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ORIGINAL RESEARCH ARTICLE

GIS Based Integrated Decision Support System for Mustard Crop in India

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ABSTRACT

A decision support system for oilseed sector is still a big challenge in India. Mustard crop is one of the major oilseed crops of India. The information on spatial distribution of mustard crop, production and estimates and creation of spatial databases for major mustard producing state Rajasthan (Alwar & Bharatpur), is being conducted through remote sensing and GIS. The generation of spatial & non-spatial data through field survey, GPS methods, thematic data using high resolution satellite images (IRS-P6-LISS-III), topographic data using SOI toposheets and collateral data from various organizations. All integration leads to the development of GIS based crop and yield estimation. The Web based Decision Support System (DSS), which can support the users like Farmers, Traders, Processors, Mandi, Transporters, Industries, for their advance planning of crop management, procurement, stock, availability and post harvesting decision like where & when to sell the seeds. The integrated agronomic data for mustard crop advisories to help producers and policy makers properly and agencies involved in policy developments like import, export, minimum support price etc. This single platform website which can implement the functions, explicit & user friendly menu screens for database maintenance, information query on spatial & non-spatial database software. This decision support system will prove as an indispensable tool in making of oil import policy timely and as a factor in deciding oil prices as it gives an estimation of mustard production before its harvesting.

Keywords: GIS, Rapeseed Mustard Crop & Yield Estimation, DSS Agricultural Information, Web Based GIS Application.

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INTRODUCTION:

Rapeseed-Mustard being the winter crop is facing a large number of problems because of small size and high mobility of the seed. It is exposed to various external vagaries, just during harvesting and after harvesting, responsible for various types of seed

losses and seed damages. There are various factors responsible for loss and damage of mustard seeds via, time of harvesting, the time period for sun drying, method and efficiency of threshing, distance from field to threshing floor, type of threshing method, type of threshing floor used, type of cleaning, method of transportation, storage types etc. The stages that have been covered under this survey are Shattering, Handling, Cleaning, Transportation, Storage and Processing. Whereas, the levels mainly covered in the said stages were Farmers at Farm level, Traders/Commission agents at Mandi level, Storage at farmers, Transporters & Processors level and Mustard oil units at Industries & Processor level.

A decision support system for various applications in major oilseeds is still a big challenge in India. Various policies like import, internal stock assessment, availability, regional distribution, crop protection system etc. are purely based on strong scientific and technology based support system. Spatial distribution of agricultural crops and their price policy and fluctuations thereof is nowhere in Indian agriculture or policy-making system. Therefore, to cater the needs of Indian mustard producers, traders, processors, policy makers, crop advisory agencies and various Govt. Departments etc. it is important to develop an integrated decision support system. This support system is categorized into three major heads like, involvement of remote sensing and GIS and field survey, creation of a spatial database for crop estimation/forecast and market price fluctuations and development of a portal which will integrate the whole information for the end users.

Study Area Description

This study area figure shows the location in Alwar and Bharatpur district of Rajasthan State for Mustard oil seed Crop acreage estimation and Yield estimation, during Rabi season of the year 2007-08 to 2009-10. Rajasthan state, contributes nearly 35 percent to the all India Mustard Production.

Geographically, Alwar district is situated in the northeast of Rajasthan between 27°04’ to 28°04’ north Latitudes and 76°07’ to 77°13’ east Longitude. Its greatest length from south to north is about 137 km. and greatest breadth from east to west about 110 km. The district was divided into 12 administrative units like subdivisions, Tehsils, and 14 Panchayat Samitis (Blocks) each under one governing authority of a Sub Divisional Officer (SDOs), Tehsildar, Block Development Officer (BDO) respectively. Mustard seeds and other agricultural products come to market through mandies established by Anaj Mandi Samiti. These Anaj Mandies are in Alwar, Khairtal, Kherli, Lachhamngarh, and Rajgard.

