J Agric Rural Dev ***4****(1&2), 175-180, June 2006* *ISSN 1810-1860*

SCHOOL OF AGRICULTURE AND RURAL DEVELOPMENT
কৃষি ও পল্লী উন্নয়ন অনুষদ

JARD
Journal of Agriculture & Rural Development

Local Level Agricultural Planning Using GIS

MD. BILAL HOSSAIN[1] AND ANWAR SADAT[2*]

[1]School of Agriculture and Rural Development, Bangladesh Open University, Gazipur, Bangladesh
[2]School of Science and Technology, Bangladesh Open University, Gazipur, Bangladesh

Received 05 April 2004; received in revised form 01 February 2005; accepted 22 June 2006

ABSTRACT

Geographical Information System (GIS) is a computer based technology that describes, stores manipulates and analyze information spatially and produces outputs in map and tabular form for decision making in the planning aspects of agricultural development. Land, soil, and land used pattern are the most vital factors for growing more crop yield from a part of land. In case of Bangladesh soil quality and land type varies widely within a small area of land. This study will focus mainly on to categorize the soil texture and land type that exist in Jibannagar thana of Chuadanga district using GIS. Moreover, the suitable cropping pattern for that area were also identified using GIS technology. In order to accumulate all the qualitative and the quantitative data, the "Thana Nirdeshika" booklet for the Jibannagar thana prepared by the Soil Resources Development Institute (SRDI), Ministry of Agriculture (MOA), Bangladesh, was used. The digital data source that has been created by the GIS project of Bangladesh Agricultural Research Council (BARC) has also been used for the study. From this study it is found that four map units remain predominantly High Land (PHL), one HL and two predominantly Medium High Land (PMHL) which indicate to use winter crop, HYV rice, Broadcast Aus and Aman rice based cropping pattern.

Key words: Land type, soil texture, cropping pattern, GIS.

INTRODUCTION

It may be mentioned that the country is divided into five-stage administrative regions. Thana is the third-order administrative unit of Bangladesh where the number of total thana is 490. Agriculture is the main occupation of the people. It plays a vital role in the growth and stability of the country's economy. The share of agriculture in Gross Domestic Product (GDP) is around 40 percent (Huq and Rahman, 1994) and 68.5 per cent of the civilian labour force are engaged in the agro-businesses (Ahmed, 1998). Therefore, the contribution to GDP depends on the successful agricultural production at local areas. Most farms are particularly the small ones, combine several production activities. The crop production activities of the farm provide its cropping systems. It comprises all components received for the production of the set of crops of a farm and the relationship between them and the environment. These components include all necessary physical and biological factors, as well as technology, labour and management. However, in the process of preparing local level agricultural production planning: climate, hydrology, physiography, crop and cropping pattern are to be consider for a planner and/or decision-marker. The agricultural decision-makers need a good information system that must be comprehensive and integrated than those of

*Corresponding author: Assistant Professor, SST, BOU. E-mail: sadat_it@yahoo.com

the past (Harsh, 1996). The technology that can accomplish this task is a Geographic Information System (GIS), which is playing active role, in spatial problems, like global and regional change (Jelinski, 1994). GIS provides facilities to use geographic information to help with decision-making and problem solving. A GIS, however, is not automated decision making system but a tool to query, analysis and produce map in support of the decision making process (Aronoff, 1993; Burrough, 1993).

Soil quality and land type of Bangladesh varies widely with in a small area of land. There are almost about 14 cropping patterns in Bangladesh depending on different land types and complex textural classes. The purpose of this study is to find out the suitable cropping pattern for the Jibannagar thana on the basis of land type and top soil texture using GIS technology, which can be used in future agricultural development planning for improving agricultural crop yields.

