E-AGRICULTURE IN ACTION:
DRONES FOR AGRICULTURE

Edited by
Gerard Sylvester

Published by
Food and Agriculture Organization of the United Nations
and
International Telecommunication Union

Bangkok, 2017

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ISBN

Space technology use in crop insurance

EXPERIENCES FROM INDIA

Crop yield estimation at the lowest specified administrative level is the most important indicator in the crop insurance scheme *Pradhan Mantri Fasal Bima Yojna* (PMFBY) of the Government of India for deciding insurance claims. For crop yield estimation, the well-established methodology of Crop Cutting Experiments (CCE) has been in use so far. However, for accurate assessment at lower administrative level (village or village *panchayat* level), the requirement of a huge number of CCE with utmost precision has been a cause of concern as it may not be practically feasible. In the current methodology of yield estimation, the allocation and selection of plots for conducting CCE is based on statistical information and carried out using random numbers. The current year crop situation (area sown and crop condition) is not taken into consideration. This makes CCE plot selection not properly representative of the actual crop situation. Additionally, carrying out such a large number of CCE, as desired under the new crop insurance programme may not be practically feasible. Hence, alternative approaches (such as the one described here) are perhaps the only solutions.

There is a need to optimize the CCE locations using satellite remote sensing data, which not only provide the crop area map, but also indicate the crop conditions. In order to evaluate and validate this a large number of pilot studies were carried out in different parts of the country. During the monsoon or rainy season of 2015, pilot studies were carried out in Kurukshetra, Shimoga, Yavatmal and Seoni districts of Haryana, Karnataka, Madhya Pradesh and Maharashtra states, respectively. During the winter season of 2015-16 two districts were selected in each state: in Haryana, Hissar district and Karnal district; in Karnataka, Raichur district and Gulbarga district; in Maharashtra, Ahmednagar district and Solapur district; and in Madhya Pradesh, Vidisha district and Hoshangabad district. During the winter season of 2016-17 the study was replicated in one block of each state selected during 2015-16, for validation of the approach. The blocks identified for the study were Ratiya of Fatehabad (Haryana), Shorapur of Yadgir (Karnataka), Babai of Hoshangabad (Madhya Pradesh) and Karmala of Solapur district (Maharashtra).

Multidate satellite remote sensing data is used for mapping the particular crop area, with the support of ground truthing. For rice crop, multidate microwave SAR (Synthetic Aperture Radar) satellite data are used, whereas for wheat and other crops multidate optical (visible and near infrared) remote sensing data are used. The examples of SAR satellite are RISAT-1 of the Republic of India, RADARSAT-2 of Canada and Sentinel-1 of the European Space Agency (ESA). Optical data is taken from Resourcesat-2 of Republic of India, Landsat-8 of the United States of America and Sentinel-2 of ESA.

Again, multidate moderate resolution satellite (e.g. MODIS or AWiFS) data are used for computation of remote sensing based vegetation indices, such as Normalized Difference Vegetation Index and Land Surface Wetness Index. These two indices indicate crop vigour and crop water status, respectively. Based on these two indices, the whole district is classified into 4 groups/strata – Very Good (A), Good (B), Medium (C) and Poor (D). The crop map generated from high-resolution satellite data is overlaid on this crop condition map to generate a condition map with respect to a specific crop. CCE points are selected randomly within each stratum, proportionate to the number of pixels under each stratum (Figure 1).

