A Proposed Decision Support System to Sustainable Production of Rice Using GIS Tools

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***Abstract*-**Rice is an important crop in the world and India holds the second position among the rice producing country. As the population increases day by day and the total cultivating land is remains fixed, the demand is getting high whereas production remains almost constant. So in this paper a GIS based decision support system for rice production is proposed to increase the yield of production. The system takes data related to ongoing practice of rice cultivation and different parameters which affects the production of rice, store these data to a database and helps to take decision in an efficient manner.

Keywords: Raster Image, Digitization

I. INTRODUCTION

Rice is a staple food in the world. Though formerly it was known as Asian crop but now a days it is producing in many other parts of the world. India produces rice in a large quantity and most of the states in India are producing this crop in an area of over 400 lakh hectare. West Bengal is the leading state in India producing more than 13% of it's total production[1].

It is very difficult to monitor and manage the rice production as it involves large land area coverage with minimum man power[2]. The major activities of rice production are land preparation, irrigation, planting and harvesting. The irregularities of these activities may affect the yield. To optimize the rice production sustainable agriculture is necessary. The concept of sustainable agriculture involves producing quality products in efficient way. For sustainable production of rice is highly dependent on the factors like climate, soil and topography[6].

Climate: Temperature and rainfall are two most important factors which affects the development, growth and yield of rice crop. As rice is a tropical and sub-tropical crop it needs a fairly high temperature ranging from 20 deg to 40 deg and the annual rainfall from 1250mm to 2000mm.

Soil: Soil is very important component for the growth of any agricultural crop like rice. So it is very much essential to analyze the physical and chemical properties of soil. Different soil properties and map have been collected and using GIS tools it is to be analysed.

Topography: Slope is the main topographic element for the production of rice. Flat fields having smooth surface are better for rice cultivation as it facilitates even and equal distribution of water.

It is very difficult to manage manually such a large volume of data related to climate, soil and topography.

Hence a right rice production management system is required in agricultural field to increase the average yield of rice crop.

GIS is an acronym for Geographic Information System. It is an organized collection of computer hardware and software designed to create, manipulate, analyze and display all types of geographically or spatially referenced data in an efficient manner[3,4,5]. Using this GIS, a tool has been developed to manage the rice production in an efficient manner.

II. OUTLINE OF THE SCHEME

Step-1.

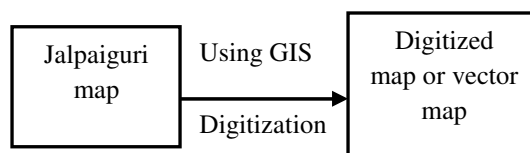Collect a map of a region and digitized the map using GIS tools. Fig. 1 illustrates this process.

Fig 1: Digitization process

Some related terms are explained here.

Raster image: A type of computerized picture consisting of row after row of tiny dots (pixels). Raster images are

also known as bitmaps. The process of data input into a raster format using an optical device is called scanning[3,4,5].

Digitization: The term digitization is used to describe the process of making a digital representation of features within a raster image using a geographic information system[3,4,5].

In this paper, a scanned map of Jalpaiguri district of West Bengal has been considered and digitized using mapinfo professional.

Step-2.

Data collected from different parts of the region in respect to climate, soil and topography and are stored in a database.

Step-3.

Make a relation between the digitized map on different layers and the database in such a way that a GUI based software is created and one can get various information regarding rice production by clicking on any section of the digitized map and it may be used as a decision making tool for the farmer[3,4,5]. Fig.2 shows the context diagram of the system.
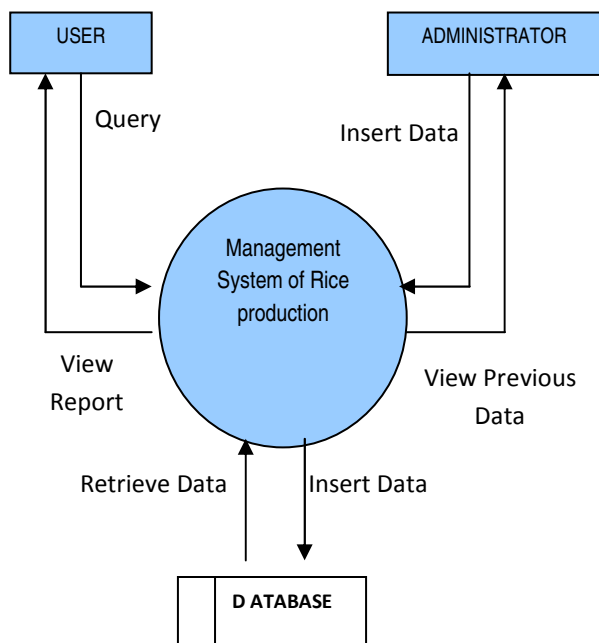
Fig 2:Context diagram of the rice management system