Geographically, Bharatpur district is situated in the eastern part of Rajasthan between 26°22’ to 27°83’ north Latitudes and 76°53’ to 78°17’ east Longitude. Its greatest length from south to north is about 125 km. and greatest breadth from east to west about 71 km. The district was divided into 10 administrative units called Tehsils, each under one governing authority of a Tehsildar. Mustard seeds and other agricultural products come to market through mandies established by Krishi Upaj Mandi Samiti (KUMS). These Krishi Upaj Mandies are in Bharatpur, Nadbai, Weir, Deeg, Kaman, Bayana, Nagar, Roopwas and Bhusawar.

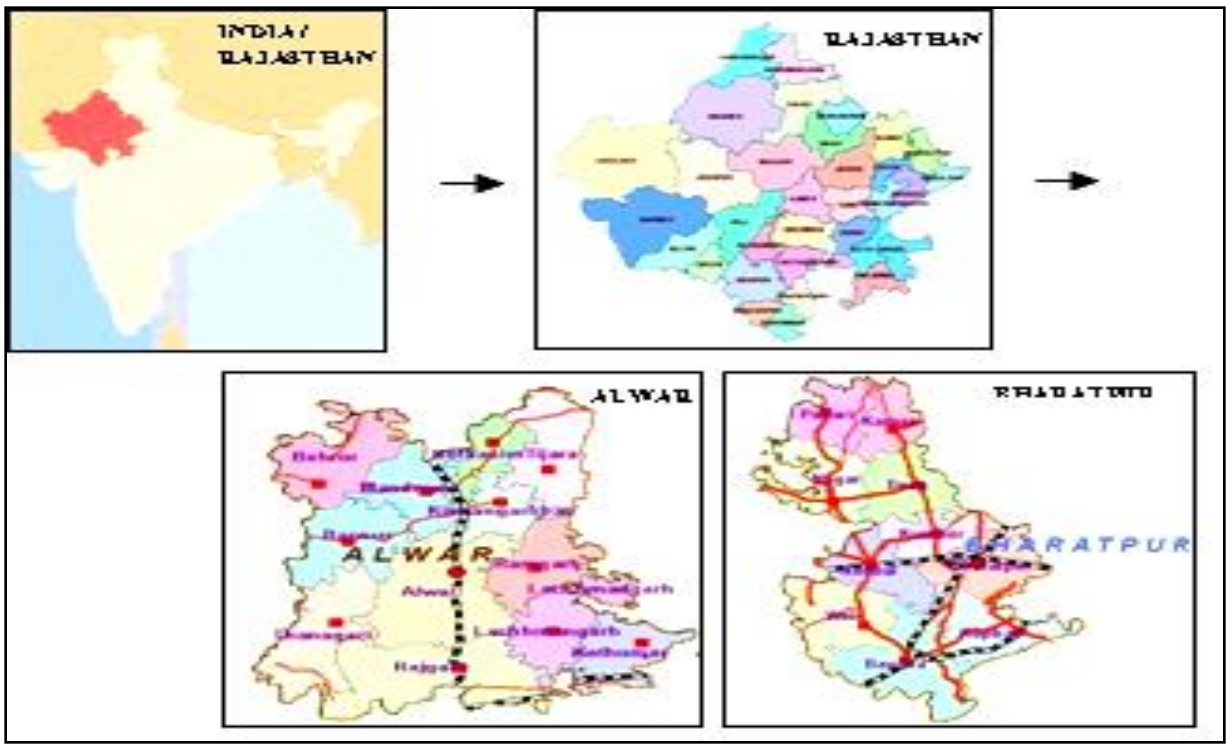


Figure - 1 Shows the Study Area Location

Material and methodology

In this Research work, there are different types of materials can use, which were collected from different Government Organizations as well as some Private Organizations also. There are some Primary Data's as well as some Secondary Data's were used for this Project work, they are described as below.

