Original Article

DISTRIBUTION OF GOAT BREEDS IN BRAZIL AND THEIR RELATIONSHIP WITH ENVIRONMENTAL CONTROLS

DISTRIBUIÇÃO DE RAÇAS DE CAPRINOS NO BRASIL E SUA RELAÇÃO COM CONTROLES AMBIENTAIS

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RESUMO: A localização de todos os rebanhos de cabras de raça pura no Brasil foi espacializada de acordo com os controles climáticos (Índice de Temperatura e Umidade, precipitação, topografia, umidade relativa do ar) e controles ambientais (altitude, tipo de pastagem). Os dados foram analisados através de uma análise de regressão, variância, logistica e cluster. Matrizes de distância foram construídas de acordo com a longitude/ latitude e os controles ambientais foram correlacionados por meio do teste de Mantel. O ponto médio para a maioria das raças foi encontrado no estado da Bahia, mas no estado de Pernambuco encontraram-se os pontos médias das raças localmente adaptadas. A Anglonubiana foi a raça comercial com o ponto médio mais ao norte, enquanto as raças Toggenburg, Saanen e Alpina tiveram o ponto médio de produção mais ao sul do país. Houve pouca diferença entre os controles ambientais para as raças localamente adaptadas e comerciais, mas raças dupla aptidão encontraram-se nas regiões com menor precipitação e Índice de Desenvolvimento Humano , mas com as temperaturas e área de mata mais elevadas . As raças comerciais são mais difundidas no Brasil do que raças locais, sendo que as últimas ocorrem um maior risco de extinção devido a doenças, seca ou cruzamento com outras raças.

PALAVRAS-CHAVE: Correlação de Mantel. Pastagem. Temperatura. Precipitação. Regressão logística.

INTRODUCTION

While small ruminant production is important in Brazil for sustaining livelihoods in otherwise harsh or unagriculturable regions, little is known about breed distribution or use in these systems. Goat production is concentrated in the Northeast of the country with 91% of the animals but in terms of milk production the Southwest region is more productive with 23% (LOPES et al., 2012). This region is situated in the Drought Polygon (LÔBO et al., 2011) and is dominated by long dry seasons, low humidity and precipitation, poor vegetation, as well as low Human Development Index (HDI) (PNUD, 2011) and low Gross Domestic Product (GDP), all of which affect how animals are farmed. Production in this region is thought to be a function of the animal´s ability to withstand the harsh environmental and climatic conditions of the region (NOGUEIRA et al., 2008; LOPES et al., 2012).

The average farm size in the Northeast region of Brazil is 13 ha (90% comprised of family farms) and they maintain less than 30% of all animals. Farms in the region generally offer few options for farming (mainly cassava, maize and beans), and small ruminants require less labour to look after them, thereby farmers or family members are able to maintain their property as well as seek employment outside the farm (LÔBO et al., 2011). Goat production in Brazil therefore has great economic and social importance, mainly in the production of milk and meat to feed these low income populations in rural areas. In most cases these farmers present low technological level and poor genetic control of their herds.

The importation of cheese from goat's milk, among other products, was banned by Brazil in 1975 by the Second National Development Plan (BRASIL, 1974). This led to an increase in the importation of dairy goat breeds such as Anglo-Nubian, Alpine, Saanen and Toggenburg (MACHADO et al., 1984). State agencies in Rio Grande do Norte, Bahia and Pernambuco also replaced imported goat milk by locally produced milk, and stimulated the use of locally produced meat in school lunches to help maintain children from lower

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income families from leaving school (SUASSUNA, 2003; SOUSA, 2007). Thus, these farmers in the Northeast use milk and meat for family consumption and for social government programs. Currently, Brazil is the world´s 15th largest producer of goats (FAO, 2012).

Environmental controls and production levels should be considered for creating animal breeding programs and several variables can be joined in a spatial model to show how these factors affect animal production (ORAVCOVA et al., 2005, JOOST et al., 2010, MCMANUS et al., 2010b). Correlation of landscape features with the animal characteristics (MANEL et al., 2003, 2010; STORFER et al., 2007, 2010) is used to understand how environmental processes can influence and change the characteristics of populations, as well as understanding how individuals are generated from environmental and geographical variations to which they are submitted. Physical, socioeconomic and climatic characteristics are important sources of variation that should be considered for animal production programs to be successful (BETT et al., 2009a, 2011; DEVENDRA, 2010).

LOPES et al. (2012) studied environmental controls on goat production in Brazil and found that different regions and States within region generate different production levels and animal use. These assumptions were based on official production data for goats and goat milk (IBGE 2012a) but no information is available on which breeds are effectively present in these regions.

The objective of this paper was to spatialize official goat breeds in Brazil and link their occurrence to environmental controls to better understand this distribution as well as identify possible risks for extinction of Goat Animal Genetic Resources in Brazil.

MATERIALS AND METHODS

Information was collected from Brazilian Association of Goat Breeders (ABCC) and the Ministry of Agriculture (MAPA). There were 1024 farmers, with 1316 flock registries with animals registered since 1999. Several farmers bred more than one breed (3 farms had 5 breeds, 11 had four breeds, 37 had three breeds and 199 had two breeds). Only information on purebred flocks was used and names were in accordance with the manner registered by the Association. The localization of all flocks of was spatialized by municipality. Breeds were classified as commercial or locally adapated (Table 1).

Vegetation cover was from the average annual (2011) Normalized Difference Vegetation Index (NDVI) derived from MODIS images (Moderate Resolution Imaging Spectro-radiometer). Images were acquired from NASA site (2012) and converted from the sinuzoidal projection to geographic lat/long in Modis Reprojection Tool (MRT) (geographic projection Lat/Long and Datum WGS 84), and the annual average was processed in the software ENVI 4.7.

Average monthly precipitation values from 2000 to 2010 were captured from image sensor TRMM (Tropical Rainfall Measuring Mission) with a spatial resolution of 0.25°, or about 27 km. The images were acquired from the NASA (2012) and processed using ENVI 4.7.

The surface temperature was taken from MODIS product mod11. These were redesigned with the MRT extension geotif, geographic projection Lat/Long and Datum WGS 84. Automatic Quality Control (QC) of the image was used. After conversion of the temperature from Kelvin to degrees Celsius by means of a Band Math tool in Envi 4.7, average temperature of the period was calculated (2000 to 2011). The average elevation and topography of the municipality was taken from SRTM (Shuttle Radar Topography Mission), with a resolution of 90 meters. In this study we used data from the processing of SRTM for a hydrologically consistent model (hydroshed) from NASA (2012). Relative humidity data were from the National Institute of Meteorology (INMET) and are the result of the average of approximately 30 years of observations from 283 weather stations distributed throughout the country. The stations were spatialized in ArcGis9.3 and humidity data were interpolated by the Topogrid module of the same software, with a pixel of 1 km.

