STRENGTHENING THE BACK BONE OF INDIAN ECONOMY THROUGH APPLICATION OF GIS IN AGRICULTURE

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ABSTRACT
India has agriculture as the main occupation. Basically, the farmlands are divided into small regions and some lands located close to the river, in the dry / wetly areas, hill areas, moderate rainfall areas, others. Land units being small, it provides farmers with a meager output, out of which some of the income is lost due to middlemen. The main crops grown here are vegetables, wheat, flowers, sugarcane, spices and others. Modern farming is about optimizing agricultural production. For this it is necessary to acquire knowledge of the whereabouts of assets and demands, analyzing this information for enhancing further business opportunities. This is where GIS can be used.

In case of India, apart from the other agricultural benefits that GIS integrates water quality information, soil maps, crop and yield maps, etc. GIS could help in using various facts specific to India, like: It being a pilgrimage place, draws lacs of people annually thus demanding huge quantities of grains, flowers, spices, etc. Its proximity to a huge market like New Delhi, “Dynamic logistic” capital of India, upcoming national airport at different places in India can be utilized for exporting the flowers and vegetables, which have a small shelf life. GIS is used to compile the above mentioned factors for boosting the output, the trade, finding suitable markets, reducing the number of middlemen and thereby benefiting the farmer.

KEY WORDS GIS, Precision Farming, Indian Agriculture, Urban Agriculture, Predictions.

AGRICULTURE IN INDIA
In financial year 1987, field crops were planted on about 45 percent of the total land mass of India. Of this cultivated land, almost 37 million hectares were double-cropped, making the gross sown area equivalent to almost 173 million hectares. About 15 million hectares were permanent pastureland or were planted in various tree crops and groves. Approximately 108 million hectares were developed for nonagricultural uses, forested, or unsuited for agriculture because of topography. About 29.6 million hectares of the remaining land were classified as cultivable but fallow, and 15.6 million hectares were classified as cultivable wasteland. These 45 million hectares constitute all the land left for expanding the sown area; for various reasons, however, much of it is unsuited for immediate cropping. Expansion in crop production, therefore, has to come almost entirely from increasing yields on lands already in some kind of agricultural use. Due to lack of information about the land and their nature, we are still not getting the proper return with the yield of those lands. The Community Development Programmed in India was inaugurated in 1952 to implement a systematic, integrated approach to rural development. The nation was divided into development blocks,
each consisting of about 100 villages having populations of 60,000 to 70,000 people. By 1962 the entire country was covered by more than 5,000 such blocks. The key person in the program was the village-level worker, who was responsible for transmitting to about ten villages not only farming technology, but also village uplift programs such as cooperation, adult literacy, health, and sanitation. Although each block was staffed with extension workers, the villagers themselves were expected to provide the initiative and much of the needed financial and labor resources, which they were not in a position to do or inclined to do. Although progress had been made by the early 1960s, it was apparent that the program was spread too thin to bring about the hoped-for increase in agricultural production. Criticism of the program led to more specialized development projects, and some of the functions were taken up by local village bodies. There was only a negligible allocation for community development in the sixth plan, however, and the program was phased out in the early 1980s.

**Geographic Information System (GIS)**

Geographic Information Technology has developed at a remarkable pace over the past two decades and will play a key role in development of nations in the 21st Century; thereupon many countries have already prepared their strategic development plans for application of GIS Technology with gigantic financing endeavors. Now time has come for all decision makers to discuss the appropriateness of GIS technology and its applications to rural development, forest management, urban development planning, land information systems and agricultural development. This will also provide a suitable solution for the use of GIS for educational infrastructure development with special emphasis on rural sector in India. Information Technology has emerged as an inevitable phenomenon influencing every walk of life of people in all sections of this society. With the ease of availability of enormous computing power and convenient access to large volume and variety of data and information, the structure and functions of all human organizations will undergo profound transformation in this century.

