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Diagnosis and Customs Revealed by Peasants and Shepherds during the Transhumant Grazing of Pastoreña Goats in the Mixteca of Oaxaca, Mexico

José Carlos López-Ojeda [1], Jacinto Efrén Ramírez-Bribiesca [1,*], Ladislao Arias-Margarito [2], Sergio Iban Mendoza-Pedroza [1], José Guadalupe Herrera-Haro [1], Juan Ignacio Váldez-Hernández [3] and Oscar Ortiz-Morales [1]

1 Recursos Genéticos y Productividad-Ganadería, Colegio de Postgraduados-Montecillo, Km. 36.5 Carretera Mexico-Texcoco, Montecillo 56230, Mexico
2 Departamento Biología de la Reproducción, Universidad Autónoma Metropolitana-Iztapalapa, Avenida San Rafael Atlixco 186, Colonia Vicentina, Iztapalapa, Mexico City 09340, Mexico
3 Ciencias Forestales, Colegio de Postgraduados-Montecillo, Km. 36.5 Carretera México-Texcoco, Montecillo 56230, Mexico
* Correspondence: efrenrb@colpos.mx; Tel.: +52-5959520200

Abstract: Transhumant pastoralism is a livelihood for many smallholders in the world. In Mexico, transhumant pastoralism has been practiced for 500 years and is classified as a system of transhumant goat pastoralism (TGP). The focus of the study was to identify and characterize the main goat herders of transhumance in the Mixteca-Baja of Mexico. The investigation was carried out in two phases: The first included exploring the districts to locate, contact, and live with the people involved, 13 peasants named *Patrones* ranging from 40 to 76 years of age. The second phase investigated the transhumant routes and the zootechnical activities of the herds. They live in five locations with an inventory of 12 thousand goats known as *Pastoreñas*. The TGP is a primary economic activity for all the people, and La *Matanza* is the main economic activity consisting of the slaughter and marketing of goats. The study revealed that the activities depend on the type of economic unit. Transhumant *Pastoreña* goats garner the highest prices paid by merchants ranging from 47–70.4 USD per goat. In conclusion, the TGP is an interesting production system, and livestock activity has an essential ecological niche combining income generation and conservation of the environment.

Keywords: *Pastoreña* goats; Mixteca region; culture; sustainable livestock

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1. Introduction

Pastoralism is the exclusive feeding on grasslands by livestock groups [1,2]. This livestock system exists on all continents in more than 100 countries. Approximately 200 million households and one billion livestock are involved, representing 10% of world meat production [3]. Pastoralism is a livelihood for many smallholders who herd goats and are classified as nomadic, semi-nomadic, or transhumant [4,5]. Transhumant pastoralism (TP) is a seasonal, cyclical movement of livestock. Its purpose is to ensure the feeding of herds during the annual cycle and is dependent on geographical conditions (low or high altitudes) and environmental conditions (rainy and dry seasons) [6,7]. The TP is noted for preserving traditional cultures [8], caring for native goats [9], providing ecosystem services with seed dispersal [10] and facilitating pollinators [11], preserving wildlife [12], controlling the prevalence of agricultural-livestock weeds [13], preventing fires [14] and providing tourism [15]. In addition, PT has been mentioned as a relevant activity to achieve the Sustainable Development Goals and the United Nations Decade on Ecosystem Restoration [16]. Due to the just stated, there is a need to describe the economic, cultural, social, and environmental importance of this pastoral activity in the Oaxacan Mixteca of Mexico.

In Mexico, TP has been practiced for 500 years. Sheep, goats, and cattle have been the primary species used by smallholders, and livestock groups preserve history, culture, economy, ecology, and social transformation [17–19]. Goats have been a component of TP in the states of San Luis Potosí [20], Guerrero [21,22], and Oaxaca [23,24], Mexico. Their classification as transhumant goat pastoralism (TGP) has led to specific productive studies in dairy and meat production. The Mixteca region of Oaxaca is a benchmark for TGP and is the central location of current research. The Mixteca region is characterized by people who have acquired empirical experiences with daily activities in TGP. Lessons from these experiences are legacy systems modified through trial–error tests over the years.

The goat–human–environment interaction has generated the presence of goats with unique characteristics, such as the case of the *Pastoreña* goat [22–25]. The empirical experience comprises knowledge of zootechnical practices concerning the rearing, reproduction, and feeding of these goats. Thus, goat-rearing has been perpetuated from generation to generation, and through oral communication, memories and collective experiences have been created among groups of people [26,27]. The technique for documenting the goat–human–environment interaction in the Mixteca region of Oaxaca is ethnozootechnia, focusing on the multidisciplinary ethno-scientific study; to reveal the practices and beliefs that social groups have formed in goat conservation and breeding [28–31]. TP in the Mixteca of Oaxaca was introduced in 1530 by Spanish civil groups and the religious orders of the Jesuits and Dominicans [32]. TP was implemented in the highlands of the Mixteca region and the lowlands of the Costa de Oaxaca region located in the Sierra Madre Sur and the Pacific Coast, respectively. Initially, the purpose of animal husbandry was to obtain skins, wool, and tallow, essential products for the mining industry [26,33]. The livestock farms had large areas of land destined only for grazing large livestock (cows, mules, horses) or small livestock (sheep, goats, and pigs). Indigenous communities participated closely in the implementation of this livestock activity. At the beginning of the seventeenth century, the animal population ranged from 158,000 to 251,000 heads of small ruminants [27,34]. However, the decrease in the indigenous population due to the presence of contagious diseases brought by Europeans prompted the acquisition of abandoned lands by the Dominican religious order and Spanish groups; thus arose the livestock ranches, known in the Spanish language as "Haciendas Volantes" (HV) [19]. The HV specialized in raising small goats, administered by the Dominicans. While groups of Spanish civilians were dedicated to raising and fattening all goats, these groups were known as breeders and fatteners. HV persisted through the first years of the 20th century; in 1910, the Revolution Movement began in Mexico, bringing the disintegration of the livestock production structure, which had existed for more than 300 years [35]. González [36] cites in his manuscript the description of private goat farms, in Spanish called "Matanzas"; these are remnants of the HV, and their peasants were Spaniards or their descendants, called "Chiveros."

