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Abstract. The present study aimed to determine the sustainability of the aAQUA (Almost All Questions Answered) e-Agriservice in Maharashtra state, western parts of India covering the four districts of the state. The study used the ex-post facto (cause to effect) research design in a quasi-intervention setting. The list of registered users was obtained from the service provider (presently Agrocom Software Technologies Pvt. Ltd.) and total of 120 users were selected randomly from four districts (30 users from each district). The sustainable-Agriservice Index (SeAGRSI) was computed based on the five dimensions viz. technological, economic, social, institutional, and political by using combinations of Multi-Criteria Analysis (MCA), Mixed Method Approach and Normalized Rank Order Method (NROM). The study revealed that the SeAGRSI for the social indicators was the highest among other dimensions of the sustainability (SeAGRSI = 0.77) followed by the technologically (0.73), economic (0.71) political (0.62) and institutional (0.58) sustainable. It was also found that the mean SeAGRSI was 0.70 as reported by one third (32.50%) of the users, which means 70 per cent the aAQUA e-Agriservice was technologically, socially, economically, institutionally and politically sustainable. The indicators developed would be useful to develop strategy for sustainability of ICT efforts in many developing countries.

Keywords: Dimensions of Sustainability, Rural ICT Projects, Sustainable aAQUA e-Agriservice Index

1 Introduction

Information and Communication Technologies (ICTs) are constantly evolving as key tools that provide access to information and knowledge for rural development in developing countries. Over the last decade, India has emerged as a testing ground for innovations in ICTs (Dossani et al., 2005; Kuriyan et al., 2008; Rao, 2008). They have the potential to enhance development activities in combating poverty, as an information, communication or knowledge component of virtually every development challenge can possibly be discerned (McNamara, 2003). There are many efforts in

India and other developing countries to demonstrate the economic benefits of ICT on productivity and growth (Draca et al., 2006; Kretschmer, 2012; Singh, 2007). Many researchers have reported that these kinds of ICT projects helped in catering needs of the farming community and facilitated in enhancing knowledge level of users/ beneficiaries of the services (Promilla, 1994; Sah, 1996; Wadkar et al., 2015). Lio and Liu (2006) reported that the use of ICTs helped to increase farmers' bargaining power, which help them to get remunerative prices to their produce. They have also found the strong correlation between the use of ICT and farmers' productivity.

However there are cases where the implementation of ICT projects has actually not made a difference, or the effects have been harmful in communities (Buré, 2007; Gomez and Hunt, 1999). Musa (2006) cites a number of authors who indicate that there is huge evidence of failure and wastage of resources linked to sudden massive implementations of ICT projects in developing countries, with the hope of promoting development and alleviating poverty. Consequently, debates have arisen with growing skepticism about the usefulness of funding or implementing ICT projects for development (Tacchi et al., 2003).

In this backdrop, there is much hope for sustainable impact arising from development oriented ICT interventions, especially in the field of agriculture (Mbarika et al., 2005; Meso et al., 2006). In the past, emphasis has been placed on the supply side (for example, infrastructure building) rather than the demand side (for example, users' willingness and capacity to acquire/ use services) (Ashraf et al., 2007; Heeks 2002). Hence, the main focus of the interventions has been on implementation of the ICT4D project rather than understanding the impact on the micro (community) level. This lack of understanding has led to many failures of ICT4D projects reported in the literature (Heeks, 2002). Several organizations have launched ICT based or e-Agriculture initiatives, which lacks the sustainability of services for long term period (Annamalai & Rao, 2003; Raju, 2004; Rao, 2006, 2008; Upton & Fuller, 2004).

Unwin (2009) states that sustainability is primarily a problem with "externally situated ICT4D programmes, and in part reflect a desire by those who create them to guarantee their continued success after the initial period of investment is over". Here little attention is paid on how initiatives can become self-supporting, and recommends that all ICT4D programmes that are introduced by external players have a framework for ensuring "continued viability beyond the initial period of funding" in order to not saddle the beneficiaries with the burden. This needs to include total-cost-of-implementation models. Finally, he has put forward a fairly simple recipe for the underlying basis of sustainability as, if people's needs are met in an appropriate, cost-effective way, then the ICT4D initiative will be sustainable.