**Urban Agriculture & GIS**

Agriculture in the city or in peri-urban areas, is a phenomenon that can be observed worldwide. This is particularly true for cities of developing countries, where food production for subsistence and marketing contributes to the improvement of livelihoods, food security and urban ecology (Smit et al. 1996, Mougeot 2005). In spite of all ongoing research on urban agriculture, in most of the developing countries’ cities few systematic surveys have
been carried out on the actual extent of urban agriculture in terms of inner city areas used for agricultural purposes. Also little is known on the spatial distribution of urban agriculture in the cities. In the world-wide context, only very limited experience with the application of Geographical Information Systems (GIS) to urban food production activities is available. A survey carried out in 1999 showed that one possible way to close the information gap is to map urban agricultural areas by combining analysis of aerial photographs with field work, and using GIS as a tool.

GIS in India

India maintains a pre-eminent position in the use of spatial imagery. The capabilities in the development of high-resolution satellites and extensive network of associated infrastructure have contributed to the growing interest in the application of GIS for a variety of India’s development needs. Indications are that these applications will continue to grow even more rapidly in the coming years. Since the spatial imagery is becoming easier to use and more affordable, the user base for GIS is expanding in several directions in seeking holistic solutions beyond image processing capabilities. The Information Technology policy of Government of India adopted in 1999 emphasizes the availability of spatial data to GIS user community and industry, thereby enabling the widespread development of Spatial Decision- Support Information System Network including Web enabled GIS application services. The Indian export from GIS segment is expected to increase to US $ 150 million in the next five years from the present level of US $ 60 million. The areas which are receiving priority attention include natural resources information assessment, monitoring and management; water shed development, environmental planning, urban services and land use planning. Most States in India and several ministries and departments of the Central and State Governments have initiated special GIS programmers relating to ground water studies, cadastral mapping, and power transmission and transportation infrastructure. The integration of socio-economic data with spatial data is increasing. The institutional infrastructures have been developed across the country catering to the local, regional and national needs. Some of the institutions with sophisticated capabilities are: National Remote Sensing Agency, Hyderabad, Indian Institute of Remote Sensing, Dehradun, Space Application Centre, Ahmedabad, Regional Remote Sensing Service Centers at Bangalore, Nagpur, Jodhpur, Institute of Remote Sensing at Anna University, Chennai and Survey of India Training Institute, Hyderabad. These institutions offer a variety of training
programmes relating to GIS besides undertaking or supporting large scale application projects. At present a large number of private firms of Indian and foreign origin have been active a undertaking GIS projects. They have been particularly responsible in introducing in the country instruments, software’s and educational programmes. Central Mining Research Institute (CMRI), one of the premier laboratory of Council of Scientific and Industrial Research (CSIR) is fully equipped with latest IT related infrastructure and their Scientist are capable for undertaking any GIS related projects of India and abroad. NIC is also providing assistance to several Central, State and Local bodies in fulfilling their specific GIS requirements. In recent years most of the organizations engaged in GIS activities have felt the need for establishing control points especially in applications such as land records management, cadastral survey and hydrographic survey. For these tasks, acquisition of Global Positioning System (GPS) has been increasing. During the year July 2000-June 2001 about 50 GPS equipments have been procured by several governmental agencies in the country. Despite these noteworthy achievements in GIS in India, there are still some limiting factors that need to be addressed, such as the restrictions on the availability of high-resolution data in sensitive areas, lack of nationwide control points, absence of more convenient repository and retrieval systems and lack of standardization of map scales. The implementation of GIS in Research Programmed raised a variety of conceptual questions for both the ecological and the socio-economic sectors of this regional, integrated research programmed. In addition to these basic units of research, spatial links between the two sectors and levels of data abstraction for the spatial database had to be defined. Using the theoretical background of the hierarchical system approach and valuable experiences of spatial data handling a consistent spatial information database can be created. Despite problems with data accuracy, logical consistency and completeness of data, a powerful tool for regional and local planning can be developed which can serve as a framework for a variety of planning purposes at the local and regional levels, as well as the transfer of know-how between governmental agencies and institutions using an interactive approach.

