Cashing in on g-tech in sugarcane prediction

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Sugarcane is a major cash crop in India. Considering its importance in agricultural economy of the country, it is critical to predict the crop correctly prior to the season to aid effective policies that can benefit all the stakeholders of the sugar value chain. Industry body ISMA (Indian Sugar Mills Association) has demonstrated the significant role of geospatial technology in arriving at such predictions

Sugarcane is a major cash crop in India and is grown across 13 states in tropical and sub-tropical zones of the country. India, on an average, produces about 340-350 million tons of sugarcane with 23-25 million sugar every sugar season. The Indian sugar industry is estimated at about USD 13 billion with about 700 odd installed units; however only about 530 are currently operational. India is the largest consumer and the second largest producer in the world, after Brazil. Its consumption, however, is only about 20 kg per capita, against world's average of 25 kg per capita, but India also consumes a lot of alternative sweeteners. Moreover, India has a capacity to export about 4-5 million tons per sugar season. Looking at the importance of sugarcane in agricultural economy of country, it is always critical to predict the crop correctly prior to the season, so as to make true representation in front of various federal bodies for timely policy interventions for the benefit of all the stallholders of sugar value chain.

Sugarcane crop surveys have been conducted throughout the country since decades, in order to gather information on associated statistics like crop acreage, yield estimation, crop health, harvest and other related agricultural issues. This information or datasets are important for the implementation of effective policies and decision support system in sugar and allied sectors in India. Such surveys are the backbone for planning and allocation of limited resources for the crops. Considering the importance of such timely, accurate and authentic data information, Indian Sugar Mills Association (ISMA) decided to undertake the project of sugarcane crop acreage and harvest reporting at country level. It was intended to supplement the current estimation system with technology-based assessment through satellite mapping. This way, the sugar industry body will not only help the sugar industry to know the sugar production data estimation / harvesting status more accurately but

also concurrently suggest government departments to take timely policy decisions in favour of sugar sector for its various stakeholders.

Satellite mapping

Remote sensing is an effective means to get reliable information about a spatially explicit object without being in physical contact with it. It is the observation of the object by a device separated from it by some distance utilizing the characteristic response of different objects to emissions in the electromagnetic (EMR) spectrum (Figure.1)

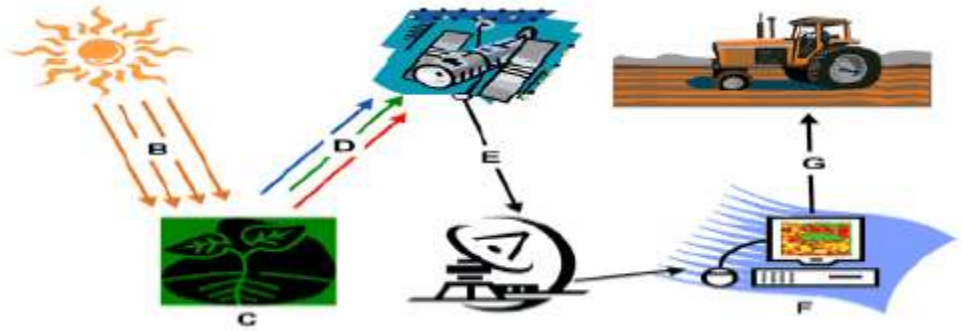

Figure 1: B is the EMR received from the Sun which is either absorbed or reflected by vegetation; D is the reflected radiation detected by sensor aboard satellite; E is the data transferred to ground station; F is the data being analyzed and information generated; G is the process of using the information on field for decision support.

Such type of surveys and creation of maps is typically known as satellite mapping. Some of the advantages of satellite mapping are:

- Rapidly collecting data over large areas as well as isolated patches with ease and quickness.
- Provides a generic understanding based on spatial distribution pattern of land cover and land use with defined accuracy
- Cost effective and near real time information extraction and dissemination
- Ease of data management and analysis

These advantages clearly spell out the need and urgency in the era of technological advancements to get accurate timely information based on technical modeling substantiated by ground truthing.

Satellite mapping is prominent in most of the sugarcane growing countries like Brazil, Thailand, Australia, USA etc. Their cropping pattern and technological advancements help them to predict the crop well in advance which not only helps these countries in predicting marketable throughput – surplus / deficit, but also timely dissemination of crop management adversity system to growers.