Until then, the productive purpose of these groups was to obtain the hips, arms, and loins of goats to make the dish known as "Mole de Caderas." The Chiveros specialized in fattening and slaughtering goats from other producers specializing in breeding; these prevailed in the Mixteca, Costas de Guerrero, and Oaxaca regions [20,37]. Traditionally, two categories persist with the goat herd. The first is the *pastoreño* herd, which comes from a business economy. A single-peasant employs people to carry out transhumance-specific tasks, highlighting groups of shepherds, assistants, and captains. Each peasant can have one or more integrated herds of 500 to 600 goats. The second classification is the "Chinchorrero" herd from the family economy. The shepherds are the women and children of the family and do not exceed 75 goats per herd; the goats are grazed around the community, and there is no transhumance. In particular, the association between the mobility of transhumant grazing, the availability of food resources, herd management practices, and social organization is not well understood. However, transhumant goat herds undergo a rapid socio-technological transformation that allows the permanence of animals and social groups, generating a social economy of subsistence and profits [8]. The transhumance system remains, although herds are often blamed for the apparent

degradation of grasslands and the deterioration of the natural ecology where herds are grazed [5]. The hypothesis of this study focuses on the concept that peasants maintain transhumance with a practical sense and with care habits in nature reserves; they have the tradition, the knowledge in breeding practices, and marketing habits obtained through time and trial–error experiences. Therefore, the objective of the study was to identify the leading producers of transhumant goats and characterize their modes of production.

2. Methodology

2.1. Characteristics of the Study Area

The Mixteca region is located northwest of the city of Oaxaca, Mexico. The Mixteca population conformed to one of the most important civilizations in Mesoamerica, with hybridization between the indigenous and the European emerging during the conquest period. Currently, 77.4% of the population lives in small rural regions scattered in populations of less than 2500 inhabitants with 36.5% food poverty, but it has a wide biological diversity with two protected natural areas. In particular, raising goats and agriculture are the main productive and subsistence activities of various indigenous groups, providing the main economic income for families. Peasants and shepherds have generated extensive knowledge on the productive efficiency of goat herds and the care of natural resources through empirical experiences that are transmitted from generation to generation. In particular, the study area is located in the foothills formed by the Sierra Madre del Sur and Sierra Madre Oriental, and its altitudes range from 600 to 3000 m above sea level [38]. Due to the differences in altitude, there is greater climatic diversity [39] at higher altitudes, and the climate is temperate humid C (f), C (m) or subhumid C (w2), C (w1), C (w0) and at a lower altitude, the climate is semi-warm subhumid (A) C (w2), (A) C (w1), (A) C (w0) or warm subhumid Aw2, Aw1, Aw0. Commonly, the climate is cold (December–February), and in some regions, it is extremely dry (October–March), except during the summer rains (May–September). The localities selected for the study were Silacayoapan (17°30′ N 98°08′ W), Juxtlahuaca (17°43′ N 97°19′ W), and Huajuapan (17°48′ N 97°46′ W) that make up the Mixteca Baja (Figure 1) where caprine transhumant activity is recorded [23,25]; however, there is no census of transhumant goat producers. The districts have an area of 6948 km^2 and a population of 246,769 inhabitants [36].

2.2. Sampling Techniques and Information Compilation

The study began in January 2019 and ended in December 2021. Initially, the work regions were visited to conduct interviews with the municipal authorities and with the purpose of explaining the project activities. Subsequently, the owners of goat herds with transhumance activity (TGP) were identified and visited using snowball sampling. Further, the study was designed with a non-probabilistic sampling, considering as a requirement (a) the number of grazing goats in each herd must be greater than 1000 animals, (b) having a transhumance activity with native grazing, and (c) the carrying out of breeding and marketing activities within the Mixtec region. The identification of the study groups is shown in Table 1.

Table 1. Classification of goat farmers and number of goats by locality.

Locality	District	Classification	Number of Goats
Huajuapan de León (HL)	Huajuapan	Br-Ft (1)	1000
Tezoatlán de Segura y Luna (TSL)	Huajuapan	Br-Ft (1)	1000
Yucuñuti de Benito Juárez (YBJ)	Huajuapan	Br-Ft (2)	1500
San Marcos Arteaga (SMA)	Huajuapan	Br-Ft (3)	2500
San Francisco Yosocuta (SFY)	Huajuapan	Br-Ft (2)	1000
Santiago Juxtlahuaca (SJ)	Juxtlahuaca	Br (3), Br-Ft (1)	5000

Br-Ft: Breeders-Fatteners, Br: Breeders. The number in parentheses corresponds to the number of goat farmers by locality.