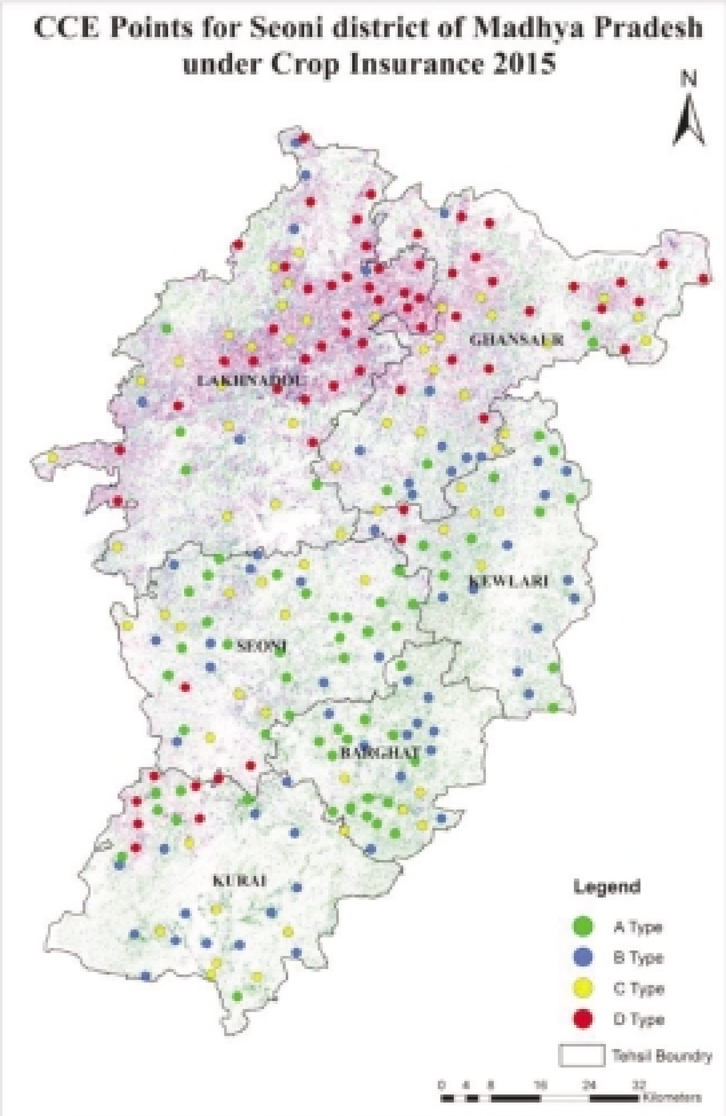

Figure 1. Crop Cutting Experiment (CCE) sites planned based on remote sensing data

The National Remote Sensing Centre, ISRO, has developed an Android app for collecting CCE data, along with geographic location and field photographs (Figure 2).

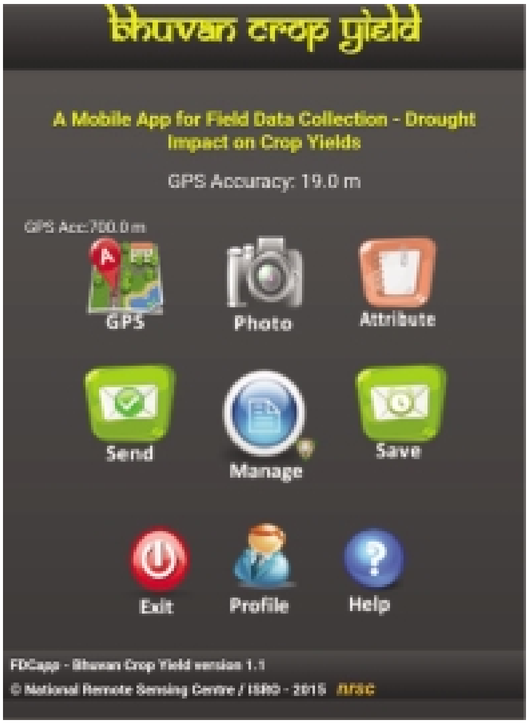

Figure 2. Android app being used for CCE data collection using smartphones, developed by NRSC, ISRO

All the CCE data collected using smartphones are uploaded real time to ISRO's Bhuvan geoportal (Figure 3).