The Temperature and Humidity Index (THI) relates the thermal comfort range of animals to the ambient temperature and relative humidity (THOM, 1959). For the calculation we used data of temperature and humidity using $THI = Ta + (0.36 \times To) + 41.5$ where: Ta = ambient temperature (°C) To = temperature of the dew point (°C). The variation in orientation, elevation (tilt and aspect) and shadows from topographical features affect the amount of insolation received at different locations.

The weighted mean center (latitude and longitude) for each breed was calculated using the number of flocks per municipality. No information was available on herd size, but all herds had more than 10 animals. Information on vegetation type by municipality was collected from the 2006 Brazilian Agricultural Census (IBGE 2012), the last available, as well as population, area and Gross Domestic Product (GDP) of the Municipality from IBGE (2012b). Human development Index (HDI) was available from PNUD. This included percentage of cover of brush and pasture (natural, planted, degraded), areas of forest or shrub, population, GDP, HDI and number of animal units per farm. Variance Inflation (>10) and collinearity (condition index – CI >30) were examined using PROC REG as these are essentially characteristics of the explanatory variables. As expected THI, temperature and relative humidity showed high values for these traits. The final model included altitude, precipitation, NDVI, temperature, topography, number of animals per farm and per km^2, area of native and planted pastures, shrub and forest as well as HDI and animals per area. All variables were spatialized in ArcGis 9.3 (Annexes) with geographic projection Lat/Long and Datum WGS 84 from the Zonal Statistics tool based on vector data related to municipalities (IBGE 2012). Data were transformed using Box-Cox transformations. Means of the climatic conditions per breed (where there were more than two herds per breed) were compared using an analysis of variation (PROC MIXED) in SAS® (Statistical Analysis System v. 9.3, Cary, North Carolina, USA). Differences were tested using Tukey (P<0.05). A binomial and multivariate logistic regression was carried out to test the presence of commercial, locally adapted, milk, meat or dual purpose breeds according to the environmental controls. Model selection was carried out considering Nagelkerke´s R^2, area under the ROC curve, Akaike information criterion (AIC) and Schwarz´s Bayesian information criterion (BIC). Cluster analyses based on median distances were used to group the breeds according to environmental dissimilarity and compared to mean distances using Mantel test in PASSaGE (ROSENBERG et al., 2011).

RESULTS

There are 16 goat breeds registered by the ABCC (http://www.abccaprinos.com.br/site/regulamento_srgc.php): Alpine; American Alpine; British Alpine; Anglonubian; Angora; Bhuj; Boer; Canindé; Jamnapari; Kalahari; Mambrina; Moxotó; Murciana; Saanen; Savanna and Toggenburg. Open herd book exists for males of the Bhuj, Canindé, Jamnapari, Mambrina and Moxotó breeds. Several breeds have no herds registered (Table 1) such as Bhuj and Jamnapari, while others have few herds. To facilitate discussion due to the low number of registered herds some breeds or breed types were grouped together (i) Azul, Canindé and Moxotó as locally adapated breeds; ii) Murciana, Angora, Mambira and Kalahari as others and iii) Alpine, British Alpine, American Alpine and Parda Alpine as Alpine.

Table 1. Number of purebred goat herds registered by Brazilian Association of Goat Breeders by breed

Breed	Type	Use	Number of herds
Alpine	Commercial	Milk	931
American Alpine	Commercial	Milk	14
Anglonubian	Commercial	Dual	526
Angora	Commercial	Hair	1
Azul*	Locally Adapted	Dual	1
Boer	Commercial	Meat	359
British Alpine	Commercial	Milk	1
Canindé	Locally Adapted	Dual	9
Kalahari	Commercial	Meat	1
Mambrina	Commercial	Milk	2
Moxotó	Locally Adapted	Dual	13
Murciana	Commercial	Dual	9
Saanen	Commercial	Milk	218

Savanna	Commercial	Meat	14
Toggenburg	Commercial	Milk	46

* Azul is not an official breed recognised by the Brazilian Ministry of Agriculture, Food and Supply (MAPA); There are also three No defined breed herds registered by the ABCC.

There was a significantly higher number of commercial goat breeders than locally adapted, with Saanen, Boer, Anglonubian and the Alpine breeds (all commercial) being the most popular. There is also no data on other genetic resources such as Repartida, Marota, Gurguéia, among others.

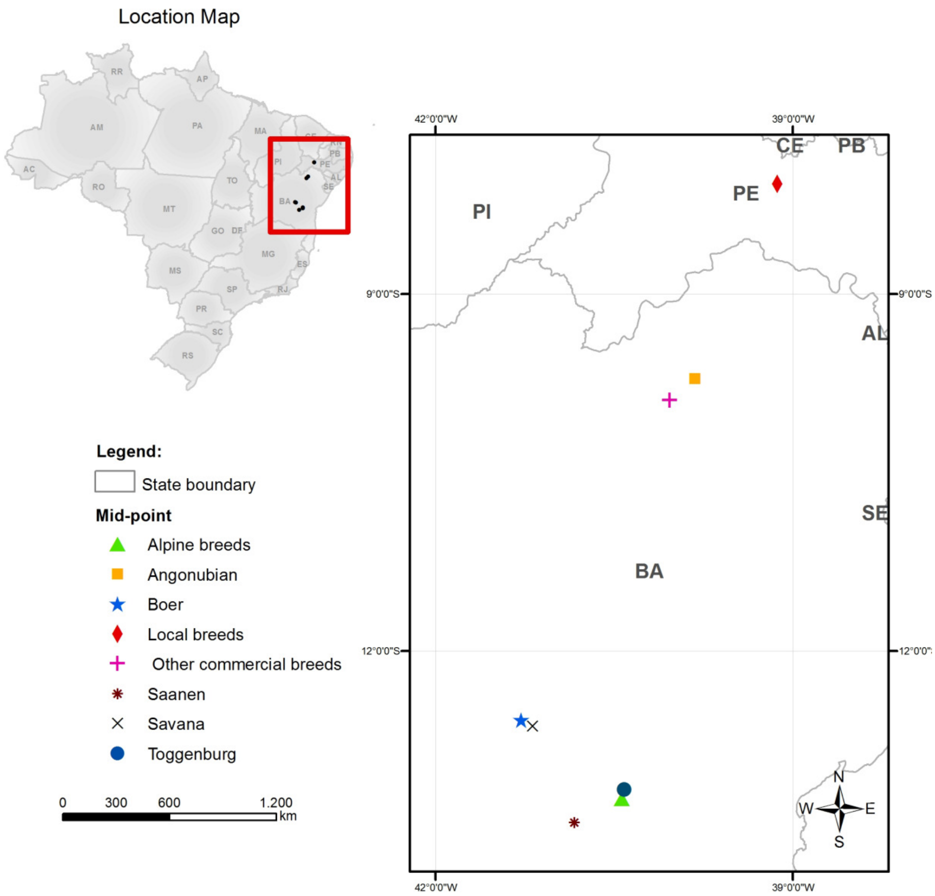


Figure 1. Midpoint of production by goat breed in Brazil. Alpine includes British and American; Local breeds include Azul, Candindé, Moxotó; Others includes Kalahari, Angorá, Mambrina and Murciana.

