

Report  
On  
Agricultural Resources Information System (AgRIS)  
Of the Core Group - V

March 2000

Constituted  
Under  
National Natural Resources Management System  
(NNRMS) Standing Committee  
On  
Soil and Agriculture and Soils (SC-AS),  
Department of Agriculture and Cooperation  
Ministry of Agriculture

## Preface

Agricultural Sector is the mainstay of the rural Indian economy around which socio-economic privileges and deprivations revolve and nay change in its structure is likely to have a corresponding impact on the existing pattern of Social equity. Sustainable Agricultural production depends on the judicious use of natural resources (soil, water, livestock, plant genetic, fisheries, forest, climate, rainfall, and topography) in an acceptable technology management under the prevailing socio-economic infrastructure. Various research studies and policy papers highlight that the Indian Agricultural sector faces resource constraints, infrastructure constraints, institutional constraints, technology constraints, and policy induced limitations. To achieve sustainable agricultural development, it is essential to combine natural resources, capital resources, institutional resources, and human resources (i.e. to optimally utilize the agricultural resources).

As an enabling technology, Information Technology (IT) plays an important role in the rapid economic growth and social transformation in developing countries. Information Technology and Bio-Technology, which are the drivers" of globalization with their complementarities of liberalization, privatization and tighter Intellectual Property Rights (IPR), are bound to create new risks of marginalization and vulnerability in the Indian Agricultural sector. To reduce the risks of marginalization and vulnerability, this Report suggests development of a comprehensive Agricultural Resources Information Systems using Geomatics Technology in district with public funding, facilitating sustainable agricultural development, and also suggests the need for development of "metadata" and application of OpenGIS model for optimal utilization of agricultural resources in India.

I acknowledge the contributions made by the Members of the Committee and suggestions of various ICAR institutes NBFGR(Lucknow), NCAP(New Delhi), IISR(Calicut),NBSS&LUP(Nagpur), and NBPGR(New Delhi) AISLUS(New Delhi) of the Department of Agriculture and Cooperation, and National Informatics Centre of the Ministry of Information Technology, in meetings of this Committee.

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## Acronyms used in this document

ACRP	Agro-climatic Regional Planning Project
Agri. Engg.	Agricultural Engineering
AgRI S	Agricultural Resources Information System
AGRI SNET	NICNET Based Agricultural Informatics & Communication
AI CRP	All India Coordinated Research Projects of ICAR
AI SLUS	All India Soil & Land Use Survey of DAC
APHNET	Animal Production and Health Information System Network
API B	ACRP Information Bank
ARI SNET	NICNET Based Agricultural Research Information System Network
ATMA	Agricultural Technology Management Agency of NATP
BFS	Buffalo Farming System
BPL	Below Poverty Line
CAZRI	Central Arid Zone Research Institute
CCBF	Central Cattle Breeding Farms
CDB	Coconut Development Board
CFS	Cattle Farming System
CGI AR	Consultative Group on International Agricultural Research
CGWB	Central Ground Water Board
CIBA	Central Institute of Brackishwater Aquaculture
CICFRI	Central Inland Capture Fisheries Research Institute
CIFA	Central Institute of Freshwater Aquaculture
CIFE	Central Institute for Fisheries Education
CMFRI	Central Marine Fisheries Research Institute
CPCB	Central Pollution Control Board
CPCRI	Central Plantation Crops Research Institute
CRI DA	Central Research Institute for Dryland Agriculture
CSSRI	Central Soil Salinity Research Institute
CSWCRTI	Central Soil and Water Conservation Research & Training Institute
DAC	Department of Agriculture and Cooperation
DAH&D	Department of Animal Husbandry and Dairying
DBMS	Data Base Management System
DDP	Desert Development Programme
DES	Directorate of Economics and Statistics
DISNIC	District Information System Project of NIC
DLR	Department of Land Resources
DOS	Department of Space
DPAP	Drought Prone Area Development Programme
DRD	Department of Rural Development
DSS	Decision Support System
DST	Department of Science & Technology

DTS	Decision Technology System
DWMR	Directorate of Water Management Research
EIS	Executive Information System
ENVIS	Environmental Information System
ES	Expert System
EWS	Early Warning System
FAO	Food and Agriculture Organization
FASAL	Forecasting Agricultural Output using Space, Agro-meteorology and land based Observations
FGDC	Federal Geographic Data Committee
GATT	General Agreement on Trade and Tariff
GDP	Gross Domestic Product
GDSS	Group Decision Support System
GEMS	Global Environment Monitoring Systems
GFS	Goat farming System
GIS	Geographic Information System
GR	Green Revolution
GRID	Grass-Root Level Informatics Development Project of NIC
GSI	Geological Survey of India
HYV	High Yielding Varieties
IARI	Indian Agricultural Research Institute
IASRI	Indian Agricultural Statistical and Research Institute
IBSRM	International Board for Soil Research & Management
ICAR	Indian Council of Agricultural Research
ICID	International Commission on Irrigation and Drainage
IHR	Indian Institute of Horticulture Research
IISR	Indian Institute of Spices Research
IMD	Indian Meteorology Department
IMSD	Integrated Mission of Sustainable Development Project of DOS
IPS	Idea Processing System
IPTRID	International Programme for Technology Research in Irrigation & Drainage
IRS	Indian Remote Sensing Satellite System
ISDA	Informatics for Sustainable Agricultural Development
ISRO	Indian Space and Research Organisation
IT	Information Technology
ITK	Indigenous Traditional Knowledge
IVRI	Indian Veterinary Research Institute
IWDP	Integrated Watershed Development Programme
KVK	Krishi Vigyan Kendra
LBR	Lead Bank Returns
MEF	Ministry of Environment & Forests
MH	Million Hectares
MINARS	Monitoring of Indian national Aquatic Resources
MIS	Management Information System

MIT	Ministry of Information Technology
MOA	Ministry of Agriculture
MT	Million Tons
NAAQM	National Ambient Air Quality Monitoring
NABARD	National Bank for Agriculture and Rural Development
NADAMS	National Agricultural Drought Assessment & Monitoring System
NAEB	National Afforestation & Eco-Development Board
NAIC	National Agriculture Informatics Centre
NARP	National Agricultural Research Project
NARS	National Agricultural Research System
NATMO	National Atlas and Thematic Mapping Organization of DST
NATP	National Agricultural Technology Project
NBAGR	National Bureau of Animal Genetics Resources
NBFGR	National Bureau of Fish Genetics Resources
NBPGR	National Bureau of Plant Genetics Resources
NBSS&LUP	National Bureau of Soil Survey & Land Use Planning
NCAP	National Centre for Agricultural Economics and Policy Planning
NCFC	National Crop Forecasting Centre of DES (MOA)
NCMRWF	National Centre for Medium range Weather Forecasting
NCT	National Capital Territory
NDC	National Data Centre of NRSA
NDDB	National Dairy Development Board
NDRI	National Dairy Research Institute
NEERI	National Environmental Engineering Research Institute
NEP	New Economic Policy
NGO	Non-Governmental Organization
NHB	National Horticulture Board
NIA	Net Irrigated Area
NIC	National Informatics Centre
NICNET	NIC Computer-Computer Communication Network
NLP	National Livestock Policy
NNRMS	National Natural resources Management System
NRC-AF	National Research Centre for Agro-Forestry
NRCs	National Research Centres of ICAR
NRDMS	Natural Resources Data Management System Project of DST
NRI S	Natural Resources Information System
NRSA	National Remote Sensing Agency
NSA	Net Sown Area
NSC	National Seeds Corporation
NSIS	National Soil Information System
NWDPRA	National Watershed Development Project in Rainfed Areas
NWIP	National Wastelands Identification Project
OAS	Office Automation System
PAP	Poverty Alleviation Programmes

PD-CSR	Project Directorate for Cropping Systems Research
PDs	Project Directorates of I CAR
PGR	Plant Genetics Resources
R&D	Research & Development
RBI	Reserve Bank of India
RDBMS	Relational Data Base Management System
R-E-F	Research - Extension - Farmer
RIDF	Rural Infrastructure Development Fund
RS	Remote Sensing
SAA	Service Area Approach
SAC	Space Applications Centre
SAP	Service Area Credit Plan
SAR	Synthetic Aperture Radar
SAUs	State Agricultural Universities
SC-AS	Standing Committee on Agriculture and Soils
SFCI	State Farms Corporation of India
SFS	Sheep Farming System
SOI	Survey of India
SPCB	State Pollution Control Board
SRA & ULR	Strengthening of Revenue Administration and Updating of Land Records
SWC	Soil & Water Conservation Programme
SWNM	Soil, Water and Nutrient Management Research
TGA	Total Geographical Area
TMU	Terrain Mapping Unit
TPS	Transaction Processing System
UNCED	United Nations Conference on Environment Development
UNEP	United Nations Environment Programme
UT	Union Territory
VSAT	Via SATellite Terminal
WMO	World Meteorological Organisation
W.R.T.	With Reference to
ZPT	Zonal Planning Team of ACRP
ZRS	Zonal Agricultural Research Stations of SAUs

Report  
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Of the Core Group - V

## Introduction

1.0 The Planning Commission had earlier set up National Natural Resources Management System (NNRMS) task force in the area of (i) Agriculture, (ii) Soils and Land Use, (iii) Urban and Rural Planning, (iv) Non-renewal Resources, (v) Forestry, (vi) Environmental Management, (vii) Oceanography, (viii) Marine and Coastal Resources, & Water Resources, for effective utilization of remote sensing data in managing the natural resources in the country. In order to pursue and guide the remote sensing applications development in the Agricultural Sector, a Standing Committee of Agriculture and Soils (SC-AS) has been constituted under the Chairmanship of the Secretary (Agriculture & Cooperation), Ministry of Agriculture, Government of India.

1.1 SC-AS is entrusted with the responsibility of examining, among the others, the role of remote sensing technology in addressing the various issues related to management of agricultural resources, after assessing the present and future capabilities of the technology in fulfilling the user requirements. In the first meeting of the re-constituted NNRMS-SC-AS, it was decided to constitute the following Core Groups to study in details the various relevant issues and suggest ways and means of meeting the application potentials of remote sensing technique for agricultural resource management: -

- (i) Group-I : Crop Production, Forecasting, Yield, Modeling and Cropping System Analysis
- (ii) Group-II : Agro-meteorological Services and Natural Disaster Management (Crop Pests, Floods and Drought)
- (iii) Group-III : Remote Sensing for Fisheries development

- (iv) Group-IV : Horticulture Crop Acreage and Production Estimation
- (v) Group-V : Agricultural Resources Information Systems
- (vi) Group-VI : Definition of a space-borne soil mapping mission

1.2 The Core Group-V on Agricultural Resources Information System (AgRIS) was constituted vide order No.9-6/96-CU.V dated September 6<sup>th</sup>, 1996, with the following composition:-

(a)	Principal Advisor (Agriculture), Planning Commission	Chairman
(b)	Deputy Director General (Agri.Engg), I CAR	Member
(c)	Economic & Statistical Advisor, DAC	Member
(d)	Director, IASRI, I CAR	Member
(e)	Director (Publications & Information), I CAR	Member
(f)	Director (DES), Government of Karnataka, Bangalore	Member
(g)	Director, NATMO	Member
(h)	Scientist/Engineer, Space Applications Centre, Ahmedabad	Member
(i)	Scientist/Engineer, ISRO Headquarters, Bangalore	Member
(j)	Regional Remote Sensing Service Centre, Bangalore	Member
(k)	Representative of ACRP Unit, Planning Commission	Member
(l)	Senior Technical Director (Agricultural Informatics Division), National Informatics Centre	Member-Convenor

The Terms of Reference of the Core Group-V are as follows:-

- (i) Identification of relevant database and design of system
- (ii) Identification of Meta-data and pilot demonstration
- (iii) Development of Decision Support System (DSS) for  
Agricultural Resource Management

1.3 The first meeting of the Core Group-V was held on **4<sup>th</sup> November, 1996** under the Chairmanship of Shri K.S.Lal, Adviser (Agri), Planning Commission.. The Chairman advised that a technical note on "agricultural resource management" can be prepared and circulated to all the Members for their inputs, and also desired that *the Committee should confine to the given terms of reference and, at any cost, focus should not be lost.* The Committee was not able to meet for further deliberations during 1997-99, due to change in the composition of the Core Group-V. The Core Group-V had the second meeting on **24<sup>th</sup> June, 1999** at ISRO Hqrs in which the

framework of AgRIS was deliberated. The Member-Convenor of the Core Group-V participated in the Second Meeting of the reconstituted NNRMS Standing Committee on Agriculture & Soils (SC-AS) held on **14<sup>th</sup> July 1999** at Space Applications Centre (SAC), Ahmedabad. The Core Group-V discussed the draft report in its meeting on **1<sup>st</sup> December, 1999**, and suggested as follows:-

- (a) To include representatives of NBSS&LUP, Department of Land Resources, and NABARD as members of the Core Group-V, in view of
- NBSS&LUP being the Nodal Agency for implementing the project Component "Digitization of Databases" under the National Agricultural Technology Project (NATP),
  - All India Soil & Land Use Survey (AISLUS) of DAC
  - Department of Land Resources (DLR) being the Nodal department for land resources development, and
  - NABARD being the Nodal Agency for Agricultural Credit
- (b) Out of the **four types of Agricultural Resources** (natural resources, capital resources, institutional resources, and human resources), focus should be only on natural resources institutional resources & human resources, and capital resources can be super imposed separately in GIS Module.
- (c) Standardization of formats in close interaction with ICAR Institutions, NATMO, NABARD, NIC, DOS, & DLR
- (d) Pilot project to be given importance in order to work out the cost and efficiency of this project and then expand to the entire country.
- (e) Strengthening of district level information and decision support packages

1.4 As desired, the draft report was sent to the following institutions for their suggestions: -

- (a) *Central Arid Zone Research Institute (CAZRI), Jodhpur*
- (b) *Central Plantation Crops Research Institute (CPCRI), Kasargode*
- (c) *Central Research Institute for Dryland Agriculture (CRIDA), Hyderabad*
- (d) *Department of Land Resources (DLR), New Delhi*
- (e) *Directorate of Water Management Research (DWMR)*
- (f) *Indian Agricultural Statistical Research Institute (IASRI), New Delhi*

- (g) *Indian institute of Horticulture Research (IIHR), Bangalore*
- (h) *Indian Institute of Spices Research, Kozhicode*
- (i) *National Bank for Agricultural and Rural Development (NABARD), Mumbai*
- (j) *National Bureau of Animal Genetics Resources, Karnal*
- (k) *National Bureau of Fish Genetics Resources, Lucknow*
- (l) *National Bureau of Plant Genetics Resources, New Delhi*
- (m) *National Bureau of Soil Survey and Land Use Planning (NBSS&LUP), Nagpur*
- (n) *National Centre for Agricultural Economics and Policy Research (NCAP), New Delhi*
- (o) *National Research Centre for Agro-Forestry (NRC-AF), Jhansi*
- (p) *Project Directorate for Cropping Systems Research (PD-CSR), Modipuram*

1.5 The committee deliberated the suggestions received from the members of the Core Group-V as well as Institutions and the draft report has been revised with respect to database parameters and pilot demonstration. Given its range of agro-ecological setting and producers, Indian Agriculture is faced with a great diversity of needs, opportunities and prospects. In view of this, pilot projects will be taken up on the basis of **Agricultural Production Systems** viz. *Arid Agro-Ecosystem, Coastal Agro-Ecosystem, Hill & Mountain Agro-Ecosystem, Irrigated Agro-Ecosystem, and Rainfed Agro-Ecosystem*. The typologies considered are: -

- a tribal district
- a hill district
- a dry-farming district
- a socially backward district
- a green revolution district
- a district dominated by cash crop district
- a coastal district
- a district in a mining/ industrial belt
- a district dominated by forest economy
- a dairy-farming district
- a district dominated by one or two urban centers
- a district in arid-zone

1.6 The Pilot project demonstration will facilitate development of decision support systems on "**production practices and systems**" which need to be adapted to respond to new market demands and export opportunities, poverty alleviation or growing labour shortages, depending on the setting [NATP98]<sup>ψ</sup>. The future growth in agriculture must come from [GBSingh2K]<sup>\*</sup> :-

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<sup>ψ</sup>[NATP98] National Agricultural Technology Project Document, 1998

<sup>\*</sup>[GBSingh2K] Professor G.B.Singh : Green Revolution in India - Gains and Pains", 21<sup>st</sup> Indian Geography Congress, Nagpur (India), January 2-4, 2000.

- (a) new technologies which are not only "cost effective" but also "in conformity" with natural climatic regime of the country;
- (b) technologies relevant to rain-fed areas specifically;
- (c) continued genetic improvements for better seeds and yields;
- (d) data improvements for better research, better results, and sustainable planning;
- (e) bridging the gap between knowledge and practice; and
- (f) Judicious land use resource surveys, efficient management practices and sustainable use of natural resources.

1.7 The Report has been organized into 5 Chapters. Chapter-1 deals with the terms of reference whereas Chapter-2 deals with various agricultural development schemes of various departments/ministries of the Central Government, which require agricultural resources information, and also various central government agencies/projects who generate agricultural resource information, the need for development of Agricultural Informatics in a coordinated manner. Chapter-3 spells out development of Information Systems and utility of Information resources, and Chapter-4 describes framework for Agricultural Resources Information System, decision support systems. Chapter-5 gives implementation strategy for pilot project demonstration, participating institutions, and Coordinating Agency. Chapter-6 elaborates the recommendations, which are required to be given due considerations.

1.8 The Report was finalised in the meeting held on 1<sup>st</sup> March 2000 under the Chairmanship of Dr.A.K.Kundra, Principal Advisor (Agriculture), Planning Commission and the Chairman of the Core Group-V.

## Chapter – 2

### Agriculture Resources Information System (AgRIS)

2.0 With the basic thrust on higher growth in food grain production and other agricultural commodities, increase in productivity and efficient use of resources in agriculture has received special emphasis all through the process of the development, since independence. The efficient use of available resources to maximize production and productivity requires **comprehensive and reliable information** on various facts of the agriculture. Hence the improvement in the existing agricultural information system is essential for better planning of agriculture resources and for evolving development strategies. Information Technology (IT) and its applications (informatics) have the potential to create major transformation in Indian agriculture, especially as India now has --- and is rapidly developing further - ---- infrastructure in Information Technology. Informatics for development includes:

- Data warehousing (Data Bases & Model Bases)
- Expert Systems & Knowledge Bases
- Networking (Internet, Intranet and Extranet)
- Geographical Information System (GIS)
- Application of Remote Sensing Data,
- Multi-media Information System
- Decision Technology System
- E-Commerce & E-Governance, and
- Digital Library

As an enabling technology, Information Technology (IT) plays an important role in the rapid economic growth and social transformation in the developing countries.

