

Scientific Paper

Selection of local resources for sheep feeding in the Las Tunas municipality, Cuba

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The objective of this study was to select the main available local resources, with potentialities for sheep feeding, in the Las Tunas municipality –Las Tunas province, Cuba–. The method of expert consultation was applied, to a panel of 26 members. The local resources were classified into non-forage and forage ones. Their evaluation was based on different criteria: annual availability, total supply cost, nutritional value, conservation time and cost, adaptability to local edaphoclimatic conditions, production in the dry season, resistance to pests and diseases, and production without irrigation and fertilization. Nine locally available resources were selected for sheep feeding, 66 % of which were forage ones. The highest value in forage resources corresponded to *Leucaena leucocephala* (Lam) de Wit (4,68 ± 0,02) and the lowest, to *Moringa oleifera* Lam (3,18 ± 0,87). In non-forage resources, calcium carbonate had the highest value (4,75 ± 0,75) and distillery vinasse, the lowest value (3,0 ± 0,10). Regarding the integral evaluation of the forage resources, the highest values corresponded to *Saccharum officinarum* L., *L. leucocephala* and the *Pennisetum* varieties: 4,54; 4,51 and 4,43, respectively; and the lowest ones to *Tithonia diversifolia* (Hemsl.) A. Gray, *M. oleifera* and *Morus alba* L.: 2,99; 2,66 and 2,64, respectively. It is concluded that in the Las Tunas municipality there are between five and six resources with potentialities for sheep production, among which calcium carbonate as non-forage resource and *L. leucocephala* as forage resource stood out.

Keywords: evaluation, animal production, food security

Introduction

The adverse economic situation faced by Cuba originates the need to increase food production radically; this objective is an issue of maximum concern and occupation by the Cuban Government and State. For such reason, a diversification of agricultural production is mandatory in order to offer meat products from different animal species.

In this sense, sheep are an important source for meat production under tropical conditions. Arece *et al.* (2013) stated that Pelibuey is the breed with more potential for the production of small ruminants in Cuba and plays a significant role, in small-scale family economy as well as in the state entrepreneurial sector.

Nevertheless, sheep production shows a set of limitations that causes scarce and unstable yields, which leads to low levels of sale and consumption of this product throughout the country; in this regard, the National Office of Statistics and Information (ONEI, 2017) indicated that 14 291 t of sheep meat were sold in agricultural markets, by the end of 2016, scenario that constitutes a limiting factor in the commercialization of this product.

On the other hand, the Pelibuey breed shows good adaptation to the tropical environment, which allows its exploitation in diverse types of productive systems, from the low-input to intensive production systems, although the former are the most widely used ones (Partida-de-la-Peña *et al.*, 2013).

Factors of diverse nature have restricted the development of sheep rearing in the tropical zone; for example, the adverse climate conditions, related to scarce and irregular rainfall volumes, high temperatures and high relative humidity. This is manifested in the insufficient productive yield of the exploited breeds, as well as in the farmers' socioeconomic situation. On the other hand, the implementation of crossing programs of tropical sheep with improved breeds is insufficient, and besides an inadequate sanitary management of the animals is made; however, the quantitative as well as qualitative limitations in the feeding basis are considered by many researchers the fundamental and most difficult problem to solve (Ruiz, 2011; Velasco *et al.*, 2015).

The above-stated facts show the importance of using feasible methodologies to identify the available resources at local level, with potentialities for

animal feeding and management. In this sense, the concept of local resource emerges as a philosophy, which could be defined as any resource that is obtained in a certain zone and is used for its benefit. This perspective, which has often been the object of research (Rendón *et al.*, 2014; Meza-Carranco *et al.*, 2016), should be assimilated and enhanced with higher intensity to aspire to improve sustainably the productivity and efficiency indexes, in production systems with sheep and other species.

Based on the above-explained facts, the objective of this work was to select the main available local resources, with potentialities for feeding sheep in the Las Tunas municipality, Cuba.

