Model for prediction of area under agroforestry in district Yamunanagar, Haryana

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Key words: Agroforestry; Prediction; Factors; Regression Analysis; Model; GIS

Abstract

Agroforestry helps in providing all necessities of life while at the same time maintains the quality of land resources. In this paper, an attempt has been made to develop a suitable model for prediction of area under agroforestry. The study has been conducted in Yamunanagar district of Haryana state and important factors responsible for growth of agroforestry in this district have been identified based on a household survey. Area under agroforestry for non-sampled villages of the district has been predicted using the developed model. A map depicting percentage area under agroforestry for all the villages of the district, classified into three different categories, has been generated using Geographic Information System (GIS) software.

1. Introduction

Forests are one of the most important renewable natural resources that contribute substantially to the social and economic development and also play a major role in improving the quality of environment. It is, therefore, important to devise land management and farming systems that are not only capable of producing food from marginal agricultural land but also capable of maintaining and improving the quality of environment. One such system is agroforestry that helps in providing all necessities of life and at the same time maintaining the

quality of land resources. The integration of farming with forestry practices on the farm for the benefit of agriculture is known as agroforesty.

Agroforestry plays a vital role in achieving integrated rural and urban development. It is, therefore, necessary to consider the factors responsible for growth of agroforestry while examining the relevance of agroforestry systems to social, economic and environmental development.

Rao (1967) studied the economics of plantation particularly of Casuarinas and Eucalyptus with special reference to the sandy soil of Nellore South Division of Andhra Pradesh. Mann and Lahire (1979), Medina and Jamson (1980), Ahuja and Mann (1975), Bhimaya and Kaul (1960), Deb Roy and Pathak (1974), Muthana (1980) conducted studies for planning, management, development and constraints in the field of agroforestry/social forestry. Mathur (1981) described socio-economic aspects of agroforestry specially with reference to shifting cultivation in northeastern part of the country. Singh (1981) explained the scope of agroforestry in Punjab and Himachal.

Yamunanagar district is the model district as far as the adoption of agroforestry in Haryana is concerned. Therefore, in the present paper an attempt has been made to develop a suitable model for prediction of area under agroforestry in this district. The district map with village boundaries has been digitized. The percentage area under agroforestry of all the villages of district along with other secondary data has been attached with the digitized district map. A map depicting percentage area under agroforestry of all the villages of the district, categorized into three different categories, has been generated.

1.1 Data used in the study

Yamunanagar district has a total number of 654 villages. The data on number of trees under agroforestry has been obtained from a previous pilot study conducted in the year 2000 by IASRI in Chhachhrauli block of Yamunanagar district to study the impact of agroforestry on socio-economic conditions of the farmers. Chhachhrauli block consists of 166 villages. In that study, the villages were divided into two categories with the help of the map available in the District Hand Book of Census 1991; (i) villages having common boundary with either of natural forest, reserve forest or protected forest and (ii) other villages. Out of 166

villages, 87 villages fell in first category and remaining 79 in the second category. A sample of 20 villages, 10 villages from each category was selected by simple random sampling without replacement. Each of the selected villages was completely enumerated and the data on number of trees under agroforestry was collected for all the households in the selected villages. Area under agroforestry for all 20 selected villages was calculated based on number of trees under agroforestry. Further, for identifying the factors responsible for agroforestry and developing the model for predicting the area under agroforestry, data on different variables from the population census of 1991 has been used for these 20 selected villages.

2. Identification of important factors in the district

Agorforestry plays a vital role in achieving integrated rural and urban development that is of great importance for planners. Therefore it is essential to find out the important factors responsible for growth of agroforestry. To find out the important factors, the data on number of trees under agroforestry, available from previous pilot study has been used. Since a tree approximately occupies an area of 20 sq. m., therefore, about 500 trees can be planted in one Hectare of land. Hence 500 trees per Hectare have been treated as standard for calculation of area under agroforesty. Since we have total number of trees for each village, area under agroforestry has been calculated for all the 20 selected villages accordingly.

Further, 1991 population census data along with the detailed data for 20 villages from the pilot study for identifying important factors for the district has been used.

