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Integrating information and communication technologies in the Iranian agricultural research system

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ABSTRACT

Capacity development is needed in the Iranian Agricultural System. Integrating information and communications technologies (ICTs) in the agricultural research system is an appropriate capacity development mechanism. The appropriate application of ICTs and information such as a National Agricultural Information System requires a systemically developed strategic plan based on identifying and recognizing system wide organizational implications. This paper explains the implications of integrating ICTs in the Iranian agricultural research system. To this aim, a survey research used based on qualitative interviewing with a selected sample, consisted of agricultural researchers and agricultural faculty members. After designing interview protocol and gathering information by interviewing with selected sample of agricultural researchers and faculty members (n=29), a qualitative procedure was used in order to analyse gathered information base on conceptual extracting and thematic categorizing of statements, including guidelines, expected outcomes, challenges and barriers of appropriate ICTs integration in the Iranian agricultural research system. Also, different phases of the ICTs integration process were explained in form of a pathway diagram. Finally, based on related Iranian lessons learned which explained in this research, some appropriate mechanisms for integrating ICTs in national agricultural research systems (NARS) were indicated.

Key words: *National Agricultural Research System, knowledge management, systemic integration, Iranian experience*

INTRODUCTION

Sustainable development of agricultural sector in Iran as a developing country seems as necessity for policy-makers and development actors. Iran is rich country in natural and agricultural resources. Existence of vast agricultural areas and highly diverse agro-climatic conditions provide an excellent opportunity for producing a range of agricultural commodities in Iran (Moghaddasi, 2004). Indeed, to attain sustainable agricultural production while conserving the resource base, the Government of Iran needs to develop the capacity of the national agricultural research system (Taeb and Keshavarz, 1999; Gharehyazi et al., 2003). According to empirical evidences, integrating knowledge and appropriate technologies in agricultural processes based on knowledge management approach and requirements of knowledge economy seems as a critical mechanism for enhancing sustainable agricultural development in Iran (Sharifzadeh et al., 2005). In order to meet challenges of food security, agricultural productivity and entrepreneurship enhancement, integrated sustainability, institutional reforms, globalization, continuing progresses of agricultural science and so on, it was necessary to develop an agricultural research system to the aim of generating and integrating information, knowledge and technologies in agricultural development process.

To attain sustainable agricultural production as well as conserving the basic resources, the Government of Iran draws an integrated agricultural education, research and extension system. Additionally, Iranian agricultural system has an institutional synergism with agricultural education and agricultural extension network. As the Iranian national agricultural research system as a nationwide network consists of several institutional stakeholders, including: agricultural and natural resources research centers that perform under supervision of Agricultural Research, Education and Extension Organization (AREEO), public agricultural university, faculties and collages of agriculture related to the Ministry of Science, Research Technology, Azad Islamic University and the others higher education centers which partially perform in line with agricultural research functions. Iran agricultural research system has internal linkages between mentioned stakeholders and farmer's organizations, also collaborative partnerships with international research centers and institutes (Taeb and Keshavarz, 1999; Gharehyazi et al., 2003).

> *Agricultural research systems and associate actors are enabling the institutions in agricultural development framework (Pretty, 1995), and plays unavoidable role in national innovation system in order to enhance capacities of knowledge-based development of agricultural sector (World Bank, 2007).*

In fact national agricultural research systems (NARS) are main sources of generation and development of technologies and knowledge in agricultural sector, as the linchpins of agricultural development (Dalrymple, 2000). In order to respond to emerge challenges such as trade and market liberalization, technological advances, environmental issues and institutional reforms, agricultural research systems need necessity reforms and integrate systematically, holistically and pluralistically into the comprehensive institutional network such as agricultural knowledge and information system (related to agricultural development area) or national innovation system (at national level) (Rajalahti, et al., 2005). Byerlee (1998) indicated some patterns as elements of an emerging paradigm for the national agricultural research systems. One of these elements is organizational development and developing the structural and management capacity of national agricultural research system (NARS). Considering the valuable capacity of ICTs, it seems that integrating the ICTs in national agricultural research systems can facilitate the process of organizational development of these systems.

