Mainstreaming ICT for fostering agricultural growth, poverty reduction and sustainable resource use to usher in rural prosperity

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1. Introduction

1.0 Agriculture, including crop & animal husbandry, forestry & agro-forestry, fisheries, and agro-industries, provides livelihoods to over 70 % of the Indian population. Agriculture is decentralised but small scale manufacturing (small and marginal farmers) units. In addition, India is a land of diversity with different types of terrain, various agro-climatic conditions, different levels of socio-economic conditions, and varied levels of regional development. There have been concerns about persistent rural poverty, unemployment and inequality, and resulting social tensions at grassroots level in India. The strategies and policies developed by the Planners and Policymakers, adopted two approaches: one focusing on the overall economic development (through percolation, trickle down and spread effect), and the other on poverty alleviation (direct intervention). Though these two approaches reinforce each other, there has been no attempt to integrate them.

1.1 At the beginning of the new millennium, 260 million people in the country did not have incomes to access a consumption basket, which defines the poverty line. Of these, 75 per cent were in the rural areas. Agricultural wage earners, small and marginal farmers, casual workers engaged in non-agricultural activities, rural women (especially women-headed households), among the others, constitute bulk of the rural poor. After decades of limited success in eliminating rural poverty, new ideas about rural development (i.e. viable society in a rural space, livelihood approach, sustainable livelihood approach, sustainable agricultural and rural livelihood approach, sustainable community concept, Multiple Livelihood Opportunities, etc) are emerging so as to reduce the vulnerability of the rural poor. Poverty Alleviation, Livelihood Opportunities and Gainful Employment are closely linked.

1.2 There have been both national and international efforts (DOT Force of the UN, the UN/ESCAP Committee on Poverty Reduction, the Millennium Development Goals, PovertyNet of the World Bank, etc) to improve information flows and communication services to eliminate poverty (ICT for Poverty Reduction), which are a necessary but not

sufficient condition. In poor rural areas, where agricultural productivity is low and unreliable and there is food insecurity, better information and knowledge-exchange can be important in lessening poverty.

1.3 The growing populations need food, clothing, shelter, fuel and fodder for their livestock. As market oriented economic development proceeds, Indian farmers in rural areas continue to experience great disparity in income compared with other sectors, and they are forced to revert to natural resources as the most accessible sources of livelihood. As the natural resources which are critical inputs for providing sustainable livelihood to the rural poor are in a degraded condition, it is difficult for the SMFs to generate gainful employment in rural areas and to come out of poverty. Lack of infrastructure, inadequate financial resources and poor managerial capabilities have further shaken their confidence to fight poverty (Narayanan Hegde, 2004) . Degradation of natural resource is a key threat to socio-economic development, and to global environment (e.g., climate change and loss of biodiversity).

1.4 Since the Rio Earth Summit in 1992, agriculture remains high on the international agenda because it brings together critical issues like water, poverty, hunger, and health. "Reaching the Rural Poor" makes broad-based economic growth its primary objective, and treats agriculture as the leading productive sector within the rural economy and closely linked to non-farm activities. Science and Technology (S&T) offers tremendous opportunities in simultaneous achievements of the goals of sustainable agriculture and improving the rural livelihoods (World Bank, 2003) . "Doubly Green Revolution" adheres about "growth in agricultural production (GAP)" and "improved livelihoods" through:

- Access to land, capital and knowledge
- Dissemination and sharing of knowledge and technologies (IPRs)
- Improvement of user training and qualification
- Affordable and accessible technologies
- Gender equity
- Improve / enable risk / benefit assessment at national, institutional and private level.

Demands for agricultural technology are changing and diversifying (Rita Sharma, 1999) :

- technologies to break the stagnation in the yield growth in intensive irrigated agriculture,
- technologies for dryland farming which accounts for 2/3rd of the country's cultivated land,
- technologies for diversification of farming systems for employment and income generation and in high value commercial crops, and development of sustainable agricultural practices that preserve natural resources while enhancing the productivity.

1.5 Informatics Networks, besides Computer Networks, are increasingly considered as development tools for achieving (a) Reaching the Unreached - Public Services; (b) From Digital Divide to Digital Opportunities for sustainable development and economic growth; (c) Fostering agricultural growth, poverty reduction and sustainable resources use; (d) Sustainable Development & Earth Care Policies - Water, Energy, Education, Health, Agriculture

& Rural Development, Biodiversity; and (e) a Cluster of Villages - Sustainable Societies in Viable Rural Space. Emergence of Information and Communication Technologies (ICTs) on the national agenda and the announcement of ICT policies by various State Governments, since 1995, have recognised the "Convergence of Core Technologies and E-Governance" as the tool for sustainable development and globalisation of economy.

1.6 Good Governance and institutions are indispensable for sound agricultural and rural development in developing countries. Models of e-Government (i.e. digital government) are continuously evolving and improvising to harness the potential offered by the Information and Communication Technologies (ICTs) and deal with new realities in the area of governance, through out the World. Generic Models of e-Government (www. digitalgovernance.org) viz., Broadcasting / Wider-Dissemination Model, Critical Flow Model, Comparative Analysis Model, E-Advocacy/ Lobbying and Pressure Group Model, are relevant while discussing "design of an e-Government for Poor". Studying and influencing the "Geometry of Information Flows" facilitates direct benefits rather than trickle-down benefits for the disadvantaged community (i.e. the Poor).

1.7 Digital opportunities have emerged as "power tool" for fostering agricultural growth, poverty reduction and sustainable resources use in developing countries. The National Agricultural Innovation Project (NAIP) of the ICAR envisages, among the others, to transfer appropriate technologies and to develop innovative models for promoting agricultural production, particularly farmers belonging to weaker sections of the Society and located in disadvantaged regions, through the Components of:

a. Collaborative Research Models for Sustainable improvement of Agricultural Value Chains;

b. Collaborative research Models for Livelihood Improvement in Disadvantaged regions.

1.8 Rural India desires to take advantage of "knowledge-intensive" techniques in sustainable crop farming and animal husbandry, to get better value-added for their products via information links to markets, and to obtain up-to-date, accurate information on entitlements viz. health and welfare benefits, employment opportunities. Innovation is the need of the hour in India's rural sector.

2. Viable Society in a Rural Space: An epitome for Rural Livelihoods

2.0 Our economic and industrial growths are dependent on production and productivity in agriculture. Agriculture, with its large dependent population, has to thrive and flourish in order to secure rural prosperity. Agricultural development, along with village & cottage industries, tiny and micro enterprises, are the cornerstone for promoting sustainable rural livelihoods (Madaswamy Moni, 2005) . Agriculture productivity is a function of seed quality, nutrient adequacy, irrigation and adoption of appropriate package of practices. Agricultural growth is an important factor in poverty reduction, especially in agrarian economies like ours, in view of its "multifunctionality" .

2.1 The constraints faced by the Indian Agricultural sector, for achieving its sustainable growth in many parts of the country, are well documented as follows:-

- Extensive pressure on land due to urbanisation

- Fragmentation of land holdings
- Frequent failure of monsoon and uneven distribution of rains (climatic aberrations)
- Depletion of ground water due to over-exploitation and lack of recharge
- Increasing areas under fallows
- Declining nutrient status of soil and soil health due to intensive cultivation - Degradation of land (problem soils)
- Infrastructural inadequacy
- Inadequate market support
- Weak linkage between farmers and R&D institutions
- Inadequate post-harvest infrastructure, processing facilities, research & extension support
- Paucity of resources for large investments with long gestation periods.
- Ineffective pre-harvest and post-harvest Supply Chain Models and CRM Models.

2.2 In areas where investments in agricultural infrastructure have lagged (Viz., State of Bihar, State of Orissa, State of Assam and State of Madhya Pradesh), rates of growth in agricultural productivity and poverty reduction also lagged (Roy and Pal, 2001) . Most parts of the Eastern Region (ER) lags rest of India on some social indicators like: (a) Poverty ratio (highest in Bihar); (b) Infant fertility (highest in Orissa); (c) Overall literacy (lowest in Bihar) and female literacy (lowest in Orissa and Bihar), and (d) Poverty incidence varies within the Eastern Region. Given the strong linkage between output growth (particularly agricultural growth) and reduction in poverty, accelerated agricultural growth is critical, to reduce poverty in the eastern region (ER) states.

2.3 The Green Revolution has been "supply- driven" whereas the Livestock Revolution is driven by "demand-driven". Livestock are a renewable natural resource but Livestock production requires natural resources such as land, feed and water. Mishra (2004) has claimed that the mixed farming system, in which livestock and agriculture are integrated or interdependent, is environmentally most benign, and also open for sustainable development in future. Studies have shown that dairy enterprises as against crops in rural areas gave large profit margins in marginal, small and medium holdings. Livestock farming is major player in dryland and hill regions. Sustainable rapid growth and development in this sector can be only ensured if the livestock owners, service providers, veterinarians and planners: become knowledge based and acquire the ability to absorb, assimilate and adopt the spectacular development in the veterinary sciences and related technologies. Bhat (2004) , therefore, envisages an urgent requirement of "Animal Production and Health Information System (APHNET)" in the country.

