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Goat production systems of the central highlands of Veracruz, Mexico

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ABSTRACT

Objective: This study was to characterize the goat production units of the central mountain area of the state of Veracruz, Mexico.

Disign/methodology/approach: A multiple case study was carried out taking into consideration socioeconomic aspects, type of forage, goat feeding, reproduction, improvement, and health.

Results: The results showed that goat and cheese production account for 50-100% of the producers' income. The forages grown and the type of goat feed used in the production units of the mountain area are: King grass, CT-115, maralfalfa, giant star grass, alfalfa, and corn. Animal reproduction is carried out by controlled mating and births take place at the beginning and end of each year. Flocks do not exceed 150 heads; the predominant breeds are Saanen and Alpine. The average daily production of milk ranges from 16 to 90 L, with a production of 0.75-3 L milk animal^{-1} day^{-1}.

Study limitations/implications: None

Findings/conclusions: The activity is family-based and involves cultivation, animal management, and milk and artisanal cheese production. Further studies are required to confirm individual milk production.

Keywords: Multiple case study, problematic, milk production, artisanal cheeses.

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INTRODUCTION

Goat production allows poor rural populations to achieve economic development (Escareño-Sánchez *et al.*, 2011). There are more than 909 million goats worldwide; the largest inventories are held by China (150 million) and India (154 million) (Bidot-Fernández, 2017). Ninety-five percent of the goat population are used in doble-purpose production (meat-milk), while the remaining is mainly used to obtain milk (Bidot-Fernández, 2017).

Image by Alexa at Pixabay

In Mexico, the heterogeneity of the goat production systems (GPS) depends on the production system type; the most common systems in Mexico are the extensive and stall-feeding systems. The Servicio de Información Agroalimentaria y Pesquera (SIAP, 2021) reported 8,830,720 goat heads. The states of Puebla, Oaxaca, San Luís Potosí, Zacatecas, and Guerrero have the largest goat inventories. There are 159,527 goats in Veracruz and they are mainly concentrated in the municipalities of Coatepec, Coacoatzintla, Perote, Tatatila, and Xico (SIAP, 2021). However, the presence of brucellosis (Martínez-Herrera *et al.*, 2010) and the areas that favor the development of goat production systems (Ramírez-Rivera *et al.*, 2017) have been the only subjects studied in the area. There are not study cases that determine the operability of these GPSs in Veracruz. Therefore, the objective of this research is to characterize the GPSs of the central mountain region of Veracruz.

MATERIALS AND METHODS

Figure 1 shows how a multiple case study was carried out to characterize the goat production units (GPUs) of the central mountain area of Veracruz (Villareal-Larrinaga y Landeta-Rodríguez, 2010). An interview card was developed, taking into account the following criteria: 1) socio-economic aspect of the producer; 2) grasses and feeding type; 3) reproduction and improvement; 4) health; and 5) milk production (Mendoza and Ortega, 2009). Six goat production units located in Pacho Viejo, Coatepec, Perote, Tatatila, and Xico were analyzed. Table 1 shows the agroecological conditions of the sites where the goat production units are located.

RESULTS AND DISCUSSION

Characterization of the Donelo GPU

The owner of this GPU is 49 years old, has a bachelor degree, and his family has three members. Activities such as cattle-raising and agriculture are carried out in this GPU, as

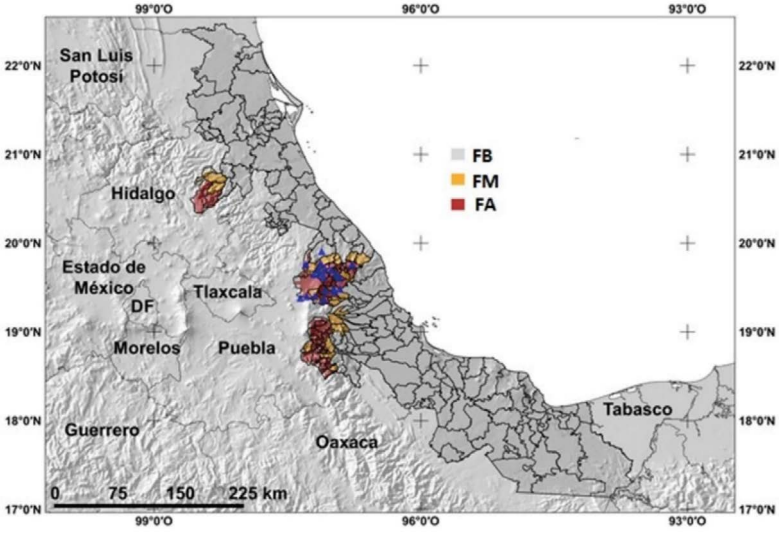

Figure 1. Predominance of goat production systems in Veracruz; LF: low favorability, MF: medium favorability, and HF: high favorability (Ramírez-Rivera *et al.*, 2017).

