Information and Communication Technologies in Agricultural Research for Development in the Asia-Pacific Region

A Status Report

Asia-Pacific Association of Agricultural Research Institutions
FAO Regional Office for Asia and the Pacific
Bangkok, Thailand

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by

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FOREWORD

Developments in the information and communication technologies (ICT) are offering new opportunities for rapid information dissemination for faster adoption of agricultural technologies at the grass root level. In addition, new Information and Communication Management (ICM) techniques offer yet more effective management of Agricultural Research for Development (ARD). Many NARS and ARD organizations in Asia-Pacific have made rapid strides in using ICT for knowledge access at all levels. Yet, the concern for "digital divide" exists and many developing country NARS have not been able to take full benefit of these new exciting opportunities that could advance the process of ARD. Sharing of knowledge and success stories through regional cooperation, is, therefore, utmost critical for NARS to reap the benefits from technological advances made elsewhere in the field of agriculture. Thanks to the "ICT Revolution", the whole world today is a "Global Village" and hence urgency to catch up with new advances in this field is indeed a formidable challenge before most of the NARS, which need to be addressed by the members of APAARI. APAARI members as well as other stakeholders of ARD can address the ICT/ICM in ARD based on a good status report that identifies the critical issues and gaps that need to be filled.

It is in this context, that APAARI, in close cooperation with its stakeholders, including NARS, FAO, and CG Centers, has been pursuing the development of Asia-Pacific Agricultural Research Information System (APARIS) for the last three years. The APARIS development is in response to the continuous information needs analysis of ARD stakeholders in the region. APARIS is intended to enable information sharing among NARS and ARD organizations, an essential component of modern research in all areas. The system is primarily driven by the National Information Nodal Points (NINPs) from member institutions, while APAARI provides a facilitator's role and an

apolitical platform to share experiences and knowledge. For the last three years, the NINPs have been providing country status data which are the basis of this report. The APARIS serves a variety of agricultural information users, including ARD professionals, institutions, learning community, and farmers. On a global level, APARIS is being linked to other regional systems and the Global-RAIS, a GFAR initiative. Efforts are being made to involve other ICT players, including e-learning deliverers, NGO initiatives, and the private sector. Such an interactive approach will result in more efficient dissemination of information that is useful for timely decision-making by the different stakeholders.

It is hoped that APARIS will play an important role towards a knowledge-based agriculture in coming years with greater involvement of its stakeholders and useful feedback from its users. This report is expected to fill in the long felt need of a synthesized status report on ICT/ICM in ARD in the Asia-Pacific region. It is also expected to play an advocacy role through sensitization of policy makers and ARD managers in the Asia-Pacific region.

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APAARI Secretariat

ACRONYMS AND ABBREVIATIONS

AAACU	Association of Asian Agricultural Colleges and Universities
AARINENA	Association of Agricultural Research Institutions in the Near-East and North Africa
ACIAR	Australian Centre for International Agricultural Research
ADB	Asian Development Bank
AFITA	Asian Federation for Information Technology in Agriculture
AGORA	Access to Global Online Research in Agriculture
AGRICOLA	Agricultural Online Access
AGRIS	International Information System for the Agricultural Sciences and Technology
AIT	Asian Institute of Technology
AKIS	Agricultural Knowledge and Information System
APAARI	Asia-Pacific Association of Agricultural Research Institutions
APAFRI	Asia-Pacific Association for Forestry Research Institutions
APAN	Asia-Pacific Advanced Network
APARIS	Asia-Pacific Agricultural Research Information System
APCoAB	Asia-Pacific Consortium on Agricultural Biotechnology
APHCA	Animal Production and Health Commission for Asia and the Pacific
APRTC	Asia-Pacific Regional Technology Centre
APSA	The Asia and Pacific Seed Association
ARD	Agricultural Research for Development

AREO	Agricultural Research and Education Organization
ARIS	Agricultural Research Information System
AROW	Agricultural Research on the Web
ASEAN	Association of Southeast Asian Nations
ASTI	Agricultural Science and Technology Indicators
AVRDC	Asia Vegetable Research and Development Centre
BARC	Bangladesh Agricultural Research Council
BAR	Bureau of Agricultural Research
CAAS	Chinese Academy of Agricultural Sciences
CABI	Centre for Agricultural Bioscience International
CAC	Central Asia and Caucasus
CARIS	Current Agricultural Research Information System
CARP	Sri Lankan Council for Agricultural Research Policy
CAS	Current Awareness Services
CASREN	Crop-Animal System Research Network
CD-ROM	Compact Disk – Read Only Memory
CG & CGIAR	Consultative Group on International Agricultural Research
CGLRC	CGIAR Learning Resource Centre
CIAT	International Center for Tropical Agriculture
CIFOR	Centre for International Forestry Research
CIMMYT	International Maize and Wheat Improvement Centre
CIRAD	Centre de Coopération Internationale en Recherche Agronomique pour le Dévelopment
CLAN	Cereals and Legumes Asia Network

COA	Council of Agriculture
COL	Commonwealth of Learning
COP	Communities of Practice
CORRA	Council for Partnership on Rice Research in Asia
CSS	Cascading Style Sheets
CTA	Technical Centre for Agricultural and Rural Cooperation
CWANA	Central and West Asia and North Africa
DOA	Department of Agriculture (Thailand)
DSG	Donor Support Group
DVD	Disital Video Disk
EDC	Education Development Centre
EFARD	European Forum for Agricultural Research for Development
EGFAR	Electronic Global Forum on Agricultural Research
eJDS	electronic Journals Delivery Service
e-NACA	electronic – Network of Aquaculture Centers in Asia-Pacific
FAO	Food and Agriculture Organization of the United Nations
FAO-RAP	FAO Regional Office for Asia and the Pacific
FAQ	Frequents Asked Questions
FARA	Forum for Agricultural Research in Africa
FORAGRO	Foro Regional de Investigation y Dessarrollo Technologico Agropecuario
FTP	File Transfer Protocol
GDS	Global Development Network
GIS	Geographical Information System
GFAR	Global Forum on Agricultural Research

GLOBAL-RAIS	Global Alliance for Regional Agricultural Information System
GMO	Genetically Modified Organisms
GoFAR	Group on Fisheries and Aquaculture Research
HRD	Human Resource Development
HTML	Hypertext Markup Language
IARC	International Agricultural Research Centers
ICAR	Indian Council of Agricultural Research
ICARD	Information Center for Agricultural Research and Development
ICARDA	International Centre for Agricultural Research in the Dry Areas
ICBA	International Centre for Biosaline Agriculture
ICIMOD	International Centre for Integrated Mountain Development
ICLARM	International Centre for Living Aquatic Resources Management
ICM	Information and Communication Management
ICRAF	World Agroforests Center
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technologies
ICT-KM	Information and Communication Technologies – Knowledge Management
ICUC	International Centre on Underutilized Crops
IDRC	International Development Research Center
IFAD	International Fund for Agricultural Development
IFPRI	International Food Policy Research Institute
IICT	International Institute for Communications for Development
ILRI	International Livestock Research Institute

iMARK	Information Management Resource Kits
iNARS	Information in NARS
INASP	International Network for the Availability of Scientific Publications
INFORM	Information Management
INGER	International Network for Genetic Evaluation of Rice
INP	Information Nodal Point
INRM	Integrated Natural Resource Management
IPGRI	International Plant Genetic Resources Institute
IPGRI-APO	IPGRI Regional Office for Asia, the Pacific and Oceania
IPM	Integrated Pest Management
IPR	Intellectual Property Rights
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
IWMI	International Water Management Institute
JIRCAS	Japan International Research Centre for Agricultural Sciences
KISS	Knowledge and Information Systems
KRS	Koronivia Research Station (Fiji)
LAN	Local Area Network
LKS	Lesser Known Species
MAFFM	Ministry of Agriculture Forests, Fisheries and Meteorology (Western Samoa)
MANAGE	National Institute of Agricultural Extension Management

MARD	Ministry of Agriculture and Rural Development (Vietnam)
MARDI	Malaysian Agricultural Research and Development Institute
MOAC	Ministry of Agriculture and Cooperatives
MSSRF	M.S. Swaminathan Research Foundation
NAAS	National Academy of Agricultural Sciences
NACA	Network of Aquaculture Centres in Asia-Pacific
NAIS	National Agricultural Information System
NARC	Nepal Agricultural Research Council
NARES	National Agricultural Research and Extension Systems
NARI	National Agricultural Research Institute (Papua New Guinea)
NARO	National Agricultural Research Organization, Japan
NARS	National Agricultural Research Systems
NARS-SC	NARS-Steering Committee (GFAR)
NGO	Non-Governmental Organization
NINP	National Information Nodal Point
NRM	Natural Resource Management
ODL	Open and Distance Learning
PARC	Pakistan Agricultural Research Council
PC	Personnal Computer
PCCARD	Philippine Council for Agriculture, Forestry & Natural Resources Research and Development
PERI	Programme for the Enhancement of Research Information
PGR	Plant Genetic Resources
PIAP	Public Information Access Points
Q&A	Question & Answer

R&D	Research and Development
RAEL	Regional Agricultural Expert Locator
RAIS	Regional Agricultural Information System
RDA	Rural Development Administration (South Korea)
RDMS	Research Database Management System
RECSEA	Regional Cooperation in Southeast Asia on PGR
RMIS	Research Management Information Systems
RRNs	Regional Research Networks
RWC	Rice-Wheat Consortium
SAARC	South Asia Association for Regional Cooperation
SAIC	SAARC Agricultural Information Centre
SANPGR	South Asia Network on Plant Genetic Resources
SDI	Selected Dissemination of Information
SDLEARN	Sustainable Development Learning Network
SEARCA	Southeast Asian Regional Centre for Graduate Study and Research in Agriculture
SMS	Short Message System
SPC	South Pacific Commission
SSA	Sub-Saharan Africa
STI	Scientific and Technical Information
TAAS	Trust for Advancement of Agricultural Sciences
TAC	Technical Advisory Committee (of the CGIAR)
TAMNET	Tropical Asian Maize Network
TEEAL	The Essential Electronic Agricultural Library
TNAU	Tamilnadu Agricultural University
TOR	Terms of Reference
TV	Television

UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UNESCO	United Nations Educational, Scientific and Cultural Organization
URL	Uniform Resource Locator
UTFANET	Underutilized Tropical Fruits Asia Network
VASAT	Virtual Academy for the Semi-Arid Tropics
VLC	Virtual Learning Center
WAICENT	World Agricultural Information Centre
WANA	Western Asia and North Africa
WAP	Wireless Access Protocol
WCCA	World Congress on Computers in Agriculture
WWW	World Wide Web
XML	Extensible Markup Language
YCMOU	Yashwantrao Chavan Maharashtra Open University

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EXECUTIVE SUMMARY

Agriculture is vital to the Asia-Pacific region. It is the mainstay of the economy of many countries in the region. Nearly 60% of the region's population derives its livelihood from agriculture. The region is also a hot spot for rural poverty. Most farmers in the region are smallholders with diverse farming practices which are highly risk-prone. These farmers have inadequate support services such as extension and poor access to markets and financial credit. Obviously, a second "green" revolution is needed not only to produce more food in the region but to enable participation of its farmers more equitably in markets, reduce poverty, generate more rural livelihoods and maintain quality of life and environment.

The potential of Information and Communication Technologies (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 ICTs 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 as also share innovations globally.

The agricultural institutions of this region play a nodal role as source of agricultural technologies and generation of agriculture related scientific and technical information. The National Agricultural Research Systems (NARS) are the most important repositories of information and knowledge about agriculture and

form the tangible backbone of agricultural knowledge and information systems (AKIS) in their respective countries and, through collaboration, in the region. However, very little is known of the capacity of agricultural research for development (ARD) Institutions of different countries of the Asia-Pacific region to use new ICT, especially computers and the Internet, in agricultural information management and communication.

Using a conceptual framework of a "National Agricultural Information System" (NAIS), the ICT use and ICM status in a NAIS is assessed at the National and collectively at sub-regional and regional level, through availability of:

a) Policies and strategies related to ICT use

b) ICT/ICM governance structures

c) The information services the NAIS provides and availability of and capacity to generate information content for the services

d) The ICT infrastructure that supports the information services.

The indicator information services are assessed at the NAIS/ NARS level and are related to the following main 7 areas of NARS information related activities:

a) Scientific and Technical Information

b) Research Data Management, especially in applications of collaborative data use such as in models, Geographical Information Systems and Knowledge Based/Expert Systems

c) Research Management Information

d) Extension and Outreach Information including Market related information

e) Distance and Open Education

f) Organization and Management

g) Messaging and Communication which included use of telephones, Fax, E-mail and Internet

Almost all countries in the region have national telecommunications policies which indicate that ICTs would be used for rural, including agricultural development. However, in most cases, the details of how this is to be achieved and the strategy to be adopted are not clear. The more technologically advanced countries in the region such as Australia, Japan, South Korea and Taiwan in the past few years have elucidated and implemented their policies by improving telecommunications infrastructure, especially by providing broad band Internet connectivity, in their rural areas. In other countries, the focus on how to bridge the "digital divide" is still under debate. The rapid advances in cellular telephony and wireless Internet technologies and reduction in costs now make this bridging very feasible, yet these advances, by its variety of options, also 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 being assured, useful and relevant information content will not be generated.

Agricultural policies of most countries in the Asia-Pacific region, though indicating use of ICT, lack clarity on how ICTs are to be used in ARD. 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 high and commercially supposed to be unviable at the moment. The fountainhead of all economic activities in the rural areas of the less economically developed countries of the region is farming 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, Philippines and Thailand, are experimenting with the approach to connect communities through public information access points (PIAPs) which include the use of information kiosks, tele-centers, public call offices and Internet cafes and low cost computers and handheld devices such as the Simputer. These PIAPs are operated through public, private, community, public-private and 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 the Asia-Pacific region.

National telecommunication and agricultural policies affect NARS and NAIS at various levels starting from investments in infrastructure and skills development, content generation and dissemination, application of ICTs 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 ICTs in agricultural research and 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 and several other regional networks also have information systems that support ARD in the Asia-Pacific region. However, there still remains a vital need to sensitize and build capacity among policy makers and senior ARD managers to enable them to play a defining role for enabling and enhancing effective ICT use in ARD at the regional levels and for their NARS through appropriate policies and strategies.

There is very little information available regarding NARS Institute level ICT and ICM governance structures. In India, the ICAR has developed ARIS cells at each of its Institute and in some State Agricultural Universities that link the national 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 and divisions that have at least some ICT governance function. The lack of 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.

At the regional level, the various research and development networks such as NACA, APHCA, APAN, APAARI and SAIC provide structures for sharing and exchange of agricultural information.

The report covers ICT applications and ICM in ARD in the following countries: Australia, Bangladesh, Bhutan, Cambodia, Fiji, India, Indonesia, Iran, Japan, Laos, Malaysia, Mongolia, Myanmar, Nepal, Pakistan, Papua New Guinea, Philippines, South Korea, Sri Lanka, Chinese Taipei, Thailand, Timor-Leste

and Vietnam. The country reports upon which this assessment is made are summarized.

Scientific and Technical Information

Scientific and Technical Information (STI) services offered in Agricultural Research Institutes of countries in the Asia-Pacific region are at the moment largely through "brick and mortar" libraries and information centers. In several countries, including Bangladesh, India, Indonesia, Iran, Malaysia, Pakistan and Vietnam, there are special Institutions and Centers that cater agricultural scientific and technical information services.

Out of the 15 countries Afghanistan, Bangladesh, Bhutan, Cambodia, Kiribati, Laos, Mongolia, Myanmar, Nepal, Papua New Guinea, Solomon Islands, Timor, Tokelau, Tuvalu and Vietnam eligible for AGORA in the Asia-Pacific region, only 8 had registered. This indicates either poor awareness or low capacity to use these services.

International Agricultural Research Institutes such as of the CGIAR in some cases provide access to STI services, especially when they are co-located with the NARS Institutes. However, Intellectual Property Rights (IPR) prevents many of these International Institutes to share STI with NARS Institutes and individual agricultural research scientists.

Several NARS have reported that they are developing "virtual libraries". Upon visit to their websites, while a few documents are available on-line on their websites, they can at best be considered as being very rudimentary as an "electronic/virtual" library.

Poor funding for libraries across all of the economically less developed countries in the region has led to, in general, limited access to quality scientific and technical information to scientists, extension agents, managers and policy makers. Poor funding also prevents generalized automation of libraries,

digitization of documents and electronic dissemination of scientific and technical information beyond the major Institutes within the NARS and with other Institutes within and outside the country.

Almost all member countries of APAARI publish agricultural research journals. Very few members indicate in their status reports that these journals are available on-line.

An emerging issue is the reduction in opportunities for agricultural scientists in the region to publish in international scientific journals. There are two main factors, Internet connectivity and costs associated with submitting the document. Most International journals now expect electronic versions to be submitted on-line which is not easy for authors as research Institutes in rural areas are poorly connected through e-mail and the web.

Research Data Management

The country papers indicate that all NARS use personal computers for managing research data. Some NARS indicate centralized research data management. Japan is working towards "Grid Networking" where data from distributed databases can be accessed throughout their research and development system. India has initiated a data warehousing and mining project in its agricultural research system.

The use of GIS is now almost commonplace in agricultural research and development such as land use planning and watershed management in the region, albeit at various levels of sophistication. Geographical Information Systems need data from multiple sources and this is indicative of collaborative data use at the NARS level. The application of GIS, however, remains at project rather than systems level. The application of computer models for use in agronomy, farming systems, precision agriculture and marketing and knowledge based

systems that induce collaborative use of data and information is emerging.

