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**International Consultation on
Agricultural Research for
Development and Innovation:
*Addressing emerging challenges
and exploiting opportunities
through Information and
Communication Technologies***

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INTERNATIONAL CONSULTATION ON AGRICULTURAL RESEARCH FOR DEVELOPMENT AND INNOVATION: ADDRESSING EMERGING CHALLENGES AND EXPLOITING OPPORTUNITIES THROUGH INFORMATION AND COMMUNICATION TECHNOLOGIES

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ICRISAT, PATANCHERU, ANDHRA PRADESH, INDIA

INTRODUCTION:

In an ever-increasing knowledge intensive agriculture, information is now even more critical for the resource poor, small holder farmers and producers of the world. This is for the simple reason that they do not have adequate resources and need to maximize their productivity and profit from whatever resources they have for their livelihoods and sustenance.

The information that these farmers now need and will need in future is not only about how to grow a crop or improve productivity of a crop. It now relates to optimizing whole farm productivity and profit as also off-farm employment since many of these farmers and their households depend on off-farm activities for their livelihoods. Many a times, this approach needs to be extended to whole communities since the community shares most of the natural resources needed as also the risks for farming and collectively affect the environment through farming activities. Optimizing whole farm productivity and profit and their aggregates at the community level, requires a thorough understanding of long term sustainability of the “farm”, a term that still defies consensus in definition. Add to this the political, social, especially around literacy and empowerment, technological and environmental constraints and barriers faced by farmers and their communities, and this makes the resource-poor farmers’ information needs complex. The environment of changing public policies, support prices and influences of global trade add further to this complexity.

In more simple terms, the resource poor farmer needs to know what, how, where and when to grow crops or raise animals in her/his farm, how to add value to the product and how best to market it so that she gets maximum long term profit. She needs to know where she can get the inputs necessary for her farming, their assured availability and access as also ease of access and their costs. She needs to know what the return on investment will be for

a mix of crops and animals grown or raised on her farm will be in the long term. She needs options for her farm and her problems in farming. The problem for her is where and how she can get all the information she needs to manage her farm and use it effectively. This is where conventional extension (a linear process of informing from a researcher to a farmer through an extension agent) and the transformation that is now needed in servicing information, knowledge, skills and technology needs of today's farmer diverge.

The main phases of the agriculture industry are: Ensuring appropriate inputs, crop cultivation and farm management, water management, fertilizer application and fertigation, pest management, harvesting, post harvest handling, processing and packaging transporting of products, preservation, processing for value addition and quality management including in case of food, its safety, appropriate storage, marketing and enabling consumption. All stakeholders of the agriculture industry and agribusiness including agricultural policy makers now need information and knowledge about these phases to manage them efficiently.

In the recent regional consultations for the Global Conference on Agricultural Research for Development (GCARD 2010), farmer organizations such as of the Central Asia and South Caucasus and the Asia Pacific region made demands for application of cutting edge technologies for their development. In ICTs, they wanted applications for whole farm productivity and economic simulations, knowledge based decision support systems, the ability to access and use information for risk assessment and mitigation including that for climate change, the use of geographical information in planning and monitoring their agriculture and market related information not only of prices but of appropriate options for increasing productivity and profit and for ensuring food safety and appropriate information for consumers.

APPLICATION OF ICTs IN AGRICULTURE AND AGRICULTURAL DEVELOPMENT

Application of new and contemporary information and communication technologies in rural and agricultural development has been advancing quite rapidly over the last decade. An analysis of published research literature in this area reveals a 10-year growth of about 2000 percent. However, the Agricultural Research-for-Development (ARD) community is not perceived to be in the lead or playing a key role in this area. The value and effectiveness of ICTs in supporting greater involvement of stakeholders in research and technology generation is often dismissed, as indicated in the complaint that *"the use of ICTs to connect sources of agricultural innovation to users, especially farmers, is considered to be limited by lack of connectivity, especially to the internet, in rural areas in developing countries"* and therefore not invested in. (Maru and Ehrle, 2003).

The perceived limitation of effectiveness of ICTs in this regard is often due to definitions of ICTs which narrowly focus on highly sophisticated hardware and internet-based

applications. Contemporary analyses accept that ICT's when applied in rural development would include, besides hardware, software and applications, processes for digital content generation, management and presentation (to the user), knowledge management and sharing and aspects of Institutional, organizational and community structures, processes and management of continuous change in all these aspects. We broadly term this blend of practices and processes as Information and Communications Management (ICM) where digital technologies play a significant if not dominant role.

