



## Role of Remote Sensing and GIS in Agriculture

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**Abstract:** Agriculture resources are among the most important renewable, dynamic natural resources. Comprehensive, reliable and timely information on agricultural resources is very much necessary for a country like India whose economy is mostly depends on the agriculture. Today remote sensing and GIS applications are being widely used for various projects relating to natural resource management. Also agriculture surveys are presently conducted throughout the nation in order to gather information and associated statistics on crops, rangeland, livestock and other related agricultural resources. This information of data is most importance for the implementation of effective management decisions at local, panchayat and district levels. In fact, agricultural survey is a backbone of planning and allocation of the limited resources to different sectors of the economy. Through this paper the authors have tried to provide a multifarious example of the above applications by reviewing the available information. The importance of remote sensing and GIS applications is also have been emphasized. Major emphasis has been attributed to variety level classification of crops, crop yield estimation for Insurance studies and agricultural risk mitigation studies. Through this paper it was observed that various agencies are working independently on different segments of the cited field. However, the efforts made in this field are still insignificant and there is a need for development of an integrated database. The information derived from this data can be used to reveal vegetative health, pinpoint the location of non-productive areas, and help in effectively planning and analyzing operations.

**Keywords:** GIS, Remote Sensing, Satellite, Images, Yield.

### Introduction

Efficiency in the agricultural sector can be increased effectively by using Information Technology tools such as remote sensing and GIS. The database for the agriculture sector can ensure greater reliability of estimates and forecasting that will help in the process of planning and policy making. Efforts to improve and harness latest remote sensing and information technology techniques to capture, collate, add value and disseminate data into appropriate destinations will be helpful for managing risk and in accelerating the growth process [1].

### Areas of Emphasis in Agriculture Segment

India has an agrarian economy with around 200 million people involved. In the current scenario unavailability of a comprehensive information database on agriculture system has often led to inefficiency in performance of the existing stakeholders [2]. Various

questions arising in the minds of stakeholders have remained unanswered. The authors have listed a few below:

#### ***Non Existence of Systematic and Sharable Database***

At present proper systematic and shareable database of different crops are not available. Some region wise database is available which are not shareable. Database for crops, which can grow in any area, area covered by each crop, yield of each crop etc is very much required to increase the efficiency in the agriculture sector. Farmers landholdings asset in terms of land size, shape, location etc are also unavailable to the others. This results in unpredictability of the output as a whole for the country.

#### ***Exporters Information***

The exporters also need information regarding the crop acreage for different crops available for export.



Fig.1 Distribution of basmati in the state of Haryana during the Kharif 2005

The cost estimation based on supply and demand is also need to be carried out and should be available to the exporters for fixing the basic price. The time required starting from sowing to the harvesting and the time required to reach to the go-down (Mandi/Storing place) should also be available to the exporters for exporting the crops. The exporters need to fix a price with their customers as well as with the farmers well before the harvesting takes place. Such committed commerce can only be obtained by a systematic flow of information. The information sought by the exporters includes variety wise acreage estimation, production estimation, health monitoring of crops, knowledge on draught and flood conditions and understand the farmer’s mind-set (farmer’s questionnaire survey) [3].

### Insurance

Insurance sector companies require some data like the actual premium to be levied in each ‘Insurance Circle’, monitor growth of the Insurer’s crop, to ascertain if there is a real loss in the crop of the insurer, to assess the actual amount of compensation to be paid to the insurer, for timely payment of compensation in order to attract the farmer etc.

Agricultural insurance is a growing phenomenon in India. Insurance companies assess the premiums and claim payout based on the agro-climatic zone, vulnerability of the crop to various disasters like floods or

drought and crop yield. With the increasing competition in the insurance sector, insurance companies need to fix a proper premium and pay out claims on time, based on the crop yield of the insurer.

The timing and amount of rainfall is very critical for crop yield. Other factors like temperature, bright sunshine hours, wind speed, sources of seed, timely use and quantity of fertilizers are the other important factors affecting the crop vigor and ultimately the yield of the crop. It is possible to assess the crop vigor using appropriate sets of satellite images during the critical stage of crop growth and correlate it with crop yield.

This data, when analyzed in conjunction with administrative boundaries such as Insurance blocks in a GIS environment, can help assessing the real ground conditions prevailing in the area concerned with a relatively good accuracy. The crop yield well before harvesting can help the insurance industries to pay out the compensation.

