GENERATION OF INFORMATION BASE ON APPLE ORCHARDS USING GEO-INFORMATICS IN SHIMLA DISTRICT OF HIMACHAL PRADESH

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ABSTRACT:

Recognizing importance of horticulture in promoting livelihood and employment opportunity and bringing prosperity to the state, the Govt. of India has extended National Horticulture Technology Mission Programme to Himachal Pradesh. The objective of Mission is to develop horticulture based farming system that is economically viable and ecologically sustainable using all the modern tools and techniques available. The space technology including remote sensing, Global Positioning System (GPS) and Geographical Information System (GIS) are the advanced tools that aid in gathering and updating information and develop scientific management plans. Updated and accurate database is pre-requisite for systematic planning of horticulture sector be it area expansion, increase in productivity or creating post harvest handling facilities. With this aim, a study was carried out to generate block wise database on apple plantation in Shimla which is the largest apple growing district of Himachal Pradesh. Remote sensing data from the Indian Remote Sensing satellites like IRSP6 has been used along with other international sensors to generate apple orchard maps, orchard conditions in term of density, terrain parameters like elevation, slope, aspect etc. The GIS tools have been used to characterize the orchard distribution pattern in relation to terrain parameters. The final outputs are in digital form amenable to produce maps at different scales as well as statistics as required by a user.

KEY WORDS: apple orchards,Blocks, DEM, Shimla

1 INTRODUCTION

Horticulture crops play significant role in the food and nutritional security of the country. The importance of these crops compounds in hilly and undulating terrains, like Himachal Pradesh where traditional agricultural activities catering to field crops is not economically remunerative and sustainable, while the climate in general is suitable for growing temperate and subtropical fruits. This scenario offers a vast potential for horticultural crops that is yet to be realized. To achieve this, the Government of India has launched the Technology Mission for Integrated Development of Horticulture (Anon, 2000, Negi et al). The systematic and scientific approach is the backbone of this Mission. Better management of the existing orchards/plantations and bringing more area under these crops is one of the methods envisaged under this project. Thus, a holistic approach for apple orchard development plan has been envisaged by the state. This calls for a baseline database of the existing apple orchards in the state. This work has been undertaken to generate such information using advanced techniques like satellite remote sensing, Geographic Information System (GIS) and Global Positioning System (GPS). A number of studies have been carried out in field of horticulture, aiming at identification of crop, area estimation, condition assessment etc. using satellite data(SAC,2001; SAC, 2003)

2 DATA USED

Different type of data viz. spatial and nonspatial were used in this study. The description of data used is given below.

2.1 Ancillary / Collateral Data

The important collateral data used includes:
Administrative boundary of the state, district and blocks, Location of settlements, drainage/rivers etc. and area and production statistics of apple and other important fruit crops of the state.

2.2 Ground Truth Data

Ground truth plan was made based on stratification of the image data, variation in crop signatures, etc. The information and location were noted with the help of maps, image print outs and Global Positioning System.

2.3 Remote Sensing Data

Indian Remote Sensing Advanced Wide Field Sensor (IRS AWiFS) and Indian Remote Sensing P6 Linear Image Self Scanning Sensor(IRSP6 LISS III) are basic remote sensing data used in this study. Temporal IRS AWiFS ((spatial resolution is 55m) data were used to select optimum dates for its identification of apple orchards. IRS LISS III data (spatial resolution is 23 m) were used to map the orchards.

2.4 Terrain data

Terrain parameters are derived using digital terrain model data (DEM). For this, the NASA Shuttle Radar Topographic Mission (SRTM) that provide digital elevation data (DEMs) for over 80% of the globe is used. The SRTM DEM has a resolution of 90m at the equator. The vertical error of the DEM's is reported to be less than 15m.

3 METHODOLOGY

3.1 Selection of optimum data

The Ancillary information on the crop phenology / calendar and the local vegetation dynamics as well as temporal data of coarse resolution sensors like AWiFS that corresponds to different growth stages was used to select optimum period for selecting optimum bio-window for apple orchard delineation. It is observed that May end data was most suitable for identifying apple orchards and derive vegetation vigour variation within the orchards. Multidate IRS AWiFS data of the area were used to monitor the dynamics of vegetation areas like forest, agriculture, and apple orchards and to select the optimum bio-window for apple identification. IRS P6 LISS III data were used for block level mapping of orchards. The district, block, were digitized in GIS environment. The block boundary was overlaid on the image to extract the boundary mask.