An information and communication technology (ICT) revolution is unfolding. Its impact is greatest in urban areas of industrialized countries, yet ICT is just as important for sustainable rural and agricultural development. Successful application of ICT requires improved awareness among development actors such as extension workers, greater capabilities among development institutions such as extension, education and research organizations, a more cross-sectoral approach to agricultural information, and a more realistic model of technology transfer. At first, development actors must empowered and equipped with ICTs, in order to obtain advantages of theses technologies during providing services to their clients. Also, integrating ICTs in communication networks allows geographical distances to be overcome and evolution of emerging information society in the age of network society to be support. Technical know-how, continuous training and exchange of information are maintained by systematic realization of the opportunities afforded by advanced information technologies (Koutsouris, 2006; Stienen, et al.,2007).

Through the ubiquitous use of ICTs, agricultural research organizations and institutes enhance their institutional capacities. Definitely, the rapid changes that are taking place in the ways by which new information is published, stored, disseminated and retrieved using the rapidly advancing information and communication technologies have exacerbated the relative deprivation suffered by researchers in the developing world (Sreenivasulu and Nandwana, 2001; Arunachalam, 2002). The new ICTs have not just made each operation faster, but have brought about a greater synergy between these operations in ways unthinkable in the earlier era mediated by print on paper. More than facilitating the interaction between agricultural researchers, ICTs can effect on all aspect of NARSs, systemically. In recent years, we have seen tremendous developments in information technologies. These technological developments are the driving force behind the current enthusiasm by scientists and

information specialists alike to apply information technologies in agricultural research (ISNAR, 2002). Setting up appropriate standards for datasets and exchange of data and information in area of agricultural research and development within the country and between countries as between public and private sectors is an emerging need. Awareness and understanding of issues around intellectual property and ICTs management is required for collaboration and building of networks where data and information can be shared (Maru, 2002).

Research institutes in developing countries are now facing what we may call 'second generation' challenges. Less concerned with the technologies themselves, these relate more to the applications and uses to which the ICTs are put, the ways they are organized, and the ways in which ICTs are embedded in the wider policy, research, and outreach work of research institutes. In particular, as research systems become more diverse and multi-dimensional in their scope and institutional composition, connections and relationships need to be fostered among researchers, across research institutes, and with clients as well as other stakeholders (ISNAR, 2002).

The “iNARS: ICTs and National Agricultural Research Systems- e-Development at the Grassroots” workshop that was held at The Hague during 16-18th December 2002 caused some useful suggestions to improve ICT use in agricultural research, included development of:

- “Shared information spaces” where research data can be shared and exchanged,
- Skills for on-line partnership and collaboration,
- Standards for agricultural research data,
- Capacity for small countries and NARS to negotiate and implement standards, and
- Awareness and training for intellectual property management in NARS.

Preparing an action plan and systemic policy-making seems as necessities in process of integrating ICTs in NARS. Considering to these necessities, the Agricultural Research, Education, and Extension Organization of the Islamic Republic of Iran in cooperation with ISNAR formulated an information policy for agricultural research (ISNAR, 1999). Systemically, the process of institutionalized integration of ICTs in agricultural research system must be in line with the concept of agricultural research information system (ARIS). An ARIS can be defined as a system that enables digital connectivity among institutions and stakeholders engaged in agricultural research within countries for sharing scientific, technical and research management information; and supports, in full or part, the infrastructure and services for electronic massaging and communication among participating institutions (Singh and Pal, 1998). Indeed, an ARIS aims to integrate and coordinate information flows and access in a country’s agricultural research system so as to benefit its stakeholders through informed research and development activities (Maru, 2002).

Certainly, any intervention in process of developing the NARS, including the ICTs integration in this system requires an institutional framework. This framework most explains the main components of the integration of ICTs in NARS, as a systemic process. Regarding to this comment, figure 1 demonstrates main interdependence components of the integration of ICTs in NARS, as: (1) Formulating an appropriate system-wide vision, related missions and common policy for systemically integration of ICTs in NARS; (2) Institutional supporting, training, management and leadership along with a prepared action plan for integration of ICTs in NARS; (3) Developing the ICTs infrastructure, hardware, software and networking; (4) Financing and providing resources; (5) Set up organizational mechanisms, such as a national committee or work force for integration of ICTs in NARS. This figure was considered as a guiding pattern for conducting this research, especially in order to prepare interview protocol and leading questions.