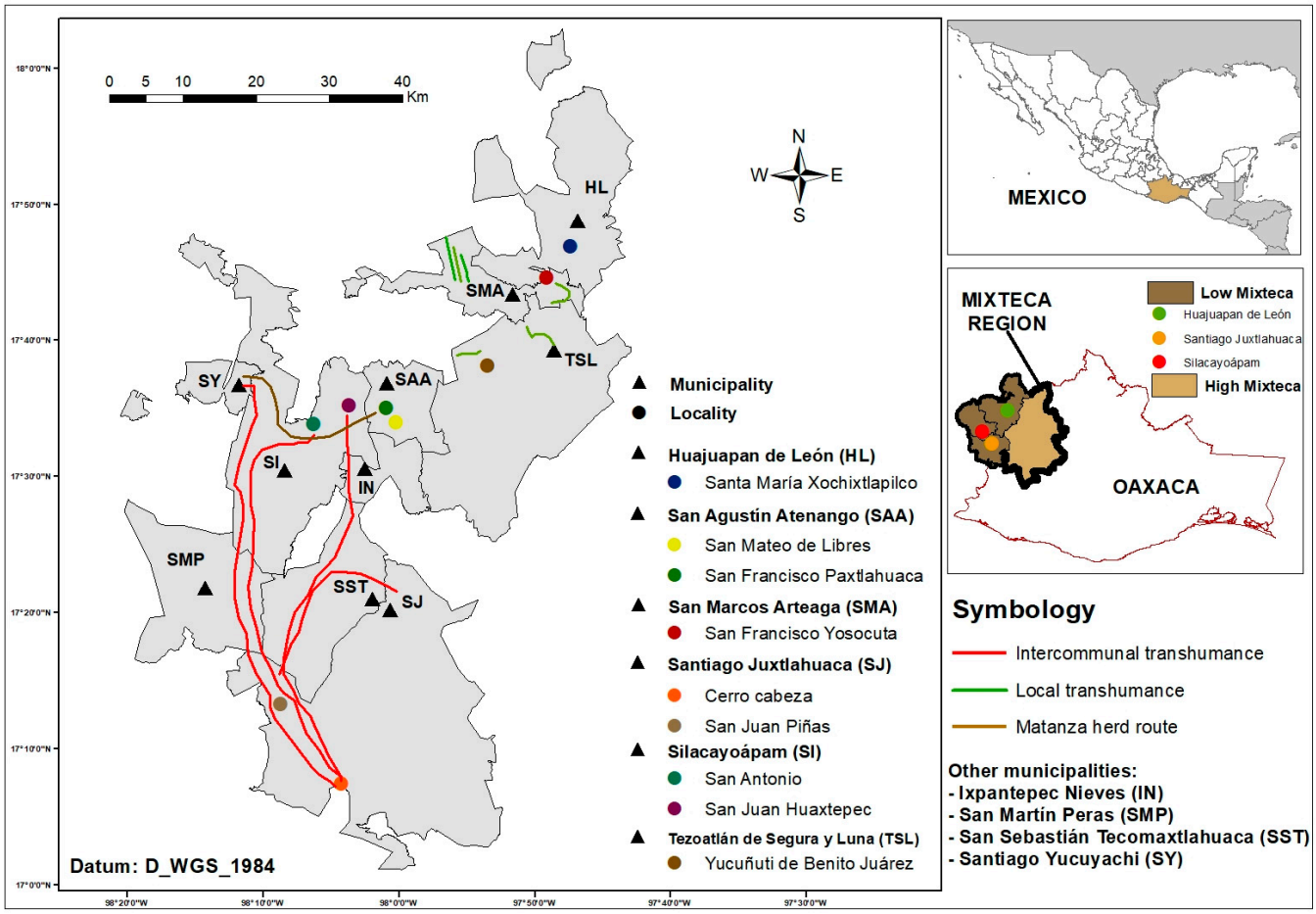

Figure 1. Location of the study area by region, district, municipality and locality.

The study questionnaire was structured in two phases:

First phase: The following points were identified: (a) the sociocultural context and the work organization between the owners of the herds (peasants, in Spanish: patrons) and the shepherds. (b) the classification and organization of the goat herds, (c) the commercialization activities and the sacrifice of the animals, and (d) the rent of the land in the transhumance activities.

Second phase: The daily activities carried out by goat herds during transhumance were identified; the points of study were: (a) classification of groups of goat herds, (b) customs and practices in the grazing of goat herds, and (c) zootechnical activities most commonly carried out in goat herds.

A pre-test of the questionnaire was conducted to assess and revise the data collection tool. The survey instrument was developed based on input from conservation and livestock program experts. In addition, a human dimension expert carefully examined the survey questionnaire to ensure the clarity of the questions and measuring scales. The first phase of the study was conducted during the first 17 months of the study; the data were collected through face-to-face interviews using a standardized structured questionnaire with open and closed questions and was corroborated with two repetitions carried out during periodic visits to the respondents. This objective was achieved through the bond of trust and friendship that existed between the interviewers, the peasants, and shepherds. The second phase was developed from the 18th to the 36th month; The activities consisted of accompanying and living with each shepherd for 2 weeks, participating in daily work, and zootechnical management of the herds during transhumance.

Subsequently, the information was ordered according to the main issues of the methodology proposed by the LIFE network (Local Livestock for Empowerment of Rural People),

which is oriented towards the rescue of the shepherds' traditional knowledge [40]. This type of traditional knowledge is known as "Ethno-animal science" [41]. Thus, the data obtained were analyzed with standard descriptive and inferential statistical tools. Additionally, the preference of the peasants and herders and the perception of different goat farming activities were obtained using a four-point Likert scale: 100%—most preferred, 75%—preferred, 50%—least preferred, 25% somewhat effective, and 0% not at all preferred. Any average and above-average scores mean that peasants and shepherds agree with this statement. The final scores were averaged, and the preferences and perceptions of the interviewees were analyzed. Simple means were used to interpret the classification data. Means were determined using the following equation:

$$\mu = \frac{\sum x_i}{N}$$

where X_i = the response selected by the ith interviewed, N = total number of interviewed in the study.

3. Results and Discussion

3.1. First Phase: The Sociocultural Context and the Organization

3.1.1. Social and Cultural Context of the Peasants (Patrones)

In the area of study, there are only 13 TGS named *Patrones* with ages ranging from 40 to 76 years (54 ± 12 years) and primary schooling. The main activity of this group is the TGP. They are in five different locations, and all together, they gather an approximate inventory of 12 thousand goats known as *pastoreñas*, cited in Table 1. The structure of the TGP is shown in Figure 2; the zootechnical purpose is carried out locally or in the region. The herds are managed for breeding; later, the goats are fattened to finish slaughter and marketing. The TGP is an activity that has persisted over time but is currently diminishing in the Mixteca Baja of Oaxaca. In fact, the age and number of the people involved and the apparent absence of interest in young people may be indicators of the decline of this activity. Oteros-Rozas et al. [42] cite that people with an average age of 63 years have greater knowledge about TGP, but the transmission of their experiences to new generations is less frequent because young people do not have an interest in pursuing this livelihood. On the other hand, TGP is a primary economic activity of all the people involved in the study; hence, agriculture is a secondary activity. The study group was classified into 3 *crianceros* (breeders) and 10 *crianceros-cebadores* (breeders–fatteners); these are names acquired by the *patron* to reflect the zootechnical purpose of their goats. The classification is outlined in Figure 3. *Crianceros* are dedicated to breeding goats, and their herds are named *trozos crilleros*. *Crianceros-cebadores* are devoted to the breeding and fattening of goats, and their herds are named *trozos crilleros* (breeding herds) y *trozos matanza* (fattening herds). In both cases, only *trozos crilleros* are transhumant. Santiago Juxtlahuaca has three *crianceros*; the rest of the study communities have *crianceros-cebadores*. However, only two of these types of *patrones* have managed to incorporate all aspects of the production cycle of TGP. They breed, fatten, slaughter, and market their goats. The *matanza* is the main economic activity related to the slaughter and commercialization of goats. The names indicate a specialization of work and a classification within society as a whole. These terminologies were introduced when the herds arrived in Colonial times. In some regions of Argentina, *criancero* is the transhumant producer who carries out the breeding [43]. The TGP can be classified as local or intermunicipality. With local, the goats are grazed around the communities where *patrones* reside, for example, in San Marcos Arteaga, San Francisco Yosocuta, Yucuñuti de Benito Juarez, and Tezoatlan de Segura y Luna (Figure 1, green lines). With intermunicipality, the goats are grazed between different Municipalities, where *patrones* do not reside, for instance, in Santiago Juxtlahuaca (Figure 1, red lines). Both types of TGP are dynamic since they are activities that depend on water, vegetation seasonality, and goat social bond. Similar aspects have been reported in the Sahel region of

West Africa [44], Spain during medieval and modern times [45], and with the short and medium-distance animal systems described by Costello and Svensson [6].

