Selected Success Stories on Agricultural Information Systems

by

Dr. Sahdev Singh
Program Director, AIT Extension
Asian Institute of Technology (AIT)
P.O. Box 4, Klong Luang
Pathumthani, THAILAND 12120

Tel: (66-2) 524-5268; Mobile: (66-81) 696-0620; Fax: (66-2) 524-5247
e-mail: ssingh@ait.ac.th web site: http://extension.ait.ac.th/

Asia-Pacific Association of Agricultural Research Institutions
FAO Regional Office for Asia and the Pacific
39 Phra Atit Road, Bangkok 10200
THAILAND

www.apaari.org

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Foreword

In most developing countries of the Asia-Pacific region, the traditional mechanisms for *Transfer of Technology* and implementation of extension programs, usually government administered, are either slow or ineffective in connecting the resource-poor farmers with up-to-date knowledge from researchers and markets for their produce. This is primarily due to rising costs of such interventions, declining public funds for rural extension, and inadequate exploitation of new means of knowledge and information dissemination by responsible government agencies. Other constraints include lack of infrastructure and education in rural areas where majority of Asia-Pacific farmers live and work. Despite such enormous challenges, there are some unique success stories in the region that demonstrate how the new information and communication technologies (ICT) can play a significant role in rural development by empowering the rural farmers with new knowledge, up-to-date information and entrepreneurship skills. Interestingly, in the wake of slow government response, lately some private sector initiatives have also come up to link the rural economies with mainstream markets using ICT. However, the primary motivation behind these initiatives is the facilitation of commercial transactions in rural areas rather than knowledge and/or technology dissemination.

In keeping up with the APAARI tradition of identifying and popularizing unique success stories of agricultural development in the Asia-Pacific region, this publication reviews diverse applications of new ICT in rural farming areas of selected Asia-Pacific countries and identifies different models of such applications by analyzing the context of local situations. It also attempts to quantify the impact of ICT by describing some successful cases where the potential of ICT is harnessed for the benefit of farmers. In conclusion, this report emphasizes that the government agencies responsible for agricultural

research and extension such as National Agricultural Research Systems (NARS) need to learn from such successful cases and also build creative partnerships with the private sector and NGO initiatives.

Dr. R.S. Paroda
Executive Secretary

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Acronyms and Abbreviations

AARINENA	Association of Agricultural Research Institutions in the North-East and North Africa
ACIAR	Australian Centre for International Agricultural Research
AFITA	Asian Federation for Information Technology in Agriculture
AGRIS	International Information System for the Agricultural Sciences and Technology
AIS	Agricultural Information Service
AIT	Asian Institute of Technology
AKIS	Agricultural Knowledge and Information System
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APAN	Asia-Pacific Advanced Network
APARIS	Asia-Pacific Agricultural Research Information System
APHCA	Animal Production and Health Commission for Asia and the Pacific
APRTC	Asia-Pacific Regional Technology Centre
ARD	Agricultural Research for Development
ARIS	Agricultural Research Information System
AROW	Agricultural Research on the Web
ASEAN	Association of Southeast Asian Nations
ASTI	Agricultural Science and Technology Indicators
CABI	Centre for Agricultural Bioscience International
CAC	Central Asia and Caucasus
CARIS	Current Agricultural Research Information System
CCRMS	Core Customer Relations Management System
CD-ROM	Compact Disk – Read Only Memory
CGIAR	Consultative Group on International Agricultural Research
CGLRC	CGIAR Learning Resource Centre
CIAT	International Center for Tropical Agriculture
CSR	Corporate Social Responsibility
CTA	Technical Centre for Agricultural and Rural Cooperation
DOAC	Department of Agriculture and Cooperation (India)
DVD	Digital Video Disk

EDC	Education Development Centre
EFARD	European Forum for Agricultural Research for Development
EGFAR	Electronic Global Forum on Agricultural Research
ENRAP	Knowledge Networking for Rural Development in Asia-Pacific Region
e-NACA	electronic – Network of Aquaculture Centers in Asia-Pacific
FAO	Food and Agriculture Organization of the United Nations
FAQ	Frequents Asked Questions
FARA	Forum for Agricultural Research in Africa
FMCG	Fast Moving Consumer Goods
FORAGRO	Foro Regional de Investigation y Dessarrollo Technologico Agropecuario
GITR	Global Information Technology Report
GFAR	Global Forum on Agricultural Research
IARC	International Agricultural Research Centers
IBLF	International Business Leaders Forum
ICAR	Indian Council of Agricultural Research
ICC	International Chamber of Commerce
ICM	Information and Communication Management
ICRAF	World Agro-Forestry Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technologies
IDRC	International Development Research Center
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
ILRI	International Livestock Research Institute
IRRI	International Rice Research Institute
ISAP	Indian Society of Agribusiness Professionals
ISAS	Indian Society of Agricultural Statistics
ISNAR	International Service for National Agricultural Research
ITC	Indian Tobacco Company
ITD	Innovations in Technology Dissemination
KVK	Krishi Vigyan Kendra (Agricultural Science Centers, India)

MANAGE	National Institute of Agricultural Extension Management
MARDI	Malaysian Agricultural Research and Development Institute
MLC	Multichannel Learning Canter
MSP	Minimum Support Price
MSSRF	M.S. Swaminathan Research Foundation
NAARM	National Academy of Agricultural Research Management
NAAS	National Academy of Agricultural Sciences
NACA	Network of Aquaculture Centres in Asia-Pacific
NAIS	National Agricultural Information System
NATP	National Agricultural Technology Project
NARS	National Agricultural Research Systems
NGO	Non-Governmental Organization
NHRI	National Horticultural Research Institute (South Korea)
NIC	National Information Center
NINP	National Information Nodal Point
ODL	Open and Distance Learning
PC	Personal Computer
Q&A	Question & Answer
RAIS	Regional Agricultural Information System
RDA	Rural Development Administration (South Korea)
SAARC	South Asia Association for Regional Cooperation
SAIC	SAARC Agricultural Information Centre
SAU	State Agricultural University
SDLEARN	Sustainable Development Learning Network
SMS	Short Message System
TAAS	Trust for Advancement of Agricultural Sciences
TERI	The Energy and Resources Institute (India)
TNAU	Tamil Nadu Agricultural University
TV	Television
UNDP	United Nations Development Program
UNESCO	United Nations Educational, Scientific and Cultural Organization

UPS	Uninterrupted Power Supply
USA	United States of America
VASAT	Virtual Academy for the Semi-Arid Tropics
VCD	Video Compact Disk
VCR	Video Cassette Recorder
VLC	Virtual Learning Center
VSAT	Very Small Aperture Terminal
WAICENT	World Agricultural Information Centre
WARDA	West Africa Rice Development Association
WISARD	Web based Information Services for Agricultural Research for Development
WWW	World Wide Web
YCMOU	Yashwantrao Chavan Maharashtra Open University

I. Introduction

Agriculture is the mainstay of the economy of many countries in the Asia-Pacific region as nearly 60 percent of its population derives livelihood from agriculture. The region has several hot spots of rural poverty, as most farmers in the region are smallholders with diverse farming systems, which are highly risk prone. In addition, these farmers have poor access to support services such as extension and the agricultural markets, knowledge, technology and financial credit. Obviously, a second "green" revolution is needed not only to produce more food in the region, but also to enable participation of its farmers more equitably in innovations and markets to reduce rural poverty, generate better rural livelihoods and maintain quality of life and environment. This second revolution could be termed as knowledge revolution and there are already some visible signs that Asia-Pacific rural agriculture is in midst of it. The new Information and Communication Technologies (ICT) are bringing about and sustaining this revolution by empowering the resource-poor farmers with up-do-date knowledge and information about agricultural technologies, best practices, markets, price trends, consumer preferences, sources of finance, weather, soil-moisture conditions and the environment.