STUDY AREA

It may be mentioned that the country is divided into five-stage administrative regions. These are Division, District, Thana, Union and Mouza. There are 490 thanas in the country. The Jibannagar thana is located at the northern side of Chuadanga district which is the western part of Bangladesh. The thana lies between latitudes $23^0$22'N to $23^0$24'N and longitudes $88^0$45'E to $88^0$57'E. The area covers 19933 hectare (ha) with total crop area (16048 ha), total uncropped area (3885 ha), settlement area (2982 ha), water bodies (432 ha) and wide river area (221 ha) (BBS 1998). The thana lies High Ganges River Floodplain (Agroecological Zone, AEZ no 11) which contain mainly Calcareous Dark Gray soil type. The study area that contains five soil series, i.e. Sara, Gopalpur, Ishordi, Ghior and Ramdia has divided into 8 map units numbered from 1 to 8 based on land type. The number 81, 82, 83 represent settlements, water bodies and wide river respectively (Fig. 1).

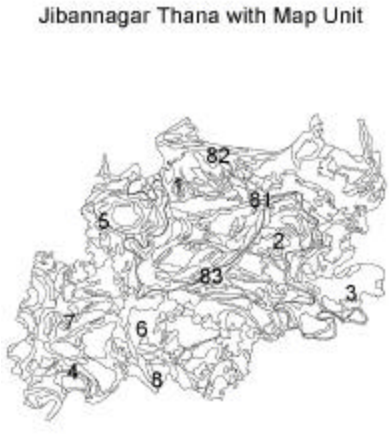

Fig. 1. Administrative boundary of Jibannagar Thana

METHODOLOGY

The methodology for this study is composed mainly of data collection procedures and manipulation, data analysis and interpretation technique in PC Arc/View. The methodology, which has been used for this study, is given below.

Data Imported: The spatial data of Jibannagar thana comprising the required information have been collected from BARC- AEZ/GIS database structure. The data set includes administrative data, climatic data and soil polygon.

Data Generated: In order to accumulate all the qualitative and quantitative data we followed the "Thana Nirdeshika (TN)" Booklet for the Jibannagar thana prepared by the Soil Resources

Development Institute (SRDI), Ministry of Agriculture, Bangladesh. At first all data have been accumulated in Microsoft Excel file. After that, those excel files have been converted into three database file for the analysis in PC Arc/View.

land_ type.dbf: The file named 'land_type.dbf' under the category of land type and that of corresponding map unit was generated using another database file. This database is comprised all the basic detail data such as, soil series, land area, land type (Table 1A) based on Map Unit number of the TN.

Table 1A. Land Type Inventory

Map Unit	Soil Series	Area (ha)	Area (%)	Land Type	Area (LT)	LT (%)
1	Sara	2237	57.89	HL	3254	84.21
1	Gopalpur	1017	26.32	HL		
1	Gopalpur	203	5.25	MHL	610	15.79
1	Ishordi	407	10.53	MHL		
	Total	3864			3864	
2	Sara	280	47.95	HL	467	79.97
2	Gopalpur	187	32.02	HL		
2	Gopalpur	29	4.97	MHL	117	20.03
2	Ishordi	88	15.07	MHL		
	Total	584				
3	Sara	157	5.27	HL	2666	89.49
3	Gopalpur	1725	57.91	HL		
3	Ishordi	784	26.32	MHL	313	10.51
3	Ishordi	313	10.51	MHL		
	Total	2979				
4	Sara	41	5.02	HL	694	85.05
4	Gopalpur	490	60.05	HL		
4	Ishordi	163	19.98	MHL	122	14.95
4	Ishordi	122	14.95	MHL		
	Total	816				
5	Gopalpur	86	10.01	HL	730	84.98
5	Ishordi	644	74.97	HL		
5	Ishordi	44	5.12	MHL	129	15.02
5	Ghior	85	9.90	MHL		
	Total	859				
6	Gopalpur	389	10.01	HL	389	10.01
6	Ishordi	2721	70.00	MHL		
6	Ghior	777	19.99	MHL	3498	89.99
	Total	3887				
7	Ishordi	217	10.01	MHL	1951	89.99
7	Ghior	1734	79.98	MHL		
7	Ghior	108	4.98	MLL	217	10.01
7	Ramdia	109	5.03	MLL		
	Total	2168				
8	Ghior	625	84.23	MLL	625	84.23
8	Ghior	78	10.51	LL		
8	Ramdia	39	5.26	LL	117	15.77
	Total	742				

texture_class.dbf: A database table comprised of different data like soil series, soil texture, area was generated in this database (Table 2A).

