological composition of the cladodes of the palm will be analyzed individually for the contents of dry matter (MS), mineral matter (MM), ethereal extract (EE), crude protein (PB) organic matter (MO), lignin (LIG), fiber in neutral detergent (NDF), fiber in acid detergent (FDA) by the methodology described by Silva and Queiroz (2002). The productivity of the forage palm was estimated, directly in the field, ten months after planting. For the procedure, plants were collected in each treatment, arranged useful areas of the parcels. The plants were cut at the first insertion,

leaving only the mother plant. Next, the precision scale weighing was done of all the cladodes harvested, separating them by parcel.

The data obtained were submitted to the analysis of variance followed by the Tukey test. Using the “PROC GLM - General Linear Models”, from the Statistical Analysis System - SAS (SAS, 2010), considering as significant values of probability less than 5% ( $P < 0.05$ ).

The climate of the region, according to the Köppen classification, is of type Aw, tropical climate, marked by a dry and rainy season. The average annual rainfall is around 693 mm, the rainy season. For the control of the weeds in the areas between parcels, only grazing was carried out without soil movement and maintenance of the vegetal remains.

Casualized Block Delineation (CBD) was used, with four treatments and five repetitions. The experimental blocks were made up of three lines for each street, and the lines were implanted in a level curve, the positions of the rackets were at least nine cm between rackets with spacing 1 m between lines and 1.40 m between rows, where two types of fertilization were tested: Mineral and organic (cattle manure and chicken bed). For the evaluation of the vegetative development of forage palm, the morphometric aspects of the cladodes and plants were observed. The characteristics analyzed in the cladodes were width, length and circumference, determined with the aid of a tape measure, according to Andrade et al. (2009). With a mechanical pachimeter they were determined to the thickness of the cladode. The cleaning of the area was carried out, demarcation of the experimental plots. Five simple soil samples (0-20 cm deep) were taken from each plot, then mixed to form composite samples, which were sent for analysis and fertility evaluation.

## Measurement, height, length and width of the cladode plant

**Figure 2.**

*Measurement of plant height.*



Source: LEMOS, B. V. (2020).

**Figure 3.**  
*Measurement of height and length of plants.*



Source: LEMOS, B. V. (2021).

As mentioned above, for the determination of plant height, length, width and perimeter measurements of the cladodes were used the tape measure and the measurement of the thickness of the cladodes performed with digital caliper.

The data obtained will be submitted to the analysis of variance followed by the Tukey test.

### **Soil Measurement and Temperature**

Fodder production is dependent on climatic conditions such as temperature, luminosity and water availability. During the dry season, fodder production is reduced, especially due to the water deficit of the soils. Therefore, the choice of management practices that reduce the problems arising from the stationality in the production of fodder must be consistent, in order to guarantee food throughout the year, particularly in arid and semi-arid regions.

The forage palm has been constituted in one of the bases of the feeding support of the dairy cattle of the Brazilian Northeast, seeing that it remains green and succulent when the majority of the forages of the semi-arid lose their leaves or dies in the dry period. In this respect, the palm Miute (*Nopalea cochenillifera* Salm Dick) presents great productive potential for the semi-arid northeast (Rego et al., 2014).

This forage often represents the majority of the food supplied to the animals during the dry season in the regions of the semi-arid northeast, which is justified by the following qualities: very rich in water, mucilage and mineral residue; present high digestibility coefficient of dry matter; and has high productivity. Bezerra et al. (2014) cite that forage palm

is considered an important ally in sustainability and in reducing the vulnerability of farming activities in the Brazilian semi-arid region, since most forage palm crops have been given attention in basic cultural handling and treatment, i.e. forage palm has never been considered as a crop, which compromises its longevity.

The soils of the Brazilian semi-arid region have low levels of organic matter, and consequently productivity depends on natural fertility, which most of the time does not meet the nutrition needs of the crops, making the addition of organic material necessary, and the use of animal manure is a soil management practice that makes the addition of nutrients feasible. The use of chemical fertilization in the Brazilian semi-arid is reduced due to the high costs and risks of losses due to the irregularity and unpredictability of precipitation, therefore, another way to increase soil fertility is in the addition of organic matter, one of the most efficient forms being the use of animal manure due to its composition, availability, benefits of application and being a common practice in the region (Alencar et al., 2011).

The presence of animal manure, mainly cattle manure, in most agricultural properties is one more tool in maintaining the fertility of the soils of the Brazilian semi-arid region. The animal manure has a variable composition due to the animal species, breed, age, feeding, farming system, animal handling, way of collection and handling. The average values in percentage of nutrients for bovine manure for NPK are 1.10; 0.65; 1.44, respectively, which corresponds to 76.20% of manure production in the Northeast and sheep manure is equivalent to 6.0% (Garrido et al., 2008) with values of 1.4; 1.0; 2.1%, respectively, for NPK (Carvalho and Guerra, 2012).