Building upon a previous report on status of ICT in ARD (APAARI, 2004), this publication reviews the current state of telecommunication policy for rural and agricultural development, diverse applications of new ICT in rural farming areas of selected Asia-Pacific countries and identifies different models of such applications by analyzing the context of local situations. It also assesses the potential impact of ICT in agricultural development by describing two successful cases – one from South Korea and the other from India – where the potential of ICT is harnessed for the benefit of small farmers. The South Korea case is a NARS initiative to provide agricultural information

services using state-of-the-art ICT to more than 100,000 farmers and extension agents per month. While the Indian case is a 5-year old private sector intervention being scaled up to empower 10 million farming households by providing them access to up-to-date farming knowledge from experts and universities, and real-time information on markets, prices, weather, etc. Both the success stories have certain common elements such as the recognition of information and decision-making needs of farmers, capacity building support to farmers to enable them master the new ICT, and a user-friendly ICT-enabled agricultural information system.

II. Regional Policy Status on ICT for Agricultural Development

Almost all countries in the region have designed national telecommunication policies for overall economic development, including rural and agricultural development. However, in most cases, the strategies of how the ICT-enabled agricultural development is to be achieved are not very clear. The more technologically advanced countries in the region such as Australia, Japan, and South Korea in the past few years have been quite successful in implementing their policies by improving telecommunications infrastructure and ICT capacity building in rural areas. In other countries, the focus on how to bridge the "digital divide" is still under debate and different approaches are being tested. The rapid advances in cellular telephony and wireless Internet technologies and reduction in costs now make this bridging very feasible, yet these advances, by the variety of options, also sometimes inhibit making the right technological choices at the National level for rural communications. In turn, this influences agricultural communications strategies. For example, the high level of illiteracy in most rural areas of the region would require broadband connectivity for audio and visual information exchange. Without this,

useful and relevant information content will not be generated and disseminated to the rural population.

Agricultural policies of most countries in the Asia-Pacific region, though indicating use of ICT, lack sufficient clarity on how ICT are to be used in agricultural development. While rural telecommunications can play a vital role in supporting and providing farm and non-farm livelihoods, access to markets, education, health services, governance, etc., the costs of connectivity are still somewhat high and commercially supposed to be unviable at the moment in many parts of the region. Farming is the major economic activity in the rural areas of the region and, therefore, agriculture must play an important role in defining telecommunications strategies for rural development. This consideration is many a times a political decision to be made at the highest policy making level in the less economically developed countries of the region.

Technologically, there are primarily two strategic approaches available for the region in the use of new ICT especially cellular telephony and the Internet; connecting individuals and households and connecting communities. With the rapid growth of cellular telephony in the region, there is considerable progress in connecting individuals, even in rural areas. Several countries in the region, such as India, the Philippines and Thailand, are experimenting with the approach to connect communities through common access points such as kiosks, tele-centers, public call offices and Internet cafes and low cost computers and handheld devices. These access points or information centers are operated through public, private, community, public-private or public-private-community partnerships. India, as an example, intends to provide such connectivity to all its 500,000 villages by 2008. Defining these strategic approaches requires a cross-sectoral perspective of telecommunications, information, education, health, governance, rural and agricultural development policies and integration of access to information services at the user community level. These perspectives are yet to emerge in many parts of the Asia-Pacific region.

National telecommunication and agricultural policies affect NARS at various levels starting from investments in infrastructure and skills development, content generation and dissemination, application of ICT for research and development and for developing ICT enabled applications and providing services to the wide and growing spectrum of clients for agricultural information. Apparently, the NARS in the region do not yet have a significant voice and an advocacy role in the development of cross-sectoral policies for their governments. This weakness can be traced to the poor capacity of senior policy makers and NARS managers to elucidate the potential role of ICT in agricultural development.

Regional organizations, such as ASEAN and SAARC, have realized the importance of ICT-enabled agricultural information systems. ASEAN has an e-Farmers program and SAARC has developed a SAARC Agricultural Information Centre (SAIC) at Dacca, Bangladesh. APAARI, FAO, APAN, APHCA and several other regional networks also have information systems that support agricultural development in the Asia-Pacific region. However, there still remains a vital need to sensitize and build capacity among policy makers and senior NARS managers to enable them to play a defining role for enabling and enhancing effective ICT use in agricultural development at the regional levels and for their NARS through appropriate policies and strategies.

There is very little information available regarding institute level ICT and ICM governance structures in most Asia-Pacific NARS. In India, the ICAR developed inter-linked agricultural information cells at each of its Institute and in some State Agricultural Universities to form a national agricultural information system (ARIS). In Malaysia, MARDI provides the governance structure for agricultural research and development information. Most research institutions in the NARS of each country in the region have computer cells, departments or divisions that provide at least some ICT governance function. The lack

of well-defined ICT/ICM structures at the research institute level inhibits the integration of ICT in content generation processes and in providing effective and efficient information services to user communities.

Policies need to be based on the principle of empowerment of farmers by creating and strengthening linkages between farmers and researchers on one hand and between farmers and markets. Traditionally agricultural research has been done in isolation, or in other words, without active participation of farmers. This is primarily due to the bureaucratic mindset of research managers as well as researchers in many parts of the region. This has led to a lack of service culture in NARS; poor research needs assessment, inadequate prioritization of research, and consequently, the lack of faith among the farmers in the research outcomes and innovations. In such a situation, ICT can bridge the gap between the farmers and researchers to make research more responsive to the actual needs.

The traditional agricultural market systems in the Asia-Pacific region are still dominated by the commodity traders or so called "middle men". Market policy development is often influenced by political lobbying by rich commodity trade groups. Restrictions on the movement of the produce across state or provincial boundaries also works against the farmers. Most often farmers feel helpless against the market forces manipulated by these intermediaries and get a price for their produce at marginal profits and sometimes at a loss. ICT such as mobile phones with SMS have now started to make in roads in rural areas and seem to be opening up opportunities for the farmers to get market price information, weather information and to a limited extent extension services.

A holistic approach in rural development policy formulation is the need of the hour. ICT need to be looked at as tools like any other agricultural machinery or tool that extend the capability of farmers.

This tool extends their knowledge base and policies should focus on how poor farmers gain easier access to such tools and services.

III. ICT Developments at the National and Regional Levels

The potential of ICT to contribute to agriculture and rural development has been well recognized. The radio played a key role in technology transfer in the first green revolution in Asia. The Internet and associated computer technologies are expected to play a similar role in information and knowledge sharing in the ongoing transformation of agriculture in the region. These new ICT will connect farming and rural communities in Asia-Pacific to global information sources and markets. They will enable individuals, households and communities to learn and acquire new skills and technologies and also share innovations globally.

The Global Information Technology Report (GITR) with a record coverage of 115 economies worldwide and published for the fifth consecutive year, has grown into the world's most respected assessment of the impact of information and communication technology (ICT) on the development process and the competitiveness of nations. The Networked Readiness Index examines an economy's ICT condition on three dimensions: the general macroeconomic, regulatory and infrastructure environment for ICT; the readiness of the three key stakeholders — individuals, businesses and governments — to use and benefit from ICT; and their actual usage of the latest information and communication technologies. According to the 2005 GITR, South Korea ranks 14 and India 40. Both countries show a marked improvement from their previous rankings.