2.4 The experience shows (Acharya, 2004) that rural livelihoods can be improved in a sustainable way if the following conditions hold true:-

- Availability of appropriate technology;
- Availability of inputs, services and credit to farmer and rural families;
- Availability of market support to farmers and rural households;

- Adequate local institutions and social capital;
- Security of tenure or rights to resources;
- Absence of poor non-friendly macro policies; and
- Good governance.

Our vision is to realise an economically and socially vibrant agricultural industry i.e. to accelerate commercialization of innovative, alternative and value-added agricultural and farm related enterprises, in rural areas. This development strategy, inter alia, facilitates skill improvement, providing employment in rural areas, transfer of technology, rural industrialization and promoting self-reliance among the people and to build up a strong rural community base. That is to build a Rural India, which shines. Farms, households, and other components of rural systems need a minimum bundle of rural infrastructure services to function efficiently, which include:

- An adequate supply of safe drinking water;
- Health and education infrastructure;
- Transportation infrastructure and services;
- Information systems; and
- An adequate and dependable energy supplies.

2.5 Agriculture in India needs a productivity and quality revolution i.e. a Total Quality Management (TQM) and a Total Factor Productivity (TFP), which can be brought out through the much-needed agricultural reforms. Agricultural reforms mean land reform plus a package of support services such as credit, marketing, pricing, and rural infrastructure (water, roads, bridges, hospitals and schools). Agricultural research, education, extension and training are the essential four pillars of sustainable Agriculture and induction of "Knowledge Triangle" (Figure-1) is essential. Information and Communications Technologies (ICTs) have tremendous role to play in these four components.

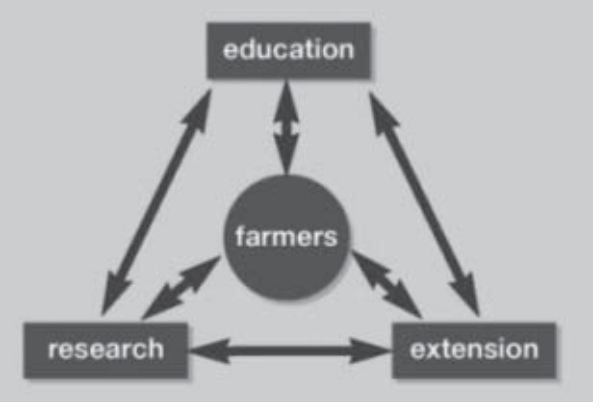


Figure-1: Knowledge Triangle (www.fao.org)

3. Agricultural Extension: An Agricultural Knowledge & Information System for rural empowerment and improved livelihoods – A Situation Analysis

3.0 Agriculture is different all over the world and hence the 'one-size-fits-all' model (i.e. "Green Revolution Model") of agriculture is inappropriate and cannot reflect the environmental, social and cultural diversity that exists around the world. Rural households at various agro eco-regions practice several farming systems. While each system might bring benefit to an individual household, the conflicts in resource utilization often nullify the effort of the whole community. Societies have also different attitudes to intensification and new technologies, and with regard to traditional forms of farming, e.g. maintaining small-scale mixed farming, specific types of produce, knowledge and skills etc. Extension strategy for rainfed farmers and farming is different than irrigated rich resource and progressive farmers (Prasad & Das, 1991) . Agricultural practices have, however, a major impact on the use of natural resources, ecosystems and biodiversity. Therefore, a better approach to sustainable natural resource management must be designed to help small and marginal farmers (SMFs) in less privileged, fragile areas. Competent techniques of transferring technologies to the farming communities are of prime importance towards all round development of the agricultural sector.

3.1 In developing countries, the productivity and incomes of the Small and Marginal Farmers (SMFs) have stagnated or even decreased. SMFs, traditionally the backbone of much of developing countries agriculture, are under threat (IFPRI, 2002) . Farmers, in particular SMFs, must be able to choose agricultural practices and technologies from the full range of approaches available for tackling their problems: agro-ecological methods, conventional research methods, and molecular biology research methods. The slack in adoption of technology by the SMFs is largely due to inaccessibility or unavailability of credit, extension, and information rather than any inherent incapability in them. Converting millions of poor farmers to the use of new technologies has been a colossal task.

3.2 Agricultural extension services, which could help reduce the risk of on-farm investments, do not reach the poor systematically. What the farmers require is discernible from the agro-advisories in farm operations being offered from the Gujarat Agriculture University (GAU) – Anand, as follows:

Sl.No	Farm operations	Percentage
1.	Pest & disease Information	32.4
2.	Sowing time information	22.7
3.	Crop information	16.3
4.	Weather information	13.1
5.	Irrigation Scheduling	4.4
6.	Tobacco crop Information	4.3
7.	Rice Crop Information	2.3
8.	Potato Crop Information	2.2

9.	Harvesting Information	1.2
10.	Fertiliser Application	1.1

3.3 There are four types of actors involved in the agricultural extension: public agencies, private agencies (input suppliers etc), production organisations (POs), and NGOs. Agricultural Extension and its services involve basic functions such as informal, dissemination, advisory, and educational. The Agricultural Extension System Infrastructure in India includes: -

- Agricultural Extension Officials (Full time) in States - 90000 (approximately)
- Extension Education Institutions (EEIs) including MANAGE - 5
- Krishi Vigyan Kendras (KVKs) in 252 Districts - 261
  (Proposed to have one KVK in every district)
- Advanced Training Institutes(ATIs) - 15
- Farmer Training Centres/Kisan Vidyapeeth - 137
- Rural Development Institutes - 52
  (mainly in the State of Uttar Pradesh)
- Trainers Training Centres - 8
- ICAR Institutes / Directorates - 85
- State Agricultural Universities - 40
- ICAR Deemed Universities - 5
- Agricultural Colleges - 300

3.5 The ATMA (Agricultural Technology Management Agency) Model, which was the extension component of NATP implemented in 7 States, during the Ninth Plan period (1997-2002), was considered as a "way forward" to increase farmer's input with respect to the followings: -

- Farming system innovations (intensification or diversification)
- Farmer organisations
- Technology gaps both in crop production systems and livestock production systems
- Natural Resources Management (Soil conservation and Water conservation, Reduction of Pesticides use through IPM Programs), and
- Marketing and Agro-processing linkages

3.6 The Agricultural Extension Service is a medium-term and long-term investment in the same way as education and research. The farm is a business and the farm manager (farmer) needs to optimize the returns from their agricultural investment. The interactions between agricultural systems and practices, economics, society and the environment are highly complex. Human Resources Development among farming communities is very essential, as they have to face the challenges at ground level: creation of technology (IPR Divide), diffusion of recent innovations (digital divide), diffusion of old innovations (extension divide) and diffusion of human skills (educational divide).

3.7 The ongoing scheme of "Agri-Clinics" intends to advise farmers on cropping prac-

tices, marketing their products, technology dissemination, crop protection from pests and diseases, market trends and prices of various crops in the markets. Agri-clinics are expected to augment the existing agricultural extension network, which continues to be the only farm support facility in most areas in India. Establishment of a "Network of Agri-Clinics and Agri-Business Centres" is a new dimension in agricultural extension services to farmers.

3.8 The Government initiative of AGMARKNET Programme during the Ninth Plan with the roadmap to network 7000 Agricultural Produce Wholesale Markets and 32000 rural markets is a step towards "market-led extension" in India and is expected to have impact on the supply-chain of pre-harvest and post-harvest segments of agricultural operations. This has definite impact on farm investment. This Government initiative (AGMARKNET) and Private initiatives (e-choubal by ITC Ltd., Agriventure, and Mahindra Krishi Vihar (MKV)) ushers in "market-led extension" in the country, facilitating farmers to (i) enhance farm productivity, (ii) improve farm gate price, and (iii) cut transaction cost. Demonstrations of Mahindra Krishi Vihar (MKV) at Madurai district in Tamilnadu have shown a significant increase in productivity (as against an average paddy yield of 1.8 – 2 Tonnes per acre, farmers have achieved yield ranging from 3 – 3.6 Tonnes per acre). The consultancy and technical support package was at a cost of about 10 % on the increase in productivity achieved (Balaji, 2001) . Community Agro-biodiversity Centre (CAbC) of the M.S.Swaminathan Research Foundation (Chennai) aims at protection of livelihood and biodiversity in villages.

3.9 According to Preeti Ramanathan (2002) , Agri-Clinics, in its present form and without the supporting commercial and legal mechanisms, would remain yet another well-intentioned government intervention in agriculture and rural development, without sustainable growth and without any relations to macro level planning, for development. The rural economy is larger than the yearly 12000 graduates or so in agriculture and related subjects, and the ills are far beyond and over encompassing. The Government expects that "Dial 1551 Call Centre" which rides on the fact that six Lakh villages have phone connections, could bypass a clearly inadequate system of extension workers and NGOs.