land_use_pattern.dbf: A database table comprised of Map Unit , land type, Land use id and cropped area (ha) was generated in this database file (Table 3A).

Table 2A. Soil Texture Inventory

Map Unit	Series Name	Soil Texture	Area (%)
1	Sara	Loamy	57.89
1	Gopalpur	Loamy/Clay loam	31.57
1	Ishordi	Clay Loam/Clay	10.53
2	Sara	Loamy	47.95
2	Gopalpur	Loamy/Clay loam	36.99
2	Ishordi	Clay Loam/Clay	15.07
3	Sara	Loamy	5.27
3	Gopalpur	Loamy/Clay loam	57.91
3	Ishordi	Clay Loam/Clay	36.83
4	Sara	Loamy	5.02
4	Gopalpur	Loamy/Clay loam	60.05
4	Ishordi	Clay Loam/Clay	34.93
5	Gopalpur	Loamy/Clay loam	10.01
5	Ishordi	Clay Loam/Clay	80.09
5	Ghior	Clay Loam/Clay	9.90
6	Gopalpur	Loamy/Clay loam	10.01
6	Ishordi	Clay Loam/Clay	70.00
6	Ghior	Clay Loam/Clay	19.99
7	Ishordi	Clay Loam/Clay	10.01
7	Ghior	Clay Loam/Clay	84.96
7	Ramdia	Clay Loam	5.03
8	Ghior	Clay Loam/Clay	94.74
8	Ramdia	Clay Loam	5.26

Table 3A. Major Land Use Inventory

Map Unit	Land_Type	L_u_id	Area (ha)
1	HL	6	1637
1	HL	4	814
1	MHL	8	407
2	HL	6	292
2	HL	4	88
2	MHL	7	88
3	HL	6	1411
3	HL	4	470
3	MHL	7	313
4	HL	6	327
4	HL	7	163
4	MHL	9	82
5	HL	7	300
5	HL	6	215
5	MHL	9	43
5	MHL	10	43
6	HL	4	194
6	HL	6	195
6	MHL	7	1749
6	MHL	8	389
7	MHL	9	867
7	MHL	10	650
7	MLL	11	108
7	MLL	12	109
8	MLL	12	313
8	MLL	11	312
8	LL	12	78

In order to interpret the land type and soil texture following categories presented by BARC 1995 have been taken into account.

Category	Area
Predominantly	≥ 80%
Mostly	70% - < 80%
Mostly with	55% - < 70%
Mostly with some	40% - < 55%
	30% - < 40%
	15% - < 30%

RESULTS AND DISCUSSION

By using GIS technology the attribute and spatial data on land type, soil texture and present land use pattern were analyzed and produced three basic maps showing land categories, texture categories and suitable cropping patterns for the study area. The results are described below.

From the study four map units (1, 3, 4 and 5) were found predominantly high land, one (2) mostly high land, two (6 and 7) predominantly medium highland and one predominantly medium low land. Out of eight map units five map units remain high land two medium high land and one medium low land (Fig. 2 and Table 1B).