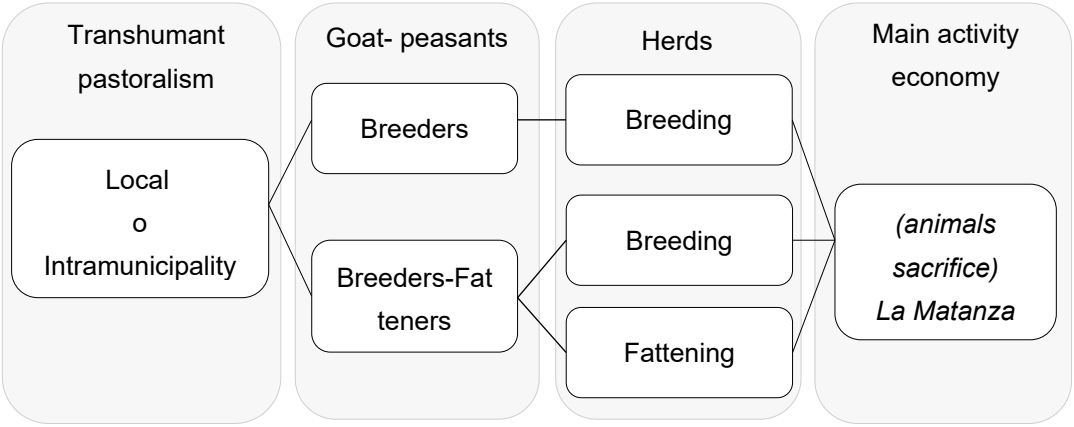

Figure 2. Structure of the Trasnhumant Goat Pastoralism.

3.1.2. Social and Work Organization

In the TGP, the social organization depends on the type of economic unit. Two breeders–fatteners with the whole productive cycle form economic business units (EBU); the rest of the breeders and breeders–fatteners integrate familiar economic units (FEU). In the EBU, the work can be divided into breeding, fattening and slaughter; and for its accomplishment, personnel is hired who later form *cuadrillas* (crews). The *cuadrillas* organize and facilitate the work in TGP and *la matanza*. The *capitan* (captain), *ayudante* (assistant), and *pastor* (shepherds) are the members of the *cuadrillas*. While in FEU, the work can only be divided into breeding and fattening, where the father, mother, and children are involved in all tasks.

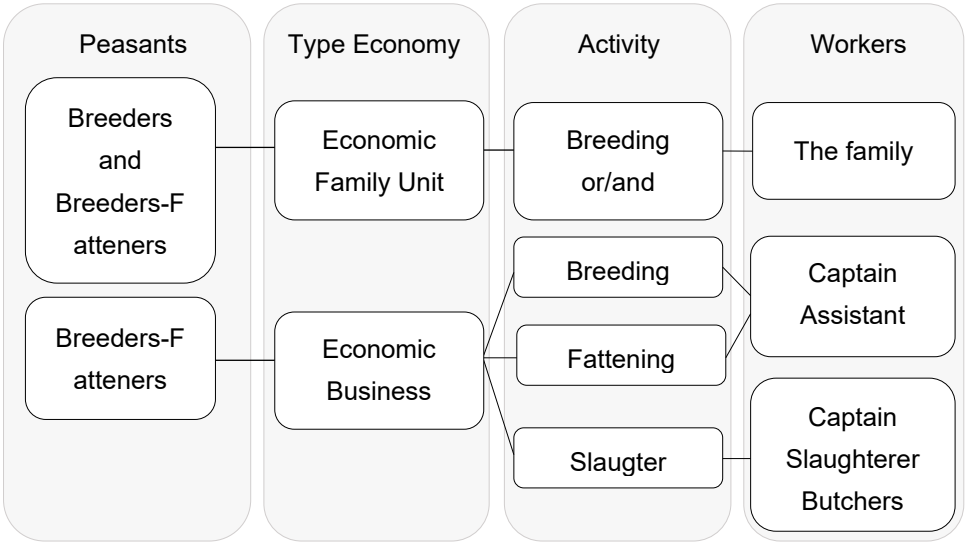

Figure 3. Organization of transhumant pastoralism.

The *cuadrillas* organize and facilitate the work in TGP and *matanza*. The *capitan* (captain), *ayudante* (assistant), and *pastor* (shepherds) are members of the *cuadrillas*. The captain is accountable to the *patron* of the crews and herds; he is his right hand. The captain has to count the goats in each herd every 15 days, and he is responsible for reaching agreements with the authorities of each community for the rental of land occupied by the goats during grazing. The assistant who collaborates in the activities of the captain is his subordinate. Finally, there are specialist shepherds for both breeding and fattening; their task with the goats is to care for and feed them. In slaughter, the captain supervises

the work of *matanceros*, *chiteros*, and *fritangueros cuadrillas*. The work of fattening and slaughter crews lasts 5 and 1 month, respectively. Conversely, in Breeding Crews, the work is maintained throughout the year.

