

Chapter-6

Information Communication Technology Policy and Sustainable Agricultural Development in India

When used as a broad tool for providing local farming communities with scientific knowledge, ICT heralds the formation of knowledge societies in the rural areas of the developing world. ICT can give a new impetus to the social organisations and productive activity of agriculture which, if nurtured effectively, could become transformational factors. The narrow mindset of transferring technology packages is to be transformed to transferring knowledge or information packages.

Convergence of ICT with agricultural development

Broad basing agricultural extension activities; developing farming system research and extension; having location-specific modules of research and extension; and promoting market extension, sustainable agricultural development, participatory research, etc. are some of the numerous areas where ICT can play an important role. IT can help by enabling extension workers to gather, store, retrieve and disseminate a broad range of information needed by farmers, thus transforming them from extension workers into knowledge workers. ICT helps the extension system in re-orienting itself towards the overall agricultural development of small production systems. Thus IT could act as a bridge between traditional and modern knowledge systems. Services that can be provided in the developing world, using ICT, are:

- online services for information, education and training, monitoring and consultation, diagnosis and monitoring, and transaction and processing;
- e-commerce for direct linkages between local producers, traders, retailers and suppliers;
- the facilitation of interaction among researchers, extension (knowledge) workers, and farmers;
- question-and-answer services where experts respond to queries on specialised subjects ICT services to block- and district-level developmental officials for greater efficiency in delivering services for overall agricultural development;
- up-to-date information, supplied to farmers as early as possible, about subjects such as packages of practices, market information, weather forecasting, input supplies, credit availability, etc.;
- creation of databases with details of the resources of local villages and villagers, site-specific information systems, expert systems, etc.;
- provision of early warning systems about disease/ pest problems, information regarding rural development programmes and crop insurances, postharvest technology, etc.;
- facilitation of land records and online registration services;
- improved marketing of milk and milk products which are fast perishable;
- services providing information to farmers regarding farm business and management;
- increased efficiency and productivity of cooperative societies through the computer communication network and the latest database technology;
- tele-education for farmers;

- websites established by agricultural research institutes, making the latest information available to extension (knowledge) workers and obtaining their feedback.

ICT initiatives for agricultural development in India

There have been some initiatives in India, using ICT for agricultural development. In most of these projects, agriculture is only a small component. Indian experiences with IT projects are:

- Gyandoot project (Madhya Pradesh);
- Warana Wired Village project (Maharashtra);
- Information Village project of the M S Swaminathan Research Foundation (MSSRF) (Pondicherry);
- iKisan project of the Nagarjuna group of companies (Andhra Pradesh);
- Automated Milk Collection Centres of Amul dairy cooperatives (Gujarat);
- Land Record Computerisation (Bhoomi) (Karnataka);
- Computer-Aided Online Registration Department (Andhra Pradesh);
- Online Marketing and CAD in Northern Karnataka (Karnataka);
- Knowledge Network for Grass Root Innovations – Society for Research and Initiatives (SRISTI) (Gujarat);
- Application of Satellite Communication for Training Field Extension Workers in Rural Areas (Indian Space Research Organisation);
- In addition to the above, a few non-governmental organisations (NGOs) have initiated ICT projects such as:
 - Tarahaat.com by Development Alternatives (Uttar Pradesh and Punjab);
 - Mahitiz-samuha (Karnataka);
 - VOICES – Madhyam Communications (Karnataka);

- Centre for Alternative Agriculture Media (CAAM);

Some exclusive agricultural portals are also available, such as:

- Haritgyan.com
- Krishiworld.net
- TOEHOLDINDIA.com
- Agriwatch.com
- ITC's Soyachoupal.com
- Acquachoupal.com
- Plantersnet.com, etc.

Three successful projects:

Gyandoot project

Gyandoot operates in Dhar District, a remote, tribal dominated, drought-prone area of Madhya Pradesh. The district has a population of 1.7 million, 54% of whom are tribal and 40% living below the poverty line. On 1 January 2000 Dhar District began the new millennium with the installation of a low-cost, self sustainable rural intranet project, owned by the community. The name of the project, Gyandoot, literally means purveyor of knowledge. It is essentially an e-governance project whose main focus is to harness IT effectively in order to improve governance at village, block and district levels. The focus is overall rural development rather than exclusively agricultural development.