3.10 Agricultural Extension programmes need to be oriented towards enhancing the decision-making abilities of rural people, especially farmers, by expanding their exposure to effective organization and management skills, not just new agricultural production technologies alone i.e. "knowledge-intensive". The task of extension would become more challenging in the wake of post WTO era, which demands a "system of market-led extension" with specific focus on diversification, post-harvest management, and export orientation. There are about 600 million farm workers, most of who are not agricultural science graduates, yet possess inherent knowledge to carry out commercial activities. What they lack is capital, access to trade, agricultural resources, market information system, connectivity among others of their ilk, decision-making support systems and market mechanisms to convert their labour into profitability.

3.11 Mohan and Moni (2001) proposed an exclusive Agricultural Extension Information System Network (VISTARNET) to reach Technology to the Small Holders (Resource-Poor-Farmers) in India, by networking the existing Agricultural extension infrastructure, given above, and also undertake "capacity building" through human resources development programme for using ICTs. However, The Government Extension machinery had been

promoting "WAICENT" for retrofitting in India during the Ninth Plan. With the implementation of DACNET Infrastructure (An e-Governance Infrastructure for development information exchange – eGOV4D and also see http://www.dacnet.nic.in) in all Directorates of the Central Department of Agriculture and Cooperation (DAC), and the AGMARKNET, the VISTARNET has been realised in India. "Dial 1551" to DACNET VSAT Nodes can generate a synergetic response to farmers.

3.12 In the Indian context, emergence of an e-Farmer is the need of the hour. Synergetic collaborations among Cooperatives, Agricultural Produce Markets, Agri-Clinics, Agri-Business Centres, and AGMARKNET could become the "pathways" to rural prosperity. The Agricultural Extension System is expected to be "an Agricultural Knowledge & Information System, using Geomatics Technology" in India. Development of Agricultural Extension XML (AeXML) is an essential requirement.

4. Developments in Digital Governance (e-Governance)

4.0 E-Government is more about putting together the IT infrastructure to make the average citizen's interface with the government easier, while e-Governance has more to do with the laws and regulation of the Internet. Models of Digital Governance (e-Governance) are continuously evolving and improvising to harness the potential offered by ICTs and deal with new realities in the area of governance. There are no rigid and finite models of digital governance. In fact, several developing countries are putting into practice innovative e-Governance models that may technologically be simple but are changing the way information is distributed in the society (http://www. digitalgovernance.org). All these models share in common, the inherent characteristics of the new technologies, which are: (a) enabling equal access to information to anyone who is a linked to the digital network and (b) de-concentration of information across the entire digital network.

4.1 Studying and influencing "geometry of information flows" is important because the aim is to use ICTs for development purposes--- those that bring real, significant changes in the lives of disadvantaged communities (i.e. farmers), rather than simple embedding of ICTs in the society. Somewhat detailed steps, as available from published materials, for e-Governance projects are given below: -

- Who are our Target groups that we want to reach out to, through ICT for Development projects?
- Small farmers with less than 1 acre of land
- Farmers who have land away from roads and markets
- Farmers farming in ecologically fragile areas
- Newly turned farmers, young and women farmers
- Farmers lacking credit, tools to enhance land productivity
- What are the key information needs of the disadvantaged community?
- Information on identifying and dealing crop pests and livestock diseases
- Technical inputs on how to carry contour bunding, land-leveling, water harvesting activities, composting to increase productivity
- Information on government subsidies and schemes on seeds, fertilizers, horticulture and

minimum support price

- Information on new crop varieties, irrigation frequency, setting up farm-based enterprises
- Information on market prices of the crops, availability of credit, agriculture fairs, soil-testing laboratories and training programmes
- What are the existing channels by which information reaches to the disadvantaged community?
- Through other farmers, progressive farmers, money lenders, teachers, public phone operator, postman and health workers
- Through government officials, agriculture extensionists, agriculture fairs, agricultural universities and NGOs
- Through radios, televisions, folk songs and newspapers
- What is the weakest link in the chain of information flows: from source to the disadvantaged community?
- Information may be available at local agricultural centres or in markets but these are not easily accessible by farmers.
- High levels of illiteracy prevent farmers to benefit from available information.
- Agriculture extensionists are knowledgeable but do not visit farmlands away from roads or in remote areas.
- Agriculture extensionists and local agricultural centres do not have updated knowledge of new crop varieties, pest control and government schemes and subsidies.

Here the disadvantaged community is the resource poor farmers (land farming and landless farming).

4.2 Information, knowledge and communication (IEC) are the lifeblood of economic and social interaction. Agriculture (genetic modification), Medicine (genome research and bioinformatics) and Information & Communication Technologies (ICTs) are the three fields where diffusion of technology holds particular promise for the poor (The Economist, November 2001). The Poor lack:

- Access to information that is vital to their lives and livelihoods:
- About market prices for the goods they produce,
- About health,
- About the structure and services of public institutions;
- About their rights.
- Political visibility and voice in the institutions and power relations that shape their lives.
- Access to knowledge, education and skills development that could improve their livelihoods.
- Access to markets and institutions, both governmental and societal, which could provide them with needed resources and services.
- Access to, and information about, income-earning opportunities.

4.3 Harnessing the information revolution for economic development, social cohesion and poverty alleviation in the 21st century is the theme for various National and International Conferences. The present day Digital opportunities (0s and 1s) will assist us in realising the concept of "sustainable communities", which is one where all stakeholders, as partners in progress on the road to economic development, will be enabled to achieve "sustainable production" and "sustainable consumption". There is a "need to bridge theory and reality (i.e. grassroots)" (Figure-2). An ICT based Gateway to farmers is essential.

4.4 ICT Diffusion and Infusion in agricultural sector provide the necessary "digital opportunities" or "advantages" for productivity increase, income generation and decrease in regional disparity. ICT has opened considerable opportunities for the rural poor, both in terms of direct employment and in improving their linkages with the market. Markets are now the driver for agricultural growth. Marketing today depends on information system, i.e. on adequate information about what people want, at what price, and who can supply it (http://www.agmarknet.nic.in). It is essential to look into the sustainability aspects of "technology transfer" to grassroots level development. ICT diffusion and Infusion should induce developments in the areas of:

- Physical connectivity to bridge distances;
- Electronic connectivity to increase communication;
- Knowledge connectivity to provide information, technology, and increased understanding;
- Market connectivity to link rural products to markets.

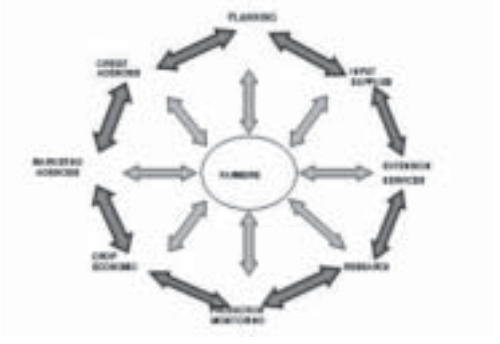


Figure2: Gateway to Farmers – Interaction of Farmer with various components of Agricultural Input-Output Systems

4.5 "Networking of People" and "Networking of Information" are essential. One of the major problems of using ICT for poor is language barrier. Content development in local languages is challenging task ahead. Grassroots level Information access (Contents) and Grassroots level access to Information (Networking) are the two essential components for grassroots level development strategies through ICT.

5. Mainstreaming of ICT for Collaborative Research Models for Sustainable improvement of Agricultural Value Chains

Agricultural Resources Information System – A Needed Domestic Strategy for Sustainable Rural Livelihoods: Proof-of-Concept projects

5.0 The scientific management of agricultural resources becomes a very important part of modern agricultural production in the 21st Century and is a new direction in the domain of agricultural engineering. Agriculture is highly dynamic in nature, because of the changing phenomenon of agricultural crops, which is further complicated by the interaction of crops with environment. A wide range of agricultural practices could be affected including potential environmental benefits that could come from minimizing adverse impacts, by reducing external inputs and greater use efficiency. Farmers, Land and Natural Resources (supported by the Land) have intrinsic and dynamic relationship.

5.1 Resources Application and Agronomic Practices are to match with soil attributes and crop requirements, as they vary across a site (McBratney and Pringle, 1997). The site-specific management (or precision farming) is farm-size and production-system neutral, and will make agriculture "information intensive". This will impact rural economies. Despite potential of economic and ecological benefits, adoption of precision technologies is very slow through out the World. The reasons for limited implementation of site-specification management (or precision farming) in Asian Countries are due to: small land holdings, cost-benefit aspect, heterogeneity of cropping system, lack of local technical expertise, and knowledge and technological gaps. In India, about 57.8 per cent of operational holdings have size less than 1 hectare.

