Spatial Analysis of Horse Distribution in Haryana

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Abstract

Haryana has a small equine population of 0.39 lakhs (18th livestock census, 2007) which is comprised of 19,658 horses, 10,772 mules, 3,920 donkeys and 4,247 ponies. In this study the Horse species is analysed, Moran's I coefficient of autocorrelation was used to investigate the spatial distribution of Horses to analyze clustering of the population in Haryana using Tehsil as a real unit. Equine census data was used to link the heterogeneity in the Horse distribution with regard to agro-ecosystems and other environmental factors related to agro-ecological zones in the state of Haryana. Comparatively lower population density (0 - 0.5/ sq km) of horses was observed in south western Haryana. Moran's I statistic revealed that the distribution of all types of equines was clustered. The distribution of the horses was characterized in terms of agro-ecosystem prevalent in the area. This ecosystem approach to characterize livestock distribution is useful in livestock production systems research planning.

Keywords: *Study the Horse species, Spatial Analysis, Agro-Ecological Zones.*

Introduction

The state of Haryana has a geographical area of 44.20 lakh hectare. About 86% of the geographical area is cultivable, of which 96% has already been brought under plough. Therefore, there is hardly any scope for bringing additional area under cultivation, except for reclamation of degraded lands affected by water logging, salinity and alkalinity. While crop production has reached at a plateau, livestock production is still growing. Animal husbandry has been taken up as an integral component of diversified agriculture. Haryana has a small equine population of 0.39 lakhs (18th livestock census, 2007) which is comprised of 19,658 horses, 10,772 mules, 3,920 donkeys and 4,247 ponies.

Livestock production systems are determined by factors such as ecological zones, livestock species, desired products, functions, management, markets and government policy (Ruthenberg1980; Simpson 1988). Livestock resources of a region are decided mainly by those factors which determine overall ecological setting for feeding, breeding and rearing of appropriate livestock species for the region. These decisions with respect to choice of livestock and cropping systems are further influenced by several other factors related to infrastructure facilities, socio-economic factors and technological developments. As described by Saxena et al. (2001) these factors include: Infrastructure facilities like animal housing, water availability, feed and fodder availability, transport, trade and marketing, animal products handling, processing and marketing etc.; socio-economic factors like social acceptance for a particular livestock species, financial resource base, land ownership, size and type of land holding, household needs of food, animal products, fuel, fiber and finance, labor availability etc. and technological factors like improved breeds of animals, fodder and crop varieties, mechanization, disease protection, access to veterinary care, access to information etc. Under influence of all above factors, livestock resources remain dynamic in time and space, making it difficult to precisely determine their spread using conventional methods, over a large territory. A geodatabase of livestock in relation to the crop rotation and agro-ecological zones is an essential tool for animal husbandry planning and management.

Agro-Ecological Zones

Haryana is an agrarian State wherein about 85 per cent of its area is under cultivation and engaging about 78 per cent of its population in agriculture. The climate of the State ranges from dry sub humid to hot arid. The annual rainfall varies from less than 300 mm in the south western parts to over 1000 mm in the hilly tracts of the Siwalik. Major parts of the State falls under the most fertile tract of indo-Gangetic alluvial plain. Soil temperature regime is Hyperthermic and the soil moisture regimes are ustic and Aridic. The State has 3 main climatic regions having average annual rainfall and air temperature as under:

Table 1: Mean Rainfall and Mean Temperature for Different Climatic Regions

Climatic Region	Mean Rainfall (mm)	Mean Temperature (C)
Hot Arid Region	300-500	27
Hot Semi-Arid Region	500-700	26
Hot Sub Humid Region	700-1050	24

An ecosystem is a homogenous geographical area. The production environment of the region in terms of agro-climate, resource endowments and socioeconomic conditions is homogenous, and majority of the farmers have similar production constraints and research needs. Specific advantages of ecosystem approach for research planning (Saxena et al.2001) are: (i) better identification of production constraints and research needs, (ii) better targeting of prospective technologies, (iii) improved assessment of farmers' responses to new technologies, and (iv) wider adoption and larger impact of research outputs.