Heeks (2002) attributed the high rates of failure of Information Systems (IS) projects in developing countries due to a "design-actuality gap" where, there is a mismatch between the desired systems state of the IS designers and the local actuality of the user needs and interest. According to Heeks (2010) identified the three issues, which need to be undertaken while planning for any ICT interventions viz design, governance and sustainability. Here sustainability is seen as wider than purely economic sustainability.

The term sustainability has grown increasingly popular in recent years as development experts and practitioners seek to measure the long-term impacts of their projects. The word is most often used to describe the desired goal of lasting change within institutions, communities, and projects. Sustainability in the context of sustainable development is defined by the World Commission on Environment and Development (1987) as "forms of progress that meet the needs of the present without compromising the ability of future generations to meet their needs". This emphasizes the aspect of future orientation as a basic element of sustainability. In the context of ICT, it is defined as “Ensuring that the institutions supported through projects and the benefits realized are maintained and continue after the end of the project” (IFAD, 2007). It talks in terms of the resource flows. It acknowledges that assessment of sustainability entails determining “whether the results of the project will be sustained in the medium or even longer term without continued external assistance”.

This poses a challenge to all development strategies and calls for the multi-stakeholder involvement, when evaluating and improving the sustainability of development strategies and development initiatives at the project and enterprise level. A narrow focus on the project itself does not suffice to surface the reasons for failure, or to identify the route towards sustainability. The reasons for failure lie inside the scope of the project, within the community itself, and outside the community in the larger socio-economic system which includes the economy. Therefore, the socio-economic, socio-personal characteristics of the target clientele, resource available with the society (target area of the project) needs to be undertaken, while planning and implementation of ICT based intervention with due consideration of its long term sustainability.

Keeping above in view, there is need to understand the loopholes in the process of ICT efforts through its assessment, evaluation and determining long term sustainability which can then inform at the policy and strategic levels. Thus in present study attempt was made to assess the sustainability of aAQUA (Almost All Questions Answered) e-Agriservice.

1.1 aAQUA e-Agriservice:

aAQUA e-Agriservice is ICT based project, launched by the Developmental Informatics Laboratory (DIL) at Indian Institute of Technology, Mumbai in collaboration with the Farm Science Centre (Krishi Vigyan Kendra, KVK), Baramati and Vigyan Ashram (NGO), Pabal, Maharashtra in 2003 as an information providing system to deliver technology options and tailored information for the problems and queries raised by Indian dairy farmers. It is capable of multi-lingual retrieval in three Languages spoken among Indian farmers – Marathi, Hindi and English, allowing the registered users (anybody can register freely) to search, ask, see and/or select agricultural keywords on the database. In addition to this, they get information on crop, livestock, government schemes and subsidies, weather and market information for proper planning and management of their farms. The field engineer prints the new queries, allocate these to the Farm Science Centre’s (KVK-Baramati) extension personnel on the basis of their area of expertise, get the answers and upload these on aAQUA. It normally provides answers to farmers queries (agri-dairy-livestock and other related) within 24 to 48 hours depending on its difficulty. After the queries are answered and uploaded on aAQUA, the kiosk operators or the users can check these. With this the farmers' query resolving process is completed (Ramamritham et al., 2011).

2 Materials and Methods

2.1 Research Design

The study used the ex-post facto (cause to effect) research design in a quasi-intervention setting. Since 2003 aAQUA e-Agriservice is continuing to deliver its services, hence it was used as the cause to change in the effectiveness of dairy farming. Further, user dairy farmers' responses were elicited to determine the sustainability of the e-Agriservice.

2.2 Sampling

The aAQUA e-Agriservice was initially launched in the eight pilot districts of Maharashtra in 2003 covering the four geographical regions of the state. The state has also covered a maximum number of registered users. The four districts viz. Pune, Nashik, Jalna and Amravati were selected randomly from four zones. The block wise list of registered users was obtained from the service provider (presently Agrocom Software Technologies Pvt. Ltd.). The blocks were divided based on number of registered users for the further sampling of the respondents. Consequently, 30 users from each block, who are rearing at least five dairy animals and posed at least one query per season, especially about animal husbandry and dairying to aAQUA were selected randomly for the purpose were selected randomly. Thus, a total 120 users were studied in the present study.

