Crop Production Forecasting

Dr. V. K. Venugopal
Former Professor & Head
Department of Soil Science and Agricultural Chemistry College of Agriculture, Vellayani
Consultant, Digital University Kerala

CDIPD
CENTRE FOR DIGITAL INNOVATION AND PRODUCT DEVELOPMENT
(A centre of excellence established by Digital University Kerala)
www.cdipd.duk.ac.in
DIGITAL UNIVERSITY KERALA
Curating a responsible digital world

Areas covered

- Includes identification of crops, acreage estimation and forecasting yield.
- Unique spectral reflectance characteristics of each crop helps in identification and discrimination.

Spectral response of a crop canopy is influenced by

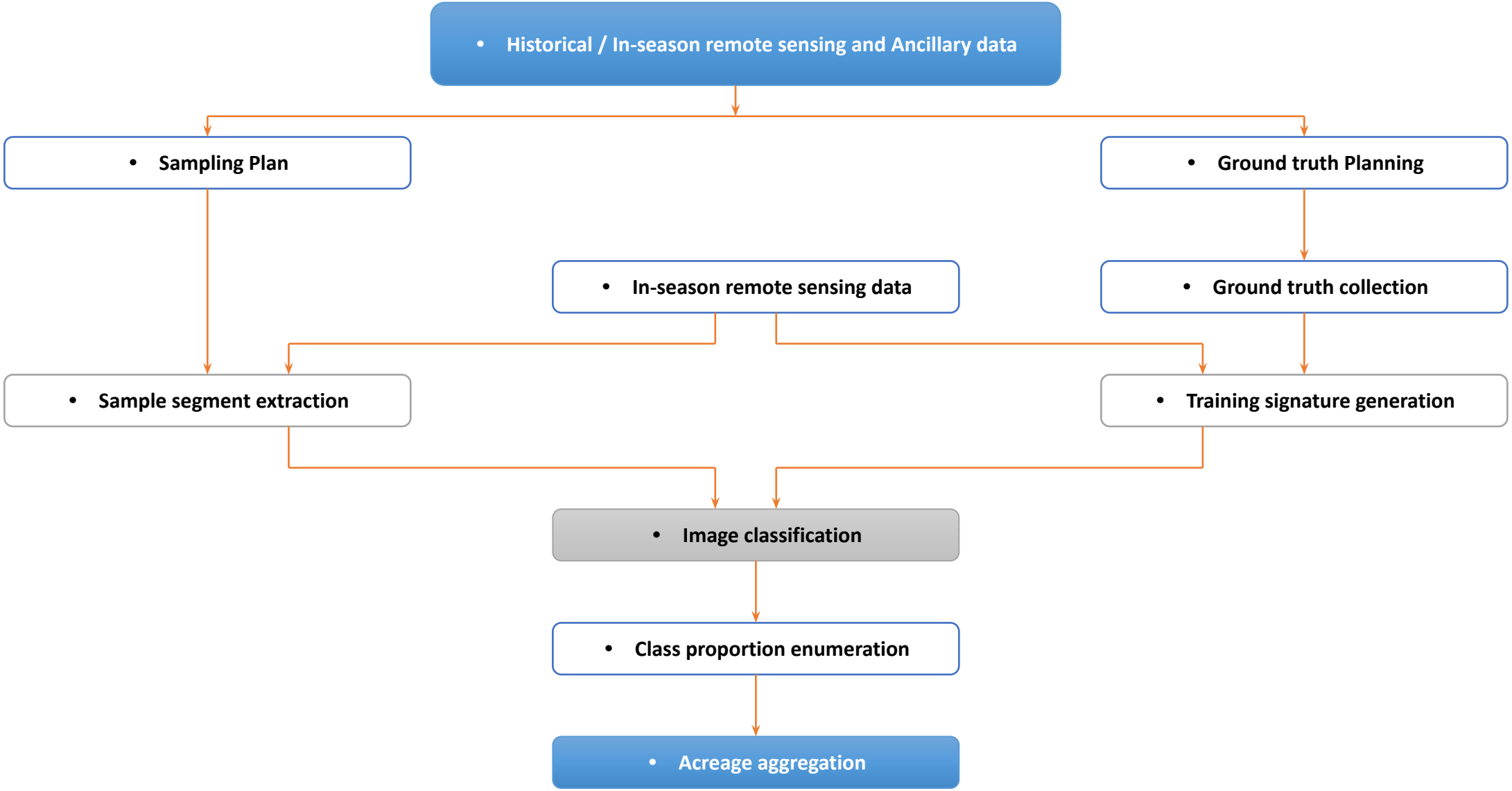
- the leaf-area index (LAI) and per cent ground cover
- Growth stage
- Differences in cultural practices,
- stress conditions
- canopy architecture.
- Each crop has its own architecture, growing period, etc., thus enabling discrimination through RS data.
- If two crops has unique spectral signature, multidate / temporal data can be utilized for discrimination