5.2 Proper analysis of the agricultural sector requires that it be 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, among the others, influencing agricultural performance:-

- Agro-climatic data
- Agro-economic data
- Agro-forestry Resources
- Animal Resources
- Capital Resources
- Crops and Cropping Systems
- Environment data
- Fisheries Resources
- Forestry Resources
- Institutional Resources
- Land owners data
- Plant Resources

- Socio-economic & infrastructure data
- Soil Resources
- Spices Resources
- Water Resources

5.3 Mollet (1984) provides details on the contents of Agricultural Resources Information System and recommends 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) basic data animal husbandry and fisheries, (vi) basic data genetic (plant, animal & fisheries) materials, (vii) basic data on land ownership, (viii) Socio-economic data, (viii) data on infrastructure for agricultural development. Zhu Zesheng and Sun Ling (1996) has proposed a seven-layered architectural model for agricultural resources management: application layer, management layer, decision models layer, decision data layer, production data layer, weather data layer, and environmental data layer. This layered approach is essential to facilitate development of metadata and application of OpenGIS model for optimal utilisation of agricultural resources.

5.4 Development of Metadata (data about data) is required, as overall rate of collection of data increases rapidly with advances in technologies such as high resolution satellite-borne Imaging systems and Global Positioning System (GPS), and with the growing number of people and organizations who are collecting and using data (Ground Truths). Synchronization of Geo-processing Technology (GPS - Global Positioning System and RS - Remote Sensing), with the emerging Information Technology Standards based on "Open Systems", "Distributed Processing", and "Componentware Frameworks" provides OpenGIS Architecture (see http://www. opengis.org) to facilitate Information Systems and Solutions, over INTERNET / INTRANET for developing DSSs (or GDSSs) on sustainable development issues. The Componentware framework includes GIS Tools, Imaging Tools, Expert Tools, and RDBMS Tools; and each Tool has algorithms, data and interfaces to services in the distributed computing environment.

5.5 One of the central innovations of the World Wide Web (WWW) was the advent of a platform-independent graphical user interface markup language. Modern markup languages, such as SGML (Standard Generalized Markup Language) and XML (eXtensible Markup Language), which were initially conceived for modeling texts, are now receiving an increasing attention as formalisms for data and knowledge modeling. Geography Markup Language (GML) is an XML encoding for transport and storage of geographic information (both spatial and non-spatial properties of geographic features) is a significant milestone in the development of truly interoperable architectures for the use of spatial information between commercial applications. The progress of GML is an example of the growing momentum for the acceptance and use of Open GIS Consortium (OGC) specifications around the world, and represents one of the most visible steps taken by the geo-spatial community towards the creation of widespread spatial interoperability. Geomatics technology facilitates building up of the following DSSs for the benefit of farming community: -

- Crop Suitability based on factor endowment
- Land Suitability Assessment;

- Land Productivity Assessment;
- Population Supporting Capacity;
- Land Evaluation and Land Use Planning;
- Land Degradation Risk Assessment;
- Quantification of Land Resources Constraints;
- Land Management;
- Agro-ecological Characterization for Research and Planning;
- Agricultural Technology Transfer;
- Agricultural Inputs Recommendations;
- Farming Systems Analysis and Development;
- Environmental Impact Assessment;
- Monitoring of Land Resources Development.
- Livestock (cattle, buffalo, goat, & sheep) Farming Systems
- Water allocation in an irrigation system
- Fodder Resources Development
- Water Bodies (Basin) Planning Systems using Watershed and Agro-Eco Region Planning Concepts

5.6 The Central Ministry of Agriculture, on the basis of Report of the Core Group-V (AgRIS Report, 2000) of the Standing Committee on Agriculture and Soils, has planned to take up "Agricultural Resources Information System" in all districts (regions) of the Country, "irrespective of past or future growth regions" (Figure-3). Development of Agricultural Resources Information Systems, using Geomatics Technology in pilot districts with public funding, has been sanctioned as a scheme during the Tenth Plan (2004-07), in the following district typologies:

- A tribal district
- A hill district
- A dryland farming district
- A socially backward district
- A green revolution district
- A district dominated by cash crops
- 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 but having vast wasteland that could be used to generate

forest cover

This pilot project demonstration in districts of above mentioned typologies, in each state, will facilitate development of decision support systems (DSSs) 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 (NATP, 1998). Agricultural Resources Information System (AgRIS) is a "way-forward" to improve agricultural productivity in rural areas, and a much "needed domestic strategy" for sustainable rural livelihoods. During the Tenth Plan, the Department has planned to:

• Initiate pilot projects on "Agricultural Resources information System (AgRIS) in districts in order to work out the cost and efficiency of this project and then expand to the entire country;

• Develop a comprehensive database on various parameters related to land use, inputs (seeds, fertiliser, agricultural technology, agricultural credit) use, and water use;

• Development of decision support systems (DSSs) packages for strengthening advisory services to farmers; and

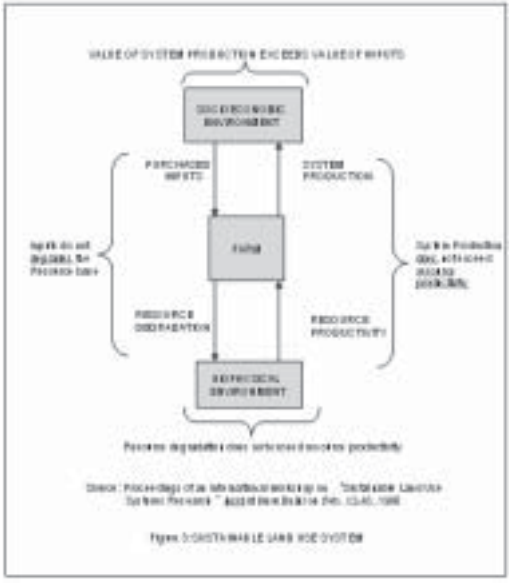
• Capacity building through Human Resources Development.

5.7 The AgRIS Project is expected to emerge as the richest "agricultural resources information system" (Figure3 and Figure-4) covering all aspects of agricultural, natural resource, and food systems, to:

• Enable farmers to locate needed information to improve yields,
• Plan for weather contingencies,
• Access research,
• Calculate treatments and runoff,
• Simulate the growing season,
• Visualize precision data,
• Manage finances,
• Buy inputs and sell outputs, and
• Monitor prices in local as well as world markets.

Guiding Principles of designing AgRIS will be as follows:-

• Focus on the Disadvantaged Communities, who otherwise will be excluded;
• Provide that information or service which otherwise will not be provided;
• Focus on utilizing and where possible building upon what is existing rather than thrusting a new intervention;
• Create an outcome which in absence of ICT, will not be produced efficiently or timely;
• Understand the difference between direct benefits and trickle-down benefits for the disadvantaged community.



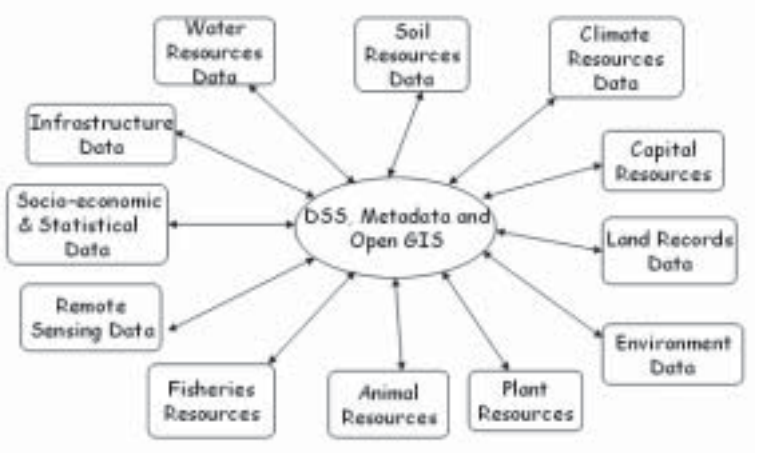


Figure-4: Components of Agricultural Resources Information

6. Mainstreaming of ICT for Collaborative research Models for Livelihood Improvement in Disadvantaged regions

(a) Digital development in Rural Areas : ICT for Micro level Planning

6.0 Indian village is a cognizable unit located in a specific agro-ecological and sociological environment. Its potentials and constraints for development are well known. As of today, the development planning is a highly compartmentalized activity managed by atomized govern-

ment departments handling agriculture, rural enterprises, forests, fisheries, water, health, education, culture, technology and livelihoods - almost in isolation of each other through different projects that rarely converge. Village problems are inter-related and the resources (natural and human) are integrated. People are both the "end and means" of development and also bound by a common space, history, culture and know-how. Indian villages are still complex, intertwined and multi-faceted.