Therefore, the geographical distribution of equines in Haryana in terms of agro-ecological zones and crop based agro-ecosystems would be studied with the following objectives.

Material and Methods

Study Area

The study area included the entire state of Haryana extending over an area of 44,212 square km. from 27039' N to 30055'5" N latitudes and 74027'8" E to 77036'5"E longitudes.

Spatial Data

i. Agro-ecozones of Haryana as per the Resource Atlas of Haryana (2004)

ii. Crop based agro-ecosystems of Haryana based on IRS-P6, LISS 3 data of the year 2007-08.

iii. Administrative boundary of Haryana up to Tehsil level.

Attribute Data

Database of the 18th Livestock census (2007) of Haryana (Department of Animal Husbandry & Dairying and Fisheries, Ministry of Agriculture, Govt. India)

Software

i. Arc Map 10
ii. ERDAS Imagine 11.0
iii. MS Office 2007

Environmental Characterization of Livestock Distribution

GIS layers of agro-eco zones and crop based agro-ecosystems were combined with the livestock distribution maps for environmental characterization of livestock distribution in Haryana. The flow chart of the methodology for the environmental characterization of livestock distribution is depicted in Figure 1.
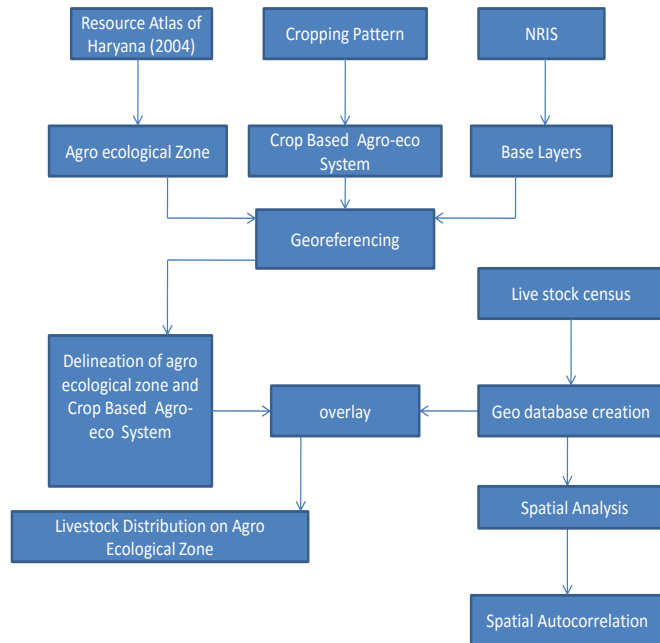
Figure 1

Spatial Autocorrelation

Autocorrelation statistic i.e. Moran's I coefficient of autocorrelation was used to investigate spatial autocorrelations based on livestock density and Tehsil location to find out broad trends (dispersed, random or clustered) in the spatial distribution of livestock in Haryana.

Classification and Density Mapping of Different Livestock Species

Density mapping for equines was accomplished using Jenk's Natural Breaks method (Jenk's 1967) and the number of classes was kept at three representing High, Medium and Low densities. The Jenks optimization method, also called the Jenks natural breaks classification method, it is a data classification method designed to determine the best arrangement of values into different classes. This is done by seeking to minimize each class's average deviation from the class mean, while maximizing each class's deviation from the means

of the other groups. In other words, the method seeks to reduce the variance within classes and maximize the variance between classes (Jenks 1967).

Spatial Trends in the Distribution of Domestic Animals in Haryana

The Global Moran's I statistic was used to measures spatial autocorrelation based on both Tehsil locations and animal density values simultaneously. The z-score and p-value were used to evaluate the significance of Moran's I statistic. The results of spatial autocorrelation in distribution of domestic animal populations based on Tehsil boundaries are depicted in Table 1.