Primary data: -

Satellite data: - Last 3 years (2007-08, 2008-09, 2009-10) study area RESOURCESAT-1 (IRS-P6) LISS-III satellite images were purchased from the National Remote Sensing Center (NRSC).

Agro-meteorological data: - All Agro-Metrological Data's were collected from India Meteorological Department (IMD) Data center, Pune. All data should be on Daily basis with the parameters of temperature (minimum & maximum), soil moisture, and rainfall (minimum & maximum) observations of our study areas.

Mandi information data: - During the field visiting time, collecting of all Mandi information with detail contacts, addresses, location of Mandi's, progressive farmers, Traders, Industries and processors in each district wise has been done. Other then this collection, some secondary source like internet, some published magazines and AGMARK web site.

Field survey work: - Real time data of Mustard crop field data should be collected year wise during the Rabi crop season in our study area. The field work data should be collected through Global Position System (GPS) instrument of GARMIN eTrax- 4.2 version of hand instrument. Primarily

the 10-15, GPS location waypoints were taken each district wise and gradually increase in year wise up to 25-30 waypoints of each study area district. It can also indicate the geographical location, elevation and direction of field as per globally. Simultaneously we collected the non-mustard field also, for our accuracy assessment, with a distance of 15-20 km. During the field work time also collected all crop field length and width, Crop Variety, and Height of Plant, Health or Quality (Poor/good/very good) and quantity of plants per Sq. Meter area.

Ancillary data: -

During the work, some secondary data's were collected from different Government organizations. The Details are as in below-

Toposheets: - For the Base map preparation we collected all Study area toposheets from Survey of India (SOI) with a scale of 1:50,000.

Soil maps: - The study area soil maps were purchased from National Bureau of Soil Survey and Land Use Planning (NBSS&LUP) Nagpur. The maps were used for study area soil characters as well as conditions and effects on their respective mustard agriculture crop area.

Software's Used: -

In this work, different types of software's were used for the data analysis, digital image processing (DIP), data storing, data capturing, data entering, statistical analysis, validation of work and data creation for web application, uploading, storage etc. There are mainly 7 categories software's used under with 8 main types.

Sl. No.	Type of Software	Purpose of Uses	Name of Software with Versions
1	GIS Software	GIS Work	Arc-GIS (9.2), Arc-View (3.2a), Gram ++ (2.1)
		Digital Image Processing	EARDAS Imagine (9.1), ENVI (4.6)
2	Statistical Software	Statistical Work	SYSTAT (13)
3	Validation Software	Validation Work	Info CROP (1.1), DSSAT (4.2)
4	GPS Software	Field Survey Work	Garmin eTrex Vista (4.0)
5	Development Software	Web Portal Development Work	ASP.NET-3.5, SQL Server-2005, JAVA Script,
6	Animation & Design Software	Design, Animation Work	Adobe Photoshop CS2, CorelDraw (12), Adobe Dreamweaver CS3
7	Server Used	Map OPEN SOURCE SERVER	

Table 1 shows the use of the Software's & Purposes

Crop & Yield Estimation Procedures

For the Mustard Crop estimation, administrative boundary of Alwar and Bharatpur district was overlaid over the remote sensing image with super-imposed of Field survey GPS location points, with the respective Taluk. The Mustard crop area was identified and estimated from the unsupervised classified images with the pixel grid values. From the Spatial Sampling Technique using Remote Sensing and GIS digital data, in the form of the Normal Difference Vegetation Index (NDVI) has been used as an auxiliary character for the crop yield estimation purpose. This ratio involves sums

Oof and differences between spectral bands, Defined in terms of the near infrared (NIR) and Red (R) bands as:

Is preferred to simple red: near-infrared ratio by many works because the ratio values are not affected by the absolute pixel values in the near-infrared (NIR) and Red (R) bands. The Values can vary in between -1 to +1 only, in their respective output attribute. The last 3 year mustard crop areas with their respective Yield estimation are as follows:-

Crop Area Estimation .

