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Space Technology Applications for Sustainble Crop Production[1]

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Dr. R.S. Paroda, Director-General, Indian Council of Agricultural Research (ICAR) and Secretary, Department of Agricultural Research and Education, Dr. R.B. Singh, Director, Indian Agricultural Research Institute (IARI), Dr. D.K. Das, Organising Secretary of the symposium; distinguished delegates to the symposium, media representatives, Ladies and Gentlemen,

At the outset let me welcome all of you to this symposium of "Advances in the Studies of Physical Environment for Resource Management and Sustainable Crop Production", organised by Indian Society of Agrophysics, IARI.

It gives me immense pleasure to meet the community of distinguished agricultural scientists, particularly those from IARI who have made great contributions to the green revolution. In the post-independence era when food security was the most crucial agenda of our country, it is you, the community of agricultural scientists, brought in the great green revolution. A quantum jump in food production, from 51 million tons in 1950 to 192 million tons now, has done proud to the nation not just by producing enough food to meet the domestic requirements but also by generating marginal export surplus.

Driven by the overriding concern for ensuring immediate food security, the pursuit of green revolution was directed towards utilisation of the resources to derive maximum benefits as per needs on a short-term basis. The genetic potential of the crops has been exploited to the best of the technological capabilities of that time. Even after creating nation-wide mega multi-purpose irrigation projects, irrigated agriculture covering 48 million ha of land area is producing at present about 2.5 tonnes of foodgrain/ha. Rainfed areas occupying about 92 million hectares, continue to have productivity of just one tonne/ha. With a wide gap between the realisable potential and the actual average yield both in irrigated and dry land areas, further compounded with massive land degradation problems to the extent of 175 million ha, the issue of accelerating the pace of green revolution is really challenging. But the fact is that in spite of all these constraints, there is no option but to increase the productivity of foodgrains per unit of soil and water using genetically superior varieties and hybrids of crops, and by optimally using the land and water resources.

The strategy of sustainable crop production lies in the integration of the principles of ecology, economics and equity. While the ecological dimension of crop production involves attention to soil health care, water management and the conservation of biodiversity, the economic dimension calls for the promotion of sustainable livelihoods through multiple income-earning opportunities. The dimension of equity requires addressing gender, class and ethnic discrimination against marginalised sectors of the society. In this context, it is extremely painful to note the recent tragedy of the starvation deaths and suicides due to unbearable economic distress by marginalised farmers in Orissa, Andhra Pradesh and Maharashtra. Hence, the attention of scientists, policy makers and administrators must be focused on the totality of sustainable agriculture system with its interlinkages to ecology, economics and equity.

The complexities confronting the challenges of sustainable crop production call for development and dissemination of appropriate technologies, supported by locale specific packages of services and public policies. Appropriate technologies involve the blending of the ecological prudence and technologies of the past, with the best in frontier technologies particularly biotechnology, information technology and space technology. Without

1. Key note address delivered at the National Seminar on "Advances in the Studies of Physical Environment for Resource Management and Sustainable Crop Production' held at the Indian Agricultural Research Institute, New Delhi; March 23-25, 1998.

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technological empowerment, farm men and women will not be able to produce more food on environmentally sustainable basis from less land, water and energy resources. Considering the depletion of resource base and impending environmental crises, the issue of immediate concern is to build the fragile agro-ecosystems along with its roots in environmental integrity and profitability. It is a true multidisciplinary mission, wherein a partnership of agriculture, informatics and space scientists is called for.

Agriculture has been at the core of Indian Space Program. While India's Earth Observation Satellites (EOS), Indian Remote Sensing Satellites (IRS) 1A to 1D, are tailored to meet the information needs of agriculture sector, INSAT series of satellites have been offering the valuable services to the farming communities. It is worth recalling that the first experiment on remote sensing of coconut wilt was initiated in collaboration with the IARI experts. Again it is here, the research support extended by this prestitious institute that the payloads of IRS were defined under Joint Experiment Program. Similarly, the wisdom of Indian Meteorological Department (IMD) was integrated while developing INSAT-VHRR payload. A synergy of IRS and INSAT series of satellites truly brings in immense technological capability which could help in addressing the entire gamut of sustainable crop production.

Never before the advent of IRS series, the country had the up-to-date spatial database on wastelands, hydrogeomorphology, land use/land cover, forest cover, soil resources, crop acreage and pre-harvest production estimates. The remarkable developments in space applications have become powerful tools for mapping spatial as well as temporal changes in soil characteristics, soil moisture and land use pattern at micro level to identify forestry, plantation, pasture land, single and double cropped areas, culturable wasteland and fallow residual lands. These in turn have led to the possibility of identifying agroclimatically coherent regions having homogeneous characteristics such as slope, soil depth, texture and water holding capacity. Satellite imageries have been operationally employed to identify underground water aquifers with more than 92% accuracy and map surface water bodies for optimal implementation of irrigation schemes. Models based on the aerial extent of seasonal snow fall and glacier inventory have been developed to predict snow-melt run off into reservoirs and rivers. Identification of water-logged areas in the command areas of the irrigation projects and inventory of crop lands and cropping patterns have facilitated efficient water use resulting in increased cropping intensity. The ability of remote sensing imageries to predict acreage and yield of major crops well in advance has proved to be of immense value in optimal planning of storage and distribution of foodgrains. Technologies of prediction, monitoring as well as management of drought and flood disasters developed using remote sensing imageries have greatly assisted in developing strategies to deal with such extreme disasters and even substantially mitigate their effects by taking timely remedial measures. Database collected over the years have been able to delineate flood risk zones, identify flow constraints and water logged areas requiring structural adjustments to prevent large scale flood damages along the river basins. Likewise continuous monitoring of vegetation indices indicating the health of the crops on a biweekly basis together with real time meteorological information has become an important means of advance identification of the onset of drought and lessen its severity by changing the cropping pattern. Quantitative and accurate information on environmental degradation obtainable from space remote sensing has provided us the unique capability to institute mid course changes, if required, to ensure that the developmental processes for increasing agricultural productivity do not result in ecological damage.