6.1 In India, "district" is the basic administrative unit at the sub-state level and also consistent with the decentralized planning process prevailing at the grass-root. With the establishment of NICNET in districts numbering about in 1985-87, National Informatics Centre (NIC) has launched its "district information system (DISNIC) " in about 27 sectors viz., agriculture, animal husbandry, education, health, industries, rural development, micro-level planning, etc., as an informatics tool for development planning and responsive administration.

6.2 The database project to facilitate micro-level planning (DISNIC-PLAN) was one among the 27 sectors in 1990s. This project has received national level appreciation in 1990s and has been included as one of the recommendations of the National Task Force on Information Technology and Software Development (1998): "Citizen IT Interface - Empowering people through the use of IT and information availability: Decentralised Planning and Implementation: DISNIC-PLAN programme should be made widespread and the database updated online should be made available to the public, the Panchayat among others".

6.3 In the era of e-Governance at grassroots, the relevance of the DISNIC Programme was felt necessary and the Planning Commission has desired to re-establish the DISNIC-PLAN Project, with institutional linkages of grassroots level organizations, to provide continuous support to development agencies in districts. This project will facilitate to arrive at "an Informatics Blueprint that covers Villages" for economic and social development; derivation of various development indicators which will act as pointers to understand the development potentials as well as constraints for sustainable development; use of data and sensitization at the lower level spatial units; relevance of geospatial intelligence, research, education, training & extension for micro level planning; institutional linkages and plan of action for implementation, etc. The Informatics Blueprint includes, among the others, parameters related to the following sector at village level:-

- Village Identification and Location
- General Characteristics
- Public Utilities
- Meteorology
- Geology
- Soil
- Water Resources & Irrigation
- Environmental Problems
- Bio-Resources & Forestry Resources
- Household Details
- Agriculture
- Cooperation
- Livestock and Animal Husbandry
- Dairy Development
- Fisheries development
- Industry
- Transport
- Irrigation
- Agricultural Machinery & Implements
- Transport & Communication
- Energy
- Markets
- Financial Institutions
- Education
- Health & Family Welfare
- Public Distribution System
- Drinking Water & Sanitation
- Development Schemes

The draft dataset is available at http://www.disnic.nic.in.

6.4 This DISNIC-PLAN new initiative, during 2004-07, will support building up databases & decision support systems, and communication systems to facilitate: sustainability of resources, poverty alleviation, empowerment of women, full employment, production systems planning, infrastructure planning and habitat planning. Production potentials of village through "circular-flows" and "chain-effect" should be understood. This project is slated for pilot implementation in 28 districts through out the Country (one district per state). After successful implementation, it will be scaled up to cover all the districts in the country.

(b) Government's Initiatives and Agenda on Agricultural Informatics & Communication in India

6.5 According to the National IT Task Force (1999) recommendation (No.79), "the Government shall take all necessary steps to boost IT for Agriculture and Integrated rural development". The Ministry of Agriculture and National Informatics Centre (NIC) emphasized informatics for Agricultural development in the National Conference on "Informatics for Sustainable Agricultural Development (ISDA-95), Many follow up actions (ICT projects: AGMARKNET, DACNET, etc) were taken up, to provide relevant agricultural information in rural areas, helping farmers to improve their labor productivity, increase their yields, and realize a better price for their produce. India is expected to become a "Knowledge Society" by 2008 and by which time, any farmer in a remote village can demand and get the following information:

- Landuse planning for cropping strategy for farmers fields based on integrated information on soil, water, weather, fertiliser and pest management models;
- How and where to get proper seeds or good quality nursery plants;
- Prevailing prices of farm equipments, agricultural produce, products and series of such set of information, which can lead to high productivity and optimum cost benefit to the farmers.

To achieve "knowledge society" in agriculture, the following things should happen:

- An agriculture information centre in each village;
- Interactive exchange of information for planning and day-to-day operations by farmers;
- Availability of all the extension and advisory services on demand;

6.6 The Vision (2020) Document of the Department of Agriculture and Cooperation envisages that "the tools of IT will provide networking of Agriculture Sector not only in the Country but also globally and the Centre and State Government Departments will have reservoir of databases"; and also "will bring farmers, researchers, scientists and administrators together by establishing "Agriculture Online" through exchange of ideas & information". Karnataka State Agricultural Policy (1995) and Gujarat State Agricultural Policy (2000) "Agrovision-2010" have envisaged Information Technology applications to globalize their agricultural sector in a big way.

6.7 Various study results strongly support that the "payoff" effect of ICT on economic growth can be achieved only through a robust National Information Infrastructure (NII), i.e., AGRISNET for the agricultural sector that supports ICT adoption and applications in Pre-Harvest and Post-Harvest Supply Chain activities. ICT diffusion derives economic force from the complementary development of a knowledge-intensive society . In the present "crucial decade" of this millennium, a high rate of investment in Information Technology capital and a supportive environment are expected to achieve "digital economy". Its rapid growth, however, depends on (M.Moni, 2000) : -

- A higher rate of productivity growth related to investment in Information Technology;
- A rise in Total Factor Productivity (TFP) growth due to Information Utilisation across the economy and resulting in "spill-over" effects;
- An increase in factor utilisation; and
- A decline in the non-accelerating inflation rate and rate of unemployment.

6.8 ICTs Diffusion and Infusion have many potential applications spanning the breadth of the agricultural industry, at all scales of organisation from farmer, to cooperative and professional bodies, from farm machinery vendors, fertiliser and chemical companies, insurance, regulators, and commodities, to agronomists, consultants, and farm advisors. This facilitates farming systems to change in response to economic, technological and social needs. The proposed strategy reinforces commitment for higher agricultural productivity in India, which has been blessed with excellent agro-climatic conditions and water resources. This "informatics-led development" in Agricultural Sector provides enough scope for reduction of new risks of marginalisation and vulnerability of small farmers, in view of the two on-going processes (i) economic reforms and liberalisation (1991) and WTO/GATT Agreements (1994) at macro level, and (ii) decentralization reforms at micro level, operating in India.

6.9 As a step towards "reaching" technology to the small Holders (Resource-Poor-Farmers) of the Country, the Central Ministry of Agriculture have taken initiatives to build up an Informatics Network - AGRISNET: A NICNET based Agricultural Informatics & Communication - during the Tenth Plan. During the Ninth Plan, this proposal did not materialize due to bureaucratic entangle. This ICT Network envisages to facilitate an integrated approach of 'Internet Technology" and "Sustainable Agricultural, Rural and Backward Area Development" with its farm and non-farm linkages. During the Ninth Plan, the AGRISNET was suggested to have nodes upto "block level", as "block" is the planning unit for agricultural development. However, in the Tenth Plan, the AGRISNET has been envisaged to have Server Access nodes at 35 State Agricultural and Cooperative Departments, and 600 District Agricultural and Cooperative Offices. To usher in "agricultural Governance" in the country, it is essential to make the AGRISNET as the "rural infrastructure" reaching upto 6.5 lakhs villages.

6.10 This Initiative is based on the recommendations of ISDA-95 Conference (Informatics for Sustainable Agricultural Development), which includes, among the others, the following Informatics Networks: -

- **AGRISNET** - an Infrastructure network upto block level agricultural offices facilitating agricultural extension services and agribusiness activities to usher in rural prosperity

- **AGMARKNET** with a road map to network 7000 Agricultural produce wholesale markets and 32000 rural markets
- **ARISNET** - Agricultural Research Information System Network
- **SeedNET** - Seed Informatics Network
- **CoopNet** - to network 93000 Agricultural Primary Credit Societies (PACS) and Agricultural Cooperative Marketing Societies to usher in ICT enabled services and rural transformation
- **HORTNET** - Horticultural Informatics Network
- **FERTNET** - Fertilisers (Chemical, Bio and Organic Manure) Informatics Network facilitating "Integrating Nutrient Management" at farm level
- **VISTARNET** - Agricultural Extension Information System Network
- **PPIN** - Plant Protection informatics Network
- **APHNET** - Animal production and Health Informatics Network networking about 42000 Animal Primary Health Centres
- **FISHNET** - Fisheries Informatics Network
- **LISNET** - Land Information System network linking all institutions involved in land and water management for agricultural productivity and production systems, which has now evolved as "Agricultural Resources Information system" project during the Tenth Plan being implemented through NIC.
- **AFPINET** - Agricultural & Food Processing Industries Informatics Network
- **ARINET** - Agricultural and Rural Industries Information System Network to strengthen Small & Micro Enterprises (SMEs)
- **NDMNET** - Natural Disaster Management Knowledge Network in India
- WeatherNET- Weather Resource System Information Network of India

(C) e-Cooperatives & CoopNet: An Internet Enterprise Development Programme for fostering agricultural and rural industries

6.11 Rural Connectivity is the lifeline of rural economy. There are about 5.5 Lakh cooperative societies with a membership of more than 236 Million and working capital of more than Rs. 3400 Billion . Cooperatives have made remarkable progress in agriculture, banking, credit, agro-processing, storage, marketing, dairy, fishing and housing (Table-1). This network covers 100% villages and 85% of rural households, and occupies a key position in agricultural development with respect to resources use, inputs use, harvesting of water resources, marketing channels, storage facilities, distribution channels, value addition, market information, and a regular monitoring network system. Cooperatives are also engaged in economic activities like disbursement of credit, distribution of agricultural inputs (seeds, fertilisers, and agro-chemicals), and arranging for Sanitary and Phyto Sanitary (SPS) measures of farm produces.