Materials and Methods

Characteristics of the study zone. The study was conducted in the Las Tunas municipality, Las Tunas province, Cuba, located at 20° 57' 25" N latitude, 76° 57' 13" W longitude, with an altitude above sea level of 90 m. the main climate variables in the last ten years averaged rainfall values of 1 038 mm, temperature of 28 °C and 76 % of relative humidity, which corresponds to a dry tropical climate.

Concerning the methodology used, there are several procedures aimed at investigating and compiling the perceptive information about a certain issue in particular; the Delphi method is one of them. It is the most widely used expert consultation research technique. It consists in the systematic utilization of an intuitive judgment by a group of individuals who have knowledge about a specific topic (Rowe and Wright, 2011).

Delphi procedure for this study. A panel of 26 experts was created, integrated by professionals with work experience in the studied zone. Two rounds of interviews took place: in the first one the quantity and types of resources that could be used in the farm were selected, and in the second one the resources were evaluated, with the experts' participation. The

questionnaire was applied in all the cases through interview to the experts; they showed differences regarding their professions and belonged to four entities: four from the Institute of Animal Science; seven from the University of Las Tunas; six from the Provincial Agriculture Delegation; five from the provincial Cuban Association of Animal Production (NGO) and four from the Las Tunas Pastures and Forages Research Station. The average of years of professional experience in the group was 26,6.

The resources were classified into forage and non-forage ones, and their evaluation was based on different criteria (table 1).

A questionnaire was elaborated that contained two questions directly related to the utilization of the potential local resources in sheep feeding in the Las Tunas municipality and its vicinity.

Question 1. Evaluate the pertinence of how many feeding resources you consider necessary in a farm for feeding sheep in Las Tunas municipality.

Question 2. Select the local resources you consider viable for sheep feeding in Las Tunas municipality, and evaluate each resource in correspondence with the proposed scale.

In the measurement of the experts' opinions, Likert's (1932) scale was used; for the evaluation of the resources an index resulting from the sum of the values of each item, from which the defining decision was made, was taken into consideration. The variable total supply cost was considered negative, as it is a detrimental element in productive systems.

Question 1: 1. Totally disagree, 2. Almost disagree, 3. Moderately agree, 4. Almost agree, 5. Totally agree.

Question 2: 1. Completely inadequate, 2. Almost inadequate, 3. Moderately adequate, 4. Almost adequate, 5. Completely adequate.

With the information obtained from each expert, according to their answers the descriptive

Table 1. Criteria used in the selection of local resources.

Non-forage resources	Forage resources
Annual availability	Annual availability
Total supply cost	Adaptability to the local edaphoclimatic conditions
Nutritional value (protein and/or energy)	Production in the dry season
Conservation time and cost	Resistance to pests and diseases
	Production without irrigation or fertilization
	Nutritional value (protein and/or energy)

statistics average and typical deviation were calculated, through the Microsoft Excel worksheet.

Results and Discussion

The panel members' opinion about the quantity of necessary resources to guarantee sheep rearing under the conditions of the municipalities indicated that they should be five or more than this value. This result is due, to a large extent, to two main factors: first, rainfall seasonality, which originates instability in the availability and quality of feedstuffs, which in turn entails that it is necessary to have a high degree of diversification in the feeding front; and, second, the imperative of balancing the diet to cover the basic nutritional requirements of the animals (NRC, 2016; Perdomo *et al.*, 2017). The values close to zero of the typical deviation (table 2) indicated that there was homogeneity in

the responses and, thus, little dispersion around them (Solanas *et al.*, 2005).

Table 3 shows the results of the selection of the resources that were mostly considered by the experts and their corresponding degree of importance. In total the resources mentioned were nine; it should be emphasized that 66 % of these resources are forage ones, which has direct relation with the principles of ruminant animal production under tropical conditions and the production costs (Alonso, 2016).

The highest values in the forage resources were obtained in white leadtree (*Leucaena leucocephala*) and the *Pennisetum* varieties; in the non-forage resources, the calcium carbonate source turned out to be the preferred one. With this selection it is guaranteed that the energy requirements are covered with sugarcane (*S. officinarum*) and the *Pennisetum* varieties.