The benefits of manure application are related to the physical, chemical and biological properties of the soil, improving soil structure, permeability, stability of aggregates, aeration and water retention in the soil, increasing pH and N, P, S, Ca, Mg and reducing Al in the surface layer, providing an increased population of macro and microorganisms that decompose organic matter provide nutrients to plants). Studies carried out with forage palm indicate increases in organic fertilization as to growth, levels of nutrients in the air part and increase in dry matter levels (Ramos, 2012).

The choice of forage palm spacing is a function of the producer's production system and is directly related to light interception, therefore, in addition to these factors it's important to consider the availability of cladodes for planting, soil type, cultural management practices such as capines, grazing, fertilizer application and consortium with other crops. Spacing, as a management strategy, is important in the establishment of palm because it defines the plant population, varying according to the fertility of the soil, amount of precipitation, exploration purpose and with the consortium to be used (Ramos et al., 2011).

The forage palm has a high potential for phytomass production, however the extraction of nutrients from the soil by the crop is high. Thus, without a fertilization program, the

sustainability of palm production systems would decrease over time, mainly due to reduced soil fertility.

The chemical-bromatological evaluation of a plant is important for providing a description of the compounds that form it, and thus offer a direction as to their biological and/or forage properties. It needs attention to its results, which can be influenced by factors such as: plant harvesting method, processing and storage, plant age. The classic analyzes commonly carried out aim to obtain information, such as the content of Dry Matter (MS), Gray or Mineral Matter (MM), Crude Protein (PB), Ethereal Extract (EE), Fiber in Neutral Detergent (NDF), Fiber in Acid Detergent (FDA).

The chemical composition of the forage palm varies with the species, age of the articles and time of year and, regardless of the genus, it has low levels of dry matter ( $11.69 \pm 2.56\%$ ), crude protein ( $4.81 \pm 1.16\%$ ), fiber in neutral detergent ( $26.79 \pm 5.07\%$ ), fiber in acid detergent ( $18.85 \pm 3.17\%$ ) and considerable levels of mineral matter ( $12.04 \pm 4.7\%$ ) (FERREIRA et al., 2000). Araújo (2009), in turn, studying the substitution of corn for forage palm (*Opuntia ficus-indica* Mill and *Nopalea cochenillifera* salm-Dyck) in complete diets for lactating cows found values of 4.5 PB in the palm giant; 7.6 MS; 10.2 MM; 27.6 NDF and 17.9 FDA in its chemical composition.

Fodder palm has limitations on protein and fiber content, but a high mineral content. Its chemical composition varies according to the species, cultivar, age of the plant and clade, fertilization, spacing and time of year (TELES et al., 2004). The protein content of forage palm is considered low, since for the growth and development of ruminal microorganisms responsible for the degradation of nutrients from the fibrous fraction of forage, the animal's diet should contain levels of around 6% to 7% crude protein (REIS et al., 2004). In forage palm, the crude protein content can vary significantly between varieties and species and is generally influenced by the age of the clade.

There are some studies comparing bromatological composition with fertilization levels and spacing, but the results differ. Araújo (2009) concluded that the percentages of mineral matter, organic matter, crude protein, fiber in neutral detergent, fiber in acid detergent, calcium and phosphorus in forage palm are not affected by the spacing and doses of phosphorus, using them as a source of simple superphosphate.

Therefore, a well-conducted cultivation under the appropriate agronomic conditions and techniques is possible to produce food of high energy value, since this plant has in its bromatological composition, low protein content and fiber insoluble in neutral detergent and rich in non-fibrous carbohydrate, with value superior to corn and sorghum silages. The palm may be supplied to cattle from fresh minced to under pasture. However, due to the low fiber content, it's recommended that it be associated with bulky foods, mainly for high-production animals. It's a strategic option for the production of cattle feed in areas with scarcity and irregularity of rainfall, because it has the potential to maintain a nimal performance in the dry



period of the year, provided that it's included in a correct and balanced way in cattle diets (Marques et al., 2017).

### Soil Temperature Measurement

**Figure 4.**

*Soil temperature measurement.*



Source: LEMOS, B. V. (2021).

**Figure 5.**

*Soil temperature measurement.*



Source: LEMOS, B. V. (2021).

### Results and Discussions

In the figures, we observed the evolution of the height and width of the plant as a function of the types of organic fertilization, we found a trend in the increase in the height and width of the plant at 120, 150 and 180 days after planting for the two types of organic fertilization, observing that there were significant interactions ( $P < 0.05$ ) between the days evaluated and the variables studied. This can be explained by the fact that the chicken bed is higher, when compared with the other species, a good part of this is due to the richer feed of

the corn and soy-based feeds. According to Hobbie and Vitousek (2000), another important factor to be considered is related to immobilization of nutrients when they are in small concentrations in materials. With regard to the bordure block, it was found that there was no influence of the days for the height of the plant, but there was a difference between the width of the same in the present work. The addition of fertilizers has improved the availability and transport of nutrients in the soil and the uptake by plants, interfering with their growth.