Sub-regional and regional initiatives can boost the use of these applications through improved collaboration for data sharing along common watersheds and littoral eco-regions. There are several agricultural research for development networks around commodities, themes and disciplines in the region. The use of ICT in data sharing and exchange, e-discussions and Communities of Practice is also emerging.

Similarly, common crop, climatological and other simulation model building, usually a very costly exercise, based on collaborative development and shared datasets such as of meteorology can enable use of "precision" agriculture techniques at National and Regional levels. There are indications that collaborative activities towards data sharing and applications are emerging across countries such as Japan and Korea and between Japan and Thailand.

While there are several research networks established under the International and Regional Organizations such as FAO and APAARI, very little is available in a documented form about how multi-disciplinary and multi-location data is shared within and across these networks. In many of these International and Regional Research Networks, there are goals such as of creating common centralized or distributed databases, models that use the data collected through networks for simulation, generating common data for geographical information systems and for use in knowledge based/expert systems etc. These data are to be collected, shared and or exchanged remotely through dedicated data networks or through the Internet. It is apparent that significant data and information management is needed at the operational level for these networks. Most information systems of the Networks are still centralized information systems with de-facto standards. There is very little evidence that the various research networks in the Asia-Pacific region have devised

methods, including standards and copyright regimes, for the exchange of data and information through their own information systems and databases. However, Japan has taken lead to develop tools such as "wrappers" to be used in grid networks for collaborative data use.

Research Networks within a NARS, in a region and those of an International nature benefits significantly from the use of electronic discussion lists (e-lists) and on-line "Communities of Practice" (COPs). The use of electronic discussion lists is emerging among researchers, managers and policy makers the region. These are also a new form of research-research, research-extension and research-extension-user community linkages. Apparently, access to Internet connectivity, language and culture is a limiting factor to the initiation and further development of e-lists and COPs in the region.

Research Management Information

Most NARS in the region are in the process of implementing or operationalizing Research Management Information Systems (RMIS) that suit their needs.

The benefits of an RMIS for the NARS not only are in managing research but also in the ability to cost outputs including technology generated from research projects. As new approaches, such as competitive grants, to ARD funding emerge, there will be a need to estimate research project costs more accurately. However, the implementation and what is termed "Institutionalization" of RMIS in the NARS of the region have been found not to be without problems that range from those related to infrastructure, operationalizing the RMIS, coordination and control of data and information flows and making use of information such as in priority setting for research, budgeting and fund allocation, and monitoring and evaluation as evidenced in Indonesia and Papua New Guinea.

Some countries like Sri Lanka and Indonesia initiated RMIS with modified versions of ISNAR's INFORM Research Management Information System. However, from their ICT Status reports in 2003, it appears that they have moved to indigenously developed RMIS. The lessons that can learned from this attempt to implement generic software applications is that it is difficult to implement these applications without adequate support and ability to customize it for NARS needs. But, this also brings heterogeneity in research management data structures in the region and may make it difficult in sharing research related information at the regional level. This information will be essential in the near future when the need for greater efficiency and effectiveness will be demanded from national agricultural research and innovation systems.

Outputs from an RMIS, such as information about NARS Institutes, Expertise, Research Programs and Projects, Project outputs including scientific papers, extension documents, technologies, processes etc. if shared through the Web and/or off-line media such as CD-ROMs and DVDs can bring greater effectiveness of research across the region. Some countries report that they contribute research project information to FAO's CARIS system. In case of the more technically developed countries of the region, these outputs, especially technologies, can bring commercial benefits as also establish IPR, which is emerging as a major issue, as in case of seed, in agricultural technologies and knowledge also.

APAARI, through the APARIS is developing and managing an Institutions, experts and research project database. It is developing an Regional Agricultural Expert Locator (RAEL) system to supplement this database.

There are several agricultural research and development networks operational in the region. Some are through the regional organizations such as ASEAN and SAARC, some are through multi-partite collaboration and others supported by

International donors and agencies that span regions according to commodities and eco-regions. The use of ICT to further enable, enhance and enlarge these networks and their communities is not very well documented.

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 Southeast 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.

Agricultural Education and Capacity Development

Asia boasts of the highest development of distance education in the world with India and China having millions of students formally registered in distance education courses and a large number of Open Universities. However, this is not reflected in distance learning in agriculture in these countries and the region.

There is very little information available on the use of ICT in open and distance agricultural education in the region. The document lists some of the initiatives and programs that use ICTs in open and distance learning in agriculture in the region. As is apparent from these initiatives there is a convergence between open and distance learning initiatives and agricultural extension through the use of ICT. There is a transformation occurring in agricultural extension with the shift towards not only providing information and expertise but also enabling learning at individual, household and community levels and in engendering and involving youth and the elderly in development, including that of agriculture.

The use of ICT in agriculture related learning and extension is creating an environment where "older" intermediaries such as extension agents are being replaced by "newer" intermediaries who have capacity to provide information services using ICT. These intermediaries, sometimes termed "infomediaries", have several typologies. Some provide connectivity through

tele-centers, public call offices, information kiosks etc. Some process global information to make it relevant to local use. Some are involved in the reverse process, making local information and innovations accessible globally. There is very little being done to build the capacities of these "infomediaries" to provide relevant agricultural information to user communities, which need not necessarily be farmers but could include extension agents, market intermediaries, input suppliers and consumers.

Organization and Management

The use of ICT in NARS offices of the region, especially the use of the personal computer, is now ubiquitous. Most NARS have implemented local area networks and computer based financial management and personnel information systems in their headquarters. However, within the NARS, the use of computers at the individual level is usually for word processing and presentation graphics even when LANs exist in the Institutes.

The linkage between the computerized financial management and personnel information systems and the Agricultural Research Management Information Systems in many NARS of the region is weak. This is also because of organizational structures and lack of data integration at the ICT applications' level in the NARS and its Institutions.

Apparently there is poor linkages between the various ICT enabled services, where they exist, for more integrated information flows for example between research and research management and STI services, between research management and financial and personnel management, between STI and extension and outreach information systems etc.

Even with improved connectivity the use of computer networks for enabling multi-disciplinary and multi-location research,

virtual sharing of research facilities, research management, extension and outreach and messaging and communication across NARS Institutes and with regional and International organizations and networks appear to be limited. Apparently, the weakness stems from the organization structures that need to adapt to new forms, such as being more flat and non-hierarchic, that use of ICT enables, lack of integration of ICT in the work processes of the NARS and lack of capacities, especially new skills in communication that the use of ICT entails. Organizational culture and structural changes are brought about by introduction of ICT and organization cultures and structures govern not only effective use of ICT but also the choice of ICT. Weak ICM at the Institute, NARS, NAIS and various other levels appears to be a central issue in most ARD organizations in the region.

While several NARS indicate centralized organizational structures for managing ICT and its use and ICM, this still remains an area of weakness when viewed with an overall regional perspective, especially as regards skills in network management, content generation and information management. The NARS are not able to retain quality staff for these information and ICT use related functions which are new to their systems.

While private sector organizations, comparably smaller in size than the NARS, have used ICT to their commercial advantage within the region, the NARS have been found to be lagging. This could be because the leadership of the NARS has not yet fully comprehended the implications of using ICT in agricultural research and development.

Messaging and Communication

Almost all NARS Headquarters and many of the outlying Institutes now have telephone and fax connectivity. However access to individual users, as in more economically developed

countries, may be limited to researchers and other users, especially those who do not hold supervisory positions.

While there is significant number of Research Institutes and Stations connected through e-mail and Internet, there are very few NARS Institutions other than the Headquarters with unlimited access to the Internet and even lesser numbers with "good" bandwidths (>64 kbps) in many countries. This bandwidth is essential for effective uploads and downloads of documents from websites, FTP sites and through e-mail.

Data from the AROW website indicates large increases in the number of ARD Institutional websites in Asia region from 2000 to February 2004. However, in a yet to be published study conducted ISNAR regarding information content of these websites, it was found that most of the websites of the NARS Institutes assessed did not follow HTML, CSS and Bobby standards. Not using established Internet/WWW standards for websites prevents universal access and will, in future, need major overhauling to integrate through use of technologies such as XML into regional and global information systems. The websites evaluated had very little information content for policy makers, managers, researchers, extension agents or farmers. Most websites were not regularly updated with some remaining as they were when first created. The lack of use of the Internet, especially the web, indicates that the NARS have yet to take advantage on new ICT either to publicize their capacities or their needs as also create a channel and medium to communicate with their clients and stakeholders including international development agencies and donors.

One of the common arguments in the use of new ICT in agricultural development is the lack of Internet connectivity to farmers. However, there is ample indication that cellular telephony and with it WAP and SMS as also wireless Internet services are creating connectivity opportunities in rural areas. Collaborative programs between Japan and Thailand through

APAN have provided proof of concept in distance education and multi-location farm research monitored from remote locations.

Taking into consideration only the NARS ICT platforms such as websites does not reveal the full vibrancy of ICT use for ARD in Asia. There are a very large number of Non-Government, civil society, community and farmer organizations information platforms in operation in the region. A NARS centric conceptual framework to assess ICT use and ICM falls short to reveal the full extent of ICT use and its vibrancy in the Asia-Pacific region.

Infrastructure

Many NARS indicate in their status reports that they have inadequate computer hardware and supporting infrastructure which in many cases include quality electricity needed to operate computers, local area networks and Internet connectivity. Similarly, some NARS indicate that their software needs remain unsatisfied. While some NARS report adequate trained staff to use ICT, a majority of them indicate that trained human resource with computer use, network administration and information management skills within the NARS remains a major problem. The NARS cannot retain trained and skilled staff who are attracted to better career prospects in the private sector.

The status (and many a times spectacular progress) of telecommunications infrastructure including Internet connectivity in each country is regularly (almost on annual basis) reported by many initiatives. However, these indices bear no relation to the state of rural telecommunications or Internet connectivity or to NARS connectivity. NARS Institutes and Research Stations are, by virtue of their activities, located in rural areas with limited telecommunications facilities.

Funding of ICT infrastructure appropriately appears to be a major bottleneck. ICTs, especially computer and network

hardware and software have very short useful life spans. When these are upgraded, new skills for their effective and efficient use are again required. Most governments and donors have either funded part of initial costs and do not include maintenance, repair and up-gradation costs as also operational costs including continued capacity development. This, again, is an issue of ICM. The need for planning total costs of operation of the entire ICT and information lifecycle, the use of open and free software etc. is not thoroughly looked at by most ARD Institutions because they lack organizational structures and capacities to do this.

As the ARD Institutions move towards operationalizing their new ICT enabled information systems, the cost of generating and integrating digital content to service the pluralistic needs of their vast array of clients with each requiring more customized information is expected to rise geometrically. The funding of these activities is not yet considered significantly by the ARD Institutions in the region.

Content Management

Most NARS in the region have content management policies. However, with limited content available on NARS websites or published in digital media, there appears to be a weakness in implementing and/or "institutionalizing" these content management policies.

ICT use needs to be integrated at the very basic content generation/management work process, information content and Institutional/Organizational structures so that ICT contributes effectively and efficiently to useful information flows and services in an organization. Content management also includes appropriate governance which includes policies, strategies, monitoring and evaluation and quality assurance. The publication of digital documents is only the tip of an Institutional "iceberg" of organization needed to make effective

and efficient use of ICT. Based on experience gained from ISNAR's activities in implementing INFORM, operationalizing ICT use in the NARS still faces problems in integrating ICT within the organization's processes.

Language for communication using ICT within countries and across the region is a severe handicap in sharing and exchange of information. The Internet, with its Anglophonic dominance limits information exchange within the region. South Asia and some countries in Southeast Asia, by their colonial past, have capacity at the policy maker, manager and scientist to communicate through English as a common language. However, there are countries that have capacity in French and, if China is included, Mandarin. At local user community level such as for extension agents, market intermediaries, farmers and consumers, language emerges as a great barrier to information sharing and exchange. Information and learning objects repositories, especially of audio, graphics and video and building local capacity in translating language are some solutions for sharing and exchanging information. Regional organizations can provide the infrastructure and support for the repositories and coordinating translation activities. This is a major content management challenge in the region.

Regional Information Networks

The region has many ARD networks and organizations such as APARIS, e-NACA, APHCA and APAN which focus on information sharing and exchange around agricultural disciplines, themes, eco-regions, commodities, major watersheds, connectivity, etc.

The common learning from information sharing and exchange activities of these networks is:

a) Data and information are collected mainly from library collections, published literature, government and research

survey data, internal management data, and personal communication

b) Isolated databases on specific topics exist with little integration

c) There is poor common understanding of the purpose of data and information collection by the networks

d) There is little awareness across the NARS of these networks

e) Availability and accessibility of databases are limited

f) Data and information collected is under utilized

g) Databases are not regularly updated or regular maintained

h) A wide variety of software is utilized to create databases

i) No common or compatible information handling methods and tools exist

j) There is little information exchange or networking

k) Users of the existing databases are mainly researchers, followed by teachers and students, extension personnel, managers and planners, and farmers

l) There is ineffective communication and presentation of the information by the networks

m) There is limited capacity of national programmes to partner in information generation and dissemination of information.

n) Most National participants are primarily clients than partners

o) E-mail in ARD Institutes is used mainly as a central mail box constraining individual usage

p) Multiplicity of major Asian languages is a difficult technical, management and cost issue.

Conclusions

There is great heterogeneity in ICT use and ICM for ARD in the region. The heterogenic use of ICT in ARD in the Asia-Pacific region emerges from:

- Lack of clear policies
- Lack of capacity
- Lack of appropriate technologies and models to use ICT for ARD in the region
- The differential capacities in the NARS of the Region to cope with the rapid transformation of ARD Information Services

While the Asia-Pacific region has seen significant development in ICT use and ICM for ARD there is still remains major information gaps on the status of ICT use in ARD in the Asia-Pacific region. There is no formal effort to evaluate this status. There is also no widely accepted framework that can enable an objective assessment and monitoring of ICT use in ARD in the Asia-Pacific region. An assessment and continued monitoring is vital as the potential of using ICT in agriculture and rural development is now universally recognized.

The common issues that emerge at NARS level in enabling ICT use in ARD based on discussion held in the APAARI Expert Consultations in 2000, 2002 and 2003 are:

- How to prioritize ICT use in ARD for maximum effectiveness?
- What should be the strategy?

The principal role of ICT in ARD is to integrate information content to satisfy the needs of agricultural communities and participants in agricultural commodity chains, connecting people who generate and use innovations and enable learning at individual, household and community levels. The use of ICT

also enables breaking of conventional Institutional, geographical, disciplinary, commodity and similar boundaries in the exchange and sharing of information, knowledge, skills and resources. The use of ICT enables "glue" the NARS by strengthening existing linkages and bringing new forms of linkages. They are also enabling evolution of "agricultural innovation systems" at various levels and in replacing the current NARS centric approaches in ARD and giving rise to something new in sharing and exchanging innovations globally. Regional collaboration and cooperation for ICT management and ICM hold great promise in contributing to agricultural development in the region.

I. INTRODUCTION

Agriculture is vital to the Asia-Pacific region. It is the mainstay of the economy of many countries in the region. Nearly 60% of its population derives its livelihood from agriculture. The region is a hot spot for rural poverty. Most farmers in the region are smallholders with diverse farming systems which are highly risk prone. These farmers have inadequate support services such as extension and poor access to markets and financial credit. Obviously, a second "green" revolution is needed not only to produce more food in the region but to enable participation of its farmers more equitably in markets, reduce poverty, generate more rural livelihoods and maintain quality of life and environment.

The potential of Information and Communications Technologies (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 ICTs 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 as also share innovations globally.

The ARD Institutions of this region play a nodal role as source of agricultural technologies and generation of agriculture related scientific and technical information. The National Agricultural Research Systems (NARS) are the most important repositories of information and knowledge about agriculture and form the tangible backbone of agricultural knowledge and information systems (AKIS) in their respective countries and, through collaboration, in the region. However, very little is known of the capacity of agricultural research for development (ARD) Institutions of different countries of the Asia-Pacific region to

use new ICT, especially computers and the Internet, in agricultural information management and communication.

The various in-country indicators of digital, networked and e-readiness such as by Economist Intelligence Unit and IBM (2004) do not indicate and are not useful to evaluate status of ICT use in agricultural research for development (ARD) Institutions in Asia-Pacific countries. Knowing the status of ICT use in NARS is essential to develop appropriate policies and strategies for effective use of ICT for ARD at country level and in the region.

This document reviews and presents the status of ICT use in NARS in the Asia-Pacific region. Its data and information is based ICT Status documents presented by National Information Nodal Points (NINPs; NARS representatives) in the region at two expert consultation in 2000 and 2003 and detailed surveys for ICT status and information needs assessment organized by the Asia-Pacific Association of Agricultural Research Institutions (APAARI) in 2002 and 2002, various country status papers presented in the iNARS Workshop on "Developing a Framework for ICT use in NARS" in 2002, Asian Productivity Organization's Study Meetings and Seminars at Delhi, India in 2002 and Yogyakarta, Indonesia in 2003 and the CTA Observatory on "ICT: Transforming Agricultural Extension" in 2003 as also documents available on the Internet, especially websites of ARD Institutions of the region. To evaluate the status of each country, it uses a framework developed by Tugrul and Maru (2003) and tested in evaluating the ICT infrastructure and use in ARD in Georgia.