### Fertilizer

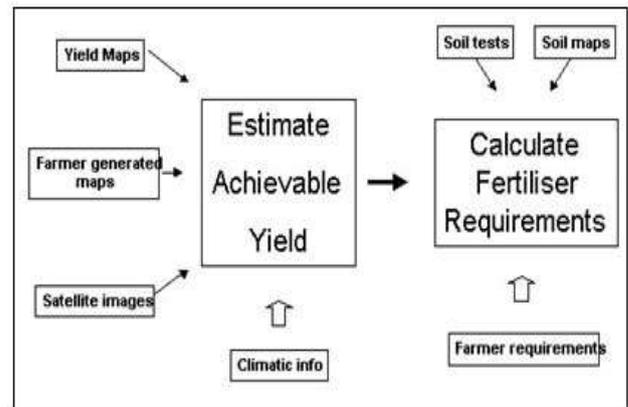


Fig.2 GIS analysis for assessment of fertilizer requirement

Fertilizer distribution companies require data like Crop type so that an assessment on the requirement of fertilizer in the region can be made, Land suitability and acreage of crop type to ascertain demand and supply of seeds & fertilizer.

Different crops and agricultural fields require different types and amount of fertilizer. It is often observed that there is either a shortage or over supply of certain fertilizer in the market.

This happens due to lack of information on agricultural field.

Analyzing land use, land capability, soil characteristics and farmer's interest one can estimate the fertilizer requirement for a particular area [4].

### **Farmers Information**

Farmers require data like Crop type that will be best suited for their field during a particular season, type and amount of fertilizer to be applied, volume of water required for best yields, location of mandi and the current price of their product in the market etc.

### **Government Information**

Government require a variety of data like total expected produce of each crop type during the current year, floods/draught conditions developing in different area, the farmers impacted by crop damage, the total irrigation water requirements and water conservation plan, capacity of cold storage, go down and subsequent transport planning for disbursement, total farm subsidies and whether the system is fully transparent, tentative revenue collection, cadastral level information, the location to open new mandi based on crop field location.

has its own portal e-kisan for farmers where they can easily access information on the crop and mandi to sell their crop. NDDB has developed a portal for purchase of milk at a rate based on the amount of fat in milk. I-kisan is being developed as a comprehensive Agri portal to address the information, knowledge and business requirements of various players in the Agri arena such as Farmers, and Agri input input/output companies [5].

Satellite based remote sensing technique combined with limited field survey provides valuable information in quick time. The data generated from satellite imageries provide information on the status of crops under observation at any particular date, and can be processed quickly. This inherent advantage provides a synoptic view, making it possible to analyze the status and trend of transplantation, crop growth and harvesting throughout the area [6].

Wide spread application of remote sensing and GIS will be helpful for creating a systematic and sharable database on crop related issues and answer the unanswered questions of different stakeholders.

The figure shows a general methodology adopted for extraction of data using remote sensing & GIS and its dissemination to different stakeholders.

Many private companies like RMSI are engaged in providing remote sensing and GIS based services to different segments of agriculture.

## **Comprehensive Agricultural Information**

Apart from the various approaches adopted so far, the solution to all the existing problems of various stakeholders, farmers, Government and industrialists/exporters can be solved only by developing remote sensing & GIS based Agriculture Information System.

## **Creation of Cadastral Level Information System**

### **Field Information System**

With the use of some satellite having a resolution of 2.5m, it is now possible to map

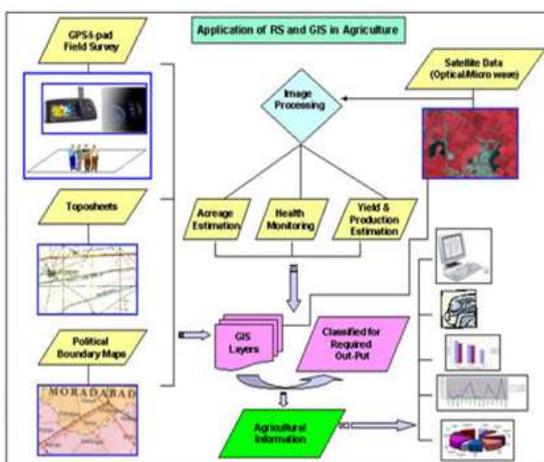


Fig.3 Application of RS and GIS in agriculture

## **Application of Remote Sensing and GIS for Agriculture in India**

In the early 1980's, the Department of Space, India initiated the use of remote sensing for land, wasteland, and hill area development. In early 1990's ITC, a private company extensively used remote sensing for crop acreage estimation. Presently ITC

the boundaries of each field. This data supplemented with information from field and other sources will help in creation of 'Field Information System'.