Gyandoot's information services have been classified as follows:

- agricultural best practices (particularly soybean);
- prices of agricultural produce in different market centres;
- online registration of applications for land records

- online provision of land records;
- education facilities such as personality tests, quizzes, question banks, etc. (for students);
- online driving licences;
- a rural email facility;
- a village auction site;
- information regarding government (rural development) programmes;
- Ask the Expert;
- transparency in the working of government;
- Gaon ka akbaar (village newspaper);
- online matrimonial sites;
- swaliram se puchiye (information for children);
- avedan patra (application formats for rural development schemes);
- registration of births and deaths;
- list of people below the poverty line (BPL).

About a quarter of the services provided by the project are related directly to agricultural development (such as agricultural best practices, market prices, online land registration certificates, the village auction site, Ask the Expert). A relatively small database has been developed regarding the best practices (packages of practices) for various crops such as wheat, gram and soybean which the farmers are using. The prevailing prices of prominent crops (wheat, gram, soybean, etc., giving varieties) at local and other auction centres of the country are available online. Other services with direct impact on agricultural development were the provision of land registration (Khasra) certificates to the farmers. The farmers make their applications through the kiosks at a cost of Rs. 10 and, after 10 days at the most, intimation that the land registration certificates are ready is sent to the kiosk

concerned. There were some legal bottleneck in providing these services at the beginning but they have been dealt with over a period of time. A village auction site was also available to the farmers for a period of three months. This costs Rs. 25 per head and could be used for selling land, agricultural machinery, bullocks or equipment. It opened a new horizon of e-transaction in these rural areas. The middlemen usually involved were successfully eliminated and buyers could browse the list of commodities for sale for Rs. 10.

The Ask the Expert facility uses a group of experts in agriculture, animal husbandry, health, etc. to answer questions by farmers and villagers about their problems, the latest techniques, improved technologies, etc. A user is charged Rs. 5 for this service.

Warana Wired Village project

The Warana cooperative complex in Maharashtra has become famous as a fore-runner of successful integrated rural development emerging from the cooperative movement. About 80% of the population is agriculture-based and an independent agricultural development department has been established by the cooperative society. The region is considered to be one of the most agriculturally prosperous in India. The project was initiated with six business centres, six IT centres and 70 village booths (kiosks). The project aimed to provide the following services:

- utilizing IT to increase the efficiency and productivity of co-operatives by setting up a state-of-the art computer network, providing agricultural, medical and educational information to the villagers at facilitation booths in their villages;
- providing communication facilities at the booths to link villages to the Warana cooperative complex, bringing the world's knowledge to the villagers' doorsteps through the internet via the National

Informatics Centre Network (NICNET), and establishing a geographical information system (GIS) of the surrounding 70 villages, leading to greater transparency in administration especially in matters related to land. There are six web-based applications that may be accessed by villagers from the facilitation booths. They provide information about:

- employment and agricultural schemes and government procedures;
- automated assistance in completing applications for government documents such as ration cards and birth and death certificates;
- crop information;
- bus and railway timetables;
- medical facilities; and
- Water supply details.

From the booths villagers can interact with the Warana management to register grievances and seek redress. Agricultural marketing information is available from the Warana web-server, giving market arrival and the daily prices of various regulated commodities. It is also possible for students to access educational and vocational information from the booths.

Other applications include the management information system for sugarcane cultivation developed by the National Informatics Centre (NIC) which leads to speedy and accurate data exchanges between factory and the farmers, using the village facilitation booths. This information is essential to the farmers. The land records application permits villagers to view and print extracts using data from a land database stored on a compact disc, or from the website of the tehasil to which they belong, right at their village booth (a tehasil is a sub-division of a district concerned with tax revenues). A Geographical

Information System (GIS) has also been developed. It includes a base map of the 70 villages involved in the project, socio-economic information, e.g. about schools, population, land under cultivation and linking cadastral maps, all translated into Marathi (the regional language of Maharashtra).