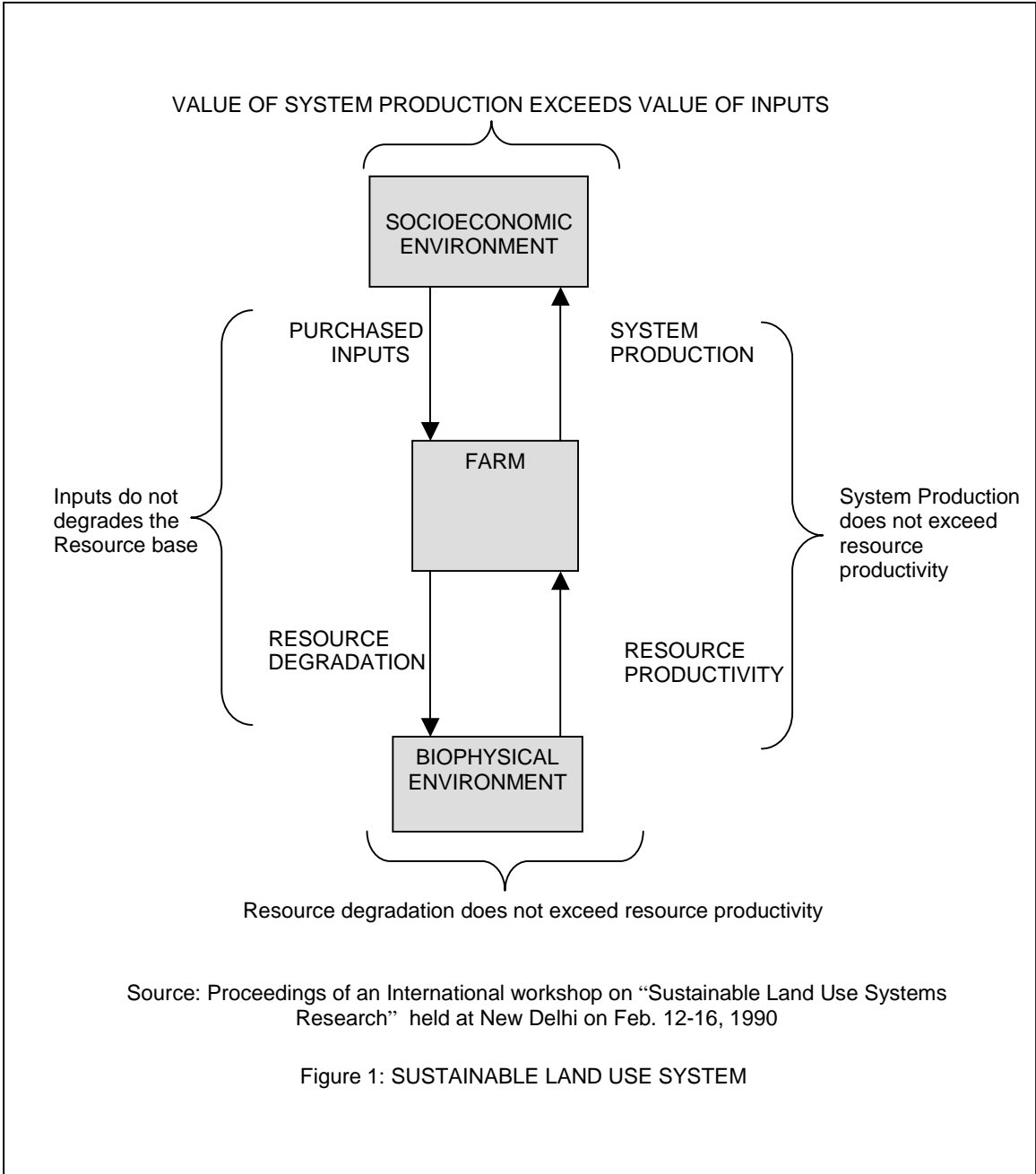
2.1 The need for information arises at the national, regional, grass-root, and individual levels. This requires (a) bridging the data gap and (b) improving information availability. In sustainable development, every one is a user and provider of information which includes data, information, and

appropriately packaged experience and knowledge. Integrated rural development and micro-level planning has been stressed for many years in the successive National Development Plans. Since India has different types of terrain, resources, climate, Socio-economic levels, administrative cultures, etc., the micro-level planning and modeling requires a "comprehensive village level spatial and non-spatial information systems". The Committee on "Study Group on Information Gap" of the Planning Commission (1989), recommended for the creation of Village level database on (i) Socio-economic, (ii) agro-economic, (iii) infrastructure, (iv) human resources and animal resources, and (v) natural resources (land and water). In order to achieve an economically sound society and environmentally benign development and utilization of natural resources, it is necessary that a comprehensive information system is developed to provide systematic and periodic information to the planners, decision-makers and developmental agencies.

## Sustainable Development

2.2 The growth in the agricultural output of the country in future would depend, to a significant extent, on the productivity of rain-fed farming. One of the main thrust in the future agricultural development strategies of the country would be the improvement in the capability of rain-fed areas. A sound **environment and resource base** are the prerequisites for sustainable development, which is defined as *"the progress that seeks to meet the needs and aspirations of the present without compromising the ability of future generations to meet their requirements"*. The perceived dependence of developmental activities on the exploitation of natural resources has been the most common factor against the achievement of sustainable development. Food and Agriculture Organization (FAO) has formulated the following definition for sustainable development in the context of agriculture, forestry and fisheries:

"Sustainable development is the management and conservation of the natural resource base and the orientation of technological and institutional change in such a manner as to ensure the attainment and continued satisfaction of human needs for the present and future generations. Such sustainable development (in the agriculture, forestry and fisheries sectors) conserves land, water, plant and animal genetic resources, is environmentally non-degrading, technically appropriate, economically viable and socially acceptable".



Both the Central and State Governments are involved in the formulation and implementation of policies and programmes, to achieve rapid agricultural development in the country. The Indian "*National Agricultural Research System (NARS)*" and the "*Extension Services*" Programmes provide necessary scientific research and training support for the agricultural development. Sustainable and optimum utilization of natural resources for agricultural development or "sustainable agricultural development" is given due importance in the recent past.

### **Economic Reforms Process**

2.3 Since July, 1991 the country has taken a series of measures to structure the economy and improve the balance of payments position. The New Economic Policy (NEP-1991) introduced changes in the areas of trade policies, monetary & financial policies, fiscal & budgetary policies, and pricing & institutional reforms, particularly with respect to the agricultural sector. The salient features of NEP-1991 are (i) liberalization (internal and external), (ii) extending privatization, (iii) redirecting scarce Public Sector Resources to Areas where the private sector is unlikely to enter, (iv) globalization of economy, and (v) market friendly state. This macro-economic adjustment programme is remarkable for its relatively painless transition compared with similar programmes elsewhere and a large part of the credit for absorption of these shocks is due to the steady increase in agricultural production.

2.4 Agricultural sector is the mainstay of the rural Indian economy around which Socio-economic privileges and deprivations revolve, any change in its structure is likely to have a corresponding impact on the existing pattern of social equality. **No strategy of economic reform** can succeed without sustained and broad based agricultural development, which is critical for (a) raising living standards, (b) alleviating poverty (c) assuring food security, (d) generating buoyant market for expansion of industry and services, and (e) making substantial contribution to the national economic growth. The GATT Agreement signed in 1995 has been a path-breaking development which will fundamentally change the global trade picture in livestock products.

## Indian Agriculture

2.5 India has a total geographical area (TGA) of 329 Million Hectares (MH) out of which about 265 MH represent varying degrees of potential for biological production [Randawa89]<sup>‡</sup>. It is reported that 143 MH has been categorized as Net Sown Area (NSA), 80 MH as under Forest & Pastures, 40 MH as under Cultivable Waste and Fallow lands. The Net Irrigated Area (NIA) increased from 21 MH in 1951-52 to 50.1 MH in 1992-93. It was projected that the end of 8th plan (1992-97) would develop 89.44 MH irrigation potential. Drylands, which constitutes about 70% of the NSA, are left to vagaries of weather and suffer from periodic drought. Drought Prone Area (DPA) is estimated to be in the order of about 260 MH, whereas 40 MH is flood-prone. [NWDB86]<sup>\*</sup> reports that wasteland is spread over 158 MH. About 12% of TGA is in arid region, which suffers from acute water scarcity. [Dhuruva89]<sup>‡</sup> report reveals that more than 50% of TGA is threatened by various types of land degradation, such as soil erosion, gully & ravine formation, salinity, water logging, shifting cultivation, etc. Out of Gross Rainfed Cropped Area, about 1/3rd receives more than 750 mm annual rainfall, while another 1/3rd receives more than 1150 mm annual rainfall.

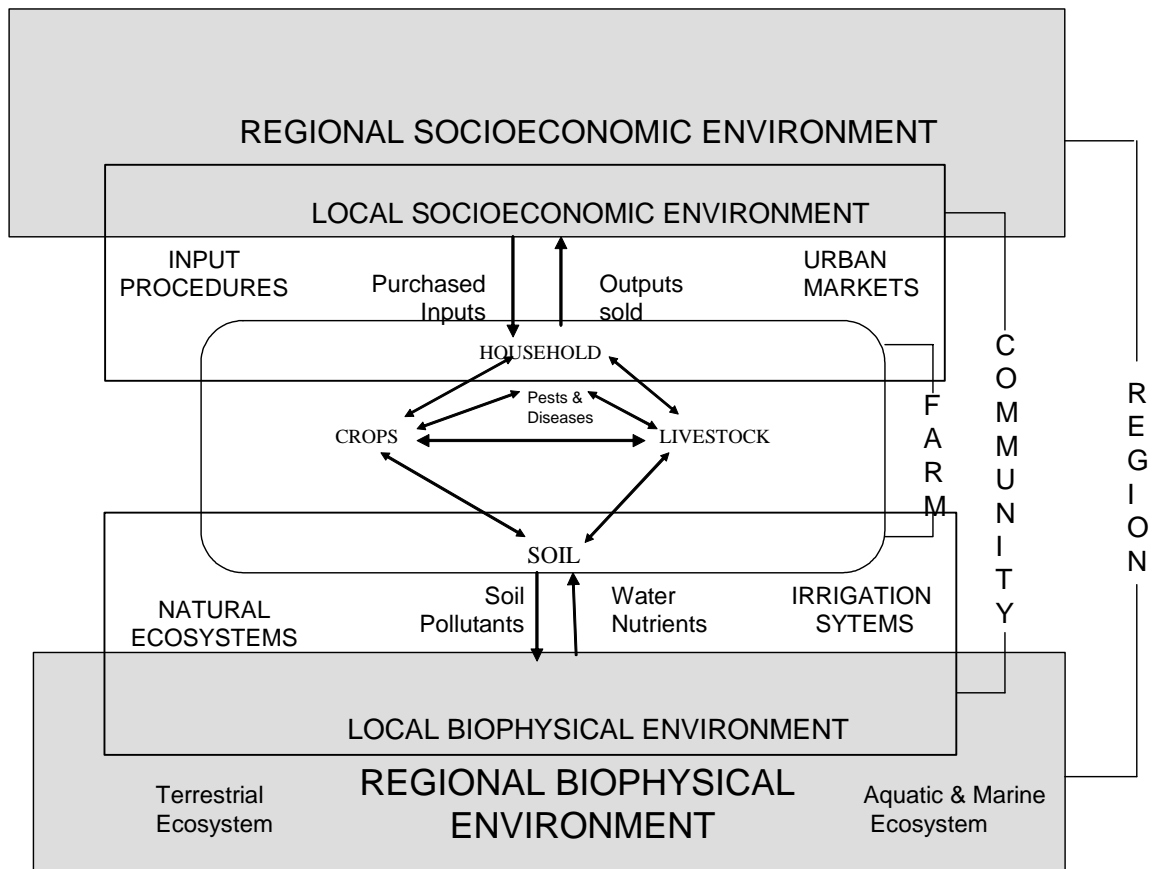
2.6 The Indian Agriculture provides employment to about 65% of the labour force, accounts for 27% of GDP, contributes 21% of total exports, and raw materials to several industries. The Livestock sector contributes an estimated 8.4 % to the country GDP and 35.85 % of the agricultural output. Production of Food Grains increased significantly from 55 Million Tons (MT) in 1949-52 to 199.3 MT in 1996-97. The average annual growth of food grains production during 1991-92 to 1996-97 was around 3.43%. Out of 143 MH NSA, 32.3% of the Land which is irrigated, produces about 58% of the Country's foodgrains, whereas 67.7% of the Land which is rainfed (unirrigated) contributes only 42% of the total foodgrains with low

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<sup>‡</sup>[Randawa89] Randawa, N.S : "Soil Resource Conservation for Agricultural developments", Indian Farming 39(7): 12-16

<sup>\*</sup>[NWDB86] National Wastelands Development Board Report, 1986

<sup>‡</sup> [Dhuruva89] Dhuruva Narayana,V.V & Prasad, B.S.N : "Soil and Water Conservation for better land & water management", Indian Farming 39(7):17-18



(Source : Proceedings of an International Workshop on "Sustainable Land Use Systems Research" held at New Delhi on February 12-16, 1990)

**FIGURE 2 : SYSTEMS FRAMEWORK**

productivity. As per the Agricultural Census (1990-91), the total number of operational holdings in India by Size Groups are as follows:-

Size Group	Operational Holdings	
	Number	Area
Marginal	59.44%	15.04%
Small	18.84%	17.41%
Semi-Medium	13.06%	23.19%
Medium	7.11%	27.04%
Large	1.55%	17.32%

2.7 Development of irrigation potential is considered as the key factor in the sustenance of "Green Revolution". Despite 50 years of development planning, rainfed agriculture is the largest and the most important sector of crop production in India. The growth of the agricultural output of the country, in future, will depend, to a significant extent, on the productivity of the rainfed farming. Integrated Watershed Development and Management has been recognised as an effective strategy for sustainable development of rainfed areas and agriculture in the country. The Ninth Five Year Plan Document (1997-2002 :Volume II) reveals that development of the vast rain-fed areas of about 90MH would require over Rs.37,000 Crores. Further, scientific treatment for soil and water conservation for 12 MH of arable and 3 M.H of non-arable land would require about Rs.7500 Crores. Development of rain-fed areas require a substantial public investment.

## Indian Fisheries Sector

2.8 India is the **seventh largest** producer of fish in the world and **ranks second** in the production of inland fish. Fish production has increased from 0.75 million tons in 1950-51 to 5.14 million tons in 1996-97, a cumulative growth rate of 4.2% per annum, which has been the fastest of any item in the food sector, except potatoes, eggs and poultry meat\*.

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\* Annual Reports of the Ministry of Agriculture

Main sources of fish are (I) Inland (ii) Marine and (iii) Brackish water. Besides fish, fisheries also includes production of prawns, shrimps, sea foods, etc. The Fisheries Sector has been playing an important role in Indian economy through employment generation, contribution of food and nutrition security and earning foreign exchange through exports. This sector has now become one of the fast growing areas of economic activity within the agricultural sector.

## Indian Livestock Sector

2.9 The Livestock sector contributes an estimated 8.4 % to the country GDP and 35.85 % of the agricultural output. India has about 19% of the World cattle and buffalo population and about 20% that of goats, and significant proportion of sheep, poultry, etc. **Indian Animal Husbandry is predominantly "rural" and an integral adjunct to crop husbandry.** India has a vast network of **scientific and research institutions** designed to support a **modernizing livestock sector**. Databases and Information Systems are essential for decision support for livestock development in the country, as the existing **livestock information system** is of poor quality. A globally significant role for the Indian Livestock System depends critically on India's ability to eradicate animal diseases. The GATT Agreement signed in 1995 has been a **path-breaking development** which will fundamentally change the global trade picture in livestock products. As an enabling technology, Information Technology (IT) plays an important role in the efficient use of available resources **to maximize Livestock production and productivity.** Information Technology (IT) and its applications (Informatics) have the potential to create major transformation in Indian Livestock Sector, which is an integral part of sound system of "**Diversified Agriculture**". The Ninth Plan sub-committee report has, therefore, envisaged to build up reliable databases and network based information systems for all activities of the Animal Husbandry and Dairying Sector, at district, state and national level, using NICNET facilities, to strengthen "Animal Production and Health Information System Network (APHNET)".

[MMoni2K]<sup>\*</sup> deals with an Information Technology Plan for the Livestock Sector and establish "Indian Livestock on-line" in the country.

## Agricultural Productivity

2.10 "Growth in Land Productivity" is due to "Pure Yield", "Pure Crop-pattern", "Pure location", and interaction among them. "Pure Location" is area based extensive farming and intensive agriculture. During pre-Green Revolution (GR) period, the decomposition is Area : Yield = 70%:30%. In Post-GR period, it is reversed. The source of growth due to "Pure Crop-Pattern" accounts for 1/6. The interaction between "crop-pattern and yield" is more important than the interaction between "location and Yield".

2.11 The Per-Hectare Productivity of Rice is 1/4th of Japan and that of Wheat is 1/3rd of France. The Per-Worker Productivity of India is at 33rd rank when compared with Germany, and 23rd rank when compared with U.S.A. As there is a wide gap between "Average Yield" in the World and India for almost all the crops, which makes Indian agricultural sector globally un-competitive for exports and attractive for imports. Agricultural producers in developed countries enjoy considerable advantage of (i) scale of economy, (ii) low cost of energy, and (iii) capital. Indian farmers have advantage of low wage rates only.

2.12 Rational Integration of important **seven** "ins", namely, Incentives (Prices), Inputs (water, fertilisers, equipments, ), Innovation (HYV, irrigation, ), Information (agricultural extension), Infrastructure (Roads, Markets, etc), Institutions (Credit), Investments in Human capital (Education, Health, etc ), will bring in about optimal outcome of agricultural production. Non-product Price factors like agricultural research and extension, government investment in agriculture, farm subsidies, agricultural credit are highly important in facilitating increase in agricultural productivity.

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\*[MMoni2K] M.Moni : "NICNET based Animal Production and Health Informatics (APHNET) in India - Reaching Technology to the Small Holders (Resource-Poor-Farmers) through Information Technology", Veterinary Council of India Seminar, New Delhi (India), 30-31, January 2000.