South Korea is considered the most wired country in the world and the Korean government has committed itself to adjusting its

organization and administration for the coming digital age. In line with such efforts, the government has included the early creation of a digital government (eGovernment) as a major task in public sector reforms which will help reinforce its relationship with Korean citizens. The eGovernment is being characterized by four features: the Government of Online Services, the Paperless Government, the Knowledge-based Government and the Transparent Government.

India's ICT industry has been export-centric and only very recently the government, NGOs and the private sector have started realizing the benefits of penetrating into the rural areas using ICT. Most agribusiness related large corporations have drawn up extensive plans to cover majority of rural households by 2010 after a highly successful implementation of diverse pilot projects on bridging the "digital divide" that exists between rural and urban populations in most parts of the region. Government efforts to provide services to rural population are still in the pilot phase, but appear promising. Several NGOs are also active in such initiatives and are playing a catalytic role to speed up the overall process of rural transformation.

Extension, Outreach and Market Information Services

Agricultural extension systems since the 1990's in the region have been significantly weakened and reduced in their effectiveness due to a variety of reasons primarily reduced funding to agricultural development when economic development policies shifted. Investments in use of ICT in extension by NARS were consequently very limited. However, in recent years, agriculture is regaining attention. Most focus is in enabling smallholder farmers, the majority in the farming communities of the region participate more equitably in national, regional and global markets.

Several countries in Asia are seeing very innovative use of ICT in agricultural and rural development. India leads the pack with more

than 40 percent of all ICT enabled rural initiatives in the region in that country.

The initiatives in the use of ICT, including community radio, cellular telephony, especially SMS and the Internet through tele-centers, information kiosks, multipurpose community centers etc., have been through the NARS Institutes, National and International NGO including farmer based organizations. In India and some South-East Asian countries such as Laos the national NGO sector, private, public-private and public-private-community partnerships are emerging as main providers of information through ICT enabled initiatives. Thus, ICTs are transforming conventional agricultural extension.

A common learning from these ICT enabled initiatives for agricultural development has been that farmers' information needs to be satisfied through use of ICT are for market related information including price trends, accessing input and support services and solving individual and community agricultural problems, especially diagnosis of disease and pest problems and getting solutions to them.

The type of services that use of "new" ICT can provide include call centers, help desks, web based question and answers, frequently asked questions, e-mail based electronic discussion lists and on-line "communities of practice". This is leading to transformation of how ICT use is also transforming through extension with the focus in rural development on universal access. There have been very few initiatives in the region to provide such universal access services through the public sector NARS. A major issue in the provision of these services, in addition to poor ICT infrastructure is also lack of readily accessible, relevant and useful information content and the organizational and management structures of the NARS that tend to isolate research from extension at various levels including in exchange and sharing of information and knowledge.

Many countries including India, Indonesia, Thailand and Vietnam have SMS services through cellular telephones for market prices of agricultural commodities. These cater to a range of clients from farmers to market intermediaries. Almost all countries have web based market agricultural information services. Many of these systems are commercial and operated by the private sector.

The use of radio and TV is again commonplace in most countries of the region as they have high coverage of radio and TV stations. The linkage of Radio and TV Stations with conventional and cellular telephony as also the Internet has been considered promising but has not yet been exploited fully. The use of community radio has been diverse. Nepal and Sri Lanka have successfully used community radio while this has not been used in India where the Government controls broadcasting media. Linkage for relevant and useful content available on-line or through CD-ROMs, DVDs and other such means with radio and television broadcasting stations has in general been weak in the region.

Almost all new ICT enabled initiatives for rural, including agricultural, development have had problems related to sustainability, in being scaled up and in being replicated elsewhere. The major issue is the costs of infrastructure and telecommunications, its access to farming communities and the usual generic nature of "public good" agricultural information which is easily available through conventional media. The advantage in using new ICT is primarily in reducing time and distance in accessing information. Without information, such as that related to participation in the market, the use of ICT offers little advantage in the region.

Agricultural information provided by the NARS in the region is at the moment largely considered as a "public" good with non exclusion and non rival properties. However, this makes it also to be broad based or "generic" and not customized to meet the specific needs of

individual farmers, households and, many a times, local communities. But, by its non-specific nature, it also excludes providing the more useful and relevant information to solve problems of individual farmers and farming communities. This questions the fundament notion of it being public good. With complex issues related to access to new ICTs by farming communities, the issue of "exclusion" and the very definition of agricultural information being a "public" good need to be debated with more rigor than is done at present.

The information flow is not symmetric. It is largely top-down from research Institutes to user communities and not vice-versa i.e. flowing back the information needs of farmers to the research Institutions and in sharing innovations developed by agricultural communities. Thus, a large section of the agricultural community, contributing to innovation in the agricultural commodity chain, is left out in the NARS centric NAIS development.

Private sector investment and involvement in providing agricultural information services, as in the agriculture of economically developed countries, is just emerging. This is parallel to increasing private sector involvement in agricultural research, development and marketing in the region especially in India, Indonesia, Malaysia, Philippines and Thailand. As this involvement increases, the NAIS as a concept will need transformation.

IV. Selected ICT-enabled Agricultural Development Initiatives

Since the early 1990's the agricultural extension systems in the region have experienced a continuous decline in their effectiveness due to a variety of reasons, primarily reduced funding to agricultural development when economic development policies shifted and lack of creativity in the NARS to harness the potential of new ICT in

information and knowledge sharing. Investments in use of ICT in extension by NARS were consequently very limited. However, in recent years, agriculture is regaining attention not only in the minds of policy makers but also serious private sector players who see a huge opportunity of entering the rural markets through ICT. Most focus is on enabling smallholder farmers of the region to participate more equitably in national, regional and global markets. Global organizations and several countries in Asia are witnessing very innovative use of ICT in agricultural and rural development. In national programs, India leads the pack with more than 40 percent of all ICT enabled rural initiatives in the region, followed by China, Malaysia, Thailand, Philippines, Pakistan, Bangladesh and others. Some examples of ICT enabled initiatives tested for agricultural development in the region as well as globally are as follows:

International Initiatives

Farm Forums: Farm forums began in Canada in the 1940s and have been used to reach large audiences in India, Ghana, Tanzania, Botswana, Zambia, Benin, Niger and Senegal. Radio programs on farming issues are produced in collaboration with agricultural extension services and broadcast using a 'listen-discuss-act' pattern of audience participation.

Radio Club: Radio Club is the francophone version of the farm forums. However, where the latter used a top-down approach, Radio Club was an early example of the empowerment approach. It involved listeners in selecting the topics for investigation, collecting the information, producing the programs, and finding solutions to location-specific problems.

Radio Campaigns: Like farm forums and radio clubs, radio campaigns can involve study groups and print materials for follow up clarification, contextualization, decision-making, and action. However,

they run for shorter periods and are often more intensively-focused, sometimes only focusing on single issues. They often involve collaboration between several agencies and because of their large audiences, use study group leaders for discussions on the issues covered in the broadcasts. Radio campaigns have been successfully employed in India, Tanzania, Botswana, and Zambia.

CGIAR Learning Resource Centre (CGLRC): The CGLRC (www.knowledgebank.irri.org/cglrc) provides CGIAR learning resources in standardized electronic format to the agricultural and natural resources management community. This pilot repository of learning objects is hosted by IRRI in the Philippines. National institutions can use these learning resources and adapt them to the language, contexts, and specific learning needs of their users. Some of the materials can be used by extension workers and farmers literate in English. The learning resources currently available include decision support tools, techniques in dryland agriculture, fishing and aquaculture, forestry, law and policy on the management of plant genetic resources, livestock breeding and diseases, plant breeding and genetics, rice production, soils, water and irrigation, and training materials for trainers.