Acreage estimation

- Broadly consists of identifying representative sites of various crops / land cover classes on the image
- Based on Ground truth collected
- Generation of signatures for different training sites
- Classifying the image using training statistics.
- The above procedure utilizes the slight differences in the spectral signatures of different crops and Hence it depends on the digital image processing techniques.
- Most of the work carried out so far has single-date data corresponding to the near maximum vegetative growth stage of the crop
- For analyzing large areas like state requires handling of large volume of data, larger efforts in ground truth collection,etc

- **Based on the crop concentration statistics, agrophysical and or agroclimatic conditions, the study area is divided into homogenous strata and sample segments from each stratum are analysed.**
- **For digital data analysis, generally ten per cent of the total population is used.**
- **During the Kharif season, the availability of cloud free data of optical sensors are difficult and thereby the potential of microwave sensor operated in C-band is utilized for acreage estimation and crop monitoring**

Methodology Acreage Estimation – Flow Chart



Yield forecasting

Yield is influenced by a large number of factors

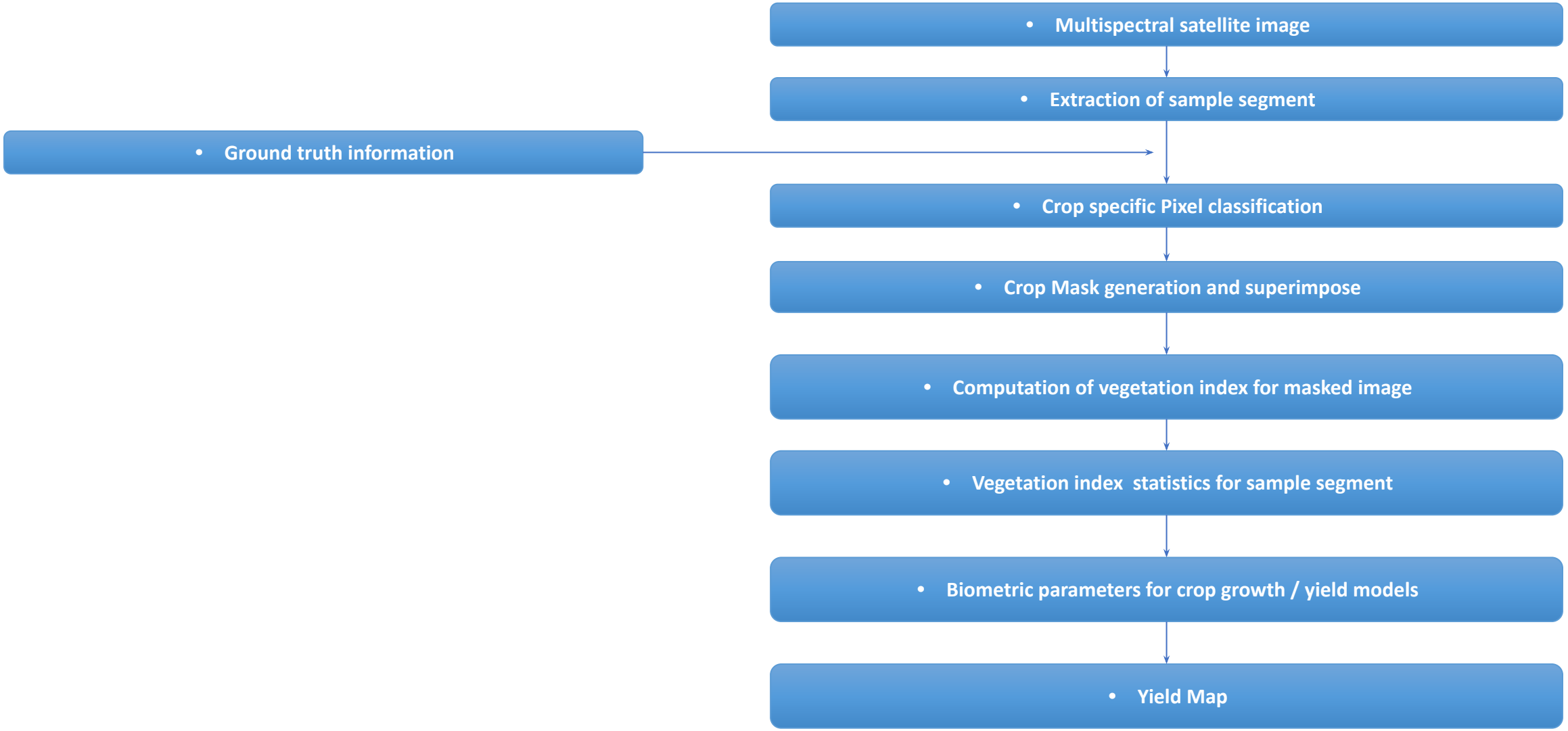
- Crop genotype,
- Soil characteristics,
- Cultural practices adopted (e.g. irrigation, fertilizer)
- Weather conditions
- Biotic influences, such as weeds, diseases, pests, etc.