6.12 Cooperatives have inherent advantages in tackling the problems of poverty alleviation, food security and employment generation. Cooperatives are also considered to have

immense potential to deliver goods and services in areas where both the State Sector and the Private Sector have failed (Verma, 2004) . By and large, cooperatives (except a few large cooperatives) are "local institutions", addressing "local needs", employing "local talent", and lead by "local leaders". Situation is emerging wherein there is a possibility of people migrating back to rural areas, as there is a vast potential in cooperatives for generating self-employment opportunities at grassroots. The contributions of Cooperatives in the Green Revolution and the White Revolution are significant. The Cooperative movement is facilitated through (a) 19 National Level Cooperative Federations, (b) 367 State Level Cooperative Federations, and 2890 District Level Cooperative Federations.

Table-1: Outreach of Cooperatives

Sr.No	Outreach of Cooperatives	Coverage/ Contribution
1	Rural Network (Villages Covered)	100%
2	Coverage of Rural Households	71.0%
3	Agricultural Credit Disbursed	42.8%
4	Fertiliser Distributed (6.049 M.Tonnes)	36.17%
5	Fertiliser Production (3.509 M.Tonnes – N&P)	25.0%
6	Sugar Produced (10.164 M.Tonnes)	50.5%
7	Wheat Procurement (6.926 M.Tonnes)	33.5%
8	Animal Feed Production/Supply	50.0%
9	Retail Fair Price Shops	20.3%
10	Handlooms	54.0%
11	Fishermen Cooperatives	21.0%
12	Storage facility (Village level PACS)	64.5%
13	Direct Employment Generated	1.15 Million
14	Self-Employment Generated	14.79 Million

(*Source:* Indian Cooperative Movement – A Profile, 2004: Developed by National Resource Centre, National Cooperative Union of India)

6.13 The Primary Agriculture Cooperative Societies (PACS), which are about 100,000 in number, are the major player at the grass root level helping farmers with credit, inputs, marketing, advisories etc. Credit is a very powerful instrument for empowerment of the resource-poor people. Credit can generate "accelerated economic growth", when loans are easily available, properly utilised and repaid in time. A cumulative upward movement of "capital supply – increased productivity – higher real income – higher capital supply" is necessary for sustainable rural development (Tapan Chakraborti, 2004) . These PACS can play a major role in revitalization of cooperative credit structure, provided if they are networked using ICT so as to facilitate "streamlining the Cooperative Credit Structure for hassle free flow of credit". Urgent steps to revitalize Cooperative Credit institutions are required.

6.14 Marketing and Commercial Production have been a longtime part of the life of Indian farmers. A network of cooperatives at the local, state, and national levels assist in agricultural marketing in India, by handling food grains, jute, cotton, sugar, milk, fruits, vegetables, and areca nuts. Global competition and new Information and Communication Technologies (ICTs) are forging new relationships within & between, different layers of agribusiness, transforming the industry from a chain to a complex web. Internet Commerce (or e-Commerce) is growing fastest among businesses and facilitate companies to integrate and maximise changes (i.e. restructuring, business-process standardisation, enterprise resource planning, etc). The Industry developments provide an insight into trends, potential impacts and prospects, as given below:

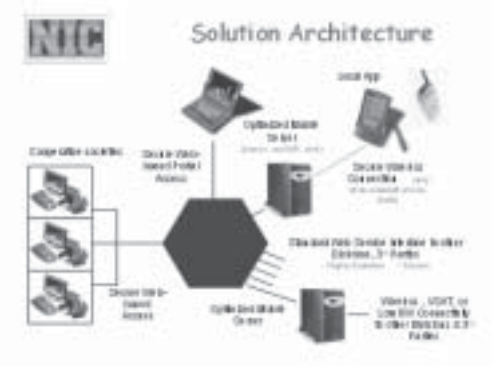
- e-marketplace/Neutral e-Hub
- e-distribution sites/Distributor model
- e-procurement sites/Aggregation model

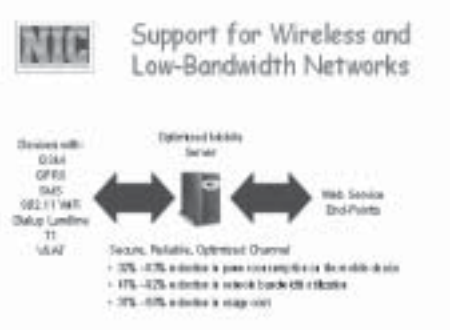
6.15 With a view to ensure "appropriate positioning" of cooperatives in the emerging liberalised competitive economy, it is essential to:

- promote cooperation among cooperatives,
- develop coordination among cooperatives,
- strengthen Primary Agriculture Cooperative Societies (PACS) through business development plan for their self-reliance,
- enhance involvement of rural poor in the Cooperative movement through Self-Help-Groups (SHGs),
- develop cooperative insurance system,
- promote international cooperative trade,
- undertake human resources development,
- develop agro processing industries,
- to widen the business in marketing of food products, seeds and fertiliser,
- provide market support to farmers,
- make available all essential "agro-inputs" to the farmers,
- undertake livelihood generation projects in tribal areas for marketing development of tribal products,
- facilitate cooperative planning,
- transfer of technology to its members and common public,
- assess and disburse of credits to its members, and also promote economic interests of the members,
- provide all types of banking facilities,
- provide godown, cold storage and processing yard facilities,
- develop market intelligence related to supply, demand, price trends, supply/market chain, value addition and processing facilities, product quality specifications, product applications, market trends,

- disseminate information to the members as well as planners, researchers, and associate organisations and business circles etc,
- develop and establish sound "information network" among cooperatives sector wise,
- develop ICT enabled services in cooperatives, and
- On-line service to its members, and many more quality services.

6.16 To begin with, it is suggested to network about 1.46 lakhs Primary Agriculture and Credit Cooperatives, 19 National Level Cooperative Federations, 367 State Level Cooperative Federations and 2890 District level Cooperative Federations. Networking of Cooperatives through state-of-the-art technology is essential, which will facilitate to get connected to a National Data Centre (24/7 Infrastructure) for achieving the followings, for which an initial investment of Rs. 2500 Crores is required:-





Network Solution Architecture

- Build relationships and alliances faster
- Re-engineer and integrate their processes
- Develop more and better value-added products and services
- Share knowledge and experiences
- Enhance innovation
- Promote Web-based business trading

(D) Warana Wired Village Experiment in 1990s: True reflection of a Public-Private-Participatory (PPP) Model of NIC and Warana Nagar Cooperative Society in the State of Maharashtra

6.17 Warana is a well-developed rural area located 30 kilometers northwest of the city of Kholapur, in one of the richest states of India, Maharashtra. The main economic activity in Warana has been sugarcane growing and processing. About 50,000 farmers live in 70 villages spread in the 25,000 Sq.km area covered by the cooperative. Another Rural digital initiative is the Warana Wired Village in Maharashtra State, which had set up information kiosks in 70 villages to enable villagers to access agricultural, medical and educational information through the Internet, in their local language (Marathi), under a Public-Private-Participatory (PPP)

Model of NIC and Warana Nagar Cooperative Society.

6.18 Farmers consider the Internet a better source of information than traditional sources such as traders, field officers, television, radio and the print media. By providing neutral information, this ICT service also minimizes cheating by unscrupulous traders quoting the prices of farm products. Community-based Telecentres offer a way of providing affordable access to ICT services in rural areas . (E) AGMARKNET: A powerful Government ICT Initiative for Rural Empowerment, a warehousing of "Data-for-Development", & a "free-trade-zone" on Internet

6.19 As a step towards to globalisation of agriculture, the Union Ministry of Agriculture has embarked upon an ICT project: NICNET based Agricultural Marketing Information System Network (AGMARKNET)" (Figure-5) in the country. This AGMARKNET project has already networked 735 Agricultural Produces Wholesale Markets (APWMs), during 2000-02 and embarked upon additional 2000 Markets during the Tenth Plan Period (2002-2007). As of 31 March 2005, 1347 APWMs have been brought under the AGMARKNET Programme, which has facilitated in developing the database on 300 commodities and about 2000 varieties. The Government initiative of the networking of agricultural produce markets (AGMARKNET) and the AGMARKNET Portal would facilitate the development of B2B and B2C e-Commerce Model in the Country (Moni, 2001) . This project has the potential of expansion to about 7000 Wholesale Markets located through out the country and further to 35000 Rural Markets in India. This ICT Project is a 'farmer-centric" project to put the progressive farmers on "global free trade zone on Internet".