**GIS in Agriculture**

- Development of a model for dam irrigation management based on GIS network models.
- Studying Effective factors in selection of under story farming lands and there effects on forest stand using GIS.
• Assessing Agricultural Sustainability in Watersheds in India using Geomantic.
• Precision farming in Indian Agricultural Scenario.
• The use of GIS, GPS and aerial imagery for mapping urban agricultural activities on open pace in cities.
• GIS Anchored Integrated Plantation Management: Tea.
• Precision Farming: Dreams and Realities for Indian Agriculture.
• Operationalization of Precision Farming in India.
• Remote Sensing techniques for Agriculture survey.
• The extraction method of surface temperature in agricultural area using Satellite Remote sensing and GIS.
• 11. The use of GPS and mobile mapping for decision-based precision agriculture Application of GIS on small farm and dairy management: SARSA green, Durgapur, West-Bengal.
• GIS applications in soil data analysis.
• Use of GIS for sampling designs for agricultural surveys.

Precision Farming (PF) in Indian Context

Precision farming is one of the most scientific and modern approaches to sustainable agriculture that has gained momentum in 21st century. Consider this situation: ‘A farmer goes to his field with his GPS (Global Positioning System) guided tractor. The GPS senses the exact location of the tractor within the field. It sends the signal to a computer on the tractor, which has a GIS, storing the soil nutrient requirement map in it. The GIS, in consultation with a Decision Support System, decides what is the exact requirement of the fertilizer for that location and then commands a variable rate fertilizer applicator, attached with the tractor, to apply the exact dose at that precise location. And all this is done within a second, before the tractor moves further. Precision farming aims to improve crop performance and environmental quality. It is defined as the application of technologies and principles to manage spatial and temporal variability associated with all aspects of agricultural production (Pierce and Nowak, 1999). In other words, precision farming is the matching of resource application and agronomic practices with soil attributes and crop requirements as they vary across a field.

Thus, the concepts of precision farming include:

• Variations occur in crop or soil properties within a field.
• These variations are noted, and often mapped.
Management actions are taken as a consequence of the spatial variability within the field.

A host of terms have been used to describe the concept of precision farming. Generally all these terms are combinations of two phrases. The first phrase is ‘spatially variable’, ‘GPS based’, ‘Prescription’, ‘Site-specific’ or ‘Precision’, whereas the second phrase can be ‘Farming’, ‘Agriculture’ or ‘Crop production’. The PF techniques, by appreciating the variability within the field and adopting management practices to cater the variability, are serving the dual purpose of enhancing productivity and reducing ecological degradation. The real value from precision farming is that the farmer can perform more timely tillage, adjust seeding rates, fertilizer application according to soil conditions, plan more crop protection programs with more precision, and know the yield variation within a field. These benefits can enhance the overall cost effectiveness of crop production, however the grower must be willing to make adjustments in his management styles to make it work. GIS has two different roles in precision farming vehicles. First, a combination of GIS and simulation models is highly relevant for precision farming. There are many simulation models for different purpose like the flow of water, crop growth, soil erosion, nutrient and pesticide leaching. GIS helps in integrating geographical data on various aspects such as soil, crop, weather and field history along with simulation models. Another aspect of GIS support to precision agriculture is the engineering component, in which the research findings are translated into operational systems for use at farm level. GIS can support this engineering activity by providing a good platform for storage of base data, simple modeling, presentation of results, development of a user interface, and, in combination with a GPS, controlling the navigation of farm. On the basis of GIS, a decision support system can be developed for operationalisation of precision farming at farm level.