iKisan Project

iKisan is the ICT initiative of the Nagarjuna group of companies, the largest private entity supplying farmers' agricultural needs. iKisan was set up with two components, the iKisan.com website, to provide agricultural information online, and technical centres at village level. The project operates in Andhra Pradesh and Tamil Nadu. However, it really proved popular in Andhra Pradesh where nine technical centres (kiosks) were established in different districts. Farmers are able to become members by paying Rs. 100 per year or Rs. 20 per month. Project services are available only to member farmers. The operators of the iKisan technical centres are agricultural graduates who act as the interface between the computer networks and the farmers. They are there to provide both on- and off-line information services. They collect online information from the iKisan.com website, and pass it on to the farmers. In addition, they assist farmers to access information from the CDROM, comprising a vast database, with which each centre is provided.

The operators, being agricultural graduates, are able to diagnose, analyse and advise about diseases and pests. With their knowledge of both agriculture and ICT, they probably constitute the best part of this project. Their online services include information on 20 crops. Another service called Let Us Talk allows online chat among farmers or between farmers and experts. There were four modules in this – chat, expert chat, bulletin and Ask Us. Market information with respect to the products and services of the companies in the

Nagarjuna group is available online, as are weather forecasting and current events. The offline services provided by iKisan are concerned with:

- Crop diagnostics, disease and pest management;
- Soil testing, sampling and fertility;
- Information about agricultural equipment and other inputs and their availability;
- Market information;
- Crop insurance information;
- Information regarding cropping patterns and systems;
- Question-and-answer services;
- Poultry- and animal husbandry-related information.

Project staff

To harness the power of the new technologies, people working on ICT projects for agricultural and rural development need to be competent. In fact, the success of any ICT project will depend largely upon the orientation and sensitivity of the people who control the power of ICT to serve the needs of rural people. So, an attempt has been made to understand the project functionaries' characteristics in terms of their socio-personal, professional and psychological competencies.

Information needs of farmers

- Marketing information
- Facilitating access to land records/ online registration
- Question-and-answer service
- Information about rural development programmes and subsidies
- Weather forecasting
- Latest (best) packages of practices

- Post-harvest technology
- General agricultural news
- Information on crop insurance
- Farm business and management information
- Input prices and availability
- Early warning and management of diseases and pests
- Dairying and marketing of milk and milk products
- Accounting and payment
- Soil testing and soil sampling information

Internet Search Tools and Techniques

- The Internet: Network of network
- Who own Internet: Almost all are private parties
- Future internet: Consortium of internets
- How to be connected?
- Dialup modems
- Satellite
- Broadband modems
- ISP (internet service provider)
- www • Searching web
- Search engine
- Subject directories/ Specialized subject directories
- Search logic/ Searching strategy
- Invisible web: database search

Computer network

- Transmission media,
- Fiber optic technology: 2000mt for 10-100 Mbps ethernet, 550 mt for 1 Gbps Ethernet

- Radio: omni directional but low bandwidth
- Microwave: limit 45 Mbps. e.g. CCTV
- Satellite network

Components of a computer network

- Node / workstation with Network interface card (internal Ethernet card commands the speed) and sender/ receiver: connected to file servers with cable. No need to have own memory device
- Transmission media: carry electrical signals from one pc to another pc
- Network operating system and Device drivers (provide security/ permission)
- Protocol, Language & Error detection
- Message, Application or Service
- Actual device and other Auxiliary components

File servers

- A fast microprocessor
- A fast hard drive with many gigabytes of storage
- A RAID (Redundancy Array of Inexpensive Disks) to preserve data after a disk casualty
- A tape back-up unit
- Numerous expansion slots
- Fast network interface card
- A big RAM

Transceivers: It is a device that contains electronic circuitry to both transmit onto and receive signals carried by the coaxial cable

Repeaters: It boosts the strength of the signal (e.g. if LAN needed a cable length between two nodes more than 100 m)

Hub: Connects all computers to a network, it helps to direct messages, it filters distorted frames. It receives, retimes and regenerates signals.

Bridges: It connects two similar networks and segmentation of larger networks into smaller clusters. It acts in level 2.