### Site suitability Studies

Use of satellite images and other ancillary & historical information will be useful to create a plot level site suitability map for each season. This map will be very helpful in selection of appropriate crop for maximum return. Some layers will be required to create site suitability analysis. These are Soil map, Soil salinity, Soil pH, Canal and distributaries network, Surface water bodies distribution (river, ponds and lakes), Historical rainfall data etc.

### System for On-line Monitoring of Crops

Regular monitoring of crops will help in taking proper measures based on the nature of risk for a particular crop field. Monitoring of crops also helps in calculation of acreage, crop stress and prediction of yield. This in turn helps different stakeholders in planning and management of crops. Following data are important for creating different life span of crops to monitor their proper growth and finally the yield of the crop. These are like Temperature, Avg. Rainfall, Crop stress, Total precipitable water data, Agricultural practices (transplantation, harvesting, tilling and flowering dates), Additional information about fertilizers, seeds etc.

### Market Related Database

Data on different aspects of market is a critical component for agriculture information system. Following data is required for the creation of database. These are Creation of field-level crop inventory, Location of different mandis, Market-wise information on major agricultural commodities, Timely forecast on production, Demand and supply of commodities, Mapping of transportation network (highways, railway and other roads), Shortest route from crop field to mandi, Information on current price etc.

### Web Based Information System

In order to provide complete information to the farmers, traders and consumers - web GIS is most effective for easy access through Internet from any part of the world.

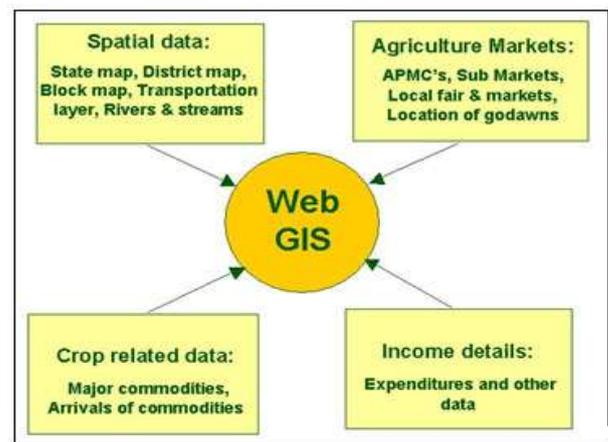


Fig.4 Components of web-GIS for agriculture

This system includes information about the crop varieties, farm management practices, markets, current prices and weather related information amongst others [7].

The concept of e-chaupal of ITC helps farmers to sell their produce directly and thereby fetch good returns. Farmers can send on-line queries related to crops, markets, and crop management practices through various centers.

### Remote Sensing and Its Importance in Agricultural Survey

Remote sensing is nothing but a means to get the reliable information about an object without being in physical contact with the object. It is on the observation of an object by a device separated from it by some distance utilizing the characteristic response of different objects to emissions in the electromagnetic energy is measured in a number of spectral bands for the purpose of identification of the object.

In such study single tabular form of data or map data is not sufficient enough which can provide can be, combined with information's obtained from existing maps and tabular data.

- Remote Sensing techniques using various platform has provide its utility in agricultural survey
- Satellite data provides the actual synoptic view of large area at a time, which is not possible from conventional survey methods.
- The process of data acquisition and analysis is very fast through Geographic Information System (GIS) as compared to conventional methods.

Remote Sensing techniques have a unique capability of recording data in visible as well as invisible (i.e. ultraviolet, reflected infrared, thermal infrared and microwave etc.) part of electromagnetic spectrum. Therefore certain phenomenon, which cannot be seen by human eye, can be observed through remote sensing techniques i.e. the trees, which are affected by disease, or insect attack can be detected by remote sensing techniques much before human eyes see them [8].

## Conclusion

Application of remote sensing and GIS is revolutionizing planning and management in the field of agriculture. Various agencies

are working independently on different segments of the problems discussed above. However, the efforts made in this field are still insignificant and there is a need for development of an integrated database. The information derived from

this data can be used to reveal vegetative health, pinpoint the location of non-productive areas, and help in effectively planning and analyzing operations. This information can be shared with all those associated with management and marketing of crops to plan for their procurement, storage, distribution and export, in advance.

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