## Constraints faced by Indian Agriculture

2.13 The major constraints faced by the Indian Agriculture are as follows:-

- Resource Constraints - capital starved (research, education, irrigation, flood control, drainage) - inadequate credit flow - No private investment - Heavy losses w.r.t irrigation, power
- Infra-structural constraints at grass-root, regional and national to take benefit of supply-chain model
- Institutional constraints: Consolidation of Holdings, Updation of land records, Regulation of tenancy
- Technological constraints: High Yield Variety (HYV) seeds for rainfed areas
- Policy induced limitations

2.14 In order to facilitate agricultural development, the following areas require immediate attention from the policy makers and planners :-

- ❖ Development of natural resources and protection of environment
  - development of land resources
  - development of water resources
  - protection and conservation of bio-diversity
  - protection of environment
- ❖ Food and nutritional security
- ❖ Diversification of Agriculture (Horticulture, animal husbandry and livestock, fisheries)
- ❖ More efficient management of inputs (seeds, fertilisers, plant protection and mechanisation)
- ❖ Development of rural infrastructure (rural roads, irrigation, and power)
- ❖ Marketing and value addition (rural markets, post-harvest management, agro-processing)
- ❖ Revitalisation of cooperative institutions
- ❖ Improving rural credits
- ❖ Research, education and extension
  - Technology generation - Indian Agricultural research system

- Education
- Extension
- ❖ Human Resources Development (farmers and agricultural labourers, NGOs, and Panchayat Raj Institutions)
- ❖ Trade and export promotion
- ❖ Land Reforms
- ❖ Enabling environment for higher agricultural growth
  - Relaxation of restricting controls and regulations
  - Parity with Industry
  - Increased private-Public partnership
  - Agricultural taxation
- ❖ Risk management
  - Crop insurance
  - Remunerative price Regime
  - Capital formation
  - Targetted Subsidies
- ❖ Management of Agriculture
  - Macro-management of Agriculture
  - Use of Information Technology
  - Plan of Action

### **Ninth Plan Strategy on Agricultural Development**

2.15 The agricultural development strategy for the Ninth Five Year Plan is essentially based on the policy on food security announced by the Government, to double the food production and make India hunger free in ten years. The Strategy to ensure food security is as follows:-

- Doubling food production
- Increase in employment & incomes
- Supplementary/sustained employment and creation of rural infrastructure through Poverty Alleviation Programmes (PAP)
- Distribution of food grains to the people Below Poverty Line (BPL)

The Ninth Plan Target is to achieve a growth rate of about 4.5% per annum agricultural output and production of 234 MT of food grains by

2001-02. The Policy thrust and key elements of Growth strategy, as proposed in the Ninth Five Year Plan Document (Volume II : PP444), are as follows:-

- Conservation of land, water, and biological resources
- Rural infrastructure development
- Development of rainfed agriculture
- Development of minor irrigation
- Timely and adequate availability of inputs
- Increasing flow of credit
- Enhancing public sector investment
- Enhanced support for research
- Effective transfer of technology
- Support for marketing infrastructure
- Export promotion

### **Information for decision making**

2.16 The major objective of Sustainable Agriculture and Rural Development is to **increase food production** in a sustainable way and enhance food security. The **Agenda-21** recommends major **adjustments in agricultural, environmental and macro-economic policy** to create the conditions for the Sustainable Agriculture and Rural Development. Recommendations of the United Nations Conference on Environment and Development - Agenda 21 (1992) on "**Information for decision making**" are as follows:-

- development of indicators for sustainable development,
- promotion of global use of indicators for sustainable development,
- improvement of data collection and use,
- improvement of methods of data assessment and analysis,
- establishment of comprehensive information framework,
- strengthening of capacity for traditional information,
- production of information usable for decision making,
- development of documentation about information,
- establishment of standards and methods for handling information,

- establishment and strengthening of electronics networking
- capabilities, and
- making use of commercial information sources.

## **Agricultural Informatics and Communication**

2.17 Agricultural planning and development require (a) knowledge about recent progress in agriculture, (b) the existing situation (especially the main problems impeding development), and (c) the potentialities for achieving agricultural objectives. This information is needed for re-assessing current investment and other development activities as well as for planning new measures, setting benchmarks against which to monitor progress. Proper analysis of the agricultural sector requires that it is seen as a system of functionality inter-related and inter-dependent elements, each of which contributes to the existing and potential level of performance of the sector. A stocktaking and diagnostic survey is needed early in the planning process to provide information about the wide range of factors influencing agricultural performance.

2.18 Informatics for agricultural development requires coordinated inter-sectoral approach and application of appropriate Information Technology (I T) tools, in the areas of

- Agricultural Research,
- Agro-meteorology,
- Agricultural Marketing,
- Agricultural Engineering and Food processing,
- Agricultural Extension and Transfer of Technology,
- Credit & Co-operation,
- Crop Production and Protection,
- Environment & Forest,
- Fertilizers and Manure,
- Fisheries,
- Irrigation and Drainage Systems,
- Livestock, Dairy Development and Animal Husbandry,
- Rural Development and Planning,

- Soil and Water Management,
- Watershed Development, and
- Wastelands Development

2.19 To facilitate formulation of the National Policies and Programmes, Ministry of Agriculture (MOA) has established an Institutional arrangement with the State Agricultural Departments for information collection, through its Directorate of Economics and Statistics (DES). In addition to this, DES has also established its regional offices to collect information on agricultural situation in the country periodically. Indian Council of Agricultural Research (ICAR), Department of Agriculture & Cooperation (DAC), and Department of Animal Husbandry & Dairying (DAH&D) also receive information on various Programs/Schemes from the Scheme implementing Agencies. MOA have established Directorates, Attached/Sub-ordinate offices, Boards (NHB, CDB), Public Sector Undertakings (NSC, SFCI), and ICAR Institutes/Directorates (89), to facilitate **development, education, extension, husbandry, marketing, production, and research**. State Governments have also established agricultural institutions/agencies in district and sub-district levels.. These institutions/agencies generate information on **development, education, extension, husbandry, marketing, production, and research**. Agricultural Census generates information on **operational holdings** level where as Livestock Census generates information on **village** level. MOA implements the following agricultural related Schemes (**whether Watershed based or Agro-climatic region based**) in the country, which require **agricultural resources information** for Planning and Development:-

- (a) Agro-climatic Regional Planning (ACRP) Project of the Planning Commission
- (b) Agro-Ecological Mapping Project of the National Bureau of Soil Survey & Land Use Planning (NBSS&LUP) of the ICAR
- (c) All India Soil and Land Use Survey (AI SLUS) of DAC
- (d) Early Warning System of Agricultural Situation in India
- (e) Forecasting of **Agricultural** output using **Space, Agro-meteorology** and **Land based** observations (FASAL) Project
- (f) National Agricultural Research Project (NARP) of the ICAR
- (g) National Agricultural Technology Project (NATP) of ICAR to strengthen **research-extension-farmer (r-e-f)** linkage

- (h) National Watershed Development Program for Rain-fed Areas (NWDPA) of DAC
- (i) Soil and Water Conservation Programs of DAC
- (j) Drought Prone Area Development programme of DLR
- (k) Dessert Development Programme of DLR
- (l) National Wastelands Development programme of DLR
- (m) Integrated Mission on Sustainable Development (IMSD) Programme of DOS & DRD

2.20 These projects have generated volume of information, which are available with the respective agencies. In addition, Indian Space Research Organisation (ISRO), using RS Techniques have developed certain models for **Integrated Agricultural Development** at regional levels, under the **Integrated Mission for Sustainable Development (IMSD)** Projects. The Front Line Extension projects of the ICAR operated through Krishi Vigyan Kendras (KVKs) have also generated considerable amount of information relevant to agricultural development at district levels. Under the NARP of the ICAR, 126 Zonal Research Stations (ZRS) are engaged in generating **location specific farm technologies**. These projects/Schemes are explained briefly in the following sections.

### **Forecasting of Agricultural output using Space, Agro-meteorology and Land based observations (FASAL) Project**

2.21 Development of Agricultural Statistics and Agro-economic Research assumes great significance in the country for formulation of agro-economic policies and programmes. The main thrust, at present, is to improve the timeliness, coverage and quality of agricultural statistics and research required for decision making on various policy issues and planning purposes. Directorate of Economics and Statistics (DES) of the Ministry of Agriculture is responsible for collection, compilation and processing of agricultural statistics in the country. DES operates the following schemes to strengthen agricultural statistics in the country:-

#### Central schemes

- Comprehensive Schemes for studying the Cost of Cultivation of principal crops
- Crop estimation Surveys of Fruits, Vegetables and Minor Crops
- Agricultural Census and Input Survey

### Centrally Sponsored Schemes

- Establishment of Agency for collection of Agricultural Statistics (EARAS)
- Improvement of Crop statistics
- Timely reporting of estimates of Areas and production of principal crops

2.22 **Crop forecasting** is an essential component of Agricultural Statistics System in the country. Timeliness and reliability are the main considerations in any forecasting system. The present crop forecasting system in the country is designed to provide crop forecasts for a large number of food and non-food crops, and these estimates become available much after the crops are harvested. **National Crop Forecasting Centre (NCFC)** of DES prepares timely forecasts/advance estimates based on the reports received from state and central governments departments, etc., to facilitate Policy decisions on production, procurement/ distribution, marketing, export/import, etc.

2.23 **FASAL** Project, a joint venture project of the Department of Space (DOS) and DAC, envisages advance reliable assessment of crop acreage and production using RS techniques and other databases available in conventional methods. Satellite data has proven a useful tool for monitoring agriculture because satellite instruments can provide accurate measurements of **cultivated land** and can distinguish a range of different crop types. **Radar remote sensing** is appropriate for **monitoring cultivated areas**, as they are most often **cloudy and rainy**. **Synthetic Aperture Radar (SAR) on board satellites** can also provide re-visit schedules for agricultural monitoring. The project "FASAL" envisages the following:-

- (a) reception of real time data at NCFC from National Data Centre (NDC) of NRSA, Hyderabad
- (b) transfer of Remote Sensing, current & historical database between NCFC and state/regional level work centres
- (c) to get processed data and results interactively from NCFC
- (d) update and maintain common database of historical as well as in-season data
- (e) access of raw and processed data for query and emergency requirement of NCFC.

The proposed AGRISNET is expected to strengthen and facilitate the project "FASAL" in achieving its objectives.

### **Early Warning System of Agricultural Situation in India**

2.24 DAC has established a "**Weather Watch System**" for decision support, which receives information from both State Governments and the concerned Central Government Departments such as IMD, Water Resources, etc., through official channel. The present institutional arrangement of DAC to collect information on "**agricultural situation**" in the country has not been able to produce an "**early warning system**" to DAC. In order to have information on "agricultural situation" timely and accurately to facilitate decision support, DAC decided to establish an "early warning system" using INTERNET and INTRANET Technology tools, which will be an independent informatics network for DAC, in addition to the existing institutional arrangement with the State Governments, .to facilitate priority action on matters related to (i) agricultural produce and (ii) agricultural commerce and trade. This requires design and development of an information system based on state-of-the-art IT tools and Networking Technology, and also an **on-line Decision Support System based on agricultural database and analytical model base**. In this context, DAC planned to create :

- ❖ A National Agricultural Informatics Centre in DAC
- ❖ A live Informatics Network for flow of information from field to DAC (Krishi Bhawan)

2.25 The proposed National Agriculture Informatics Centre (NAIC) of DAC would be a **reservoir of all data** related to agriculture and receive data for update from this **independent information system** network. The type of information to be collected is as follows:-

- (a) Acreage expected by crops
- (b) Availability of inputs (fertilizers, seeds, pesticides, credit, power, irrigation, etc)
- (c) Condition of standing crops, pest attacks, if any
- (d) Harvesting activities, activity of labor, etc
- (e) Marketing and price trends, and
- (f) Preparation of land for the ensuing crop
- (g) Progress in sowing and transplantation activities,

- (h) Progress of rains, flood, drought conditions, if any
- (i) Weather condition (in general)
- (j) Allied agricultural activities such as livestock, horticulture, etc

2.26 The required information will need to be **crop-specific** and discrete enough to reflect changes in the situation from day to day. To begin with, the required information will be mainly on **Rice, Wheat, Cotton, Sugarcane, Potato, Onion, Rapeseed & Mustard, Groundnut, and Pulses**. It can cover all the "forecast" crops under this EWS later. An indicative list of topics to be covered for each crop grown in the area is as follows:-

- (a) Availability and usage of Seeds/Fertilizers/Pesticides
- (b) Credit use
- (c) Crop glut /failure situations
- (d) Crop sowing pattern
- (e) Disease outbreaks
- (f) Distribution network
- (g) Harvesting/post harvest technology
- (h) Impact of Central/state/local policies on agriculture
- (i) Irrigation facilities
- (j) Manpower usage
- (k) Marketing of produce - Market prices
- (l) Production
- (m) Storage of produce
- (n) Usage of mechanical/electrical equipment
- (o) Weather conditions, and
- (p) Any other happening related to agriculture

### **Agro-climatic Regional Planning (ACRP) Project**

2.27 Agro-Climatic Regional Planning Project (ACRP) of the Planning Commission aims at more scientific utilization of available resources, both natural and man-made, for sustainable agricultural development. After completion of its zonal (15) and sub-regional (73) level, ACRP has embarked upon district/sub-district level exercise as part of the decentralized planning framework. ACRP is associated with a more **diversified agriculture** encompassing *agro-processing, animal husbandry, crop husbandry, dairying, fishery, floriculture, horticulture, and poultry*, for the agro-meteorologically homogeneous regions and sub-regions.

2.28 Data bases on demographic, infrastructure facilities, natural resources endowment, and socio-economic indicators of each of agro-climatic regions, sub-regions, zones and sub-zones, in a multi-level framework with village level resolution, over an efficient data communication system, is an essential requirement for ACRP. In order to strengthen database component of ACRP, the Planning has sponsored **Agro-Climatic Planning and Information Bank (APIB)** project to DOS. This project is under implementation in 3 districts in the State of Karnataka. Apart from giving the basic day-to-day agricultural information, APIB is aiming towards better management of the agriculture sector through supply of relevant information for **increasing** crop productivity, **diversification** of agriculture, **promoting** sustainable agriculture, and **supporting** the national agricultural research system. The Ninth Plan Sub-Committee on Agro-Climatic Regional Planning (ACRP) has recommended making the NARP Centres (127) responsible for strengthening databases for decision support facilitating agricultural development.

### **National Agricultural Technology Project (NATP)**

2.29 Ministry of Agriculture has initiated National Agriculture Technology Project (NATP), funded by the World Bank, during the Ninth Five Year Plan Period (1997-2002). Indian Council for Agricultural Research (ICAR) in close collaboration with the Department of Agriculture & Cooperation (DAC) is implementing the National Agricultural Technology Project (NATP). This project is expected to augment the national capacity and efficiency in agricultural research, technology development and transfer of technology for increasing agricultural productivity and profitability on a sustainable basis.

2.30 The Directorate of Extension of DAC has been given the responsibility of **agricultural extension component** of NATP for implementation. Under NATP, it has been envisaged to set up **Agricultural Technology Management Agency (ATMA) in 25 pilot districts** and in blocks of these districts, to provide on-line Agricultural Information to the farmers, NGOs, etc., using the **state-of-the-art** Information Technology and computer networks,

facilitating linking of various agricultural related institutions, district level LANs, Agricultural Radio Stations, Agricultural TV broadcasting and computer based multi-media based interactive packages, interactive satellite education, etc NATP envisages **database development on Agriculture and allied sectors** at district level to strengthen decision support and information dissemination in district as well as sub-district (block) levels.

2.31 **Agricultural Research Information System (ARIS)** of ICAR focuses on the development of an information system which is strategically important sub-component in the management of **NATP**. **ARIS** aims at developing an implementation strategy with definite objectives for making full use of the opportunities for agricultural research and technology dissemination for overall development of sustainable development. **Natural Resource Management Division** of ICAR is responsible for "development of databases and GIS" to strengthen NATP, both in centralized and decentralized pattern, viz.

- (a) animal husbandry database,
- (b) climatic database,
- (c) crop-wise database,
- (d) fisheries database,
- (e) genetic material database,
- (f) natural resource database, and
- (g) socio-economic database.

2.32 This **Database Project** component has been taken in a mission mode with the involvement of the following Institutions:-

- (a) Central Plantation Crops Research Institute (CPCRI)
- (b) Central Research Institute for Dryland Agriculture (CRI DA)
- (c) Directorate of Water Management Research (DWMR)
- (d) Indian institute of Horticulture Research (I I HR)
- (e) Indian Institute of Spices Research (I I SR)
- (f) National Bureau of Animal Genetics Resources (NBAGR)
- (g) National Bureau of Fish Genetics Resources (NBFGR)
- (h) National Bureau of Plant Genetics Resources (NBPGR)
- (i) National Bureau of Soil Survey & Land Use Planning (NBSS&LUP)
- (j) National Centre for Agricultural Economics and Policy Planning (NCAP)
- (k) National Informatics Centre (NIC)

- (l) National Research Centre for Agro-Forestry (NRC-AF)
- (m) Project Directorate for Cropping Systems Research(PD-CSR)

## National Watershed Development Project in Rainfed Areas

2.33 “Watershed” is a geo-hydrological unit of area for the **development of rainfed farming**. National Watershed Development Project in Rainfed Areas (NWDPR) is implemented in 2479 **watersheds** in as many blocks of 350 Districts in all the States and Union Territories with peoples's participation at planning and implementation stages. NWDPR extends to more than 10,000 villages, involving more than 10 Million people and 5 Million cattle in 115 Agro-Climatic Zones. NWDPR has been operational in (i) *arid and semi-arid areas*, (ii) *extremely high monsoon areas*, (iii) *marshy plains*, (iv) *mountainous uplands*, (v) *saline coastal areas*, and (vi) *waterlogged lowlands*. NWDPR endeavors to achieve sustainable production of bio-mass and consequent restoration of ecological balance in the vast tracts of rain-fed areas in the country. At the State level, the following **State Departments** are involved in implementing watershed development activities:-

- Agriculture
- Animal Husbandry
- Fisheries
- Forestry
- Horticulture
- Minor Irrigation
- Rural Development, and
- Soil Conservation

2.34 National Watershed Development Programme in Rainfed Areas (NWDPR) contains features of programmes such as *Drought Prone Area Development Programme (DPAP)*, *Desert Development Programme (DDP)*, and *Integrated Watershed Development Programme (IWDP)*, with the additional dimensions of improving arable lands through better crop management technologies. Watershed Management being a multi-disciplinary and long term approach, the keys to successful implementation of any such effort are **accurate and appropriate survey, planning and monitoring**. Food & Agriculture Organization (FAO) recommends **four levels** of survey and planning to be taken up at:

- (a) National level quick reconnaissance survey using RS Techniques and Aerial Photographs for identifying major watershed problems and areas.
- (b) District level survey and planning for a cluster of watershed or in conjunction with regional development plans.
- (c) Watershed and sub-watershed level for planning and economic analysis.
- (d) Farm or community level to improve farm management and community development with the watershed area.

2.35 The Report of the Planning Commission's Sub-committee on 'Databases for 25 Years Perspective Plan for Development of Rainfed Areas (1996)' recommended :-

- (a) Application of Remote Sensing data for development of watersheds,
- (b) Development of Expert Systems/Knowledge bases for watershed management,
- (c) Development of Multimedia applications on rain-fed area development strategies,
- (d) Development of Decision Support Systems (DSSs),
- (e) Establishment of Geographic Information System (GIS) facilities at Central, State, District level for overlay and analysis of spatial and non-spatial data sets, and
- (f) Linkages with different institutions involved in Watershed Management for Rain-fed areas.

