REMOTE SENSING AND AGRICULTURAL STATISTICS: RATIONALE, SCOPE AND AIMS

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Experience in Use of Remote Sensing for Crop Statistics in Assam

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INTRODUCTION

Traditionally crop production forecast is based on crop inventories and yield surveys. Crop inventories involve the identification of crops and measurement of their area. This can be achieved using census and ground survey techniques. However, over large areas, the application of such techniques becomes costly and unreliable. The 1990s have seen major development in the use of satellite remote sensing for crop acreage and production forecasting in the state of Assam. The use of satellite data as source of information on changes in agricultural cropping and for production forecasting has been made in Assam since 1992-93 under the project Crop Acreage and Production Estimate (CAPE). The objectives was to develop an optimum procedure for pre-harvest acreage estimation and production forecasting of *kharif* rice for all the districts of the state and of rapeseed/mustard for selected districts. The project was initially started for three years from 1992 which was later extended till 1997-98. The project was sponsored by the Ministry of Agriculture and Co-operation, Government of India and implemented by Space Applications Centre (SAC), Ahmedabad throughout India. Assam Remote Sensing Application Centre, Guwahati was involved as nodal agency and Department of Agriculture along with Department of Economics and Statistics, Government of Assam as collaborative agencies for implementation of the project in Assam.

Since the availability of data for *kharif* rice was very poor due to cloud coverage, efforts were concentrated on mustard crop. Mustard is a dominant crop grown in the *rabi* season in the state. Studies were restricted to 12 districts considering the percentage area under mustard over geographical area of the district. However, the non-availability of data for all the 12 districts during the period of study also affects the sustainability.

Efforts were also made to estimate wheat acreage in three districts and rice acreage in five districts on pilot basis.

STUDY AREA AND METHODOLOGY

The state of Assam, having a geographical area of 78,438 sq. km lies between

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90^0 and 95^0 30'E longitude and 24^0 and 27^0 30'N latitude. Rapeseed/mustard is the most important *rabi* crop in the state, grown between November and January. The state has about 2.75 lakh hectares of area under mustard crop producing around 1.50 lakh metric tonnes (as reported by the Department of Economics and Statistics). The study area during the period 1992-93 to 1997-98 taken under CAPE project is as follows:

1992-93 - 8 districts.
1993-94 - 11 "
1994-95 - 7 "
1995-96 - 8 "
1996-97 - 10 "
1997-98 - 4 "

Data Used

Satellite data of IRS-LISS-II and LISS-III were used during the period of study except for 1994-95, where Landsat TM satellite data were used for mustard crop analysis. Single-date data were acquired from mid-December to mid-January for estimation of mustard crop.

Methodology

The analysis work was done by computer analysis of satellite data through a stratified random sampling method suggested for large crop production forecasting (ISRO, 1990). The methodology comprised the following major steps:

(i) *Sampling design*: The entire state of Assam was divided into square grid of 5 km x 5 km on 1:1 million scale map giving a 10^0 tilt in X and Y direction to align it with the satellite orbit. Next, the non-agricultural grids were screened out using historical remote sensing data in the form of False Colour Composite (FCC) paper prints. From the rest of the grids in each district, 10 per cent sample segments (square grids) were randomly selected and marked on the map. To reduce the sampling error in terms of CV, stratification was done within the district based on crop density and 10 per cent sample segments were selected from each stratum.

(ii) *Sample segment extraction*: The top left corner of each selected sample segments were digitized to obtain their geographic coordinates. Next, digital satellite data were loaded in the computer to generate digital FCC image and few ground control points (GCP) were identified both in map and image. The GCPs were digitized to get their longitude and latitude coordinates. A transformation model was generated between map and image coordinates. Using this transformation model, the geographic coordinates of selected segments were converted into image coordinate and a programme was run to extract c rresponding images of 5 km x 5 km size from the loaded digital satellite data. After having done this, all the segments were joined

together to form one single image.

(iii) *Training signature generation*: Sites of mustard and other vegetation classes, viz., forest, plantation, water, etc., were demarcated in the image. The digital values of pixels (picture element of size 36 x 36 m in the case of IRS) falling inside the training sites were analysed to generate statistics in terms of mean, standard deviation, Var-Cov matrix, error matrix, etc. The accepted classification accuracy for the mustard crop is aimed to be more than 95 per cent.

(iv) *Supervised classification:* Based on statistics generated for different classes, maximum likelihood supervised classification was done which employs the Mahalanobis distance to assign an unknown pixel to the nearest training class.

After classification, mustard acreage of each segment is enumerated. The results were aggregated to obtain district level acreage. The Relative Deviation (RD %) of remote sensing (RS) acreage over conventional acreage (BES) was calculated as:

$$RD\ (\%) = 100\ X\ (RS - BES)/\ RS.$$

RESULTS AND DISCUSSIONS

The districtwise mustard acreage for all the districts is given in Table 1. The remote sensing acreage estimates were compared with the figures of conventional method of BES (Bureau of Economics and Statistics) estimates by determining relative difference. The results of the estimates show that the gap between the two sets of data has reduced in time. However, to meet the accuracy goal, it is required to reduce CV further. This calls further improvements in stratification.

The significant decrease in RD (%), as mentioned below, over conventional data clearly demonstrates improvement of methodology as well as satellite sensor.

Year	RD % (+)
1993-94	106.24
1994-95	97.26
1995-96	5.01
1996-97	10.93

The fluctuation in RD % may be due to the following reasons:

1. Non-availability of cloud free date specific satellite data to cover entire selected sample segments so as to get the desired level of acreage estimation.
2. In Assam, variation in soil, climate, etc., sowing time of mustard crop varies from place to place. Therefore, to cover all the growing stages, it is essential to go for multi-date satellite data analysis. But in the present study this was not considered due to cost factor.

