ISSN 2250-3153

IGDSS - Applied Technology at the Grassroots Using Satellite imagery and Mobile GPS at village level for on-site plot level Crop-Mapping

Vinit Raskar

Watershed Organization Trust (WOTR), Pune, India

***Abstract*-** Acquiring trustworthy information on crop type and production is very essential for developing countries like India as agriculture is considered as the backbone of its economy. Comprehensive, reliable and timely information on agricultural resources is very much necessary. Though there are numbers of methods for estimation of crop type and production, each method has its own strength and weaknesses. Apart from crop type, associated information is also equally important to understand the reasons behind farmers' cropping decisions. Though accurate crop data is important for agricultural planning this methodology is may help us in agricultural as well as economic planning. Crop data generated by government agencies used to prepare a catalog of crop information such as Name of crop, area under crop, variety. Traditional methods of crop data collection may not provide reliable information. Use of high resolution satellite images along with geospatial tools and mobile GPS in crop mapping gives a better idea about cropping variation in a particular season along with their spatial distribution. On-site updation of data provides for real-time accuracy.

***Index Terms*-** GIS, Mobile GPS, Satellite image

I. Introduction

Agriculture surveys are conducted by government in order to gather information and statistics on crops and other related agricultural resources. This data is most important for the taking of effective management decisions. GIS application in agriculture plays a vital role throughout the world by helping farmers to increase production, reduce costs, and manage their land more efficiently. Mapping individual crops, and their associated information at plot level plays an important and significant role in understanding cropping pattern of the area. Adopting such a kind of technology in agricultural survey helps in building definite databases on seasonal cropping patterns. Efficiency in agriculture can thus be augmented by using Remote Sensing and GIS.

II. Objective

1. To develop a methodology aimed at obtaining sesaonwise plot level crop data using High resolution satellite image and mobile GPS.

2. To arrive at realistic spatial distribution information and area estimation of crops in a village.

III. Data and software used

This method involves pre-field work database generation. To map plot level data, high resolution satellite images was needed. For this survey, cartosat stereo images were used. To identify plot data on ground ArcPAD software was used with Garmin M10 asus mobile GPS. For database generation, processing and analysis purpose ArcGIS 10 software was used.

IV. Methodology of On-site Crop mapping in the field

Step1: Toposheet of selected area is georeferenced. Using this georeferenced toposheet, cadastral map of village is rectified. At the time of rectification, google earth is used for reference to maintain better accuracy. Then *gat* (survey) numbers are digitized from georeferenced cadastral map.

Step2: Cartosat image is georeferenced using selected ground control points (GCP's) from the village. These points were major drainage lines, intersection of roads, waterbodies etc.

Step3: The village map is then overlaid on cartosat image to get the actual village area. The village area is then extracted from satellite image using clip tool of ArcGIS software.

Figure 1: Clipped Cartosat image for village Kauthe Khurd.

Step4:-To map plots, shapefile is created with name "Village plots". Then plots were digitized from satellite image. Here, major farm bund was taken as plot. All such farm bunds in village are digitized.

*Note: - Plots are different from *gat* numbers. One *gat* can have more than one plot.

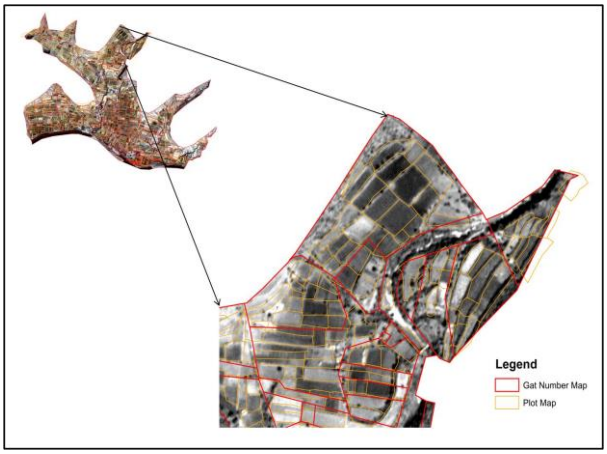

Figure 2: Plots demarcated from Satellite image and plots in gats.

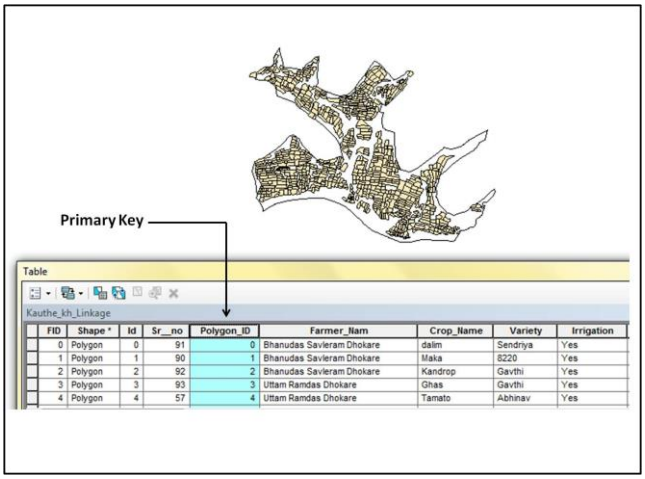

Figure 3: Geodatabase linked to Plot shapefile keeping polygon ID as a Primary Key.