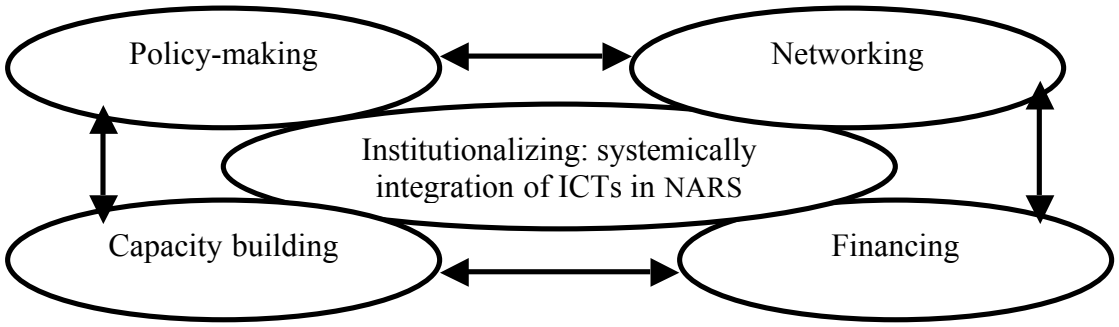

Figure 1: *Interdependence components of integration of ICTs in NARS*

METHODOLOGY

The major purpose of this research was to investigate main aspects of integration of ICTs in the Iranian NARS. Along to this purpose, a qualitative interview protocol was formulated in order to conduct a semi-structured interview as main approach for collecting appropriate data and information. This protocol was based on a main issue, as "integration of ICTs in the Iranian agricultural research system". Regarding to research propose and different dimensions of integrating ICTs in the Iranian agricultural research system, these leading questions included in the prepared interview protocol as axial themes of interviewing:

1. How do you think about the guidelines of integration of ICTs in the Iranian agricultural research system?
2. How do you think about the expected outcomes of integration of ICTs in the Iranian agricultural research system?
3. How do you think about the challenges and barriers of integration of ICTs in the Iranian agricultural research system?
4. What is the rational order of the process of integrating the ICTs in the Iranian agricultural research system?

The mentioned questions was considered and followed as research objectives. The research questions were formulated based on literature review about ICTs and situation of the Iranian agricultural research system and through an introductory interview with a selected expert, researchers and faculty members in subject area of information technology and management. Actually, the interview protocol included research objectives, main issue or theme of interviewing, selected questions, time table and location of interviewing, position of interviewees and interviewers, and coordination preparations.

Using a purposive sampling method, an appropriate and informed sample (n=20), including agricultural researchers of Agricultural Research and Education Organization (n=11) and faculty members of public agricultural faculties and colleges of Ministry of Scientific, Research and Technology (n=9) were selected and interviewed. Having Knowledge and information or practical experience related to ICTs in agricultural research area was considered as criteria of selecting

agricultural researchers and faculty members for interviewing. The interviews were done face–to-face and recorded by two type-recorders. During interviewing, interviewers tried to take some special and thematic notes. These notes were used during the analyzing phase in order to extract and categorize conceptual statements.

Analysis*:* After research interviews were done based on prepared protocol and leading questions, researchers tried to produce transcripts of interviews, in form of written texts. In fact, these written texts and the notes were taken during interviews, consisted the sources of data and information for analyzing. The transcripts of interviews were analyzed by reviewing the texts and notes, then extracting appropriate statements from the texts and notes, both directly and indirectly, or interpretively. The extracted statements were categorized based on their thematic relationship. Also, through conceptual reviewing and meaning interpreting the statements categories and based on a logical institutional order, the process of ICTs integration in the Iranian agricultural research system was explained in form of a pathway diagram.

