



AgEcon SEARCH
RESEARCH IN AGRICULTURAL & APPLIED ECONOMICS

The World's Largest Open Access Agricultural & Applied Economics Digital Library

This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.

Help ensure our sustainability.

Give to AgEcon Search

AgEcon Search

<http://ageconsearch.umn.edu>

aesearch@umn.edu

*Papers downloaded from **AgEcon Search** may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.

REMOTE SENSING AND AGRICULTURAL STATISTICS: RATIONALE, SCOPE AND AIMS

Proceedings of National Seminar held on April 21-22, 1998



INDIAN SOCIETY OF AGRICULTURAL ECONOMICS
in collaboration with
SPACE APPLICATIONS CENTRE, INDIAN SPACE
RESEARCH ORGANISATION, DEPARTMENT OF SPACE
Ahmedabad

SUPPLEMENT TO INDIAN JOURNAL OF AGRICULTURAL ECONOMICS,
VOL. 55, NO. 2, APRIL-JUNE 2000

Application of Remote Sensing in Agricultural Statistics

R.L. Narasimhan and Harish Chandra *

INTRODUCTION

The estimates of production of various crops are pre-requisites for making policy decisions regarding the agricultural sector. These are required by various government agencies such as Ministry of Agriculture, Ministry of Food and Civil Supplies, Ministry of Commerce, Ministry of Rural Areas and Employment, Planning Commission and Central Statistical Organisation. The estimates of crop production are presently compiled by Directorate of Economics and Statistics, Ministry of Agriculture (DESAg) based on the reports received from State Government authorities which are mainly prepared by the revenue agencies on complete enumeration of area and yield estimates on the basis of crop cutting experiments conducted jointly/individually by Central/State Government authorities. As the results of crop cutting experiments are received much after the crops are harvested, the crop production estimates are finalised after considerable delay and do not serve towards timely policy development many a time. In this paper, we will examine the requirement of crop production estimates by various agencies and also whether such requirement could be met by the application of modern technology such as remote sensing and if so, to what extent and then leading to some recommendations.

REQUIREMENT OF AGENCIES DEALING WITH PRICE POLICY

At present, 24 commodities are covered under the minimum support programme. These include paddy, wheat, jowar, maize, ragi, barley, gram, *tur*, *moong*, *urad*, groundnut, rapeseed/mustard, *toria*, soyabean, sunflowerseed, sesamum, nigerseed, copra, cotton, jute-mesta, virginia flue cured (VFC) tobacco and sugarcane which together account for 82 per cent of the gross cropped area and 75 per cent of the total value of crop output in the country. This apart, some other commodities like onion, potato, ginger, chillies, black paper, castorseed and some fruits are included under the market intervention scheme (MIS). The MIS is much more flexible in terms of period of support operations, coverage of area and level of support prices. The minimum support prices (MSP) are the procurement prices at which public agencies procure grains from the market. The Food Corporation of India (FCI) is the nodal agency for implementation of price support policy for rice, wheat and coarse cereals. The FCI makes necessary arrangements with State Governments for purchase of these

* Director and Joint Director, respectively, Ministry of Statistics and Programme Implementation, Central Statistical Organisation, Government of India, New Delhi-110 001.

The views expressed are of the authors and do not necessarily reflect the views of their organisation or Government of India.

commodities. For other commodities the nodal agencies designated for implementation of support policy are National Agricultural Co-operative Marketing Federation (for oilseeds and pulses), Cotton Corporation of India, Jute Corporation of India and the Tobacco Board. Besides the state marketing federations and co-operative marketing organisations also provide support in disposing the produce of farmers at reasonable prices. These organisations require the data of production to estimate the requirement of capital, storage and transport facilities and the extent of export and import of the commodities to be permitted to stabilise the domestic supply and prices, etc., for their efficient working (Acharya, 1997).

REQUIREMENT OF CENTRAL STATISTICAL ORGANISATION

The Central Statistical Organisation (CSO) at present uses the estimates of 74 agricultural crops/crop groups, including by-products, for the purpose of estimation of Gross Domestic Product (GDP) in the agricultural sector (Government of India, 1989). These are divided into four broad categories, viz., (i) 45 items of principal crops, (ii) 10 items of minor crops, (iii) 11 items of miscellaneous and unspecified crop groups, and (iv) 8 items of other products and by-products. The principal crops can be further disaggregated into groups, viz., cereals, pulses, oilseeds, sugar, fibres, drug and narcotics, condiments and spices, fruits and vegetables and other crops. The list of crops under each of these groups is given in the Appendix. The CSO is now required to compile quarterly estimates of GDP under the Special Data Dissemination Standards with a time lag not exceeding a quarter.