## **Soil and Water Conservation (SWC) Programmes**

2.36 Soil and Water are essential prerequisites for the primary agricultural production systems. According to the recent statistics on Land Resources of India, it is found that more than 50% of the Total Geographic Area (TGA) of 329 Million Hectares, about 173.64 Million Hectares (53%) face *environmental degradation* problems arising from *alkalinity, ravines, salinity, shifting cultivation, water logging, water erosion, and wind erosion*. Extensive and intensive land-use for agriculture, not only has increased soil erosion problems, but also has generated problems like water-logging, salinity, acidity, nutrient stress, etc. It is estimated that, in the year 2000 AD, the *per-capita availability of land* is likely to decline from

0.89 hectares in 1952 to 0.33 hectares. It is, therefore, essential at this juncture, *to plan for sustainable land use from village level (Figures-#)*, providing scope for the resources development, in a long term perspectives. The main objectives of **SWC** programmes are:

- prevention of land degradation and reclamation of area,
- improvement of productivity,
- management of resources, and
- human Resources Development

2.37 Implementation of SWC Programmes are strengthened by (i) All India Soil and Land Use Survey (AISLUS), (ii) State Soil Survey Organizations, (iii) National Land Use Board, (iv) State Land Use Boards, and (v) Soil Conservation Training Centre (Hazaribagh). In order to strengthen SWC Programmes, State Governments have also set up separate State Soil and Survey Department in many states viz. *Assam, Bihar, Kerala, Maharashtra, Manipur, Meghalaya, Nagaland, Orissa, and Punjab*. SWC schemes as well as the supporting organizations generate voluminous resources data which can be used for decision support and policy making.

### **National Agricultural Research System**

2.38 An excellent agricultural knowledge system has been established through appropriate *agricultural research and education* by State Agricultural Universities (SAU-28), Central Agricultural University (1), and ICAR Deemed Universities (CIFE, IARI, IVRI, NDRI) and ICAR Institutes/PDs/NRCs (85) located throughout the country. About 120 Zonal Research Stations (ZRS) of ICAR are engaged in generating *location specific farm technologies* and disseminating through local developmental agencies. **All India Coordinated Research Projects (AICRP)** provide a *nationwide, cooperative and Interdisciplinary research network linking ICAR institutes with SAUs* to focus attention of commodities and species of national importance.

2.39 Research Institutes carry out basic and fundamental research on problems related to (i) *a commodity* (e.g. rice), (ii) *a group of*

*commodities* (e.g. plantation crops), (iii) *a discipline* (e.g. soil science), (iv) *a geographical area* (e.g. Islands), (v) *an ecological area* (e.g. arid zone), (vi) *a technology* (e.g. jute), and (vii) *a specific issue* (e.g. soil salinity). This kind of research activities requires **agricultural resources information** on a **state-of-the-art** IT Tools platform. ICAR Institutes and SAUs have a **network of Regional Stations or sub-stations** to cover diverse agro-ecologic areas for developing suitable technologies. **National Bureaus are established to collect and conserve basic resources (plant genetic, animal genetic, fish genetic and land) of agriculture.** National Research Centres (NRC) are the "Centres for Fundamental Research" in specific areas to provide basic research support to agricultural sciences. NRCs feed the National Network of Research Institutions with raw materials, technology and information for subsequent adoption in different production-oriented research programmes.

2.40 Implementation of the recommendations of the UN Conference on Environment and Development (**Agenda-21**) in respect of the development of information systems is essential for decision making for sustainable agriculture and rural development. Agenda-21 of UNCED, FAO and UNEP, International Board for Soil Research and Management (IBSRM), and CGIAR centres, have recognized the importance of ***Soil, Water and Nutrient Management (SWNM) research*** to facilitate sustained production, keeping intact or improving the essential qualities of the *land and water resources*. SWNM research requires a sophisticated **Information System Network** to share information between the national programmes, and to facilitate the sharing of results between "*users of land and water*" and those engaged in "*research related to land and water use*".

2.41 In order to strengthen information management within the National Agricultural Research System (NARS), ICAR has initiated Agricultural Research Information System (ARIS) Project. ***Agricultural Research Information System Network (ARISNET) over NICNET*** envisages to link 89 ICAR institutions, 28 State Agricultural Universities, 107 Agricultural University Colleges, 261 Krishi Vigyan Kendras (KVK), and about 850 Agricultural Research Stations in the Country. ***Agricultural Research Information System (ARIS)*** of ICAR

focuses on the development of an information system, which is strategically important sub-component in the management of NATP.

### **Natural Resources Information System (NRIS) - Linkage and Networking Project**

2.42 Remote Sensing has provided a new impetus for the earth, resource and environmental scientists. Increasing population and diminishing resources have compelled us to consider better ways for management of natural resources. The Indian Remote Sensing satellite System (IRS) has become the mainstay of the *National Natural resources Management System (NNRMS)* for effectively managing natural resources of India. National Remote Sensing Agency (NRSA), a premiere institution of the Department of Space (DOS), receives the satellite data, and distributes it after processing. Data from IRS is used for several applications such as

- (a) agricultural crop acreage and yield estimation,
- (b) drought monitoring and assessment,
- (c) flood mapping
- (d) forest resources survey
- (e) land use and land cover mapping
- (f) mineral prospecting
- (g) ocean/marine management
- (h) wasteland management, and
- (i) water resources management

2.43 The Committee Report on *Natural Resources Information System (NRIS) - Linkage and Networking Project* of DOS, envisaged about 435 district level NRIS Nodes in conjunction with DISNIC Nodes of NIC, 26 state level NRIS Nodes, 182 NRIS project Nodes (7 Themes and 26 States), and 42 NRIS Regional Nodes (7 themes and 6 regions). NIC has implemented "*Natural Resources Information System (NRIS) - Linkage and Networking Project*" in its pilot project districts. DLR through its land resources development programmes, DAC through its NWDPPRA Projects, and DST through its NRDMS Projects, have been involved in the implementation/development of *Natural Resources*

*Information System (NRI S) to strengthen their schemes through their implementing agencies.*

## **Integrated Mission of Sustainable Development (IMSD) project**

2.44 **Integrated Mission of Sustainable Development (IMSD) project** of the Department of Space, aimed at generating locale specific action plans by integrating resources information, as derived from satellite data in conjunction with socio-economic data, for natural resources development in a sustainable manner. IMSD Project have drawn data from DISNIC databases available in various districts. IMSD project provides (i) spatial information on various **natural resources** viz. *ground water prospects, land use, slope, surface water bodies, etc.*, and also (ii) the *action plan maps* for land and water resources development on 1:50000 scale. IMSD project covers about 84 Million Hectare (MHa) area in 175 districts of the country.

## **National Atlas and Thematic Mapping Organization (NATMO)**

2.45 Maps and Atlases prepared by NATMO, based on *geographical researches, cartographic expertise, quantitative techniques* together with the *application of remote sensing data*, have details on *the status of the Indian agricultural, likely changes and other parameters related to sustainability of agricultural practices.* ***Agricultural Atlas, Land Resources Atlas, Forest Atlas, Irrigation Atlas and Water Resources Atlas of NATMO provide basis for the development of GIS on the Agricultural Sector.*** NATMO has also brought out District Planning Map Series (DPMS), under the DST sponsored Project, in about 200 districts of the country. These atlases have the following information on agriculture:-

- Agricultural Markets
- Agricultural Regions
- Agricultural Labour
- Crop Region
- Cropping & Farming
- Crops & Plantations
- Drought Areas
- Ground Water
- Irrigation
- Land Capability
- Land Holdings

- Land under Cultivation
- Land use
- Livestock
- Pressure on Land
- Rainfall
- River Basin/Drainage
- Rural Population Density
- Rural Population
- Rural Settlements
- Soil Cover
- Soil Fertility
- Soil Reaction
- Soil Regions
- Soil texture
- Surface Runoff
- Water Balance
- Water Resources

## All India Soil & Land Use Survey (AISLUS)

2.46 AISLUS of DAC deals with inventorying of soil and land resource survey for agricultural and non-agricultural development programmes. AISLUS undertakes (i) *prioritization of watersheds in the catchment areas*, (ii) *soil and land resource mapping of selected watersheds*, and (iii) *district-wise land degradation mapping on 1:50,000 scale using RS techniques*. AISLUS has brought out Watershed Atlas on 1:1,000,000 scale, which provides a **uniform delineation and codification system** of the watersheds that could be followed by all concerned agencies dealing with watershed approach, on a common basis. State Governments may take up the work of preparation of Watershed Atlas for their States on the lines of the Watershed Atlas of India for a uniform delineation and codification of micro-watersheds, as has been done in the State of Tamilnadu\*. The whole country has been divided into **six river resources** regions, 35 basins, 112 catchments, 550 sub-catchments and 3,237 watersheds, and the **digital watershed atlas** provides the polygon level of information depicting the name of the rivers belonging to the river resource region, basin, catchment, sub-catchment, watershed along with codes, besides the extent and the district and State it flows when a cursor is placed on the map.

## National Bureau of Soil Survey and Land Use Planning (NBSS&LUP)

2.47 NBSS&LUP, a premier Institute of ICAR, is with the mandate to prepare *soil resources maps at state and district level*, and also to provide

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\* Sub-Committee Report on "Development of Databases for Rainfed Areas" of the Planning Commission's Committee for the preparation of a "25 Years Perspective Plan for the Development of Rainfed Areas", 1996

research inputs in *land evaluation, land resource management, land use planning, RS applications, soil correlation & classification, soil genesis including soil mineralogy and soil micro-morphology, soil resource mapping*. The Bureau has the mandate to correlate and classify soils of the country and maintain a National Register of all the established soil series. The Bureau has been carrying out *agro-ecological and soil degradation mapping* at the country, state, and district levels for qualitative assessment and monitoring the soil health towards viable land use planning. NBSS&LUP has generated ***state-wise soil survey information*** of the whole country, through the Soil Resource Mapping Project, and also developed **DSS on land evaluation procedures** viz. *land capability classification, land productivity index, soil-site suitability analysis for land utilization types*, to obtain cropping plans for the district. NBSS&LUP also brings out a series of district based information entitled "Soil based land Use Planning Series" under the Soil Resource Mapping Project. NBSS&LUP is the Nodal Agency for implementing the NATP Database Component ***"Digitization of Databases"*** in collaboration with the ICAR Institutes.

## **Land Resources Development Programme**

2.48 Department of Land Resources of the Ministry of Rural Development deals with:-

- Land reforms, land acquisition, land revenues, land records and other related matters.
- Promotion of rural employment through Wastelands Development.
- Promotion of production of fuel wood, fodder and timber on non-forest lands, including private wastelands.
- Research and development of appropriate low cost technologies for increasing productivity of wastelands in sustainable ways.
- Inter-departmental and inter-disciplinary coordination in programme planning and implementation of the Wastelands Development Programme, including training.
- Promotion of people's participation and public cooperation, and coordination of efforts of Panchayats and other voluntary and non-Government agencies for Wastelands Development.

Programmes/ Schemes of Department of Land Resources are as follows:-

- Land Reforms.
- Drought Prone Area Programme

- Desert Development Programme
- Integrated Wastelands Development Scheme

The Land Reforms Policy adopted, since Independence, aims at

- *restructuring agrarian relations to achieve an egalitarian social structure;*
- *elimination of exploitation in land relations;*
- *realizing the age-old goal of land to the tiller;*
- *increasing agricultural productivity and production and infusing equality in local institutions.*

DLR has sponsored **projects for Land Records Computerisation, in association with NIC, in 534 districts in the country, under the Centrally Sponsored Scheme for "Strengthening of Revenue Administration & Updating of land Records (SRA & ULR)"**, with an budget outlay of Rs.162.74 Crores.

### **Drought Prone Areas Programme (DPAP)**

2.49 The basic objective of the Drought Prone Areas programme (DPAP) is

- **to minimize the adverse effects of drought on the production of crops and livestock and productivity of land, water and human resources**, thereby ultimately leading to the drought proofing of the affected areas,
- **to restore** ecological balance by harnessing, conserving and developing natural resources, i.e. land, water, vegetative cover, and raising land productivity, and also
- **aiming at** promoting the overall economic development and improving the socio-economic condition of **the resource poor** and disadvantaged sections inhabiting the programme areas.

These areas are characterized by large **human and cattle populations** which are continuously putting heavy pressure on **the already fragile natural resource base for food, fodder and fuel**. This continuous biotic pressure is leading to fast and continuous depletion of *vegetative cover, less and less rainfall, increasing soil erosion and fast receding ground water level*, due to continuous exploitation without any effort to recharge the underground

acqifers. Since 1995-96, a new approach based on watershed development has been adopted and so far **6454 watershed development projects** have been sanctioned for implementation in 13 States through local communities\* .

## Desert Development Programme

2.50 On the recommendations of the National Commission on Agriculture in its Interim Report (1974) and the Final Report (1976), the Desert Development Programme (DDP) was started in the year 1977-78, with the objective:

- to mitigate adverse effects of desertification and adverse climatic conditions on crops, human and livestock population, combating desertification.
- To restore ecological balance by harnessing, conserving and developing natural resources, i.e. land, water, vegetative cover, and raising land productivity

This programme is under implementation in the **hot desert areas** of Rajasthan, Gujarat, Haryana, Karnataka and Andhra Pradesh, and **in the cold deserts** of Jammu & Kashmir and Himachal Pradesh. **The major problems are continuous depletion of vegetative cover, increase in soil erosion and fall in ground water table.** All these factors account for **diminishing** productivity of land and loss of natural resources.

## Wasteland Development

2.51 DLR has initiated National Wastelands Identification Project (NWIP), in collaboration with the National Remote Sensing Agency and the Survey of India, to prepare **district-wise wastelands maps on 1:50,000 scale** by using satellite data. **Wasteland maps for 146 districts** have been prepared and distributed to the concerned State and district level agencies. Selection of these districts is based on the criterion that 5% or more of the geographical area of these districts is estimated to be wastelands. Wasteland is classified according to the following classification:-

- Gullied & or Ravenous Land
- Upland with or without Scrub

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\* see <http://www.rural.nic.in>

- Water Logged & Marshy Land
- Land affected by Salinity/Alkanity-Coastal/Inland
- Under Utilized Degraded Notified Forest Land
- Shifting Cultivation Area
- Degraded Land Under Plantation Crops
- Degraded Pastures/ Grazing Land
- Mining Industrial Wastelands
- Sands-Desertic Coastal
- Steep Slopping Area
- Barren Rocky/Stony Waste/Sheet Rocky Area
- Snow Covered and or Glacial Area

## Water Resources Development Programme

2.52 Agriculture is the greatest user of Water accounting for 80% of all consumption. Animal Husbandry and Fisheries require abundant water. Development of Water Resources, since Independence, has been undertaken for specific purposes like *irrigation, flood control, hydro-power generation, drinking water supply, industrial and various miscellaneous uses*. As a result, a large number of projects comprising dams, barrages, hydro-power structures, canal net-work etc., have come up all over the country in successive Five Year Plans. India has a vast potential for hydro-power generation (assessed as 84,000 MW at 60 percent load factor), particularly in the Northern and North-Eastern Region.

2.53 A broad assessment of the area that can be ultimately brought under irrigation, **both by surface and ground water**, has indicated that ultimate irrigation potential of the country would be of the order of 139 Million Hectares. **Ground water** is the mostly replenishable distributed resource of the earth. **40% of the irrigated area is due to Ground water in India**. The annual ground water recharge from rainfall and seepage from Canals and Irrigation systems is of the order of 67 M ha-m of which 40% (i.e 27 M ha-m) is extractable economically. The present utilization of Ground water is roughly about 13 M ha-m, and about 14 M ha-m is available for **exploitation & utilization of ground water** in the country. During the past four decades, there has been a phenomenal increase in the **growth of ground water abstraction structures**, due to implementation of technically viable schemes for the development of the resource, backed by

- liberal funding from Institutional Finance Agencies,
- improvement in availability of electric power and diesel, good quality seeds, fertilizers, government subsidies etc.

2.54 The **ground water irrigation potential** steadily increased from 6.5 M.Ha. in 1951 to 45.73 M.Ha. in 1997. One important factor, among others, for the shift towards ground water irrigation is the inordinate delay in completion of Major surface irrigation project and their consequent cost escalation. This has resulted in **increase in the average cost per hectare** of potential created has risen from Rs. 1,060 during 1<sup>st</sup> Five Year Plan to Rs. 427,000 in 7<sup>th</sup> Five Year Plan.

2.55 The **irrigation potential** created stands in the vicinity of 93 M.Ha. by 1999 as against 22.6 M.Ha. in 1951. The irrigation projects are classified into three categories viz. Major, Medium and Minor. Projects, which have a cultivable, command area (CCA) of more than 10,000 Ha. are termed as major projects, those which have a CCA of less than 10,000 Ha but more than 2,000 Ha are termed as medium projects and those which have a CCA of 2,000 Ha or less, are known as minor projects. Minor irrigation projects have both surface and ground water as their source, while major and medium projects mostly exploit surface water resources. The break up of the ultimate irrigation potential under the above three categories is,

- *58 M.Ha by major and medium irrigation projects,*
- *17 M.Ha by minor surface water schemes, and*
- *64 M.Ha by minor ground water scheme.*

2.55 The CCA Programme was started in 1974-75 with a view to bridge the gap between irrigation potential created and its utilization and optimize productivity/production from agricultural land, spread over 23 States and 2 Union Territories. Under the Accelerated Irrigation Benefits Programme (AIBP), the Special Category States of North-East Region, Hilly States of Jammu & Kashmir, Himachal Pradesh and Sikkim as well as the drought prone Kalahandi, Bolangir and Koraput districts of Orissa, get Central Loan Assistance (CLA) with relaxed norms, to expeditiously complete their irrigation projects.

2.57 On the issue of **equity and social justice**, the policy lays down that **water allocation in an irrigation system** should be done so that disparities in the availability between the *head-reach* and *tail-end* farms and between *large* and *small farms* should be obviated by adoption of a **rotational water distribution system and supply of water on a volumetric basis** subject to certain ceilings.

2.58 As a consequence of water resources development works, apart from the major objectives, there has been development in **inland fish production**. India has now the distinction of being **the seventh largest producer of fish** in the world and **second largest producer of inland fish** after China. Amongst the States, **West Bengal** is the highest producer followed by Andhra Pradesh and Bihar. These three States put together produce about 50 percent of total inland fish production in the country, while West Bengal alone accounts for about one third of the production.