Sl. No	Study Area	Total Area (In sq.km)	Crop Estimation As Per -2007-08 (in hector)	Crop Estimation As Per -2008-09 (in hector)	Crop Estimation As Per -2009-10 (in hector)
1.	ALWAR	8459.884	217825.517	293724.637	265273.92
2.	BHARATPUR	4326.626	122306.227	214933.766	122710.5216

Crop Production Estimation for the Year 2007-08/2008-09/2009-10

Sl. No.	Study Area	Crop Production Estimation 2007-08 (in tone/hector)	Crop Production Estimation 2008-09 (in tone/hector)	Crop Production Estimation 2009-10 (in tone/hector)
1	ALWAR	4.744	8.627	7.037
2	BHARATPUR	1.495	4.619	1.505

Crop Yield Estimation for the Year 2007-08

Sl. No.	Study Area	Crop Production Estimation 2007-08 (in tone/hector)	Crop Production Estimation 2008-09 (in tone/hector)	Crop Production Estimation 2009-10 (in tone/hector)
1	ALWAR	4.744	8.627	7.037
2	BHARATPUR	1.495	4.619	1.505

Crop Yield Estimation for the Year 2008-09

Sl. No.	Study Area	Crop Production Estimation 2008-09 (in tone/hector)	Crop Area Estimation 2008-09 (in hector)	Yield Estimation 2008-09 (kg/hector)
1	ALWAR	8.627	293724.63	0.029371
2	BHARATPUR	4.619	214933.76	0.021490

Crop Yield Estimation for the Year 2009-10

Sl. No.	Study Area	Crop Production Estimation 2009-10 (in tone/hector)	Crop Area Estimation 2009-10 (in hector)	Yield Estimation 2009-10 (kg/hector)
1	ALWAR	7.037	265273.92	0.0265273
2	BHARATPUR	1.505	122710.52	0.0122646

Forecast Crop Area and Yield Estimation

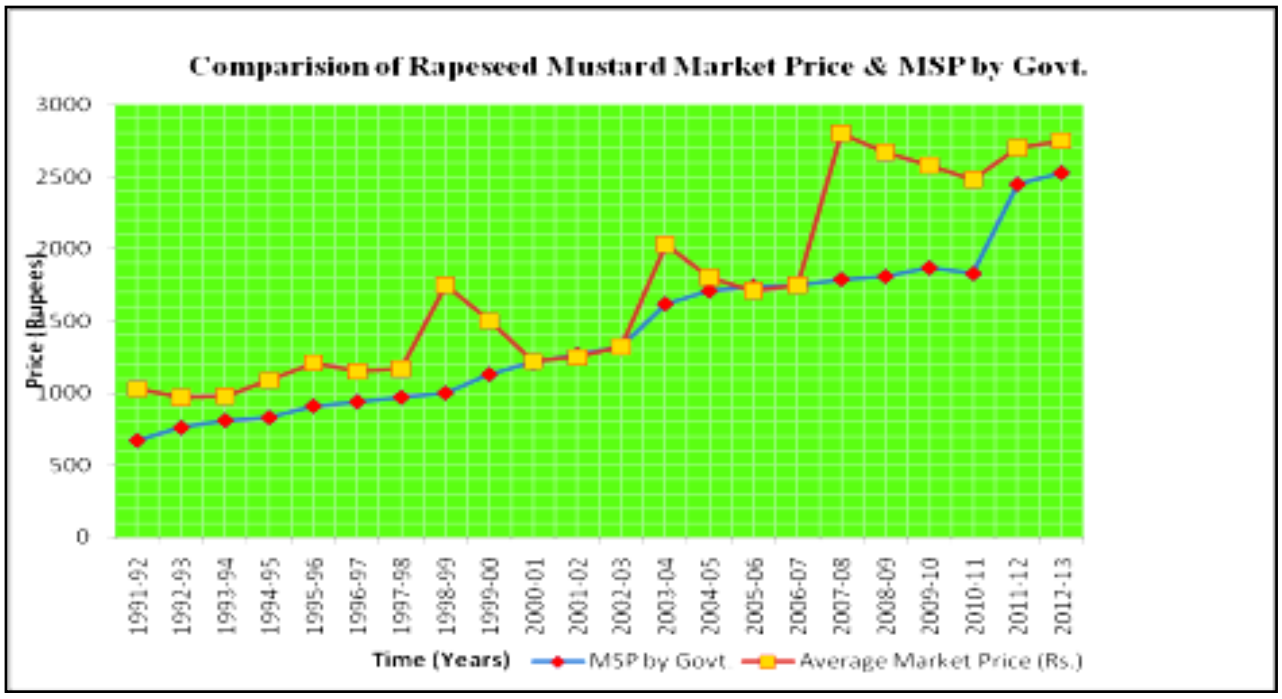
The ground level/ field survey estimates of Area, Production, and Yield and price comparison of mustard is as follows:

Govt. Estimates of Mustard* **				**PhD Research Work Estimates of Mustard**		
Year	**Area (Million hectares)**	**Production (Million tons)**	**Yield (Kilograms)**	**Area (Million hectares)**	**Production (Million tons)**	**Yield (Kilograms)**
2007-08	5.83	5.83	1001	5.02	4.81	958
2008-09	6.30	7.20	1143	6.57	6.88	1047
2009-10	5.59	6.61	1182	6.67	6.72	1007
2010-11	6.51	7.67	1179	6.85	6.96	1016
2011-12	5.88	6.03	1026	6.02	6.62	1028
2012-13*	6.91	7.81	1130	-	-	-

***** First Advance estimates

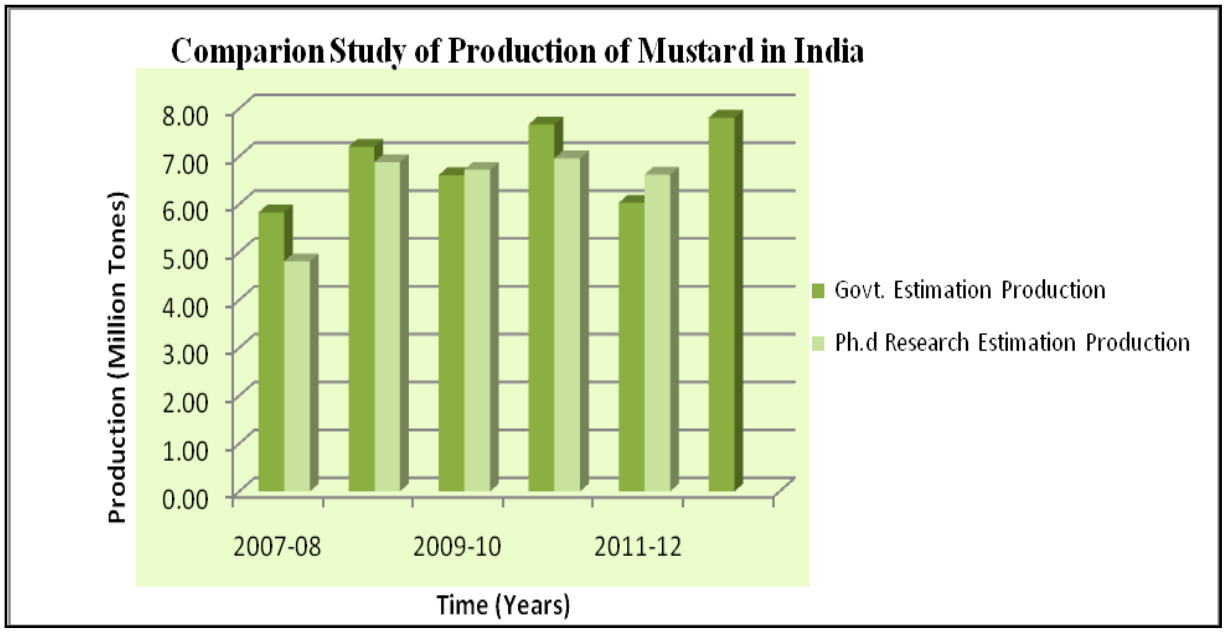
******* Director of Economics & Statistics; Dept. of Agricultural & cooperation; Ministry of Agriculture.