METHODOLOGY ADOPTED AND SOURCE OF DATA FOR CALCULATION OF GDP IN AGRICULTURAL SECTOR

First the output of agricultural sector is evaluated at current prices. Thereafter, Gross Value Added from Agriculture and allied sector are arrived at after making necessary deductions from the value of output used for intermediate consumption. The various items considered for intermediate consumption (inputs) in this sector are (i) seed, (ii) manure – chemical fertilisers, organic and inorganic manure (iii) livestock feed, (iv) irrigation charge (payable to the government), (v) market charges, (vi) electricity, (vii) pesticides and insecticides, (viii) diesel oil and current repairs and maintenance and other operational costs.

Production of Principal Crops: The estimates of area and production of principal crops at the state level are regularly obtained from the DESAg publication *Area and Production of Principal Crops in India*. However, in the case of sugarcane, outturn excluding the quantity converted into gur by the cane growers is taken and gur is evaluated separately.

Minor Crops: The estimates of area and outturn of minor crops, viz., cashewnut, indigo and papaya are also published annually in the same publication of DESAg but with a time lag of one year. The estimates for the current year are, therefore, obtained

by projecting previous years' estimates on the basis of past trend and are revised subsequently when the data become available. For mango, citrus fruits and grapes, in the absence of current outturn estimates from any source, the same are prepared using (i) the yield rates available from the reports of the Directorate of Marketing and Inspection (DMI) and the State Agricultural Departments and (ii) the area figures taken from the Land Use Statistics (LUS). The production of coffee, rubber and opium are obtained from Coffee Board, Rubber Board and Central Bureau of Narcotics respectively. In the case of tea the estimates of output available from Tea Board relate to production of processed tea instead of raw tea leaves. Since processing is an activity outside the scope of agriculture, the output of raw tea leaves alone is to be taken into account in the agricultural sector and this is being taken to be equal to the input of raw tea leaf together with its value which is obtained from the Annual Survey of Industries (ASI).

Miscellaneous and unspecified crops: For miscellaneous crops and unspecified crop groups, direct outturn estimates are not available. The estimates of output for these crops are obtained by applying an appropriate average value of yield per hectare to the total area under these crops.

REMOTE SENSING MODELS

Remote sensing (RS) technology has potential in estimating crop acreage and production at district/group of districts and regional level due to its multispectral, synoptic and repetitive coverage. This technology is being used operationally by many advanced nations. The Foreign Agricultural Service (FAS) of U.S. Department of Agriculture has been using RS data together with soil moisture and crop yield models to estimate global agricultural production. Similarly, the Directorate General for Agriculture of the European Community uses a range of RS data in estimating the total production of important crops. In India, the Crop Acreage and Production Estimation project (CAPE) has been in progress ever since the launch of first Indian Remote Sensing Satellite (IRS)-1A in 1988 (Government of India, 1997). This project, funded by the Ministry of Agriculture, is being executed jointly by Department of Space, State Remote Sensing Centres, State Departments of Agricultural and Agricultural Universities.

The project is aimed at providing pre-harvest acreage and production estimates at an accuracy of 90 per cent with 90 per cent confidence (90/90 criterion) for the major crops, viz., wheat, rice, *rabi* sorghum, cotton, mustard, groundnut. The acreage covered under this project accounts for 90 per cent of wheat, 89 per cent of rice, 83 per cent of *rabi* sorghum, 61 per cent of *kharif* groundnut, 65 per cent of cotton and 55 per cent of rapeseed/mustard. Pilot studies were conducted for sugarcane in Uttar Pradesh and for bajra in Rajasthan. The satellite/sensors available during the early phase of this project permitted production estimation of only a few crops (wheat, rice and sorghum) grown in homogeneous and contiguous areas meeting the 90/90 criterion. Production forecast trials were successful in states like Punjab.

The Indian Agricultural Statistics Research Institute (IASRI) has conducted an experiment based on the data on remote sensing for the Sultanpur district of Uttar Pradesh. The area covered was approximately 2000 sq.km. The data used pertained to the year 1986. The results of this experiment were published in the form of a paper by Goyal *et al.* (1994) of IASRI in which the estimates of average crop yield at district level were compared by using two procedures, namely, estimating crop yield only through survey method based on crop cutting experiments without using remote sensing data and the procedure based on use of crop yield survey data along with use of satellite remote sensing data for post-stratification of the crop area through digital image processing techniques and through visual interpretation of false colour composites (FCC). It was found that the post-stratified estimator based on satellite data is more efficient as compared to the crop yield estimator based on conventional methods of crop yield estimation. It has also been observed that use of normalised different vegetation index for post-stratification crop area provides more efficient estimator as compared to the use of visual interpretation of FCC. It was also suggested that the study being located to a specific area and for a particular period was only suggestive in nature, it has been recommended that these experiments be repeated on more locations and over different periods before this technique can be recommended for operational use.