Conceptual Framework

ICTs for ARD are considered as radio, television, telephony, fax, computers and the Internet. The framework introduced in this document is used to assess the status of ICT use and Information and Communication Management (ICM) in the

NARS of different countries in the Asia-Pacific region. It bases this assessment on the concept of a National Agricultural Information System (NAIS). The NAIS, similar to the NARS, is considered a "system" that organizes and manages the flow and use of information related to agricultural research and development at the National level. In most situations in the Asia-Pacific region, the NAIS may be equated to the information management system of the NARS. Its constituents, such as its actors, stakeholders and clients are also similar to those of the NARS.

National Agricultural Information Systems

The conceptual basis of a NAIS, as stated above, has its foundations on the concept of a NARS. This is a system that brings structure and organization to agricultural research and development at the National level of a country. This concept has evolved over the last forty or so years. It considers the mainly public sector agricultural research in the South Countries to be organized under a central command structure. In each country the NARS manages financial, human and information resources and assets to meet the overall national objectives, through research and development, for agriculture. The NARS, as a concept, consists of public agricultural research and development Institutions, Universities, Non-Governmental Organizations (NGOs) and, has over a period of time, been expanded to include the private sector as also public-private and the emerging public-private-community partnerships in agricultural development.

Each NAIS has structures that enable and enhance ICT use and information and communication management (ICM). These structures are both formal and informal. These include policies, strategies, regulations, rules etc. and organizational structures such as communication patterns, reporting relations, reward systems and accountability among others. These structures support the various information related processes to be effective and efficient in the NARS organization.

One of the ways to describe ICT use and ICM processes in a NAIS is to describe the information services provided to users by the NAIS, the applications of ICT that support the information service, the management of source and flow of information content through the ICT enabled services and the ICT related physical (hardware, software, connectivity) infrastructure that is needed to provide the services. Included in this framework are the management structures that govern the NAIS through formulation of appropriate policies, strategies and resources allocation for its functions, administration and growth.

ICT use and ICM Assessment Framework

Assessing ICT use and ICM in a NAIS would therefore be an assessment of:

a) Policies and strategies related to ICT use

b) ICT/ICM governance structures

c) The information services the NAIS provides and availability of and capacity to generate information content for the services

d) The ICT infrastructure that supports the information services.

The indicator information services are assessed collectively at the NAIS/NARS level for the Asia-Pacific region in this document. They are related to the following main 7 areas of NARS activities:

a) Scientific and Technical Information

b) Research Data Management, especially in applications of collaborative data use such as in models, Geographical Information Systems and Knowledge Based/Expert Systems

c) Research Management Information

d) Extension and Outreach Information including Market related information

e) Distance and Open Education

f) Organization and Management

g) Messaging and Communication which included use of telephones, Fax, E-mail and Internet

This framework for assessment is illustrated in Figure 1.

Figure 1: Framework for assessing ICT use and ICM in a NAIS

MANAGEMENT	Infrastructure	Hardware	Electricity, Housing, Telephone, Fax Computer, Audio, Video Equipment, Peripherals, Radio Studio and Broadcast Facility, TV Studio and Broadcast, Network Equipment
		Software	Operating Systems, Office Suites, Application Software, Utilities
		Skills	User, Systems Administration, Content Generation, Information and Communications Management
		Connectivity	LAN, WAN/VPN, Internet, "Plain Old" Telephony, Cellular Telephony
	Content	Scientific and Technical	Indexes and Catalogues, Research Journals and Published Document, Grey Literatures
		Research Data	Databases
		Research Management	Information on institute, projects, experts, outputs
	Applications	Scientific and Technical Information System (STIS)	Management of Procurement, Cataloguing, Circulation of Hard and Electronic Copies; Inter-library Loans, Web-based on-line search and access, Virtual Libraries
		Research Database Management System (RDMS)	Management of Personal, Institutional and Networked Research Database

Figure 1: *(continued)*

MANAGEMENT	Applications	Research Management Information System (RMIS)	Management of Institutes, Research Programs, Projects, Outputs and Experts Information
		Extension and Outreach Information System (EOIS)	Management of Information Needs of Extension Agents, Farmer, Rural Entrepreneurs etc.
		Education Information System (EIS)	Management of On-Campus and Distance Education; Supporting educational courses, Learning Objects repositories
		Organization Management and Administration Information System (OMAIS)	Financial. Personnel, Farm and Research Inventory Management
		Messaging & Communication System (MCS)	Managing connectivity for Telephone and Fax network, LAN, WAN/VPN, Internet
	Services	Scientific and Technical Information Services	On-line access to indexes and Catalogues; Selected Dissemination of Information, Current awareness Service, On-line Full Text access, Virtual Library
		Research Data and Information	Research Databases. GIS, Weather and Crop Models, Expert Systems
		Research Management Information Service	Institute, Program, Project, Expert, Output Information
		Extension, Outreach and Market Information Services	On-line documents, Current information, FAQs, Help Desks, Market information databases, Decision Support Systems
		Educational Information Services	Courseware and Educational resources
		Organization and Management Information Services	On-line accounting, personnel & administration help desks
		Messaging and Communication Services	Telephone Directories, E-mail Post Box, Intranet and Internet access and Directories, Yellow Pages, E-Lists, Community of Practices

The clients for the information services are identified as:

- Policy Makers
- Research and Development Managers
- Scientists, Teachers and Students
- Extension Agents
- Input Suppliers and Market Intermediaries
- Financial and Marketing Organizations
- National and International Donor and Development Agencies
- Non-Governmental Organization, Community Based Organizations and Farmer Organizations
- Farmers
- Consumers

Each of the clients has a different portfolio of information services and within each service the need for content. Many clients are also producers of information.

The data and information from the APAARI Survey, Status reports presented by NINPs at APARIS expert consultations and papers presented at the various regional and international workshops and conferences and data collected from the Internet were organized as per the above framework for assessing the status of ICT use and ICM in the NARS of each country of the region. The papers from APAARI consultations are included as annexure to this document. The papers of other workshops and conferences are available either at websites or through requests to the respective organizations.

II. NATIONAL AND REGIONAL POLICIES FOR ICT IN AGRICULTURAL RESEARCH FOR DEVELOPMENT

National Policies

Table 2 summarizes the status of National policies related to ICT use in agriculture. The source for this information has been through the country status reports presented by the NINPs and an extensive list of documents available on the Internet for each country in the region.

Table 2: Policies and Strategies related to ICT use in Agriculture in the Asia-Pacific Region

Country	Telecommunication Policies include ICT use in Agriculture and Rural Development	Agricultural Policies include use of ICT for development
Australia	Yes	Yes
Bangladesh	Yes	Yes*
Cambodia	Yes	?
Fiji	Yes	?
India	Yes	Yes*
Indonesia	Yes	Yes*
Iran	Yes	Yes*
Japan	Yes	Yes
Laos	Yes	Yes*
Malaysia	Yes	Yes
Mongolia	Yes	Yes*
Myanmar	Yes	Yes*
Papua New Guinea	Yes	Yes
Pakistan	Yes	Yes*
Philippines	Yes	Yes*
South Korea	Yes	Yes
Sri Lanka	Yes	Yes*
Taiwan	Yes	Yes
Thailand	Yes	Yes*
Vietnam	Yes	Yes*

* In most of these countries, the policy and strategy for ICT use for agricultural and rural development is not well documented.

Almost all countries in the region have national telecommunications policies which indicate that ICTs would be used for rural, including agricultural, development. However, in most cases, the details of how this is to be achieved and the strategy to be adopted are not clear. The more technologically advanced countries in the region such as Australia, Japan, South Korea and Taiwan in the past few years have elucidated and implemented their policies by improving telecommunications infrastructure, especially by providing broad band Internet connectivity, in their rural areas. In other countries, the focus on how to bridge the "digital divide" is still under debate. The rapid advances in cellular telephony and wireless Internet technologies and reduction in costs now make this bridging very feasible, yet these advances, by its variety of options, also 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 being assured, useful and relevant information content will not be generated.

Agricultural policies of most countries in the Asia-Pacific region, though indicating use of ICT, lack clarity on how ICTs are to be used in ARD. For the more industrially and economically developed countries in the region, farming is of minor economic importance. Rural connectivity is primarily for social reasons, especially since the rural population is aged and individuals need to be connected to urban areas for this reason. For the less economically developed, rural telecommunications have economic, social and political implications. 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 high and commercially supposed to be unviable at the moment. The fountainhead of all economic activities in

the rural areas of the less economically developed countries of the region is farming 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, Philippines and Thailand, are experimenting with the approach to connect communities through public information access points (PIAPs) which include the use of information kiosks, tele-centers, public call offices and Internet cafes and low cost computers and handheld devices such as the Simputer. These PIAPs are operated through public, private, community, public-private and public-private-community partnerships. India, as an example, intends to provide such connectivity to all its 500,000 villages by 2008 (Ingale, 2003). Defining these strategic approaches require 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 the Asia-Pacific region.

National telecommunication and agricultural policies affect NARS and NAIS at various levels starting from investments in infrastructure and skills development, content generation and dissemination, application of ICTs 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 ICTs in agricultural research and development.

Regional Policies

Regional organizations, such as ASEAN and SAARC, have realized the importance of ICT enabled agricultural information systems. ASEAN has an E-Farmers program (Mahendra, 2003) and SAARC has developed a SAARC Agricultural Information Centre (SAIC) at Dhaka, Bangladesh (Rikabder, 2002). APAARI, FAO (Riggs, 2000) and several other regional networks also have information systems that support ARD in the Asia-Pacific region. However, there still remains a vital need to sensitize and build capacity among policy makers and senior ARD managers to enable them to play a defining role for enabling and enhancing effective ICT use in ARD at the regional levels and for their NARS through appropriate policies and strategies.

III. GOVERNANCE STRUCTURES FOR ICT/ICM IN ARD

The NARS structure varies in the region. Countries like Bangladesh (Razzaque, 2000; Rikabder, 2002), India (Alam, 2000; Jain, 2003), Indonesia (Soedjana, 2003a, 2003b) Malaysia (Saadan, 2000), Nepal (Basnet, 2000) and Pakistan (Chaudhary, 2000) have public sector central "command and control" type of NARS organizations. Some countries like Thailand (Paiboonrat, 2000) and Vietnam (Son, 2002) have government ministries and departments that have agricultural research and development responsibilities. In some countries, such as Korea (Shim, 2003) and Laos (Phanh, 2003), agriculture research is organized under the Agricultural Research Institutes model.

NARS ICT/ICM governance structures reflect the NARS structures in their heterogeneity. In India, as an example, the

central ICT/ICM governance structure is the Agricultural Research Information System (ARIS) of the Indian Council of Agricultural Research (ICAR) (Alam, 2000; Jain 2003). In Malaysia, Malaysian Agricultural Research and Development Institute (MARDI) provide the central governance structure (Saadan, 2001). Similarly, Thailand and Vietnam are enabling an information exchange network for its Ministry of Agriculture and Cooperatives (MOAC) (Paiboonrat, 2000) and Ministry of Agriculture and Rural Development (MARD) (Son, 2002) respectively. Vietnam has specific Information Center for Agricultural Research and Development (ICARD). Taiwan organizes its agricultural information services under direction of the Council of Agriculture (Lin, 2000). Korea has an ARIS model for governance of ICT enabled agricultural information systems. In some countries, such as the Philippines (Malicsi, 2002; Faylon, 2003), the governance structures for research and extension are divided under different organizations. Several countries in the region do not yet have a governance structure for ICT enabled information systems/services.

There is very little information available regarding NARS Institute level ICT and ICM governance structures. The ICAR has developed ARIS cells at each of its Institute and in some State Agricultural Universities that link the national ARIS (Jain, 2003). In Malaysia, MARDI provides the governance structure for agricultural research and development information (Saadan, 2000).

Most research institutions in the NARS of each country in the region have computer cells, departments and divisions that have at least some ICT governance function. The lack of 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.

At the regional level, the various research and development networks such as NACA (Bueno, 2000), APHCA (Riggs, 2000)

and regional networks such as APAN (Ninomiya, 2000), APAARI (APAARI, 2000, 2002, 2003) and SAIC (Rikabder, 2002) provide structures for sharing and exchange of agricultural information.

IV. INFORMATION SERVICES IN ARD

IV.1. Scientific and Technical Information

Scientific and Technical Information (STI) services offered in Agricultural Research Institutes of countries in the Asia-Pacific region are at the moment largely through "brick and mortar" libraries and information centers. In several countries, including Bangladesh (Ahmed, 2003), India (Alam, 2000), Indonesia (Soedjana, 2003a), Iran (Gharedagli, 2000), Malaysia (Saadan, 2003), Pakistan (Chaudhary, 2000) and Vietnam (Son, 2002), there are special Institutions and Centers that cater agricultural scientific and technical information services.

Library automation is the starting point and critical to ICT use for scientific and technical information services. Library automation to provide access to electronic catalogues and services such as Current Awareness Services (CAS) and Selected Dissemination of Information (SDI) is now becoming commonplace in the main NARS Institutes in many countries in the region. This enables even remote research stations to access scientific information strengthening within NARS linkages.

Table 3 indicates the country wise status of library automation and existence of NARS Library Networks in the Asia-Pacific Region.

Many of the NARS Institutions have or are developing capacities to provide on-line access to bibliographic catalogues and full texts to their clients on LANs and through the Internet. Several countries, including India, Indonesia, Malaysia and Sri Lanka, are developing "electronic" and "virtual libraries.

Table 3: Status of Library automation and existence of NARS Library Networks in the Asia-Pacific Region

Country	Library Automation in NARS	NARS Library Network
Australia	Yes	Yes
Bangladesh	?	No
Cambodia	?	No
Fiji	Yes	?
India	Partial	Partial
Indonesia	Partial	Planned
Iran	Partial	Planned
Japan	Yes	Yes
Laos	Partial	Planned
Malaysia	Yes	Yes
Mongolia	?	?
Myanmar	?	No
Papua New Guinea	Yes	?
Pakistan	Yes	Yes
Philippines	Partial	?
South Korea	Yes	Yes
Sri Lanka	Yes	?
Taiwan	Yes	Yes
Thailand	Yes	Yes/?
Vietnam	Partial	?

Table 4 lists the more prominent agricultural scientific and technical information sources that are accessed by most of the NARS in the region.

Out of the 15 countries Afghanistan, Bangladesh, Bhutan, Cambodia, Kiribati, Laos, Mongolia, Myanmar, Nepal, Papua New Guinea, Solomon Islands, Timor, Tokelau, Tuvalu and Vietnam eligible for AGORA in the Asia-Pacific region, only 8 had registered (AGORA, 2004).

Table 4: Major Sources and Initiatives of Agricultural Scientific and Technical Information Sources in the Asia-Pacific Region

Initiative	Description
AGRIS	AGRIS is the international information system for the agricultural sciences and technology. It was created by the Food and Agriculture Organization of the United Nations (FAO) in 1974, to facilitate information exchange and to bring together world literature dealing with all aspects of agriculture. AGRIS is a cooperative system in which participating countries input references to the literature produced within their boundaries and, in return, draw on the information provided by the other participants. To date, 240 national, international and intergovernmental centers participate from all over the world.
AGRICOLA	**AGRICOLA** (**AGRIC**ultural **O**nLine **A**ccess) is a bibliographic database of citations to the agricultural literature created by the National Agricultural Library (NAL) and its cooperators. Production of these records in electronic form began in 1970, but the database covers materials in all formats, including printed works from the 15th century. The records describe publications and resources encompassing all aspects of agriculture and allied disciplines, including animal and veterinary sciences, entomology, plant sciences, forestry, aquaculture and fisheries, farming and farming systems, agricultural economics, extension and education, food and human nutrition, and earth and environmental sciences. Although the AGRICOLA database does not contain the materials, thousands of AGRICOLA records are linked to full-text documents online, with new links added daily. AGRICOLA is searchable on the World Wide Web.
AGORA – Access to Global Online Research in Agriculture	The AGORA site provides free access to more than 500 journals from major scientific publishers in the fields of food, agriculture, environmental science, and related social sciences. AGORA is available to students and researchers in qualifying not-for-profit institutions in eligible developing countries, over half of which are in Africa. More information can be obtained from: agora@fao.org.

Table 4: *(continued)*

Initiative	Description
CABi	CAB International is a 90 year old, Inter-Governmental, not for profit organization that provides scientific and technical information support to the Anglophonic Southern countries. CABI maintains a bibliographic database (CAB ABSTRACTS) covering a wide range of topics in agriculture, natural resource management and rural development which is accessible through various products (Internet, CD, printed). The database comprises over 4 million records, and over 7,000 journals and technical report series are scanned each year from which around 180,000 records are added to the database. Subsets are also available through other initiatives such as AGORA. CABI is developing a range of compendia, encyclopaedic multi-media tools that bring together scientific information from diverse sources to give in-depth coverage of a particular topic. The compendia are available on CD and the internet, and the development of each is sponsored by a development consortium.
electronic Journals Delivery Service (eJDS) Programme	The electronic Journals Delivery Service (eJDS) Programme is geared to facilitate free access to current scientific literature. The goal is to distribute individual scientific articles via email to scientists in institutions in Third World countries that do not have access to sufficient bandwidth to download material from the Internet in a timely manner and/or cannot afford the connection. Providing scientists with current literature will support their ongoing research.
Global Development Network (GDN) – Free Journal Access Portal	GDN supports and links policy research institutes from 11 regions and more than 100 countries. GDN fosters research and knowledge sharing. GDN offers a range of journals services to address the difficulty faced by many researchers in the global south in accessing journal articles to support their research.