GIS and Farming System Analysis

Rural project analysis demands a precise local socio-economic and agro-ecological assessment for extended regions. GIS allows combining local data with remote sensing for agro-ecological land-use modeling over broad areas. Farm system analysis supplies socioeconomic indicators at local and at regional level. Local data is included as quantitative and qualitative constraint. Joining both sources in a spatial database enables to spatially model the farming system. Quantification is possible of both, the socio-
economic performance of the individual farming unit as a component of a farming system as well as its reciprocal influence with the natural environment. The spatial distribution of the individual farming units shows that middle-size farms are located on the most suitable soils. There is no distinction per classes in respect to the distance to the urban centers. Smaller units are concentrated along the main roads. Rural schools are distributed evenly in the district, from which follows that 60% are accessible mainly for the middle to larger units. The agricultural area averages 50% of the available farming area; In coincidence with this result, total farm income is closely related to agricultural area. Per hectare profit is higher in intermediate classes, with higher incidence of intensive land use activities. GIS-Farming system analysis is able to characterize a region down to the level of the individual farming unit. The natural environment and its interaction with the farming units is spatially quantified. Farmland use is precisely characterized at the field level. The livelihood of rural population is accurate evaluated through socioeconomic indicators.

![Climate change and Globalization](image)

(Climate, rainfall and soil in India)
Methodology

In order to achieve the desired result, a step-by-step procedure as given below is adopted.

(a) Data Collection
- Location map of a region.
- Land use information from Nagar Nigam.
- GPS reading of the Study area (GPS Receiver used: I Finder, H2O)
- Road network information
- Field survey: This included extensive interviewing of farmers, manual survey and field photographs

(b) Data Processing
- Scanning the map containing the desired road network
- Georeferencing of the scanned map in “ERDAS Imagine 8.7”.
- Import the georeferenced map to “ArcView GIS 3.2a” for Digitization.
- Digitize the road network and market locations and enter their attribute data.
- The layers were thus formed and suitable markets as well as location of facilities viewed suitably in the map.

Issues

“India has a well-documented history of maps but the rigid framework of restriction of map data policy has tied down GIS players within India. In addition, there is no ‘quality standard’ or certification standard for GIS data produced, and end users are unable to evaluate the quality of data supplied by GIS players. The other real obstacles are low awareness of the benefits of GIS, no clearly outlined government policy in this area, and the lack of finance to support GIS solutions, especially at the state and local government level.” Precision farming, though in many cases a proven technology is still mostly restricted to developed (American and European) countries. The reasons for limited implementation of PF in Asian countries (India) are following:

- Small land holdings
- Cost/benefit aspect of PF system
• Heterogeneity of cropping systems
• Lack of local technical expertise
• Knowledge and technological gaps

Out of these, the two major problems for implementing PF in Indian agriculture are small land holdings and cost of PF system. We shall discuss these two and see how remote sensing can help. In India more than 57.8 per cent of operational holdings has size less than 1 ha. With this field size, and the farming being mostly subsistent farming, it is difficult task to adopt the techniques PF at individual field level. However, for adoption of PF, one can consider, instead of individual fields, contiguous fields, with same crop, under similar management practices. Since, management practices, like seed rate, fertilizer rate etc. are mostly based upon the agro-ecological units, they remain similar for a large area. In these cases the PF can be adopted as Information based agricultural system, i.e. at least the farmer has the information about the soil type of his field before adopting the fertilizer practices.

CONCLUSIONS

A broad overview of the implementation of GIS & current trends in agriculture. This article highlighted traditional agriculture tools & GIS as new tool for precision farming in India. The article also highlighted utility of the geographic information system methodology to grow up the Indian agriculture market and provide the directions highlighting the need for improved farming in India through GIS. The article also emphasize on unpredictable markets and lack of knowledge, non scientific farming practices do reduce the revenue of the farmers drastically analyzing as well as utilizing the available facilities, exploiting the strategic location of the study area and locating the appropriate markets easily would definitely enhance the output and revenue of the farmers in India. Precision farming is essential for serving dual purpose of enhancing productivity and reducing ecological degradation. Though it is widely practiced for commercial crops in developed countries, it is still at a nascent stage in most of the developing countries. The study on precision agriculture has already been initiated in India, in many research institutes, such as Space Applications Centre (ISRO), MS Swaminathan Research Foundation, Chennai, Indian Agricultural Research Institute, New Delhi, Project Directorate of Cropping Systems Research, Modipuram. In coming few years PF may help the Indian farmers to harvest the fruits of frontier technologies without compromising the quality of land and thereby turning the green revolution into an evergreen revolution.
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