3.1.3. Shepherds Organization

The shepherds categorize the grazing areas located to the north as thick forests and those to the south as thin forests. The main types of vegetation identified are shown in Figure 4. They mention that the thick forests (*monte grueso*) facilitate the fattening of the goats, while the thin forests (*monte delgado*) do not facilitate the fattening of the goats but prevent them from starving. Transhumance from the north to the south begins after registering the first frosts in December. The return from south to north starts with the presence of rains in May. In both cases, the tour lasts ten days. In northern localities, grazing takes place from June to November during the summer and fall seasons. In southern localities, grazing occurs from December to May during the winter and spring seasons. Most of the shepherds come from Vista Hermosa and El Molino, belonging to the municipality of Huajuapan de León. Although some are originally from San Sebastián Tecomaxtlahuaca and San Miguel Cuevas in the municipality of Juxtlahuaca. Despite the fact that the shepherds have fixed homes in their communities of origin, their lives take place in the mountains, together with the goat herds. The shepherds and their families form the basic unit of transhumant goat pastoralism. They live in *rancho* (Figure 5, middle right), defined as a shelter that is built with tarps, like a tent, that they call a *malteado*. There are two tents, one is used as a bedroom, and the other is used to cover the fire where they cook their food. Both tents are built each time the herds are moved to another paddock. They carry the *rancho* with the help of horses and donkeys. In all pastoral systems, the camp is essential and is where all people take shelter from inclement weather, and it is also the meeting point for family coexistence [46]. The *rancho* is part of the social identity of the families of the shepherds in the Mixteca; another similarity of refuge in the neighboring state of Guerrero is known as *jato* [22]; in other countries, it is named *yurt* Mongolia China, and *the huts* in Massai Tanzania [47].

Figure 4. Main types of vegetation: **Left**: low deciduous forest (**below**), Oak forest (**center**) and Pine-oak forest (**above**). **Right**: Breeding herd between Pine-oak forest (**above**) and Mountain mesophilic forest (**below**).

Figure 5. (**Upper left**), goat Pastoreña herds (trozo). (**Upper right**), chiteros crew sun exposed salted meat to dry, which will become chito. (**Middle left**), the image shows rancho formed by two canvas tents and the shepherd makes his food. (**Middle right**), the shepherd shaves the mother's tail to prevent possible vaginal infections. (**Under left**), the shepherd makes a mark on the goat kids. It has to be the same mark carried by the goat-mother (identification). (**Under right**), goat kids (4 days old) tied to a bush by a rope of a lower limb to prevent them from going out to graze with the flock.

3.1.4. Trozos (Breeding Herds) Organization

As mentioned, in TGP, there are *trozos crilleros* (breeding herds) and *trozos matanza* (fattening herds); this classification facilitates the work of Crews. Breeding herds are organized by sex and condition, forming six types of pieces: Pregnant or Non-Pregnant Females; Neutered or Non-Neutered Males; and female or male weaned kids. Fattening herds are classified according to gender into: *cabreros* (female) and *chiveros* (male). In this way, six herds are formed and ordered by age and health: *puntal* and *Viejo* (over 5 years old); *mediapunta* and *punta* (older than 2 years); *traspunta* and *Hospital* (skinny or diseased goats) (Figure 6). Fattening herds are formed by goats extracted from breeding and *chinchorreros* herds. Dehouve et al. [19] mention a herd structure in the HV from the 18th century, which has persisted over time. In this study, the classification is detailed with better precision, showing a diversity of the structure of TGP. The breeding herds are formed from 300 to 1200 goats, and they carry out transhumance. In the case of the fattening, herds are integrated from 300 to 550 goats, and they do not carry out transhumance. The fattening herds are grazed for only 5 months (from June to October). The meadows reserved for these herds are only grazed for one day, with rest intervals of 45 days. This grazing management is used to make the most of the plant biomass production during the rainy season. The breeding herds are grazed throughout the year. The meadows used for grazing goats are used for just 3 or 5 days; after this time, the meadows are no longer used until the following year.

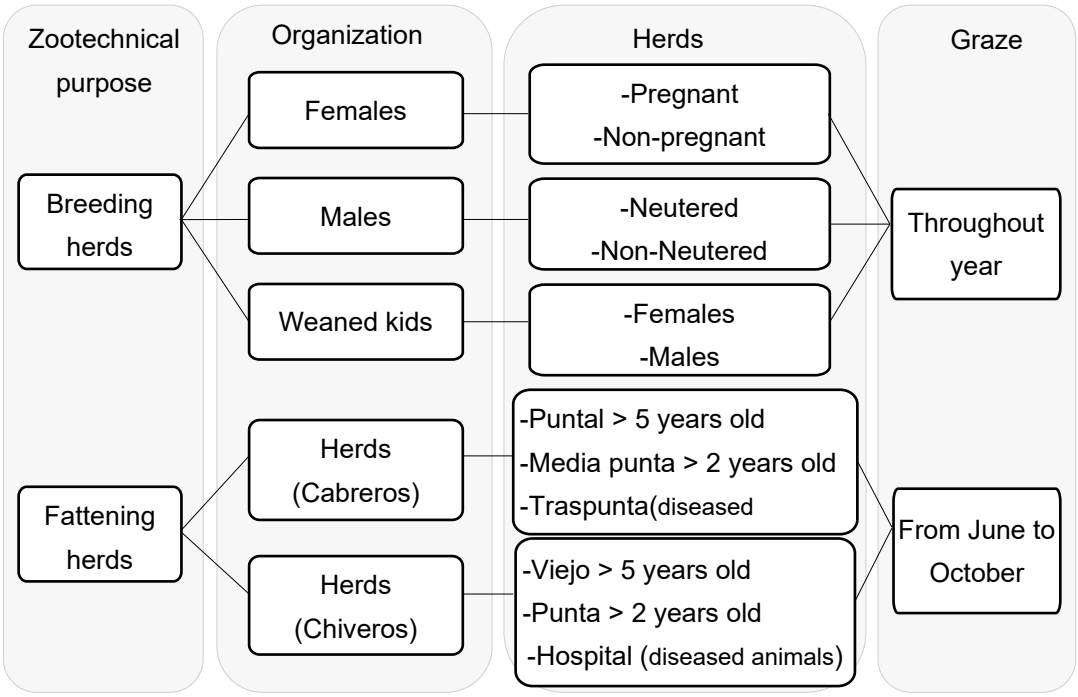

Figure 6. Organization of the different herds.