RESULTS

In this research, interview's findings were analyzed in a qualitative manner. At first, in order to analysis research finding, notes and texts of interviews were reviewed and a list of thematic statements were extracted. After it, these statements were reviewed, screened and integrated based on conceptual proximity. Then, extracted statements classified to three categories. As follows, these categories formed in line with the research objectives as base of leading questions of interviews.

First category**:** Guidelines for institutionalizing the ICTs integration in the Iranian agricultural research system**.** This category consists of extracted statements of the first leading question of interviews:

- System-wide assessment of opportunities, challenges, personal needs and organizational contexts of ICTs integration in the Iranian agricultural research system;
- Strategic planning for integrating ICTs in the Iranian agricultural research system;
- Recognizing the competitive advantages and specific situation of different stakeholders of the Iranian agricultural research system, including agricultural research institutes, universities, private sector, etc;
- Formulation a national plan for ICTs integration in the Iranian agricultural research system;
- Strengthening the Public-private partnerships in process of ICTs integration in the Iranian agricultural research system;
- Planning for attracting the aids of donors and international actors of agricultural research and development;
- Facilitating participation of agricultural research actors, including researchers, managers, faculty members, and etc, in all stages of ICTs integration in the Iranian agricultural research system;
- Set up a national agricultural research information system based on appropriate application of ICTs;
- Networking through identifying interactions and feedback mechanisms among agricultural research actors;
- Appropriately financing plans of ICTs integration in the Iranian agricultural research system;

- Clarifying administrative and management procedures, rules and regulations for integrating ICTs in the Iranian agricultural research system;
- Analyzing information-seeking behaviors of researchers and another agricultural actors, including information needs, information sources, communication patterns, information channels, etc;
- Institutional supporting, including training courses, technical supports, providing incentives, promoting a pro-ICTs culture and learning environment in the Iranian agricultural research system; and
- Developing infrastructures of ICTs in the Iranian agricultural research system, including hardware, software and network infrastructures.

***Second category*:** Expected outcomes of institutionalizing the ICTs integration in the Iranian agricultural research system**.** This category consists of extracted statements of the second leading question of interviews:

- Improving process of scientific information and data exchange in agricultural research;
- Promoting scientific interaction and communication among agricultural researchers and sharing the useful information and experiences;
- Facilitating process of professional development of agricultural researchers through e-learning, e-reporting, facilitated accessing to scientific resources, information sources and communication;
- Taking advantages of international partnerships in terms of co-financing, co-planning, co-management, co-evaluation, coordinated implementation of agricultural research projects, priority-setting, monitoring, agricultural technology spill-out, etc;
- Promoting multi-levels and multi-actors collaboration in agricultural research;
- Developing management, coordination, partnerships and organizational capacities of the Iranian agricultural research system;
- Meeting information needs of agricultural research stakeholders;
- Improving information flows and communication patterns, such as availability, accessibility, relevancy, trustworthiness of information content, and synergistic diversity of information channels and sources in the Iranian agricultural research system;
- Empowering agricultural research actors to provide information, technology, knowledge and professional support to their stakeholders and partners, such as extension and education institutions, farmers, rural communities, etc;
- Systemically sharing and managing ICTs capacities in the Iranian agricultural research system through networking;
- Strategically integrating plan of ICTs integration in agricultural research system to national strategic plans of ICTs development;
- Enhancing institutional linkages of agricultural research stakeholders and actors of the Iranian agricultural research system in framework of agricultural knowledge and information system(AKIS), including universities, extension organizations, farmer organization, agricultural cooperatives, governmental bodies, etc; and
- Building and developing capacities of knowledge management in process of sustainable agriculture development in Iran.