Figure-5: A Synoptic View of AGMARKNET Portal

6.20 AGMARKNET appears to be filling a huge gap by providing access to information at reasonable cost. The AGMARKNET venture is a heartening initiative from the much criticized and slow-to-react government, especially on the issue of easing the infrastructural constraints on agriculture (Times of India, 2002) . The advantages of this database accrue to the farmers, as they are not forced to sell their produce in the nearest market at uneconomical prices. The challenge, if the full potential of such ventures have utilized, is to take IT to rural India in a big way. Constraints/Challenges are (a) connectivity in rural areas, (b) training the

stakeholders and (c) ensuring data updation in real time frame (http://www.eapf.net/casestudies/in/agmarket.asp). Anand Sagar (2003) considers AGMARKNET, a step towards "Rural Empowerment" and also "Data for Development". Kari Holland of Washington University (USA) categorizes AGMARKNET (India) as follows:-

- Nationwide market information for wholesale produce,
- Project supported by various departments and state boards of agriculture,
- Access mainly through the Internet,
- Customers pay (some),
- Computer facilities at the markets,
- Software for download,
- Daily market prices,
- Information collected by nodes in the various markets,
- Weekly trends,
- Information on loans, policies and regulations,
- Income has increased (for some), and
- Bypass middlemen.

6.21 The Inter-Ministerial task force on Agricultural marketing Reforms (2002) has suggested creating an "Atlas of Agricultural Markets" as well as "e-Commerce" on AGMARKNET Portal so as to enable producers (farmers) directly transact business with the buyers. This Digital Advantage Project has already achieved the followings:-

- "Reaching the Unreached i.e. resource poor farmers",
- "reduction of distress sale",
- "right to information",
- "base for production planning",
- "base for marketing led agricultural extension",
- "increased competition",
- "reduced marketing margins",
- "vertical linkages in export crop markets that connect multinational traders to domestic traders"

6.22 The country is now witnessing a unified "agricultural marketing price information system" for the entire country. The general Hypothesis is “the more farmer produces the less he gets” – i.e. not getting adequate returns for his toils. This AGMARKNET venture benefits the farming communities from the new global market access opportunities and also strengthened the internal agricultural marketing system in India. There have been requests for AGMARKNET venture in various developing countries (ASEAN), Countries in Africa region, etc., in view of its operational efficiency in India. The Regional Workshop of Asian Productivity Organisation (APO) at Manila in 2004 recommends the AGMARKNET System for its member countries for replication. AGMARKNET is an effort to bring rural people into the mainstream economy and emerges as model of informatics-led-grassroots develop-

ment in the country.

(F) Digital Opportunities: A way forward for Reduction of Spatial Disparities and Enhancing Opportunities for Development of SMEs to penetrate into export markets

6.23 Small and Medium Enterprises (SMEs) have always been the engine of growth in developing as well as in transition economies. Many developed economies (i.e. Japan, U.S.A) owe their industrialization to SMEs. SMEs are proven innovators and the driving force behind a number of technological breakthroughs. SMEs have been identified as high potential sector for employment generation and source of livelihood to millions of people in Asian, African, and Latin American countries.

6.24 In India also, SMEs are the second biggest employment generators after agriculture, providing jobs to over 9.2 million people, and accounts for 39 per cent of industrial production and 34 per cent of exports. It is estimated that there are around 350 Urban SME clusters and approximately 2000 Rural and Artisan based clusters (Rural SMEs) in India. This does not include the Small & Marginal Farmers (SMFs), who constitutes of about 67% of the farming community in India. The process of globalisation has impacted SMEs much more than larger business enterprises, and SMEs are at crossroads now. While developed countries have already taken a lead in this direction, developing countries have yet to fully exploit this system particularly to invigorate Small & Medium Enterprises (Jürgen Bischoff, 2001) . There is a need for serious global thinking on how to ensure greater stability of SMEs, how to provide greater social security for those working in this sector, and, at the same time, how to retain the dynamic force that drives this sector (Vajpayee, 2002) .

6.25 Areas of business that are targeted for improvement of SMEs are: User profiling, Supply Chain, Value Chain, Customer-Relation-Management (CRM), SME Networks, and Suppliers Cooperation. The challenge for entrepreneurs is to think about creating solutions for the twin engines of future growth – Rural India and SMEs. Cluster approach, Industrial Estates, Industrial Growth Centres, Export Processing Zones, Industrial Parks and Integrated Infrastructure Development Centres etc., have been the spatial policies for infrastructure development of SMEs. The Hypothesis: "the proximity of a web of businesses lowers the unit cost of infrastructure, leads to accretion of skills and is a source of informational economies" holds good in respect of SMEs.

6.26 Rapid emergence of knowledge-based economies required a paradigm shift in technology transfer services from traditional methods (i.e. horizontal company-to-company transfer of commercialized technology through a worldwide network of technology brokers) to Internet and vertical transfer of technology from R&D labs to industries. SMEs face information asymmetries in two ways: (i) in their own access to market- and business-related information, and (ii) as providers of services to poor people. Attention is required to SMEs evolution and to the "external" factors, related to "digital economy" that affects SMEs success and development in the era of globalisation, addressing:

- Structural changes in SMEs organization and management related to the impact of digital economy;
- Changes in the competitive scenario that may affect the SMEs evolution;
- Interventions and policy instruments that have contributed to foster the SMEs adaptation

to digital economy.

The focus is on SMEs' best practices in exploiting the opportunities provided by ICT to improve performance and visualize a "digital SME" in the process (http://www.etw.org), characterized as:-

- An SME whose products and services are predominantly digital;
- An SME which uses digital methods as the primary means of carrying out core operations - marketing, sales, service etc (e.g. a pure dot.com);
- An SME that exploits the benefits of digital methods to a significant extent.

6.27 An effective strategy to overcome this inherent weakness of SMEs is to network enterprises with institutions and organisations active in the area of SMEs development, information networks, and data bases as well as with technology generators. Supply Chain Management (SCM) is important for SMEs, as the supplier, the customer, the logistics partner and the manufacturer together involve in the material flow, the information flow and the fund flow. Establishing such an integrated service package on Internet for SMEs is a very challenging task (Vadim Kotelnikov, 2001) . Indian SMEs have realized the importance of productisation and specialization to survive in an ever-changing market. There have been attempts, as listed below, to provide Information services through ICT for SMEs

- Technology4sme.com & Business e-Coach for Asia-Pacific SMEs, established by UN APCTT - an Asia network of Model Technology Transfer Agencies (MTTAs).
- SMEs in India (www.smallindustryindia.com) with over 50 categories and 30 Lakhs records.
- TIFAC (Technology Information, Forecasting and Assessment Council) - http://www.tifac.org.in – for technology and business links, partner with TIFAC;
- Indian Patent database - http://www.indianpatents.org.in

6.28 According to (Frank Wilson, Tony Swash and Stephen Anderson) , there has been a gap existed between the strategic level of support for business development (regional focus) and the SME level of development (specific business development). It has been further argued in (Wilson and Pardo et al, 2001) that the threat of marginalisation faced by SMEs in the increasingly digital economy can be reduced by systematic support for transformation of traditional business approaches, sectors, and networks. Knowledge Management for regional business development may become a more critical issue, as the digital economy becomes more established.

6.29 In India, Internet among the Customers and SMEs is very limited. The Scenario of "internet connectivity is slow, access costs are high and connections are unreliable" has been removed by the National Broadband Policy 2004: "Always On" data connection with a minimum download speed of 256 kbps. But the key to its success lies in meeting the content development challenge driven by Governments and right regulatory environment (Neel Rattan, 2004) . Availability of broadband services at affordable price levels shall have a significant impact on India's GDP, facilitate new investment, create job opportunities, provide access to new and improved services, and increase productivity through infrastructure creation (Dayanidhi Maran, 2004) . Case Study Reports show that rural GDP in South Korea has gone up due to availability broadband connectivity.

6.30 The evolution of Network Based Computing relates to Distributed and Mobile Computing (DMC) and two new directions of computing; Grid computing and Pervasive computing will impact SMEs for emerging as "digital SMEs" and improving their competitiveness. Internet Commerce (e-Commerce) is growing fastest among businesses and four types of economic activities drive its growth (i.e. formation of Free Trade Zone on Internet):

- building up the Internet
- e-Commerce among Businesses
- digital delivery of goods and services
- Retail sale of tangible goods.