Routers: It acts in level 3. It divides the network logically but not physically. It has direct signal traffic efficiently. It routs messages between any two protocols, between linear bus, star and star wired ring topologies. It also route messages across fiber optic, coaxial and twisted-pair cabling.

Switches: Links several LANs. It provides packet filtering between LANs. It increases network performance by providing each port with dedicated bandwidth. Always prefer managed switch than unmanaged switch.

Road map to achieve the intended benefits:

- a) Access of ICTs to villagers through info-kiosks
- b) Human resource development
- c) Imparting ICT skills to users
- d) ICT skill development to Extension personnel (Transfer of technology)
- e) Strengthening capacity of SAUs and ICAR institutes
- f) Investment in ICT software development activities
- g) ICT packages in vernacular languages
- h) Promoting and strengthening of tripartite linkages among public and private sector, farmers' organizations
- i) Focal point
- j) Choosing stakeholders
- k) Agriculture education/ research/ extension management
- l) Agro based rural development

- m) IT in Agricultural production
- n) IT based GIS in Agriculture
- o) Rural internet
- p) Information centers in villages
- q) Virtual class rooms
- r) Agricultural communications
- s) Educational satellite

Critical success factors of ICT projects:

- Basic infrastructure
- Electricity
- Telephony
- Connectivity
- Maintenance in a rural context
- Types of services provided by ICT projects
- Content development (Static and Dynamic)
- Creation of websites
- Database/ archives creation
- Data mining/ visualization
- Simulation
- Digital library system
- Online crop bulletin
- Handbook for farmers

Revamping networking in any institute for Agriculture

The Local area network which is with 100Mbps backbone needs to be upgraded with the implementation of managed 10G ready Ethernet Switches that supports converged communication applications like IP Telephony, Video Conferencing, and data, Internet & mailing applications. It shall be a three tiered network with robust chassis

based Layer3 /Layer-4 switching equipment lying at the network core. This Core Switch shall form the first tier of connectivity. The Second tier of the network backbone shall comprise of Layer-3 Distribution or Aggregation Switches which will aggregate all uplinks from the Edge Switches that form the third tier. A three tier network has more advantage than the two tier network as the Layer-3 Distribution switches offer local routing for network traffic between the adjacent Edge Switches without sending unnecessary traffic to the network core. Secondly, using Distribution Switches in the network reduces the quantity of passive cabling required for connecting all Edge switches to the Core switch. Thus the three tier network architecture connecting the Edge switches to the Distribution switches and thereafter, the Distribution switches to the Core switches shall form the Campus Wide Network backbone.

The proposed network backbone should be future proof and should be scalable for future expansion as and when required. Further, in order to support sustained high throughput for running varied applications including data and database applications like ERP/e-Governance applications, VoIP or IP Telephony, Video Conferencing, multimedia traffic comprising of CD quality voice/audio and HD standard video for e-Classrooms & Video lectures where online streaming of dissection of specimen etc. may be transmitted, it is necessary that the backbone should be 10G ready from day one. Network should be scalable, secure and shall be sustainable for at least the next 10 years without requiring 'forklift' upgrades. Having a 10G backbone from day one shall future proof the network with respect to the performance requirements for all network services and applications in the years to come.

Based on the functionality of the network for connecting various devices and remote locations, the network architecture can be further categorised into distinct sections described below.

Internet / Unsecured Zone

This zone comprises of the Internet connectivity from the ISP (in this case the 1.0 Gbps NKN link from BSNL or other service providers) that gets terminated on the router.

A modular router with at least 4 nos. of 10/100/1000BaseT copper ports and multiple expansion slots for installing WAN interfaces (like Serial, E1, etc) should be present. The proposed Router should offer good performance with adequate amount of memory and shall be able to support routing throughput of 200 Kbps or better.

A set of two security appliances configured in a highly available cluster is recommended to protect the network from the external unsecured Internet. During normal operation when both appliances are active and functioning, they shall share the load of all outgoing connections and provide security in conjunction. In case one of the appliances fails, the other firewall shall continue to provide the firewall support while all Internet bound sessions are failed over to the remaining active appliance.