3.2 Geo-referencing, Image stacking and Database

Since, satellite data from many sources with different spatial resolution was used, UTM projection system with WGS84 (earth model) was used as referencing scheme. One date from the set of LISS III data was considered to be the master image and was geo-referenced using GCP's (Ground Control Points) from 1:50,000 Survey of India toposheets. The data of other dates were registered to the master image using image-image GCP's. The image-image registration was done with sub-pixel (<0.5 RMSE with second order polynomial) accuracy. The digitized district and block boundaries were overlaid on the image database. The ground truth data on orchards collected using GPS and maps were overlaid on images with attributes on orchard characters. The digital forest map at 1;50, 000 scale of FSI was used to identify the forest classes.

3.3 Classification

A two step classification approach has been used to map the apple area. In the first step, a non - vegetation classes has been masked using Normalized Difference Vegetation Index (NDVI) thresholding. The exact values of NDVI for thresholding can be known with the help of satellite data and ground information.

$$NDVI = (NIR - R) / (NIR + R)$$

After masking non – vegetated area, unsupervised classification technique (ISO data clustering), is used to carry out preliminary orchard inventory. The known ground truth sites were used to assign clusters to orchard classes. Thus, a preliminary mask of orchard area was created. This was used for detailed ground truth data classification.
Final classification was carried out using the maximum likelihood supervised classification using known ground truth data. Efforts were made to use as many class variations so as to reduce the number of unclassified pixels and achive at least 90 per cent classification accuracy.

3.4 Density/Vigor Categorization

NDVI (Normalized Difference Vegetation Index) was computed for orchard classes from NIR and Red bands using the following relationship.

$$NDVI = (NIR - R)/(NIR + R)$$

Where, NIR and R are DN (Digital Number) values in Near Infrared and Red bands, respectively.

3.5 Characterization of Growing Environment

Some of the horticultural crops like apple orchards are concentrated in hilly terrain of higher elevations due to the physiological requirement of cool temperature of the crop. Thus, slope, aspect and elevation are some of the deciding factors for orchard condition and productivity. Incorporation of this information also improves the classification accuracy through logical decision rules.

Digital Elevation Model (DEM) generated was used as a image channel to and orchards were further characterized on the basis of slope, elevation and aspect of orchards, using logical modeling. The final orchard area has been calculated after labeling all the classes and merging them into major classes based on density or some logical merging. The acreage under each class was estimated, and their class accuracy can be assessed. Orchard maps were generated and hard copies were taken at desired Scale.

4 RESULTS AND DISCUSSION

4.1 Area

Shimla is a major apple growing district in the state having 376.30 Sq. Km. area. Shimla district has 8 administrative blocks. Jubbal Kotkhai is major apple growing block with little more than 21percent share of orchard area of district. The other major blocks are Rohru, Narkanda and Theog. Block wise orchard area estimated using remote sensing data is shown in table1.

Table-1 : Apple area (in Sq Km.) in Shimla district and its blocks.

S. No.	**Block/District**	**Apple Area** (Sq. Km)	**% of Apple area of district**
1.	Jubbal-Kotkhai	79.42	21.1
2.	Rohru	61.42	16.32
3.	Narkanda	53.73	14.28
4.	Theog	45.97	12.21
5.	Rampur	40.66	10.8
6.	Chopal	38.19	10.15
7.	Chirgaon	35.52	9.43
8.	Mashobra	21.36.	5.67
	Shimla Dist.	**376.30.**	

4.2 Density

Most of apple plantation in the district belonged to dense or moderately dense category. Narkanda and Rampur blocks have highest percent of dense category (40%) orchard area of block. Figure 1 shows blockwise distribution of apple orchard density.