  - Spectral data of a crop is an integrated manifestation of the effect of all these factors on its growth.

Approaches adopted for yield modeling using RS data area

- **Remote Sensing data or derived parameters are directly related to yield**
- **Remote Sensing data is used to estimate some of the biometric parameters, which in turn are input parameters to a yield model.**
- **Spectral index of the crop canopy (NIR / Red, Greenness index (Green/Red+green+blue), NDVI) at any given point of time reveals the crop growth and its decay as affected by various factors in the time domain**

Methodology : yield forecasting – Flow chart



Estimation of Acreage & Crop Production of Soya bean through Remote Sensing & GIS Case study in Madhya Pradesh

- Soybean is a major agricultural commodity which is being exported from India,
- Prior knowledge of the expected acreage and production of soybean is very important for planning purposes for exporters and government

Exporters require data on:

- Produce of soybean that would be available for export
- Base price that can be fixed based on supply and demand
- Time by which the soybean may reach the Mandi/Market

Government requires data on:

- Total acreage of soybean in the state, Expected yield of soybean
- Total expected production of soybean during the current year

Traditional methods

- Traditionally methods extremely tedious job involving extensive travel and various interpolation methods based on the sample taken.
- Cumbersome, costly,time consuming , too generalized and not fully reliable..

Remote sensing methods

- yield of soybean crop is directly related to the NDVI values of soybean calculated using optical image.
- the yield of soybean crop for Kharif season,2007,by comparison and correlation of NDVI and Yield values for the years 2005, and 2006
- Entire cropped area is taken into account and not based on sampling sites
- No spectral signature in form of GPS attribute available for historical years,
- Ancillary crop acreage data collected from state government or other agencies, and general NDVI value ranges for each crop type, has been used for classification of different crop types.
- provides an alternative, accurate, fast and economic method of acreage estimation and yield prediction