***Third category*:** Challenges and barriers of institutionalized ICTs integration in the Iranian agricultural research system. This category consists of extracted statements of the third leading question of interviews:

- Systemically considering multi-aspects of the process of ICTs integration, such as organizational, technological, human, social, network and infrastructure, financial, political and professional dimensions;
- Structural diversity, department fragmentation and deficiency of institutional coordination of different actors of the Iranian agricultural research system in process of ICTs integration;
- Lack of apex body for formulating and conducting the process of ICTs integration in the Iranian agricultural research system;
- Lack of an institutionalized network of national agricultural research system in Iran;
- Weakness of network and ICTs infrastructure and capacities in agricultural research system of Iran;
- Weakness of commitment and accountability of the Iranian policy-makers and managers to develop the ICTs capacities in agricultural research system;
- Inefficiency and ineffectiveness of current organizational structure and institutional arrangement in the agricultural research system of Iran;
- Lack of clarified, crystallized and pro-accountable institutional mandates, goals and policies of actors of the Iranian agricultural research system related to system-wide and integrative development and management of ICTs; and
- Lack of appropriate standards for monitoring, evaluating and assessing impacts of institutionalizing the ICTs integration in the agricultural research system of Iran in terms of infrastructure, networking, hardware and software, on-line services, connectivity, security, content, management and professional capacity.

Realistic perception or rich picturing of ICTs integration in the Iranian agricultural research system needs considering the conceptual interdependence and related institutional implications of statements, including guidelines, expected outcomes, challenges and barriers of institutionalized integration of ICTs, systemically. Indeed, formed categories explain several interdependence dimensions of same phenomena, "integration of ICTs in the Iranian agricultural research system".

Mapping research findings: Related to the forth question in the interviews (prioritizing and ranking the measures of ICTs integration by interviewees) and based on reviewing and conceptualizing the three extracted statements category, a pathway diagram of integration of ICTs in the Iranian agricultural research system was explained in Figure 2. Indeed, this figure was developed by meaning interpretation of extracted statements (three categories) and conceptually analyses of these categories. Then, extracted concepts were structured based on a logical institutional order which interviewees were explained related to the forth question.

Figure 2, explains a schematic plan for integrating the ICTs in the Iranian agricultural research system. Really, this figure draws a rational pathway as an institutional framework for the ICTs integration.