3.1.5. La Matanza (Sacrificial Activities)

La matanza (an activity that includes slaughter and butchering of goats, such as processing and marketing of meat and subproducts) is the culminating activity of goat herding. It is an economic activity that monopolizes herds of creole, *pastoreña*, and *costeña* goats. Merchants pay the highest prices for transhumant *pastoreña* goats, with purchase prices from 1000 up to 1500 MXN per goat (46.9–70.4 USD), compared to the national average price of 1157 MXN (54.3 USD). The purpose of *la matanza* is the slaughter of the goats for the marketing of loin, arms, and hip. These parts are the primary ingredients for making the traditional food known as *mole de caderas* [48]. The work activity of *la matanza* is divided into four periods: (1) purchase and collection of goats, (2) fattening period, (3) slaughter and butchering, and (4) processing. (1) *La matanza* begins in the month of June, buying and collecting the creole, *pastoreña*, and *costeña* goats from *chinchorreros* or *pastoreños* herds throughout the Mixteca region. (2) The goats are transported to the grazing regions by truck to be fattened for 5 months. (3) Later, the goats are transferred to the slaughter sites located in the regions of Santa María Xochixtlapilco and San Sebastián Tecomaxtlahuaca. (4) The places of slaughter are organized by groups of day laborers who make up the slaughter chain. Initially, crews of people are formed who are responsible for the slaughter and butchering of goats. The crews are made up of *matanceros*, *chiteros*, and *fritangueros*. The *matanceros* crew slaughters the goats and obtains the carcasses. Each person is paid 200 MXN (9.0 USD) per day for their work. The *chiteros* crews are butchers because they cut the meat into shoulders, hips, and loins. In fact, those who carry out this activity are paid 250 MXN (11.7 USD) per day. As soon as the pieces of meat are cut into small strips, salt is added, and then let settle for 12 h, so that excess water is eliminated and to facilitate drying. Lastly, both the meat and meatless bones are placed on palm mats for direct drying in the sun to obtain the final product (Figure 5, upper right). The dried and salty meat is named *chito*. The *fritangueros* crews are dedicated to frying ribs, livers, kidneys, and udders using the fat of the same goats; this work activity is paid with 500 MNX (23.4 USD) per day. All *matanza* activities end in the second week of November and are an inheritance of the HV, documented by Dehouve et al. [19]. At present, *la matanza* processes continue to provide direct and indirect employment to families in the region [35], and it is the only

means by which *pastoreños* herds are marketed and contribute to the economy [49]. In the world, there are no published reports of similar livestock activity.

3.1.6. Land Rental

The grazing of herds generates economic income for localities where they are distributed. The economic income is collected from payment per animal each month 15 MNX (0.6 USD), per herd each month 15 thousand MNX (677.20 USD), or per season for 6 months of 50 thousand MXN (2257.33 USD). The economic payment is accompanied by extra supplies such as sodas, beers, and three or four adult male goats used in the religious festivities of each locality. An alternate payment made by *patrones* of *interlocalities* transhumance is permission for the goats to cross the territory during the north-south and south-north herding. The payment ranges from 300 to 2000 MXN (13.54–90.29 USD). The amount depends on the days that the tour lasts in each locality. Moreover, all payments are collected by the Municipal Authorities of each locality. The income received is used for the purchase of musical instruments from the public schools, and indirectly the excreta of the herds contribute the benefit of the fertilizer to the agricultural lands; According to Gentle and Thwaites [50], all these contributions motivate rural people to continue maintaining the tradition of transhumant pastoralism, although as already mentioned, young people are losing interest in livestock activities.

3.2. Second Phase 2: Characteristics of Goat Herds in Transhumance

3.2.1. Pastoreña Goat Classification

Pastoreña goat is exclusive in the TP of the Mixteca region. Domínguez et al. [26] obtained the genetic profile of this goat and demonstrated that it is unique in the world with well-defined characteristics, clearly separated from Blanca Andaluza and Blanca Celtiberica goats. In this study, 90% of the goats maintain a white or creamy hair coating, as mentioned by Villarreal-Arellano et al. [27]. The colors are chosen because it is easier to see goats when grazing in vegetation with excess weeds (Figure 5, upper left). Furthermore, few goats (10%) have black, brown, or combinations of coatings. All-male goats (100%) with these coatings are castrated in the first week of age, avoiding the proliferation of those traits. Fertility, prolificacy, and adaptability are characteristics of *Pastoreña* goat that emphasize *patrones*. For example, a herd of 275 females had a fertility and prolificacy rate of 98% and 1.4% (twins), respectively. In terms of adaptability, walking long distances over rough terrain is the most essential adaptive characteristic. In addition, they are considered long-lived goats as the females can live up to 10 years, while the males live more than 12 years.

On the other hand, goats of both sexes are classified according to their age in: *cabrito* (up to 7 months), *matanza* (from 8 to 12 months), *puntal* (around 6 years old), *viejo* (after 6 years). There are also goats with some distinctive peculiarities: *estacas* (stakes): Male goats are castrated before the first week old. These males will have a female phenotype and behaviors female during their adult life. There are three or four goats in each herd; they are docile and are used to move the pieces to other pastures because they wear the cowbell. *Primales*: It is made up of groups called *matanza. Puntal* or *viejo*: goats that were castrated to integrate the fattening herd or slaughter herd. The castration technique used by all production units (100%) is the twisting and insertion of the testicles into the abdominal cavity. The main objective is to suppress the blood supply of the pampiniform venous plexus [51]. Manfloras or machorras: Hermaphrodite goats are not common, as they are born every 3 or 4 years. These goats are considered a good luck charm due to the cosmovision of *patrones* since the goats increase in the herd. They are retained in the piece until their death and never sold. *Memas*: Female goats that do not have adult female behavior and are rarely pregnant. The *manfloras* and *memas* are conserved with the pieces by culture—it is believed that the functions of this group of females are to stimulate and synchronize the estrus to the other females of the herd. The terms *machorra*, *manflora,* and *horra* are in common use among shepherds in Colombia, Andalusia, and the Canary Islands;

they refer to sterile females [52]. In Mendoza, Argentina, the term *manflora* is used by goat shepherds [53].

3.2.2. Grazing of Goat Herds in Transhumance

TGP is practiced in different vegetation types with varying altitude gradients, as cited by the FAO [16] (Figure 4). In all the goat production units in this study (100%), altitude is the factor that determines herd mobility. In northern localities, low deciduous forests can be observed below 1900 altitude and oak forests between 1900 and 2100 altitudes. In southern localities, pine-oak forests can be observed from 1200 to 2800 altitudes and mesophilic mountain forests between 2800 and 3000 altitudes. The territory is mountainous at 60–70%, and this physiographic condition does not limit the grazing of goats, and also, there is no competition with other livestock species for spaces for their food [54]. Some social sectors are unaware of TGP management and assume that transhumant herds are the cause of ecological disasters that are observed in Mixteca. However, there is no evidence of erosion caused by the transhumant activity, although other authors [55] suggest implementing methodologies to assess the deterioration or conservation of the areas grazed by goat herds.