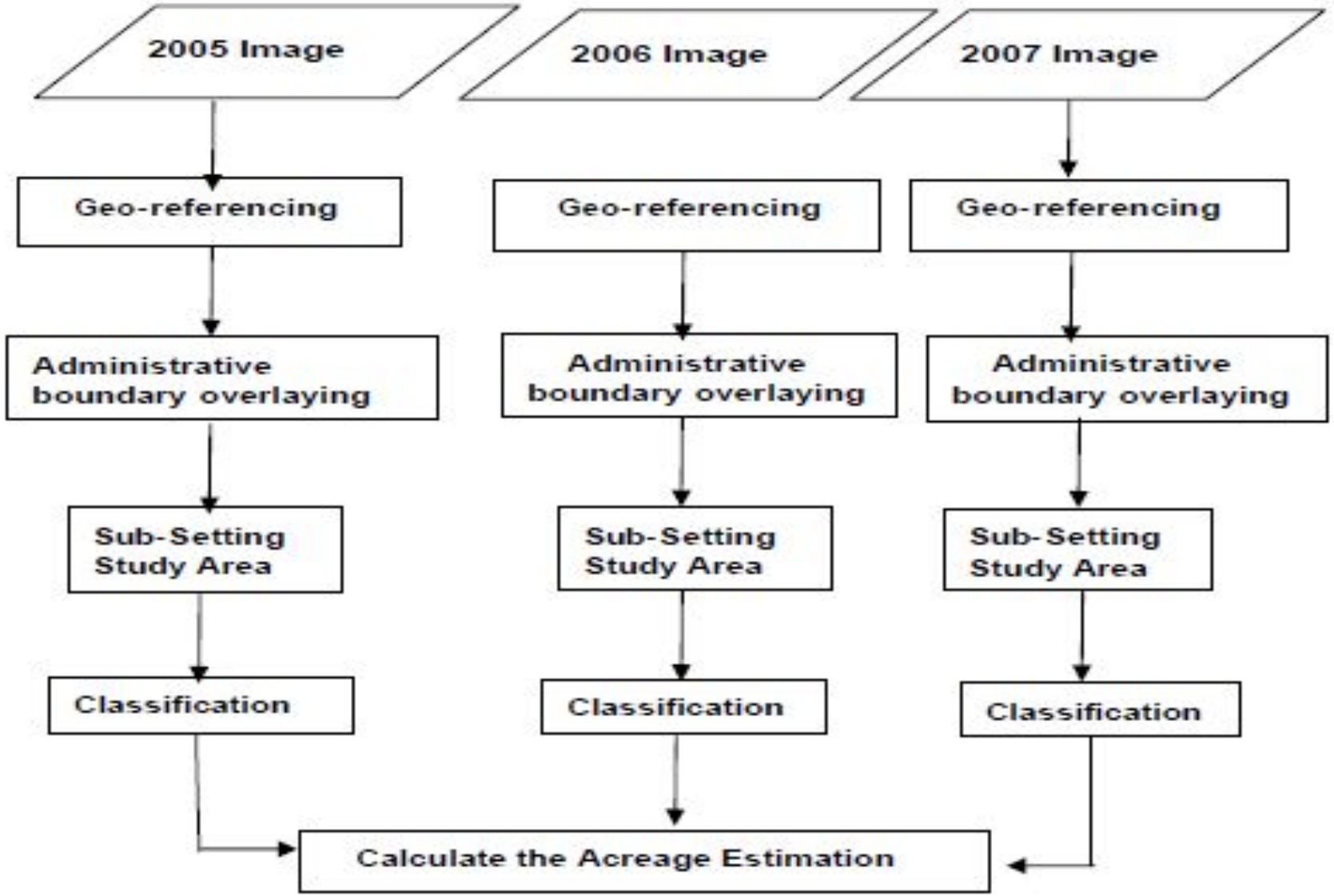
Methodology

- Selection of the datasets, processing of the satellite data,
- Incorporation of ground information,
- Analysis of the satellite data,
- Generation of the output products.
- Images of the following dates are used, 1 June, 19 July, 23 August, 2 September and 1 October 2007, 2006, 2005 dates images.
- First June data is pre-cultivation data,
- 19th July,23rd August and 12th September show growing period and 1st October mature stage.
- 19th July, 23rd August and 12th September also show mixed crops in various growing stages,