The progress in hardware, software, connectivity, data management and integration of computing systems enables new forms of data gathering; both human assisted and automated. It is bringing new capacities for processing data and information dissemination. In future, this process of connecting communities or "social networking" to new knowledge and information is likely to accelerate with advanced technologies which bring far greater processing powers, robust, reliable, storage capacity and connectivity.

This progress will also enable new forms of participatory science and research, extension and learning to those within agricultural communities who are not yet included in these processes. Extension, as it is understood now as being "linear" from research to farmer through extension agents will be as in a network with pluralistic sources and users of information and knowledge Learning, infused with local or specific as well as global information, will be ubiquitously available and pervasive for all in a community. It will change the realm of agricultural science and its impact on development, where it will not be only the formally educated scientists who bring new technological innovations but whole communities who do so. All within an agricultural community will be both producers and consumers of information and innovations.

SIGNIFICANT GLOBAL INITIATIVES IN ICM IN ARD OVER THE LAST DECADE:

Over the last decade a series of international workshops and consultations have been organised and commitments have been made by a wide range of organizations. Significant ones include the GFAR Triennial conferences, the ISNAR 2003 workshop, two multi-stakeholder workshops on International Information Systems in Agricultural Science and Technology (IISAST) in 2005 and 2007, the Global network on RAIS (Regional Agricultural Information Systems), and the GFAR-led workshops on ICM4ARD. FAO has realigned its existing initiatives such as the AGRIS network and brought forward its work on Agricultural Information Management Standards (AIMS). The CGIAR has implemented ICM projects involving domain-specific research (e.g. biotechnology, GIS applications, learning resources management). Specific regional and international "ICT for Agriculture" associations (e.g.

IAALD, AFITA, EFITA, WCCA etc) have held seminars and conferences, to consider in detail the challenges in the adoption of ICT in ARD and have formulated a number of initiatives. The EFITA study on ICT adoption in ARD of many countries of the world has produced valuable insights. Detailed studies on adoption from various countries of Asia were considered in detail in an AFITA conference in 2006.

In summary, the key insights emerging from this set of conferences were:

- ICT uptake offers many opportunities but still remains a major challenge;
- the consequences for not using ICT are recognized as serious;
- the economic benefits of ICT are not always perceived;
- Training in how to realize economic benefits from ICT is paramount;
- Public funding for such ICT training is justified.
- Top-down approaches in adoption of ICT need to be coupled with participatory, bottom-up approaches for greater success
- Digital inclusion must be an a priori policy and market forces alone cannot guarantee such inclusion and wide adoption of ICT
- Research is needed in identifying practical solutions for ICT uptake
- End-user needs coupled to national policies should determine ICT compatibility

The above meetings indicated that the main challenges are in advocating increased investment and targeting it appropriately, generating and managing content that is economically produced and affordable to all involved, rapidly building capacities and bringing organizational change towards more efficient and effective information flows. It also led to the launching in 2008 of an international multi-stakeholder initiative on Coherence in Information for Agricultural Research for Development (CIARD), co sponsored by all the main international organizations and regional forums that had been involved in the discussions to meet these challenges. The CIARD vision is “to make public domain agricultural research information and knowledge truly accessible to all”, with the partners share the common objective of working together to collaboratively develop common standards, share knowledge, and contribute to effective and coherent institutional approaches in agricultural science and technology information. The realization of this vision will contribute significantly to meeting the challenges facing ICM for agricultural research for development (ARD). A CIARD Manifesto and Values set were developed through a series of regional consultations in 2009 involving 150 people from 70 countries are now being advocated for adoption by all actors in ARD.

The Science Forum 2009 at Wageningen devoted significant attention to the role of ICT/ICM's in ARD in a specific participatory session which built on the findings of previous years as above. The ARD-relevant opportunities arising from ICT advances in recent times were the increasingly (a) ubiquitous connectivity (b) precise tools and applications (c) accessible data and information (d) diverse applications in the “cloud” and (e) interconnected knowledge bases.

The participants at this Forum believed that the current application of ICTs in agricultural science, research and technology generation can be clustered around:

- *Data Collection* – Enabling collection of agricultural and environmental data from biological and environmental sources, with or without human interaction.
- *Number Crunching* - Enabling management, sharing and processing of large datasets, modeling and simulation, image processing and visualization.
- *Geo-spatial applications* – Enabling data and information related to geography and space to be managed, processed and visualized
- *Decision Support and Knowledge based systems and robotics* – Enabling data and information to be organized with added experiences of experts
- *Embedded ICTs in Farm equipment and processes (Agrionics)* – Enabling greater efficiencies in farm equipment and agricultural processes
- *Connecting Communities and Enabling Learning* – Using ICTs to connect communities such as of farmers, researchers and all connected to agriculture and its practice.