Results and Discussion

Horse density in Haryana is very low comparison of other animals. Range of density of horse is 0 to 3.2 based on natural breaks method as shown in figure 2.

High (1.5-3.2) density lies only two agro-ecological zones and only two Crop based agro-ecosystem zones; Rugged hilly terrain of Aravali range, hot and semiarid, little to moderate available moisture and its 90-120 days growing season and second one is Yamuna alluvial plain, hot and semiarid, little to moderate available moisture and 120-150 days growing season. Crop based agro-ecosystem zones are Rice/Wheat and Bajra/Jawar/Guwar/Fallow-Wheat/Others. Show in table1. High density of horse lies only two tehsil; Nilokheri (Karnal district) and Pataudi (Rewari district).

Medium density of horse lies in 21 tehsils show in table1 .Its lie in six agro-ecological zones and five Crop based agro-ecosystem zones. Medium density lies in northern part of Haryana state.

Low (0.-0.5) density of horse lies above half state. Its lie in seven agro-ecological zones and five Crop based agro-ecosystem zone shows in figure2 and table1
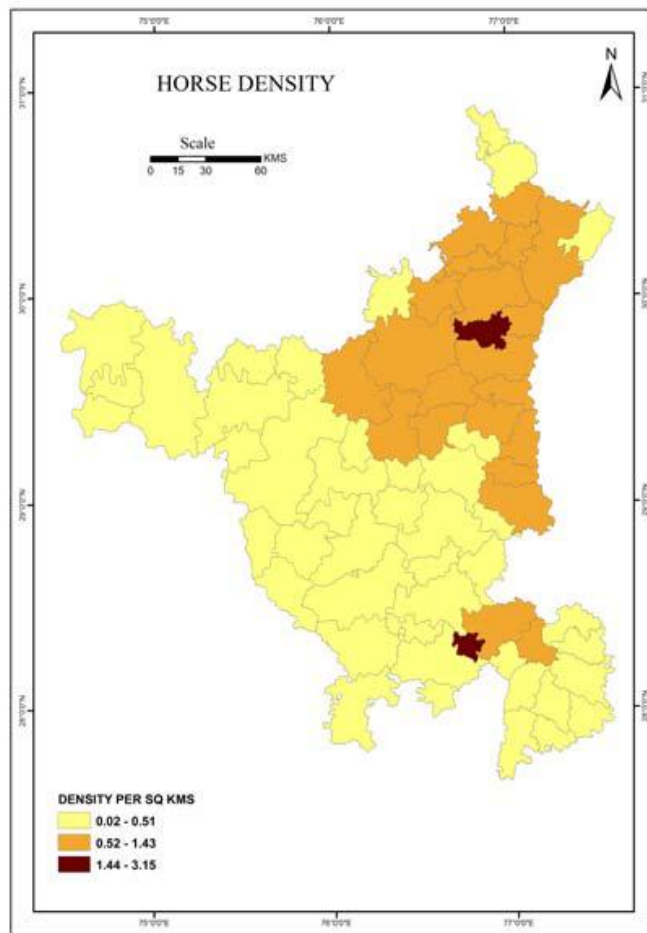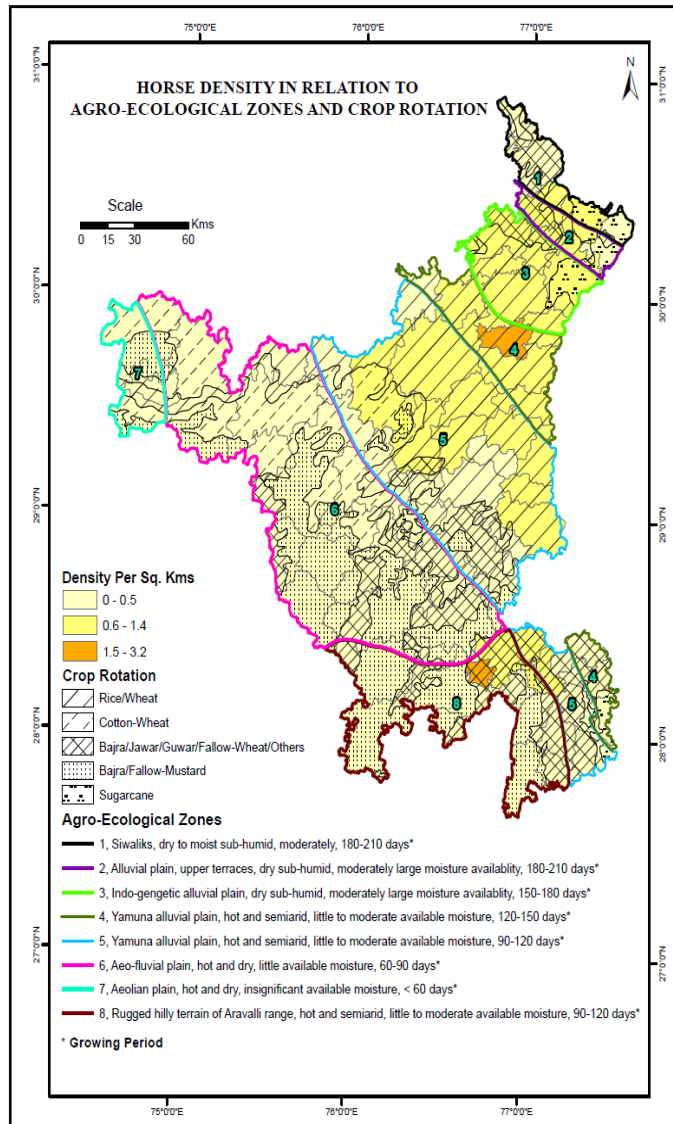