Table 1. Location of GPU and agroecological conditions.

GPU	Rainfall Mm	Altitude Masl	Dominant vegetation	Climate type	[4]AAT °C
Donelo	1,500	1,208	MMF[1]	C(M) y C(FM)	18
Las Lajas	1,500	1,440	MMF[1]	C(M) y C(FM)	18
La Chiviada	1,750	2,011	MMF[2]	C(FM)	19
Rincón del Rio Frio	1,346	1,867	MMF[3]	C(fa)	20
Hermanos- Enríquez	493.6	2,400	FF, PF & XS[3]	BS1kw	12

GPU: Goat Production Unit; MMF: Mountain Mesophyll Forest; Mm: milimeters; Masl: Meters above sea level; [1]García-Franco *et al.* (2008); [2]García-de la Cruz *et al.* (2013); FF, PF, XS; Fir forest, Pine forest and Xerophytic scrub; [3]Márquez y Márquez (2009). [4]AAT: Average Annual Temperature (INAFED, 2005).

well as production and sale of artisanal cheeses. Fifty percent of its income comes from goat production and the sale of cheeses. The GPU has 1 ha and it can be classified as a small property. A temporal worker is hired per day's wage. The inventory is made up of 127 goats (80 breeding females, 3 bucks, 20 goatling, 4 weaned goatling, 20 replacement males and females) of the Alpine and Saanen breeds, acquired in Celaya, Guanajuato. This GPU is focused on milk and artisanal cheese production. Goats are fed with the following grasses: King grass (*Saccharum sinense* L.), CT-115 (*Cenchrus purpureus*), maralfalfa (*Pennisetum* sp.), and Giant Star grass (*Cynodon plectostachyus* Schum, Pilger). Their diet is supplemented with white mulberry (*Morus alba* Linn.) and orange bagasse (*Citrus sinensis* L.), acquired in local juice bars (Figure 2a). The grasses are grown in the GPU and fertilized with goat faeces. The commercial product "La Posta" (15.0% protein, 3% fat, 9% fiber) is used as supplement. Controlled mating is carried out, using three males. Kids are born from November to May and they are weaned after a two-month lactation period. Deworming is carried out every four months and 5% Closantil is applied to eliminate parasites of the *Strongyloides* spp. genus. The goats are vaccinated against brucellosis (*Brucella melitensis*) and clostridial disease (*C. perfringens*, *C. chavoei*, *C. sordelli*, *C. haemolyticum*). Each goat produces approximately 2 L of milk; forty goats are hand milked, obtaining 80 L day^{-1}. Lactation lasts from 8 to 10 months. The GPU uses a stall-feeding arrangement.

Characterization of the Las Lajas GPU

The owner of this GPU is 50 years old, has a bachelor degree, and his family has two members. This GPU is focused on milk production, breeding stock, and agriculture. This producer makes and sells different types of artisanal cheeses, which account for 20% of his income. The GPU has 55 ha and mechanical methods are used to prepare the land. The producer employs two temporal workers and two permanent workers. The goat inventory is made up of 46 goats (20 breeding females, 1 buck, and 25 kids) of the Alpine breed (Figure 2b), acquired in Querétaro and Veracruz. The goats' diet includes Kikuyo grass (*Pennisetum clandestinum*, var. Whittet), Giant Star grass (*Cynodon plectostachyus* Schum, Pilger), and King grass (*Saccharum sinense* L.). Goat and cow manure is used to fertilize a 5.5 ha area. Fodder seasonality is addressed using ensilage, supplemented with a Purina commercial product (20% raw protein). Controlled mating is carried out. Births take place

from September to October and goatling are weaned 2.5 months later. Albendazole (10%) is used to control internal parasites, while ivermectin is used to eliminate external parasites. This producer mentioned that his flock is free from brucellosis. Milk production per goat varies from 1 to 1.5 L; twenty goats are hand milked per day and lactation lasts seven months. Milk is used to produce artisanal cheeses. This GPU uses a partial stall-feeding arrangement.