The grazing routes of five breeding herds and two fattening herds were identified and traced. The mobility of the PTC is carried out on communal land, and the local authorities are the only ones that allow access to grazing [11] through a monetary payment (see Section 3.1.6). There is no rule or special protection by local, state, or federal governments to legislate grazing routes. The breeding herds practice intermunicipality transhumance and maintain four routes: (1) Santiago Yucuyachi–Cerro Cabeza, (2) San Antonio–Cerro Cabeza, (3) San Juan Huaxtepec–Cerro Cabeza and (4) Santiago Juxtlahuaca–Cerro Cabeza. The four routes are exemplified by the red lines from left to right in Figure 1. In the rainy season, breeding herds graze from middle May to November in northern localities such as Santiago Yucuyachi, San Antonio, San Juan Huaxtepec, and Santiago Juxtlahuaca. In the dry season, these herds graze from the middle of December to the beginning of May in southern localities such as Cerro Cabeza and San Juan Piñas. While fattening herds graze from the beginning of June to the middle of October in northern localities such as San Francisco Paxtlahuaca and San Mateo de Libres. All *patrones* (100%) chose a small part of the routes that the transhumant herds traveled in the 20th century [19].

The shepherds comment that not only the expansion of agricultural lands but also the damage to crops caused by animal grazing are the main causes of cancellation of the transhumance that was practiced from the Costa region in Guerrero to the Mixteca region in Oaxaca. These problems are constant in pastoral activities in other parts of the world [47]. In this study was identified that the herders programmed the grazing routes, considering the availability of water and forage as a priority. In the regions, a high forage density of trees, shrubs, and herbs is common, but if there are no water springs along the way, the shepherds do not consider it an ideal route for grazing. Specifically, the shepherds are organized based on the needs of the herds, and the grazing routes are determined by the ecological and environmental conditions of each season, as occurs with transhumance shepherds of Greece [56].

In general, the daily grazing of goats is divided into three periods for all production units (100%). First period: the shepherds name it almuerzo (lunch); it begins at 08:00 and ends at noon. Second period: it is called sesteo (siesta), the goats return from grazing and rest lying on the periphery of the ranch, beginning at noon h and ends at 15:00 Third period: it is known as cena (dinner), and it is starting at 15:00 and ends at 19:00 There is a similarity between the transhumant grazing of this study and that reported by Martínez et al. [22] in the neighboring state of Guerrero. This is because the ancestor of the current transhumance is the HV that transited between the aforementioned territories [19]. Goat graze areas are divided into paddocks and are subdivided according to the feeding period: Lunch or Dinner (Figure 7).

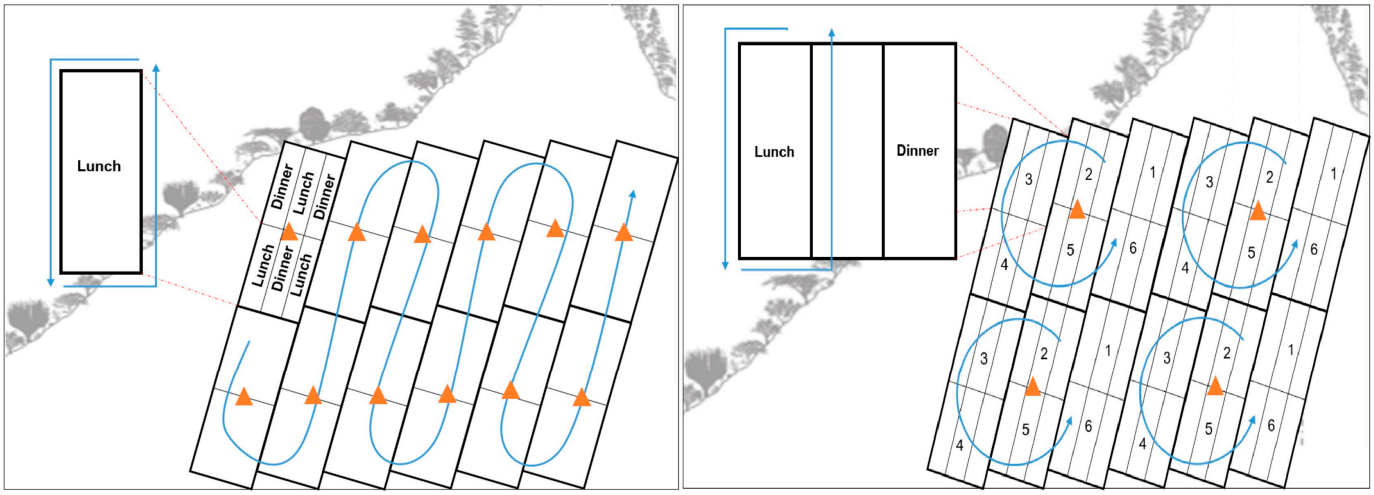

Figure 7. Schematization of the paddocks and their subdivisions (lunch, dinner) used by Crillero (**left**) and Matanza (**right**) herds. The ranch (orange triangle) is located in the center of 1 (**left**) and 6 (**right**) paddocks. Each number represents a grazing. Left above: a paddock is exemplified; the blue lines indicate the movement of the shepherds during grazing.

The work of the shepherds is to keep the herd within a corresponding area to be used, taking care of the periphery of subdivisions. The paddocks are used only once and are returned to them until the following year. In particular, the larger paddocks (around 56 ± 16 ha) are used by crilleros herds (Figure 7, left). The maximum grazing time is 3–5 days in this type of paddock. The duration in each pasture is due to the goats trampling, urinating, and defecating the forage, and consequently, consumption decreases. The change of paddocks also requires that of the rancho. The movement of goats between paddocks is performed in a zig-zag, with an upward and downward direction (Figure 7). The smaller paddocks (around 1.5 ± 0.4 ha) are used by matanza herds only for one day (Figure 7, right). A paddock is divided into three parts: The first part is used for lunch, and the third is used for dinner. The second part can be offered at lunch or dinner, which depends on the goats' appetite. The napping time is carried out in the region where the goats ate, and the purpose is to reduce energy expenditure due to displacement and avoid the loss of body weight of the animals. After dinner, this flock is also herded to rancho for night care.