The production midpoint for most breeds is in Bahia State with the locally adapted breeds furthest to the Northeast (Figure 1). Individual breed or breed group maps are in Figure 5. Of the commercial breeds, the Anglonubian is found the furthest to the Northeast. Saanen, Alpina and Toggenburg, the main breeds used for milk production, have their midpoint furthest to the South. The lack of development of goat production is evident in the Centerwest and North of the country with few or no purebred flocks. The Commercial breeds have the most widespread distribution as expected, being reared in several ecosystems. In general there were few differences between the breeds in terms of environmental controls (Table 2), although there is a tendency for locally adapted breeds such as Canindé and Moxotó to occur in areas of higher THI, lower RH and higher mean daily temperatures, while breeds such as Toggenburg and Alpine occur in more favourable conditions. Locally adapted and dual purpose animals are generally reared in more stressful conditions.

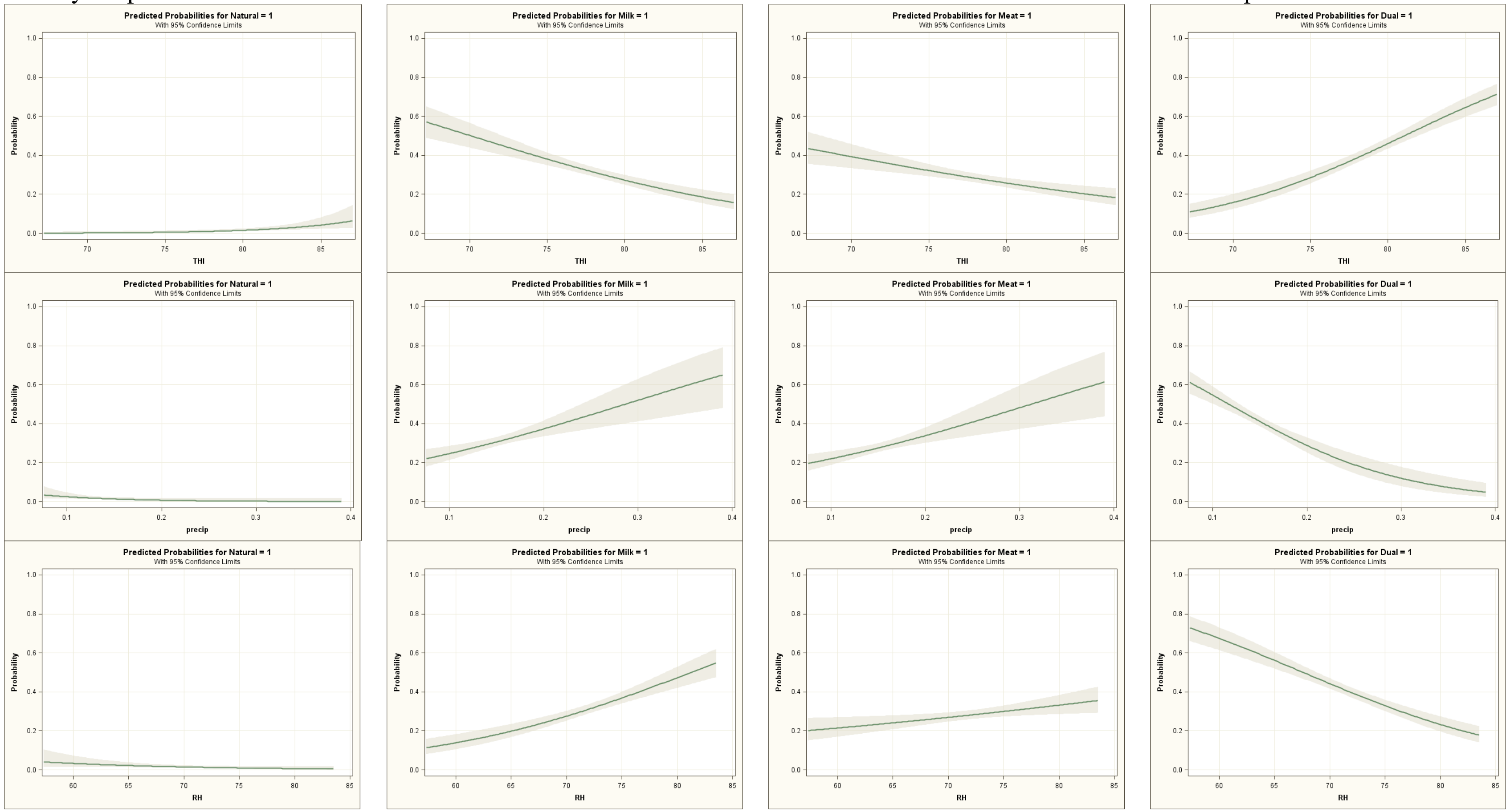
Table 2. Means of environmental control variables by breed of goat in Brazil