Characterization of the La Chiviada GPU

The owner of this GPU is 62 years old, has a bachelor degree, and his family has three members. Cattle-raising activities account for 50% of his income. He produces and sells artisanal cheeses. The GPU has 19 ha and animal and manual traction are used to prepare the land with the help of a temporal worker, hired per day's wage. Goat inventory is made up of 62 goats (45 breeding females, 2 bucks, 5 weaned goatling, 10 replacement males and females) of the Alpine and Saanen breeds (Figure 2c) acquired from other local GPUs. The type of grasses grown to feed the goats are Kikuyo and Orchard (*Dactylis glomerata*). The grasses are fertilized using goat manure. The commercial product La Posta (15% raw protein) is used as supplement all year round. Controlled mating is carried out, using two males from the Saanen and Alpine breeds. Births take place from September to October and weaning is carried out after 2.5 months. Parasites from the *Haemonchus* sp. genus are controlled with the Famacha© method and the goats are vaccinated against brucellosis. Milk production per goat reaches 0.75 L. Forty-eight goats are hand milked, obtaining a total of 36 L day^{-1}. Lactation lasts eight months. This GPU uses a partial stall-feeding arrangement.

Characterization of the Rincón del Río Frío GPU

The owner of this GPU is 54 years old, has a bachelor degree, and his family has five members. This GPU carries out cattle-raising activities and produces artisanal cheeses. Both activities account for 100% of his income. The GPU has 35 ha and animal and manual traction are used to prepare the land. The producer employs one temporal worker and one permanent worker. Goat inventory is made up of 143 goats (60 breeding females, 3 bucks, 20 goatling, 20 weaned goatling, and 40 replacement males and females). The goats are crossbred Alpine-Saanen (Figure 2d) and they were acquired in the Tatatila region. Goats are feed Orchard grass (*Dactylis glomerata* L.), Taiwan grass (*Pennisetum purpureum* Schum), and forage oat (*Avena sativa*) grown in the GPU. Grass is cut by hand and 5 ha are fertilized using organic manure. Fodder seasonality is minimized using peach (*Prunnus persica*), apple (*Pyrus malus* L.), pear (*Pyrus communis*), avocado (*Persea americana*), acorn (*Quercus ilex*), and plum (*Prunus domestica* L.). During grazing, the goats eat different wild plants, such as silverleaf nightshade (*Solanum eleagnifolium*.), flameberry (*Urera caracasana*), bracken fern (*Pteridium aquilinum* L.), tree tobacco (*Nicotiana glauca* Graham), field bindweed (*Convolvulus arvensis*), and Alder (*Alnus acuminata* Kunth). Controlled mating is carried out and births take place from February to March. Weaning is carried out when kids are 2.5 months old. Deworming is carried out every four months. The producer stated that his goats are free from brucellosis. Vaccination is carried out twice a year to prevent blackleg (*Clostridium*

chauvoei) and pneumonia, which can affect goats from May to December, as a result of the sudden temperature changes. Milk production per goat reaches 1.5 L and a total of 40 goats are milked per day, obtaining approximately 60 L day^{-1}. Lactation lasts 10 months. This GPU uses an extensive system.

Characterization of the "Enríquez" GPU

This GPU is located in the high plateau of the state of Veracruz. The producers are 29 and 54 years old. Their education level ranges from primary to high school. They carry out cattle-raising and agricultural activities, which account for 50% of their total income. The average surface of the GPU is 6±2 ha and they are used to grow alfalfa (*Medicago sativa*) and corn (*Zea mays*). Mechanical and manual techniques are used to prepare the land and the labor is carried out by the family itself. The inventory is made up of 68 heads (40 breeding females, 3 bucks, 3 goatling, 1 weaned goatling, 20 males, and 1 replacement female), acquired in the state of San Luis Potosí (Figure 2e and f). Goats are fed alfalfa, corn waste, and annual wall-rocket (*Diplotaxis muralis*). Overall, 3.5 ha are fertilized with goat urea and faeces. Providing dried fodder minimizes the fodder seasonality problem, supplemented with the Bayer™ Magnaphoscal commercial product. The producers carry out controlled mating procedures with three males (two Saanen and one Alpine). Females give birth from November to January and from March to May. Goats are dewormed every four months and they are vaccinated against brucellosis, pasteurellosis (*Pasteurella multocida*), clostridial diseases (*C. perfringens*, *C. chavoei*, *C. sordelli*, *C. haemolyticum*), and coccidiosis (*Eimeria arloingi*, *Eimeria faurei*, *Eimeria gilruthi*, *Eimeria caprovina*, *Eimeria ninakohyakimovae*). The average milk production fluctuates between 1.5 to 3 L per goat and the producers milk 23 to 30 goats by hand, in order to produce 34.5 to 90 L day^{-1}. Lactation lasts from 6 to 7 months. This GPU uses a partial stall-feeding system.