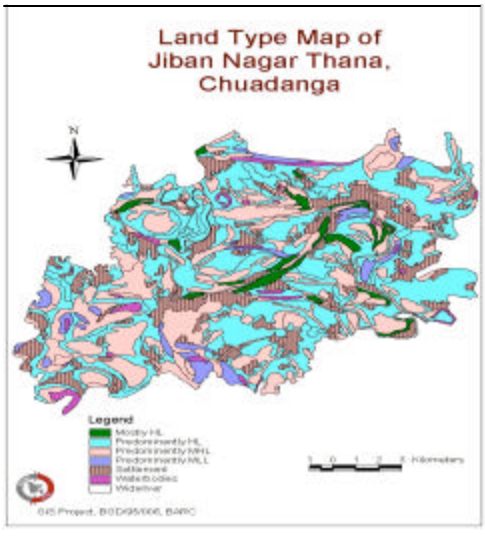

Fig. 2. Land type map of Jibannagar Thana

Table 1B. Land Type Classification

Map Unit	Land Type Class
1	Predominantly HL
2	Mostly HL
3	Predominantly HL
4	Predominantly HL
5	Predominantly HL
6	Predominantly MHL
7	Predominantly MHL
8	Predominantly MLL
81	Settlement

Moreover, in case of soil texture it was found that three map units (5, 7 and 8) remain predominantly clay loam soil, one (6) mostly clay loam soil, two (3, 4) loamy with clay loam soil, one (1) mostly loamy with clay loam and another (2) remains loamy with some clay loam soil (Fig. 3 and Table 2B).

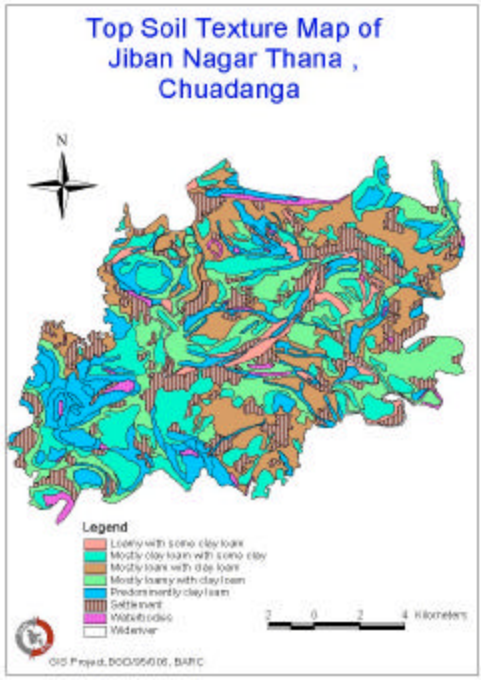

Fig. 3. Top Soil Texture map of Jibannagar Thana

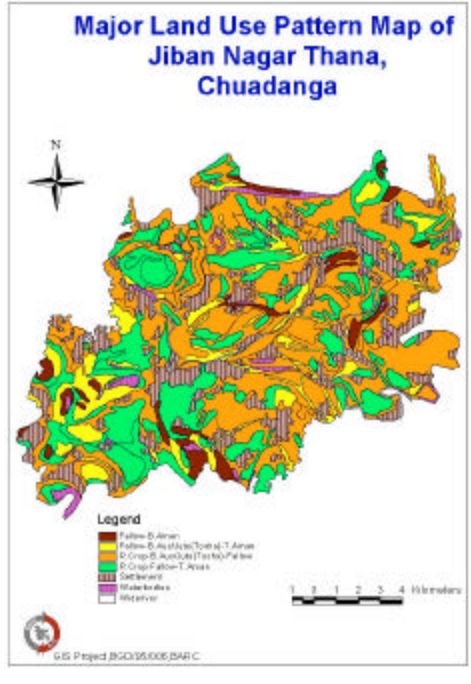

Fig. 4. Major Land Use Pattern map of Jibannagar Thana

Hence, it was also found that four map units (5, 6, 7 and 8) remain predominantly and mostly clay loam soils and rest of the map units also remain clay loam soils in association with loamy soils. Clay loam is referred to a best soil for agricultural production in Bangladesh. In consideration of