The Forum identified the potential of ICT's to contribute to making ARD more inclusive through enhanced multiple flows of highly-targeted, location-specific and location-aware information. While recognizing the rise of new types of agri-preneurs who made use of new ICT developments, the Forum emphasized the need to take advantage of potential for delivery of various ICT-enabled services to rural people: such as market access, access to international export markets, traceability systems, mobile financial services and mobile extension services.

With this background, GFAR, in association with ICRISAT/CGIAR, FAO and APAARI organized an international workshop (7-11 December 2009, Patancheru, India) to consider the following core issues:

- What new strategies, policies, and actions are needed to enhance and sustain the adoption of ICM in ARD that contributes to the livelihoods of resource-poor farmers and other stakeholders in the market and value-addition chains?
- What needs to be done to make content available, accessible, applicable, affordable and appropriated/used effectively at all levels and among all the actors in ARD?

- How can ICM capabilities in ARD be sustainably developed across all the dimensions of enabling environment, institutions and individuals?
- How can investments be targeted effectively?

SUMMARY OF WORKSHOP OUTPUTS:

There were 53 participants, drawn from 25 countries and 8 international organizations. The event comprised an initial open “Market Place”, where a range of ICT-based activities and interventions were displayed and discussed. This was followed by a two-day participatory workshop, which started with scene-setting presentations on the main themes and issues for discussion and an overview of the outcome of the Science Forum 2009 (Wageningen), with the critical issues recommendations on strengthening the role of ICM to be taken forward to the forthcoming GCARD conference (Montpellier, March 2010). The participants then worked in groups to analyse and develop innovative the set of 18 possible future directions related to the three themes on ICTs in agricultural science that had emerged from the Science Forum, namely: (i) high return investments; (ii) high impact capacities, policies and institutions; and (iii) high impact innovations.

The groups presented and discussed their outputs in plenary, and the 18 original topic areas were then synthesized into a set of 14 priority areas for action. A summary of the action areas is provided below.

INSTITUTIONAL CHANGE

Change in organizations that generate, manage and disseminate information and enable learning for agricultural development is now an urgent requirement. This change has to be pervasive within the organizations enabling more rapid, inclusive, effective, efficient and economic information and knowledge flows. This requires changes not only in ICT systems but information management and communication systems, organizational structures including those of accountability and reward and in work processes wherein the main output is considered to be new information. There is a significant role for leadership in agricultural development organizations to understand the management of information and its flow in organizations with use of ICTs.

POLICY

Generate ICT supportive policy documents at the level of institutions and countries:

There is a pressing need for a compact and highly analytical policy document that sets forth various steps and measures that foster better streaming of ICT/M in ARD for its greater effectiveness. Such a document needs to be available at the national as well as at the institutional levels. Steps and measures to include:

- promoting linkages and exchanges between experts and workers in ICT and in agriculture, involving the staff of universities and NARS institutions
- setting forth core issues in contemporary digital intellectual property management in agriculture and outlining how awareness programs can be organized (these should include non-research personnel as well)
- emphasizing the importance of developing and negotiating standards in information exchange across stakeholders

To bolster all these measures, a compilation of good practices and success stories on the use of ICT/M in ARD should be made available. Special awareness sessions involving multiple stakeholders, especially the non-profits and practicing farmers, should be organized to seek their inputs and understanding.

Develop new and appropriate tools for Monitoring and Evaluation of Information and Knowledge Services for Agricultural Development:

A key gap is in the availability of tools and specific metrics for assessing the effectiveness of information and knowledge interventions in agricultural development through research and innovation. They are needed to focus better the ARD itself on outcome and impact, and to engender even higher levels of accountability. This is an area of known under-investment and policy makers perhaps have not paid attention to the existence of this gap. There is a need for tools that can help in measurement of technology impact generally and of ICT tools in particular. They should be part of or blended with appropriate systems for evaluation. The needs and requirements of different stakeholders in development of such indicators and tools must be considered.

INFORMATION CONTENT

Open Up Access: reliable and comprehensive:

All the proposed public sector investment actions need to be anchored in promoting a regime of Open Access (OA) to all data and information in ARD. This will make content

generation economic and affordable for use by all agricultural development actors and stakeholders. There are challenges in practice of OA in research since the mindset and habits are not easy to change; considerations as to who pays for research operate. The sheer volume of material to digitize is a disincentive in effort and costs, and often ARD stakeholders perceive that a vast portion of it may not be immediately relevant to farmers. The need to re-work intra-organizational work and information flows to facilitate OA mandates is also viewed by organization managers as a major challenge which is difficult to achieve. Notwithstanding the challenges, making available ARD data and information in substantial quantity via an open access route is critical to the success and sustenance of various innovations and investments just outlined.