Besides having standard firewall functionalities like NAT/PAT, stateful firewall and packet filtering, etc., these security appliances shall also support features like intrusion prevention service (IPS), Web filtering, etc. These security appliances have IPSec VPN functions so that site-to-site and site-to-remote-user VPN connections can be established. Authorised User's having broadband or dial-up Internet connections can use the VPN facility to login to the network and use local network services and applications.

Each of these security devices should have at least 8 – 10 nos. of 10/100/1000 Mbps copper (RJ45) Ports along with modular slots to add high performance network interfaces in future.

The Internet Router shall connect to both security appliances and the appliances in turn shall connect to the Core switch using 10/100/1000 Mbps copper links.

The Security appliances shall also connect to a L2/L3 Ethernet switch, referred here as DMZ switch.

The De-Militarised Zone (DMZ)

The DMZ is a secluded zone carved out of the Internet Zone where Servers that shall be accessible from the outside world (Internet) shall be hosted. These servers running DNS, Web, e-Mail services shall connect to the L2/L3 Ethernet Switch (DMZ Switch) which in turn connects to both the security appliances. Policies shall be defined in the security appliances so that traffic from Internet can only access certain service ports on the servers (*like port 80 & 443 for HTTP & HTTPS, Port 52 for DNS, Port 110 and 25 for POP3 and SMTP respectively*).

Core Network Zone

The Core Network shall have the L2-L4 Core Switch; preferably a chassis based switch with redundant power supply and switching fabrics. It shall have multiple payload slots where line cards or interface modules with multiple ports (1Gbps Copper, 1Gbps Fiber and 10Gbps Fiber) shall be installed for connecting to different active network equipments.

The core switch shall have 10G OFC links with the Distribution Switches and Server Farm Zone Switch. This core switch shall also connect to the Firewall and locally installed equipments like Wireless

Controller, IP-PBX, and Video Conferencing equipment/MCU using Gigabit UTP links.

The Core switch shall support Layer-2 – to – Layer-4 switching and Layer-3 static & dynamic routing. It shall support standard IEEE protocols for VLANs, Quality of Service, Link Aggregation, etc. The Switch shall also support multicast features and shall be IPv6 ready. It shall offer Access Control Lists to control network traffic across the network.

Internal Server Farm Zone

The Internal Server Farm Zone shall have all application, database, directory, anti-virus, etc. All network links from these servers shall be aggregated on a Layer-3 Gigabit Stackable Switch which shall be referred here as the Server Farm Switch which in turn shall be uplinked to the core switch using 10G OFC / UTP link.

There shall be network attached storage (NAS) with 1Gbps/10Gbps iSCSI based connectivity to the servers. The storage shall be used for keeping all data from the servers and the network at a single point from where it may be easily archived using a LTO Tape Library with Auto loader.

Alternatively, instead of Tape based archive (which has its drawbacks in terms of limited life of media and risk of spoilage due to humidity, dust, etc) video, images, audio files, etc., may be archived on separate sets of inexpensive SATA drives within the NAS.

WAN Zone

On the availability of 4 Mbps links and terminated on a WAN router having 150 Kpps or better performance. The downlink from the WAN router shall be terminated on the Security Appliances discussed earlier, so that all traffic from remote locations are filtered to

eliminate any risk of unauthorized access or infiltration of malicious software.

Wireless Backhaul

Point-to-Multi-Point (P-MP) and Point-to-Point (P-P) Wireless backhaul links based on OFDM technology and operating on the free spectrum of 5.8 GHz is needed proposed for linking the HQ with the remote locations say KVKs.

Since, the Leased circuit based connectivity between HQ and remote locations may be prone to outage for P2P LL, a secondary link of Wireless P-MP backhaul links can be established among these sites. Further, HQ may discontinue with the Leased circuit based connectivity to reduce recurring costs and use the P-MP backhaul between the HQ campus and other sites.

In order to develop faster and reliable communication between the various KVKs and the HQ campus to encourage collaboration on various research activities, these KVKs located around the state may be connected using the WBSWAN infrastructure.