III. RESULT

A Jalpaiguri district map of West Bengal prepared by NRDMS, Jalpaiguri has been collected first[9].
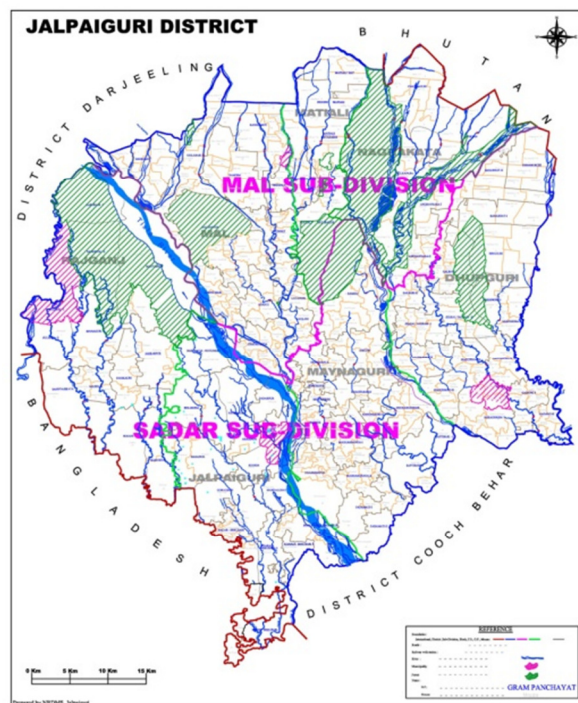
Fig 3: Jalpaiguri District Map

Then using mapinfo professional it has been digitized with proper registration. After that, different layers have been generated for boundary map, soil map, climate map etc. and a thematic view of these maps help the user to take decisions.

Fig 4: Digitized map of Jalpaiguri District

Non spatial Data has been collected mostly from census data and field survey. The following table shows the rice production of different years in Jalpaiguri and which also shows the production per hectare area in kilograms[7,8,9,11,12].

Table 1: Rice production of Jalpaiguri district

Year	Area(in thousand hectares)	Production in thousand tonnes	Yield (kg/ha)
2006-2007	229.7	419.0	1824
2007-2008	236.1	372.4	1578
2008-2009	235.4	391.2	1662
2009-2010	227.5	435.3	1913
2010-2011	224.1	493.7	2213

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Rainfall is very important factor of any crop. For crop like rice required 1250mm to 2000mm annual rainfall. The table 2 shows annual rainfall (in mm)[12].

Table 2: Rainfall of Jalpaiguri District

Year	Rainfall (annual) in mm
2006	3017
2007	3480
2008	3531
2009	3155
2010	3880
2011	3135

It shows that the annual rainfall of this district is more than 3000mm which is quite more than the requirement.

The table 3 shows the annual average minimum and maximum temperature of the selected study zone[12]. From the table it is clear that the average temperature of Jalpaiguri is 23 – 24 degree C which is perfect for rice crop.

Table 3:Temperature recorded of Jalpaiguri District

Year	Average max temperature	Average min temperature
2004	37	8
2005	37	10
2006	37	9
2007	38	8
2008	37	9

Major parts of the district are under the foothill area called Dooars and the rest of the district is plain area. Many rivers flowing through this district create flood every year and directly effects soil condition of the District. The main rivers are Teesta, Torsha, Jaldhaka, Sankosh, Murti etc. These rivers play an important role on soil formation and affects on soil properties. Soil of the district is alluvial in nature. As the alkaline materials from the soil are taken away by leaching rains it becomes acidic. Soil acidity can be measure by the pH level of the soil. The table 4 shows different soil pH value and the corresponding soil acidity level[10].

Table 4: Soil pH value

pH level	Soil acidity
4.0	Intensely acidic
4.5	Very strongly acidic
5.0	Strongly acidic
5.5	Medium acidic
6.0	Slightly acidic
6.5	Very slightly acidic
7.0	Neutral
7.5	Slightly alkaline
8.0	Medium alkaline

The soil pH level can be increased by applying lime on the ground. The table 5 gives the block wise information of different soil types and pH level which is very much helpful for rice crop. These data are inserted into a database.

Then a relation may be made between spatial and non spatial data which helps the user of this software to get appropriate information regarding rice crop cultivation and it may be used as a decision making tool.

Table 5: Block wise soil property

Block	Soil type	Soil PH level
Rajganj	Course loamy, fine loamy-course loamy, very few fine loamy	>=5.0 and <=6.0
Jalpaiguri	Course loamy, fine loamy-course loamy, very few fine loamy	>=5.0 and <=6.0
Mainaguri	fine loamy-course loamy, few course loamy-fine loamy	>=5.0 and <=6.0
Dhupguri	Course loamy, fine loamy-course loamy	>=5.0 and <=6.0
Nagrakata	fine loamy-course loamy, course loamy	>=5.0 and <=6.0
Meteli	fine loamy-course loamy	>=5.0 and <=6.0
Malbazar	Course loamy, fine loamy-course loamy	>=5.0 and <=6.0

IV. CONCLUSION

The aim of this research paper is to develop a suitability map for rice crop production using GIS which helps the farmer for decision making to get maximum yield. The study carried out based on soil, climate and topographic factors of the Jalpaiguri district of West Bengal. This proposed method may be implemented on other crops also. The system can be enhanced to include data related to different aspects of cultivation such as irrigation, drainage and so on.

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