land type there are five different land types in Bangladesh on the basis of floodplain. These are high land (HL), medium high land (MHL), medium low land (MLL), low land (LL) and very low land (VLL). Generally HL and MHL are never be flooded. HL and MHL receive not more than 30 cm and 90 cm of water respectively during flood (BBS 1995). However, the area that remains the predominantly clay loam soil is suitable for producing winter crop, HYV rice, local Aus, Aman and Broadcast Aman paddy due to low depth of water stagnant. From the study it should be mentioned that the Jibannagar thana is suitable for cultivation of winter crop, HYV rice, Broadcast Aus and Aman rice based cropping pattern which is shown in figure 4.

Table 2B. Soil Texture Classification

Map Unit	Texture Class
1	Mostly loam with clay loam
2	Loamy with some clay loam
3	Mostly loamy with clay loam
4	Mostly loamy with clay loam
5	Predominantly clay loam
6	Mostly clay loam
7	Predominantly clay loam
8	Predominantly clay loam
81	Settlement
82	Water bodies
83	Wide river

Table 3B. Major Land Use Pattern for Jibannagar Thana

Map Unit	Major land use pattern
1	Rabi Crop-Broadcast Aus/Jute (Tosha)-Fallow
2	Rabi Crop-Broadcast Aus/Jute (Tosha)-Fallow
3	Rabi Crop-Broadcast Aus/Jute (Tosha)-Fallow
4	Rabi Crop-Broadcast Aus/Jute (Tosha)-Fallow
5	Rabi Crop-Fallow-Transplanted Aman
6	Rabi Crop-Fallow-Transplanted Aman
7	Fallow-Broadcast Aus/Jute (Tosha)-Transplanted Aman
8	Fallow-Broadcast Aman
81	Settlement
82	Water bodies
83	Wide river

CONCLUSION

GIS acts as a power full tool to analyze both spatial and attribute data and proved its potential to interpret data more accurately. It has been widely used in agricultural production and planning and agricultural modeling as well. We used this tool to derive a production strategy in a local area. It has successfully indicated the most potential areas based on the soil characteristics and also recommended land-unit-specific suitable crops to grow all year round. These results may offer profit for all stakeholders in agriculture.

LITERATURE CITED

Ahmed, M. 1988. Bangladesh Agriculture: Towards Self Sufficiency. Ministry of Information, Government of Bangladesh, Dhaka.

Aronoff, S. 1993. Geographic Information System: A Management Perspective. WDL publications, Ottawa, Canada.

BARC. 1995. Fertilizer Recommendation Guide. Bangladesh Agricultural Research Council, Farmgate, Dhaka-1215.

BBS. 1995. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Mininstry of Planning, Govt. Peoples' Republic of Bangladesh, Dhaka.

BBS. 1998. Statistical Year Book of Bangladesh. Bangladesh Bureau of Statistics, Statistics Division, Mininstry of Planning, Govt. Peoples' Republic of Bangladesh, Dhaka.

Burrough, P. A. 1993. Principle of Geographic Information System of Land Resources Assessment Monograph on Soil and Resources Survey. No. 12, Oxford Science Publications, Oxford University Press Inc., New York.

Harsh, S. B. 1998. “Agricultural Information Systems: Current Applications and Future Prospects” Agricultural Information Technology in Asia and Oceanic. pp. 1-8.

Huq, S. and Rahman, A. A. 1994. An Environmental Policy of Bangladesh. *In* "Environment and Development in Bangladesh" (A. A. Rahman, S. Huq, R. Haider and E. G. Jansen, Eds.), Vol. 1. University Press Limited, Dhaka,

Jelinski, D. E. 1994. Multiple Roles for GIS in Global Change Research Agenda. *In* "Environmental Management and Analysis: Ecosystem to Global Scale" (W. K. Michener *et al*., Eds.), London: Taylors & Francis.