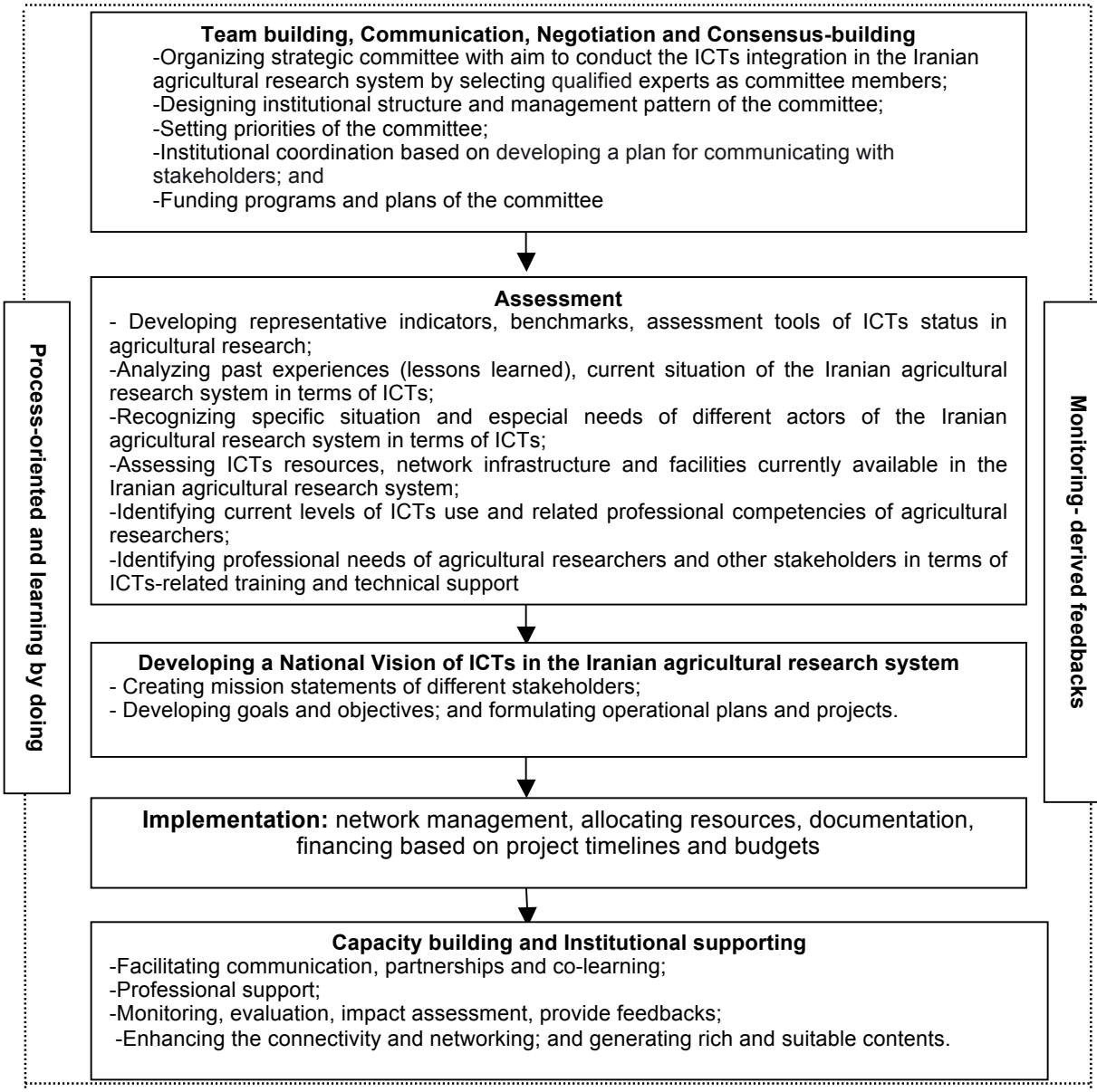

Figure 2: *Phases of the process of integrating ICTs in the Iranian agricultural research system*

According to figure 2, integration of ICTs is a process which starts by team building, with aim to prepare an institutional platform for conducting the integration of ICTs (first phase). The second phase of this process is situational assessment of the Iranian agricultural research system with regard to indicators of ICTs development, integration and applications. At third phase, based on data and information of the second phase, national vision, missions and strategies of ICTs integration will be developed. At the forth phase, based on vision, missions and strategies which prepared in former phase, appropriate programs will be planned and performed with aim to implement the of ICTs integration. In reality, as explained in the fifth phase, the ICTs integration in

the Iranian agricultural research system need to appropriate capacity building and institutional supporting as a continuing process in form of professional development related to effective ICTs application, monitoring, and evaluation, connectivity and networking enhancement , etc.

CONCLUSION AND REMARKS

In this paper we have indicated that Agricultural research systems are main components or subsystems of agricultural knowledge and information system (AKIS). It plays critical roles in process of development and extension of knowledge, information and technology in agriculture sector based on knowledge management approach and sustainability process. Regarding importance of agricultural research for policymakers and other actors of agricultural development area, any institutional intervention along with the sustainable agricultural development strategies requires the organized and coordinated institutionalized role plying of agricultural research system.

As mentioned before the Iranian national agricultural research system needs institutional supporting and capacity building based on designing and implementing appropriate strengthening mechanisms. Regarding to this comment, appropriate integrating the information and communication technologies (ICTs) in Iranian NARS seems as an appropriate and useful mechanism. To take advantages of ICTs advances in national agricultural research system, developing countries such as Iran need appropriate planning, realistic policy-making and sustainable financing. So managers and policy makers of Iranian agricultural research system must try to identify the issues related to the process of integrating the ICTs in national agricultural research system. As findings explained, in spite of relevance instance of beneficially and necessity of integrating the ICTs in agricultural research system, this question may be raised that what are the rational pathway of integrating the ICTs in Iranian NARS. In order to answer this question and related issues, this research was done based on qualitative interviewing as main procedure methodologically.

Current perspectives of developing the ICTs can considered as emerging opportunities in process of developing capacities of the Iranian agricultural research system. Taking advantages of the increasing capacities of ICTs require appropriate planning. Planning process of integrating ICTs in the Iranian agricultural research system must be based on recognizing current situation and related challenges, identifying expected outcomes and formulating institutional guidelines.