2.59 **The country has adopted a National Water Policy in September 1987** which recognize water as one of the crucial element in development planning. **Water Resource planning, has to be done for hydrological unit**, such as the drainage basin as a whole or for a sub-basin. **Flood moderation could be effected in flood prone basins, where storage-reservoirs have been provided.** \*National Commission On **Integrated Water Resources Development Plan**, constituted by the Government of India in 1996, under the Chairmanship of Dr. S.R.Hashim, Member, Planning Commission, has submitted its report in December (1999) with its recommendations on **various important issues viz.,**

- irrigation,
- flood control,
- hydro-power,
- industrial uses of water,
- institutional aspects,
- inter-basin transfers,
- international dimensions,
- legal issues,
- local water resources development and management,
- navigation,
- research & development needs, and
- water quality and environmental aspects

## Afforestation and Eco-development

2.60 The National Afforestation and Eco-Development Board (NAEB)<sup>ξ</sup> of the Central Ministry of Environment and Forests is responsible for promoting afforestation, tree planting, ecological restoration and eco-development activities in the country, with special attention to the degraded forest areas and lands adjoining the forest areas, national parks, sanctuaries and other protected areas as well as the ecologically fragile areas like the Western Himalayas, Aravallis, Western Ghats, etc. NAEB, among the other functions, implements *programmes to restore fuelwood, fodder, timber and other forest produce* on the degraded forest and adjoining lands in order to meet the demands for these items, and coordinate and monitor the action Plans for afforestation, tree planting, ecological restoration and eco-development.

### Environmental Pollution (Water Quality & Air Quality) Monitoring

2.61 Ministry of Environment and Forests (MEF)<sup>ξ</sup> implements "environmental information system (envis)" in the country. Central Pollution Control Board (CPCB) & State Pollution Control Boards (SPCBs) are responsible for implementation of legislation relating to prevention and control of environmental pollution.

### Water Quality Monitoring

2.62 Inland water quality gets monitored on 25 physico-chemical and biological parameters, through about 480 stations under Global Environment Monitoring System (GEMS) & Monitoring of Indian National Aquatic Resources (MINARS). The **National Water Quality Monitoring Network programme** covers about 126 rivers (including the tributaries), wells, lakes, creeks, ponds, tanks, drains and canals. CPCB monitors "water quality" of North Western Region rivers and a few lakes wells conducted on a quarterly basis and at all the other locations on a monthly basis.

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<sup>ξ</sup> see <http://envfor.nic.in>

<sup>ξ</sup> see <http://envfor.nic.in>

## Air quality Monitoring

2.63 CPCB operates National Ambient Air Quality Monitoring (NAAQM) programme through States Pollution Control Boards (SPCBs) and the National Environmental Engineering Research Institute (NEERI), Nagpur. NAAQM network comprises of 290 stations covering over 90 towns/cities distributed over 24 States and 4 Union Territories. NAAQM Programme monitors the following parameters: -

- Pollutants - Sulphur dioxide (SO<sub>2</sub>), Nitrogen dioxide (NO<sub>2</sub>) and Suspended Particulate Matter (SPM), Ammonia (NH<sub>3</sub>), Hydrogen Sulphide (H<sub>2</sub>S), Respirable Suspended Particulate Matter (RSPM) and Poly-Aromatic Hydrocarbons (PAH);
- Meteorological Parameters - wind speed & direction, temperature and humidity.

Based on Annual Mean Concentration (microgram per cubic meter of ambient air) of SO<sub>2</sub>, NO<sub>2</sub> and SPM and the Notified Ambient Air Quality Standards, the Ambient Air Quality Status is described in terms of Low (L), Moderate (M), High (H) and Critical (C) for Industrial (I), Residential and mixed use (R) areas of Cities/Towns in different States/UTs

## Institutional Finance for Agriculture Development

2.64 **Agriculture Credit** is a crucial input for increasing agricultural production and productivity. Mainly Commercial banks, Regional Rural Banks, Land Development Banks, and Cooperative banks disburse institutional finance for agricultural credit. **Share of commercial banks in total institutional credit to agriculture is about 48%, that of Cooperative banks is about 46%, and Regional rural Banks account for 6% only. Short-term Credit accounts for 2/3<sup>rd</sup> of the total institutional lending to the Agriculture.** The credit policy intends to improve **the access to institutional credit**, by small and marginal farmers and other weaker sections. Agricultural Credit provided by various agencies was Rs.16, 494 Crores in 1993-94 and Rs. 30,976 Crores in 1997-98\*. Measures taken in 1998-99 to improve credit flow to agriculture include, among the others,

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\* Government of India, Economic Survey (1998-99)

- establishment of at least one specialized agricultural bank in each state to cater to the needs of high-tech agriculture
- issue of Kisan Credit Card to farmers
- augmenting Rural Infrastructure Development Fund (RIDF) with a corpus of Rs.10000 Crores with NABARD to finance rural infrastructure development projects by states.

2.65 National Bank for Agriculture and Rural Development (NABARD), an apex institution for agriculture and cooperative development provides refinancing for loans given to the Agricultural Sector. The network of Cooperative Banks involved in **Farm Credit** is as follows:-

• State Cooperative Banks	28
• District Central Cooperative Banks	362
• State Land Development Banks(SLDB)	20
• Primary Units of SLDB	2970
• Primary Agricultural Credit Societies (PACS)	90783

2.66 Rural credit delivery mechanism in India has been streamlined under a system called **Service Area Approach (SAA)** and monitoring of credit flow has also been clearly defined by RBI /NABARD under a system called "**Lead Bank Returns (LBRs-2&3)**". Credit plans are prepared for each of the villages in the Service Area for the Annual Plan period (April-March), on the basis of village profiles prepared using detailed **village surveys**, and aggregated at block level to become Service Area Credit Plan (SAP) for that branch. **A Common Network Centric Software in district is required for monitoring and evaluation of LBR.** NABARD requires data **on the following parameters** around **September-October** of the current plan period, which will facilitate planning the credit needs for the succeeding Plan period and make provisions in PLCPs and SAPs, and **yield data** by the end of season:-

- Exact area selected for development along with phasing details.
- Plans of area treated with soil and water conservation measures.
- Technical basic data of the watershed.
- Land use land capability classification, survey number wise.
- Recommended land-use, cropping and allied activity plans, survey number wise & farmer-wise.
- Credit components having potential for which budgetary grants are not provided (like land leveling, fodder, small machinery, plantation etc.)
- Economics - input-output parameters and unit costs.

- Alternate land-use systems and diversified activities, holding-wise for each village.
- Information on cropping systems and models to work out loans.
- Seasonal conditions and contingency plans for drought conditions.
- Data on crop-cutting experiments and yields of the watershed, village-wise to workout recoveries etc.

2.67 **Informatics on Agricultural Credit** is expected to facilitate (i) survey work, (ii) planning, (iii) execution of infrastructural works, (iv) extension, (v) ensuring adequate supply of inputs, (vi) credit planning, (vii) liaison with banks. The IT-Plan\* for the Department of Agriculture and Cooperation (DAC) recommends **establishment of an NICNET based Agricultural Credit Informatics Network (ACIN)**, linking all the banking institutions dealing with agricultural credits at block level. NABARD is expected to play a leading role in the establishment of ACIN.

### **National Informatics Centre**

2.68 National Informatics Centre (NIC) is the nodal S&T organization in the Ministry of Information Technology (MIT), for informatics development and networking in government and corporate sector for decision support. Informatics development, inter-alia, includes **Information Technology applications development and services**. NICNET Nodes have been established in all the Civilian Central Government Departments and several associated organisations, Secretariats of 25 State Governments, one National Capital Territory (NCT), and 6 Union Territory Administrations, and 520 District Collectorates, to facilitate informatics development for decision support and information exchange.

2.69 With the establishment of the NICNET in the country, during the Seventh Five Year Plan Period, NIC has initiated the District Informatics Development Programme, DISNIC, as an informatics tool for developmental planning and responsive administration in districts. Under the DISNIC Programme, development of information systems/ databases in about 27 sectors, which include agricultural sectors, were taken up. In order to strengthen Agricultural Information Systems and databases in districts,

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\*IT Plan for the Agriculture Sector - Proposal for "**NICNET Based Agricultural Informatics and Communication**" (**AGRISNET**) to facilitate higher sustainable agricultural productivity and establish "indian Agriculture on-line" in the Country, submitted by NIC to the Department of Agriculture & cooperation (DAC) in May, 1998.

NIC has launched **DISNIC-AGRIS** project in the districts. With the implementation of the **DISNIC Programme**, NIC has played the major role in the information revolution at district level. In order to strengthen the block level planning, as proposed in the working group report on block level planning (1978), NIC has taken up **project initiatives** to strengthen **Grass-root level Informatics Development (GRID) Programme**. The **DISNIC-PLAN** Project for providing Informatics support for decentralized planning was successfully implemented in many States.

2.70 Natural Resources Informatics Programme (NRIS) aims to provide **GIS based Natural Resources Spatial Data Services over NICNET**, in coordination with agencies like NBSS&LUP, NRSA, Department of Agriculture & Cooperation and State Level Resource Organizations. Over 50 thematic layers were identified and developed using remote sensing, field survey and GIS techniques in 1:2,50,000 scale, which are important in integrated regional planning in districts. Natural Resources Database for various natural resources-cum-socio-economic themes, such as **geology, geomorphology, land use/land cover, soils, population, village amenities, infrastructure facilities**, etc., have been developed in the pilot districts of Aligarh, Bulandshar, Mathura and Bharatpur, and **spatial data services** have been made available over NICNET. Natural Resources Informatics is now being taken-up on country-wide basis, in districts, in higher scales of 1:50,000 and more, with emphasis on specific problems of watershed management, forest mapping, soil & water conservation and so on. **Land records computerization** is on-going in **534 districts** in the country, in collaboration with the Department of Land Resources.

### **NICNET Based Agricultural Informatics & Communication (AGRISNET)**

2.71 In view of the recommendations given by **ISDA-95\*** and various sub-Groups for formulation of the Ninth Plan in the Agriculture Sector, and also the NIC's IT Plan for the Agricultural Sector, the Department of Agriculture and Cooperation (DAC) has taken steps to establish "**Agricultural Information System Network (AGRISNET)**" in collaboration NIC, during

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\*ISDA-95 : National Conference on "Informatics for Sustainable Agricultural Development" (ISDA-95), organised by National Informatics Centre, in collaboration with the Ministry of Agriculture and the Ministry of Rural Development, 25-26 May, 1995, Vigyan Bhawan, New Delhi.

the Ninth Plan. The Proposal recommends (i) the state-of-the-art IT infrastructure requirements to establish AGRISNET as the INTRANET over NICNET, (ii) development of databases and information systems for decision support for evaluation, monitoring and policy formulations, and (iii) human resources development, (iv) multi-media based training and demonstration of transfer of technology to strengthen **Farm Research and Education** using broadcast VSATs, (v) **special interest groups** in respect of subjects, problems, programmes, schemes, etc, and above all, to make **Indian Agriculture on-line** for INTERNET and INTRANET access through AGRISNET Nodes. AGRISNET Nodes are envisaged to be established at

- DAC Hqrs (Krishi Bhawan),
- DAC Attached Offices and its regional offices,
- DAC Subordinate Offices and its regional units,
- DAC Public Sector Undertakings (NSC&SFCE) and sub-units,
- DAC Autonomous Organizations,
- Apex Cooperative Organizations
- State Agriculture Departments
- NCT/UT Agriculture Departments
- District Agriculture Offices [520+], and
- Block Agriculture offices [5000+]

**"Network-centric"** applications using Data warehousing techniques, Expert Systems & Knowledge Bases, GIS Technology, RS Technology, and Internet/Intranet Web Technology, will be made available in AGRISNET Nodes.

## Chapter 3

### Development of Information Systems and Utility of Information Resources

3.0 Development of Information Systems and utilization of Information Resources over INTERNET/INTRANET is a matter of strategic importance in all countries today. Development of Information Services for the use of society at large, necessitates the participation of Government in the growth of Information Systems and Information Resources. Information Systems (IS) are assuming an ever increasing importance in the national development process. Computer-based Information Systems are, **today and in the foreseen future**, a pre-requisite for the National Development; and development within the Government Administration can be used as a **“Lever for Technical Development in Society”** as a whole.

3.1 Informatics Network plays an important role in the information flow from the implementation level to the planner at Macro(national) level, Macro-meso (region covering more than one state) level to Meso (state) level, and Micro (District, Block and Village) level. Informatics development for sustainable agricultural development requires coordinated inter-sectorial approach and application of appropriate Information Technology (IT).

3.2 Information Technology (IT) is a multidisciplinary field emerging from *computer technology, software technology, database technology, and communication technology*. Government of India considers **“Information Technology (IT) as an agent of transformation of every facet of human life which will bring about a knowledge based society in the 21<sup>st</sup> Century”**<sup>\*</sup>. Database Technology has migrated from hierarchical to network in 1960s, network to relational in 1970s, and now from relational to object-relational with web-enabling capabilities over INTERNET/ INTRANET access. IT-led development is taking place through **“information shop”**, or **“Community based Communication Centres”**, **“Internet portals”**, using **Information Super Highways**.

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<sup>\*</sup> Report of the National Task Force on "Information Technology and Software Development", Government of India, 1998

3.3 Informatics, which is an IT application, is taking advantage of (i) Multi databases (Federated and non-Federated databases), (ii) information system research and development methodology, (iii) relational-object methods, (iv) knowledge base and expert systems, (v) Geographical Information System (GIS) technology, (vi) Model bases, (vii) Distributed query capabilities over INTERNET / INTRANET. Distributed databases are the converging point of **networking and databases technologies, to bring "Power to the People"** for planning and responsive administration in the country.

3.4 **Multi-database system** is one that allows users to access and modify data items resident in many heterogeneous environments in various nodes which are being connected by networks. **Federated database** system is a collection of cooperating database system that are autonomous and possibly heterogeneous. **Distributed database** system and query system continues to be an extensive area of research. **Knowledge Base Management system** is a computer system that manages the knowledge in a given domain or field of interest and exhibits reasoning power to the level of a human expert in this domain.

3.5 An **Informatics model** will have the knowledge components such as **objects, events, know-how, precedence** and **cause-and-effect** relationships and **Meta-knowledge**. Application of knowledge representation schemes such as **semantic networks, first-order logic**, (predicate logic), **frames, rule-based systems** (production systems), and **procedural** representation will be appropriately done to strengthen the knowledge base system. **Fuzzy logic** is proving itself as a powerful tool in **knowledge modeling**.

3.6 **Data warehousing systems** have become a key component of information technology architecture. A Data warehouse is a structured extensible environment designed for the **analysis of non-volatile data**, logically and physically transformed from multiple source applications to align with business structure, updated and maintained for a long period, expressed in simple business terms, and summarized for quick analysis.

3.7 The field which has emerged to study this development is **Information Systems (IS)**, which is a combination of **Computer Science and Management**, with supporting disciplines such as **Psychology, Sociology, Statistics, Political Science, Economics, Philosophy, and Mathematics**.

Information systems research addresses a wide range of issues concerning the technology, development and management of information systems, as well as their organizational and social impacts.

## Metadata - Data about Data

3.8 Geographic information system deals with spatial data related to geometry and topology. Meta means, "change" and Metadata ("data about data") describe the origins of and track the changes to geo-spatial or non-spatial data. Data Base Management System (DBMS) software provides conceptual schema and internal schema framework to store metadata ("data about data") to facilitate descriptive information about non-spatial data as per the Database Standards Committee on metadata. Metadata includes information about the currency, accuracy, data content and attributes, sources, prices, coverage, and suitability for a particular use. **Data describing a data set** is becoming more important for locating and accessing information of all kinds. Metadata standards are simply a common set of terms and definitions that describe geospatial and non-spatial data. Metadata standards provide a way for data users to know:-

- What data are available
- Whether the data meet specific needs
- Where to find the data
- How to access the data

3.9 The information needed to create metadata is often readily available when the data are collected. A small amount of time invested at the beginning of a project may save money in future. The initial expense of documenting data clearly outweighs the potential costs of duplicated or redundant data generation. Metadata standards on soil geographic data, vegetation geographic data, developed by the Federal Geographic Data Committee (FGDC) of the United States Geological Survey\*, provide a systematic way to collect metadata. The major uses of metadata are :-

- *To maintain an organization's internal investment in data*
- *To provide information about an organization's data holdings to data catalogues, clearing houses, and brokerages, and*

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\* Federal Geographic Data Committee of U.S. Geological Survey Report No: FGDC-STD-001-1998, GDC-STD-006, and also see <http://www.startkart.no/isotc211/scope.html>

- *To provide information needed to process and interpret data to be received through a transfer from external sources.*

3.10 The information included in the standard is selected based on four roles that metadata play:-

- Availability - data needed to determine the sets of data that exists for the problem identified
- Fitness to use - data needed to determine if a set of data meets a specific need
- Access - data needed to acquire an identified set of data
- Transfer - data needed to process and use a set of data

3.11 This metadata organization will facilitate for internet access to distributed sites where data are produced, maintained or used. Metadata has information about *identification information, data quality information, spatial data organization information, entity & attribute information, distribution information, and metadata reference information.*

3.12 Development of metadata is required *as the overall rate of collection of data increases rapidly with advances in technologies* such as high resolution satellite-borne imaging systems and global positioning system and with growing number of people and organizations who are collecting and using data (spatial and non-spatial). That number will continue to grow with the growing awareness among information technologist that indexing by location is a fundamental way to organize and use digital data. The **OpenGIS<sup>®</sup>** Model of the Open GIS Consortium Technical Committee\* envisages to synchronize geo-processing technology with the emerging Information Technology standards based on *open systems, distributed processing, and component-wise frameworks*, and to facilitate interoperability through "common specification" over internet/intranet. The "Pluggable Computing Model" provides a conceptual framework ("reference model") that positions the **OpenGIS Specification** in the broad context of Information Technology. The **Pluggable Tool Services** include **GIS Tools, Imaging Tools, Expert Tools, and RDBMS Tools**. Each Tool has **algorithms, data, and interfaces to services** in the distributed computing environment. Benefits of the Pluggable Computing Model are as follows:-

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\* see <http://www.opengis.org>

- To facilitate understanding the role of the Open GIS Specification in the larger context of Information Technology
- To permit increased resource sharing between organizations and processes
- To enhance data connectivity among users and applications
- To improve the ability of developers and users to integrate new capabilities into existing environments as well as incorporate legacy systems into new environments.

## Chapter-4

### Framework for Agricultural Resources Information System (AgRIS)

4.0 Agricultural sector is the mainstay of the rural Indian economy around which **Socio-economic privileges and deprivations revolve**, any change in its structure is likely to have a corresponding impact on the existing pattern of social equality. Agricultural Production on a sustainable nature depends on the judicious use of natural resources like soil resources, water resources, animal resources, crop/plant genetic resources, in an acceptable technology management under the prevailing Socio-economic infrastructure. The **economic concept of Land Resources**<sup>\*</sup> is defined as "*the total sum of the natural resources and man-made resources over which possession of the earth's surface gives control*". In **rural and agricultural sector, animal resources** play an important role both in agricultural production and economy of the people. More **efficient and sustainable use** will have to be made of increasingly scarce **land, water, and germplasm** resources. The Central Ministry of Agriculture (MOA) is responsible for implementation and formulation of national policies and programs to achieve agricultural growth through optimum utilization of the land resources, water, soil, plant, fisheries resources, & livestock resources.