Table 4: *(continued)*

Initiative	Description
International Network for the Availability of Scientific Publications (INASP)/ Programme for the Enhancement of Research Information (PERI)	This network provides access to scientific and scholarly information through electronic means. It includes more than 10,700 full-text on-line journals, current awareness databases, and document delivery of major scientific, technical, medical, social science, and humanities materials from a wide range of sources. More information can be obtained from: inasp@inasp.info.
TEEAL – The Essential Electronic Agricultural Library	TEEAL is a full-text and bibliographic CD-ROM library of more than 140 of the world's most important scientific journals in the field of agriculture. It is available well below cost to more than 100 of the lowest-income food-deficit countries, as listed in the World Bank's 1998-99 *World Development Report.* More information can be obtained from: gracian@cyberplexafrica.com.
TROPAG/Rural	The Royal Tropical Institute publishes TROPAG & RURAL. TROPAG contains abstracts from literature on the developing rural areas of Africa, Asia, the Pacific and the Americas. The TROPAG database has over 5,000 journals and relevant literature on agricultural development, crop cultivation, animal husbandry, forage and pasture, forestry, post-harvest operations, farming systems and environmental management in the tropical regions from 1975 onwards are covered. The RURAL database covers social and economic development in rural areas of developing countries from 1985 to 1994.

Internet access to scientific and technical literature in the region is now available through NARS Institute libraries particularly of the Universities and at Institutes located in capital cities, large towns or at NARS Headquarters. However, available bandwidth, and, in some cases, cost as also user skills in searching agriculture related literature limit effective use of the Internet as a source of internationally available agricultural STI. Apparently, poor or total lack of or the cost of Internet connectivity and access is a limiting factor in its generalized use in the NARS Institutes and, more so, by individual users located at outlying and remote Institutes and Research Stations away from the Headquarters of several low income countries in the region. Lack of widespread awareness of availability of STI through Internet from sources such as of those listed in Table 4 also limits Internet use.

International Agricultural Research Institutes such as of the CGIAR in some cases provide access to STI services, especially when they are co-located with the NARS Institutes. However, Intellectual Property Rights (IPR) prevents many of these International Institutes to share STI with NARS Institutes and individual agricultural research scientists.

Several NARS have reported that they are developing "virtual libraries". Upon visit to their websites, while a few documents are available on-line on their websites, they can at best be considered as being very rudimentary as an "electronic/virtual" library. This reporting could be an error in defining a "virtual" library.

Poor funding for libraries across all of the economically less developed countries in the region has led to, in general, limited access to quality scientific and technical information to scientists, extension agents, managers and policy makers. Poor funding also prevents generalized automation of libraries, digitization of documents and electronic dissemination of scientific and technical information beyond the major Institutes

within the NARS and with other Institutes within and outside the country.

Almost all member countries of APAARI publish agricultural research journals. Very few members indicate in their status reports that these journals are available on-line.

An emerging issue is the reduction in opportunities for agricultural scientists in the region to publish in international scientific journals. There are two main factors, Internet connectivity and costs associated with submitting the document. Most International journals now expect electronic versions to be submitted on-line which is not easy for authors as research Institutes in rural areas are poorly connected through E-mail and the Web.

IV.2. Research Data Management

The country papers indicate that all NARS use personal computers for managing research data. Some NARS indicate centralized research data management. Japan is working towards "Grid Networking" (Ninomiya, 2003) where data from distributed databases can be accessed throughout their research and development system. India has initiated a data warehousing and mining project in its agricultural research system (Jain, 2003).

The use of GIS is now almost commonplace in agricultural research for development such as land use planning and watershed management in the region, albeit at various levels of sophistication. Geographical Information Systems need data from a multiple sources and this is indicative of collaborative data use at the NARS level. The application of GIS however remains at project rather that systems level. The application of computer models for use in agronomy, farming systems, precision agriculture and marketing and knowledge based systems that induce collaborative use of data and information is emerging.

Sub-regional and regional initiatives can boost the use of these applications through improved collaboration for data sharing along common watersheds and littoral eco-regions. There are several agricultural research for development networks around commodities, themes and disciplines in the region. The use of ICT in data sharing and exchange, e-discussions and Communities of Practice is also emerging.

Similarly, common crop, climatological and other simulation model building, usually a very costly exercise, based on collaborative development and shared datasets such as of meteorology can enable use of "precision" agriculture techniques at National and Regional levels. There are indications that collaborative activities towards data sharing and applications are emerging across countries such as Japan and Korea and between Japan and Thailand.

While there are several research networks established under the International and Regional Organizations such as FAO and APAARI, very little is available in a documented form about how multi-disciplinary and multi-location data is shared within and across these networks. In many of these International and Regional Research Networks, there are goals such as of creating common centralized or distributed databases, models that use the data collected through networks for simulation, generating common data for geographical information systems and for use in knowledge based/expert systems etc. These data are to be collected, shared and or exchanged remotely through dedicated data networks or through the Internet. It is apparent that significant data and information management is needed at the operational level for these networks. Most information systems of the Networks are still centralized information systems with de-facto standards. There is very little evidence that the various research networks in the Asia-Pacific region have devised methods, including standards and copyright regimes, for the exchange of data and information through their own information systems and databases. However, Japan has taken

lead to develop tools such as "wrappers" to be used in grid networks for collaborative data use.

A major area in ARD is the development of Bioinformatics. The Rice Genome Project indicates the direction for collaboration that is emerging in this area. One of the most important needs has been food and Biosafety information sharing including Specific Pathogen Free standards applied in the region.

Research Networks within a NARS, in a region and those of an International nature benefits significantly from the use of electronic discussion lists (e-lists) and on-line "Communities of Practices" (COPs). The use of electronic discussion lists is emerging among researchers, managers and policy makers the region. These are also a new form of research-research, research-extension and research-extension-user community linkages. Apparently, access to Internet connectivity, language and culture is a limiting factor to the initiation and further development of e-lists and COPs in the region.

IV.3. Research Management Information System

Most NARS in the region are in the process of implementing or operationalizing Research Management Information Systems (RMIS) that suit their needs. Table 5 lists countries that have reported planning or implementation of some form of an RMIS.

The benefits of an RMIS for the NARS not only are in managing research but also in the ability to cost outputs including technology generated from research projects. As new approaches, such as competitive grants, to ARD funding emerge, there will be a need to estimate research project costs more accurately. However, the implementation and what is termed "Institutionalization" of RMIS in the NARS of the region have been found not to be without problems that range from those related to infrastructure, operationalizing the RMIS, coordination and control of data and information flows and making use of

Table 5: Status of RMIS Implementation in NARS of Asia-Pacific Region

Country	Research Management Information System
Australia	Yes
Bangladesh	Yes (under implementation)
Cambodia	Planned
Fiji	Yes
India	Yes
Indonesia	Yes
Iran	Yes
Japan	Yes
Laos	Partial
Malaysia	Yes
Mongolia	?
Myanmar	?
Papua New Guinea	Yes
Pakistan	Yes
Philippines	Yes
South Korea	Yes
Sri Lanka	Yes
Taiwan	Yes
Thailand	Yes
Vietnam	Partial

information such as in priority setting for research, budgeting and fund allocation, and monitoring and evaluation as evidenced in Indonesia (Soedjana, 2003b) and Papua New Guinea (Powesu, 2001).

Some countries like Sri Lanka (Pieris, 2000; Padmini, 2003) and Indonesia (Soedjana, 2003b) initiated RMIS with modified versions of ISNAR's INFORM Research Management Information System. However, from their ICT Status reports in 2003, it appears that they have moved to indigenously developed RMIS. The lessons that can learned from this attempt to implement generic software applications is that it is difficult

to implement these applications without adequate support and ability to customize it for NARS needs. But, this also brings heterogeneity in research management data structures in the region and may make it difficult in sharing research related information at the regional level. This information will be essential in the near future when the need for greater efficiency and effectiveness will be demanded from national agricultural research and innovation systems.

Outputs from an RMIS, such as information about NARS Institutes, Expertise, Research Programs and Projects, Project outputs including scientific papers, extension documents, technologies, processes etc. if shared through the web and/or off-line media such as CD-ROMs and DVDs can bring greater effectiveness of research across the region. Some countries report that they contribute research project information to FAO's CARIS system. In case of the more technically developed countries of the region, these outputs, especially technologies, can bring commercial benefits as also establish IPR, which is emerging as a major issue, as in case of seed, in agricultural technologies and knowledge also.

APAARI, through the APARIS is developing and managing an institutions, experts and research project database. It is developing a Regional Agricultural Expert Locator (RAEL) system to supplement this database (APAARI, 2003).

There are several agricultural research and development networks operational in the region. Some are through the regional organizations such as ASEAN and SAARC, some are through multi-partite collaboration and others supported by International donors and agencies that span regions according to commodities and eco-regions. The use of ICT to further enable, enhance and enlarge these networks and their communities is not very well documented.

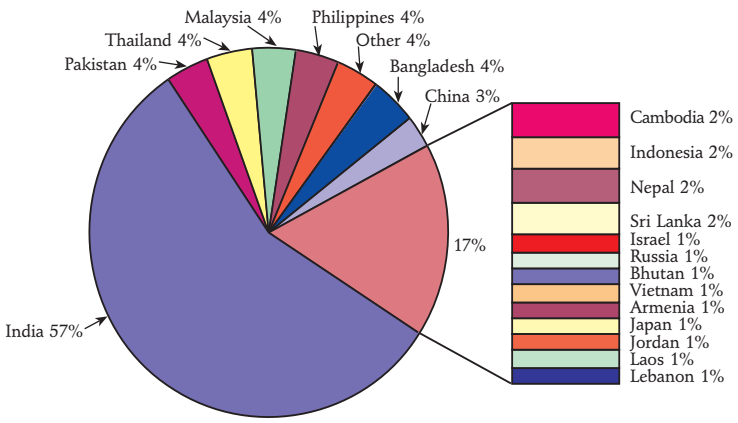
IV.4. Extension, Outreach and Market Information

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 55 percent of all ICT enabled rural initiatives in the region in that country (Figure 2).

Table 6 lists representative examples of Global and ICT enabled initiatives in the Asia-Pacific region for agricultural development.

Figure 2: ICT Enabled Initiatives in Rural Development[1] in the Asia-Pacific Region



[1] From Digital Dividend Website.

Table 6: Examples of ICT enabled initiatives for Agricultural Development

Title	Description
Farm forums	Farm forums began in Canada in the 1940s and have been used to reach large audiences in e.g., 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. But where the latter used a transmissionist, top-down, deficit 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 locally determined 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 tightly-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, e.g., India, Tanzania, Botswana, and Zambia.
CGIAR Learning Resource Centre (CGLRC)	The CGLRC (www.knowledgebank.irri.org/cglrc) provides CGIAR learning resources in standardized electronic 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

Table 6: *(continued)*

Title	Description
	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 IFPRI 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. ISNAR's training approach involves interactive, action-oriented learning and group work grounded in work contexts. ISNAR's Learning Team offers programs and communities-of-practice for research program managers and plans to introduce e-learning courses.
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

Table 6: *(continued)*

Title	Description
	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 Agroforestry Center (ICRAF)	ICRAF (www.worldagroforestrycentre.org) is concerned with raising awareness and providing training in agroforestry 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 for 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

Table 6: *(continued)*

Title	Description
	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 and the International Livestock Research Institute in South Asia. This coalition shares information, knowledge and skills related to climate literacy, drought preparedness, best practice in dryland agriculture and other issues through ICT and distance learning. VASAT offers a compilation of training materials and is currently planning to design, develop and test ICT-based information exchange models and a Learning Objects Repository, and to link rural communities and their organizations with international and national centres of excellence and expertise in drought and desertification management. It will do this in collaboration with the CG IARCs, CGIAR partners such as FAO, Commonwealth of Learning (COL) and NARES, Intermediary Organizations and the rural communities and it will adopt a common approach with the proposed CGIAR ICT-KM and learning projects.
Agricultural Knowledge and Information System (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 website covers such topics as livestock and animal resources, fisheries and aquaculture, crops, markets and agribusiness, producer organizations and irrigation and drainage.
All India Radio Farm School Program	This program began in the 1960s, had considerable success and reached many thousands of smallholders. The programs were

Table 6: *(continued)*

Title	Description
	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 contextualized with the help of the studio guests. The communities were also encouraged to develop their own websites and produce content that could then be hosted on the station's server. Users included local farmers and producers.
Tamilnadu Agricultural University (TNAU)	The TNAU Directorate of Extension Education was one of the pioneers in distance education to help farmers, farm 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

Table 6: *(continued)*

Title	Description
	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 Univeristy (YCMOU) Extension, Community Education and Non-qualification programs	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 Technology Project being implemented with World Bank assistance by the India Ministry of Agriculture. 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-centred decision-making.
NAARM Virtual Learning Centre (VLC)	VLC is a pilot site of the National Academy of Agricultural Research Management in

Table 6: *(continued)*

Title	Description
	Hyderabad, Andhra Pradesh, designed to build the capacity of India's National Agricultural Research System (NARS) in Research Management by providing on-line, 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 of the courses are designed by the faculty of NAARM to facilitate easy learning and interaction.
M.S. Swaminathan Research Foundation	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.

Table 6: *(continued)*

Title	Description
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-groups	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, agricultural extension etc. It is probably the largest agriculture and rural development professional network in the world It has over 9,000 members, 75 chapters, 400 NGO partners, and 110,000 farmers sign ups 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.

Table 6: *(continued)*

Title	Description
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 middlemen, 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 Tamilnadu 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 Centres	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

Table 6: *(continued)*

Title	Description
	and export local crops. EDC provides Multichannel Learning Centres, 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.
Asia-Pacific Regional Technology Centre (APRTC)	agLe@rn (www.aprtc.org/agLe@rn) 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

Table 6: *(continued)*

Title	Description
	agriculture. The agLe@rn courses, which contain interactive components, cover such topics as ICT for agricultural professionals, integrated pest management in rice, cotton and vegetable cultivation, responsible pesticide use and integrated soil fertility management. It involves Tamil Nadu Agricultural University, University of Agricultural Sciences – Bangalore, G.B. Pant University of Agriculture and Technology, WorldView International Foundation and private sector representatives CropLife Asia and CropLife International. It ialso links with ITC's e-Choupal Initiative to reach small holder farmers. APRTC's website and courses are hosted on a server managed by the Japanese Ministry of Agriculture, Forestry and Fisheries.
FAO Regional Office for Asia and the Pacific (RAP)	RAP, at the extension workers in the use of hand-held computers containing a request of the Government of Thailand, is training decision support program for maize farmers. The program guides them on how much fertilizer to use, the optimum planting dates, and the expected yield. The project aims to save foreign exchange by reducing wasteful use of imported fertilizers, and the experience gained from this project will be used to develop similar computerized farm decision support programs for other crops.
ENRAP – Knowledge Networking for Rural Development in Asia-Pacific Region	Knowledge Networking for Rural Development in Asia-Pacific region Project (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.

Table 6: *(continued)*

Title	Description
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.

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, 2003) and some Southeast 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 (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.

Many countries including India (Khairnar, 2003), 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.

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 (Basnet, 2000, 2003; Mahaseth, 2003) and Sri Lanka (Wijekoon, 2002) have successfully used community radio while this has not been used in India (Maru, 2002) 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.

The iNARS Workshop "Developing a Framework for Effective ICT use to benefit smallholder farmers" at The Hague in December 2002 and the CTA observatory "ICT-Transforming Agricultural Extension" in September 2003 indicated 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 ICTs – 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 ICTs. New perspectives are needed to understand and manage these pluralistic information flows and effectively use ICTs.

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 on the basis of 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 as also act as information and knowledge intermediaries are emerging. For an ICM agenda for ARD, this perspective can also enable evaluate the gaps and propose new approaches to fulfill them.

IV.5. Distance and Open Education

Asia boasts of the highest development of distance education in the world with India and China having millions of students formally registered in distance education courses and a large number of Open Universities. However, this is not reflected in distance learning in agriculture in these countries and the region.

There is very little information available on the use of ICT in open and distance agricultural education in the region. Table 6 also lists some of the initiatives and programs that use ICT in open and distance learning in agriculture in the region. The APRTC (Raab, 2003) and the CGIAR IARCs such as IRRI and ICRISAT have lead activities in this area in the region. The CGIAR, through IFPRI, is initiating a Global Agricultural Open University aimed at providing post graduate agricultural education in the distance mode. ICRISAT has initiated the Virtual Academy for Semi-Arid Tropics with a focus initially on drought mitigation in SSA and South Asia.

As is apparent from the initiatives listed in Table 6, there is a convergence between open and distance learning initiatives and agricultural extension through the use of ICT. There is a transformation occurring in agricultural extension with the shift towards not only providing information and expertise but also enabling learning at individual, household and community levels and in engendering and involving youth and the elderly in development, including that of agriculture.

The use of ICT in agriculture related learning and extension is creating an environment where "older" intermediaries such as extension agents are being replaced by "newer" intermediaries who have capacity to provide information services using ICT. These intermediaries, sometimes termed "infomediaries", have several typologies. Some provide connectivity through tele-centers, public call offices, information kiosks etc. Some process global information to make it relevant to local use. Some are involved in the reverse process, making local information and innovations accessible globally. There is very little being done to build the capacities of these "infomediaries" to provide relevant agricultural information to user communities, which need not necessarily be farmers but could include extension agents, market intermediaries, input suppliers and consumers.