ISNAR Learning for Institutional Innovation: ISNAR (www.isnar.cgiar.org) (archived site) was one of the 16 Future Harvest Centers supported by the Consultative Group on International Agricultural Research (CGIAR). ISNAR, now an IFRPRI program, aims to contribute to the generation and use of knowledge to foster sustainable and equitable agricultural development and help bring about innovation in agricultural research institutions in developing countries. Its main areas of work is strengthening human capacity in institutional innovation in agricultural research. The outputs include training modules and materials, distance learning programs, publications, and radio and TV programs.

IRRI Rice Web: IRRI Rice Web (www.riceweb.org) is a compendium of the history of rice, where and how it is grown, its processing and trade, recipes, research issues, terminology and literature. It has been developed by the International Rice Research Institute (IRRI) in the Philippines, in collaboration with the West Africa Rice Development Association (WARDA), Cote d'Ivoire and Centro International Agricultura Tropical (CIAT, Colombia). It has received international recognition as an outstanding educational website for students, researchers and the community at large. The site is user-friendly and the information is multi-layered. For example, a click on 'Research' opens up a page providing access to critical research issues, international research centers, international rice research collaborative mechanisms, new research tools, research databases and conversion factors.

World Agro-Forestry Center (ICRAF): ICRAF (www.world agroforestrycentre.org) is concerned with raising awareness and providing training in agro-forestry and integrated natural resource management. It works in collaboration with a consortium of educational and training institutions, and its target groups are the rural poor in the developing countries of the tropics. It is beginning to use ODL and ICT to deliver its programs and form links with other global providers and learning systems.

Virtual Academy of the Semi-Arid Tropics (VASAT): VASAT (www.vusat.org) is an information, communication and non-formal distance education coalition for rural communities and intermediaries led by the International Crops Research Institute for Semi-Arid Tropics (ICRISAT) (www.icrisat.org). It comprises an e-library, working documents, a research projects database, an image library, meteorological data, IARC training material and other resources. VASAT's partners are research institutions and councils, higher education institutions, corporate bodies, state government bodies and project groups, the Commonwealth of Learning, the International Water Management

Institute, South Asia Regional Office, International Service for National Agricultural Research (ISNAR) and the International Livestock Research Institute (ILRI) in South Asia.

Agricultural Knowledge and Information Systems (AKIS): AKIS has been developed by the World Bank and FAO to link farmers, agricultural educators, researchers and extension workers and generate, share and utilize agriculture-related technology, knowledge and information. This webpage on the World Bank website covers topics such as livestock and animal resources, fisheries and aquaculture, crops, markets and agribusiness, producer organizations and water management.

Asia-Pacific Agricultural Research Information System (APARIS): APAARI with the support from ACIAR and GFAR has been developing APARIS (www.apaari.org) since 1999 with an aim to promote the use of new ICT for better information and communication management (ICM) in agricultural research for development (ARD) of the Asia-Pacific region. APARIS has primarily been designed to serve as a regional de-centralized platform for efficient information and knowledge sharing among the region's NARS, advocacy and capacity building tool for promotion of ICT in ARD. In this regional knowledge network, NARS are represented by their respective national agricultural information systems (NAIS or national nodes) through national information nodal points (NINP). APARIS also acts as a regional node linking NAIS to global (such as WAICENT, AGRIS, CARIS, WISARD, ASTI, AROW, CABI, etc.) and other regional agricultural information systems (RAIS) such as InfoSys+, AARINENA-RAIS, Agroweb-CAC, FORAGRO-RAIS, FARA-RAIS, e-NACA, AFITA, etc.

ENRAP – Knowledge Networking for Rural Development in Asia-Pacific Region: ENRAP, available through www.enrap.org, is an IFAD and IDRC funded initiative to support knowledge networking

amongst rural development projects in Asia-Pacific region through strategic use of ICT by project staff and, ultimately, the agricultural communities.

Pan Asia Networking: Pan Asia is an IDRC initiative designed to help researchers and communities in Asian countries find solutions to their social, economic, and environmental problems, understand the positive and negative impacts that ICT can have on people, cultures, the economies and societies, and develop ICT applications that can promote sustainable development.

Sustainable Development Learning Network (SDLearn): SDLearn, formerly APRTC, is a continuing education e-learning program for agricultural educators and other professionals in the public, private, educational and NGO sectors involved in developing farming communities and promoting sustainable agriculture. The program offers courses, which contain interactive components, and cover topics such as ICT for agricultural professionals, integrated pest management in rice, cotton and vegetable cultivation, responsible pesticide use and integrated soil fertility management.

National Initiatives

All India Radio Farm School Program: This program began in the 1960s, had considerable success and reached many thousands of smallholders. The programs were broadcast in 144 districts and special farm units were established in 46 radio stations to provide a farm broadcasting service daily.

Kothmale Community Radio: The Kothmale Community Radio Internet project (www.kothmale.net) was designed to test an ICT access model for 200,000 people in marginalized communities in the central hill region of Sri Lanka. Supported by UNESCO, the project used community radio as an interface between the community and the

Internet. The community radio station broadcast daily 'Radio Browsing the Internet' programs in which the presenters, supported by studio guests, browsed the Internet live with listeners who had requested them to surf the Web on their behalf. The information accessed was explained and contextualised with the help of the studio guests. The communities were also encouraged to develop their own Web sites and produce content that could then be hosted on the station's server. Users included local farmers and producers.

Tamil Nadu Agricultural University (TNAU): The TNAU Directorate of Extension Education was one of the pioneers in distance education to help farmers, farm n women and rural youth in India learn new production technologies and adopt new technologies. The Directorate provides Farm Schools on All India Radio, which broadcast 13 lessons over 3 month periods at the rate of one lesson per week organize one-day contact programs for participants to discuss issues with the scientists and program presenters. It also offers correspondence courses, also conducted over 3 month periods by mailing out six audio cassette and print lessons per fortnight and organizing three-day contact programs at the end of the courses. Video lessons in agriculture and allied fields are also broadcast or distributed on cassettes to farmers, extension workers, government and non-government organizations, etc. The Directorate plans to strengthen its ICT system.

Yashwantrao Chavan Maharashtra Open University (YCMOU): The YCMOU (www.ycmou.ac.in), established as a state open university in 1989, collaborates with local government agencies and NGOs to provide non-formal education on agriculture and crop production and other programs, using distance education and self-study print and audiovisual materials, study groups and practical demonstrations.

National Institute of Agricultural Extension Management (MANAGE): MANAGE (www.manage.gov.in) is responsible for the

Innovations in Technology Dissemination (ITD) component of the National Agricultural Technology Project (NATP) being implemented with World Bank assistance by the Ministry of Agriculture, Government of India. ITD will provide computers and Internet connection for all participating agencies, researchers, extension managers and farmer clients in 28 districts in 7 States, videoconferencing between the participating organizations, training and information for farmers on, e.g., crop technology and market intelligence, and funding for the communication expenses. It has set up a network of information kiosks to provide training in and access to ICT for disadvantaged rural communities. These kiosks offer information on, e.g., farmers' rights, loans and grants. The basic aim is to re-orientate extension to be more demand-driven, integrated with research and directed towards self-sustainability and farmer-centered decision-making.