4.1 India is endowed with regional diversities for its uneven "economic and agricultural" development, on account of (i) Agro-climatic environments (15 Zones/127 regions), (ii) Agro-ecological regions (20) and 60 sub-regions, (iii) Agro-Edephic regions, (iv) Terrain mapping sub-units, (v) Natural resources endowments (geology, geomorphology, soil, ground water, surface water, & infrastructure), (vi) Human resources (Population density), (vii) Level of investments in rural infrastructure, and (viii) Level of investment in technology.

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<sup>\*</sup> Raleigh Barlowe "Land Resources Economics - The Political Economy of Rural and Urban land Resource Use", Michigan State University, Prentice-Hall, Inc. Englewood Cliffs, New jersey , 1958, Page No.7

4.2 **Agricultural planning and development**<sup>δ</sup> require (a) knowledge about recent progress in agriculture, (b) the existing situation (especially the main problems impeding development), and (c) the potentialities for achieving agricultural objectives. This information is needed for re-assessing current investment and other development activities as well as for planning new measures, setting benchmarks against which to monitor progress. Proper analysis of the agricultural sector requires that it is seen as a system of functionality inter-related and inter-dependent elements, each of which contributes to the existing and potential level of performance of the sector. **A stocktaking and diagnostic survey** is needed early in the planning process to provide information about the wide range of factors influencing agricultural performance.

4.3 The spatial statistics of land use however reflects a different situation of diversified cropping system, productivity and production dynamism, regional imbalances and socio-economic peculiarities. The diverse planning and research and development activities on the **present and future** use of natural resources, requires a comprehensive database system to help in identification of technologically non-degrading approaches for land use plan. Presently, no systematic approach has been adopted to collect and collate data on various aspects of animal population, livestock and fisheries products, marketing opportunities etc. Socio-economic parameters play a vital role in influencing shaping and guiding agricultural production management and information. Therefore, generating and digitizing Socio-economic database along with bio-physical factors like **soil, water, production system and animal resources** on continuous basis is essential to objectively **monitor & evaluate** the current and future agricultural growth and development. In this process of database creation, technological database like, **package of practices, cropping pattern and systems, post harvest technology** etc., will also be included to facilitate decision support.

4.4 The committee on "**Study Group on Information GAP**"<sup>\*</sup> of Planning Commission, in 1989 has recommended that national agencies such as (a)

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<sup>δ</sup> Mollet, J.A : "Planning for Agricultural Development", Croom Helm (London & Canberra), St.Martin's Press, New York, 1984

<sup>\*</sup>On the basis of the recommendations of this Report, NIC has initiated the "**DISNIC-PLAN**" project in association with the MLP Division of the Planning Commission in States. This project was successful in the states viz., Maharashtra, Tamilnadu, Madhya Pradesh, Kerala, Orissa, and Assam (Cachar District).

National Remote Sensing Agency (NRSA), (b) Survey of India (SOI), (c) Geological Survey of India (GSI), (d) National Atlas and Thematic Mapping Organization (NATMO), (e) National Sample Survey Organization, and (g) Central Ground Water Board (CGWB) were to provide the required information through **nationwide surveys and mappings** for facilitating micro-level planning. To undertake sustainable development at grass-root level, data bases on demographic, Socio-economic, and infrastructure facilities, natural resources endowment of the district, with village level resolution, and an efficient data communication system are essential requirement of resources (man-made and natural) management in the country. **Integration of this natural resources informatics into Terrain Mapping Units (TMU) on natural boundaries, is a must for environmentally compatible planning, management, and sustainable development<sup>@</sup>.**

4.5 Sustainable and optimum utilization of natural resources for agricultural development or "sustainable agricultural development" is given due importance in the recent past. "Agro-climatic" Regional Planning (ACRP), National Agricultural Research Project (NARP), Agro-Ecological Mapping, and "Watershed" based planning in rain-fed areas for agricultural development, are undertaken in the country. Ministry of Rural Development and Ministry of Agriculture implements their development schemes on watershed basis<sup>κ</sup>.

## Soil Resources

4.6 India is a vast country with a variety of *landforms, climate, geology, physiography, and vegetation*. **Soil resources are the most precious non-renewable vital resources** for growing food, fibre, and fuel wood to meet the human needs. Management of Soil Resources is essential for both the continued agricultural productivity and protection of environment. Soil performs many functions such as *media for biomass production, filtering & buffering, a habitat and gene reservoir, a source of raw materials, a substitute for buildings, roads and other structures, and as an archaeological artifact*. **Impairment in any function of soils reduces their quality, value, and capacity to provide basic necessities to support**

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<sup>@</sup> Report on "Natural Resources Informatics for the districts of Aligarh, Bulandshar, & Mathura", Remote Sensing Applications Centre, Aligarh Muslim University, Aligarh (A Sponsored Project of NIC), 1996

<sup>κ</sup> Dr.Rajah Chelliah Committee on Watershed Development programme, Ministry of Rural Development

**ecosystems.** In order to assess the potential and problems of different soils and to develop rational land use for optimizing agricultural production, it requires consistent and comparable information about soils\*. Variety of purposes of soil include

❖ in agricultural sector

- command area development,
- soil conservation in catchments areas,
- rain fed farming,
- watershed management, and
- reclamation of degraded lands

❖ in non-agricultural sectors

- construction of roads, railways, dams and engineering structures, etc.

4.7 Because of lack of adequate information on soil resources and improper land use planning, have resulted in many of the present day land degradation problems in the country such as *salinity, alkalinity, and waterlogging in command areas, severe erosion in catchments areas leading to siltation of reservoirs, decrease in productivity of crops*, etc. with the setting up of the National Land Resources Commission at the Centre and Land Use Boards in the States, the necessity for soil resource maps, for developing rational land use plans has become all the more important. **NBSS&LUP has recognized about 500 soils, termed as soil series so far.** In collaboration with NBSS&LUP, NIC has initiated a database project "***National Soil Information System (NSIS)***" in 1994 with participation of all stakeholders, with databases on *climatic, land and environment, soil taxonomy, soil morphology, soil analytical data, soil interpretive grouping, soil series directory, & soil survey directory* at its kernel.

4.8 Soil Survey and preparation of soil maps are being carried out by NBSS&LUP, AISLUS, CAZRI, CSSRI, CSWCRTI, NRSA, RRSSC, IIRS, State Departments of Agriculture, State Soil Survey Units, State Agricultural Universities, State Remote Sensing Application Centres, etc. ***Soil maps are being used as critical input for generating action plans for development of land and water resources on sustainable basis.*** Since many agencies are involved in soil survey and preparation of soil mapping, it is

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\* J.L.Seegal, "Soil Resource Mapping of Different States of India - Why & How?", NBSS&LUP Publication (Bulletin.23), 1990.

found that the soil surveys lacked correlation, uniform nomenclature and appropriate mapping units with legends. *This strongly recommends for development of "metadata"<sup>@</sup> concept on soil data in the country to strengthen correlation, uniform nomenclature and appropriate mapping units with legends.*

4.9 In the coming millennium, on the basis of current trends in the consumption pattern, the estimated total requirement of food grains is likely to be around 245 Million Tons by 2006-07. By considering various factors like population growth rate, diminishing per capita of land and water resources, and increasing land degradation problems, it is estimated that India will be required to produce an additional 5 - 6 million tons of food grains annually in 21<sup>st</sup> Century. This will lead to tremendous pressure on soil resources along with competitive demand for it from industrialization and urbanization. However the **capacity of soil to produce** is limited and its limits to production are set by its inherent characteristics, agro-ecological settings, and its use and management.

4.10 A review of the **soil mapping and land degradation mapping** was conducted by an Inter-Agency Expert Committee constituted by the Ministry of Agriculture and the Department of Space, and on the basis of the recommendations, a **National Mission on "Mapping of Soils and Land Degradation at 1:50,000 Scale"**<sup>\*</sup> has been proposed with a **project cost of Rs. 106 Crores**. Soil resource Maps used for various levels are as follows:-

(a) National level	1:1,000,000
(b) State level	1:250,000
(c) District level	1:50,000
(d) Command Areas & pre-irrigation survey	1:50,000 & 1:25,000
(e) Farm level/micro watershed	1:4,000 - 1:8,000
(f) Soil Conservation Programme	1:4,000 - 1:8,000
(g) Reclamation of salt-affected soils	1:4,000 - 1:8,000
(h) Optimum Land Use Planning	
At District Level	1:50,000
At Village Level	1:4,000 - 1:8,000

<sup>@</sup> Soil Geographic Data Standard (September 1997) of the Soil Data Subcommittee, Federal Geographic Data Committee, US Geological Survey

<sup>\*</sup> Project Proposal on "National Mission on Mapping of Soils and Land Degradation at 1:50,000 Scale" by Inter Agency Expert Committee (ICAR, DAC & DOS), December, 1999

4.11 The major objectives of the proposed project are :

- *Mapping of soil resources at 1:50,000 Scale for entire country*
- *Mapping of land degradation at 1:50,000 scale, and*
- *Creation of uniform soil and land degradation database for the entire country*

## **Animal Resources**

4.12 **Animal Resources of India** are perhaps **the richest** in the world with about 500 Million livestock alone (excluding poultry) and India's breeding tracts are mainly in the rainfed areas. India has about 19% of the World cattle and buffalo population and about 20% that of goats, and significant proportion of sheep, poultry, etc. The Bovine population (Cattle & Buffaloes) constitutes about 62% of the Indian Livestock Population. **Development of livestock** has been envisaged as **an integral part of sound system of diversified agriculture**. In animal production, **the major aim** is for raising ecologically adapted animals and efficient utilization of locally available feed resource. Dairy development is intimately linked with cattle population, breed improvement, cattle health and disease management, and fodder development etc.

4.13 Animal Husbandry in India is essentially a endeavor of millions of small holders who rear animals on "**Crop Residues**" and "**Common Property Resources**" without generally allowing them to compete with man for food grains. The small holders produces milk, meat, wool, etc., for the community with virtually no capital, resource, training and at a cost that no modern technology in the world had ever produced. **Food and Fodder Resources will be crucial to the future development of "livestock resources" in the Country**. There is **very little scope for increasing the area under fodder production**, keeping in view the priority for food grains, pulses and oil seeds. Development of Fodder Resources is basically an activity based on a **multi-disciplinary approach** involving the areas of agriculture, animal husbandry, environment & forests, revenue, rural development, and wasteland development. Various research studies suggest that

- (a) concerted efforts should be made for green fodder production through increasing the productivity of fodder per unit area and also greening of waste lands, and also
- (b) attention to be paid for R&D in the area of non-conventional feed ingredient utilization by Livestock and Poultry.

4.14 Studies on crop systems and a comprehensive classification of the entire country into 15 Agro-Climatic Zones and 127 Agro-Climatic Regions with focus on crops have been conducted. There are **no studies** on **total livelihood systems involving man, animal and crops as part of the whole**, interacting with nature and managing natural resources to their best advantage. **National Livestock Policy (NLP) Studies** classifies the country into **four livestock farming system** viz., Cattle Farming System (CFS), Buffalo Farming System (BFS), Sheep Farming System (SFS), and Goat farming System (GFS), **to observe the possible linkage between livestock systems and cropping systems, demographic and agro-climatic features.**

4.15 **Research in animal production systems<sup>φ</sup>** is a highly complex undertaking and demands specialized data management procedures, research methods and analytical tools. Where **improving livestock production systems** is concerned, the researchers, technicians and the farmers must be familiar with the target system in descriptive terms, and be able to evaluate its behavior in time and space, which requires

- ❖ identifying system components, their variations and interrelations;
- ❖ identifying inflows and outflows; and
- ❖ quantifying system production and productivity.

4.16 **Data on the environment parameters, feed resources, and diseases prevalent in particular places** is to be collected for developing future strategies<sup>φ</sup>. A huge data is being generated at **Central Cattle Breeding Farms (CCBF) farms** which requires proper processing and dissemination among these breeding farms and centres for choosing the

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<sup>φ</sup> [Balain et al 95] D.S.Balain and Kiran Singh: "NICNET based Information system for evaluation, conservation, and management of Livestock Genetic Resources and their Improvement for higher production", National Conference on Informatics for sustainable Agricultural Development (ISDA-95), New Delhi, 1995.

best germ-plasm for faster genetic improvement of **cattle and buffalo wealth** of the country. Despite the vast population of **sheep and goats** and **the rich bio-diversity** in terms of the number of indigenous breeds available in the country, the **production and productivity** has been relatively low, as compared to the advanced countries. The major factors contributing to the low productivity include\* :-

- ❖ Poor exploitation of genetic potential of indigenous animals
- ❖ Low absorption of available technology
- ❖ Inadequate resources of feed and fodder
- ❖ Insufficient health cover
- ❖ Inadequate marketing and credit support, etc

## Fisheries Resources

4.17 Water Resources of India contain diverse group of flora and fauna. [NBFG2K]\* reports that **Fish Genetic Resources comprise of 2118 species of finfish, which includes 1360 Marine fish, 82 Brackish Marine, 16 Brackish, 73 Warm Brackish Marine, 67 Warm Brackish, 366 Warm, 34 Cold warm and 120 Cold.** With the diverse fish fauna, the development objectives are to **judiciously & optimally** utilize the resources for :-

- enhancing production and productivity of fishermen, fish farmers and fishing industry;
- increasing fish production and thereby, raising nutritional standard of people;
- earning of foreign exchange from export of marine products;
- improving Socio-economic conditions of traditional fishermen;
- generating employment for coastal and rural poor; and
- conservation of depleting species of fish.

4.18 Considering the dynamic trend, free-flow of information is of crucial importance for fisheries development, sustenance and rational program planning. It has been felt that dearth of database and absence of technological strategy has resulted in, fisheries not getting the priority that it deserved, in the mainstream of national agricultural policies. **Information availability** on fisheries has lagged far behind that of other disciplines and

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\* Department of Animal Husbandry and Dairying - Annual Report (1996)

\*National Bureau of Fish Genetic Resources (NBFG2K) - "Digitization of database - Fish Genetic Resources' Planning and Methodology Review" under National Agricultural Technology Project (NATP) , 28-29, January, 2000

an evaluation indicated that fisheries scientific literature output is less than 10. Inadequate infrastructure facilities, poor communications, lack of trained manpower are further limiting the access and dissemination of fisheries information to the users. [IIMA80]<sup>1</sup> suggested a computerized Management Information System on various fishery sub-systems viz., Credit Subsystem, Development Subsystem, Distribution Subsystem, Education Subsystem, Extension Subsystem, Processing Subsystem, Production Subsystem, Regulatory Subsystem, and Requisite Supply Subsystem, and also standardization of formats for data collection and collection methods. [TCCFC50]<sup>2</sup> recommended strengthening of database on Fisheries. Effective conservation and sustainable utilization has been hampered **due to lack of species-specific database**. ICAR Fishery Institutes have relevant data of these species. It is therefore required to generate **database on Water Resources and Fish Genetic Resources**, and also to develop maps for information access.

4.19 In order to facilitate optimum utilization of the available fisheries resources in the country and also to meet the objectives of fisheries and aqua-culture development programs during the 9th Five Year Plan, the Working group on “Fisheries for the formulation of Ninth Five Year Plan” has recommended to consider introduction of an information system for fisheries within the overall framework of the Network being introduced by National Informatics Centre (NIC), to improve database of various aspects of fisheries. Recommendation of the Ninth Five Year Plan Working Group on Fisheries **“on database development”**:-

- It is generally felt that the **resource data base is highly inadequate** in the country.
- While the methodology for estimation of marine fish landings was worked out way back in the sixties, such programs for the inland sector could only be initiated during mid-eighties.
- As compared to the marine landings which are in organized landing centres, the same is not true for the inland sector where both the resource and the landing centres are highly dispersed, making estimation procedure “cost and labour” intensive.

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<sup>1</sup> [IIMA80] “Marine Fish Marketing in India (Volume-VI) & “Inland Fish Marketing in India (Volume-VIII)”, Indian Institute of Management, Ahmedabad, 1980.

<sup>2</sup> [TCCFC50] Technical Committee Report on Coordination of Fisheries Statistics (1950), Ministry of Agriculture

- Estimates of production from other coastal marine sector are compiled through the Stratified Random Sampling methods, designed by CMFRI, in all the maritime states.
- Need to improve the database of various basic aspects of fisheries such as the resource availability, harvest and post-harvest infrastructure, etc., is felt.
- Considering the vastness of the resources and the potential for development of fisheries in the country, base for fisheries information and statistics should be expanded so that the data right from the district level could be collected, compiled and analyzed at the state and central levels.
- The Fisheries division in the Ministry of Agriculture would formulate and implement "informatics on fisheries" in respect of NIC". For collection, storage and dissemination of information/data flow from "Block level" to the "Centre" would be evolved and necessary computer network would be installed for the purpose.

#### CI FA suggested

- to make the **information on fish diseases** and their preventive measure over NICNET, since the composite fish culture/poly-culture is a lucrative business and a lot of people have taken up this venture in the recent past;
- to make available modern technologies/methodologies on catfish culture, prawn culture (freshwater and brackish water), pearl culture etc., which are very profitable, to the entrepreneurs for adoption through the fisheries database.
- To make available important information on nutritional aspect of fish food to the entrepreneurs for utilization, adoption of the same for getting higher production and better profit;
- To conduct Socio-economic surveys for inland fisheries to analyse on the increase of standard of living of fishermen.

**FISHNET** is envisaged to facilitate dissemination of information and creation of on-line databases in fisheries sector in the area of production, supply, distribution, extension, credit, regulations and development strategies in the country.

## Plant Resources

4.20 India has taken a lead among the developing nations in establishing a well organised and functioning plant genetic resources system. National Bureau of Plant Genetic Resources (NBPGR) is the nodal organization in India for *exchange, quarantine, collection, conservation, evaluation and the*

*systematic documentation* of germ-plasm resources. The whole concept of ***conservation of plant genetic resources*** in India has undergone a conceptual transformation, evolving gradually over the past four decades. Regional stations of NBPGR (Akola, Thrissoor, Nainital, Shillong, Shimla, Jodhpur, Cuttack, Ranchi, Amaravati) represent different phyto-geographical regions with distinct ecological conditions.

4.21 NBPGR maintains the **national base collections** of different crops, kept under long term storage at -20°C in the National Gene Bank. Also in-vitro collections are maintained in the National Plant Tissue Culture Repository. Its regional stations maintain Field collections. NBPGR has also developed facilities for cryo-preservation of seeds, pollen and in-vitro cultures in liquid nitrogen (-196°C). Besides, a chain of clonal repositories have been envisaged under its network. *Computerised national data-base on plant genetic resources and National Herbarium of cultivated and wild plants are also operative under its system.*

4.22 The basic researches related to conservation and utilization of germ-plasm form an integral part of NBPGR's research programs, so as to improve quality and effectiveness of multi-faceted services for the sustainable management of plant genetic resources. In addition, **National Research Centre on DNA Finger Printing (NRC on DNA Finger Printing)** and an **All India Co-ordinated Projects on Under-utilized and Under-exploited crops**, strengthen research on Plant Genetic Resources. Major efforts are now devoted towards developing a comprehensive **national plant genetic resources system in the country**, with NBPGR as the leading organization linked effectively with other 30 ICAR Institutes, NRCs, AICRPs and SAUs. Each of these Centres is designated as the ***National Active Germplasm Site*** for specific crop(s) and has been assigned responsibility of maintaining, evaluating and supplying germ-plasm out of its collection to the user scientists. ***ARISNET provides effective linkage to strengthen this Plant Genetic Resources Informatics Network in India.***

### **Water Bodies (Basin), Watershed, and Agro-EcoRegion Planning**

4.23 No major watershed has a homogeneous composition. The landscape, climate, and agronomic characteristics of each watershed **vary** considerably. Each watershed contains a complex mixture of

- soil types,
- landscapes,
- climatic regimes,
- land use characteristics, and
- agricultural systems.