Market Price and Minimum Selling Price (MSP) of Mustard

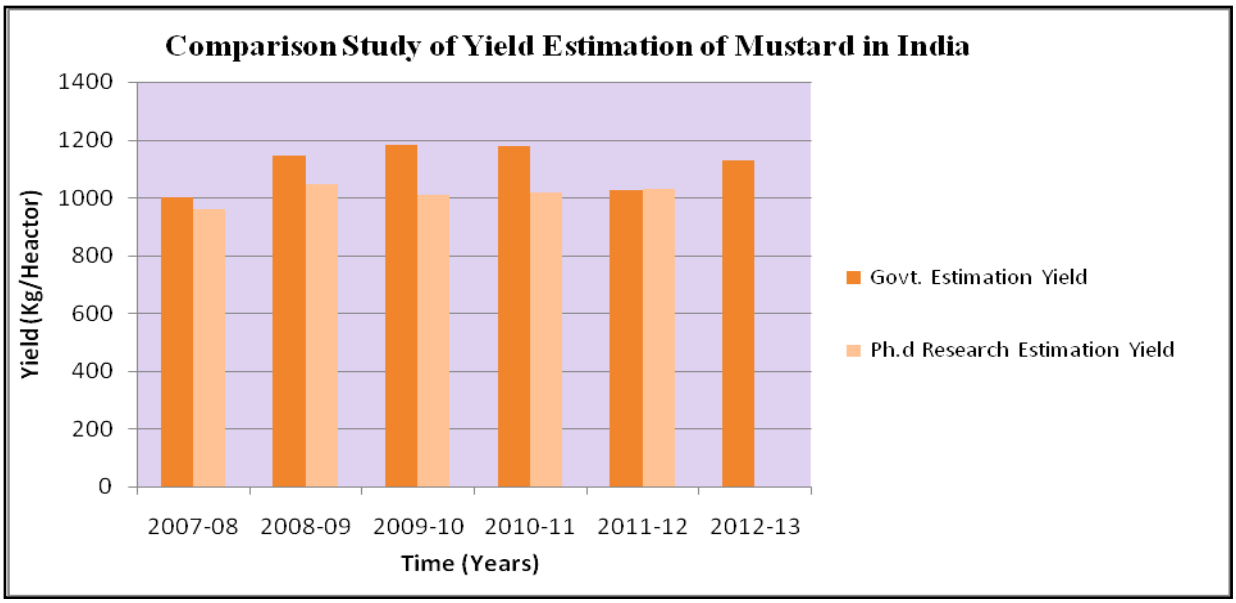


Comparisons Study of Crop, Yield and Area Estimation

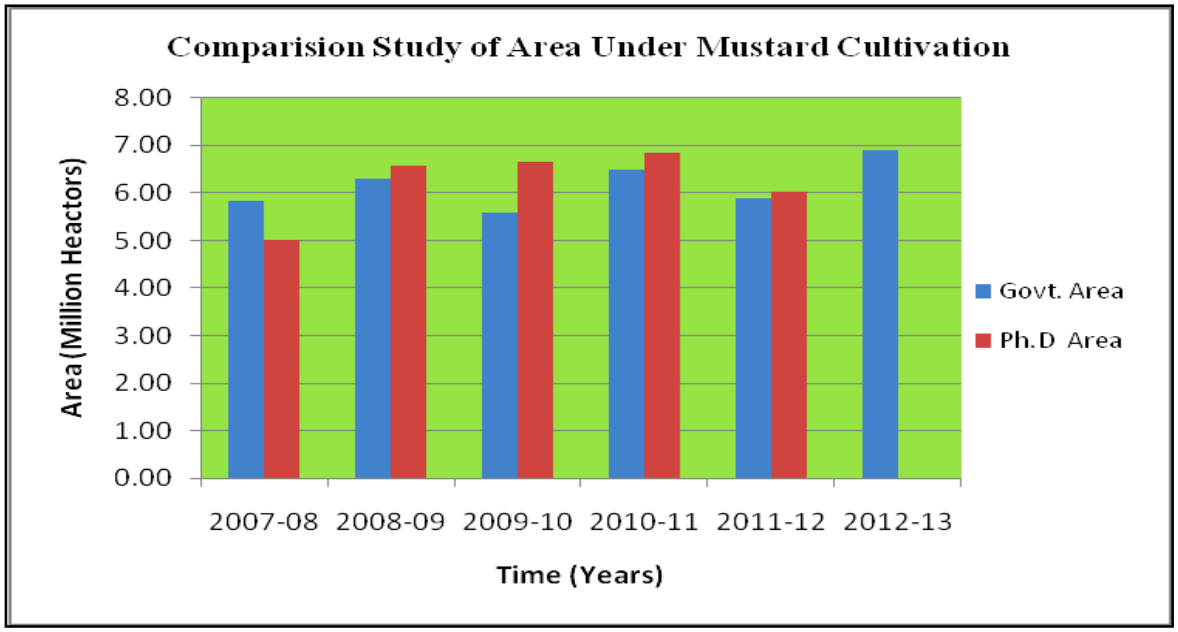
Crop Production Estimation of Mustard in India:-



Yield Estimation of Mustard in India:-



Area under Mustard Cultivation:-



Development of web based information system

Web based GIS are evolved from different Web maps and client-server architecture to distributed ones. As such, Internet reshapes all functions of information systems including: gathering, storing, retrieving, analyzing, and visualizing data. Moreover, disseminating spatial information on the Internet improves the decision making processes.

Development of the Web and expansion of the Internet provides two key capabilities that can greatly help the stakeholders. First, the Web allows visual interaction with data. By setting up a Web Server, clients can produce maps. Since the maps and charts are published on the Internet, other clients can view these updates, helping to speed up the evaluation process. Second, because of the near ubiquitous nature of the Internet, the geospatial data can be widely accessible. Clients can work on it from almost any location. The combination of easy access to data and visual presentation of it addresses some of the primary difficulties in performing Geosciences evaluations. Web GIS is not without its challenges. The primary problem is speed; GIS relies on extensive use of graphics. Connection speeds over the Internet can make heavy use of graphics intolerably slow for users. This facility, to view maps with administrative and other necessary overlays. The site have facilitated user in query regarding crops and growing environments.

Figure - 2 Online GIS Based DSS Web Portal.

This facility, to view maps with administrative and other necessary overlays. The site have facilitated user in query regarding crops and growing environments.

GIS Map Viewer: - This functionality has display shape files along with attributes stored in the shape file's database. There will be basic user controls like zoom in/out, pan, identify and layer

on/off buttons. The user can click or mouse over to the desired area of the map and will get a data sheet right on the map face.