Certainly, integration of ICTs in national agricultural research systems can enhance institutional and professional capacities of these systems. As Iranian experiences showed us, integration of ICTs in the national agricultural research systems as a planned and evolutionary process should be based on a holistic, systemic and comprehensive approach. According to findings of this study and lessons learned from other developing countries (Rezvanfar et al., 2006; Palmieri, 2002; Shaker, 2002; Arunchalam, 2002; ISNAR,2002; Maru and Ehrle, 2003; Maru, 2002; Ghodake, 1999; ISNAR, 1999a; ISNAR, 1999b; Kapange, 1999; Sam, 1999; Shangang, 1999; Singh, et al. 1998), policy-makers of national agricultural research systems in developing countries need to build a national institutional framework for institutionalized integration of ICTs in their national agricultural research system. The core issues and implications of stakeholders of national agricultural research systems in developing countries for integration of ICTs in their systems that extracted based on findings of this research and lessons learned from other countries are following:

- Building a national body, such as a national council or an expert committee with aim to realistic policy-making, strategic planning, multi-institutional coordination and system-wide

management of integration of ICTs in national agricultural research system based on consensus-oriented negotiation, communication and feedback;

- Recognizing specific institutional situation, comparative advantages, technical capacities, infrastructures and professional capital of stakeholders of the national agricultural research system in terms of ICTs integration and application;
- developing multi-actors partnerships and coordination through networking in order to link all stakeholders of national agricultural research system;
- Building institutional capacity through team building, purposeful facilitation and supporting, innovation and co-learning in process of integration of ICTs in national agricultural research system;
- Developing professional competencies related to developing and applying ICTs in agricultural research area based on professional development components such as, professional need assessment, practical training, facilitating experimental learning, merit-based evaluating and rewarding;
- Sustainable financing and accountable allocating and managing resources for effective integration of ICTs in national agricultural research system and facilitated sharing of ICTs capacities by different stakeholders;
- Developing appropriate institutional linkages in order to absorbing appropriate supports from international and regional centers and donors, such as ISNAR, FAO, World Bank, etc;
- Dynamically, systemically and participatory institutionalizing a multi-phase process, including priority setting, planning, implementation, monitoring, evaluation and impact assessment in order to ensure and facilitate effective integration of ICTs in national agricultural research system; and
- Multidimensional and holistically considering different components of ICTs integration in national agricultural research system and their synergetic interactions, including software, organization-ware, techno-ware, human-ware, hard-ware, infrastructure, management of information and knowledge system, and related institutional implications.

REFERENCES

Arunchalam, S. (2002). Communication flow between scientists - The case of agricultural research. Paper presented at: *The iNARS: e-Development at the Grassroots Workshop*. An International Workshop Organized by ISNAR and IICD. The Hague, 16-18 December 2002.

Byerlee D. (1998). *The Search for a New Paradigm for the Development of National Agricultural Research Systems Rural Development Department*. Washington, DC: The World Bank.

Dalrymple, D. G. (2000). *The Role of Public Agricultural Research in International Development*. Oregon State University Extension Service Special Report 1017, June 2000.

Gharehyazi, B., Aghajani M. and Ranjbar G. (2003). Case study of Islamic Republic of Iran, In: *Report of the APO Study Meeting on Integration of Agricultural Research and Extension*. PP.159-169.

Ghodake, R. D. (1999). Potential of and challenges to the development of agricultural research information in Papua New Guinea: The case of NARI. In *Proceedings of the International Conference on the Development of Agricultural Information Management, Technology and Market in the 21st Century*. China Agricultural SciTech Press. pp. 85-92

ISNAR (1999). *Information Policy for Agricultural Research (IPAR)*. The Agricultural Research, Education and Extension Organization of the Islamic Republic of Iran (AREEO) in cooperation with ISNAR. The Hague: International Service for National Agricultural Research.

ISNAR (1999a). *Agricultural research information system (ARIS).* The Indian Council of Agricultural Research. ISNAR Pub. No. 59.