Figure 2

Figure3

Table 2: Horse Density in Relation to Agro-Ecological Zones and Crop based Agro-Ecosystem

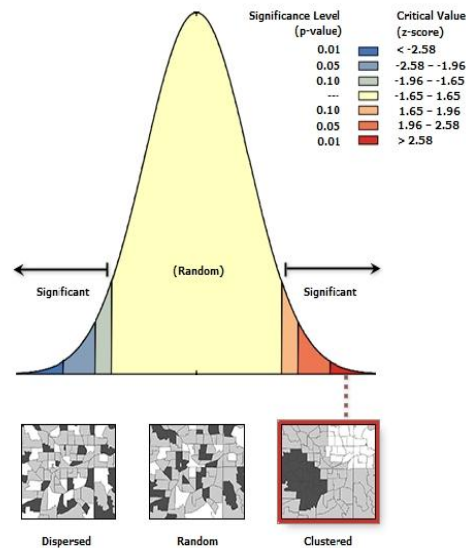| Horse Horse Density ((Per sq. Km)	Tehsil	Agro-Ecological Zones	Crop based Agro-Ecosystem
High (1.5 - 3.2)	Nilokheri, Pataudi	1. Yamuna alluvial plain, hot and semiarid, little to moderate available moisture, 120-150 days growing period. 2. Rugged hilly terrain of Aravalli range, hot and semiarid, little to moderate available moisture, 90-120 days growing period.	1. Rice/Wheat 2. Bajra/Jawar/Guwar/Fallow-Wheat/Others
Medium (0.6 - 1.4)	Kaithal, Narwana, Jind, Safidon, Assandh, haraunda, Karnal, Indri, Thanesar, Pehowa, Jagadhri, Panipat, Samalkha, Ganaur, Sonipat, Gurgaon, Sohna, Naraingarh, Ambala, Barara, Shahbad	1. Siwaliks, dry to moist sub-humid, moderately, 180-210 days growing period. 2. Alluvial plain, upper terraces, dry sub-humid, moderately large moisture availability, 180-210 days growing period. 3. Indo-gengetic alluvial plain, dry sub-humid, moderately large moisture availability, 150-180 days growing period. 4. Yamuna alluvial plain, hot and semiarid, little to moderate available moisture, 120-150 days growing period. 5. Yamuna alluvial plain, hot and semiarid, little to moderate available moisture, 90-120 days growing period. 6. Rugged hilly terrain of Aravalli range, hot and semiarid, little to moderate available moisture, 90-120 days growing period.	1. Rice/Wheat 2. Cotton-Wheat 3. Bajra/Jawar/Guwar/Fallow-Wheat/Others 4. Bajra/Fallow-Mustard 5. Sugarcane
Low (0-0.5)	Dabwali, Sirsa, Rania, Ellenabad, Fatehabad, Ratia, Tohana, Hisar, Adampur, Siwani, Loharu, Tosham, Bawani Khera, Hansi, Narnaund, Julana, Maham, Bhiwani, Dadri, Mahendragarh, Narnaul, Bawal, Rewari, Jhajjar, Kosli, Ferozepur Jhirk, Punahana, Hodal, Hathin, Nuh, Taoru, Palwal, Ballabgarh.	1. Siwaliks, dry to moist sub-humid, moderately, 180-210 days growing period. 2. Alluvial plain, upper terraces, dry sub-humid, moderately large moisture availability, 180-210 days growing period. 3. Yamuna alluvial plain, hot and semiarid, little to moderate available moisture, 120-150 days growing period. 4. Yamuna alluvial plain, hot and semiarid, little to moderate available moisture, 90-120 days growing period. 5. Aeo-fluvial plain, hot and dry, little available moisture, 60-90 days growing period. 6. Aeolian plain, hot and dry, insignificant available moisture, < 60 days growing period. 7. Rugged hilly terrain of Aravalli range, hot and semiarid, little to moderate available moisture, 90-120 days growing period.	1. Rice/Wheat 2. Cotton-Wheat 3. Bajra/Jawar/Guwar/Fallow-Wheat/Others 4. Bajra/Fallow-Mustard 5. Sugarcane