2.3 Development of Sustainable aAQUA e-Agriservice Index (SeAGRSI)

In this study, Mendoza and Prabhu's (2003) Multi-Criteria Approach (MCA), mixed-method approach suggested by Parkins et al., (2001) and Normalised Rank Order Method (NROM) of Guilford (1954) is followed to analyze complex problems involving multiple criteria to develop sustainability index. An index is the number that is composite of two or more other numbers (Kerlinger, 1983) and a composite index is an aggregation of sets of variables for the purpose of meaningfully condensing large amounts of information (Dash et al., 2007).

There are three advantages of this method viz. firstly; it can deal with mixed sets of data, quantitative or qualitative, including experts' opinions. In this case, qualitative information from existing researchers in area, experts groups, and experiential knowledge has distinct advantages for assessing sustainability indicators of rural ICT project (Mendoza and Prabhu, 2003). Secondly, it enables a collaborative planning and decision-making, provides an opportunity to develop mechanism for the involvement and participation of stakeholders in the sustainability assessment process. Finally, these methodologies are intuitive, transparent, and have strong technical and theoretical support in its procedure. In present study sustainability was assessed under these five categories of sustainability viz. Technological, Economic, Social, institutional and political on the lines of Pade et al., (2006) categories of the sustainability.

Assessing the Importance of Sustainability Indicators. In the first part of analysis, the 25 indicators had been identified after reviewing the literature and discussion with experts in the field of agricultural extension, ICT, dairy science, etc. The expert driven indicators need to be assessed for its local acceptability (Parkins et al., 2001).

In the second part of analysis, we evaluated the appropriateness sustainability indicators in terms of their degree of importance by simply ranking each indicator ('Most Relevant', 'Relevant' and 'Not Relevant' and scored as 2, 1 and 0, respectively). For this purpose, indicators were sent by post, through e-mail and also handed over personally to a judge's panel of 40 in the field of ICT for development, extension education, and dairy economics, veterinary and animal science of state agricultural universities and selected ICAR institutes. Based on their responses, relevancy weight of an indicator estimated using the formula as follows:

$$\mathbf{RW} = \frac{\textbf{Most Relevant X 2} + \textbf{Relevant X 1} + \textbf{Not Relevant X 0}}{\textbf{Maximum Possible Score}}$$

Finally, the items/ statements were framed on each selected indicator based on review of literature and discussion with experts in the field of agricultural extension education. The statements were edited based on 14 criteria suggested by Edward (1969).

Determination of Scale Values. In the next analysis we examined each dimension using NROM of Guilford (1954) for judging their current condition relative to their perceived target or desired condition. It is used to assign specific weights (scale values) to each dimension of the based on their perceived significance. The method has got a unique advantage that it can be used with any number of variables and does not require a large number of judges. In the study, selected indicators under 5DS were ranked by the group of judges according to their perceived significance in determining the sustainability of the aAQUA e-Agriservice. Ranking (1 to 5) was obtained from 30 judges who involved experts in the field of social science, extension education, rural development and especially ICT experts. In the next step, the proportions were worked out for the ranks assigned by all the judges by using following formula.

$$p = \frac{(\mathbf{R_i} - \mathbf{0.5})\mathbf{100}}{\mathbf{n}}$$

Where,
p = centile value which indicated the area of the dimensions in the normal distribution
R_i = the rank value of the dimension i in the reverse order as five to one
n = the number of dimensions ranked by the judges

Computation of the Composite Index. Each dimension of SeAGRSI consists of a number of indicators and items/ statements and hence, their range of total scores was different. Therefore, the total score of each dimension was converted into unit score by using simple range and variance as given below.

$$\mathbf{U_{ij}} = \frac{\mathbf{Y_{ij} - Min\ Y_{ij}}}{\mathbf{Max\ Y_j - Min\ Y_j}}$$

Where,
U_{ij} = unit score of the i^{th} respondents on j^{th} dimension
Y_{ij} = value of the i^{th} respondent on the j^{th} dimension
Max Y_j = maximum score on the j^{th} dimension
Min Y_j = minimum score on the j^{th} dimension