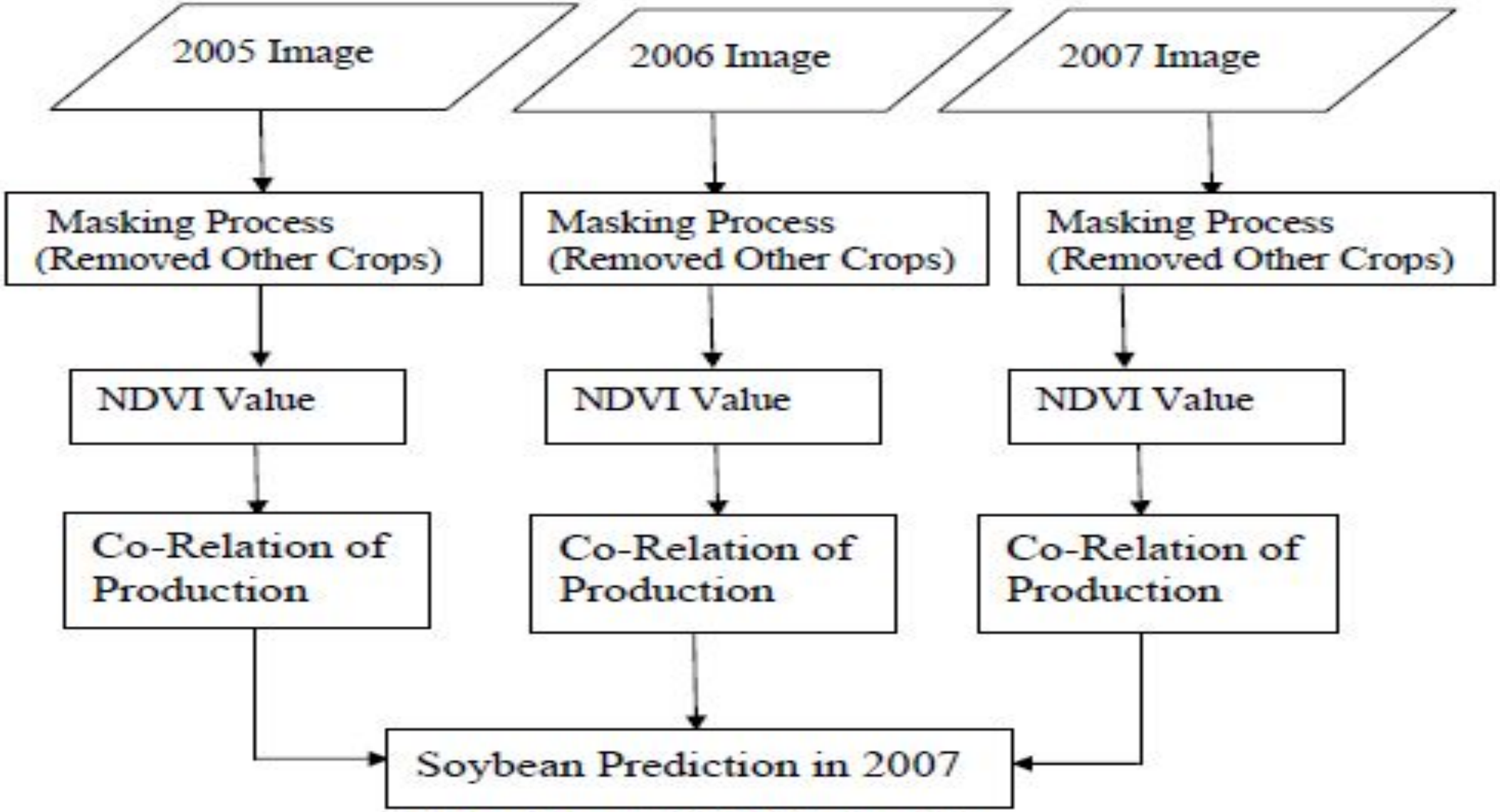
- 1st October image only soybean is depicted as other crops have been harvested.
- Images of soyabean growing areas in its mature stage for three successive years.
- NDVI on all the october images (2007,2006,2005). was compared the scene average NDVI values for individual districts over the years, to get the predicted yield of soybean.
- Hybrid classification techniques were used to show the spatial distribution of soybean in the different districts of the study area.
- This included classification of multi-temporal satellite images using unsupervised, supervised and time series based techniques

Acreage Estimation

- District wise acreage estimation of Soybean was done by using the following mathematical calculations-
- Area in meter =Numbers of pixels of clusters * Resolution of the image
- Area in hectare= Area in meter2 / 10000
- For MODIS - Area in meter2 =Numbers of pixels of clusters * 250*250