**Table 1**

Evolution of height (APL), plant width (LP), cladode length (CC) and cladodium width (LC) of the forage palm (*Nopalea cochenillifera*) at 120, 150 and 180 days after planting, due to different types of fertilization.

Types of ferti- zation	Days after planting											
	120				150				180			
	APL	LPL	CC	LC	APL	LPL	CC	LC	APL	LPL	CC	LC
(cm)												
Embroidery	44,9b	51,7b	16,9b	7,2b	41,8b	54,9b	16,7b	7,9b	44,5b	61,9c	17,7b	8,2b
Cattle Manure	41,5b	51,9b	17,2a	8,0a	42,1b	55,9b	17,5b	8,1a	52,3a	65,7b	19,1a	9,4a
Poultry Manure	48ba	58,8a	16,4b	8,3a	49,7a	60,3a	18,9a	8,6a	52,5a	70,1a	19,6a	9,0a

Averages followed by the same letter in the column do not differ statistically from each other by Tukey's test at 5% probability.

Source: The authors (2021).

Alencar et al. (2011), state that the higher the density of the plants, the greater the final height of the plants, due to the reduction of lateral stretching of the stem, and the competition between forage plants. The addition of organic matter via bovine manure had significant effects in improving soil quality, in addition to a greater water retention and soil cover. According to Dubeux Jr. and Santos (2005), working with forage palm, where animal manure was used, these results were superior to those obtained with the isolated use of chemical fertilizers. Studies carried out with forage palm show that there is a correlation between increased productivity, nutrient levels and dry matter in cladodes when there is an increase in organic fertilization (RAMOS, 2012). Lima et al. (2015) reported a PMS of 23.04 t ha<sup>-1</sup>year<sup>-1</sup> with irrigated Chicken palm, at the density of 50 thousand plants, preserving secondary cladodes and with chemical and organic fertilization.

The block containing bovine manure showed a lower growth than that found in the block of manure of chicken bed, possibly must have occurred by the absence of fertilization, with this, the forage palm did not have a uniformity, it removed all nutrient reserve from the soil verifying a lower variation. Miron et al. (2011) concluded that the substitution of the

chemical fertilizer by dung led to an increase in the yield and nutritional value of wheat hay as well as nutrient levels and water retention in the soil, and reduced the number of invasive species. According to the authors, adopting dung would increase the profits of dairy products in the regions and reduce groundwater contamination, due to reduced use of chemical fertilizers.

The soil temperature in the palm plantation was found to be higher at times of 11:00 (37.8°C), 13:00 (42.4°C) and 15:00 (39.8°C), directly influenced by the absorption of water and nutrients, growth and development, and therefore crop productivity. Palm is relatively demanding in soil, hence its response to organic fertilization. Contrary to popular belief, the palm has temperature and soil requirements. The ideal daytime/nighttime temperature of the palm is 25/15°C. Of course, there is no such temperature in the semi-arid part of the Northeast, but it has been observed that in places with a minimum temperature of 18°C, the palm is much healthier than in places with a minimum temperature of 21°C. Table 1 1-Soil temperature in the planting of palma\* in the municipality of Santana do Ipanema, Alagoas. According to Farias et al. (2005), palm growth is favored at higher altitudes due to reduced air temperature and increased relative humidity at night (55%-60%). Species of the genus *Opuntia* do not adapt to low altitude regions, high night temperatures, and low temperature ranges. This occurs in some regions of the semi-arid and is the cause of low productivity and even palm death (SANTOS et al., 2006). According to Albuquerque (2000), the species *Nopalea* is more demanding in fertility, humidity and requires milder night temperature when compared to other cultivars, and is thus not indicated for backcountry areas.

**Table 2.**

*Soil temperature measurement in palm plantation*

Variable	Hours	C° (%)
Temperature	11:00 a.m.	37,8°
Temperature	1 p.m.	42,4°
Temperature	3:00 p.m.	39,8°

Source: The authors (2021).

## Conclusion

Organic fertilization with chicken bed had a significant effect on the variables studied when compared to bovine manure. The dung has a more complete composition with practically all the necessary elements for plants can be used exclusively in fertilization.

Several studies are being carried out in the semi-arid region, however, understanding of regional natural resources is not yet fully elucidated, leaving several gaps to be clarified. Livestock farming, soil and water management are of the utmost importance in the region, as

it's certainly the foundation of stability for a large part of the rural producers. The irregular distribution of rainfall within the year itself and between years has pointed to this activity of lower risk when compared to agriculture, so it should be better understood.

Therefore, cacti species can be exploited as animal fodder in these regions. Forage palm has many varieties and qualitative attributes that are attractive to forage. Because of its photosynthetic metabolism and its adaptation to semi-arid, forage palm growth and production may be slow under natural conditions. In irrigated cultivation and adequate nutritional supply, this forage expresses its full productive potential.

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