Thus, the score of each dimension ranged between zero to one, i.e. when Y_{ij} is minimum, the score is zero and when Y_{ij} is maximum the score is one. Then, the unit scores of each respondent were multiplied by the respective scale value of the each dimension and summed up. Thus, the score obtained was divided by the total scale values and multiplied by 100 to get the SeAGRSI for each user.

$$\mathbf{SeAGRSI_i} = \frac{\sum \mathbf{U_{ij}} * \mathbf{S_j}}{\mathbf{Sum\ of\ scale\ values}}$$

Where,
$SeAGRSI_i$ = sustainable e-Agriservice Index of i^{th} respondent
U_{ij} = unit score of the i^{th} respondent on j^{th} dimension
S_j = scale value of the j^{th} dimension

The status of the aAQUA e-Agriservice was calculated based on the total index score of all the indicators. The classification of the users into the five categories (very low, low, medium, high and very high sustainable level) was done based on the composite sustainability index scores by using Cumulative Square Root Frequency (CSRF) method as suggested by Dalenius, and Hodges (1959). The above categories were equated with the Adrianto et al. (2005) classification as, extremely weak performance, poor performance\ unfavourable, acceptable, very favourable performance, and sustainable for better interpretation of results.

3 Results and Discussion

As mentioned in the previous section, the first analysis for sustainability indicators was to generate a set of indicators under five dimensions (technological with 5 indicators; social – 6; economic – 5; institutional – 4; and political - 2) in terms of their importance judged by a group of stakeholders and experts. The next part of analysis was to estimate the "relative weightage" and "scale values" elaborated from the perceived targets or conditions judged by the stakeholders and experts. Finally, data were collected from the target users of the e-Agriservice on each indicator and computed sustainability index (SeAGRSI). The results are presented in Table 1 and 2.

Table 1. The operational definition of sustainability indicators under 5DS with their scale values and relevancy weightage

Indicators	Operational Definition
Technological Sustainability *(Scale Value = 7.37)*	
Appropriateness *(RW=0.80)*	The degree to which aAQUA e-Agriservice was suitable for the farming communities' needs, interest and their social-cum-infrastructural situations.
System capability *(RW=0.84)*	The ability of an aAQUA web-portal to provide the agro-advisory services to farmers effectively and efficiently. It undertakes the operational simplicity of portal and its availability to the users.
Information quality *(RW=0.88)*	It refers to the value of the output produced by aAQUA e-Agriservice as perceived by the users.
Integrated performance *(RW=0.78)*	The arrangement of different features to provide information regarding agriculture and allied sectors.
Usability *(RW=0.80)*	The ease of use as well as degree of comfort and satisfaction users had with the aAQUA e-Agriservice.
Social Sustainability *(Scale Value = 6.23)*	
Local adaptability *(RW=0.83)*	The extent to which the technology was adaptable to the existing local conditions of the farmers.
Societal acceptability *(RW=0.83)*	The extent to which the technology was acceptable by the different sectors of the society.
Cultural desirability *(RW=0.83)*	The extent to which the technology fits with the cultural patterns, ethos and values of the society.
Loyalty intention *(RW=0.79)*	Perceived ways of technology experience and word-of-mouth publicity of the e-Agriservice used for fulfilling their farming needs.
Service provider commitment *(RW=0.77)*	The extent to which the portal managers/ experts and kiosk operators were loyal to respond and solve the query of farmers.
Self-reliance *(RW=0.88)*	The extent to which the technology improves the capacity to execute decisions and making the individual farmers independent in farming practices.