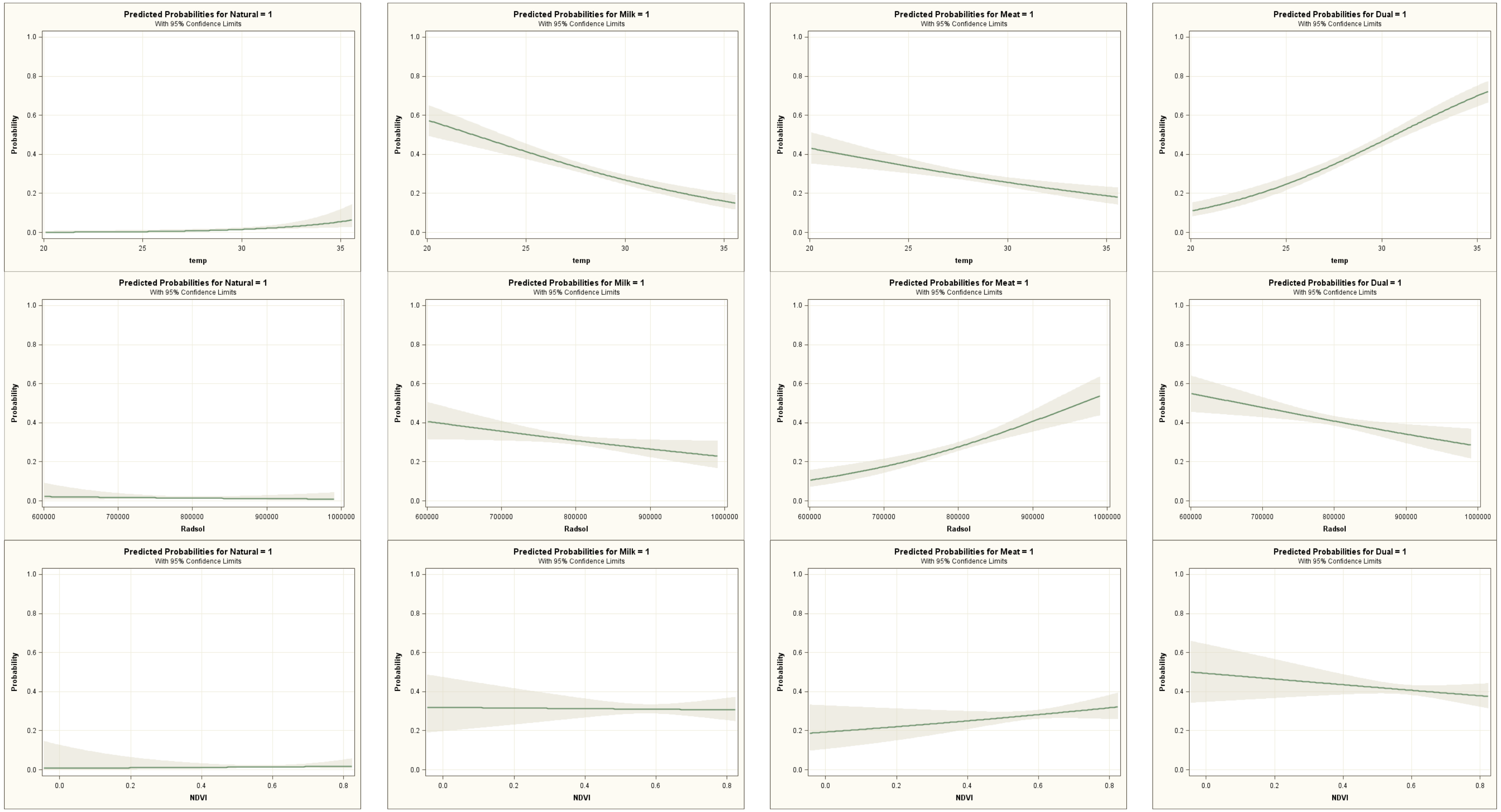
Breed	THI	Alt	Precip	NDVI	RH	Temp	Top
Canindé	81.84[a]	184.2[c]	0.124[b]	0.560[b]	68.08[a]	31.34[a]	805372
Moxotó	80.54[ab]	254.0[c]	0.147[ab]	0.602[a]	70.33[ab]	30.27[a]	784317
Murciana	80.23[abc]	150.3[c]	0.156[ab]	0.593[ab]	72.16[ab]	29.95[ab]	771803
Anglonubian	79.58[abc]	404.4[bc]	0.143[ab]	0.576[ab]	70.15[ab]	29.58[ab]	793816
Savanna	78.12[bc]	410.7[bc]	0.159[ab]	0.585[ab]	70.82[ab]	28.47[bc]	808735
American Alpine	77.88[bc]	364.5[bc]	0.144[ab]	0.602[a]	71.69[ab]	28.25[bc]	785438
Boer	77.74[bc]	446.6[ab]	0.157[ab]	0.586[ab]	72.07[ab]	28.13[bc]	811541
Saanen	77.53[bc]	397.6[bc]	0.157[ab]	0.564[ab]	73.07[a]	27.92[c]	791930
Alpine	77.26[c]	450.7[ab]	0.156[ab]	0.605[a]	72.47[ab]	27.75[c]	793970
Toggenburg	76.66[c]	524.5[a]	0.161[a]	0.614[a]	73.81[a]	27.24[c]	807862
Breeds with few herds							
Angora	74.60	36.1	0.14	0.34	77.60	25.53	771620
British Alpine	83.50	331.3	0.15	0.62	61.96	32.90	796548
Azul	80.72	572.1	0.09	0.62	65.43	30.67	780955
Kalahari	80.05	572.3	0.17	0.55	62.21	30.35	872240
Mambrina	77.87	16.2	0.24	0.70	74.53	28.09	906214
Commercial vs Local							
Commercial	78.37[a]	419.9[a]	0.152[a]	0.580[a]	71.58[a]	28.61[a]	798660
Locally Adapted	81.03[b]	227.4[b]	0.138[b]	0.586[b]	69.48[b]	30.68[b]	792338
Type							
Dual Purpose	79.64[a]	394.57[b]	0.143[b]	0.576	70.15[a]	29.62[a]	793442
Meat	77.74[b]	445.87[a]	0.157[a]	0.579	72.07[b]	28.12[b]	811403
Milk	77.38[b]	421.38[ab]	0.157[a]	0.586	72.91[c]	27.82[b]	793442

THI – temperature and humidity index, Alt – altitude (m); Precipitation (mm/day); NDVI – normalized difference vegetation index; RH – relative humidity; Top – Topography. [a,b] Different letters in the same column indicate significant differences using the Tukey Test ($P<0.05$)

There is little difference between the probability of occurrence of locally adapted and commercial breeds (Figure 2). On the other hand, there is a clear difference between these probabilities comparing milk and meat breeds versus dual purpose breeds. The latter tend to occur in regions with higher temperatures, topography and THI, but lower rainfall and NDVI. Pasture type and social factors had little effect on the occurrence of locally adapted and commercial breeds but again dual purpose breeds had a different distribution compared with milk and meat (Figure 3). The former occurred in areas with more shrub/bush and animals per farm but less forest and HDI.