Analysis of this data has shown that CCE planning using remote sensing based indices is statistically efficient and hence it would optimize the number of CCE. Based on the success of these studies, the Karnataka state government used this approach for operational CCE planning during the monsoon season of 2016 and the Odisha state government used this approach, for rice crop, during the rainy season of 2017.

Figure 3. Crop Cutting Experiments data uploaded to ISRO's Bhuvan platform

Also, the guidelines of the country's crop insurance programme, PMFBY, advocate the use of satellite data for optimization of CCE and the use of smartphones for CCE data collection has been made mandatory (Government of India, no date).

The user of this technology will be the state agriculture departments and the insurance companies. However, the farmers will benefit indirectly from this technology, as it ensures more accurate and timely CCE data collection, which is essential for deciding crop insurance claims.

Various factors have contributed to the success of this work:

- the urgent need for improving/rationalizing the CCE;
- the long experience of use of satellite data for crop assessment in the Republic of India;
- the availability of a large variety of high resolution satellite data;
- smartphones have become easily accessible in the country;

- the availability of the Bhuvan Portal for geographical data storage;
- the regular exercise of capacity building of state agricultural department officials by MNCFC for smartphones-based data collection;
- the showcasing of this technology in various forums — seminars, workshops, training etc.

Nevertheless, there are still many limitations in the use of this approach.

- As of now, the operational crop area estimation using satellite data is being carried out for eight crops (rice, wheat, cotton, sugarcane, potato, rapeseed, mustard, jute and sorghum). Hence, the remote sensing-based CCE planning approach is limited to these eight crops, as a crop map is essential for CCE planning.
- Even among the eight crops mentioned above, for some crops (other than cereals) the relationship between remote sensing-based index and crop yield is comparatively poor. In these cases, remote sensing-based CCE planning may not be statistically viable.
- Remote sensing-based CCE plans can only be generated after a crop has reached the maximum vegetative stage. Hence, it provides very limited lead time for its field implementation.
- For the majority of monsoon season crops, getting cloud free optical data is difficult, because of persistent cloud cover during the rainy season. This limits the implementation of remote sensing-based CCE planning.
- Even though there has been a tremendous increase in smartphone use in the country, many field officials do not have access to smartphones. For them smartphone-based data collection is difficult.

Various lessons learned during the pilot studies and the implementation phase are given below:

- there was an overwhelming response by the implementing officials to learn the new technology;
- even with a comparatively lower number of experiments, yield values were statistically very close to the values derived from a large number of experiments conducted in a conventional manner;
- much new information about the crops (such as major variety, major agronomic practices, sowing and harvesting dates, harvest index, stresses) could be obtained from the data collected through smartphones;
- there is a need to use higher resolution satellite data to improve the crop classification accuracy; and
- there is a need to combine the remote sensing-based indexes with other yield controlling parameters, such as soil and weather, to improve the statistical efficiency of CCE planning.

Given the regular improvement in the quality of satellite data being available, and the tremendous growth in various other related technologies (e.g. UAV based imaging, big data analytics, cloud computing, crowd sourcing, sensor networks, Internet of things, artificial intelligence), this approach will also improve further.

The pilot studies have been carried out for different crops (rice, wheat, cotton and sorghum) in different agro-climatic regions of the country. The methodology has also been operationally implemented in Karnataka and Odisha states. Hence there is scope for replicating the approach and upscaling it to national scale, subject to the constraints mentioned above.

References

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For more information

Dr Shibendu S. Ray, Director
Mr Sunil K. Dubey, Assistant Director
Mahalanobis National Crop Forecast Centre
Department of Agriculture Cooperation & Farmers' Welfare
Ministry of Agriculture & Farmers' Welfare, Government of India
Pusa Campus, New Delhi - 110 012
Email: ncfc@gov.in

Ming Xiao
School of Automation, Guangdong University of Technology
E: xiaoming1968@qq.com

Yanping Yu
Shenzhen Wissea Electronic Science & Technology Co., Ltd.
E: yuyanping@wissea.com