4.24 Yet, this complexity is not unmanageable. Each watershed can be subdivided into Agro-Ecoregions having *similar soil types, landscapes, climatic regimes, crop and animal productivity, and hydrologic characteristics*. The physical, agronomic, and hydrologic characteristics of a watershed can then be described and represented using a few relatively homogeneous agroecoregions.

4.25 The characteristics of each agro-Ecoregion affect crop and animal management and productivity within the watershed, and determine the potential for production of various types of non-point source pollution. For instance, one agro-Ecoregion within a watershed may be characterized by *steep landscapes with loamy well drained soils* that support corn and soybeans as well as small grain production. Another may be characterized by *flat landscapes with poorly drained silty clay soils* that support primarily corn and soybean production. These two Agro-Ecoregions have different *water erosion* potentials and are suitable for a *unique and different* suite of crop management practices. Thus, the use of Agro-Ecoregion characteristics within the context of **basin and watershed planning** strengthens the planning process by providing detailed information for several factors that affect both *farm management and water quality*.

4.26 **Agro-Ecoregion Planning** is useful in conjunction with Watershed Planning for developing a list of priority needs in monitoring, research, education, and implementation activities for various basins (water bodies) in the Country. Using the agro-Ecoregion characteristics along with existing *water quality monitoring information*, it is possible to determine :-

- where the steepest and most erosive landscapes are located,
- where the water quality problems are most severe,
- where land use patterns are most conducive to non- point source pollution production, and

- where the research knowledge base concerning sources of pollution and methods of managing pollution is weakest.

4.27 For **each major watershed**, it is **suggested** to engage **all stakeholders** within the watershed, in discussions and coordinated planning efforts those cross-state boundaries. The planning cycle involves: -

- identification of impaired water-bodies and the type of impairment,
- prioritization of the impaired water bodies according to risk and severity of the pollution, value of the resource, and likelihood for success,
- development of integrated management strategies involving a combination of technical assistance, education, financial incentives, monitoring and water quality standards, and regulation,
- preparation of a watershed management plan with specific goals, actions, partnership strategies, and monitoring plans,
- implementation of the watershed management plan, and
- evaluation of changes in water quality.

### **Agro-Meteorology**

4.28 Drought is universally acknowledged as a phenomena associated with scarcity of water and occur due to (i) deficit in rainfall, (ii) depletion of ground water, (iii) inadequate supply of water through surface water bodies like rivers, streams, canals, tanks, etc., (iv) insufficient moisture in the sub-surface layer of the soil, and (v) increase in demand for water compared to availability. Drought conditions lead to (i) decline in food and fodder production, (ii) reduction in power generation from Hydroelectric projects, (iii) fall in industrial production, (iv) distress sale of cattle, (v) migration of people, (vi) unemployment, and (vii) Poverty. Drought has multiplier effect on agricultural production during the subsequent year also, due to (I) non-availability of quality seeds for sowing of crops, (ii) inadequate draught power for carrying out agricultural operations as a result of either distress sale of cattle or loss of life, (iii) reduced use of fertilizers as the investment capacity of the farmers decline, (iv) non-availability of raw materials in agro-based industries, and (v) deforestation to meet the energy needs in domestic sector as agricultural waste may not be available in required quantity. Recognizing the important role of agricultural meteorology in agricultural development, ICAR has on-going All India Coordinated Research Projects (AI CRP) in Agro-meteorology. The **WMO Commission for Agricultural Meteorology** stressed the need for establishing minimum

weather parameters (rainfall, temperature including soil & surface temperature, radiation, humidity & cloudiness, wind speed & direction, and evaporation) for all available stations in the country.

## **Identification of relevant database and design of system**

4.29 Agricultural Resources Information System will have data and information on basic resources such as (i) soil resources, (ii) water resources, (iii) climate resources, and other data sets (collated from Remote Sensing as well as conventional means) such as (iv) basic data on crops, (v) animal husbandry and fisheries, (vi) genetic (plant, animal & fisheries) materials, (vii) land ownership, (viii) Socio-economic data, (ix) infrastructure for agricultural development. **Management of land and water resources needs an integrated approach.** For sustainable agricultural production, it is necessary to focus attention on *soil and climate resource base, current status of soil degradation, and soil-based agro-technology* for optimizing land use. Collecting existing data from various Government agencies and departments is the first step towards comprehensive survey and planning of agricultural development. The **existing data** may be obtained from the reports of :-

- (a) Soil survey
- (b) Geological survey
- (c) Forest inventories
- (d) Hydro-meteorological studies
- (e) Aerial photographs and contour maps
- (f) Ownership data and infrastructure information
- (g) Rainfall and stream flow data
- (h) Land use details
- (i) Development plans

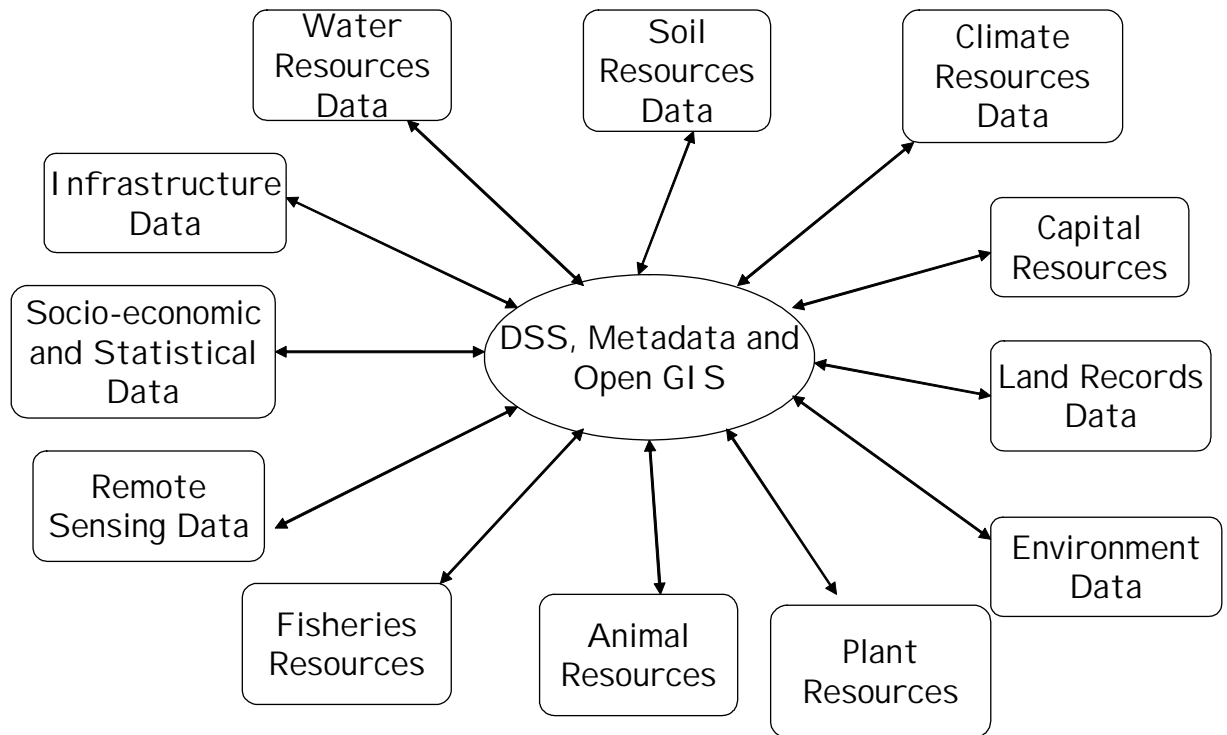


Figure3: Components of Agricultural Resources Information Systems

4.30 These existing reports are to be converted into "metadata" to facilitate

- availability - data needed to determine the sets of data that exists for the problem identified
- fitness to use - data needed to determine if a set of data meets a specific need
- access - data needed to acquire an identified set of data
- transfer - data needed to process and use a set of data

#### **A. Basic data**

- (i) Basic Data on Crops
  - Production of major crops
  - Area cultivated in each major crop
  - Yields per Unit of Area for each crop
  - Areas sown but not harvested
  - Areas of fallow, double cropped, irrigation and inter-cropped land
- (ii) Information on livestock numbers, production and Yield per unit
- (iii) Trade statistics on agricultural commodities and the extent to which imports/exports are involved
- (iv) Information on size, character, technology and organization of farms, by groups

#### **B. Inventory of Agricultural Resources**

For increasing production at micro level, inventory of currently used, potentially available, and an evaluation of the quantity and quality of these resources is required. The inventory and appraisal should cover *natural, capital, institutional and human (manpower)* resources.

##### **Natural Resources**

- Information on physical feature [topography, geology, soils, natural vegetation, and hydrology (surface and sub-surface)] to determine the land's capability for agricultural development;
- Maps depicting differences in physical land characteristics, meteorological, climatological, hydrological, geological, and geo-

morphological conditions; population densities, types of land tenure systems used, proximity to markets and urban centres, transportation and other infrastructures;

- Areas of immediate growth potential ( where climate, soil and water conditions are favourable for agriculture and where technology needed to substantially increase output of major crops, already being grown, is available);
- Areas of future growth potential (where favorable climatic and soil conditions exist but lack one or more elements of (i) adequate & controlled supply of water, (ii) technology required for substantially increasing production of a major crop or crops, currently grown, or capable of being growing, and (iii) transportation needed to bring the areas into national economy);
- Areas of low growth potential (where climatological, soil, topological or other deficiencies without economic means for correcting them, exist) which require technological breakthroughs before substantial increases in output are possible..

### **Capital resources**

- Investments in agriculture (buildings, water systems, irrigation works, drainage systems)
- Agricultural implements and machinery
- Work animals and breeding stock
- Agricultural inputs (seeds, fertilizers, pesticides & insecticides)

### **Institutional Resources**

- Research
- Extension
- Training
- Provision of short, medium and long-term credits
- Marketing, and
- Development plans

**Human Resources** (*to find out what extent the human conditions act as a constraint on increased output and can contribute to increased output*)

- Labour forces (owner-farmers, sharecroppers, and wage labourers)
- Labour Force (employed, under-employed, and unemployed; seasonal variations)
- Level of literacy, education, nutrition of agricultural population

### **Plant Genetic Resources Database (as proposed by NBPGR)**

- Institutes involved in Plant Genetic Resource (PGR) Conservation and utilization,
- list of key scientists in each institution,
- list of crops and activities dealt with,
- Information on Ex-situ collections
  - species name,
  - number of accessions for this species,
  - type of material held (wild, landrace, advanced cultivar, breeder's material, mutants etc.),
  - geographical distribution of these accessions,
  - place of safety duplication etc.
- Database of available plant genetic diversity and associated Indigenous Traditional Knowledge (ITK) in different parts of India, to facilitate planning of strategies for future exploration.
- Early warning information on depleting species
  - the loss of habitat (deforestation, development, agricultural colonization of new lands and desertification);
  - disturbances of habitat (road construction or new human settlements); natural disasters (floods, droughts);
  - the loss of cultivated crops/local varieties/land races through the adoption of new crops with the consequent abandonment of the traditional ones; and
  - changes in agricultural practices etc.

### **Soil Resources (as proposed by NBSS&LUP/NSIS)**

### **Climate Resources (as proposed by CRIDA)**

### **Crops and Cropping System database (as proposed by PDCSR)**

### **Animal Resources Database (as proposed by NBAGR)**

**Horticulture database** (as proposed by I I HR)

**Plantation Crops database** (as proposed by CPCRI)

**Spices Resources database** (as proposed by PDCSR)

**Agro-forestry database** (as proposed by PDCSR)

**Ground water Database** (as proposed by CGWB)

**Water Bodies Database** (as proposed by NBFGR & PDWMR)

- *Physical Parameters*
  - River Order
  - River Origin/End
  - Area with brackish water
  - Catchments Area
  - Flow Rate
  - Total discharge
  - Water Storage in reservoir
  - Present use of surface water
  - Average annual potential in the river
  - Existing/ongoing/proposed/hydroelectric projects
  - Pollution load
  
- *Code for Aquatic Zones*
  - Unique code for each water-body (individual first order river, wetlands, reservoir, lakes)
  - Alpha numeric Coding
  - Water body/Watershed identifier
  - Unique code for zones/sub zones
  - Code should indicate
    - Topo Sheet No (SOI)
    - Watershed Zone
    - District/State
    - Already existing codes
    - AI SLUS coding for watershed
    - SOI Topo Sheet Number
  
- Marine Capture Fishery database (CMFRI)
- Inland Capture Fishery database(CI CFRI)

- Culture Fishery database (CI FA & CI BA)
- Conservation database (NBFGR)

## **Environment database (as proposed "ENVI S")**

### **Database on Watershed**

- **General data**
  - watershed name,
  - location,
  - boundaries,
  - size,
  - shape,
  - elevation,
  - slope,
  - the presence of streams, tributaries, etc.
- **Physical data**
  - geological data,
  - soil data (soil texture, depth, soil series, physical and chemical properties),
  - geomorphological data (drainage patterns, stream density and order, channel profiles etc.)
- **Climate, hydrology and water resource data**
  - precipitation,
  - evaporation,
  - wind,
  - temperature,
  - humidity,
  - rainfall,
  - stream flow,
  - surface water,
  - ground water,
  - water quality, etc.
- **Land Use, Land Cover, Land Capability data –**
  - land use by classes,
  - ownership,

- land capability, etc.
- **Cropping pattern, irrigation requirements, agricultural inputs availability, etc.**
- **Erosion data –**
  - kinds of erosion, extent, causes, etc
- **Infrastructural data**
  - transportation networks,
  - housing, public services,
  - survey of agro-industry, etc.
- **Socio-economic/Demographic data**
  - population,
  - rate of growth,
  - composition,
  - migration,
  - employment, and
  - other demographic factors affecting rate of resource use, etc.
- **Minimum needs of the farmers**
  - more roads,
  - domestic/ irrigation water,
  - housing,
  - marketing arrangements,
  - recreation facilities.)
- **Awareness of farmers about the causes and problems facing the watershed.**
- **Economic data**
  - farms production,
  - farms income,
  - farm models,
  - farming systems,
  - land use patterns,

- employment,
- labour demand and supply,
- rural enterprises,
- marketing, etc.

## Maps

- **base map** showing boundary, sub-watersheds, villages, roads, etc;
- **topographic map** showing contours, elevations, land forms, streams, etc;
- **soil map** showing soil types and boundaries, depths and soil limiting properties
- **climatic map** showing mainly rainfall, but statistics may include temperature, evapo-transpiration, etc.;
- **geology map** showing rock types, structures, displacement, morphology, etc.;
- **slope map** showing different slope classes or exposures/aspects;
- **present land use map** showing major land uses and cover types;
- **land capability or land suitability map** showing different land capability classes; or land suitability classes;
- **land-use adjustment map** showing land being over-used or under-used and adjustment needs;
- **erosion or sediment source maps** showing sites of various types of erosion and sediment potential areas;
- **hydro-meteorological network map** showing the location of climatic and stream gauging stations;
- **water resource map** showing surface and underground sources.

## Remote Sensing Applications

- Raw Data (Image, Segment, boundary mask)
- Processed Data (Classified image, segments, districts, NDVI /Ratio, spectral yield models)

- Administrative boundaries and toposheet coverage (State, District, Taluka/Block Village)
- **Ground Truth**
  - Historical, in season
  - Sampling Plan
  - Geographical location of segments, stratification
- **Crops Details**
  - Crop Calendar
  - Crop Statistics (District/Taluka Level)
  - Historical Acreage, Yield, Production
  - High yielding varieties, local varieties (Area)

#### **In Season Data**

- Acreage, Yield, Production
- Sowing/Transplanting date
- Seed Distribution
- Crop Growth Condition report
- Disease/Pest and their major area of occur

#### **Agro-Meteorological Data**

- Met Observatories
- Location, Institute, Data available
- **Historical Data**
  - Daily minimum temperature, maximum temperature, rainfall, rainy days, relative humidity, sunshine hours, wind speed & direction, evaporation

#### In season data

- Daily minimum temperature, maximum temperature, rainfall, rainy days, relative humidity, sunshine hours, wind speed & direction, evaporation
- **Processed Agro-MET data**
  - ET, Soil moisture satisfaction index

#### Agriculture inputs

- Irrigation
- Fertilizer (Chemical and Manure Fertiliser, Improved Seeds)
- Plant Protection Measures
- New Implements
- Soil conservation and land reclamation Programme

#### Land

- Landuse Pattern (Area under agriculture, forest, waste land, urban)
- Soil Maps (Type, class, depth, field capacity, permanent wilting point, water holding capacity, pH)
- Water Resources, Irrigation status

#### Econometric

- Price, marketing, credit, subsidy, government policy

### **Historical Agriculture Database (Districtwise)**

4.31 In order to undertake analytical studies, development of "datawarehousing" on agricultural statistics and data, available with Ministry of Agriculture and other Agricultural related Agencies, is essential. Decision Support System will be established using "data warehousing", "data mining" and "GIS" techniques. The analytical outputs will be made available in hard copy formats as well as through "web-enabled" programmes using the

universal "browsers". The Historical Database on Agriculture, among the others, will include the Information details on the following:-

- Sectoral Outlook
- Policies and procedures
- Perspective plan documents
- Plan Schemes
- District-wise land use patterns since 1970-71.
- District-wise rainfall and weather statistics from the IMD since 1970-71.
- Time series on reservoir levels.
- District-wise soil characteristics, water balances and irrigation by sources.
- Organisation of data by agro-climatic zones.
- Production and consumption of fertilisers by district since 1970-71.
- Availability and consumption of seeds by type by district as available currently with the district.
- Availability of other agricultural inputs such as implements, pumpsets, tractors, power, etc.
- District-wise operational holdings on a quinquennial basis from 1970-71.
- District-by-district agricultural practices - in terms of cropping patterns, seasons, linkages to industry, subsistence farming or farming for surpluses, etc.
- Area, production, yield and farm harvest prices of all major crops for all districts from 1970-71 onwards.
- Market-by-market and commodity-by-commodity wholesale prices on a daily basis since 1970-71.
- District-wise output data on horticultural commodities since earliest date available currently with the district.
- District-wise data on inland/marine fisheries since earliest date available currently with the district.
- District-wise data on livestock on a quinquennial basis since 1972.
- A database on forestry, fodder crops, sericulture and apiculture to the extent data is available currently with the district.