Develop and negotiate standards for enhanced information and data exchange:

While investing in improved data handling and processing capacities, it is essential also to invest in the development of standards that can significantly improve the efficiency of interoperability and interchange of data across stakeholders. Re-use of data will add to the general efficacy of ARD and standards need to be developed or existing standards need to be adapted through negotiation. This set of actions will also contribute to more focused development of software applications and platforms that are specific to the ARD domain. Current capacity among ARD stakeholders in this regard is limited. The standards development processes must be seen to be neutral between suppliers and users of information. Standards change frequently and need to be upgraded to keep pace with technology developments and balanced with the modes of how the information may be used. The challenge of accommodating different human languages in standards development is still a formidable one. All such challenges should be considered in making the investment in this area.

BUSINESS MODELS

Foster innovative business models:

Emergence of new generation mobile technologies (including but not limited to smart phones) and the corporatization of this space of innovation requires development of new business models for application of ICT/M in ARD. They would be useful in taking advantage of the continuing reduction in unit costs in telecommunication and the opportunities for purposive social networking using technologies. They are also useful in attracting the corporate IT sector, which does not know agriculture well, into investing in ARD. Models that can offer a wide band of applications and involvement of public, private sectors and community organizations should be fostered, so that the costs of implementing them in other contexts can be minimized; they should demonstrate effective integration of subsidies, support as well as investments. Potential bias against small-holder farmers should

be guarded against, while over-investment in a narrow range of technologies should be discouraged. A culture of continuous innovation needs to be fostered.

PEOPLE – BUILDING CAPACITIES

Invest in Cross-sectoral Capacity Building: ICT experts in agriculture and ARD experts and extension personnel in ICT/M:

Capacity development in ICT/M on a significant scale is necessary to enable ARD researchers and innovators at all levels and extension personnel to make better use of a host of new developments, and to foster content generation in the digital realm in a substantial manner. Very large increase in digital content is almost a pre-condition for developing consistent and reliable information services. In the innovation systems paradigm, such capacities will be helpful in designing new ways of information exchange and services delivery among various stakeholders. More importantly, such coming together will make applied ICT research in ARD more focused and purposive. It is important also to invest in training of IT-Computer science specialists in ARD to foster development of agri-domain specific hardware such as soil nutrient sensors and software such as for small farm production and profit optimization. It is evident that new leaders are needed in bridging the expert-farmer communication and exchange gap, and cross-sectoral training is a critical. Ingrained habits of communication among extension personnel and organizational patterns in information management and exchange are not easy to change, and the best face-to-face communication practices in extension may not be transferable to the tech-mediated exchange. The solutions may also lie in face to face communications supported by those that are technology mediated and vice-versa. These concerns need to be addressed while developing capacity-building processes. There is clear lack of training materials in this regard, and incentives are not readily available. The possibility of ICT-trained ARD/extension personnel leaving the sector is not distant. The benefits, however, outweigh all such challenges.

Enhance investments in new knowledge and information intermediaries:

Current context of trade flows and resource degradation requires several disparate actors to come together in farming, and this coming together needs to be facilitated at various levels with skill. Rapidly increasing learning needs among the farmers also require that facilitators be accessible at appropriate levels. There are known limitations such as connectivity, or generation gaps and the like. Notwithstanding all these, investments in fostering new knowledge intermediation through use of technologies must be made. These initiatives should also be viewed as part of the efforts to reduce the high overhead costs in dealing with large numbers of farmers and their communities.

Innovations require new capacities to be built:

There is a clear need for the development of capacities covering the sectors of conventional outreach and extension and ICT. Such capacities, while not readily available, can only be developed with policy support and allocation of resources. ICT in ARD needs to be recognized as a professional curriculum in training and education, which enables combining ICT with broader agricultural development concerns. Few such efforts exist globally and sharing of experiences is to be encouraged.

INCENTIVES

Develop Incentives to Recognise ICT/M or Non-traditional Outputs in ARD:

Currently, ICT/ M efforts in ARD do not attract the same level of recognition as traditional outputs from agricultural research. This has led to poorer motivation for stakeholders to contribute to content generation. We need to develop a system of incentives to reward such non-traditional outputs in ARD, keeping open the possibility that some of the contributors may not be researchers but practitioners or farmers.