NAARM Virtual Learning Centre (VLC): VLC is a pilot site of The National Academy of Agricultural Research Management in Hyderabad, Andhra Pradesh, designed to build the capacity of India's NARS in Research Management by providing online, non-formal, free and interactive learning in agricultural research management, information management and human resources management that can be emulated by the various institutions of NARS. All courses are designed by the faculty of NAARM to facilitate easy learning and interaction.

M.S. Swaminathan Research Foundation (MSSRF): MSSRF (www.mssrf.org) seeks to impart a pro-nature, pro-poor and pro-women orientation to job-led economic growth in rural areas by harnessing science and technology for environmentally sustainable and socially equitable development. Its Honda Informatics Centre collects, collates and disseminates actionable information through various database services. The Farmers' Rights Information Service is a multimedia database on agrobiodiversity in India and tribal communities' contributions to conservation and biodiversity. The Every Child

a Scientist Centre provides underpriviledged children with opportunities to nurture their inherent talents through the use of ICT. The Information Village Research project, Pondicherry, uses ICT and local languages to provide market information, education, employment news, and information on health, crops, weather and fishing conditions to 12 underprivileged villages. The Hindu Media Resource Centre takes scientific issues to the wider community. The MSSRF-TATA Virtual Academy for Food Security and Rural Prosperity is also under development.

Gyandoot: Gyandoot (www.gyandoot.net) is an award-winning intranet in Dhar district in Madhya Pradesh that connects rural cybercafes to the Internet and serves the everyday needs of the local people. The cybercafes are located on the roadsides of the central villages where people normally travel. Together, they serve over half a million rural people, who can access prices and volumes of local and national agricultural produce markets on a daily basis, print out land records for crop loans from banks, apply for caste, income and domicile certificates and other government services, gain public grievance redressal, and access rural Hindi e-mail, employment news, a rural newspaper, and various e-learning and e-advisory services.

Indian Society of Agribusiness Professionals (ISAP) e-group: ISAP (www.isapindia.org) is a network of professionals in India and the SAARC countries that serves farmers and small rural entrepreneurs and the many agricultural graduates who fail to find gainful employment or work in isolation. It uses a mix of face-to-face meetings, seminars and workshops, e-mail, discussion lists, SMS, telephony, a Website and Agri-clinics to share information nationwide. It is run by professionals in irrigation, food processing, international trade, research, and agricultural extension. It is probably the largest agriculture and rural development professional network in the world. It has registered over 9,000 members, 75 chapters, 400 NGO partners, and 110,000 farmers and has answered well over 3,000 queries/problems raised by the

farming community. ISAP was selected by Digital Partners, USA, as one of the Most Promising Social Enterprises for their 2002 Award.

Farm Management and Information Service: Rural Development Administration (RDA) of South Korea runs this service on its web site. RDA maintains a database of agricultural technology and provides it though the web site (www.rda.go.kr). The web site also offers Question/Answer and FAQ services for interested farmers. Approximately 100,000 visitors make use of this service every month. Technical problems raised by the farmers are rapidly resolved through voluntary participation of researchers and scientists.

ITC's e-Choupal: The Indian Tobacco Company (ITC) began e-Choupal as a cost-effective means of dealing directly with farmers to buy agricultural products for export. The system is now becoming a meta-market for rural India. Farmers can strike orders with ITC directly through Internet kiosks, the ITC and the farmers achieve savings by bypassing the intermediaries, and the local entrepreneurs gain commissions on the transactions made through their kiosks. The kiosks can also be used for companies to sell products and services directly to the farmers and train the farmers on how to use them. The system is emerging as a one-stop shop for selling and buying of a range of products and services including government services in the rural market.

Indiagriline by EID Parry: The AgriPortal of EID Parry (www.indiagriline.com) is designed to address the specific needs of the rural farming community and catalyze e-commerce in agricultural and non-farm products by offering a network of partnerships. The content is developed in Tamil by EID Parry in collaboration with the Tamil Nadu Agriculture University and its Research Stations, Tamil Nadu University for Veterinary and Animal Sciences, National Horticulture Board, AMM Foundation, Murugappa Chettiar Research Centre, and other players in agricultural media and publishing.

Multichannel Learning Centers: The Education Development Centre (EDC) in Papua New Guinea provides technical assistance in community-based learning for sustainable development. With funding from the Norwegian Rainforest Foundation, the EDC has teamed up with partners to organize the 10 tribal groups of the Managalas Plateau into a micro-enterprise to jointly harvest, market and export local crops. EDC provides Multichannel Learning Centers (MLCs), which use a variety of media to educate the people about the issues involved, and interactive radio instruction, which combines broadcasts, drama, audience participation and other learning methods. Local clans gather round the radio, listen to the programs in pidgin and then hold meetings on managing and conserving their part of the rainforest under threat from loggers and land developers. This approach is an improvement on earlier efforts that were over-reliant on extension workers with a limited understanding of the issues and print materials that the people found difficult to follow. The programs are also distributed to students in schools, women's groups, and literacy and reading clubs.

Pinoy Farmer Business Development: Pinoy Farmer Business Development was initiated by the Philippines Department of Agriculture in partnership with Winrock International to develop an ICT-supported extension service. The project aims to help local farming and fishing communities make sound business decisions, create new business opportunities, and achieve profitable and sustainable farm innovations. The farmers access information on new technologies and markets through radio and TV programs, and receive support for improved crop production, quality control methods, processing, packaging and marketing.

V. Success Stories on Agricultural Information Systems

South Korea's Agricultural Information Service – A NARS Initiative

Agricultural research and technology development in Korea started when the Agricultural Demonstration Station was established in 1906. This station was reorganized in 1962 as the Rural Development Administration (RDA) to take a significant role in the successful industrialization and modernization of the Korean economy through the effective development and transfer of agricultural technologies, and though efficient implementation of rural development programs in rural communities. RDA now serves as the NARS of South Korea and is an active APAARI member. It has been extensively profiled in APAARI Newsletter in its December 1993 issue (www.apaari.org).

For the past three decades, RDA has disseminated high-yielding cultivars and cropping technologies to attain self-sufficiency in rice and some other important food crops. It has also contributed greatly in vegetable production by introducing technologies that enable farmers to produce crops year-round. Furthermore, RDA has also improved rural environment and fostered young farmers to enhance the competitiveness of Korean agricultural products. Continuous and sizable investment in agricultural research by the Korean government highlights the importance of technology development in advancing the agricultural industry.

Successful research has enabled the re-orientation of industry's development thrusts and the exploitation of global markets for Korea's agricultural products. Korean agricultural technologies and development experiences have already reached the level where those things can now be shared with other developing countries. RDA, as

the central government agency responsible for agricultural research and technology development, is conducting various national research programs in the areas of crop improvement, soil management, crop protection, and sustainable agriculture, which are not usually pursued by the private sector. Much attention is being given to production systems and technologies that promote and protect agricultural environment and safety of products as well. RDA is striving to promote key technologies including the leading-edge biotechnology, with the aim of maintaining basic food security. RDA maintains very close relationship with Provincial Agricultural Research and Education Services, Metropolis Extension Service, City/County Rural Extension Centers, Farmers' Counseling Office, Region Specific Crop Experiment Stations, and Institutions and/or Agricultural Experiment Stations throughout the country. The following are the major RDA Institutes/Stations:

- National Horticultural Research Institute (NHRI), Suwon
- Taegu Apple Research Institute/NHRI/RDA
- Naju Pear Research Institute/NHRI/RDA
- Cheju Citrus Research Institute/NHRI/RDA
- Pusan Horticultural Experiment Station/NHRI/RDA
- National Alpine Agricultural Experiment Station/RDA
- National Seed Management Office/RDA