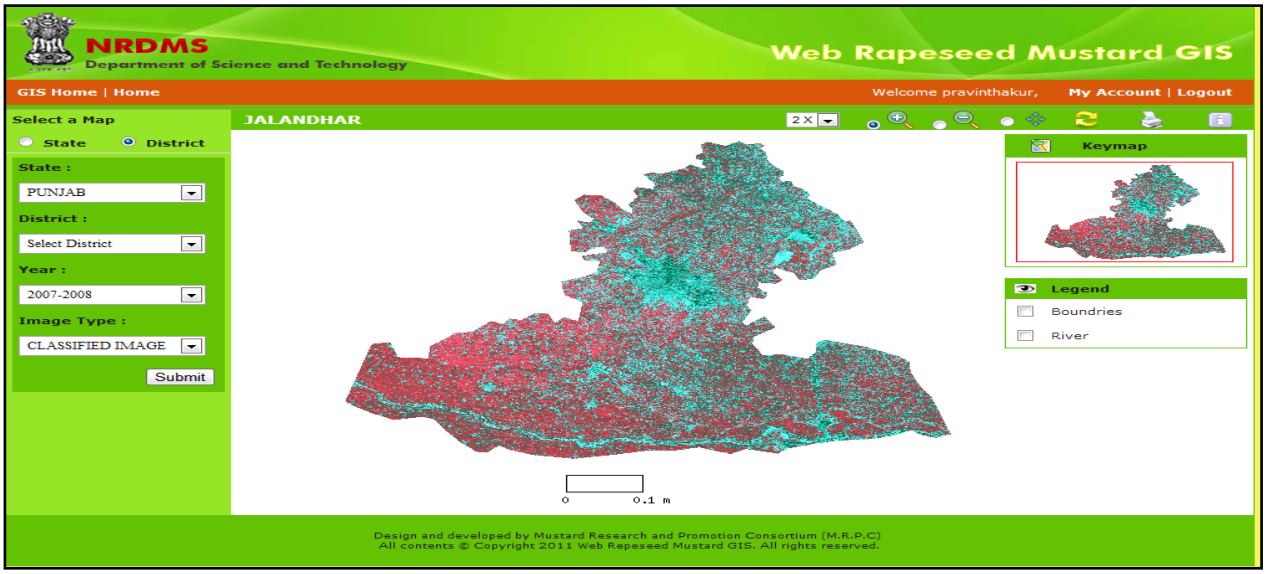


Figure - 3 Shows the GIS Map Viewer window.

Weather News Windows: - This will show updates on weather for important locations; representative of important crop growing areas. This window will be linked to weather information provider which will be selected based on regularity and use condition (paid/free).

Figure - 4 Shows Agriculture Information window.

Market News Windows: -

This will display commercial aspect of the crop under consideration like present market price, differs from previous price etc. If needed stock quotes may also be flashed. Besides these specific windows, there will be regular tabs like home, profile, about us, career, events etc., as the client may suggest and provide data for display.

Figure - 5 Shows Market Information window.

Discussion of web based information system

Web Portal development is under process for which the Crop & Yield Estimation including the real time changing; through the GIS web portal is done. Mainly it will represent all previous, current and future estimation related information, market price, Mandi information, trader's information as well as all oil Manufacture Industries related to Mustard Oil. It will also provide information on soil characters, meteorological activities, which will help farmers to take appropriate decisions i.e. method and time of sowing, harvesting, and selling the seed to nearest Mandi as well as industries, from where they can get the maximum values for their products. Crop, Yield, Farmers Suggestion, journal, lab-testing information is also available on payment basis from this web side. This web site is very useful for fetching information about Rapeseed Mustard. After up-loading of this website in web server any one can asses some general information, and after getting registered to the site one can assess all downloading, queries and get all real time data information about this oil seed crop. This web portal can attach in the form of open source at Google, some Specific Agricultural, or linking web site. For getting any information user can register freely in the FORMS tools, then they can access all useful material, which pops up as a separate window. This web site is now in Under Construction.

Figure - 6 Shows the Forum window

Conclusions

This application is a software independent system that users do not have to buy GIS software and this system can be viewed through all internet browsers. The response time for generating map based information related to the server configuration and network connection. However users are able to retrieve location based agriculture information within minutes.

The web based Rapeseed mustard GIS system built for the Farmers, Traders, Industries, District wise Mandi's and Processors community in the Alwar and Bharatpur districts of Rajasthan State, with the required functionality farming community's requirements. This system will also help to generate of user satisfaction with this system; areas that need to be improved will be addressed in the future of this system.

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