- Cost of cultivation data available with the DAC
- Infrastructure for agriculture such as number of markets, storage capacities, etc.
- Central government schemes and expenditure on these schemes since 1987-88.
- India's foreign trade with respect to agricultural commodities.
- International trade in agricultural commodities of interest of India.

## Decision Support System

4.32 Decision Support Systems (DSSs) can deliver the technology of management and the relevant knowledge which managers need to get their jobs done. Most of today's DSSs support **the "choice" phase** of decision making. Enhanced DSSs, known as Management Support Systems (MSSs), are attempting to fill the gaps in decision-making support, not provided by the traditional DSSs. For complete support of critical management activities of communication and decision making - including qualitative and creative processes - a collection of computer information system, as given below, is required:-

- Decision Support System (DSS)
- Group DSS (GDSS)
- Executive Information System (EIS)
- Executive Support System (ESS)
- Expert System (ES)
- Idea Processing System (IPS)
- Management Information System (MIS)
- Office Automation System (OAS)
- Transaction Processing System (TPS)

4.33 DSSs, Group DSSs, ESSs, and components of ESSs and MISs primarily support the decision making process. **"A complete set of enhanced DSS together with an IPS constitutes a Decision Technology System (DTS) which provides complete, integrated support for all phases of the decision-making process and delivers the complete technology of**

**management for full decision support"**<sup>α</sup>. Development of Decision Support Systems on the following areas facilitating Agricultural Resources Management are envisaged using the state-of-the-art IT tools :-

- (i) Crop Suitability based on factor endowment
- (ii) Land Suitability Assessment;
- (iii) Land Productivity Assessment;
- (iv) Population Supporting Capacity;
- (v) Land Evaluation and Land Use Planning;
- (vi) Land Degradation Risk Assessment;
- (vii) Quantification of Land Resources Constraints;
- (viii) Land Management;
- (ix) Agro-ecological Characterization for Research and Planning;
- (x) Agricultural Technology Transfer;
- (xi) Agricultural Inputs Recommendations;
- (xii) Farming Systems Analysis and Development;
- (xiii) Environmental Impact Assessment;
- (xiv) Monitoring of Land Resources Development.
- (xv) Livestock Farming Systems [Cattle farming Systems (CFS), Buffalo Farming Systems (BFS), Sheep Farming Systems (SFS), and Goat Farming Systems (GFS)]

There have been a lot of research publications and also software products developed by various Agricultural Research institutions, both in India and abroad. It has been envisaged to utilize these packages and **develop DSSs in districts** for agricultural resource management.

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<sup>α</sup>[Guissep91] : Guissepi A.Forghione 1991 "Decision Technology Systems : A Step Toward Complete Decision Support", Information Management Systems, Vol. 8, No 4, Fall 1991, Auerbach Publishers

## Chapter 5

### Implementation strategy

5.0 The Central Ministry of Agriculture (MOA) is responsible for implementation and formulation of national policies and programs to achieve agricultural growth through optimum utilization of the **land resources, water, soil, plant, fisheries resources, & livestock resources**. Both the Ministry of Agriculture and Ministry of Rural Development implement, through State Agricultural and Rural Development Departments, various central sector and centrally sponsored schemes related to agricultural and rural development, **on watershed basis**. These schemes include, among the others, land resources development for increasing agricultural productivity. MOA is working out Information Technology Plan, in collaboration with NIC, to implement "**NICNET based Agricultural Informatics and Communication**" in the country, **to achieve higher sustainable agricultural productivity** and also to make "**Indian Agricultural Sector On-line**". This IT Plan is likely to be implemented as a centrally sponsored scheme of the MOA. Information Technology (IT) and its applications (informatics) using the state-of-the-art IT Tools and products to develop the followings, which will have the potential to create major transformation in Indian agriculture:-

- Data warehousing (Data Bases & Model Bases)
- Expert Systems & Knowledge Bases
- Networking (Internet, Intranet and Extranet)
- Geographical Information System (GIS)
- Application of Remote Sensing Data
- Multi-media Information System
- Decision Technology System
- E-Commerce & E-Governance, and
- Digital Library

5.1 As an enabling technology, Information Technology (IT) plays an important role in the rapid economic growth and social transformation in India. The Core Group-V has deliberated IT related issues for strengthening "**Agricultural Resources Information System**" in all districts (regions) of

the Country, "*irrespective of past or future growth regions*"\*. Various Research Studies and Policy papers have highlighted the major constraints viz. **Resource Constraints** (research, education, irrigation, flood control, drainage), **Infra-structure Constraints** (at grass-root, regional and national to take benefit of supply-chain model), **Institutional constraints** (Consolidation of Holdings, Updation of land records, Regulation of tenancy), **Technological Constraints** ( High Yield Variety (HYV) seeds for rainfed areas), and **Policy induced limitations**, faced by the Indian Agricultural Sector. According to Prof.G.B.Singh\*, the future growth in agriculture must come from:-

- (g) new technologies which are not only "cost effective" but also "in conformity" with natural climatic regime of the country;*
- (h) technologies relevant to rain-fed areas specifically;*
- (i) continued genetic improvements for better seeds and yields;*
- (j) data improvements for better research, better results, and sustainable planning;*
- (k) bridging the gap between knowledge and practice; and*
- (l) judicious land use resource surveys, efficient management practices and sustainable use of natural resources.*

5.2 Integrated Watershed Development and Management has been recognized as an effective strategy for **sustainable agricultural development** in the country. The Ninth Five Year Plan Document (1997-2002 : Volume II) has estimated that development of the vast rainfed areas (90 million hectares) would require over Rs.37,000 Crores, and scientific treatment for soil and water conservation for 12 million hectares of arable and 3 million hectares of non-arable land would require about Rs.7500 Crores. **Applications of Information Technology in the agricultural sector up to grass-root level, will strengthen the Policy thrust and key elements of Growth strategy**, as proposed in the Ninth Five Year Plan Document (Volume II : PP444):-

- *Conservation of land, water, and biological resources*
- *Rural infrastructure development*

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\*National Centre for Agricultural Economics and Policy Research (NCAP), Indian Council of Agricultural Research, New Delhi

\*[GBSingh2K] Professor G.B.Singh : Green Revolution in India - Gains and Pains", 21<sup>st</sup> Indian Geography Congress, Nagpur (India), January 2-4, 2000.

- *Development of rainfed agriculture*
- *Development of minor irrigation*
- *Timely and adequate availability of inputs*
- *Increasing flow of credit*
- *Enhancing public sector investment*
- *Enhanced support for research*
- *Effective transfer of technology*
- *Support for marketing infrastructure*
- *Export promotion*

5.3 Informatics development for decision support in the agricultural sector, which **ipso facto** includes rural development sector, requires coordinated inter-sectoral approach and application of appropriate Information Technology (IT) tools, in the areas of :-

- |   |   |
|---|---|
| • <i>Agricultural Research,</i>                             | • <i>Fisheries,</i>   |
| • <i>Agro-meteorology,</i>                                  | • <i>Irrigation and Drainage Systems</i>                    |
| • <i>Agricultural Marketing,</i>                            | • <i>Livestock, Dairy Development and Animal Husbandry,</i> |
| • <i>Agricultural Engineering and Food processing,</i>      | • <i>Rural Development and Planning,</i>                    |
| • <i>Agricultural Extension and Transfer of Technology,</i> | • <i>Soil and Water Management,</i>                         |
| • <i>Credit &amp; Co-operation,</i>                         | • <i>Watershed Development, and</i>                         |
| • <i>Crop Production and Protection,</i>                    | • <i>Wastelands Development</i>                             |
| • <i>Environment &amp; Forest,</i>                          |   |
| • <i>Fertilizers and Manure,</i>                            |   |

## Pilot Project Demonstration

5.4 Given its **endowment with regional diversities** (Agro-climatic regions, Agro-ecological regions, Human resources (Population density), Level of investments in rural infrastructure, and Level of investment in technology) for its uneven "economic and agricultural" development, Indian Agriculture is faced with a great diversity of needs, opportunities and prospects. **Agro-Ecoregion Planning** is useful in conjunction with Watershed Planning for developing a list of priority needs in monitoring, research, education, and implementation activities. **In view of this**, pilot projects will be taken up on the basis of **Agricultural Production Systems** viz. *Arid Agro-Ecosystem, Coastal Agro-Ecosystem, Hill & Mountain Agro-Ecosystem, Irrigated Agro-Ecosystem, and Rainfed Agro-Ecosystem*. for which **the typologies considered** are :-

- a **tribal** district
- a **hill** district
- a **dry-farming** district
- a **socially backward** district
- a **green revolution** district
- a district dominated by **cash crop** district
- a **coastal** district
- a district in a mining/ industrial belt
- a district dominated by forest economy
- a **dairy-farming** district
- a district dominated by one or two urban centers
- a district in **arid-zone**
- a district which is **flood-prone and water-logged** and having a sizable area of wasteland which could respond to forest cover

The Pilot project demonstration, **one district of above mentioned typologies, in each state**, will facilitate **development of decision support systems on "production practices and systems"** which need to be adapted to respond to new market demands and export opportunities, poverty alleviation or growing labour shortages, depending on the setting [NATP98]<sup>ψ</sup>.

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<sup>ψ</sup>[NATP98] National Agricultural Technology Project Document, 1998

## Participating Institutions

5.5 All the Institutions, as given below, of the Central Government and State Governments involved in various aspects of agricultural development will be associated with the development of Agricultural Resources Information System in the Country. It is also suggested that **separate working group** will be established to basic input on project issues like technical and organizational support, before starting the pilot project.

- Ministry of Agriculture
  - Department of Agriculture & Cooperation
    - All India Soil & Land Use Survey
    - Directorate of Economics & Statistics
  - Department of Animal Husbandry & Dairying
  - Department of Food Processing Industries
  - Indian Council of Agricultural Research
    - ICAR Institutes
    - ICAR Project Directorates
    - ICAR National Research Centres
    - ICAR Deemed Universities (IARI, NDRI, IVRI, CI FE)
    - ICAR National Bureaus (NBPGR, NBAGR, NBFGR & NBSS&LUP)
- Ministry of Rural Development
  - Department of Land Resources
  - National Institute of Rural Development
- Ministry of Information Technology
  - National Informatics Centre
- Ministry of Science & Technology
  - National Atlas & Thematic mapping Organization (NATMO)
  - Indian Meteorology Department
  - National Centre for Medium range Weather Forecasting (NCMRWF)
- Planning Commission
  - Agro-Climatic Regional Planning Unit
- National Bank for Agriculture and Rural Development
- Ministry of Water Resources
  - Central Ground Water Board
  - Central Water Commission
- Ministry of Environment & Forests
  - Central Pollution Control Board
- Department of Space
  - Regional Remote Sensing Services Centres
  - Space Applications Centre
  - NNRMS Project
- State Agricultural Universities
  - Zonal Research Stations (120)

- State Agricultural (Agriculture, Horticulture, Soil Conservation, Animal Husbandry & Fisheries) Departments
- Department of Geography in various Non-Agricultural Universities (~ 65)

### **Coordinating Agency**

5.6 The **Core Group-V of the NNRMS-SCA** will be the coordinating Agency and the **Project Directorate** is suggested to be set up under the **Agricultural Informatics Division** of National Informatics Centre.

## Chapter 6

### Recommendations

6.0 The Core Group - V recommends the following suggestions in the areas of Agricultural Resources Management and its Optimal Utilization for higher sustainable agricultural development, to be given due consideration, during the pilot demonstration as it will facilitate involvement of various Institutions to work on **common problem themes**, in a collaborative manner. This will result in **"no duplication of efforts"** among resource agencies. The Core Group-V has been guided by the technological issues as how to reach the **"Resource-Poor-Farmers"** through Information Technology applications, and also that the agricultural resources information system should be designed in such a manner to support the various management systems at **National, State, District and Village level vis-a-vis catchment, watershed and micro watershed level**. It is felt that **AgRIS should develop data base in a way** that various kinds of information related to agricultural resources could easily be retrieved for projection at National, State, District and Village level, and should generate database for mega, macro and micro level planning and implementation.

6.1 Since MOA has formulated schemes to establish AGRI SNET nodes in districts during the Ninth Plan period and extend to block levels during the Tenth plan period, the following recommendations, as suggested below, may be implemented in **mission** mode: -

- Reaching-the-Unreached, **"resource-Poor - farmers"** through Information Technology Applications;
- Development of a comprehensive agricultural resources information system (AgRIS) using Geomatic technology in districts with "public funding";
- Strengthening "agricultural resources information system (AgRIS)" in all districts, regions of the country, "irrespective of past or future growth regions";
- Development of AgRIS should be based on the Watershed Atlas of India of AISLUS for further generation of databases to cater to the demands of database at macro, meso, and micro levels;

- To establish Agricultural Resources Information System (AgRIS), on a pilot scale, in one district in each state, equipped with the state-of-the-art IT tools (Computer System, GIS System with plotter & digitizer, Software for data base and analysis, NICNET VSAT, etc);
- The pilot districts will have resources persons drawn from ICAR Institutes (NBSS&LUP, IGFRI, CRIDA, NRCs, Institutes & Directorate), State Agricultural University, State/District Agricultural Departments (Agriculture, Fisheries, Animal Husbandry & Dairy Development, and Forestry), Geological Survey of India, NIC, ISRO (RRSSC & SAC), NATMO, ACRP ZPT, Forestry Survey of India, NDDB, CGWB, AISLUS, NWDPPRA project unit, SWC project Unit, NABARD, District lead Bank, and District Planning Office; one agricultural economist and one ecologist;
- **Traditional practices** and methods used for soil and water **conservation** should be collected and requisite knowledge base at District, State and National level be generated which will be extremely useful in the context of the "Convention on Bio-diversity". The well proven and indigenous practices should be patented.
- Data generated by various Central and State agencies, during their normal surveys and routine activities, will be collated by their district offices and R&D groups, and be stored at District Centre for online retrieval through NICNET as well as for the development of integrated database development; All R&D groups will pass on their data for storage and further analysis and dissemination to this pilot district centre, obviating multi-point search by Users and Planners in the districts.
- The existing 9-fold classification for landuse and landcover needs revision for better agricultural planning, as it is not based on fertility of soil and the topography of land resources. Agro-Edaphic Classification is expected to facilitate physical production potential, ecological sustainability, and economic viability.
- DLR sponsored projects for Land Records Computerization, in association with NIC, in 534 districts in the country, under the Centrally Sponsored Scheme, may be extended to cover all aspects of land resources in order to develop "land information system" in districts.
- **Common Property Resource Mapping** may be initiated, to begin with Panchayat levels.

- DLR sponsored project on district-wise wastelands maps on 1:50,000 scale by using satellite data, to cover all potential districts; Wastelands maps for 146 districts have been prepared;
- Agricultural Atlas, Land Resources Atlas, Forest Atlas, Irrigation Atlas and Water Resources Atlas of NATMO provide basis for the development of GIS on the Agricultural Sector. These atlases should be made available on 1:50,000 scale to strengthen **the Agricultural Resources Information System (AgRIS)** in districts.
- In collaboration with NBSS&LUP, NIC has initiated a database project "**National Soil Information System (NSIS)**" in 1994 with participation of all stakeholders, with databases on climatic, land and environment, soil taxonomy, soil morphology, soil analytical data, soil interpretive grouping, soil series directory, & soil survey directory at its kernel. This should be implemented.
- National Mission on "Mapping of Soils and Land Degradation at 1:50,000 Scale", proposal initiated by ICAR, DOS and DAC, to be implemented, in the pilot districts to be identified for Agricultural Resources Information System.
- Development of Decision Support Systems (DSSs) on "**Production Practices and Systems**" which need to be adopted to respond to new market demands and export opportunities, poverty alleviation or growing labour shortages, depending on the agricultural production settings;
- Development of generic decision support systems (DSS) using databases and model bases for agricultural planning, and management at micro watershed/ levels; and also to establish GIS centres at block or Panchayat levels.
- **DSS on water allocation in an irrigation system** to remove the existing disparities in the availability between the *head-reach* and *tail-end* farms and between *large* and *small farms*, to achieve "equity and social justice"
- **DSS on Land Resources Development, given in the DSS Section;**
- Linkages to development of Development of National Water Database as envisaged in the World Bank aided National Hydrology Project; effective linkages with International Commission on Irrigation and Drainage (ICID), and the UNDP sponsored International Programme for Technology Research in Irrigation and Drainage (IPTRID) for utilization of various Crop-Water models available as public domain

software for water resources management in agricultural planning in districts;

- **DSS on Water Bodies (Basins)** based on agricultural development using Watershed and Agro-Eco Region Planning Concepts;
- Development of Agrometeorology Database providing vital information of long term and short term objective in agricultural production, planning and management;
- NICNET based National Agricultural Drought Assessment and Monitoring System (NADAMS) and also Agromet Advisory Services in districts;
- DSS on Fodder Resources development;
- **National Livestock Policy (NLP) Studies** classifies the country into four livestock farming system viz., Cattle Farming System (CFS), Buffalo Farming System (BFS), Sheep Farming System (SFS), and Goat farming System (GFS), to **observe the possible linkage between livestock systems and cropping systems, demographic and agro-climatic features. DSS on Cattle Farming System (CFS), DSS on Buffalo Farming System (BFS), DSS on Sheep Farming System (SFS), and DSS on Goat farming System (GFS) may be developed.**
- "Development of databases and GIS" to strengthen NATP, both in centralized and decentralized pattern, viz.
  - (h) animal husbandry database,
  - (i) climatic database,
  - (j) crop-wise database,
  - (k) fisheries database,
  - (l) genetic material database,
  - (m) natural resource database, and
  - (n) socio-economic database.
- Agricultural Resources Information System will have these sub-databases as its kernel, to begin with in the pilot districts.
- **Involvement of Institutions viz., ICAR Institutions, State Agricultural Universities, Rural development Institutes, NIC, DOS, NATMO, GSI, CGWB, Departments of Geographical Research, etc working on spatial data generation and application of spatial theory for problems solving in respect of agricultural development, rural development and backward area development;**

- Metadata standards provide a way for data users to know:-
  - *What data are available*
  - *Whether the data meet specific needs*
  - *Where to find the data*
  - *How to access the data*

Metadata Base is required to be established for Agricultural Resources Information System to be made available over NICNET for information access. This **Core Group-V strongly recommends for development of "metadata"<sup>@</sup> concept on soil data, to start with, in the country to strengthen correlation, uniform nomenclature and appropriate mapping units with legends.**

- Information Technology related training of all Officials and Officers of State Departments of Agriculture and its sub-state level offices, in a mission mode so as to empower the existing manpower of the Department with the Information Technology tools to facilitate the development of Agricultural Resources Information systems (AgRIS) in the Country.

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<sup>@</sup> Soil Geographic Data Standard (September 1997) of the Soil Data Subcommittee, Federal Geographic Data Committee, US Geological Survey