The FAO through its iMARK (Information Management Resource Kits) have initiated an open learning program for capacity development in ICT use and ICM for professionals in ARD Institutions (Riggs, 2003). The Technical Centre for Agricultural and Rural Cooperation (CTA), The International Institute for Communications for Development (IICD), FAO, the CGIAR International Agricultural Research Centers, the World Bank, Asian Development Bank, Asian Productivity Organization and several other International and Regional Development Agencies have programs and projects that support, through a variety of ways which include face-to-face training, workshops, toolkits etc., capacity development in ICT use and ICM. However, most are aimed at capacity development of NARS information and ICT managers.

IV.6. Organization and Management

The use of ICT in NARS offices of the region, especially the use of the personal computer, is now ubiquitous. Most NARS have implemented local area networks and computer based financial management and personnel information systems in

their headquarters. However, within the NARS, the use of computers at the individual level is usually for word processing and presentation graphics even when LANs exist in the Institutes.

The linkage between the computerized financial management and personnel information systems and the Agricultural Research Management Information Systems in many NARS of the region is weak. This is also because of organizational structures and lack of data integration at the ICT applications' level in the NARS and its Institutions.

Apparently there is poor linkages between the various ICT enabled services, where they exist, for more integrated information flows for example between research and research management and STI services, between research management and financial and personnel management, between STI and extension and outreach information systems etc.

Even with improved connectivity the use of computer networks for enabling multi-disciplinary and multi-location research, virtual sharing of research facilities, research management, extension and outreach and messaging and communication across NARS Institutes and with regional and International organizations and networks appear to be limited. Apparently, the weakness stems from the organization structures that need to adapt to new forms, such as being more flat and non-hierarchic, that use of ICT enables, lack of integration of ICT in the work processes of the NARS and lack of capacities, especially new skills in communication that the use of ICT entails. Organizational culture and structural changes are brought about by introduction of ICT and organization cultures and structures govern not only effective use of ICT but also the choice of ICT. Weak ICM at the Institute, NARS, NAIS and various other levels appears to be a central issue in most ARD organizations in the region.

While several NARS indicate centralized organizational structures for managing ICT and its use and ICM, this still remains an area of weakness when viewed with an overall regional perspective, especially as regards skills in network management, content generation and information management. The NARS are not able to retain quality staff for these information and ICT use related functions which are new to their systems.

While private sector organizations, comparably smaller in size than the NARS, have used ICT to their commercial advantage within the region, the NARS have been found to be lagging. This could be because the leadership of the NARS has not yet fully comprehended the implications of using ICT in agricultural research and development.

IV.7. Messaging and Communication

Almost all NARS Headquarters and many of the outlying Institutes now have telephone and fax connectivity. However access to individual users, as in more economically developed countries, may be limited to researchers and other users, especially those who do not hold supervisory positions.

While there is significant number of Research Institutes and Stations connected through e-mail and Internet, there are very few NARS Institutions other than the Headquarters with unlimited access to the Internet and even lesser numbers with "good" bandwidths (>64 kbps) in many countries. This bandwidth is essential for effective uploads and downloads of documents from websites, FTP sites and through e-mail.

Data from the AROW website indicates large increases in the number of ARD Institutional websites in Asia region from 2000 to February 2004. However, in a yet to be published study conducted by ISNAR regarding information content of these websites, it was found that most of the websites of the NARS

Institutes assessed did not follow HTML, CSS and Bobby standards. Not using established Internet/WWW standards for websites prevents universal access and will, in future, need major overhauling to integrate through use of technologies such as XML into regional and global information systems. The websites evaluated had very little information content for policy makers, managers, researchers, extension agents or farmers. Most websites were not regularly updated with some remaining as they were when first created. The lack of use of the Internet, especially the web, indicates that the NARS have yet to take advantage on new ICT either to publicize their capacities or their needs as also create a channel and medium to communicate with their clients and stakeholders including international development agencies and donors.

One of the common arguments in the use of new ICT in agricultural development is the lack of Internet connectivity to farmers. However, there is ample indication that cellular telephony and with it WAP and SMS as also wireless Internet services are creating connectivity opportunities in rural areas. Collaborative programs between Japan and Thailand through APAN have provided proof of concept in distance education and multi-location farm research monitored from remote locations.

Taking into consideration only the NARS ICT platforms such as websites does not reveal the full vibrancy of ICT use for ARD in Asia. There are a very large number of Non-Government, civil society, community and farmer organizations information platforms in operation in the region. A NARS centric conceptual framework to assess ICT use and ICM falls short to reveal the full extent of ICT use and its vibrancy in the Asia-Pacific region.

V. INFRASTRUCTURE AND CONTENT MANAGEMENT FOR ICT/ICM IN ARD

Infrastructure

Many NARS indicate in their status reports that they have inadequate computer hardware and supporting infrastructure which in many cases include quality electricity needed to operate computers, local area networks and Internet connectivity. Similarly, some NARS indicate that their software needs remain unsatisfied. While some NARS report adequate trained staff to use ICT, a majority of them indicate that trained human resource with computer use, network administration and information management skills within the NARS remains a major problem. The NARS cannot retain trained and skilled staff who are attracted to better career prospects in the private sector. The status (and many a times spectacular progress) of telecommunications infrastructure including Internet connectivity in each country is regularly (almost on annual basis) reported by many initiatives. However, these indices bear no relation to the state of rural telecommunications or Internet connectivity or to NARS connectivity. NARS Institutes and Research Stations are, by virtue of their activities, located in rural areas with limited telecommunications facilities.

Funding of ICT infrastructure appropriately appears to be a major bottleneck. ICTs, especially computer and network hardware and software have very short useful life spans. When these are upgraded, new skills for their effective and efficient use are again required. Most governments and donors have either funded part of initial costs and do not include maintenance, repair and up-gradation costs as also operational costs including continued capacity development. This, again, is an issue of ICM. The need for planning total costs of operation of the entire ICT and information lifecycle, the use of open and free software etc. is not thoroughly looked at by

most ARD Institutions because they lack organizational structures and capacities to do this.

As the ARD Institutions move towards operationalizing their new ICT enabled information systems, the cost of generating and integrating digital content to service the pluralistic needs of their vast array of clients with each requiring more customized information is expected to rise geometrically. The funding of these activities is not yet considered significantly by the ARD Institutions in the region.

Content Management

Most NARS in the region have content management policies. However, with limited content available on NARS websites or published in digital media, there appears to be a weakness in implementing and/or "institutionalizing" these content management policies.

ICT use needs to be integrated at the very basic content generation/management work process, information content and Institutional/Organizational structures so that ICT contributes effectively and efficiently to useful information flows and services in an organization. Content management also includes appropriate governance which includes policies, strategies, monitoring and evaluation and quality assurance. The publication of digital documents is only the tip of an Institutional "iceberg" of organization needed to make effective and efficient use of ICT. Based on experience gained from ISNAR's activities in implementing INFORM, operationalizing ICT use in the NARS still faces problems in integrating ICT within the organization's processes.

Among several workshops, observatories and meetings related to development of information systems for ARD, content management emerges as a major recommendation. However, this subject is vast and cannot be dealt as a "generic" recommendation. There is a need to specify content

management needs at the information service such as STI or for extension and outreach as also at each system component level i.e. the information organization, the information platform, the intermediaries and at the user community in an integrated manner.

Language for communication using ICT within countries and across the region is a severe handicap in sharing and exchange of information. The Internet, with its Anglophonic dominance limits information exchange within the region. South Asia and some countries in Southeast Asia, by their colonial past, have capacity at the policy maker, manager and scientist to communicate through English as a common language. However, there are countries that have capacity in French and, if China is included, Mandarin. At local user community level such as for extension agents, market intermediaries, farmers and consumers, language emerges as a great barrier to information sharing and exchange. Information and learning objects repositories, especially of audio, graphics and video and building local capacity in translating language are some solutions for sharing and exchanging information. Regional organizations can provide the infrastructure and support for the repositories and coordinating translation activities. This is a major content management challenge in the region.

VI. REGIONAL ORGANIZATIONS AND NETWORKS

The region has many ARD networks and organizations such as APARIS, NACA (Bueno, 2000), APHCA (Riggs, 2000), APAN (Tadahiro, 2000 and Ninomiya, 2003) which focus on information sharing and exchange around agricultural disciplines, themes, eco-regions, commodities major watersheds, connectivity etc.

The common learning from information sharing and exchange activities of these networks is:

- Data and information are collected mainly from library collections, published literature, government and research survey data, internal management data, and personal communication
- Isolated databases on specific topics exist with little integration
- There is poor common understanding of the purpose of data and information collection by the networks
- There is little awareness across the NARS of these networks
- Availability and accessibility of databases are limited
- Data and information collected is under utilized
- Databases are not regularly updated or regular maintained
- A wide variety of software is utilized to create databases
- No common or compatible information handling methods and tools exist
- There is little information exchange or networking
- Users of the existing databases are mainly researchers, followed by teachers and students, extension personnel, managers and planners, and farmers
- There is ineffective communication and presentation of the information by the networks
- There is limited capacity of national programs to partner in information generation and dissemination of information.
- Most National participants are primarily clients than partners
- E-mail in ARD Institutes is used mainly as a central mail box constraining individual usage
- Multiplicity of major Asian languages is a difficult technical, management and cost issue.

VI.1. Asia-Pacific Agricultural Research Information System (APARIS): An APAARI Initiative

APAARI, based at the FAO Regional Office in Bangkok, was established in 1991 as a non-profit and neutral forum to promote and facilitate inter-institutional cooperation at regional and international levels for agricultural research. At present, APAARI has approximately 40 member institutions – 20 national agricultural research systems (NARS) and 20 regional and international research institutes. APAARI activities are directed to enhance the exchange of scientific and technical know-how and information in agricultural research for development; assist in strengthening research capability of member institutions and promote cross linkages among national, regional and international research organizations. APAARI, in consultation with its stakeholders, has developed a long-term perspective plan and strategies to address relevant issues, including regional collaboration, networking of research programs; human resource development (HRD); policy advocacy; resource generation and publication enhancement.

Improvement in information and communication management (ICM) is emerging as a priority in agricultural research for development (ARD) organizations that facilitate knowledge dissemination on improved agricultural technologies, farming systems and natural resources management. National agricultural research systems (NARS) of many Asia-Pacific countries are no exception as they are rapidly increasing the use of information and communication technologies (ICT) in knowledge management. However, significant diversity exists among these NARS in terms of their capacity to effectively use new technologies such as ICT to fulfill their role as agricultural knowledge producers and providers to a variety of users, including ARD professionals, farmers, and the learning community. APAARI members are major knowledge developers in the agriculture sector and several of them are also involved in agricultural education at various levels. To enhance

inter-institutional knowledge and information sharing, APAARI has established a web-based regional information network named Asia-Pacific Agricultural Research Information System (APARIS).

Over the last few years, APAARI has organized several expert consultations to strengthen APARIS by bringing together diverse stakeholders on a common platform. The most recent expert consultation in December 2003 was the third organized by APAARI on the subject and it assessed the progress made by various NARS in the area of ICM since the last such consultation in 2002; explored the existing opportunities for enhancing the role of ICM in ARD; and discussed potential improvements in APARIS by focusing on expanding its user-base to also include the learning communities and their information needs. APARIS also serves as a portal to information resources of member NARS and other regional and international ARD organizations and acts as an information link between NARS and the international ARD organizations. The following is a brief summary of the APARIS development over the last few years and its proposed future activities.

APARIS Phase I (1999-2002)

APARIS, being web-enabled, is closely integrated with the APAARI website (http://www.apaari.org/). The following are seven main components of APARIS at present:

1. Management Information System (MIS) Tools:

1.1 Regional Research Networks (RRNs) Database: This database currently has information on 19 regional research networks, and it continues to develop in order to cover all the networks that effectively operate at both the regional and the sub-regional levels (*i.e.,* South Asia, Southeast Asia and the Pacific). Some example RRNs included in this database are NACA, APAFRI, INGER, COGENT, the Regional Network on Plant Genetic Resources, CLAN, CORRA, the Rice-Wheat

Consortium and others. This database also provides access to the websites of the RRNs, when they exist. Thus simultaneously it provides a portal function to the RRNs, and this last dimension forms part of the general "Gateway or Portal Function" as well as provides access to the information resources that these networks offer.

1.2 NARS Database: With FAO/SDRR support, work on this database initially started to provide information on the NARS of the Asia-Pacific region. However, since similar information exists on FAO/GFAR and ISNAR websites, it was decided to provide a linkage to those sites from APARIS.

1.3 Regional Associations Database: It provides information on regional associations that are related to ARD. It is restricted to those users who have registered with APAARI. The registration is free and can be done on-line quickly. The registration process helps APAARI to develop a contact list as well as assess the future potential of implementing access to restricted information resources such as paid subscriptions to scientific journals through APAARI website.

1.4 ARD Projects Database: APARIS provides access to projects databases that already exist, either at the global level (such as CARIS), at the regional level (*i.e.* in regional research networks), or at the corporate level in important research institutions (*i.e.* the CG centers).

1.5 Daily Agriculture News: This information service facilitates access to headlines of important agricultural news at the global level that can be of interest to end users in the Asia-Pacific region. This information is presently being generated by a web-based information service (www.moreover.com). By clicking on headlines, users can read detailed news story.

1.6 Database on Agricultural Research and Development Indicators: One of the main information requirements that policy-makers and research managers face is that of keeping

track and of analyzing key indicators of agricultural research activities in any country or region. This refers to such indicators as public and private investment in agricultural R&D, number of researchers, distribution of the R&D investment in the various sub-sectors of agricultural production and of agro-ecosystems, indicators of technology transfer and of technology adoption, innovation indicators, impact indicators and others. APARIS provides access to the ASTI (Agricultural Science and Technology Indicators) Project of IFPRI and ISNAR.

2. Information on Regional Events related to ARD and to ICM:

This component has two databases.

2.1 Meetings and Events related to ARD and ICM: This database provides information on important meetings and other events taking place in the Asia-Pacific region in the area of agricultural research for development (ARD) and of information and communication management (ICM).

This database also covers APAARI activities and events, and provides general information on scientific and technological events that are being organized by stakeholders in the region.

2.2. ICM Training Activities in the region: This database lists training activities taking place in the region with a focus on ARD and information and communication management (ICM).

3. Facilitate Access to Scientific Publications generated by Agricultural Research in the Region: There are several scientific publications posted on the APAARI website including both APAARI publications and ARD publications from other sources.

4. Electronic Forums to facilitate dialogue among stakeholders of ARD in the region on issues of strategic importance: APARIS will respond to the concrete demands generated by its members, to make sure it is needs-driven and user-driven. Access to the

following electronic forums was provided in this phase and is presently available through the APAARI website:

4.1. Electronic Forum on Information and Training Requirements in the Asia-Pacific region: This forum was carried out by the NINPs of the region in order to provide basic inputs for the design of the APAARI website and for the construction of initial phase of APARIS. This electronic forum took place from May to July of 2000 as an exercise in ICT need-assessment of member NARS.

4.2. Access to the EGFAR NARS Forum: This is an electronic forum being organized by the GFAR Secretariat at the global level, aimed at facilitating the exchange of information and experiences among the NARS on research management issues that are of interest to them.

4.3. Specialized Thematic Electronic Forums can be facilitated by APARIS on topics of common concern to the NARS of the region provided there is a demand/suggestion from a member NARS or any stakeholder.

5. Gateway/Portal Service: The objective of this component of APARIS is to facilitate access to information resources on the web, both through search engines and by facilitating access to websites of institutions that work on ARD and to websites that are related to specialized topics of ARD. This is only a portal service, and not a database. In some cases, these "portal services" are related to the databases that are described in Section 2 above (Management Information System Tools). The following portal services are currently being provided by APARIS:

5.1 Portal to Regional Research Networks (RRNs): This portal facilitates access to the websites of the Regional Research Networks that operate in the region, when these websites exist. This portal is based on the database on RRNs described in Sub-section 1.1 above.

5.2. *Portal to the Websites of NARS Institutions in the Asia-Pacific region (through EGFAR/NDIL):* Access to the websites of the NARS institutions in the region was facilitated through the NDIL Directory that was developed by the GFAR Secretariat.

5.3. Portal to Web-enabled information on key topics/themes of ARD: This portal facilitates access to websites on various topics related to agricultural research, particularly regional priority topics.

5.4. Intelligent Gateway or Portal Facility: A pilot project was formulated with CABI to develop an Intelligent Gateway or Portal Facility to information resources on the web that will provide a very important additional service: screening of information in order to provide quality control on information retrieval from the web, and thus to facilitate coping with the information overload or so called "information glut" that the rapid expansion of internet websites has generated. In a meeting in Bangkok in November 2001, a proposal was presented by CABI for the implementation of this initiative. This proposal has two practical components: the first one refers to the improvement of the computer infrastructure (servers) that APARIS is presently using to be able to implement this portal function (purchase of additional hardware and software). The second one has to do with the actual work itself, covering the salaries of the persons that will do the work. With respect to the first component it will have to be determined if the additional hardware is really required, or if the same server capacity can be obtained through other means, thus reducing the costs of the proposal. Once the final version of the proposal is agreed upon, it will then depend on the possibility of obtaining funding for this proposal from the CABI Partnership Programme and from other interested donors.