The studies have also indicated that the spectral vegetation indices at maximum leaf area index of the crop bears high correlation with yield. Randhir Singh and Ibrahim (1996) of IASRI has studied the use of spectral data in Markov chain model for pre-harvest forecast of wheat yield in a simulation study. To facilitate the use of satellite data in Markov chain model, wheat growth was divided into several phenological stages like vegetative, flowering, earing, etc., to correspond with the repeat satellite cycle. The data were collected representing the stages of the Markov chain at 21, 38, 49, 59, 87 and 95 days after sowing. The simulation studies of spectral observations show that reliable forecast of wheat yield with standard error less than 5 per cent can be obtained by using spectral data upto stage 4 or 5, i.e., after 2 or 3 months after sowing. It was also recommended that the Markov chain model using satellite data for crop yield forecasting was appropriate, though need was emphasised to examine the other multiple variate techniques like principal components analysis, etc., to compare their efficiencies with the Markov chain model approach. Goyal, Singh and Chhikara (1994) also suggested few post-stratified estimators using spectral data and calculated their efficiencies and bias as well the impact of misclassification of units on the bias and relative efficiency. On the basis of simulation it was shown that both the bias and efficiency were adversely affected in the presence of misclassification of sample units in the post-strata.

CONCLUSION

The remote sensing technology has shown that it can be effectively employed in estimating the crop yield of major crops. However, its potential in estimating yield of

minor crops is yet to be demonstrated. The practice of mixed cropping and cloud cover particularly in the North East over a large part of the year hampers its utility at all-India applications. The requirement of production estimates by Central Statistical Organisation can not be met fully by this technology. Therefore, it is recommended that the application of remote sensing may be encouraged for more crops and more areas. It may be used to supplement the traditional system of data collection of area enumeration and crop cutting experiments.

APPENDIX

LIST OF AGRICULTURAL CROPS USED FOR CALCULATING GDP IN AGRICULTURE SECTOR

Sr. No. (1)	Category (2)	Items (3)
A.	Agricultural crops	
I.	Principal crops	
	1. Cereals	Paddy, wheat, jowar, bajra, barley, maize, ragi and small millets.
	2. Pulses	Gram, moong, arhar, horsegram, masoor, urad and other pulses.
	3. Oilseeds	Linseed, sesamum, groundnut, rapeseed and mustard. castor, coconut, safflower, nigerseed, soyabean and sunflower.
	4. Sugars	Sugarcane
	5. Fibres	Kapas, jute, sunhemp, mesta.
	6. Drugs and Narcotics	Tobacco
	7. Condiments and Spices	Cardamom, dry chillies, farlic, black pepper, dry ginger, turmeric, coriander and arecanut.
	8. Fruits and vegetables	Banana, potato, sweet potato, tapioca and onion.
	9. Other crops	Guar seed
II.	Minor crops	Cashewnut, indigo, papaya, tea, coffee, rubber, opium, mango, citrus fruits and grapes.
III.	Miscellaneous and unspecified crop groups	Other cereals, other oilseeds, other sugars, other fibres, other dyes and tanning materials, other drugs and narcotics, other condiments and spices, other fruits and vegetables, fodder, miscellaneous food crops and miscellaneous non-food and grass crops.
IV.	Other products and by-products	The remaining products and by-products like gur indigenous production only); baggasse, and by-products of crops like stalks and straw; cotton, jute and arhar sticks and cane trash.

REFERENCES

- Acharya, S.S. (1997), "Agricultural Price Policy and Development: Some Facts and Emerging Issues", *Indian Journal of Agricultural Economics*, Vol.52, No.1, January-March.
- Government of India (1989), *National Accounts Statistics: Sources and Methods*, Central Statistical Organisation, New Delhi.
- Government of India (1997), *Report of the Expert Group on Crop Forecasts and Advance Estimates*, Directorate of Economics and Statistics, Ministry of Agriculture, New Delhi.
- Goyal, R.C.; Randhir Singh and R.S. Chhikara (1994), "Estimation of Crop Yield Using Post-Stratification Based on Satellite Data", *Journal of Indian Society of Agricultural Statistics*, Vol.46, No.2.
- Singh, Randhir and R.C. Goyal (1993), *Use of Remote Sensing Technologies in Crop Estimation Surveys*, Indian Agricultural Statistics Research Institute, New Delhi.
- Singh, Randhir and A.E.I. Ibrahim (1996), "Use of Spectral Data in Markov Chain Model for Crop Yield Forecasting", Photonirvachak, *Journal of the Indian Society of Remote Sensing*, Vol.24, No.3.