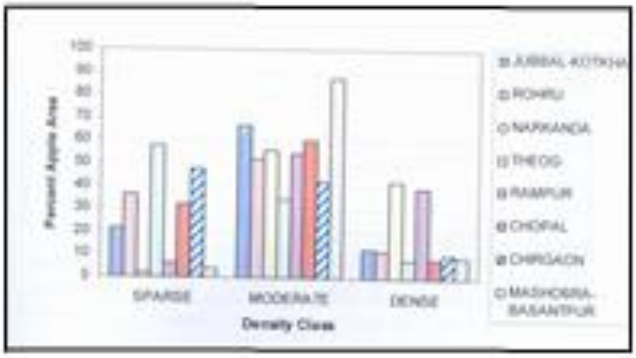

Figure 1 : Apple orchard density in Shimla

4.3 Elevation

Elevation range 1500-2500m supports majority of apple plantation as shown in figure 2. It is observed that in all the blocks at least 50% of block level apple area falls in elevation range 2000-2500m.

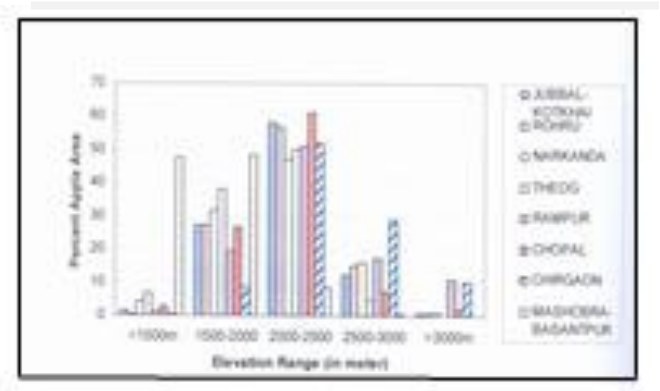

Figure 2 : Apple orchard at different elevation range in Shimla district

4.4 Aspect

Nearly seventy percent apple grows on hills having North-East and South East Slopes. Blockwise distribution is shown in figure 3.

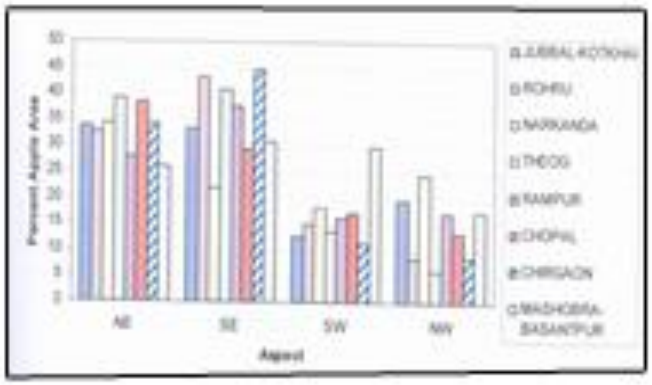

Figure 3 : Apple orchard in different aspect direction in Shimla district

4.5 Slope

Majority of apple orchards (62.5%)are located on slopes, 21-40^0. Blockwise distribution is shown in figure 4.

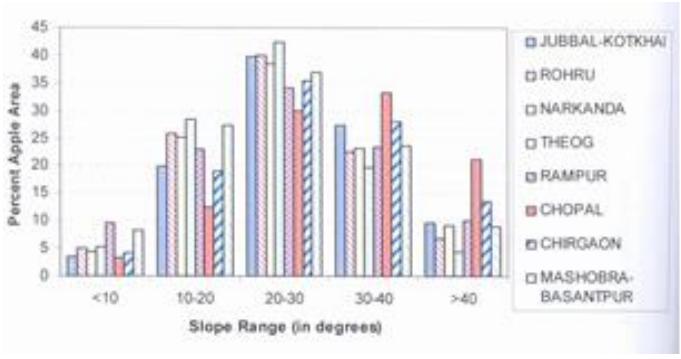

Figure 4 : Apple orchard at different slope range in Shimla district

The maps showing distribution of apple orchards and apple orchards in relation to elevation is shown in figures 5-7.