2.1 Identification of the factors

The data from the household survey (pilot study) was compared with the 1991 population census data for the above-mentioned 20 villages based on certain variables like-‘Area of the village’, ‘Total population of the village’ and ‘Number of households’ in the village to identify these 20 villages in the census data. Once the 20 villages were identified in the census data, area under agroforestry for these villages was taken from the household survey while other variables (54 in number) were taken from the census data. This database was finally used for the

purpose of analysis. First of all Correlation Matrix was obtained based on which 9 variables affecting agroforestry were identified. The identified variables are;

(1) Male Agricultural Laborers, (2) Total Irrigated area, (3) Total cultivated area, (4) Total number of literates, (5) Male cultivators, (6) Female Agricultural Laborers, (7) Number of Households, (8) Area under forest and (9) Distance from market.

Further, Stepwise regression analysis technique was used for identifying the most important factors responsible for growth of agroforestry. 'Area under agroforestry' was treated as dependent variable while other 9 factors highly correlated with 'Area under agroforestry' were taken as independent variables. The model used in the analysis is as follows:

$$Y = a + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k + \varepsilon \qquad \ldots\ldots\ldots\ldots (1)$$

where Y is area under agroforestry

X_is are independent variables, i = 1,2,…,k ,

k = total no. of independent variables = 9

a is constant

β_i s are regression coefficients of X_is and

ε is the error term.

Based on this analysis, the following five important factors responsible for growth of agroforestry have been identified:

1. Male Agricultural Laborers
2. Total Irrigated area
3. Total cultivated area
4. Total number of literates
5. Male cultivators

3. Prediction of area under agroforestry

Based on the data available for 20 villages selected in the sample, multiple regression analysis was carried out using 'Area under agroforestry' as dependent variable (Y) and all five identified factors as independent variables (Xs) to

develop a suitable model for area under agroforestry. The model used in the analysis is given as:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + \varepsilon$$

where a = constant and b_1, b_2, b_3, b_4 and b_5 are regression coefficients of independent variables X_1 (Male Agricultural Laborers), X_2 (Total Irrigated area), X_3 (Total cultivated area), X_4 (Total number of literates), X_5 (Male cultivators) respectively and ε is the error term with mean 0 and variance σ_ε^2.

The results obtained are as follows:

Coefficients	S.E. (Coefficients)
a (constant) = -1.457984	13.373991
b_1 = 0.211642	0.165452
b_2 = 0.145047	0.104952
b_3 = 0.099507	0.111987
b_4 = -0.051401 and	0.061599
b_5 = 0.44091	0.173222

$R^2 = 0.81180$

Area under agroforestry was predicted for rest of the villages of Yamunanagar district using this model i.e.

$$\hat{Y} = -1.457984 + 0.211642\ X_1 + 0.145047\ X_2 + 0.099507\ X_3 - 0.051401\ X_4 + 0.44091X_5$$

where X_1, X_2, X_3, X_4 and X_5 were available in the census data.

4. Digitization of the district map with village boundaries

Yamunanagar district consists of two Tehsils Chhachhrauli and Jagadhari. All the villages of Chhachhrauli and Jagadhari Tehsils of the district have been digitized separately using Tehsil maps with the help of ARC Info, GIS software, and a digitizer. The digitized Tehsil maps were geo-referenced and joined together. The digitized map of district Yamunanagar is given in Fig.-1.

District Map with Village Boundaries
District-Yamunanagar
Haryana, India

Fig.-1

5. Attachment of attribute data with the map

After obtaining the area under agroforestry for all the villages of the district, percentage area under agroforestry has been calculated for all the villages as under:

Percentage area under agroforestry

=Area under agroforestry/Total geographical area x 100

The attribute data including area under agroforestry and percentage area under agroforestry have been attached to the georeferenced district map with village boundaries. Now by clicking on any village on the map, information like area under agroforestry, percentage area under agroforestry, irrigated area, cultivated area, geographical area, village population, number of households etc. of that particular village can be seen.

The 25^{th} and 75^{th} percentile of percentage area under agroforestry of all the villages have been obtained. All the villages have been categorized as

(1) Villages <= 19.87 % area under agroforestry

(2) Villages > 19.87 % and <= 45.07 % area under agroforestry and

(3) Villages > 45.04 % area under agroforestry.

A map given in Fig.-2 depicting percentage area under agroforestry of all 654 villages of the district classified into three different categories has been generated using Arc Info software.