Create incentives for collaboration between ICT and ARD communities:

Special purpose competitive grants can be established requiring experts in ICT and ARD to work together. The policy document can advise international and national organizations on setting up such grants. Joint publications involving ARD and ICT research workers should be encouraged. International organizations such as the CGIAR should foster cross-sectoral communities and should provide with forum and standards for dialogues and exchanges. Online social spaces need to be utilized for this set of engagements.

TECHNOLOGY

Invest in greater data and information generation and handling capacity, hardware and software and in improved human-computer interfaces:

The ARD sector needs to invest more in data and information generation and storage, archiving and curation to ensure minimal duplication of research efforts. New technologies such as sensor networks need to be deployed to facilitate acquisition of near real time environment information; all such data needs to be processed and stored according to new and widely accepted protocols and standards in data management. There is inadequate investment, even when incremental and low cost avenues exist and are emerging rapidly such as through cloud computing, in appropriate hardware/ software and platforms for improved data storage, access and management and this is to be rectified by policy makers. While outsourcing is a common practice in industry in these matters, the ARD sector at present lacks the necessary capacity and needs to augment it.

Ensure that new ICT tools in ARD have clear purpose(s) linked to development impact:

The ICT based tools designers and users (who are likely to be from across sectors such as IT-CS areas and extension) should stay in active contact throughout the design and development process. The process should be inclusive of the stakeholders for whom the tools are being designed for. The preference is for non-proprietary, open source tools and platforms. Such design/development or adaptation process is essential for the ARD sector to conserve resources and time. The groups acknowledged that there would be challenges in making them easily available, and in rendering them affordable, accessible and applicable. The benefits here would outweigh the challenges. The dissemination or delivery process could infuse a continuous arrangement to check for the effectiveness of the tools and platforms and their usability by different user communities.

INFRASTRUCTURE

ICT in ARD should be integral to efforts at enhancing rural connectivity:

The rural areas are in urgent need of new investments and ICT access and availability can be a significant mover in these efforts. Building of general purpose ICT infrastructure in rural areas can offer great synergies with education and health programs. This will provide new opportunities for improved extension/advisory services and for farmer-farmer learning. The ARD sector can contribute to development of new standards for the organization and operation of rural information centers, and can help foster a new class of farmer-entrepreneurs that can mediate in information flows. This can also help understand the role

of information in value-chains using successful examples from countries such as India (e-Chouppal, Anand Model of Dairy Cooperatives) and Argentina.

The conclusion from the Workshop was to propose a Strategic Framework and Action Plan for ICM in ARD with a clear perspective on deliverables by the ARD community. This was endorsed by the participants.

STRATEGIC FRAMEWORK AND ACTION PLAN WITH A PERSPECTIVE ON THE DELIVERABLES

PREAMBLE

- There is a reassertion of commitments made since 1999 (starting from the FAO-GFAR Global Workshop, GFAR Triennial Conferences, ISNAR 2003 Workshop, IISAST Global Workshops in 2005 and 2007, Global.RAIS and ICM4ARD Workshops, CIARD Workshops etc) that the ICM in ARD community will
 - strive to make agriculture related information globally available, more accessible, affordable and applicable and contribute to enabling effective use of information by bringing greater relevance and usefulness, for (by) all ARD stakeholders especially the resource poor small holder farmers and producers.
 - will continuously improve information and communications management for agriculture related information, generation, storage, storage, processing and use of content in the most economical and effective manner and with equity of access and use by the global community

- will conduct research and contribute to innovation to improve use of ICTs and ICM for agricultural development and agricultural research for development

ACTION ELEMENTS

- To optimize the efficiencies in and to reduce the cost of content transformation and generation by:
 - A. Contributing to improving effective use of information by enabling learning systems, making information relevant and applicable, more accessible and universally available with equity to all ARD stakeholders
 - B. Bringing greater coherence, interoperability and integration of information systems, data and processes through appropriate norms, standards, rules, regulations, governance structure
 - C. Enhancing access to and sharing of information including considering issues of Intellectual Property Rights such as through increased availability of agricultural information as a public good
 - D. Improving security (for authenticity and integrity) of information systems and their content as also in the use of information
- Enabling new capacities for better information management and use by all ARD stakeholders across the world, especially poor, agricultural communities
- Enabling appropriate changes in agricultural development and research systems, Institutions and processes such as for greater, inclusion, collaboration and partnership and more equitable flows of agricultural information world wide through new Institutions for ICM for agricultural development at global, regional and national levels
- Providing appropriate advocacy for improving and increasing investment, especially public sector investment, in improving agricultural information and communication management, global sharing and exchange of information, new knowledge, skills and technology that contributes to agricultural development of nations and communities all over the world.

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