6. Strengthen Knowledge Networks on ARD in the APAARI region:

6.1. Facilitating access to the information resources of Regional Research Networks (RRNs): In collaboration with the consortium of institutions that participate in the RRNs identified in the RRN Database (see Sub-section 1.1 above), information can be provided on what data/information is available in the research organizations that constitute each RRN (i.e. NACA, APAFRI, INGER, Rice-Wheat Consortium, etc.).

6.2. Pilot Project on the Development of Knowledge Networks in specific areas of ARD: A pilot project was formulated that was aimed at supporting a few cases of the development of "knowledge networks" among researchers in specific fields of research. However, this initiative needs further consideration by APAARI members.

7. Dissemination of Information through APAARI website and publications: The objective of this component of APARIS is to: (a) facilitate dissemination of the results of APAARI activities through the APAARI website, through publications and through CD-ROMs, and (b) facilitate access to other relevant publications related to ARD in the region. This is an important activity that has been integrated into the Regional Strategy to implement the APAARI 2025 Vision. The following components were developed:

7.1. Provide general information on APAARI (nature, objectives, mandate, members, activities, *etc.*). This is done in a special section on APAARI website ("About APAARI"), from where all the important documents of APAARI can be downloaded (such as mission statement, Vision 2025, constitution, members, *etc.*).

7.2. APAARI Publications and CD-ROMs: A CD-ROM with 17 Success Stories was developed and released in 2001. Three more Success Stories have been published since then and therefore, a new CD with 20 Success Stories has been released recently.

7.3. Access to other ARD publications: Access to interesting and relevant papers and publications on agricultural research for development topics that are produced by other partners (*i.e.* the CGIAR, development agencies, *etc.*) are also made available through the APAARI website.

APARIS Phase II (2002-2004)

After the completion of Phase I, a general APARIS framework was in place and in October 2002 APAARI organized the second ICT expert consultation on further development of APARIS. An APARIS steering committee was formed to provide policy support, undertake strategic planning, provide overall technical guidance, source external funds, and monitor the progress of APARIS work plan.

The steering committee in its first meeting in October 2002 reviewed and accepted the terms of reference (TOR) for NINPs which were developed during the expert consultation. The TOR of NINPs include following functions:

- assess the status and needs of respective NARS with regard to ICT in ARD;
- monitor and update to improve relevance and effectiveness of APARIS contributions to APAARI vision and mission;
- identify, collect, organize and make accessible information systems within the subject scope of APARIS;
- establish and operate information services for national and regional clientele based on APARIS processed information; and
- share skills, knowledge and experiences in handling and management of information among NINPs.

Linking of APARIS with other regional, sub-regional and global agricultural information systems, and functional enhancements or value addition in it emerged as the priorities for its future development after the consultation process.

As a follow up of the recommendations of the second ICT expert consultation, in April 2003 APAARI organized a meeting to formalize the bilateral cooperation between APAARI and the members of its support group in the area of ICT (FAO, GFAR, ISNAR and AIT). This exercise resulted in identification of specific areas of collaborative activities that synergize the resources of support group members and APAARI. The most recent expert consultation in December 2003 was the third organized by APAARI on the subject and it assessed the progress made by various NARS in the area of ICM since the last such consultation in 2002; explored the existing opportunities for enhancing the role of ICM in ARD; and discussed potential improvements in APARIS by focusing on expanding its user-base to also include the learning communities and their information needs. With regard to the Phase II developments in APARIS following activities were identified (not in any specific order):

(1) Development of a Regional Agricultural Expert Locator (RAEL) on APAARI website

It is widely recognized that internet/digital technologies are bringing down the barriers to information flow that have traditionally existed in government and corporate work environments, particularly in the Asia-Pacific region. New channels of communication are opening up and the area of ARD is no exception. Currently NINPs serve as links between APARIS and the member NARS for sharing information of general nature. This new initiative, RAEL, is aimed at creating multiple input points (within a NARS) for APARIS. RAEL will maintain a database of agricultural experts and their profiles. The database will be populated by interested experts themselves. The RAEL function has three main modules:

- Expert-Profile Module

  The profile of each expert will be maintained in this module. This module will have restricted access and only

registered experts will be able to manipulate their respective profile records.

- Research-Data Module

  This module will maintain a database of the past and present research/consulting projects, publications, presentations and professional activities of the experts.

- Search Module will be accessible to all and it will provide results using both the above modules.

Besides these three main modules, this function will also have some smaller modules for data security and user management to handle issues such as setting user's account, encrypting user's password, and user verification. The main modules will have following basic utilities:

- Expert-Profile Module: complete functionality of data management (add, edit, delete, view) with basic security system for user registration, verification and authorization, with encryption for the user password.
- Research-Data Module: complete functionality of data management (add, edit, delete and view) for a specific user and also a basic upload function (user can upload files for project/research/presentation).
- Search Module will have a basic search function, it can search a keyword at a time.

(2) A simplified gateway function on APAARI website using open source software

The APARIS Gateway function, consisting of a search module, will act as a multi-host search engine to locate ARD information resources on the internet within the APAARI member institutions. In August 2003, NINPs were requested to provide brief summaries and URLs of digital information resources available in their respective NARS. The gateway function has a search module where a user can enter keyword(s) and get

the search results based on it. During the search process, the gateway will perform following actions:

- Connecting to the APAARI member institution's servers,
- Searching the requested keyword in each web file,
- Retrieving the information from the selected file(s),
- Saving the meta-data information in an internal database of the function to reduce the search time in future, and
- Displaying the search results in a standard XML format to the user.

(3) A brochure of useful ARD information resources

This is a collaborative activity of APAARI, FAO, ISNAR and CABI. The brochure is planned as a handy ready-reference that a user can keep near his/her work computer rather than in a book shelf. The ARD information resources available from FAO, GFAR, CG Centers and NARS are categorized based on some basic ARD subject areas and geographical coverage. Each ARD information resource is briefly described about its content, target audience, and the way to use it if it involves log-in or any other access procedure. In this first edition, only freely available information resources are being included.

(4) ICT need assessment of member NARS to develop better capacity building programs

National Information Nodal Points (NINPs) of APAARI members participated in an ICT need assessment survey and prepared a status report for their respective NARS. These reports were analyzed by APAARI and formed a basis for initial development of APARIS. To make the results of this survey widely available APAARI decided to publish a benchmark report tentatively entitled "*ICT in ARD: Status and Progress in the Asia-Pacific Region.*" At present, there exists no comprehensive publication that can help ARD policy makers of the region in decision-

making with regard to capacity building, ICT adoption models, and creation and management of ARD digital information resources. APAARI anticipates that the region's NARS and donors will find such a publication of significant value. The publication will also list the digital information resources available in the region and it is hoped that many ARD professionals will find such information useful in their work.

To ensure use of most up-to-date data about the status and future plans regarding ICTs in NARS in the publication, in August 2003 NINPs were requested to update the earlier information/data. They were also requested to provide a list of information resources of their respective NARS available over the internet, including URLs and brief descriptions (one paragraph). These inputs form the basis of this present report.

(5) Redesigning, link validation and update of APAARI Website

APAARI website, set up in 1999, provides several in-house and internet information resources for APAARI stakeholders and ARD professionals. The website has more than 300 linkages to various national, regional and international institutions, networks, and other relevant organizations. Most of these external linkages were created at the time of website set up. Though APAARI has regularly updated its own content, some of the external linkages need to be revalidated and updated. In the last 2-3 years new information resources have become available that may be of interest to APAARI stakeholders and ARD professionals who visit the site. The main objective of this activity is to check and update the site content, ensure validity of linkages from APAARI website, and search and add new relevant links at appropriate places. The specific tasks to achieve the main objectives include:

a. Critically checking in-house information on APAARI webpage and updating it,

b. Listing all the linkages available from APAARI website and validating the information returned from them,

c. Repairing broken links and deleting dead-links,

d. Visiting NARS and other member websites and listing information resources available on them,

e. Editing collected information and arranging it in subject-matter format, and

f. Improving the interface to make navigation user-friendly. In general, more pictures are being incorporated into website.

An APAARI CD has been developed to provide the APAARI website as an off-line resource to those who lack adequate internet connectivity. In the first phase, 1,000 copies of *APAARI on CD* are being distributed to APAARI's diverse stakeholders.

(6) Linking of APARIS with agricultural information systems developed by GFAR, FAO, CG and other regional, sub-regional and national agencies.

APAARI considers further strengthening of member NINPs a priority for potential linking of APARIS with agricultural information systems of NARS as well as those of sub-regional and global organizations through the proposed GLOBAL-RAIS project of GFAR. The APAARI expert consultations provide NINPs an opportunity to become familiar with the development and management aspects of a distributed information system as envisioned under the GLOBAL-RAIS initiative and also applicable to APARIS. Due to diversity, size of human population, and geographical coverage of the Asia-Pacific region, constraints and issues faced by APARIS are quite similar to those of a global agricultural research information system. In this respect, APAARI can benefit from the experiences of other organizations such as AARINENA, FARA, FORAGRO and EFARD.

(7) Training Workshop on Capacity Building for Developing National Agricultural Information Systems (NAIS) of Cambodia, Laos, Myanmar, Bhutan, East Timor, Mongolia and Vietnam

APAARI is actively engaged to bridge the so called "digital-divide" by assisting developing NARS to effectively use ICM in agricultural research. NARS of some countries of the region, including Bhutan, Cambodia, Laos, Mongolia, Myanmar, and Timor-Leste are currently not the members of APAARI and hence been unable to benefit from the APAARI expert consultations on ICT/ICM that have helped several member NARS in developing their national agricultural information systems (NAIS). Vietnam has only recently become a member. Therefore, to contribute in bridging the "digital-divide," recently APAARI organized a training workshop, in collaboration with GFAR, AIT, FAO, UN-ESCAP, SDLEARN and JIRCAS/NARO, to assist NARS of the above mentioned countries by training their appropriate officers in ICM and building NAIS. During the workshop, trainees were assisted in defining their respective NAIS and in developing prototype websites of their respective NARS as a delivery medium for NAIS. Significant amount of training material, including video-recorded lectures on key topics, has been collected and organized in web-based and CD-based formats. This training material could be further developed as an e-Learning tool in collaboration with AAACU, SDLEARN and others for future sub-regional and national training programs under APARIS. Possibilities of using Internet-based video conferencing tools to deliver training modules are also being explored as more and more countries are joining APAN (Asia-Pacific Advanced Network). Asia-Pacific Consortium on Agricultural Biotechnology (APCoAB), a new APAARI initiative, can potentially help develop training modules covering subject areas such as agricultural biotechnology and biosafety. Such modules as well as educational materials developed in collaboration with AAACU could also be delivered through APARIS.

(8) A National Workshop on Linking Farmers with Researchers through ICT

In several developing countries of the Asia-Pacific region, the existing Transfer of Technology mechanisms and extension programs, mostly government run, are either slow or ineffective in bridging the linkages between the research community and the farmers. This is partly due to inadequate exploitation of new means of knowledge and information dissemination by these agencies. To partially fill the gap, lately some private initiatives have come up, however, the primary motivation behind these initiatives is mainly the facilitation of commercial transactions in rural areas rather than knowledge/technology dissemination.

Hence, it is relevant that the role of information and communication technologies (ICT) in taking scientific knowledge/technologies to the end users is properly examined and understood in order to reap the benefits that have effectively been harnessed by the developed nations. In view of these issues, it seems that the time has come to recognize agriculture as a rural entrepreneurial activity, delivering a wide range of local, national and international products. And, just like any other economic activity in the twenty-first century, it has its own unique technological and information needs. It requires all pertinent managerial skills for timely planning, risk assessment, efficient resource utilization, product innovation, technology adoption, etc. under a dynamically changing environment. After the recent outbreak of Bird Flu in some Asian countries, the most common feature in the media reports from various countries was the farmers complaining about delay in release of useful information by relevant government agencies to tackle the problem at the farm level. It should serve as an example of how timely information is becoming central to decision-making in all aspects of food production and distribution.

Information Communication Technologies (ICT), becoming continuously inexpensive, offers a wide variety of tools that can help develop information products and services designed specifically to enhance the decision-making capabilities of the newly emerging agricultural entrepreneurs. ICT can not only strengthen the traditional channels of information dissemination further, but also create new ones that allow localization of content-rich information products and services and their real-time delivery through multiple channels. However, like any other technology, ICT has a cost associated with it such as the cost of building infrastructure – personal computers, modems, connectivity, bandwidth, user training, cost of developing the technology, cost of maintaining the systems and of course the problem of obsolescence. It needs to be deliberated as to whether ICT is sustainable for rural development and for the resource poor common man.

Several independent public and private initiatives are under way to bridge the digital divide that exists between the urban and the rural India. There appears a clear need to bring all these initiatives together to start a dialogue process for creating an accelerated forward movement. Novel partnerships of various players, who can compliment each other, are needed to develop and disseminate information products and services in an economically sustainable and effective manner. Some of the relevant agencies represented by these players include agriculture research institutes, cooperatives, the private sector, NGO's, foundations, and concerned government departments at national and state levels. A consortium approach of combining the independent efforts is proposed as it offers the required flexibility in a partnership.

In order to deliberate on above issues, a workshop on "Role of ICT in taking scientific knowledge/technologies to the end user" is being organized by National Academy of Agricultural Sciences (NAAS), India, Trust for Advancement of Agricultural Sciences (TAAS), Asia-Pacific Association of Agricultural Research

Institutions (APAARI), Thailand and Indian Society of Agricultural Statistics (ISAS), New Delhi to discuss the new opportunities.

Proposed APARIS Activities for 2004-2007

The APARIS Business Plan for 2004-2007 focuses on 3 broad themes: advocacy, capacity development and integration. The deliberations during the Third APARIS Steering Committee meeting held on 8th August 2004 prioritized the APARIS activities for 2004-2007 as follows:

a. Advocacy for enabling, enhancing and enlarging agriculture related information systems at national, sub-regional and regional levels in the Asia-Pacific region

1. Collecting, collating and providing access to information, on a biannual basis, related to status of ICT use and information systems in NARS of the region and agriculture and rural development related ICT use indicators at national and regional level (2005 and 2007).
2. Developing an advocacy paper on ICT and agricultural information related policy and strategy issues at national, sub-regional and regional level that can provide fact-based support for advocacy role of APARIS (early 2005).
3. Organize, during APAARI General Assemblies, a 1/2 day sensitization and awareness workshop on policy and strategy issues in enabling, enhancing and enlarging agricultural information systems for senior NARS and agricultural policy makers and managers (2004-2007).
4. Identify and publish success stories on ICT/ICM in ARD using case studies from selected Asian countries (2005).
5. Associate and network with other initiatives and forums to promote awareness about ICT/ICM in ARD and also publicize APARIS in the on-going AFITA Conference in Bangkok as well as the next one in India in 2006;

FAO-RAP/SPC sub-regional workshop in the Pacific in September 2004; and as co-sponsor of the NARO Field Server Workshop in Bangkok in January 2005. (2004-2007)

b. Capacity development for ICM and use of appropriate ICT for national agricultural information systems

1. An Asia-Pacific Regional Workshop for NINPs for need assessment and to evolve a framework for National Agricultural Information Systems (in 2005)
2. Three Sub-regional Training Workshops for NINPs and two ICT/ICM trainers from each country (in 2006):
    a. South Asia (Iran, Afghanistan, Pakistan, India, Nepal, Bhutan, Bangladesh, Sri Lanka) in collaboration with SAIC
    b. Southeast Asia (ASEAN countries) in collaboration with SEARCA
    c. the Pacific (APAARI member countries) in collaboration with SPC
3. National Workshops, facilitated by NINPs and trained NAIS trainers, for two officers from each major national agricultural institute (in 2007)

c. Integration of information resources within NARS, in the Asia-Pacific region and with other regional and global agricultural information systems such as the GFAR webring.

1. Develop an on-line compendium of good practices, standards, guidelines, protocols etc. for agricultural information exchange and sharing in the Asia-Pacific region (2004-2007)
2. Participate, as a representative of the Asia-Pacific Region's NARS, in negotiations related to setting of standards, guidelines, protocols related to agricultural information systems at the global level (2004-2007)

3. Conduct seminars at Sub-regional levels, South Asia, Southeast Asia and the Pacific countries related to sharing and exchange of information, especially on the use of standards, guidelines and best practices in agricultural information systems in conjunction with the Sub-regional training workshops proposed in the Capacity Development section and other APAARI related activities. (2004-2007)
4. Further strengthen the directory of agricultural information on the web and the Gateway/Portal function to access the information resources of various institutes (2005-2007)
5. Promote data and information sharing among various member institutes using applications such MetBroker and localized crop models
6. In consultation with GFAR and other regional and sub-regional forums, integrate APARIS as Asia-Pacific node in the Global Web Ring of Agricultural Information Systems (2004-2005).

Based on the suggestions of APARIS Steering Committee, APAARI has developed a proposal for submission to GFAR and other potential collaborators and donors in close consultation with APARIS Steering Committee members and focal points in Support Group Organizations such as GFAR, FAO-RAP, ACIAR, AIT, JIRCAS/NARO, CABI, SDLEARN and others.

VII. CONCLUSIONS

Based on the overall status of ICT use in ARD, countries in the Asia-Pacific region can be approximately placed in four groups as illustrated in Table 7. This table was compiled from the information resources listed in the Bibliography section.