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Figure 4

Spatial Autocorrelation Report of Horse Density

Moran's Index: 0.335676
z-score: 4.281135
p-value: 0.000019

Conclusion

The geographical distribution of livestock resources in Haryana in terms of agro-ecological zones and crop based agro-ecosystems were studied to determine the distribution characteristics of horses in Haryana with regard to the different agro ecological zones. The livestock data from 18th Livestock census of Haryana 2007 (Department of Animal Husbandry & Dairying and Fisheries, Ministry of Agriculture, Govt. India) was used to create Haryana Livestock Geodatabase having Tehsil wise population of Horse. This livestock geodatabase is a ready source of livestock census in relation to the map of Haryana where queries related to livestock populations at district and Tehsil level can be answered. The broad spatial distribution trends of the different livestock species in Haryana using Tehsil as the areal unit were identified and livestock distribution maps for each species were created using Jenk's Natural Breaks method with three classes representing High, Medium and Low densities. Moran's I Statistic investigated if the spatial distribution of various domestic animal species and breeds in Haryana, was clustered, random or dispersed.The Global Moran's I statistic was used to measures spatial autocorrelation based on both Tehsil locations and animal density values simultaneously. The z-score and p-value were used to evaluate the significance of Moran's I statistic. The Moran's I statistic revealed that the distribution of all the animal species studied was clustered except indigenous female cattle which were found randomly distributed. Clustered distribution of all animal species was highly significant (p = 0.000019, Z score = 4.281135). Heterogeneity in livestock distribution was analyzed in relation to the five major cropping patterns representing crop based agro-ecosystems and the eight agro-ecological zones of Haryana based on soil, physiography, bio-climate and length of growing period. The five major crop rotations were Rice/Wheat, Cotton-Wheat, Bajra/Jawar/Guwar/Fallow-Wheat/Others, Bajra/Fallow-Mustard and Sugarcane. Horse population is rare and scattered in Haryana showing clustering in certain parts.

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