The HQ campus shall have a Wireless P-P link to the nearest WBSWAN PoP. Similarly, the various KVK's shall connect to their respective and nearest WBSWAN PoP using wireless P-P backhaul links. Using WBSWAN as their carrier network, these KVKs can thus communicate with the HQ campus. Since IP based connectivity is the underlying technology used by all these networks, these remotely located KVKs can access all authorised applications and services hosted at the HQ campus including IP Telephony (thus reducing reliance on recurring cost and dependence on mobile phones and conventional PSTN providers), Video Conferencing, E-mailing, etc.

Internet connectivity from the HQ campus may also be shared 24x7 with these KVKs thus eliminating the need to have dial-up & broadband facilities at these locations.

Local Area Network (wired & wireless/Wi-Fi)

The local Edge network at the HQ campus and the remote locations is the network where end-users and their devices shall connect to the network. L2 managed Gigabit Switches with and without Power-over-Ethernet shall be used as Edge switches to which the user nodes/end-points connect.

Wireless Access Points (AP) shall also be connected to these Edge Switches for data uplink to the network backbone. Both indoor as well as outdoor AP's shall be used to create Wi-Fi hotspots across the campuses (HQ and other remote locations linked by P2P-LL). Latest IEEE 802.11n capable Access points shall be used as which offer greater coverage, higher throughput and support large number of clients per AP than conventional 802.11a/b/g capable AP's. However, these 802.11n capable AP's shall also support 802.11a/b/g standards for backward compatibility with older Wireless LAN Clients.

Wireless IPS devices with sensors are also recommended to thwart possible intrusion and hacking attacks via the Wireless network. It may be noted that wireless networks provide easy access to a connected network by bypassing the firewall and security setups which guard the Internet zone.

Uplinks from all nearby Edge switches shall be aggregated to Distribution switches placed at particular locations so that minimum passive cabling and lesser number of uplink ports on the core switches are required. These Distribution switches shall be Layer-3 Managed Gigabit Switches with two or more 10G uplink ports to be used for connecting to the Core Switch using Single mode OFC. The Edge switches may be uplinked to their respective Distribution switch using 10G or 1G UTP/OFC links.

The Passive Networking Components

As discussed earlier, Single mode Optical Fibre Cables (OFC) shall be used for all backbone links between the network core and distribution switches and wherever necessary, between distribution and Edge switches. OFC links may also be used for 10G links between the Server Farm Switch and the Core switch.

EIA/TIA Standards based structured cabling shall be implemented for the OFC and UTP based passive network cabling. All cabling components (Cables, patch panels, patch/mounting cords, I/O, etc) shall be branded, MNC quality while all cabling accessories (conduits, casings, raceways etc) used for laying the cables (OFC/UTP) shall be ISI marked/certified or better for ensuring their longevity.

Servers & Storage

Servers used for hosting the applications shall be branded, with Intel Xeon or equivalent AMD processor based rack mountable servers. With required quantity of physical memory and storage needed to host the OS, these servers shall have latest available energy conserving features built in.

Virtualisation technology shall be deemed important in using maximum available server resources and for better application redundancy and availability.

The storage device ideally shall have iSCSI compliant interfaces for connecting to the servers and the network. Support for Fiber Channel interfaces should also be present and may be implemented when required. The storage device shall be expandable and shall also support integration into a full-fledged Storage Area Network (SAN) with the induction in future of SAN switches (with iSCSI and FC interfaces).

The storage device shall support connectivity with Tape drives/libraries using FC (Fibre Channel) or SCSI interfaces (Small Computer System Interface) for facilitating of data backups. Optionally, as mentioned earlier, the storage device may support addition of a separate enclosure with inexpensive SATA drives for data archival.

Unified Communication - IP Telephony, Audio/Video Conference

IP-PBX that supports PSTN/Digital trunks shall be installed at the HQ campus. This shall facilitate telephony service within the IP based network across the campus and also with all connected sites at remote locations / KVKs without relying on telephony service providers for landline and mobile and thus saving considerable revenue.

The IP Telephony infrastructure proposed for HQ shall also have integration with mailing service to enable complete collaboration, scheduling and preserve a single directory for all mailing as well as telephony users.