In India, lot of individual mills and trading houses in sugar sector have tried to conduct acreage estimation, but faced issues in correctly estimating and

implementing the sugar production, projections based on acreage estimation by satellite mapping. The basic issues with satellite mapping in the Indian context are:

- Mixed cropping pattern with sugarcane crop like wheat, mustard, onion, garlic.
- Sugarcane crop signature on satellite images look similar to maize, wild grass, plantation like poplar, banana etc (in early stages).
- Package of practice differs not only in zones but even in same district, same village or even in same field, which gives different crop signature (even among same variety).
- Different varietal composition and different period of sowing across zones in tropical and sub-tropical region.
- Lack of technical know-how and agricultural aspects i.e. selection of correct satellite images, past correct data, cropping pattern etc.

Taking cue from the practical experiences, ISMA tried to develop an indigenous model on satellite mapping to suit the Indian sugarcane planting pattern. A combination of GIS software, image analysis software and location based data (GPS), have been tried and tested over the last three years and it was realised that the use of remote sensing technology can produce accurate results in vegetation mapping. Remote sensing satellites capture and store the ground features as infrared images. In India, National Remote Sensing Centre provides high-resolution satellite images or they liaison with international agencies, if a specific requirement arises. Remote sensing captures reflectance of objects in various bands using infra-red (IR). These values are then processed using image processing software to map the regions in the map. Basically there are 4-7 bands based on different satellite sensors and agriculture mapping requires a minimum of four bands, green, red, near IR and far IR. Combining the images creates a false-color image which is the most ideal one for software. A true-colour image can be created which gives an image which closely resembles a real scene. Different plant species reflect light in various ranges. A ground truthing is done at this stage to find out the reflectance value of the given area where sugarcane cultivation is present. A number of spectral signature classes are created to do analysis on the image. The result of the image is again classified into stages to show different growth stages of sugarcane. A ground truthing is again done to fine tune which in turn increases the accuracy of the output.

Based on satellite mapping fundaments, ISMA firstly used theory of elimination, to get vegetation maps of targeted areas which comprises of all green vegetation including all crops / plantation / forests etc with past archive images for comparison elimination among vegetation. Once the vegetation index on satellite images was zeroed in, it was segregated into sugarcane and look-alike crops signatures. Then,

hybrid satellite images e.g. Liss-3 + Aster or AWiFS + Liss-4 (the sensors in satellite with the resolution like Liss III – 23.5 m; Liss IV – 5.8 m; AWiFS – 56 m; Aster – 15 m) were used for complete acreage estimation with minimum error % on acreage estimation in comparison to actual ground situation.

However, combination of images helps in getting more clarity on areas having mixed cropping pattern. Concurrently, archived images of last few years were used, so that through 'time series analysis', different crops could be segregated on their period of sowing and harvesting basis. Once the preliminary report on acreage was obtained, it was cross checked with actual field reports and wherever conflict arose, it was eliminated with ground truthing, along with sugar mills. Ground truthing was done with GPS survey by collecting the random crop signatures on the field for comparing and removing the conflict areas. In initial years, we kept ground field reports as a benchmark to develop satellite mapping baseline data sets.

This is the first time that surveys have been carried out, state-wise and district-wise for the sugarcane area, through satellite mapping in India on such a large scale. Sugarcane acreage has been estimated on a detailed analysis of the satellite mapping.

Benefits

ISMA has been undertaking satellite mapping for three years i.e. 2011-12/ 2012-13/ 2013-14. The process uses high resolution remote sensing coupled with GIS. With over 2 lakh crop signatures collected at various crop growth stages from different locations, ISMA is today capable of delivering very high accuracy data on acreage, quality of crops, spatial distribution, water availability and topography. ISMA has also undertaken studies to see the interdependence of various datasets, for instance some ground breaking studies have been done to analyse the relationship of quality of crop vs. crop height at which it is grown; slopes vs field aspects are also being researched in relation to crop health. Critical data on flooding trends and flood disaster mitigation have also been studied for selected mills with great success.

ISMA has continuously been on research to cull out the variations of ratoon signatures with that of normal crops, so as to provide more insights into the data. All these research aspects have opened up new avenues and will help in providing more accurate and advanced information to the mills. With the advanced scientific modeling done over the last three years, ISMA aims to make more and more data available to the mills in the years to come, so that strategy call on mill management can be taken with back-up of scientifically based data sets.