Locally adapted Breeds | Milk | Meat | Dual Purpose




Predicted Probabilities for Natural = 1
With 95% Confidence Limits
Predicted Probabilities for Milk = 1
With 95% Confidence Limits
Predicted Probabilities for Meat = 1
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Predicted Probabilities for Dual = 1
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Probability
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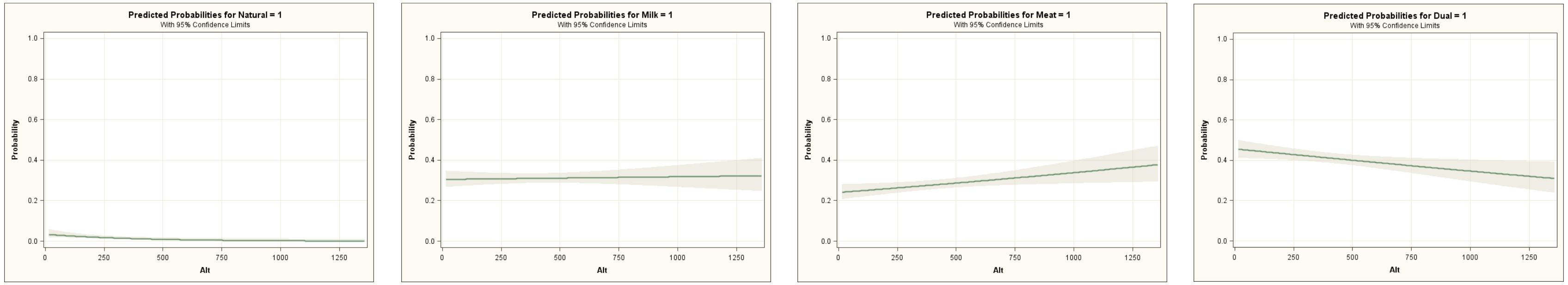
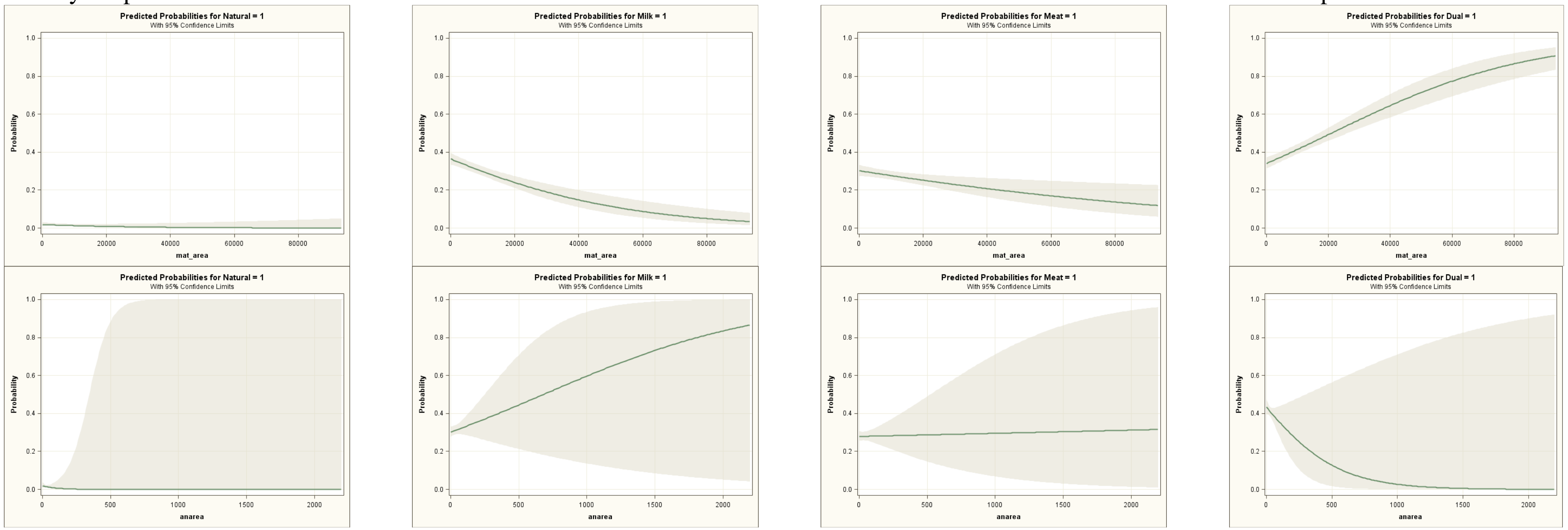
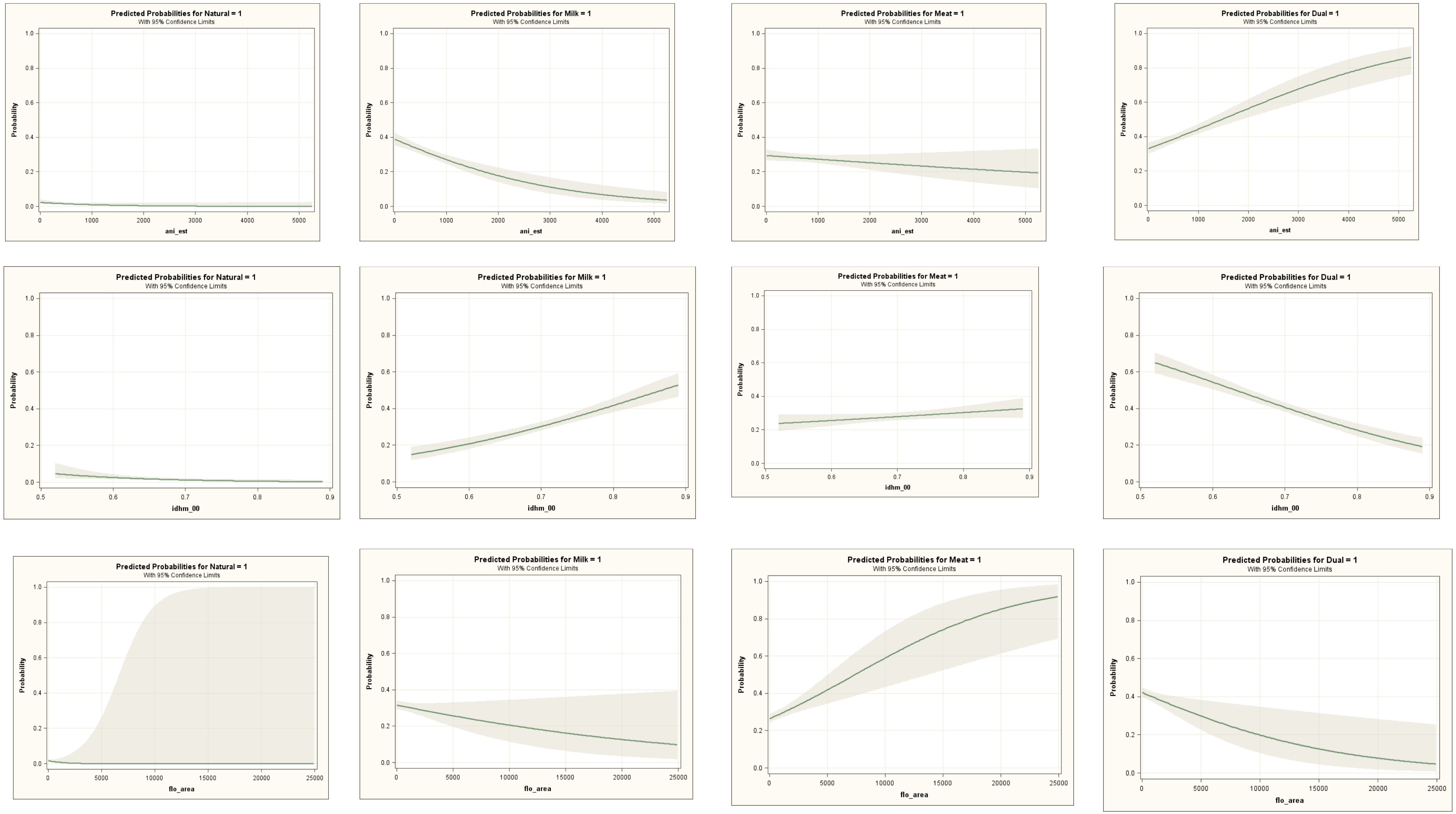


THI – Temperature Humidty Index; precip – precipitation; RH – relative Humidity; Temp- Air temperature; NDVI – Normalised Difference Vegetation Index; Alt – Altitude; Radsol – Topography

Figure 2. Effect of environmental control variables on occurrence of different goat breed types in Brazil.