Step5: After digitizing all the plots, a unique plot ID is assigned to each plot. Shapefiles of village gat, village boundary and village plots are then transferred on mobile GPS. Care has should be taken that all shapefiles should be in the same projection i.e. UTM.

Step6: The field investigator with the help of mobile GPS starts locating plots in the field. The investigator clicks on the GPS pointer fixed on the screen to get plot ID and notes it down in data down.

Step7: To get information of plots, field investigator needs the help of a local resource person from the village. This resource person accompanies the field investigator throughout the survey and helps in coordinating the interaction between the investigator and the farmer whenever required.

Step8: During this survey, investigator collects plotwise information on various parameters like plot owner, crop name, crop variety , whether plot is irrigated or rainfed, source of irrigation, method of irrigation, group or individual irrigation, fertilizers used, approximate production, rationale for crop selection, market places, and proposed crop planning.

Step9: It may so happen that the whole plot is not cultivated. i.e. plot may not be equal to cropped area. If the actual the cropped area is less than the plot area, then the investigator records cropped area and fallow area separately.

Step10: Information is thus collected for all plots in a village. This information is then transferred into a geodatabase format to bring the database onto the GIS platform. Using basic tools in ArcGIS, geodatabase is linked to each plot of shape file using "Plot ID" as primary key.

Step11: This database linkage is temporary. To make it permanent the shapefile has to be exported into a new shapefile again.

Using this shapefile various thematic maps can be generated based on different attributes.

Spatial Analysis based on linked plot data

The process of examining the locations, attributes, and relationships of features in spatial data through various analytical techniques in order to address a question or gain useful knowledge is known as Spatial Analysis. It extracts or creates new information from spatial data. (ArcGIS 10, help)

Spatial analysis plays crucial role getting information on spatial distribution of various parameters from plot data. New information can be created using spatial query set. (Fig.4 shows the distribution of plots owned by farmer "Shantaram Dhokare").

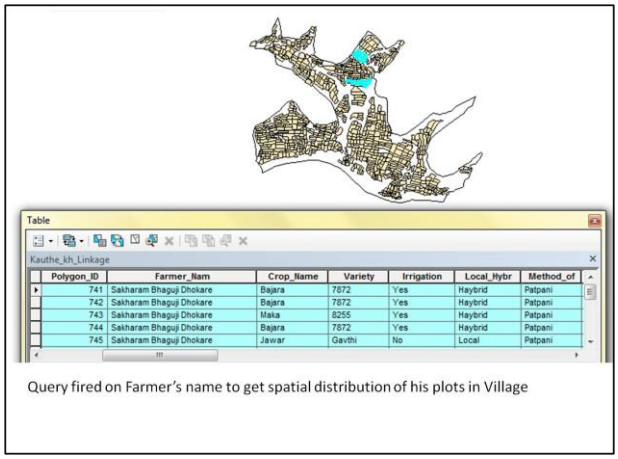

Figure 4: Highlighted plot shows the result of the query asked to linked plot data.

A definite, layered, attributed database can thus be generated.

V. ADVANTAGE OF THE METHODOLOGY/SURVEY

1. As plot mapping is done from satellite image before field work, investigator does not need to walk around the plot for mapping. If topography is undulated and investigator is not able to walk around the plot then he/she can simply click on the pre-

defined plots on Mobile GPS to get plot ID. This saves much time in the field.

2. Large amounts of data can be efficiently and accurately collected and processed in a very short time (eg. 200 plots/day). This reduces cost and brings down the overall budget of survey.
*Note: - Labor cost includes per day charges of resource person and field investigators

3. If some trouble occurs in GPS in the field, there are no chances of data losses, as the Plots are already saved in shapefile format.

4. As this is on-site mapping and field investigator physically verifies each plot so there are very less chances of data duplication.

5. Plot generation from satellite image is a **one time activity**. Same plot shapefile can be used to map crops of different seasons over the years.

VI. Validation of the Survey

This survey is totally field based, depends on local resource persons and field investigators. So, to validate crop survey, 20% sample plots with well spatial distribution in village were selected and those plots were verified in the field using mobile GPS. It was found that there were no gaps in collected data.

VII. Limitations

1. Duration of crop survey for particular season is not fixed, as that may vary due to delay in rainfall and late sowing of crop which may result in missing of data.

2. Image rectification has to be very correct, shift in image leads to shifting in plots. On ground investigator may not get exact plot.