3.2.3. Zootechnical Activities of Goat Herds

The mating season is named *corrida*, and there are three. (1) In 55% of the herds, the big mating (*corrida grande*) occurs in December and January, with the presence of parturitions in May and June. (2). In 33%, the medium mating (*corrida media*) occurs in the females that were not pregnant, and the bucks are exposed again in May and June to give birth in October and November. (3) In 22 %, the minor mating (*corrida menor*) is organized with the primal females (puberty 6–7 months) during October, and the birth of the kids will take place in March. One month before the delivery of the kids, only injectable selenium is applied to pregnant goats. Veterinarians recommend this zootechnical practice in the region to improve the survival of the offspring [57]. The peasants are not opposed to medical and zootechnical recommendations; they empirically evaluate the suggested activities. The group of bucks grazes a kilometer away from the herd of females; only a shepherd (adolescent or a lady) takes care of the males so that they do not integrate with the females. During the night, the bucks rest separately, and the herders implement noise signals to prevent the entry of a buck into the herd of females. Later in the mating periods, one buck is selected for every 40 females, meeting the following characteristics: (a) Age from 2 to 3 years, (b) Males with good body conformation, (c) white or creamy coverage, (d) Large testes with the presence of a longitudinal bipartition in the middle of the scrotum. The herders believe that this last selected physical characteristic is associated with higher sperm

production and quality [58,59]. They also believe that the offspring-female descendants of the selected bucks, during adulthood, may have more twin kids, well-conformed udders, and better milk production [22]. Most of the births in goats are registered during the first hours of the morning (6:00 to 11:00 h). The shepherds evaluate the females that give birth to three offspring if the goat has good body condition and suckles all the offspring (in very few cases). They will continue with the mother; otherwise, they will sacrifice kids to ensure the survival and growth of the other offspring. Birth weights range from 2.9 to 3.3 kg, coinciding with other reports in the region [22,60]. After the births, the shepherds (100%) identify the mothers and their kids with a mark or numbers on the rib (Figure 5, under the left). Furthermore, it shaves the tails of both animals in kids to avoid adhesion of meconeus or feces in the perianal region, and the mothers prevent vaginal infections (Figure 5, middle right). The mother–calf bond is named *ahijadero,* and the kids are attached to a bush with a rope around the neck or a lower limb, avoiding their loss and facilitating their suckling (Figure 5, under right). After five or ten days, the kids are released and go out with their mothers to graze. The shepherds mention that the restraint allows the mother–kids bonding, the kid is physically strengthened, and the kidnapping of the kids by predators such as coyotes (*Canis latrans*), pumas (*Puma concolor*), and lynxes (*Lynx rufus*) is avoided. Kids goats have identified in-ear notches during the month of age. Each employer has its brand for its goats, preventing the loss or theft of goats [45,60].

3.3. Theoretical Support of Mixteca Transhumance

The theoretical-methodological approach identified in this study indicates that goat transhumance is based on the coherence postulate that "smallholders have reasons to do what they do". They consider livestock groups as a complex system, which includes the context of the production system, family participation, work, and marketing decisions [61]. Global knowledge in cases of transhumance implies the following methodological assumptions: (a) Transhumant production unit of goats should be used alongside the concept "livestock system in goat breeding" [62]; (b) there is a conceptual framework of "reasonableness" in the daily work practices carried out by owners and shepherds, that is, there is a "practical logic" [63]; and (c) in animal production systems there are "uses and customs", these are integrated with some types of strategies that are linked to traditions and the marketing economy, allowing their existence [61].

The maintenance of autonomy in each herd studied has allowed comprehension of the production goals. In general terms, transhumance means "doing things well", having relevance to how animal production should be performed, and having a social capital [64], which at the same time is collective in the Mixteca region where daily and extreme poverty abounds. The different social classes are possible due to economic strategies; the importance of the honorability and family prestige of the owners and shepherds are a symbolic capital, where livestock and agricultural contexts are handled [61,64]. There is a friendly exchange of knowledge with daily practices. Still, at the same time, there is mistrust towards government agencies when they suggest changes in goat farming due to failure in some livestock programs. In Mixteca, new young owners immediately own fractions of herds; they have social exchange networks and symbolic capital to "become owners". This activity strengthens the productive/rural identity, establishing styles or ways of family and a social life that are inclined to livestock or agriculture, facilitating efficiency in production units, and being able to continue maintaining the sustainability of transhumant herds. The main results show how the ranchers' conditions develop dynamic practices and strategies for the production units. In this sense, not only the endogenous or unique needs but also the exogenous or collective conditions are essential in the objectives of livestock. The role of this type of collaborative practice is strengthened by the work theories cited by Pulina et al. [65]. These are essential life norms and can only be broken due to force majeure, such as advanced age, absence of successors, or health problems. Goat herds are the heritage of many families, and the transhumance system has allowed the identification

of educational, succession, symbolic, and economic strategies that maintain the traditions and economy of the region.

4. Conclusions

The description of the PTC visualizes a complex social, productive, and economic organization. Consequently, this local goat culture has unique characteristics worldwide, which should continue to be studied in detail to guide new research projects and implement public policies in accordance with their reality, establishing sustainability indicators. The methodological process, the accompaniment on the herd routes, and the coexistence of the researchers, together with the peasants and shepherds, generated reliable information. The data collected allowed us to know and write the traditions, experiences, and unique characteristics of the TGP of the Mixteca, Oaxaca. The transhumance practiced in the region is an interesting production system that has not been given sufficient ecological, environmental, social, and economic importance in the region. This livestock activity has an essential ecological niche; it provides employment, income, and conservation of the environment. However, it is necessary to integrate future planning to avoid the deterioration of sustainable natural resources and loss of cultural traditions. The particularities described in the study carried out still leave social, economic, and zootechnical questions. The points cited that must be analyzed and addressed by the government, social groups, and researchers to reduce poverty and improve the quality of life, mainly in the family nuclei of the peasants, shepherds, workshops, and small merchants.

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