RDA's Agricultural Information Service

The Director of Technology Information, who reports to the Director General of Farm Management and Information Bureau of RDA, administers the Agricultural Information Service (AIS). The AIS has a staff strength of 45, including 31 researchers, 1 administrator, 7 computer specialists, 3 librarians and 3 technical support staff. The AIS is responsible for providing following support activities:

- Statistical Analysis Support
- Computer Support
- Information Development
- Information Management
- Cybersystems
- Agricultural Library

AIS disseminates information on newly developed technologies and efficient farm management practices through mass media such as internet (RDA web site), radio, television, newspapers, and magazines. RDA publishes a number of technical books, periodicals, pamphlets, leaflets, and posters for effective technology transfer. CD, DVD, VCR tapes, and other audio-visual aids are also made available to the extension offices. The areas of emphasis also include:

- Analysis of domestic and international agricultural trends
- Development of management technology for farmers
- Profitability analysis of agricultural and livestock production and economic analysis of agricultural technologies
- Information support for agricultural research and extension
- Enhancement of agricultural library service

AIS has integrated all national institutes into a high-speed network. Under the e-Government initiative of South Korean Government, AIS utilizes the principle of Core Customer Relations Management System (CCRMS), which is widely used in the service industry sector. The main functions of this system are e-mail consultation, Short Message Service (SMS), and crop-wise virtual meeting rooms as shown in Figure 1. The system has registered 35,000 farmers and 8,000 researchers or extension workers.

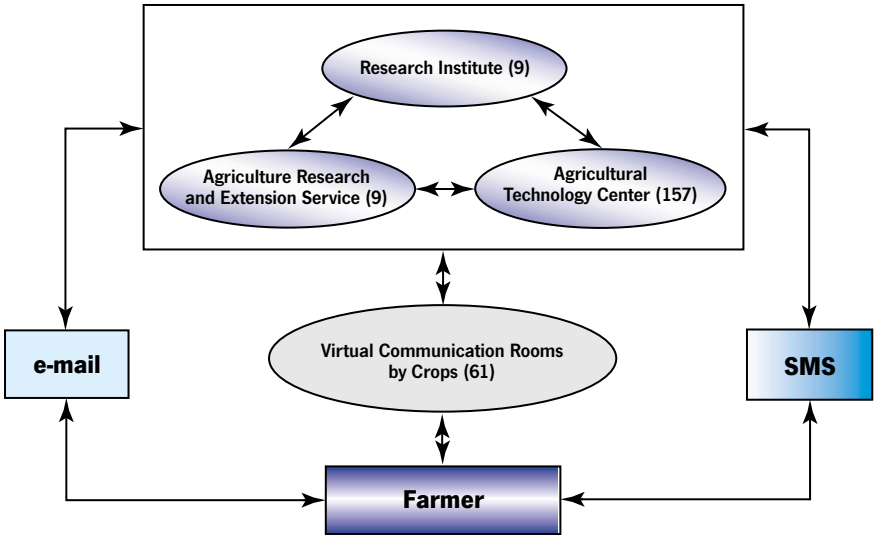

Figure 1: Conceptual Framework for Customer Relations Management of AIS

AIS produces databases of agricultural technology information and provide them through a special homepage, http://ccss.rda.go.kr, (Figure 2). Owing to the customized service, monthly visitors count more than 100,000. Technical problems raised by farmers are rapidly resolved by voluntary participation of researchers in answering the questions delivered through the internet.

Internet-based training courses for farm managers are offered to help farmers as well as extension workers. These courses are rich in content and use up-to-date animation, flash and moving screen technologies for added attractiveness. Subject matter specialists within RDA serve as lecturers in these video courses delivered through the internet and on CD-ROMs. About 1,000 farmers or extension workers take the course annually.

AIS also maintains a knowledge portal for agricultural sciences and technology where individual researchers and experts interact with each other and are also able to share implicit knowledge, know-how,

Figure 2: User-friendly Interface of RDA's Agriculture Information Service

experience, case study and research output. Such informal interactions result in free flow of creative ideas, improved quality of research and collaborative projects, which benefits all, including the farmers. AIS also assists the farmers in developing their homepages for e-shopping malls.

ITC's e-Choupal – A Private Sector Initiative

The term "Choupal" is a Hindi word, which means the meeting point in a village. The Indian Tobacco Company (ITC) is a multi-billion dollar private corporation with business interests in tobacco, hotels, consumer products and, more relevantly, in agricultural inputs and commodities. In 2000 through its International Business Division, ITC embarked upon a path-breaking idea to directly reach smallholder farmers with an aim to develop a unique business relationship with them using ICT. The project was named e-Choupal to signify its use of ICT as a communication medium and was based on the knowledge sharing found in the traditional "Choupal" model, but it took the concept one step further. It eliminated the intermediaries such as local intermediaries who purchased the produce from farmers in the

local 'mandi' (local agriculture marketplace). Initially, a few soybean growing villages of Madhya Pradesh state of India were selected for the pilot phase of the project. ITC supplied an e-Choupal kit to each village with the following components:

1. A standard personal computer (PC) with an operating system, multimedia kit, and connectivity interface
2. Connection lines via either telephone or VSAT (Very Small Aperture Terminal)
3. A power supply consisting of UPS (Uninterruptible Power Supply) and solar-powered battery backup
4. A dot-matrix printer

Through this set up a dedicated ITC website (www.soyachoupal.com) was accessible to the farmers introducing them to the World Wide Web and available information resources on Internet. The site and the data uplink are maintained by ITC Infotech India Ltd., an ITC subsidiary. The e-Choupal site provides links to following critical information and knowledge resources:

- Weather Information: local weather forecasts to help farmers decide agricultural operations
- Best Agricultural Practices: Information for farmers to increase their productivity
- Market Information: Options to explore world demand, world production, 'mandi' trading volume, and 'mandi' price lists.
- Q&A forum (FAQs): The website provided an interactive feature, which allowed the farmer to ask a question and have it answered by the appropriate panel of experts.
- News page: This website held excerpts of relevant news items, including government decisions on subsidies or minimum support prices (MSP's) and innovation in other

countries. Local news pertaining to farmers successes were also posted.

- Place for suggestions: The website was fluid, continually tailored to meet the farmers' needs. ITC relied on the farmers' participation to keep the site relevant and in a constant improvement mode.

The 'e-Choupals' or village internet kiosks managed by farmers – called "sanchalaks" (coordinators) – themselves, enable the agricultural community access ready information in their local language on the weather and market prices, disseminate knowledge on scientific farm practices and risk management, facilitate the sale of farm inputs (now with embedded knowledge) and purchase farm produce from the farmers' doorsteps. Thus, decision making by farmers becomes information-based. Real-time information and customized knowledge provided by e-Choupal enhance the ability of farmers to take decisions and align their farm output with market demand and secure quality and productivity. The aggregation of the demand for farm inputs from individual farmers gives them access to high quality inputs from established and reputed manufacturers at fair prices. As a direct marketing channel, virtually linked to the 'mandi' system for price discovery, e-Choupal eliminates wasteful intermediation and multiple handling. Thereby it significantly reduces transaction costs. Using e-Choupal as an additional trading way for the soybean farmers with following benefits:

- Farmers have better knowledge of prices and could have a much better control over the timing of making its trade.
- Reduce the monopoly power of intermediaries, which cut the costs for both the farmers and soybeans processors.
- Save time and efforts for soybean farmers.
- The transparency of the e-Choupal – the fact that the website was accessible to anyone, including the government,

to cross-check ITC's prices at any time – helped to convince the government to legalize the purchases of beans (and other agricultural commodities) outside the 'mandi' as it was the only place to do the purchase before

- Farmers could use e-Choupal to buy the supplies they need.