As a facilitator of nation-wide planning for agriculture resource development on the basis of agro-climatic zonation, the applications of space remote sensing have graduated from mapping across the various scales to micro-level decision making for sustainable development. It is worth mentioning here that the remote sensing based Integrated Mission for Sustainable Development (IMSD) project being carried out in 175 districts of the country have been quite successful in enriching the ground water potential, increasing the cropping intensity alongwith the net returns from the field, and finally conserving the land and water resources. In fact, IMSD is an experiment that has established the interlinkages among grass root level farmers, administrator/policy makers and multi-disciplinary scientific communities. With the successful operationalisation of National Natural Resources Management System (NNRMS) under the Department of Space (DOS), the space, ground and user segments have been properly tuned to respond to the challenges of sustainable crop production in the country.

In view of the fact that agricultural inputs management covers a wide gamut ranging from the agricultural research, basic inputs of seed, fertiliser, soil ameliorants including micro-nutrients, plant protection, credit both short-term and medium/ long term, soil moisture, transmission of research results to the field in post harvest technology and marketing, the relevance and utility of informatics in agriculture assume paramount importance. Also, the globalisation of economics including agriculture has thrown up fresh challenges of undertaking critical analysis of the implications of various developments as a result of tariff and non-tariff regulations and intellectual property rights in the field of agricultural trade. Towards these, a national infrastructure, called National Natural Resources Information System (NRIS), has been established for the availability of organised spatial and non-spatial data and multi-level information networking to contribute to local, national and global needs of sustainable development. Similarly, single window approach based pilot project to supply information to all the users and decision makers at the grass root level farming community is being implemented in the form of Agro-climatic Planning and Information Bank (APIB). One of the most crucial information that is directly linked up with pricing, export-import, procurement etc., is the pre-harvest production estimates of the major crops in the country. The revised Crop Acreage and Production Estimation (CAPE) project, now called Forecasting Agricultural Output using Space, Agrometeorology and Land-based observations (FASAL) is being launched for the multi-stage production forecasting of the major crops with improved accuracy, timeliness and scope. All these efforts are aimed at building the informatics infrastructure in the agricultural sector.

The INSAT-VHRR observations on clouds, cyclonic depressions, surface radiance and monsoon parameters in Indian ocean have really strengthened the agro-meteorological services in the country. To disseminate the appropriate locale specific agricultural packages, there are several programmes such as 'Krishi Darshan' being beamed through all the regional channels. An operational system of public instruction has been established since 1995, using the INSAT Training and Development Communication Channel (TDCC) for disseminating improved agriculture practices, training primary teachers, panchayat raj, elected representatives, anganwadi workers, wasteland development functionaries etc. Recently, Jhabua Development Communication Project (JDCP) has been undertaken by ISRO in Jhabua district of MP to provide communication support to the developmental activities and also interactive training to the development functionaries and common people. The establishment of a large scale operational development communications network would certainly help in turning the stagnant rural societies into information rich vibrant societies.

The future earth observation missions such as NASA-EOS, ESA-ENVISAT, Japanese ADEOS, Indian Remote Sensing satellites (CARTOSAT, RESOURCESAT, CLIMATSAT etc.) are extremely promising in view of the fact that there are about 70 EOS missions already planned globally which would carry onboard 230 sensors. These instruments include imaging multi-spectral radiometers, polarimetric radiometers, imaging radar, Lidar, interferometric multi-frequency SAR, etc. There are also application areas that require scientific understanding of radiation transfers in the microwave region and hyperspectral domain. The strength of any EO system lies in its planned synergy and simultaneity of measurements spread over a long time. It is here that I see an important role to be played by agrophysicists in providing the fundamental research support. It is only through the active participation of this community that the experiments on calibration/validation of sensors with diverse spatial, spectral, radiometric and temporal resolutions are feasible. Similarly, the development of spectral library consisting the unique signatures of our crops, soils and minerals is another area where agro-physicists hold the key. Above all, the applications of space remote sensing to agriculture is routed through agricultural physics. Hence, together we are an active interface in the mission of sustainable crop production.

I am sure that this forum, comprising of many eminent personalities in agriculture, remote sensing and GIS fields, will, in coming three days, discuss various aspects related to physical environment for resource management and sustainable crop production. I am sure, this forum will come up with specific suggestions and recommendations which could be taken up further towards realising the goals of sustainable development.

I wish the symposium all success. Thank you.