Table 2. Stadigraphs of the application of the Likert scale for the selection of the necessary feeding resources in a sheep production farm.

Item	Average	Standard deviation
One resource	1,00	-
Two resources	1,00	-
Three resources	2,30	0,56
Four resources	3,72	0,97
Five resources	4,40	0,61
More than five resources	4,45	0,78

Likert scale: 1. Completely disagree, 2. Almost disagree, 3. Moderately agree, 4. Almost agree, 5. Completely agree.

Table 3. Stadigraphs of the application of the Likert scale in the determination of the importance of the feeding resources.

Item	Average	Typical deviation
<i>L. leucocephala</i>	4,68	0,02
<i>Saccharum officinarum</i>	3,65	0,24
<i>Pennisetum</i> varieties	4,30	0,06
<i>Tithonia diversifolia</i>	3,28	0,40
<i>Moringa oleifera</i>	3,18	0,87
<i>Morus alba</i>	4,02	0,63
Calcium carbonate	4,75	0,35
Common salt (NaCl)	3,80	0,24
Distillery vinasse	3,00	0,10

Likert scale. 1. Completely inadequate, 2. Almost inadequate, 3. Moderately adequate, 4. Almost adequate, 5. Completely adequate

Protein could be covered mainly with white leadtree, Mexican sunflower (*T. diversifolia*) and mulberry (*M. alba*). The minerals would be covered with the calcium carbonate sources, salt and distillery vinasse. The proposed list served as starting point in the selection of the resources with higher potential, in order to guarantee the stable growth and development of the different sheep categories under the conditions of the locality. Similarly to the above-explained case, the values of typical deviation indicated that the dispersion around the responses was low, which showed a high level of consensus.

Regarding the selection of forage resources, the first three species turned out to be the ones with the best integral scoring (table 4). In the case of white leadtree, most of the surveyed persons stated that it adapts well to the soil and climate conditions of the territory, coinciding with the results obtained by Pérez-Corría *et al.* (2014) and Román-Miranda *et al.* (2016), and Miranda *et al.* (2016), who concluded that it is a species with excellent performance in many parts of the world and shows good chemical composition and nutritional value. The variable yield in the dry season, one of those with higher discriminating capacity in this research, was qualified as sufficient, which coincides with the reports by Bacab *et al.* (2013) and Reyes *et al.* (2015) under tropical conditions, where the yields were 2,47 and 2,04 t DM ha⁻¹ per month in the dry season, respectively.

Based on the resistance to the attack by pests and diseases, the experts' judgment was equally positive; because, although this species is preferably attacked by phytophagous insects, such as

Heteropsylla cubana and *Mormidea pictiventris*, there are enough organisms that act as biological controls, for which they do not represent an important threat for the sustainability of the systems in which the tree is used (Alonso *et al.*, 2005).

Another aspect considered as positive was its yield without irrigation and fertilization, conditions under which animal husbandry is developed in the Las Tunas municipality. Thus, the weighting of the criteria that were analyzed indicated that white leadtree shows a remarkable integral value for its utilization in local productive systems.

Sugarcane turned out to be the species of higher integral value, due to its excellent dry matter yield in low-input systems under tropical conditions, in dry seasons; and due to its rusticity, in spite of its nutritional deficiencies, which can be solved in the proposed technological scheme. This species, because of the above-mentioned attributes, is considered by many researchers as strategic par excellence (Martín, 2004). Similar results to those of sugarcane were obtained in the evaluation of the *Pennisetum* varieties, among which are: *Cenchrus purpureus* x *Pennisetum glaucum* cv. OM-22, *Cenchrus purpureus* vc. CT-169, elephant grass and others. It should be emphasized that the nutritional value of this species is higher than that of sugarcane, and their yields in tons of dry matter per hectare are very similar, factors that show their real possibilities (Nava-Cabello *et al.*, 2013).

In the other species (Mexican sunflower, drumstick tree and mulberry) the results were lower, because they showed lower dry matter yield in the dry season without irrigation and fertilization,

Table 4. Results of the evaluation of the forage resources.