Launched in June 2000, e-Choupal, has already become the largest initiative among all Internet-based interventions in rural India. e-Choupal services today reach out to more than 3.5 million farmers growing a range of crops – soyabean, coffee, wheat, rice, pulses, shrimp – in over 31,000 villages through 5372 kiosks across seven states (Madhya Pradesh, Karnataka, Andhra Pradesh, Uttar Pradesh, Maharashtra, Rajasthan and Kerela). Besides being nominated to the prestigious Stockholm Challeng 2006, ITC's e-Choupal has won numerous other awards as follows:

- The Development Gateway Award 2005 (previously known as the Petersberg Prize) for its trailblazing e-Choupal initiative. ITC is the first Indian company and the second in the world to win this prestigious award.
- The 'Golden Peacock Global Award for Corporate Social Responsibility (CSR) in Emerging Economies for 2005'. The Company received this award for its e-Choupal and social and farm forestry initiatives that are transforming lives and landscapes in rural India.
- The Corporate Social Responsibility Award 2004 from The Energy and Resources Institute (TERI) for its e-Choupal initiative. The Award provides impetus to sustainable development and encourages ongoing social responsibility processes within the corporate sector.
- The inaugural 'World Busines Award', insstituted jointly by the International Chamber of Commerce (ICC), the HRH Prince of Wales International Business Leader's Forum

(IBLF) and the United Nations Development Program (UNDP). This award recognizes companies who have made significant efforts to create sustainable livelihood opportunities and enduring wealth in developing countries.

- The 'Enterprise Business Transformation Award' for Asia Pacific, instituted by Infosys Technologies and Wharton School of the University of Pennsylvania.
- PC Quest's IT Implementation Award in the 'Best Project' category.
- The Golden Peacock Innovation Award 2004.
- The NASSCOM award for 'Best IT User in FMCG' in 2003. The Award is a recognition of ITC's successful integration of its IT usage with its business processes.
- The Seagate Intelligent Enterprise of the Year 2003 Award, for the most innovative usage of Information Technology.

According to ITC, the problems encountered while setting up and managing e-Choupals are primarily of infrastructural inadequacies, including power supply, telecom connectivity and bandwidth, apart from the challenge of imparting skills to the first time internet users in remote and inaccessible areas of rural India. As new e-Choupals are being continuously added, further information is available on www.e-Choupal.com.

VI. Lessons Learned on Secrets of Success

RDA's AIS is a government policy-initiated NARS-driven system, while ITC's e-Choupal a profit-driven initiative. In this regard, it is interesting to note that both the initiatives ultimately result in the same outcome, i.e., farmer empowerment. Except for e-procurement of farmers' produce by e-Choupal, both systems provide the farmers with expert knowledge on farming practices, real-time information on market

prices, weather and global trends. In terms of interaction, AIS provides various state-of-the-art options to farmers for real-time consultation with experts and researchers. ITC's e-Choupal also provides similar consultation opportunities in asynchronous mode. From sustainability point of view, the e-Choupal approach seems more robust, while the RDA's AIS is part of government services provided in the rural areas under the e-Government policy framework of South Korea.

While the above two initiatives rely solely on Internet as the channel for service delivery, in general the initiatives in the use of ICT, including community radio, cellular telephony, especially SMS and the Internet through tele-centers, information kiosks, multipurpose community centers etc., have been through the NARS Institutes, National and International NGO including farmer based organizations. In India (Ingale, 2002) and some South-East Asian countries such as Laos the national NGO sector, private, public-private and public-private-community partnerships are emerging as main providers of information through ICT enabled initiatives. Thus, ICT are transforming conventional agricultural extension.

A common learning from these ICT enabled initiatives for agricultural development has been that farmers' information needs to be satisfied through use of ICT are for market related information including price trends, accessing input and support services and solving individual and community agricultural problems, especially diagnosis of disease and pest problems and getting solutions for them (APAARI, 2004).

The type of services that new ICT can provide include call centers, help desks, web based question and answers, frequently asked questions, e-mail based electronic discussion lists and on-line "communities of practice." This is leading to transformation of how ICT use is also transforming through extension with the focus in rural development on universal access (Richardson, 2003). There have

been very few initiatives in the region to provide such universal access services through the public sector NARS. A major issue in the provision of these services, in addition to poor ICT infrastructure is also lack of readily accessible, relevant and useful information content and the organizational and management structures of the NARS that tend to isolate research from extension at various levels including in exchange and sharing of information and knowledge.

The use of radio and TV is again commonplace in most countries of the region as they have high coverage of radio and TV stations. The linkage of Radio and TV Stations with conventional and cellular telephony and also the Internet has been considered promising, but has not yet been exploited fully. The use of community radio has been diverse. Nepal (Basnet, 2003; Mahaseth, 2003) and Sri Lanka (Wijekoon, 2002) have successfully used community radio, while this has not been used in India (Maru, 2003) where the Government controls broadcasting media. Linkage for relevant and useful content available on-line or through CD-ROMs, VCDs, DVDs and other such means with radio and television broadcasting stations has in general been weak in the region.

Almost all new ICT enabled initiatives for rural, including agricultural, development have had problems related to sustainability, in being scaled up and in being replicated elsewhere. The major issue is the costs of infrastructure and telecommunications, its access to farming communities and the usual generic nature of "public good" agricultural information which is easily available through conventional media. The advantage in using new ICT is primarily in reducing time and distance in accessing information. Without information, such as that related to participation in the market, the use of ICT offers little advantage in the region. The innovative use of village-level entrepreneurship in the ITC's e-Choupal initiative for long-term sustainability is worth noting and indicative of ways that can work elsewhere.

Agricultural information provided by the NARS in the region is at the moment largely considered as a "public" good with non exclusion and non rival properties. However, this makes it also to be broad-based or "generic" and not customized to meet the specific needs of individual farmers, households and, many a times, local communities. But, by its non-specific nature, it also excludes providing the more useful and relevant information to solve problems of individual farmers and farming communities. This questions the fundamental notion of it being public good. With complex issues related to access to new ICT by farming communities, the issue of "exclusion" and the very definition of agricultural information being a "public" good need to be debated with more rigor than is done at present.

The information flow is not symmetric. It is largely top-down from research institutes to user communities and not vice-versa, i.e., flowing back the information needs of farmers to the research institutions and in sharing innovations developed by agricultural communities. Thus, a large section of the agricultural community, contributing to innovation in the agricultural commodity chain, is left out in the NARS-centric agricultural information system development.

Private sector investment and involvement in providing agricultural information services, as in the agriculture of economically developed countries, is just emerging. This is parallel to increasing private sector involvement in agricultural research, development and marketing in the region especially in India, Indonesia, Malaysia, Philippines and Thailand.

It is becoming increasingly evident that linear information flows that dominated the traditional model of technology transfer from the formal research systems to the farmers by way of the formal, government-owned extension system, are being replaced by pluralistic information flows between farmers as the demanders of services, and various providers of these services. These information flows can be

enhanced through the use of ICT – but probably to a different extent at different levels in the system, as different actors have different kinds of information needs and communication problems, and varying access to ICT. New perspectives are needed to understand and manage these pluralistic information flows and effectively use ICT.