Locally adapted Breeds Milk Meat Dual Purpose





Mat_area – Area of shrub/bush; anarea – number of animals per km^2; ani_est – number of animals per farm; idhm_00 – Human Development Index; flo_area – Area of forest

Figure 3. Effects of pasture and social factors on occurrence of different goat breed types in Brazil.

Using environmental controls (Figure 4) there was a clear difference between dual purpose (Canindé, Moxotó and Mambrina) and commercial such as milk Alpine breeds and South African meat breeds. The Anglo Nubian does not obey this classification as it is dual purpose and is classified with in the specialized breeds. Many times the breeders of this breed treat it as specialised for a single purpose (meat or milk). The fact the specialised Murciana breed is classified with the dual purpose breeds may be a bias due to few herds being registered. Also there are few Angora, Azul, Kalahari and Mambrina herds.

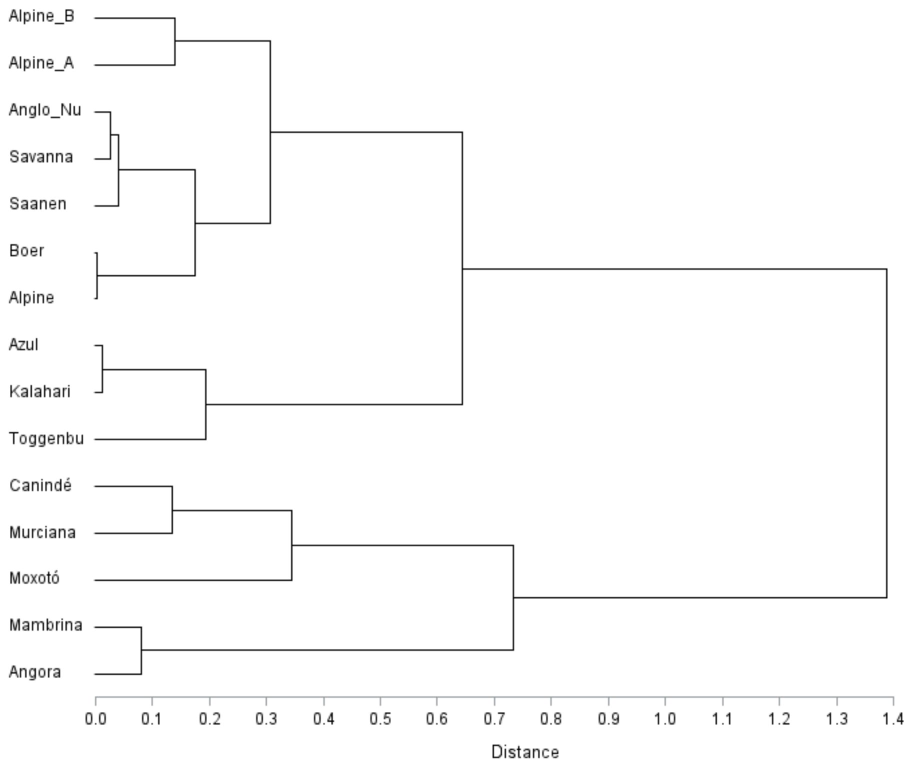


Figure 4. Dendrogram of goat breeds using environmental controls.
Alpine_A – American; Alpine_B - British

Figures 5 and 6 show the wider distribution of commercial compared to local breeds, as well as the concentration in the Northeast of the country. Most goat breeds have a regular distribution up to approximately 1000km from their breed midpoint.

Mantel correlations were low between geographical and genetic distances.