Regarding the family composition and age of the producers, Dorantes *et al.* (2012) reported that goat producers in the southern Estado de México have an age range of 51.9±11.1 years and that their families have 6.7±2.5 members. However, there was a noticeable difference in the education level: producers from the municipality of Perote have the greatest education gap. These results match the findings of Hernández *et al.* (2013) who determined that producers from Tehuaxtla, Puebla have a maximum education level of high school. Land ownership is similar to the findings reported by Hernández *et al.* (2011) for producers from the state of Coahuila, 20% of which were ejidatarios and 60% owned small properties. Mendoza and Ortega (2009) and Hernández *et al.* (2013) reported similar goat inventories in the states of Oaxaca (53-470) and Puebla (30-110). Family members' participation in goat production has also been documented in the GPUs of Comarca Lagunera, Coahuila, and the area of the Mixteca Sierra located in the state of Puebla (Hernández *et al.*, 2011, 2013; Escareño-Sánchez *et al.*, 2011). Another contrasting aspect is the type of feeding, which can be the result of several factors, including the geographical location of the GPU. For example, the type of feeding used in the Perote GPU matches the type of feeding used by GPUs located in arid areas (Coahuila, San Luis Potosí, Nuevo León, etc.), which are limited to alfalfa, oats, maguey, and corn waste (Baraza *et al.*, 2008). The mountain mesophyll forest (MMF) vegetation may explain the greater diversity of food

Figure 2. Goat Production Unit. a) Donelo; b) Las Lajas; c) Chiviada; d) Rincón del Rio Frio; e) Hermanos Henríquez; f) Familia del Ángel.

available for goats in the Las Lajas (Coatepec), Rincón del Río Frío (Tatatila), and Chiviada (Xico) UPCs; goats can eat various fruits in this region, including toxic plants that may cause miscarriages and death (Moreno *et al.*, 2010). The reproduction and improvement results match the findings of Escareño-Sánchez *et al.* (2011), who reported births from November to February. Bucks are selected based on phenotype, race, and record; meanwhile, in the state of Oaxaca, goat producers choose goats based on visual characteristics (Mendoza and Ortega, 2009). The low number of brucellosis cases in the GPUs included in this study matches the findings of Martínez-Herrera *et al.* (2010), who reported a 0.5% occurrence

of brucellosis in the municipalities of Coatepec, Perote, Tatatila, and Xico. The producers who participated in this research were helped by technicians from the Sistema Especie Caprino from the state of Veracruz (SIPECAV A.C.); they are organized in GGAVATs (Cattle-Raiser Groups for Technology Validation and Transfer). The system used by the GPUs included in this research prevails in the states of Oaxaca, Aguascalientes, and Puebla (Mendoza and Ortega, 2009). In some cases, the milk production results (2-3 L/day) are higher than the results reported by Escareño-Sánchez *et al.* (2011) for Comarca Lagunera: a daily milk production of 1.5 L per goat and 56.9 L per flock. Goat producers who participated in this research are considered to be innovative producers, given their openness to technological changes, group activities, entrepreneurial attitude, etc. (Issaly *et al.*, 2007). For his part, only the producer from the "Donelo" GPU is considered to be a "producer-spreader", because he shares information about goat production, cheese making, and health and handling practices courses, among other activities.

CONCLUSIONS

Goat production in Veracruz is carried out in mountain mesophyll forests and xerophytic scrub, located in mountains and high plateau regions, respectively. This situation has determined the establishment of goat systems with partial or full stall-feeding arrangements. Family members participate in every aspect of this activity, including crop growing, animal handling, milk production, and artisanal cheese making. Goat inventory is below 150 heads and the average milk production ranges from 16 to 90 L per GPU.

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