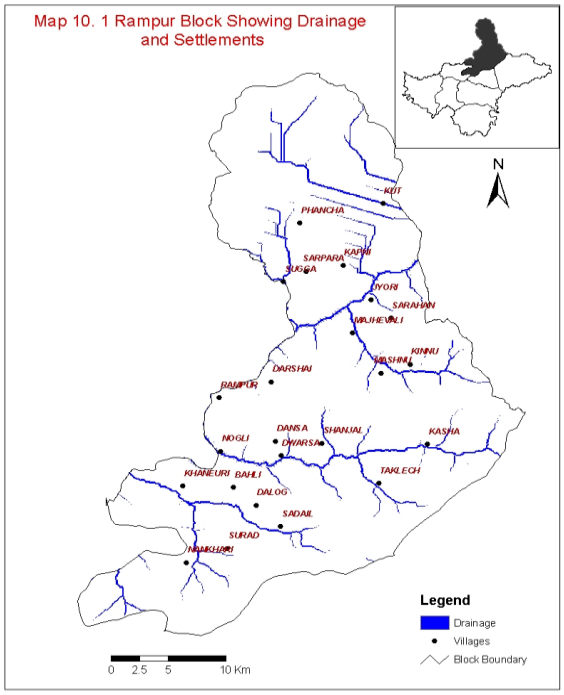

Figure 5: Rampur Block showing drainage and settlement

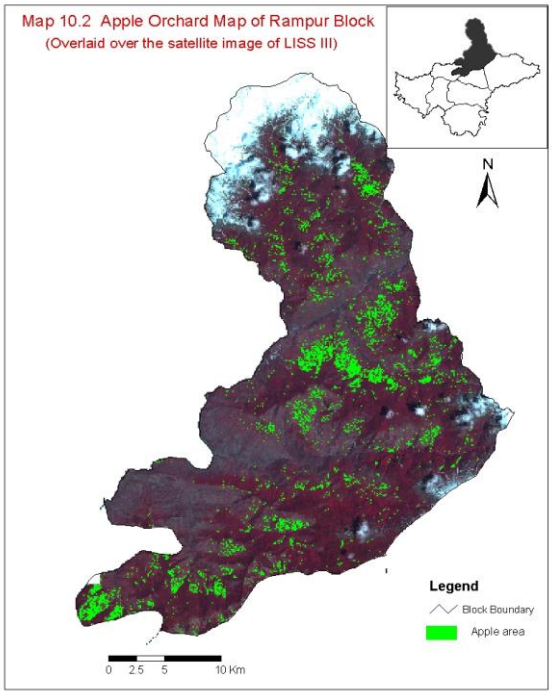

Figure 6: Apple orchard map of Rampur

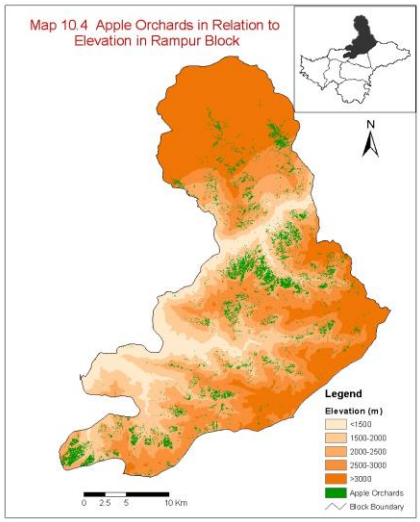

Figure 8:Apple orchards in relation to elevation in Rampur Block

CONCLUSIONS

Apple orchards have been mapped using high resolution remote sensing data from most advance Indian Remote Sensing (IRS) satellite P6. More than ninety percent accuracy has been achieved using remote sensing data acquired during May and following a multistage classification algorithm. Normalized Difference Vegetation Index (NDVI) has been used to categorize orchards into three classes: dense, moderate and low. Accuracy of dense and moderately dense

orchards has been matched with field observation with 95% accuracy. The digital elevation model derived using satellite data has been found very convenient to relate the orchards with terrain parameters. The salient results obtained are:

- Shimla is major apple growing block having 376.30Sq. Km. area under apple orchards.
- Elevation range 2000-3000m and Slope 21-40^0 is supporting majority of orchards in Shimla district.
- Narkanda block in Shimla district has large and contiguous pockets of dense orchards.
- The terrain parameters indicate that dense orchards lie in elevation rangeof 2000-3000m.Thus these sites can be used as reference sites to standardize site suitability and management plan of apple orchards. Since the density matched well with the age of the plantations, sites belonging to dense category may be ones need planning for rejuvenation. There is large scope of improving the production through development of sparse orchards.
- Around 26% of orchards belonged to sparse category in Shimla district.

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