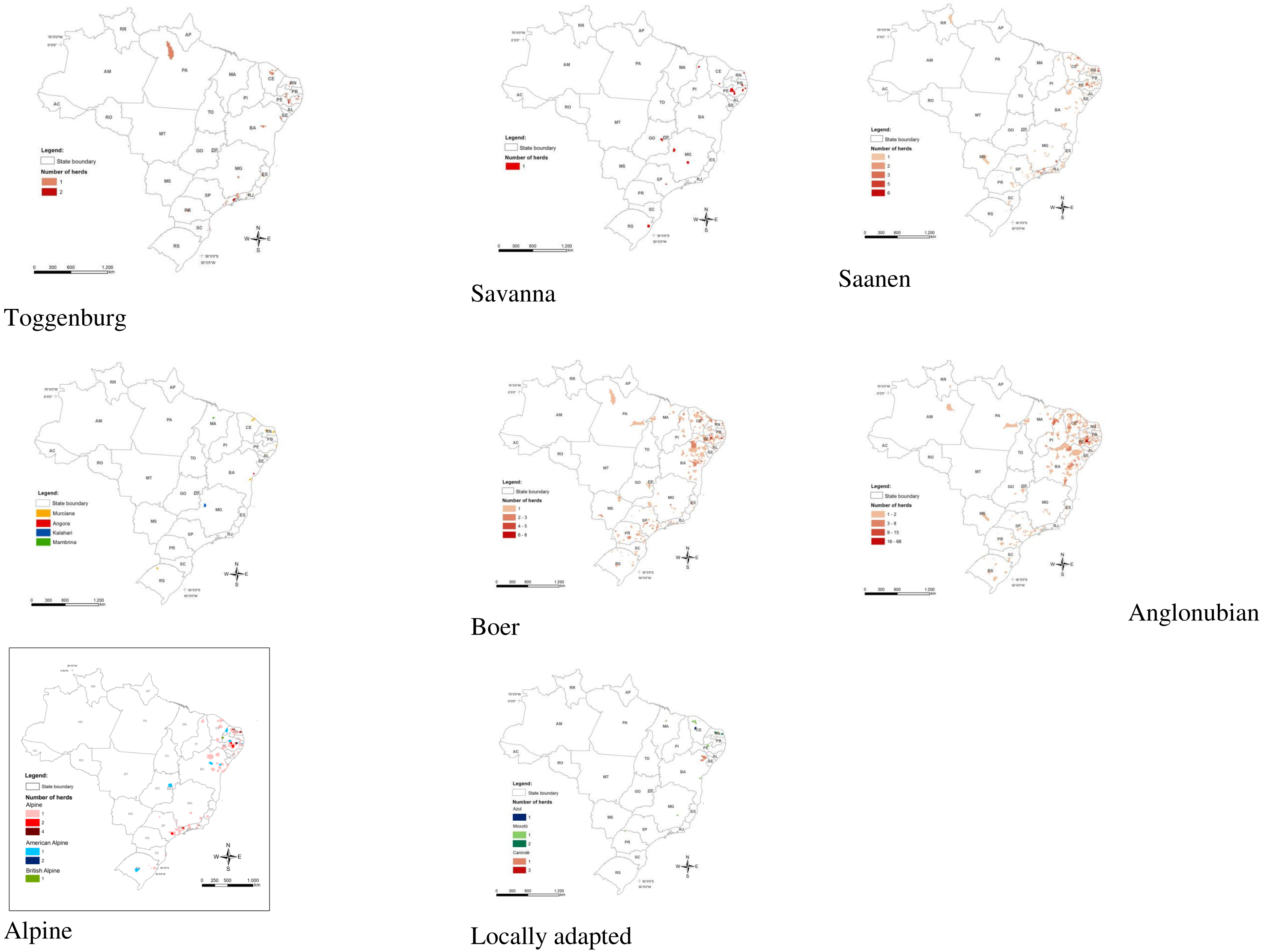


Figure 5. Localization of purebred goat herds in Brazil by breed.

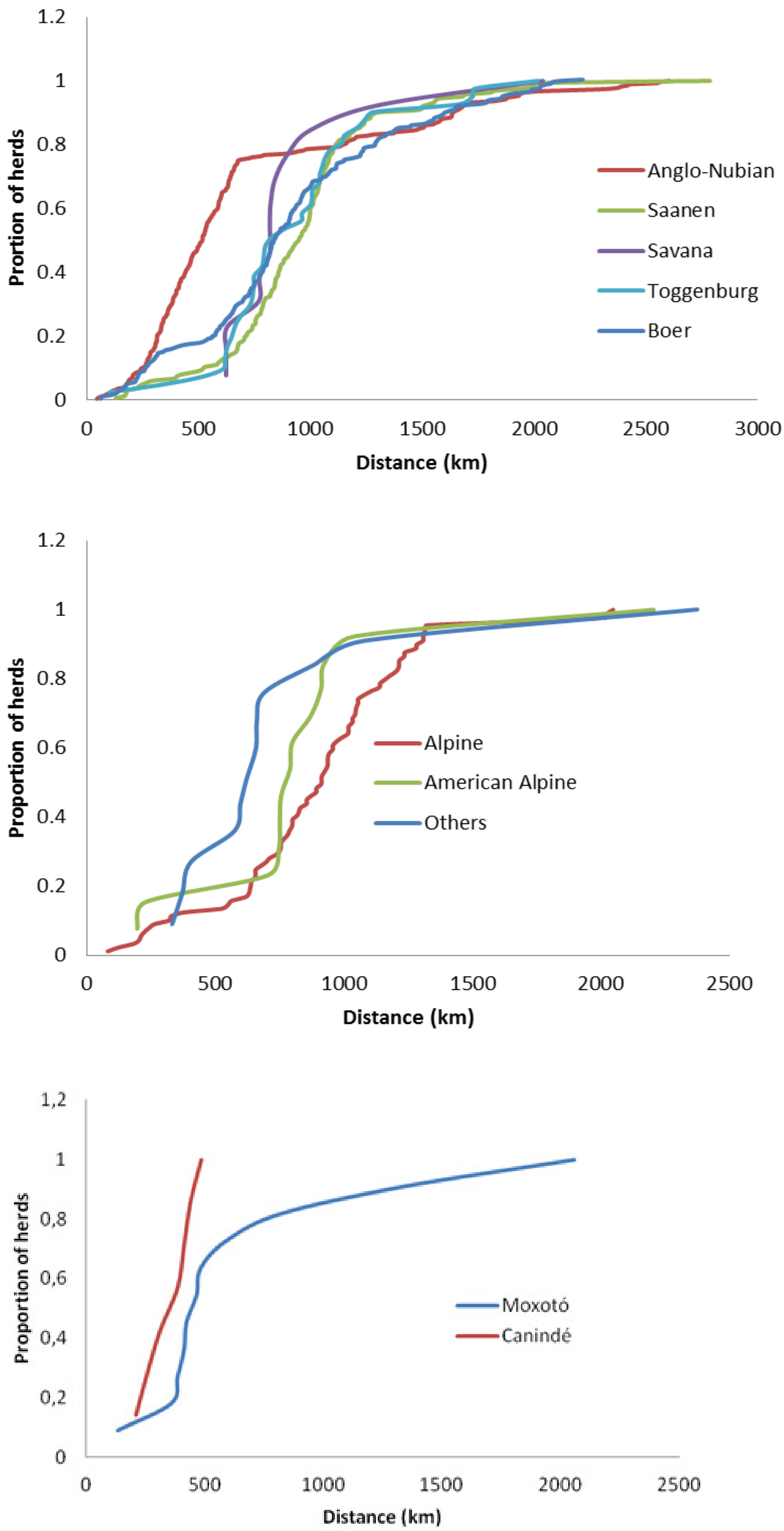


Figure 6. Distance of purebred goat herds in Brazil from breed Midpoint.

DISCUSSION

According to CORDEIRO e CORDEIRO (2009) the major breeds of goats raised in Northeast Brazil are the imported Boer, Anglo-Nubian, Savanna, and Kalahari, as well as the native Moxotó, Canindé, Gurguéia, Repartida, Marota. This is not upheld with official registers. These same authors state that the SRD (animals of undefined breed) represent 70% of the animals in the Northeast, but from the present study these numbers are much higher. Brazil has over 286,000 goat farmers (IBGE, 2012) but only 1024 have registered purebred animals. The low effective number of herds of purebred goats is due to several factors: lack of tradition of commercial production, small herd size, low HDI of the farmers, market and commercialization conditions as well as sanitary problems. Most goat farms are small with a national average of 20 animals per herd (IBGE, 2012). The lack of resources for these farmers may prevent them from registering their animals, associated with the high cost of registering animals in the herd book.

Goats in Brazil are mainly used for milk production and most breeds are milk or dual purpose as seen in Table 1, with meat being obtained from adult or cull animals (MCMANUS et al., 2008; OLIVEIRA et al., 2009). Exotic breeds were introduced for higher productivity, as well as for the crossing of different breeds to obtain an animal that is able to withstand the environmental limitations of the region without affecting production and development (SANTOS et al., 2005). The rearing of goats in the Northeast is closely linked with the social and economic conditions (LOPES et al., 2012) and the use of meat, milk and leather from these animals has been crucial and strategic for the development of the Northeast (CANIELLO, 2012).