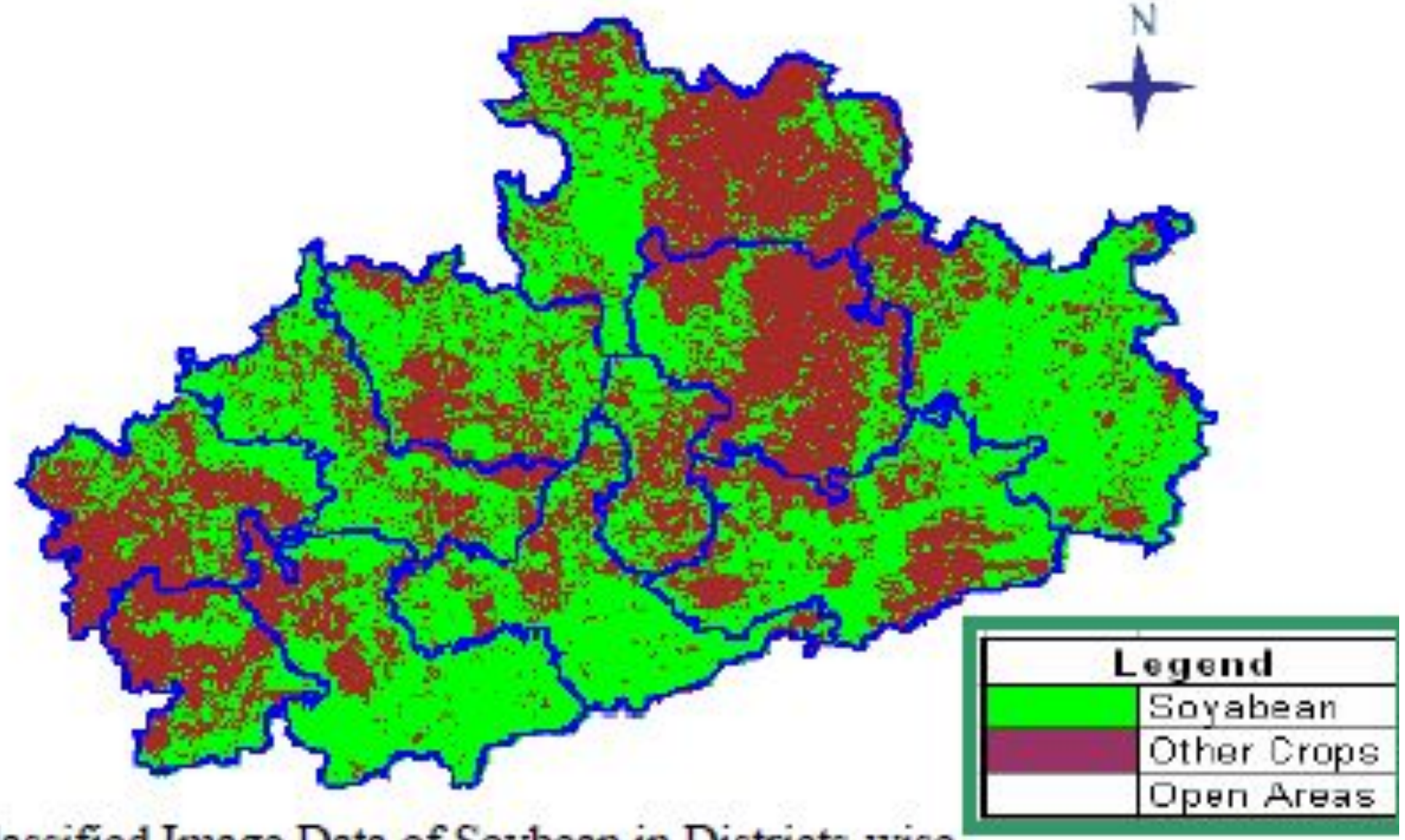
Flow Chart of Acreage Estimation



Flow Chart of Yield Estimation

Method adopted

- Yield and prediction for the different districts of the study area
- Crop yield was calculated by comparison of the NDVI** values of Soybean for the years 2005, 2006 and 2007
- Appropriate cloud free satellite images during the heading stage of the soybean crop were selected for all the three years.
- These appropriate satellite images were then masked with the map showing the spatial distribution of soybean for the corresponding satellite images for the respective year
- Further NDVI was calculated for all the three years.
- Statistical analysis was done between the NDVI values and Production values of Soybean for the years 2005 and 2006.
- Correlation factor was formulated between the NDVI and Crop yield was used to predict the Yield of Soybean for the year 2007, based on the NDVI value of Soybean for the same year 2005



Resulted Classified Image Data of Soybean in Districts-wise

RESULTS

- **The total acreage of soybean estimated using RS and GIS techniques in the different**
- **Major districts of Madhya Pradesh is 26.5 in Lakh ha.**
- **Ujjain>, Shajapur = Sagar> Bhopal**
- **Satellite based estimation of crop yield shows an average yield of 844 kg/ha for all the major soybean growing districts of Madhya Pradesh.**
- **Indore has shown a remarkable increase in the yield due to its improved farm management practices recorded highest yield followed by by Ujjain and Sagar and lowest by Sehore**

Conclusions

- **Methodology is promising and enhanced the quantitative accuracy of acerage estimation using MODIS-based image classification**
- **It ensured that the soybean cultivation areas were exactly extracted.by analysis of spatial data combined with related MODIS data extraction process, using time series based classification for training samples a fields.**
- **GIS was a very helpful tool to pinpoint the location of potential areas of soybean fields.**
- **The two 250 m bands of MODIS provided moderate spatial resolution and daily observation of the land surface.**
- **Data are well suited for mapping areas of soybean fields and for assessing growth parameters of soybean.**
- **Integration of GIS, MODIS-based image analysis enhances the quantitative and qualitative accuracy of classification of soybean fields.**
- **Methodology proved to be feasible, accurate, repeatable, and fast, since the GIS database and GPS were available.**
- **Range of relative error of classification was small.**


Thank You