There is great heterogeneity in ICT use and ICM for ARD in the region. In Group B, C and D of Table 7 except for Malaysia, there is no report of a functional ICT enabled library network. This is a major weakness that inhibits collaboration and coordination in improving access to quality scientific and

Table 7: Status of ICT in ARD for Selected Asia-Pacific NARS – A Summary Table by APAARI

Codes: × = poor/ very poor ↑= emerging/reported ✓ = exists/developed blank = unknown/not reported

NARS	Science & Technology Information (Library Automation & Networking)	Research Data MS (Databases and GIS use)	Research MIS (projects, funding, personnel, location)	Extension & Outreach IS (policy, public and private sector using ICT to reach farmers)	Agricultural Education System (distance learning opportunities)	Organization MIS (LANs and Websites)	Rural Infrastructure (Electricity, Telecom, Internet Connectivity)	Skills (Users, Developers, Managers, Language)	Group
Australia	✓	✓	✓	✓	✓	✓	✓	✓	A
Japan	✓	✓	✓	✓	✓	✓	✓	✓	
Malaysia*	✓	✓	✓	✓	✓	✓	✓	✓	
South Korea	✓	✓	✓	✓	✓	✓	✓	✓	
Chinese Taipei	✓	✓	✓	✓	✓	✓	✓	✓	
China PRC	✓			✓	↑	✓	↑	↑	B
India	↑	↑	✓	↑	↑	✓	↑	✓	
Pakistan	↑		✓	↑	↑	✓	↑	↑	
Philippines	↑	↑	✓	↑	↑	✓	↑	✓	
Thailand	✓	✓		✓	↑	✓	↑	↑	
Bangladesh*	×	×	×	×	↑	↑	×	×	C
Fiji	✓		✓				↑	×	
Indonesia	↑	↑	✓	✓	×	↑	×	↑	
Iran	↑	↑		↑		↑	×	×	
Papua New Guinea	↑		↑	↑	↑	✓	×	↑	
Sri Lanka		↑	↑	↑		✓		↑	
Vietnam	×	↑	×	↑			↑	↑	
Afghanistan	×	×	×	×	×	×	×	×	D
Cambodia	×	×	×	×	×	×	×	×	
Laos	×	×	×	×	×	×	×	×	
Mongolia	×	×	↑	×	×		×	×	
Myanmar	×	×	×	×	×	×	×	×	
New Caledonia	✓	✓							

Notes: MS = Management System IS = Information System MIS = Management Information System A = Advanced
B = Less Advanced C = Developing D = Slowly Developing

* Special Remarks: Border Line Status

technical information through use of ICT. The ability to use GIS reflects significant capacity to develop and integrate local, multi-variate databases at NARS level. However, most GIS use is at project rather than system level indicating the need for more rapid integration of data from multiple sources and its use at the national level. Though several countries have indicated use of computerized research management information systems, the impact of computerization of these systems on efficiency of research is not known. The most effective use of ICT for agricultural development appears not to be from the NARS but the NGOs and the private sector. A strong NGO sector and the entry of the private sector, as seen in India, contributes significantly to the use of ICT in agricultural development, especially when related to market information. There is very little use of ICT for Open and Distance Learning by NARS Institutes. Infrastructure, in terms of availability of hardware, software and availability and quality rural connectivity, is a major constraint. While user skills, especially in use of computers and the Internet are improving, more advanced skills in content, network and information systems management within ARD Institutions remains weak. The skills to enable community mobilization in the use of ICT enabled information systems are also sparse. However, most of the skills required for rapid development of the infrastructure, information management and community mobilization is available within the region.

The heterogenic use of ICT in ARD in the Asia-Pacific region emerges from:

- **Lack of clear policies:**

  The use of ICT in ARD is dependant not only on agricultural research policies but a wide envelope of policies related to:

  - Rural Telecommunications, especially in rural areas where most ARD Institutes are based

- Rural Development, including Agricultural development
- Infrastructure, especially electricity
- Education
- Governance

There is a lack of clarity in conceptual frameworks to enable, enhance and enlarge communities that use ICT to share and exchange agriculture related information for research, development and entrepreneurial purposes. This contributes to the slow development of clear policies that integrate ICT use not only in agriculture or agricultural ARD but also across sectors which include telecommunications, education, health, trade, governance etc. as would be needed for overall rural development.

There is need to create awareness and sensitize top policy makers and managers not only in agriculture but also in different sectors such as telecommunications, education, governance about the need for a cross-sectoral approach for ICT use in agricultural and rural development at National and Regional levels. There is a need for NARS leaders to advocate and lobby appropriate policies for effective use of ICT in their organizations and for agricultural development. There is a need to develop capacity, through sensitization and awareness building, among NARS leaders for this purpose.

There is shift of ICT use and ICM development's strategic focus from building ICT infrastructure to effective and efficient use of ICT through appropriate Institutions, Institutional and Organizational Structures and Processes. This shift is occurring as attention in most NARS of the region shifts from installing infrastructure towards operationalizing information systems using ICT. At the moment, the emphasis in operationalization of information

system through use of new ICT is primarily in computerizing existing systems. However, ICT transform not only information systems but organizational structures and process and, in many cases, give rise to new Institutions.

There is an urgent need to share information about strategies for ICT use in ARD. For example, the success of the South Korean model that focuses on content generation by all actors in agriculture and national policies, especially broadband access, for rural telecommunication is yielding great success.

The Korean, Indian and Thai experiences indicate that ICTs have significant potential to transform ARD systems in the Asia-Pacific region. The main weakness in rapid development of ICM not only in this region but globally has been the poor contribution of research in how ICTs interact with ARD systems and what governance and management policies, strategies, institutions, structures, mechanisms and processes can enable further development and transformation of agricultural development.

- **Lack of Capacity:**
  - NARS Leadership
  - Inadequate funding for ICT use in NARS
  - Infrastructure, which includes hardware, software, connectivity, electricity and housing
  - Skills to use and manage ICT and Information in the context of agricultural research for development

The issue of capacity building for effective ICT use, information and communications management and information use for ARD needs to be examined in greater depth.

- **Lack of appropriate technologies and models to use ICT for ARD in the region:**

  It is now becoming more apparent that ICT use in ARD as in the North where information services are primarily from the private sector and a form of "private" good, may not be an appropriate model to be applied for ARD in the South in general and for most countries of the Asia-Pacific region. Primarily, ICT use for agricultural and rural development and poverty alleviation in the region will have to be community and household focused instead of targeting the individual. Access to the newer technologies will have to include all sections of the society since equity in access to information is, in the South countries, also linked to economic and social equity. Engendering and including the youth and the elderly will be essential. The strategy has to be to enlarge the information space of the agricultural communities to include essential global information related to agriculture and enable learning to empower, act and negotiate with stakeholders for action to benefit the community. The communication and learning mechanisms will need to be participatory and non-hierarchic because of issues that need to be solved through providing access, using new ICT, to information and knowledge and which relate to equitable social, economic and political empowerment of user communities. They will also have to be based on the recognition that innovation occurs across many actors in the production, marketing and consumption chains of agricultural commodities.

  Technologically, bandwidth and cost in accessing and using the technology will be the main factors in ICT use. Socially, satisfying the needs of the user community and capacity to use information effectively will define ICT use. The political implications of using new ICT and the potential inequity it can bring will constitute resistance to

ARD. These issues need to be considered at various levels, international, regional, national and community to identify appropriate technologies and models to use ICT in agricultural and rural development.

- **The differential capacities in the NARS of the Region to cope with the rapid transformation of ARD Information Services**

  Scientific and Technical Information

  From experiences of several countries, access to ICT, especially computers and Internet connectivity to scientists, researchers and technicians is essential to keep them connected to rapid developments and scientific literature in their scientific disciplines. NARS Institutes must have local area networks that are connected to the Internet. This facilitates information sharing and exchange and access to information on the Internet. Each user must have independent e-mail accounts within the LAN even if they share computers. Many of the NARS are finding it difficult to cope with the financial and management demands that ICT make on their organizations.

  Library automation is essential. Library networks at National levels immediately bring efficiency and cost savings to the NARS. They are fundamental to quality research. However, there are very NARS with centralized structures that can bring forth networks and the underlying organizational structures needed to facilitate the networks.

  Electronic and Virtual libraries need to be developed by each NARS as they form the fountainheads of agricultural innovation. Indigenous content and access to scientific and technical information beyond researchers is now becoming essential as agricultural innovation spreads across commodity chains and is produced by a multiplicity of actors and not only the formal research establishment. The

emergence of issues around intellectual property rights also requires indigenous capacities to manage scientific and technical information to safeguard copyrights. However funding and capacities limit the NARS in developing these new information platforms for ARD.

Research data management

ICTs enable multi-disciplinary and multi-location research and research data sharing and exchange. ICT enabled collaborative activities at National, Regional and International level include use of GIS, biotechnology/ bioinformatics, simulation models development and application and knowledge networking. These activities are emerging but need to be accelerated through "virtual" laboratories, alliances, consortia and similar new mechanisms of collaborative research. For many NARS, this is an issue of restructuring and needs national level policy and strategy interventions.

Research Management Information

Better management of Research Management Information is increasingly becoming essential as new forms of research funding such as competitive grants and private sector funding of public sector research emerges.

Sharing and exchange of research management information for enabling technology sharing across NARS in the region is also essential to bring efficiency in research investments.

Several NARS are attempting to cope with this challenge. A regional initiative in developing capacity for RMIS may support the NARS.

Agricultural Extension, Outreach and Market related information

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.

ICT brings new information sharing and exchange platforms such as call centers, help desks, websites with Q&A, FAQs and the use of multiple media, such as SMS, Internet radio and Internet through radio etc. Linking radio and TV stations to the Internet and providing off-line access to information to broadcasting stations bring new forms of communications for development. The use of new ICT in innovative ways is enables farming communities to participate in innovation systems. The NARS need to innovate ICT use in enabling communications with their clients.

Agricultural Education

Open and distance learning for farming communities to enable equitable participation in markets is the most critical challenge to agricultural development in the region. Similarly, the urgent need for continuing education to agricultural and rural development professionals now needs to be satisfied in the region. Innovative approaches such as by the SDLEARN by linking with private and community sector information providers for enabling learning needs to be more broadly emulated.

The NARS of the region have lagged behind in this area and capacity needs to be developed for them to occupy a central role in this area. There is a need to enable them to develop Virtual Learning Centers with Learning Object Repositories as the starting point towards effective ICT use for learning.

Organization and Management

ARD Institutions in the region are now overcoming infrastructural issues and are facing problems in operationalizing ICT enabled information systems. It is expected that they will also face and will need to solve coordination and control issues including IPR in their ICT enabled information systems.

Transformation of institutions and emergence of new institutions, structures and processes are now vital to bring effective ICT use and ICM in ARD. ICT use brings new forms of institutional governance and institutional governance affects ICT use. The critical challenge is to integrate ICT in work and business process of ARD Institutions to generate useful, relevant and credible information for user communities.

Content Management

Among several workshops, observatories and meetings related to development of information systems for ARD, content management emerges as a major recommendation. However, this subject is vast and cannot be dealt as a "generic" recommendation. There is a need to specify content management needs at the information service such as STI or for extension and outreach as also at each system component level i.e. the information organization, the information platform, the intermediaries and at the user community in an integrated manner.

As collaboration develops among ARD Institutions at the national, regional and global levels, the need for data and information exchange standards and governance structures, especially related IPR, becomes critical. Regional and International ARD Institutions must start considering the development of these standards, structures and governance Institutions.

The focus in content management is shifting from document management to information objects management. There is an urgent need to develop capacity in this area.

Infrastructure

There is a shift from hardware and software centric infrastructure development as PCs become more ubiquitous in the NARS. The need for broadband, persistent connectivity not only of Internet but through wireless and cellular technology for ARD Institution many of which are located in rural areas now needs to be satisfied. Policy makers need to be sensitized that these ARD Institutions can emerge as major information platforms to satisfy local information needs not only in agriculture but in health, education, governance etc. if they are better connected.

User skills in the region are now more widespread. However there is a growing realization that access to information is not synonymous to access to ICT but includes the ability to use information for action. These need new capacities to be developed in user communities. In ARD Institutions, technology, information and communications management skills remain a pitfall. Public sector ARD Institutions in the region are not able to retain more qualified and experienced staff in ICT.

Regional Networks

Regional networks now have the critical role to add value to regional sharing and exchange of information. They also have to play a role promoting, through sensitization, awareness and capacity building in ICT use in Agricultural Policies and Strategies at national and regional levels. They need to play a central role in developing conceptual frameworks for effective ICT use and in building networks to share information, knowledge, skills and resources in ICT use for ARD. Regional organizations are also emerging as Asia and sub-regional level information centers. They must initiate collaborative research in GIS, Simulation Models, Knowledge Bases, generation, sharing and exchange of Information and Learning Objects and providing repositories for these objects. Regional networks have a critical role in standardization and governance for information exchange and sharing in the region and in enhancing the evolution of information networks to knowledge networks.

While the Asia-Pacific region has seen significant development in ICT use and ICM for ARD there is still remains major information gaps on the status of ICT use in ARD in the Asia-Pacific region. There is no formal effort to evaluate this status. There is also no widely accepted framework that can enable an objective assessment and monitoring of ICT use in

ARD in the Asia-Pacific region. An assessment and continued monitoring is vital as the potential of using ICT in agriculture and rural development is now universally recognized.

The common issues that emerge at NARS level in enabling ICT use in ARD based on discussion held in the APAARI Expert Consultations in 2000, 2002 and 2003 are:

- How to prioritize ICT use in ARD for maximum effectiveness? In view of financial and skills constraints should the focus be on ICT use in:
  - Scientific and technical information?
  - Research data management?
  - Research Management?
  - Extension and Outreach?
  - Agricultural education?
  - Enabling communication and messaging between Institutions and/or Researchers?
- What should be the strategy?
  - To provide NARS Institutes with appropriate infrastructure?
  - To focus on generation of digital content for NARS clients?
  - To develop computer use, ICT and ICM management skills?
  - Or appropriately combine all the above?

The principal role of ICT in ARD is to integrate information content to satisfy the needs of agricultural communities and participants in agricultural commodity chains, connecting people who generate and use innovations and enable learning at individual, household and community levels. The use of ICT also enables breaking of conventional institutional, geographical,

disciplinary, commodity and similar boundaries in the exchange and sharing of information, knowledge, skills and resources. The use of ICT enables "glue" the NARS by strengthening existing linkages and bringing new forms of linkages. They are also enabling evolution of "agricultural innovation systems" at various levels and in replacing the current NARS centric approaches in ARD and giving rise to something new in sharing and exchanging innovations globally. Regional collaboration and cooperation for ICT management and ICM hold great promise in contributing to agricultural development in the region.

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Annexure I: Summary of Country Reports

Using the various country reports provided by NINPs, APAARI has developed a regional summary table (Table 7, page 92) for a general classification of various NARS into categories based on the extent of ICT/ICM use in ARD.

Australia

The status of ICT application in Australia's ARD System appears to be much better than most of its Asian counterparts. ACIAR considers information management and communication very important to its core business. Technology is used throughout the organization to assist with project and information management. It reports that the amount of electronic communication has increased dramatically in recent years and has become more important than the telephone and fax. An electronic document management system (EDMS) has recently been introduced to help organize electronic information. ACIAR communicates its project research through contribution to several international agricultural on-line databases. These include:

a) ARRIP – Australian Rural Research in Progress; to which ACIAR contributes project inform it's project information system

b) DAI – Development Activity International, run by IDRC in Canada, to which ACIAR contributes project info from it's project information system

c) ABOA – Australian Bibliography of Agriculture, ACIAR's conference proceedings and monograph series are represented here at both the individual paper and the whole project level

ACIAR has also begun to contribute to the Australian Federal Government AusInfo publications on-line database.

Among the challenges the ACIAR reported in its 2000 status report were with its partner countries who have limited bandwidth and a lack of technical expertise and equipment. Similarly, training of ACIAR staff had also become very difficult, as the organization structure requires staff to be skilled in a large number of software packages.

Bangladesh

Bangladesh, as per its status report in 2003, still had a very nascent ICT application in ARD. Though the cellular telephony initiative, Grameen Phone, in rural Bangladesh has gained international recognition, its use for ARD is not reported.

Bangladesh Agricultural Research Council (BARC) through its Agricultural Information Centre (AIC) serves information needs of the country's research system. AIC is concerned with identification, collection, processing, storage and dissemination of agricultural information in Bangladesh. It provides information and documentation services to the scientists and related professional within the NARS and other government and non-government organizations. AIC has developed a national agricultural information database, which contains about 13000 Bangladesh literature published since 1975 and is being updated regularly. BARC has a Geographical Information System (GIS) project, which is aimed at providing data support to the scientists, extension agents, policy makers in respect of research programming, location specific production planning and providing advisory services to the government on land use and disaster management in agriculture.

An attempt was made in early nineties to formalize a National Agricultural Information System (NAIS) in Bangladesh. The goal of the NAIS was to maintain a national cooperative communication network and information collection and exchange system in support of the NARS in order to assist in the advancement of all areas of agricultural research and

development. But project could not be implemented mainly due to financial constraints.

BANSDOC initiated a project titled "Automation and Networking of Science and Technology Libraries in Bangladesh" in March 1995 with the objective to facilitate exchange and sharing of Science and Technology information resources of the country and the world at the shortest possible time. BARC, as a member of this network, contributed its information resources to the system. But the objectives of the project have not been achieved.

South Asian Association for Regional Cooperation (SAARC) comprising of Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka established SAARC Agricultural Information Centre (SAIC) in 1989 at the BARC campus, Dhaka. The contribution of this centre to ARD appears to be marginal as can be gathered by a visit to its website.