Voice mails, multiparty conferences, adhoc and pre-scheduled conferencing, call forwarding, centralised directory, call recording, etc features shall be inherent within the system. With deployment of Wireless network across the sites, WLAN handsets with full mobility support may be used.

Interactive Voice Response Systems (IVRS) may be implemented wherein field workers, farmers can dial in and uses tiered multiple choice based response system to get their queries answered. Surveys and feedbacks from the connected locations thus will be easily recorded without the need to have unnecessary paper work.

Video Conferencing shall be useful in facilitating collaboration amongst researchers, reaching out to farmers and field workers from the confinement of one's office or classroom or even the Laboratory.

Hardware based VC as well as software VC clients (installed on laptops) may be used for multi-party conferences.

Along with IVRS, video kiosks running applications compatible to the IP Telephony system may be used for disseminating useful information amongst the farmers in the remote rural areas where KVKs are present with connectivity to HQ as explained above.

Software and Applications

Microsoft's Windows Server and Desktop Operating Systems, along with SQL server software and MS-Exchange Server software for mailing and collaboration shall be required. Academic licensing may be purchased at discounted rates.

Anti-Virus software with license for all servers, laptops and desktops are also essential to keep virus and malware at bay.

Network Management Servers are also deemed necessary to manage all network equipments and monitor the network health and state.

Power Conditioning

In order to sustain the availability of network services and applications throughout the campus as well as at all remote locations/sites that connect to the proposed HQ network, the sudden power outages need to be prevented using proper power conditioning equipments. At the Central facility at HQ campus where the Core switch along with all servers, Routers, firewalls, IP-PBX, WLAN controllers, etc. are to be housed, at least two 15 KVA Online UPS with 3-phase input needs to be commissioned. These UPS should be able to provide backup power to all active network equipments and server/storage devices for at least two hours at a stretch in case of power failure or load shedding.

Dedicated DG Sets are also recommended for the central facility at HQ Campus.

At all distribution switch locations, rack mounted, 1 KVA online UPS with one hour backup should be necessary. All Edge switches shall have dedicated 600 VA or 750 VA offline/line-interactive UPS with 30 minutes backup support.

All these locations with Power supply sockets (for AC mains input or for output from UPS/input to equipment) shall be properly grounded with 2.0 ohms or lesser resistance value for the earthing.

All towers/masts/poles at locations where Wireless backhaul radio (P-P or P-MP) are mounted shall have lightning arrestors, earthing for the tower installed with permissible resistance value same as mentioned above.

Server room cum Network operations centre

At the HQ campus, the Central facility/room housing all active networking equipments (core switches, controllers, routers, firewalls, IP-PBX, etc), servers and storage shall have an air conditioned and dust & moisture free environment. This is highly recommended to ensure longevity of equipments and uninterrupted services / limited outage due to heat & dust.

This room/facility also referred as 'server room' or 'Network operations centre or NOC' shall also have workstations/desktops which shall be used as management client for managing and monitoring the network and various equipments and servers/storage.

Warranty and Onsite support

The commissioning of this entire project, should kick start the product support warranty for replacement/repair of damaged spares for a limited period, preferably 3 years. The warranty shall be onsite warranty arranged with the system/network integrator with back to back warranty confirmed by the respective OEMs.

The system/network integrator shall also deploy a site engineer at the HQ to take care of day to day problems and for administering the network & facilities.

Conclusion

- Efforts should be made to incorporate ICT in all endeavours related to agricultural development.
- The organisations and departments concerned with agricultural development need to realise the potential of ICT for the speedy dissemination of information to farmers.
- Government at national and state level in India has to reorient agricultural policies so that a fully-fledged strategy is formed to harness ICT's potential for assisting overall agricultural development.
- It is also recommended that, before ICT services are set up in a region, efforts are to be made to develop among the farmers both a satisfactory level of faith in the intentions of the ICT staff and a firm commitment to the goals of the proposed project.
- It is also suggested that participatory and rapid rural appraisals are carried out to ascertain what information the farmers need. In the process, the farmers' self-fulfilling faith in the information services provided should be enhanced.
- It is further recommended that the farmers be instructed in how to get the best possible use out of the services provided.

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