7. Conclusion

Important factors responsible for growth of agroforestry in Yamunanagar district of Haryana State have been identified and based on these factors a suitable model for predicting the area under agroforestry has been developed. Area under agroforestry for non-sampled villages of the district has been predicted using this model. A map depicting percentage area under agroforestry of all the villages of the district classified into three different categories has been generated. The identification of important factors, prediction of area under agroforestry and generation of map are based on the available data with respect to agroforestry. However, to make an effective prediction in agroforestry study, the database containing more attributes affecting agroforestry would be useful.

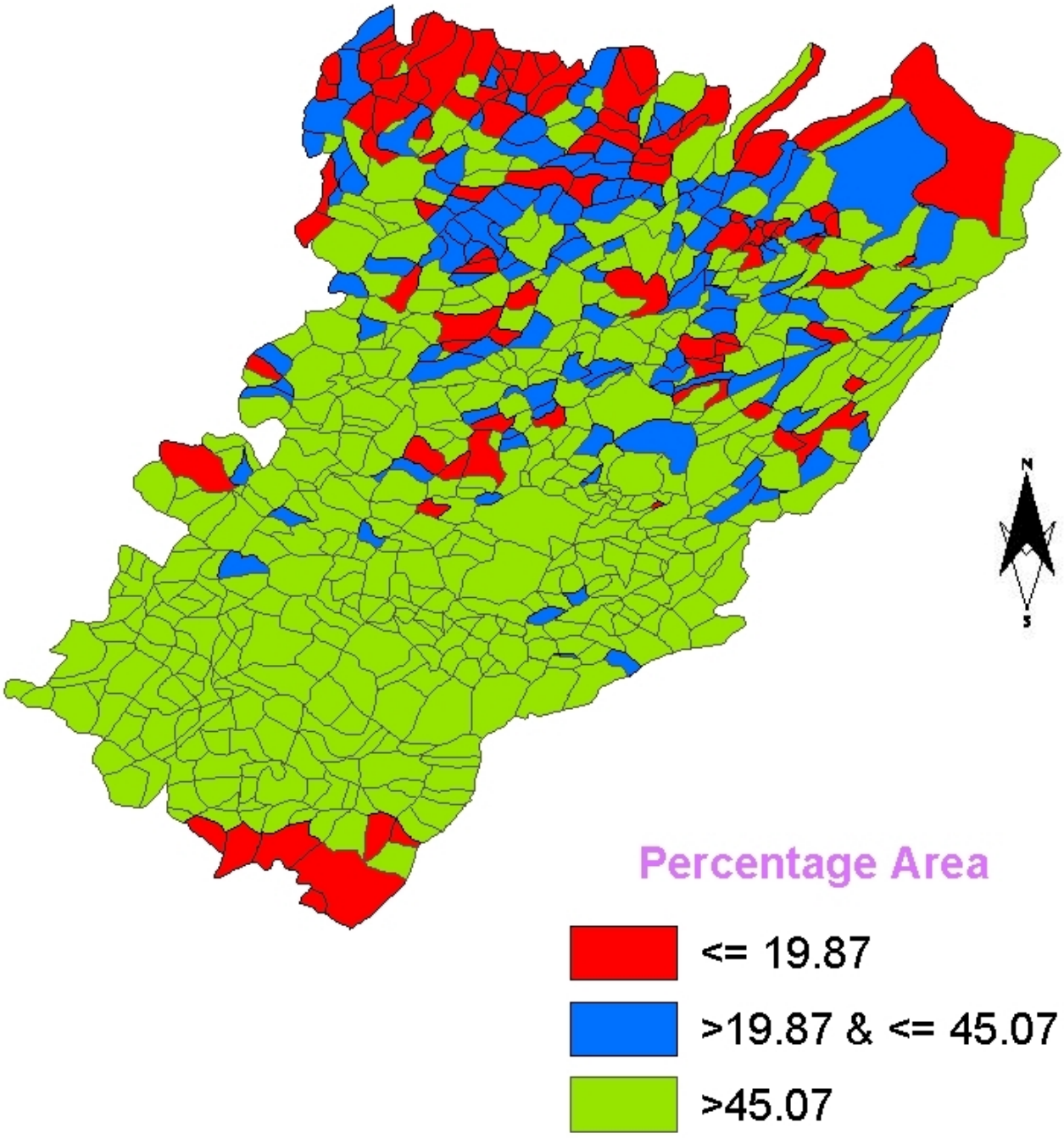
Percentage Area under Agroforestry,
District-Yamunanagar,Haryana,India
N
S
Percentage Area
<= 19.87
>19.87 & <= 45.07
>45.07

Fig. -2

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