Bhutan

There is very little information available on the application of ICT to ARD in Bhutan. In a report made in an APAARI training workshop for development of NAIS in 2004 it was stated that ICTs are primarily used for messaging and communication by Ministry of Agriculture. A website is under development by the Ministry.

Cambodia

Telecommunications infrastructure in Cambodia beyond urban centers such as Phnom Penh is extremely poor and is a major limitation to application of ICT to ARD. The Cambodian Agricultural Research and Development Institute (CARDI) has initiated development of a website.

Fiji

There is very little information available on the application of ICT to ARD in Fiji. In a report in workshop organized by the Asian Productivity Organization, Fiji indicated issues related to ICT applications to ARD as:

- Lack of financial support
- Unequipped extension centers
- Shortage of skilled and expertise manpower for designing and using data programs or far making use of internet in the governmental extension system/lack of attention to its application.
- Lack of integration and coordination with research and extension for the production of qualitative information materials.

India

From 1991, India has initiated programs to develop an Agricultural Research Information System (ARIS). More than 400 ARIS cells have been created at each ICAR Institutes(49), Project Directorates(10), National Research Centers(27), State Agricultural Universities (SAU; 32), Zonal Research Stations (ZRS; 120) and Colleges(170). Every campus, including SAUs and their ZRSs as well as ICAR Institutes and Project Directorates have been provided with a LAN server and PC workstations with associated LAN cabling.

An Agricultural Research Personnel Information System (ARPIS) has been developed to maintain computerized bio-data and service history of scientific staff working at ICAR institutes. ARPIS is being expanded to include technical and administrative staff of all ICAR institutes and upgraded to web-enabled system. Agricultural Research Financial Information System (ARFIS) is a another software package developed under ARIS which can maintain computerized monthly accounts of all ICAR institutes

and ICAR headquarters, grants to SAUs, All India Coordinated Research Projects (AICRP), A.P. Cess Fund Research projects, Revolving Fund schemes.

The ICAR website www.icar.org.in provides information about the ICAR and it's research activities in addition to linkages to all the institution under Indian NARS.

India has several NGO and private sector initiatives to use ICT for ARD. The Status report to APAARI lists several of these initiatives.

In the application of IT to agriculture, for India, the ultimate goal is to develop an agricultural research and management support system based on the multitude of information available from national and international sources in electronic form through connected computer networks or Internet. The basic steps taken in India to achieve these aims are:

- **Intranet and strengthening of Internet connectivity** within ICAR/NARS is essential. Electronic connectivity has been provided to all the institutions under NARS, but the bandwidth available is not sufficient and needs to be improved for better access to the national & international resources related to agriculture.
- **Development of e-Extension Infrastructure:** An ambitious program of e-Extension by connecting 200 selected Krishi Vigyan Kendra (KVKs) and 8 Zonal Coordinating Units (ZCUs) through an Intranet and Internet has been taken-up by ICAR to strengthen these selected KVKs to enable them to deliver extension services through cyber media using Internet technologies. These KVKs will be developed as Information hubs by providing Servers, computers with UPS, printer, scanner with OCR, provision for small LAN, e-content creation and trainings. These KVKs will be provided Internet connectivity for global access and enabling them to act as gateway to locally

relevant agricultural extension information. They will be developing basic user training modules for IT users of extension services. The ZCUs would also be connected, so that they can effectively monitor the extension activities of these KVKs.

- Well-equipped **Information nodes with Internet access at all levels,** including village information kiosks are indispensable for any meaningful information system for agriculture sector. There are 500,000 villages in India. Village information kiosk is supposed to be an Internet connecting node with minimum facilities to link to Internet and provide access to databases and information sources. These kiosks are to run on paid basis like STD/ISD telephone booths. Some of the states viz., Andhra Pradesh, Maharashtra, Karnataka, Madhya Pradesh, Kerala, Tamil Nadu etc. have already established such kiosks which are growing at fast pace.
- Simultaneous **human resource development (HRD)** by motivating, providing training, exposure through technical discussions/seminars/workshops, developing off-campus global learning centres on Internet and access digital libraries etc. This is necessary not only in the uses of available information but also in the methodology of developing computerized information sources in the field of their own specialization in the shape of credible Databases, Expert Systems & research support Modules.
- Conversion of existing valuable research experience and proven results into electronic form in order to evolve a comprehensive knowledge base. Generation of data warehouses of agricultural research, production, management and marketing data with suitable query system can go long way in achieving these objectives. Tools of system analysis, object oriented techniques and query processing are necessary. Data warehousing provides complementary technology for strategic/tactical

decision-making by data synthesis, data analysis and consolidation, multidimensional data analysis using knowledge based techniques to extract meaningful information out of huge listless data.

- Development of Management Information System (MIS): The development and implementation of MIS calls for highest level of intervention in an organization, since during the process one has to reengineer the Business Processes of the organization so as to draw maximum benefits from MIS. If the business processes are faulty, the MIS is not expected to give tangible benefits. Therefore, implementing MIS is a formidable challenge to the management of the organization, as it requires re-alignment of business processes and simultaneous computerization of the working system. The MIS should be capable of capturing data at the point of data generation, processing and analyzing the data captured, and generating the suitable reports required by management. The ICAR having the multiple responsibilities of carrying out agricultural research, education and extension of research results to farmers field poses a challenging case for MIS implementation.

Indonesia

Indonesia, like many other Asian countries, has problems with Internet connectivity in its rural areas. While cellular telephony has shown significant growth, Internet connectivity in rural areas is limited, costly, with poor bandwidth and quality of connection.

The Centre for Agricultural Data and Information (CADI) is one institutional unit under direction of the Ministry of Agriculture (MOA). The main tasks of CADI is to develop and operate agricultural and agribusiness information system and provide services on agricultural data and information. Since 1996, a computer network backbone at MOA head office in Jakarta had been installed and has one corporate account for

Internet access, so that each working unit at MOA head office can access Internet and communicate to each other through an e-mail system. Each provincial and district office should have had its own account for Internet access as well, while central office had to provide guidance and training. However, until now, many of the district offices do not have connection to the Internet due to the technical problems such as lack of people who have skills to use Internet, and some of the districts do not even have Internet service provider. So far, there are 78 districts, and five provinces in Java which have been provided two computers connected to the Internet, while provinces and districts in Sumatra is expected to follow by the end of 2003.

The following are the list of problems related to the Internet utilization in agricultural information dissemination in Indonesia in general according to Billah (2003):

- Many of the management levels especially in provincial and district offices have not understood the important of Internet as powerful media for information dissemination, and still many of them think that the use of computer is only for replacing traditional type writers.
- Many agricultural local offices have not been equipped with sufficient numbers of computers and printers, or even the computers that they have is very old one that they can not use it for Internet access.
- Many staff at local agricultural offices including farmers still do not have enough knowledge and skill to exploit the cyber world to improve agricultural productivity and competitiveness.
- Many of government officials especially those in regional are not aware of the power of information in agribusiness development.
- Many districts or district areas have not been reached by Internet service provider (about 30% of the total districts),

especially in rural areas. Up to now there is no ISP which has the service that covers all districts or cities.

- There are still many complaints regarding the slowness of the speed of Internet access.

Iran

The use of ICT is developing rapidly in Iran. However, its application to ARD largely remains at the planning and/or implementation stage because of poor ICT infrastructure and weak ARD organizations. The Agricultural Research and Education Organization (AREO) is attempting to organize its ICT application plans. AREO and its research and development Institutions have websites.

Japan

Japan is a developed country. Its ICT infrastructure and application in ARD is far advanced than most other countries in Asia. However, very little official information is available about the status of ICT applications in ARD.

Laos

The infrastructure for Internet based communication in Laos is weak. The Ministry of Agriculture and Forestry and the National Agriculture and Forestry Research Institute are developing their information systems for ARD.

The main constraints are:

- Scarce resources and human skills
- Lack of Technical skills
- Very few detailed studies at the local level (watershed level)
- Insufficient data in the local level
- Weak linkages within and across ARD organizations
- Coordination with other organizations is weak

Malaysia

Although Internet technology is rapidly expanding in Malaysia, ICT development and Internet accessibility and connectivity in the agricultural sector have been confined largely to within the Ministry of Agriculture, its departments and agencies, research and educational institutions and a few major private agencies involved in agriculture. The Ministry of Agriculture, Malaysia has spearheaded the utilization of information technology and Internet services in agriculture through the setting up of its Malaysian Agriculture Information Highway, the *Agrolink* (www.agrolink.moa.my). This agricultural information resources site launched in early 1995; is probably the first in Asia to go on-line provides information on the Ministry, its departments and agencies and the agriculture industry in Malaysia as a whole.

The focus of ICT initiatives in the Ministry of Agriculture is to support the establishment of institutional framework needed to facilitate the public-private sector consultative and collaboration mechanisms as outlined in the National Agriculture Policy. This includes the establishment of Business Development Center; a one-stop center electronically linking the four Departments and eight Agencies in the Ministry with other relevant focal points for more efficient communication services. The *Agrolink* portal and the Integrated Commodity Information Service are constantly being enhanced to provide local and global information more efficiently and to become the tools for rapid communication for all parties involved in agricultural development in the country. To accelerate the development of information intensive and knowledge-based agricultural industries, several community-based portal such as *Taninet* (www.taninet.com.my), Akisnet (www.akisnet.com.my) and *Padinet* (www.padinet.com.my) were also developed. Other sources of electronic agricultural information include Mardinet (www.mardi.my), the Homepages of MPOB (www.mpob.gov.my), The Cocoa Board of Malaysia (www.koko.gov.my),

Malaysian Rubber Board (www.lgm.gov.my) and FRIM (www.frim.gov.my).

Despite this encouraging development, as a whole the usage of ICT in agriculture in the private sector is still at its infancy with only large companies investing some form of ICT facilities to enable Internet access to their information systems while most of the medium to small size companies and most farms and estates of smallholders do not have extensive ICT facilities to aid their agricultural activities. Nevertheless, a few databases and system tools have been developed by CABI International in collaboration with local research institutions such as MARDI which have become useful sources of information in agriculture development. MARDI has established a Research Management Information System.

The issues related to ICT application in ARD in Malaysia also related to connectivity, relevant content and human capacity development as also public awareness of the impact of ICT in agriculture.

Mongolia

Mongolia, like other Asian countries, have problems of connectivity across its vast expanse. Efforts are being made by the Ministry of Food and Agriculture to establish a multi-purpose agricultural information system.

Myanmar

The ICT infrastructure and ICT application for ARD is very weak in Myanmar. Efforts are however being made to strengthen and use ICT for ARD. Myanmar has similar issues such as connectivity, human capacity and content as several other Asian countries in application of ICT for ARD.

Nepal

Communication infrastructure in rural Nepal is weak. The Nepal Agricultural Research Council (NARC) has planned and initiated activities to use ICTs including Telephones, Fax and the Internet in its organization. At the project GIS and Expert Systems are being developed and used at the community and farmer levels.

Pakistan

Over the past almost 20 years Pakistan Agricultural Research Council (PARC) has been supplementing the ICT resources of the agricultural research and academic institutions in the country. In 1991, PARC implemented a USAID Project "Management of Agricultural Research and Technology (MART)" for Agricultural Libraries Strengthening Programme and libraries of 21 major agricultural R&A institutions in the country were strengthened. They were provided IT equipment such as computers with CD-ROM units, printers, microfiche/film reader/printers, photocopiers and copies of selected international databases on CD-ROM and back volumes of selected journals. The libraries and information professionals of these institutions were trained in the use of equipment and facilities provided as well as in modern information handling techniques. As a result of these deliberate efforts, the Council is now promoting and participating in the use of ICT at four levels: PARC level; the national level; the regional level and the international level.

The Internet and E-mail both are being used extensively in the agricultural research sector. With the spread of internet facility to more than 1,100 cities, towns and locations of Pakistan and with the expected explosion of this facility, the number of towns connected is going to be doubled in the next two years and the number of users to surpass 500,000 from the present 200,000 users. The new concept of satellite Internet/cable is also gaining popularity in Pakistan for information, education as well as entertainment.

There are about 25 major databases on Pakistani agriculture developed and maintained by various public and private sector organizations. PARC is the pioneer in the introduction/use of agricultural databases in Pakistan like AGRIS, CARIS and CABI etc. The Scientific Information Directorate, NARC is the first National Liaison Office for AGRIS of FAO network in Pakistan. Similarly, PARC is the pioneer in the development of indigenous agricultural research databases in the country. Pakistan Agriculture (CATPAK) is so far the largest database on agricultural research with more than 44,000 bibliographic records and abstracts. In total, 11 in-house developed databases have been uploaded on PARC website.

The main issues related to ICT application for ARD in Pakistan are:

- Lack of resources to acquire ICT equipment
- Relatively high cost of hardware/software
- Lack of trained manpower and brain drain
- Rapidly outdating ICT
- Lack of computer-readable material for sharing
- Agricultural libraries need computerization
- Low literacy rate
- Poor quality of service by electricity and telephone departments in rural areas.

Papua New Guinea

Papua New Guinea is making significant efforts to apply ICT applications in ARD. It has established a Research Management Information System and is upgrading its library systems by incorporating ICTs and developing a virtual library with links to Australian Agricultural Information Systems. However, poor connectivity, content, human capacities and capital investment limit progress in the use of ICT for ARD in this country.

Philippines

The Philippines, like several other countries in Asia, have embarked on a plan to use ICT applications for ARD. While there have been significant successes such as the Development Support Communication Project and PCARRD driven initiatives, the same issues as in other countries dog the Philippines in applying ICT to ARD namely connectivity, content management, capacity and capital for investment in ICT enabled information systems.

Chinese Taipei

Chinese Taipei falls in a group that includes Japan, Korea and Australia in their ICT infrastructure and application for ARD.

Thailand

The Department of Agriculture (DOA) has established DOA Information Services Center (DISC) with the aim of facilitating the internal network development, update contents structural, lay out a service model for major users groups and provide new ICT for information and knowledge bases dissemination. The establishment of DISC was approved by DOA as a part of DOA-IT Master Plan, on November 1, 1998 and is being implemented. The main objectives of DISC are servicing the agricultural information needs by various group of users name as: farmers, agricultural products exporters, agro-industry sectors and researchers. The information provided should be the knowledge sources for the production sites to enhance the contribution to food security and poverty eradication through research promoting sustainable agricultural development based on the environmentally sound management of natural resources.

In Thailand, there are a large number of organizations currently involved in data collection and information processing related to agriculture, markets for agricultural products and resources rewired for agricultural production. This applies to all technical

departments within the Ministry of Agriculture and Cooperatives (MOAC), national and regional research organizations, universities, donor-funded projects, and private sectors. There is very little coordination of these efforts and the transparency and reliability information provided is often inadequate. Recent studies and assessments carried out within MOAC confirm a high degree of heterogeneity and frequent overlap of available data. High quality, up-to-data data sets co-exist with poor quality or outdated data, data collection methods are not uniform and there is a lack of common data standards and coordinated data management efforts. These problems leaving users uncertain about data quality and availability and limit the possibilities of combining data from different sources. This lack of transparency and the cumbersome information exchange procedures have led many agencies to produce their own data independent from and ignorant of the efforts of other parties.

The urgent needs for developing and setting up a shared information repository, inventory, translator and information exchange network are crucial. MOAC should be a central body for nation cooperation between information providers and set the full benefits for all users. As the National Agricultural Information Portal has been established the international linkages should be easily plug-in.

In addition to the content management issues, Thailand has a major problem in generating human capacity to apply ICT for ARD.

Timor-Leste

Timor-Leste is among the youngest countries of the World. Its ICT infrastructure is still undeveloped. It has very little human capacity in developing and using ICT enabled information systems for ARD.

South Korea

South Korea has a well developed broadband connectivity infrastructure and has applied a content centric strategy to provide through ICT enabled information systems. The South Korean Model for ICT enabled information systems need to be emulated by those Asian countries where Internet connectivity is rapidly spreading.

Sri Lanka

The Sri Lankan Council for Agricultural Research Policy has been promoting and supporting ICT applications for ARD. CARP was among the early adopters of ICT for research management in the early 1990s. CARP with the assistance of the GTZ Project with grant-aid from the Federal Republic of Germany has developed a Local Area Network (LAN), an agricultural database, and provided training for staff in GIS; thereby transforming and upgrading the existing systems of communication from the Secretariat. CARP is now building a "Virtual" or "Electronic Library" for the benefit of the Scientists of the NARS. CARP is also the coordinating center for the Agricultural Information Network (AGRINET), established in 1984, to promote sharing and development of resources of 30 libraries of NARS, agricultural research institutes and agricultural faculties of universities. AGRINET operates a number of resource sharing programs with the view of satisfying the information needs of agricultural scientists and technologists.

E-mail and Internet facilities are available at most institutes of Sri Lanka National Agricultural Research System (SLNARS). However, these services are based on dial up connections making the transactions slow and sometimes unreliable particularly at the remote locations where agriculture is based. Some well-placed institutes have set up websites giving information on their objectives, services and staff particulars. Most of these are static and without linking to on-line databases.

Sri Lanka in its reports to APAARI emphasizes the urgent need for capacity development for ICT applications for ARD.

Vietnam

Vietnam has a rapidly improving ICT infrastructure. However, ICT application for ARD is handicapped by its ARD organization which is at the moment undergoing structural change. Significant progress has been made by the Information Center for Agriculture and Rural Development (ICARD) in recent years in applying ICT for ARD in Vietnam.