TABLE 1. AREA UNDER MUSTARD IN ASSAM

(000 ha)

Sr. No.	District	1993-94			1994-95			1995-96			1996-97			1997-98		
		Remote sensing	Conven-tional	Relative deviation (per cent)	Remote sensing	Conven-tional	Relative deviation (per cent)	Remote sensing	Conven-tional	Relative deviation (per cent)	Remote sensing	Conven-tional	Relative deviation (per cent)	Remote sensing	Conven-tional	Relative deviation (per cent)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1.	Barpeta	12.36	24.00	94.10(-)	24.74	14.90	39.77(-)	24.17	24.70	2.19(-)	27.71	25.00	9.78	--	--	--
2.	Darrang	23.85	26.44	10.86(-)	19.41	26.81	38.12(-)	23.87	24.67	3.35(-)	19.42	25.66	32.13(-)	--	--	--
3.	Dhemaji	--	11.25	--	--	11.12	--	9.74	--	--	11.29	12.77	13.11(-)	15.90	12.77	19.68(+)
4.	Dhubri	7.57	14.05	85.60(-)	13.85	14.22	2.67(-)	14.99	14.98	0.00	15.05	15.45	2.52 (-)	--	--	--
5.	Golaghat	--	9.96	--	--	9.75	--	11.99	9.96	19.58(+)	5.65	9.08	60.71(-)	6.60	9.08	37.73(-)
6.	Kokrajhar	7.76	20.81	168.17(-)	18.35	20.45	11.44(-)	18.72	18.88	0.85(-)	22.13	14.40	34.91(+)	--	--	--
7.	Lakhimpur	13.48	19.35	43.54(-)	--	19.14	--	20.25	19.15	5.43(-)	36.63	20.63	43.68(+)	22.80	20.63	0.52
8.	Jorhat	9.53	10.92	14.58(-)	--	13.00	--	9.32	14.15	51.82(-)	--	9.80	--	9.80	9.80	--
9.	Nalbari	4.22	11.50	172.50(-)	12.35	11.70	5.26(+)	9.69	11.50	18.68(-)	12.15	11.50	5.35(+)	--	--	--
10.	Nagaon	20.86	27.26	30.68(-)	--	25.61	--	--	22.45	--	--	23.59	--	--	--	--
11.	Sonitpur	16.28	17.19	5.58(-)	18.70	17.34	7.27(+)	--	17.91	--	--	18.56	--	--	--	--
12.	Morigaon	--	9.67	--	6.75	10.52	55.85(-)	--	10.05	--	11.37	11.05	2.81(+)	--	--	--

3. Since administrative boundaries of newly created districts are still under scrutiny, hence accuracy level may not meet the desired goal.

Wheat Acreage Estimation

In Assam, a pilot study was taken under CAPE project to estimate the wheat acreage. Three districts, namely, Dhubri, Barpeta and Nalbari were taken as study area. The result (Table 2) shows high RD % except in Dhubri district. This is due to overlapping in sowing time of both mustard and wheat crops and that cannot be separated in the existing bands of satellite sensors. This problem might be overcome through specific information of sowing time in different places/districts, while selecting the satellite date of pass for the particular crop.

TABLE 2. WHEAT ACREAGE ESTIMATION (1993-94)

(000 ha)

		1993-94		
Sr.No.	Districts	Remote sensing	Conventional	Relative deviation (per cent)
(1)	(2)	(3)	(4)	(5)
1.	Dhubri	18.56	16.55	10.84 (+)
2.	Barpeta	21.03	9.70	53.87 (+)
3.	Nalbari	11.56	4.20	63.67 (+)

Microwave Remote Sensing Data for Rice Acreage Estimation in Assam

Non-availability of cloud free satellite data in optical bands for Assam hampers the crop acreage estimation. Keeping in view this constraint, microwave satellite data (ERS-SAR) was used during 1997-98 for *kharif* rice. The study covered the five districts of the state and the result is found to be encouraging (Table 3).

TABLE 3. RICE ACREAGE ESTIMATION (1997-98)

(000 ha)

		1997-98	1996-97	
Sr.No	Districts	Remote sensing	Conventional	Relative deviation (per cent)
(1)	(2)	(3)	(4)	(5)
1.	Dhemaji	58.00	50.72	12.55 (+)
2.	Golaghat	80.30	75.34	6.18 (+)
3.	Jorhat	83.00	84.34	1.61 (-)
4.	Lakhimpur	82.70	85.20	3.02 (-)
5.	Nagaon	147.40	141.60	3.94 (+)

CONCLUSIONS

The experience so far gathered over the years in crop acreage estimation using remote sensing clearly demonstrates that optical bands of satellite data could be used in the *rabi* season while microwave band is used for *kharif* crops. In both the cases, two-date data, if not multi-date, could be of immense help in delineating different crops in a given area. Under such circumstances, the use of high resolution data would help in crop identification.

Agricultural application of remote sensing is time critical. The accurate identification of crop types depends on the availability of images acquired within specific time. Finally, it is not gainsaid that the remote sensing-based crop statistics is a complementary information to the BES data.

REFERENCES

Government of Assam (1998), *Agricultural Statistics, 1992-93 to 1997-98*, Published by Bureau of Economics and Statistics, Guwahati, Assam.

Indian Space Research Organisation (ISRO) (1990), *Status Report on Crop Acreage and Production Estimation*, ISRO-SAC Status Report, RSAM/SAC/CAPE/SR/25/90, Space Applications Centre, Ahmedabad.

Indian Space Research Organisation (ISRO) (1998), *Crop Acreage and Production Estimation Results, 1992-93 to 1997-98*, Space Applications Centre, Ahmedabad.