Economic Sustainability *(Scale Value = 7.27)*	
Economic feasibility *(RW=0.77)*	The capacity of farmers to afford and avail the e-Agriservice facility to solve problems of farming within his realm of financial status and position.
Economic viability *(RW=0.78)*	The returns to investment of every rupee counts. It deals with the economic and financial profitability of project induced products and services.
Cost incurred to users *(RW=0.80)*	The amount spent by the users in availing the e-Agriservice.
Potential monetary benefits *(RW=0.85)*	The degree to which the users got benefited by utilizing the e-Agriservice.
Economic gain to the service provider *(RW=0.80)*	The extent to which the service provider got profit by delivering timely services to the farming community.
Institutional Sustainability *(Scale Value = 5.83)*	
Institutional expansion *(RW=0.77)*	The ability of the stakeholders in providing sustainable e-Agriservice to the farming community.
Lucrative linkages and partnership *(RW=0.78)*	The degree to which the association of the stakeholders in maintaining the functioning of the aAQUA e-Agriservice in post project period.
Capacity building and training *(RW=0.80)*	The degree to which the service providers undertaken the training programs and other related activities to update knowledge of the users.
Stakeholders' engagement *(RW=0.81)*	The degree to which the stakeholders were committed to facilitate and share a better understanding in providing the e-Agriservice.
Political Sustainability *(Scale Value = 5.30)*	
Political determinism *(RW=0.78)*	Ability to work together (both public and private) for agreed ends without obstructing the existing intricacies and implications of political set up.
Government commitment *(RW=0.81)*	The degree to which the government functionaries were providing public facilities-cum-services and promoting private investment in a particular area for enhancing efficiency and effectiveness of the e-Agriservice activities.

The importance of degree of indicators was judged using a 3-point scale by the expert group. It is clear from Table 1 that almost all the indicators are rated moderately to highly relevant. It can be seen from the relevancy weight value, ranging from 0.77 to 0.85, showing that all the developed indicators are important. The scale values based on the response of experts reveal that technological (7.37) and economic (7.27) dimensions were more important followed by social (6.23), institutional (5.83) and political (5.30) dimension (Table 1). In experts' perspectives, the study found that the technological and economic sustainability are more important than social, institutional and political dimension of rural ICT sustainability.

Table 2. Sustainable e-Agriservice Index (SeAGRSI) by the users (n=120)

Sustainability Level	Range	Frequency
Extremely Weak Performance	(< 0.60)	18 (15.00)
Poor Performance	(0.61 - 0.66)	24 (20.00)
Acceptable Performance	(0.67 - 0.74)	39 (32.50)
Very Favourable Performance	(0.75 - 0.79)	20 (16.67)
Sustainable	(>0.80)	19 (15.83)

Note: Figures in parenthesis indicates percentage

The composite Sustainable e-Agriservice Index (SeAGRSI) was worked out by taking into account all the five-dimensions of sustainability. The SeAGRSI by user group ranged from 0.53 to 0.84. It is evident from Table 2 that almost one third (32.50%) of users informed that the e-Agriservice performed at an acceptable level (0.67 to 0.74) of sustainability, followed by poor performance (0.61 to 0.66) and very favourable performance (0.75 to 0.79) level of sustainability categories, respectively. On the three point continuums viz. Poor performance (extremely weak performance + poor performance), Acceptable performance, and Sustainable (very favourable performance + sustainable) level of SeAGRSI, 65 per cent of users reported that the aAQUA e-Agriservice had acceptable to a sustainable level of performance.

The possible reason might be, the e-Agriservice is technically realistic, user-friendly and accepted by the dairy farmers. Socially compatible and there was no any relation of this technology to the farmers dynamics (relationship within the community), which hampered use of the e-Agriservice. Farmers had to pay a meager amount to access this facility, and get the appropriate return on investment. Thus, the e-Agriservice is technologically sound, socially acceptable and economically viable. However, on institutional and political dimension, the technology is not able to provide the same level of service as like during the pilot project period, such as capacity building and training to the new users, kiosk accessibility etc. These are the reasons for the poor performance level of sustainability in the study area.

In target users' point of view, it was inferred that the social sustainability was more crucial than other dimensions of the sustainability to continue the services of aAQUA e-Agriservice in Maharashtra. The sustainability index for the social indicators was the highest among other dimensions of the sustainability (SeAGRSI = 0.77) followed by the technologically (0.73), economic (0.71) political (0.62) and institutional (0.58) sustainable.