Item	<i>L. leucocephala</i>	<i>S. officinarum</i>	<i>Pennisetum</i> varieties	<i>T. diversifolia</i>	<i>M. oleifera</i>	<i>M. alba</i>
Adaptability to the local edaphoclimatic conditions	4,65	4,78	3,6	4,03	3,22	2,06
Production in the dry season	4,31	5,00	5,00	2,30	2,43	2,08
Resistance to pests and diseases	4,66	4,75	4,70	4,07	1,87	2,21
Production without irrigation and fertilization	4,20	4,90	4,85	1,86	2,04	2,21
Nutritional value	4,75	3,31	4,00	2,46	3,75	4,67
Integral value	4,51	4,54	4,43	2,94	2,66	2,64

compared with the previous ones. The reports by Ruiz *et al.* (2012), Meza *et al.* (2016) and Pentón *et al.* (2016) support this statement. The low nutritional value of *T. diversifolia* was interesting, which could have been related to its low dry matter content, of 10 and 12 % for the rainy and dry seasons, respectively, according to Lezcano *et al.* (2012). In *M. oleifera* the main deficiency was the susceptibility to pests and diseases and to the invasion by weeds in the establishment stage (Meza *et al.*, 2016; Padilla *et al.*, 2017). Based on the criteria expressed by the panel members, the integral evaluation of these last three species was lower than three units, for which they were placed (according to the scale) in the categories «Completely inadequate» or «Almost inadequate»; this implied that they were not chosen as potentially usable resources for sheep production under the specific conditions of the Las Tunas municipality.

In general, in all the non-forage resources an adequate level of consensus was reached regarding their favorable nutritional and economic feasibility for feeding sheep. The qualitative evaluation of the three non-forage resources that were selected by the experts is shown in table 5.

The chosen calcium source was considered as highly available, because it can be acquired by farmers throughout the year, aspect that, combined with the little quantity that is necessary in order to cover the requirements of the animals, confers a low cost to it. With regards to the other attributes, it was considered that it shows sufficient nutritional value with regards to the nutrient it contributes; and its physical and chemical properties allow that, under adequate conditions, the product could be preserved for a long time period. The sum of the above-mentioned criteria indicated, integrally, that the calcium-carrying source is considered adequate.

Regarding the distillery vinasse, resource that according to Vargas *et al.* (2014) is appropriate for feeding different animal species, especially ruminants, was equally evaluated as available in high

degree and low cost, because it is a residue from the process of obtaining alcohol. Its nutritional value was qualified as sufficient. On the other hand, its conservation is feasible and lasting as long as it is done in airtight containers. Another important aspect, but not studied in this research, is that the utilization of distillery vinasse constitutes an alternative to decrease environmental contamination (Rendón *et al.*, 2014). The above-stated fact allowed to conclude that such resource is appropriate for feeding sheep in the territory.

The criteria that were expressed in the case of common salt (NaCl) were also favorable; the least positive aspect was cost, which could be lower depending on the places where the product is purchased. Although it is an available resource, it is not ideal to supply the mineral deficiencies that could appear in the animals, for which it would be necessary to implement the use of multiple mineral supplements that make a contribution of other important elements for the functioning of the animal organism (Stewart, 2013).

It is concluded that there are between five and six resources with potentialities for sheep production in the Las Tunas municipality, among which calcium carbonate as non-forage resource and *L. leucocephala* as forage stand out.

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Table 5. Average and integral values of the application of the Likert scale in the evaluation of the non-forage resources.

Item	Annual availability	Total supply cost	Nutritional value	Conservation time	Integral value
Calcium carbonate	5,00	-1,40	4,35	5,00	3,23
Distillery vinasse	5,00	-2,20	4,36	4,86	3,00
Common salt (NaCl)	5,00	-2,10	4,55	5,00	3,11

Likert scale. 1. Completely inadequate, 2. Almost inadequate, 3. Moderately adequate, 4. Almost adequate, 5. Completely adequate.

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