ISNAR (1999b). *Strategy for development of information technology in agricultural research (ITAR).* The Philippine Council for Agriculture, Forestry and Natural Resources Research and Development. ISNAR. Pub. No. 61

ISNAR (2002). iNARS: ICTs and National Agricultural Research Systems- e-Development at the Grassroots. *Workshop Report: An International Workshop Organized by ISNAR and IICD*. The Hague, 16-18 December 2002.

Kapange, B. W. (1999). The role of agricultural information in decision making: Experience of the Tanzanian agricultural research information system. *IAALD Quarterly Bulletin* (XLIV) pp.123-130.

Stienen, J.; W. Bruinsma and F. Neuman (2007). How ICT can make a difference in agricultural livelihoods. International Institute for Communication and Development (IICD). *The Commonwealth Ministers' Reference Book.*

Koutsouris, A. (2006). ICTs and Rural Development beyond the Hype. *Journal of Extension Systems.* No.1, Vol.22, PP:46-62

Maru, A. (2002). A Normative Model for Agricultural Research Information Systems. In: *Report of 3rd AFITA Meeting.* Available online at: www.jsai.or.jp/afita/afita-conf/2002/part0/p019.pdf

Maru, A. and Ehrle, K. (2003). Building a framework for ICT use in Agricultural Research and Development: Is the North different from the South? In: *Proceedings of EFITA 2003 conference*. PP.504-512.

Moghaddasi, M.S., (2004). The importance of discovery for a country's agriculture. *World Transactions on Engineering and Technology Education*.3(2):297-298

Palmieri, V. (2002). Latin America and Caribbean: ICT use in NARS. In: *Proceedings of Workshop "iNARS:Rooting ICT's in National Agricultural Research Systems, ISNAR*, The Hague.

Pretty, J., (1995). *Regenerating Agriculture: Policies and Practice for Sustainability and Self–reliance*. London: Earthscan publication Limited.

Rajalahti, R. , Woelcke, J. and Pehu, E. (2005). Developing Research Systems to Support the Changing Agricultural Sector. *Agriculture and Rural Development Discussion Paper 14.* Washington, DC.: The World Bank,

Rezvanfar, A. ; Sharifzadeh A. and M. Sharifi (2006). Integrating the information and communication technologies (ICTs) in the Iranian agricultural research system. *The national Indian seminar on information and communication technology: opportunities and*

challenges for revitalizing extension system. December 27-29, 2006, NAVSARI (GUJARAT).

Sam, J. (1999). An overview of the Ghana Agricultural Information Network System (GAINS). *IAALD Quarterly Bulletin* (XLIV) pp.107-112

Shaker, M.H.Z. (2002). A Framework for Developing and Implementing Effective Information Systems for Agricultural Research and Development in Egypt. In: *Proceedings of Workshop "iNARS:Rooting ICT's in National Agricultural Research Systems, ISNAR*, The Hague.

Shangang, J. (1999). Development strategy of agricultural information network in China. In *Proceedings of the International Conference on the Development of Agricultural Information Management, Technology and Market in the 21st Century*. China Agricultural SciTech Press. pp. 53-60

Sharifzadeh A., Gholamrezaei S., and Moradnejadi H., (2005). Developing a ICTs's Plan in Educating and supporting process of Agricultural Extension's Workers. Paper presented at The *Fifth International Congress on Information Technology in Agriculture, Food and Environment* (Itafe, 05). 2-14 October 2005, Adana, Turkey.

Singh,C. and Pal, K.(1998). Agricultural Research Information System (ARIS) of ICAR *DESIDOC Bulletin & Information Technology*, 18(2) 5-12

Sreenivasulu, V., and Nandwana, H.B. (2001). Networking of Agricultural Information Systems and Services in India. *INSPEL* 35(4): 226-235

Taeb, M. and Keshavarz, A. (1999). "Country Status Report: Iran", *National Agricultural Research Systems in the Asia-Pacific Region – A Perspective,* Asia-Pacific Association of Agricultural Research Institutions, FAO Regional Office for Asia and the Pacific, Bangkok.

World Bank (2007). *Enhancing Agricultural Innovation: How to Go Beyond the Strengthening of Research Systems.* World Bank, Washington DC.