3. One plot may have inter cropping or mix cropping pattern, which needs separate entry. So at the time of data display, there are chances of skipping of inter cropping or mix cropping pattern crop data.

4. GPS battery backup is short, so need to have extra batteries and other accessories to save time and data in the field.

5. This survey is limited to only agricultural plots so data on common property land resources (CPLR) is not included.

VIII. Potential Application Areas

As this survey is related to crop mapping it has many applications. Major applications areas are as follows:

1. Watershed Development

In watershed development, crop monitoring can be done using this method. If this survey is conducted regularly at appropriate point from implementation to completion of a project, plot wise changes can be observed in cropping pattern. These changes can be plotted against treatments undertaken. Thus it can be very effective survey in monitoring and impact assessment.

2. Water Budgeting

Water Budgeting includes calculating water balance of the watershed area and to budget the available water for the planning of monsoon, winter and summer crops. Plot level data of the crops helps us to understand the cropping pattern of the village and can be used to calculate water remaining after each season. Also this data helps us to do crop planning based on previous year cropping pattern and current water availability. This enables the community to plan their village/watershed water resources.

3. Agriculture

It is useful to study the production level of particular crop season wise, also it will be helpful to identify and track the specific variety grown. As soil properties are linked to each plot, assigning hydrological soil groups is possible. Agro-advisories can be then shown spatially.

IX. Areas of Usage

This methodology can meet the needs and requirements of a variety of stakeholders in various types of projects.

1. For Farmers

i. Planning suitable crops
ii. Integrated Nutrient Management
iii. Integrated Water Management
iv. Integrated Pest Management

2. For Government Agencies

i. Identify farmers impacted by crop damage
ii. Total irrigation requirement and water conservation needs in Projects
iii. Estimating crop production
iv. Estimating capacity of storage godowns needed
v. Tentative estimations of revenue collection
vi. Planning location of the markets and *mandis*

3. For Insurance Sector

i. Monitor growth of insured crop
ii. Assess actual crop Insurance
iii. Monitor timely payments of compensations

4. For Agricultural inputs to companies

i. Estimating distribution and supply of seeds to areas to be covered under specific crop
ii. Identifying suitable varieties as per soil and weather data

5. Fertilizer companies

i. Estimating demand and supply of fertilizers
ii. Ensuring timely availability of fertilizers to the farmers

Taking it Forward…

To develop, establish and implement any field based methodology, participation of local people or farmers is very important. As this survey is related to crop and ownership

mapping, there has to be full participation of land owner. The following methodology has been proposed to increase the active participation of farmers in this survey.

1. Demonstration of survey to Farmers

Complete digitized plot map will be prepared using satellite image. From village cadastral map, we will take *gat* numbers. These maps will be shown to farmers. As the farmers know their *gat* numbers they will come to know which plots falling in their gat numbers. To identify plot accurately physical feature map will also be provided to farmers so they will get an idea regarding location of their plots for site association. Once the farmer identifies his/her plot, s/he can provide detailed information about crops in that plots.

2. Data collection from Farmers

With the help of demonstration of survey, farmer will know the spatial distribution of the plots in village. As each plot will be having unique ID, farmer will send the information PlotID wise to field investigator or field investigator will collect the information from farmer. It may happen that farmer is big land holder and may have many plots. In this case if farmer is not able to identify plots then s/he will be taken to the plots and using mobile GPS, plots can be identified. This information will be collected for each season of particular year, so comprehensive database will be generated on cropping system.

3. Validation of Survey

As mentioned earlier, sample plots will be selected to verify the collected data in every season.

X. Benefits of Farmers Participation

1. As the farmer is key person in this survey, he will be aware of what kind of activities are going on in his field. So this can be called as grass-root participative techno survey.

2. There are very less chances of data duplication and along with spatial data, accurate attribute data also will be collected which will improve the data quality and can be used in various domains.

3. It will be cost effective.

XI. Conclusion

Looking at the need of reliable data on crop and their applicability in various sectors there is continuous technological updation is going on. In this case, use of GIS, Remote Sensing and mobile GPS can be an efficient solution. Use of these tools will become mandatory in coming years in agricultural domain as these technologies have been proved most efficient and accurate compare to traditional methods. Use of advanced technology with grass root or local knowledge is always advantageous to get better results and generate trustworthy information. Generating, managing and updating such a kind of database can be utilized for development of Decision Support Systems which will further support Spatial Decision Support System (SDSS) on Crop management.

References

[1] Garmin asus nuvifone M10 Owner's manual

[2] J.Punnithavathi, S.Tamilnethi, and R.Baskaran (2012),"Agricultural concentration and cropwise changes in Thanjavur district, Tamilnadu using geographical information system."

Authors

First Author – Vinit Raskar, Watershed Organization Trust (WOTR), Pune