There are several differences to be seen between sheep and goat breeders (MCMANUS et al., 2014). Several goat breeders have two or more breeds on their farm, while sheep breeders tend to have a single breed. The distribution of these two species within the country is also very different.

According to ALDERSON (2009), vulnerability of a breed can increase with limited geographical distribution. This is especially true in harsh environments and those at risk from disease, drought or even human action such as crossbreeding. This would indicate that the locally adapted Brazilian goat breeds are all at risk, due to the low number of purebred herds registered and their limited distribution in an area which is known for prolonged droughts and harsh environmental conditions (LÔBO et al., 2011). This is also evidenced by the fact that only 23 of the herds sampled here were locally adapted compared with 1291 commercial.

Many national statistics do not separate goats from sheep (small ruminants), especially with respect to slaughter. In the Northeast of the country, sheep production is based on hair breeds which further reduces this separation. These animals tend to be slaughtered on-farm in non-inspected conditions. Estimates state that more than 90 % of small ruminants are slaughtered in this manner (SILVA, 2002). This means that the registered slaughter houses tend not work at full capacity and pelts are sold salted to dealers before arriving at the tanning factory. These are usually skinned inadequately, many becoming unsuitable for processing, thereby affecting the profitability both for the farmer and industry. This means that Brazil has to import these products from abroad while national production goes to waste.

Brazilian exports of goats and sheep products are minimal but the country imports significant quantities of leather/skins (mainly from Australia Middle East and Africa) as well as fresh meat (from Uruguay) (MAPA, 2012). Informal slaughter makes it difficult to obtain accurate official numbers on the sector (SORIO & RASI, 2010). To improve this situation research is necessary on-farm, as well as on slaughter, commercialization and marketing (RIBEIRO et al., 2002).

Of the commercial breeds, the Anglonubian is found the furthest to the Northeast. The Anglonubian is a dual purpose breed (meat and milk) and is known to have a higher heat tolerance than commercial milk breeds (STEMMER et al., 2009). Saanen, Alpina and Toggenburg, the main breeds used for milk production, have their midpoint furthest to the South. This distribution also reflects the importance of the Northeast in goat production in the country, with approximately 91% of animals in this region (LOPES et al., 2012). It also reflects the more important milk production in the Southeast where 3% of the herd produce 23% of the milk. The largest purebred herd in the country is the Anglonubian, followed by Boer and Saanen (Table 1), all imported breeds and different from sheep distribution (MCMANUS et al. 2014) where a Brazilian breed is the most prevalent.

Purebred goat breeds in Brazil tend to have a higher distribution than purebred sheep breeds (McMANUS et al., 2014) with approximately 80% of the herds within 1000km of the midpoint (Figure 3), compared to 500km in sheep. The low number of registered herds and large distances between them mean that germplasm exchange is difficult which may restrict the development of goat production in the country, especially non-traditional areas such as the Center-west and North.

LOPES et al. (2012) found a positive relationship between milk and goat production, technical services, temperature range and medium air temperature. Areas with good pastures are strongly related to establishments with water. Small ruminant production has also been shown to be influenced by factors such as local vegetation, average air temperature and altitude (PEACOCK; SHERMAN, 2010), although the latter was not seen here. These factors influenced the implementation and creation of production units due to their influence on production characteristics and adaptation of animals used (JOOST et al., 2010). The successful production of small ruminants also depends on socioeconomic factors (HEWITSON et al., 2007, SIBBALD et al., 2008) because the larger the population, the Gross Domestic Product and the area, the greater the demand for animal products and also the larger production in adjacent areas.

Farmers generally try to eliminate external factors that negatively affect production. These include environmental factors (climatic, vegetation and geomorphology), socioeconomic (GDP and population) and technological (nutrition, management, reproduction, health and sanitary conditions) (HERRERO et al., 2009, 2010).

Most animals reared in north-eastern Brazil are created extensively. Although this region shows higher effective goat numbers, the soil and climate conditions and lack of government incentives are unfavourable for animal production. In south-eastern Brazil, the animals are raised mostly in confinement or semi-confinement (GONCALVES et al., 2001; SOARES FILHO et al., 2001; BARROS et al., 2005; GONÇALVES et al., 2008; NOGUEIRA et al., 2008). Not only is there heterogeneity of production between regions, countries or individual farms, but also there exists uncertainty and risk associated with future circumstances that may promote differentiation between the goals of rearing and maintaining breeding animals (male and female) more suited to specific regions (SMITH, 1984; OLESEN et al., 2011).

Technical guidance, water resources, marketing services, productivity, monitoring and evaluation of activities of establishment of dairy goats are very important for the sustainability of breeding programs for dairy goats (BETT et al., 2009b). These should therefore be taken into consideration because they are often difficult to change (WOLLNY, 2003; LOPES et al., 2012).

In general, goat breeding has shown promise, particularly in tropical areas. Herpin e Charley (2008) found that the main challenges for animal production include sustainable development, climate change, biodiversity management, water quality, food safety, emerging diseases and bioenergy as well as a demand to increase the world food supply as a response to growing demographics (DUBEUF, 2011). According to Hermuche et al. (2013), based on environmental controls, it would be possible to expand small ruminant production in Brazil to about 2.8 million km^2, mainly in the Northeast and Centerwest of the country.

CONCLUSIONS

While commercial breeds are widespread in Brazil, local breeds have a more restricted distribution, putting them at higher risk of extinction through drought, disease or crossing with other breeds.

Conflict of Interest

The authors declare that there is no conflict of interest

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ABSTRACT: The localization of all flocks of purebred goats in Brazil was spatialized in ARCGIS along with climatic (THI, precipitation, topography, relative humidity) and physical environmental controls (altitude, pasture type). Data were analysed using analysis of variance, logisitic regression and cluster analyses. Distance matrices were constructed using longitude/latitude and those from environmental controls and these were correlated using Mantel test. Midpoint for most breeds was in Bahia State, but in Pernambuco for locally adapted breeds. The Anglonubian was the commercial breed with the northernmost midpoint. Toggenburg, Saanen and Apline breeds had the southernmost midpoint. There was little difference between environmental controls for locally adapted and commercial breeds, but dual purpose breeds were in regions with lower rainfall and HDI but higher temperatures and shrubland. Commercial herds are more widespread in Brazil than local breeds putting the latter at higher risk of extinction through drought, disease or crossing with other breeds.

KEYWORDS: Mantel correlation. Pasture. Temperature. Precipitation. Logistic regression.

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