6.31 ICT diffusion derives economic force from the complementary development of a knowledge-intensive society (Eunice Wang, 1999) . The diffusion of ICT throughout all sectors (primary sector, secondary sector and tertiary sector) is, therefore, far more important than the production of ICT industries per se, to usher in economy growth and development based on "digital technologies". India is expected to gain from the "emerging Digital Economy", as it has:

- affordable access to core information resources, cutting edge technology and to sophisticated telecommunication systems and infrastructure;
- the capacity to build, operate, manage, and service the technologies involved;
- policies that promote equitable public participation in the information society as both producers and consumers of information and knowledge; and
- a work force trained to develop, maintain and provide the value-added products and services required by the information economy.

A synergetic collaborative relationship among Small Industries Development Organisation (SIDO), Khadi & Village Industries Commission (KVIC), National Informatics centre (NIC), Indian Postal System (IPS), and Bharat Sanchar Nigam Ltd (BSNL) can invigorate SMEs in India, through Value Chain, transfer of technologies, and utilise their IPRs. This will also facilitate SMEs to access both national and international business networks and emerge as "digital SMEs".

6.32 ICT diffusion for economic growth and sustainable development of SMEs, thus, emerges as a powerful tool for reducing spatial disparities and enhancing opportunities at grassroots level. However, it is essential to have an "Integrated Policy Framework for Community and SMEs Development in Digital Economy" in the country.

7. Mainstreaming ICT for Sustainable Rural Livelihoods: A Way forward

7.0 Rural India should be given a chance through Digital Networks for Farmers (DNF), DISNIC Programme, e-Cooperatives, and Digital SMEs to usher in "digital inclusion" for fostering rural prosperity and grassroots level development, and also provide a broad base for upliftment of rural poor. Grassroots level information access and grassroots level access to information are the required components of "information and communication" strategy for grassroots level development in India. There is a "need to bridge theory and reality at grassroots". Converting millions of poor farmers to the use of new technologies has been a

colossal task.

7.1 Science & Technology offers tremendous opportunities in simultaneous achievements towards the goal of sustainable agriculture and improving rural livelihoods. Digital opportunities have emerged as "power tool" for fostering agricultural growth, poverty reduction and sustainable resources use in developing countries. The PovertyNet in India takes the form of the Government's Digital Initiatives and Agenda (viz., DISNIC, AGRISNET, AgRIS, AGMARKNET, DACNET, VISTARNET, APHNET, FISHNET, HORTNET, SeedNET, PPIN, COOPNET, FERTNET, ARISNET, AFPINET, ARINET, NDMNET, etc), as a step towards "reaching" agricultural knowledge and technology to the rural Poor. Synergetic collaborations among cooperatives, Agricultural Produce Markets, Agri-clinics, Agri-Business centres, and AGMARKNET could become the "pathways" to rural prosperity. This "digital development in rural areas" of India facilitates rural prosperity, rural empowerment, and a warehousing of "data for development" is a step towards digital inclusion to foster rural enterprise in India. Strategies for Effective Communication and Public Awareness to be adopted are as follows:-

A. Suggested Action Plan

- QMS – Quality Management System to be adopted
- Intranet for Collaborative Research
- Portals in 22 officially recognised Indian Languages – Localisation
- Portal Models to be adopted
- Broadcasting / Wider-Dissemination Model
- Critical Flow Model
- Comparative Analysis Model
- E-Advocacy/ Lobbying and Pressure Group Model
- Integrated Services Model
- Geometry of Information Flow to be documented
- Capacity Building of all Stakeholders involved in the Collaborative Research Models.
- Participation of all Agricultural Colleges (about 300 in number) which generate more than 12000 Graduates per annum
- Establishment of Agricultural Resources Information System (AgRIS) in all Agricultural Colleges, State Agricultural Universities, ICAR Deemed Universities, and ICAR Institutes/Directorates.
- Development of Proof-of-Concept Projects in pilot districts (Typology identified)
- Agricultural Resources Information System
- AGMARKNET led Market extension system
- Digital SMEs
- E-Cooperative and COOPNET of Agricultural & Rural Credit Societies
- ICT for Micro level Planning

- Networking Departments of Geography (~ 215), Departments/Faculties of Agricultural Marketing, Centres for Regional Development Studies, and Agricultural Colleges (~ 300) for spatial data analysis.

B. Possible Output: Creating Geo-Spatial Intelligence for Sustainable Development at Grass root Level

- Location Specific Databases
- Location Specific Decision Support Systems
- Location Specific Information Communication Systems based on Geometry of Information Flow
- Community Action Plan

Partial List of Outputs

- An e-Governance Model: G2G, G2B, G2C and C2G Framework
- Quality and Reliable Information Services
- Information modeling of village:
- Parameterization of Information system: Dataset – Informatics Blueprint for a Village
- Grass root information to Access for Development
- Sampling Framework for Impact Study
- Transfer and Utilization of Appropriate Technology
- Database on:
- Village Identification and Location
- General Characteristics
- Public Utilities
- Meteorology
- Geological Conditions
- Soil characteristics
- Environmental Problems
- Bio-Resources & Forestry
- Household Details
- Agriculture, Horticulture, Floriculture
- Agricultural Inputs
  - Agricultural Machinery & Implements
  - Seeds
  - Fertilizers
  - Credit
  - Pesticides
- Land use Pattern

- Water use Pattern
- Cropping Pattern
- Seed Consumption and Constraints
- Fertilisers consumption and constraints
- Pests and Diseases Incidences
- Agricultural Services
- Livestock and Animal Husbandry
- Fisheries
- Industry
- Irrigation and Water Resources Related Problems
- Transport & Communication
- Power & Energy
- Marketing Infrastructure and Price Trends
- Financial Institutions
- Educational development
- Health & Family Welfare
- Public Distribution System
- Drinking Water
- Cooperatives
- Social Welfare
- Women and Child Development
- Development Schemes
- Sports and Cultural Activities
- Public Grievances – Constraints and Problems prohibiting Growth
- ICT facilities at district planning unit and identified blocks
- Local Language Interface
- Workshop, Seminar and Conferences for and with Stakeholders
- problem specific portals in village
- Information Access through Distributed and Mobile Computing Services
- Virtual Call Centre on Village level Problem
- Capacity building of officials of districts and sub-districts
- Target group based information retrieval and advisory system: spatial and Non-spatial
- Enriched cadastral map through GIS process
- Facilitates Skill Improvement
- Raw Material Availability/ Requirements
- Agricultural/Industrial Waste Details

C. Possible Outcome: Creating Geo-Spatial Intelligence for Location Specific E-Government Program

- Planning for Development and Utilization of Resources
- Improve Government Programs and Services through the use of Modern Scientific Methods and Technology

Partial List of Possible Outcome:

- Right to Information
- Digital inclusion for fostering rural prosperity and empowerment
- Improvement of Quality of Life at grassroots level
- Need Based Research & Technology Generation
- Grass root Access to information for Development
- Facilitate more scientific and transparent way to locate / plan for facilities in the rural areas.
- Addressing Ecological Restoration and Sustainable Livelihoods
- Promotion of public participation and appraisal in the planning process leading to effective citizen interface
- Better rural livelihoods opportunities
- Improved production system and planning
- Improved integrated macro/micro nutrient management system
- Stakeholders Satisfaction – Researchers, Planners, NGOs etc.
- Interoperability of Information System
- Content generation and content management for grassroots level development
- Rural infrastructure development and capital formation (Education, Health, Road & Bridges, Communication etc)
- Effective Land resources management and environment protection
- Improved Habitat planning, social development and economic development
- Better disease surveillance and control
- Better understanding of Nutrition security
- Promotion of Intellectual Property Rights in the era of Globalisation at grassroots level
- Natural resource management and conservation leading to sustainable development
- Development/ formulation of location specific Schemes, based on community needs
- Optimizing Government expenditure on developmental schemes (i.e. public utilities and services) leading to effective bottom up Monitoring &Evaluation (M&E)
- Strengthening cooperative development for boosting rural economy
- Development of schemes facilitating deceleration of out-migration
- Better Disaster management and relief plan modeling
- Employment opportunities in untapped areas and income generation

- Enhancing Women empowerment and integrated child development
- Strengthening of rural extension and advisory services (agriculture, horticulture, fisheries, floriculture, dairy, veterinary, health, education etc)
- Identification and Promotion of agro and rural industries
- Widening market reach for Household & Rural products and services
- Documentation of traditional knowledge and its use
- Identification of Entrepreneurial development Programme
- Promotion of Global Practices with respect to the local market
- Planning and promoting forward (post-harvest processing of Primary Products and marketing) and Backward (input chain) linkages for Agricultural Development in Rural Areas.
- Better planning, management and conservation of water bodies and sustainable consumption and water use, in view of impending climate change
- Exploitation of non-conventional energy sources
- Application of technologies such as database technology, web technology, GIS technology, Remote sensing technology, GPS technology and Local language information processing techniques for strengthening and enriching cadastral mapping content so as to facilitate Land Use Planning and management.
- Minimizing / removal of inter-sectoral disparities through Spatial Planning

Trustworthy Networking and Information System reinforces Commitment for Productivity and Sustainable Development.