The growing involvement of the NGO, Community Organizations and Private Sector in agricultural information services, especially related to the market, also raises questions whether the NAIS should conceptually be related on the concept of NARS, the Agricultural Knowledge and Information System (advanced by FAO and World Bank) or the Agricultural Innovation System, that incorporates the concept of information and knowledge sharing and exchange across the agricultural commodity market chain or something else. There appears to be links between each of the concepts and how information flows are defined within them, but a clear and widely accepted framework on how a National and Regional Agricultural Information System can be defined and described is still missing. Without this description or conceptual frameworks, policies and strategies are difficult to develop and implement.

One perspective that emerges from the proceedings of the above mentioned workshops and other activities related to use of ICT for Development is that at a generic or "systems" level these information flows through use of ICT are enabled through a chain of components which include:

- An "information organization" that generates and processes information
- An "information platform" that enables dissemination, sharing and/or exchange of information
- An "information bus (pathway)" that transports information between the "information platform" and its user community

- "Information and Knowledge Intermediaries" that intermediate by either localizing and/or globalizing information as per the needs of the user community
- A user community that is not geographically defined but forms on the basis of common needs, objectives, values, etc. Communities that use agricultural information are formed based on commodities, eco-regions, disciplines, etc.

Apparently, the basis for providing information services are to be defined not by "suppliers" of information but by needs of the user communities who use information to enlarge their "information space" and learn from it to act in ways that are beneficial at individual, household and community levels. The role of ICT is primarily to further enable, enhance and enlarge the "information spaces" and the user communities and enable learning within the user communities.

This perspective has several ramifications on enabling and enhancing ICT use and the development of ICM agenda for ARD at the national and regional levels. Primarily, taking consideration of pluralistic information flows, it questions the central place the NARS occupy at present as the prime "suppliers" of agricultural information and "managers" of information flows for ARD. Further, it accepts that a large number of new actors for satisfying the information needs of user communities by generating information, enabling its dissemination, sharing and exchange, providing pathways and also act as information and knowledge intermediaries. For an ICM agenda for ARD, this perspective can also enable evaluate the gaps and propose new approaches to fulfill them.

VII. Extent of Adoption of Technology

Owing to the customized service, monthly visitors to RDA's AIS count more than 100,000. Technical problems raised by farmers are rapidly resolved by voluntary participation of researchers in answering the questions delivered through the internet. In addition, Internet-based training courses for farm managers are offered to help farmers as well as extension workers. These courses are rich in content and use up-to-date animation, flash and moving screen technologies for added attractiveness. Prominent specialists within RDA serve as lecturers in these video courses delivered through the internet and on CD-ROMs. About 1,000 farmers or extension workers take the course annually.

With regard to ITC's e-Choupal, at present 5,372 e-Choupals are available in 7 Indian states covering 31,000 villages and benefiting 3.5 million farmers. ITC has drawn up ambitious 1 Billion US Dollar investment plans for future in its e-Choupal initiative to benefit 10 million farmers in 100,000 villages of 15 Indian states by 2010.

Many countries in the region, including India (Khainar, 2003), South Korea, Indonesia (Mahendra, 2003) Thailand (Paiboonrat, 2000) and Vietnam (Dieu, 2003) have SMS services through cellular telephones for market prices of agricultural commodities. These cater to a range of clients from farmers to market intermediaries. Almost all countries have web based market agricultural information services. Many of these systems are commercial and operated by the private sector.

VIII. Benefits and Impact at National and Regional Levels

Agricultural extension is transforming in the region replacing linear information flows with pluralistic information flows. New actors in providing information services such as non-government organizations, farmer organizations and the private sector including individual small entrepreneurs is emerging. Re-intermediation through new capacities of conventional intermediaries such as extension agents and by new actors such as those who run public call offices, Internet cafes, information kiosks and input suppliers is occurring. The NARS have content but not the processing and delivery capacity through use of new ICT to satisfy user needs. There is an urgent need to create public-private-community partnerships in agricultural information delivery, sharing and exchange to and between users.

Information needs of farmers and rural entrepreneurs are shifting from being agricultural technology centric towards effective participation in national and global markets and towards sharing of innovations and market information in commodity chains most of which are across national boundaries. NARS centric agricultural information systems are being replaced by information systems around commodities and markets. The NARS need to transform to meet these needs.

In India, Trust for Advancement of Agricultural Sciences (TAAS), National Academy of Agricultural Sciences (NAAS), Indian Society of Agricultural Statistics (ISAS) and the Asia-Pacific Association of Agricultural Research Institutions (APAARI) jointly organized a national workshop on "Role of Information Communication Technology in Taking Scientific Knowledge/Technologies to the End Users" on 10-11 January 2005 at the Indian Agricultural Research Institute, New Delhi. Around 70 experts representing different stakeholders, i.e., Public Institutions, NGOs, Foundations, Private

Sector, Farmers' Commission, International Agricultural Research Centers deliberated on all relevant issues by which ICT can become a catalyst of change in Indian agriculture and came up with following comprehensive recommendations:

1. ICT based initiatives for agricultural development, including farmers prosperity, should be multi-dimensional in nature, addressing problems of rural communities in holistic manner touching all aspects of rural life including agriculture, human/animal health, education, banking, governance, entertainment etc. This can be achieved by setting up rural knowledge centers using broadband connectivity with multi-media interactive modules in problem solving mode by developing a synergy among various stakeholders involved.
2. Knowledge intensive products and services for empowerment of our farmers are urgently needed. This would require a well coordinated system among government, public and private organizations. In this context, Indian Council of Agricultural Research (ICAR) and the Department of Agriculture and Cooperation (DOAC) under the Ministry of Agriculture can play a leading role in having a National Agricultural Information System (NAIS) established.
3. The existing knowledge dissemination agencies in the country such as ICAR Institutes, SAUs, KVKs, NIC as well as other non-government and private sector institutions need to be networked rather than creating a new institution so that available information/knowledge is shared and transmitted freely to the end users. These institutions should work complementarily in a partnership mode to pool required resources and also using a certain level of subsidiary responsibility and authority.
4. Suitable mechanisms need to be developed for the creation of location specific knowledge capsules in the form

of CD-ROMs, Portals, Kiosks, etc. through involvement of specialized institutions.

4. Complexities in the second-generation agriculture would require greater role of emerging ICT tools and methods in complementing the existing extension system. This would require capacity building of extension functionaries for the transfer of knowledge without dissemination losses to the end users. At the district level, the KVKs could in future play an important role provided given specific ICT mandate with commensurate human resource.
5. Village level ICT should be the ultimate goal for easy access to required knowledge by the farming community. This could be achieved through promotion of Rural Information Clinics or Rural Internet Chaupals by the enthusiastic young entrepreneurs, well trained as ICT agents by the SAUs and ICAR institutions located throughout India. For access to knowledge at the farmers' door steps, above goal must be met.
6. There is also a need to reorient the agricultural extension curriculum so that extension workers in future are spatial and information specialist as well. The NARS should be proactive in providing user friendly, need based and locally relevant trainings.
7. There should also be an emphasis on gender equity by letting women have easy access to ICT, ensuring gender oriented content, and the increased women participation in the application of ICT.
8. There is a strong need to establish joint ventures with the Private Sector and NGOs to enrich ICT resources in terms of both hardware and software, and the relevant content creation.
9. To empower agricultural community with needed information and knowledge in the coming decade (by 2015), the

Government should come out with an Agricultural ICT Policy with a mission-oriented strategy to implement the same in a time bound manner. Only through such commitment at the highest level, we shall be able to address the concern of "digital divide" and empower Indian farmers to be well-informed and globally competitive.

While these recommendations are specific to Indian agriculture, the underlying principles of implementing ICT-enabled agriculture for rural development will be valid in most developing countries of the Asia-Pacific.

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