The findings of the present research are in consonance with the findings of the Best and Kumar (2008) found that the lack of long term financial viability was a major reason for the closure of the telecentres. The telecentres that were owned by the individuals with prior training in computers or that had a separate trained operator, remained operational for a longer period. In the present research, after the project period, the rights of the web-portal handed over to the private company (Agrocom Software Technologies Pvt. Ltd.), which provided the technical support to the web-portal and KVK Baramati as project partner institute remained for providing information and solving the farmers' queries.

Thus, it can be concluded that the social sustainability was crucial for ICT based technology in the rural areas followed by the technological sustainability. The loyalty of the farmers towards the usage of the service and service provider's commitment were the vital factors which lead to the social acceptability of the technology. The information quality and usability of the e-Agriservice were found to be the important parameters for the suitability of the technology for the farming community. The farmers have to pay a meager amount to access the e-Agriservice. Better co-ordination and linkages among the different actors of the e-Agriservice and strong and positive-will make it institutionally and politically sustainable.

4 Conclusion

Information is a key ingredient for success of any individual and same is true in the case of farmers as well. Readily availability of information at the right time and in right form will enhance the success rate of farmers. In this background, during the last two decades, many organizations have undertaken knowledge interventions for promoting scientific dairy farming. In this process few organizations succeeded and others have failed in achieving the targeted outputs and their scaling up of delivery, monitoring and evaluation still remains at the pilot project stage. Among these interventions that have made significant progress in taking messages to the farming community the present study highlighted the sustainability of the aAQUA e-Agriservice. The study revealed that the SeAGRSI for the social indicators was the highest among other dimensions of the sustainability (SeAGRSI = 0.77) followed by the technologically (0.73), economic (0.71) political (0.62) and institutional (0.58) sustainable. It was found that 32.50 per cent of users reported the acceptable level of performance and equal number of users reported very favourable to a sustainable level of performance of aAQUA e-Agriservice. Experts' opined that the technological and economic sustainability are more important than social, institutional and political dimension of rural ICT sustainability. However the target users' reported that the social sustainability was more crucial than other dimensions of the sustainability to continue the service of the e-Agriservice in Maharashtra.

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References

1. Adrianto, L., Matsuda, Y., and Sakuma, Y.: Assessing local sustainability of fisheries system: A multi-criteria participatory approach with the case of Yoron Isaland, Kagoshima prefecture, Japan. Marine policy, 29 (1): 9-23 (2005)
2. Annamalai, K. and Rao, S.: *What works: ITC's e-Choupal and profitable rural transformation: Web-based information and procurement tools for Indian farmers*. Washington, DC: World Resources Institute (2003)
3. Ashraf, M. M., Hanisch, J., and Swatman, P.: ICT intervention towards development. *3rd Conference on Computer and Information Technology (ICCIT), Bangladesh. Developing Countries: Theory and Practice*, City University of Hong Kong Press, pp: 83-100 (2007)
4. Best, M. and Kumar, R.: Sustainability failures of rural telecentres: Challenges from the Sustainable Access in Rural India (SARI) project. *Information Technologies and International Development,* 4 (4): 31-45 (2008)
5. Bure, C.: Grounding gender evaluation methodology for telecentres: The experiences of Ecuador and the Phillipines. Ottawa: Telecentre.Org, International Development Research Centre (IDRC) (2007)
6. Dalenius, T. and Hodges, J. L.: Minimum variance stratification. *Journal of the American Statistical Association,* 54: 88-101 (1959)
7. Dash, R., Chattopadhyay, P., and Pahuja, N.: Environmental sustainability index for Indian states. Centre for Development Finance Institute for Financial Management and Research, Chennai (2007)
8. Dossani, R., Misra, D. C., and Jhaveri, R.: Enabling ICT for rural India. *Project Report, Asia-Pacific Research Center, Stanford University and National Informatics Centre, Government of India* (2005)
9. Draca, M., Sadun, R., and Reenen, J. V.: Productivity and ICT: A review of the evidence, *Centre for Economic Performance (CEP) discussion paper No. 749*, London school of economics and political science, London (2006)
10. Guilford, J. P.: *Psychological methods*. Tata McGraw Hill Publishing Co. Ltd. Noida, UP (1954)
11. Heeks, R.: Information systems and developing countries: Failure, success and local improvisations. *The Informatio Society,* 18 (2): 101-112 (2002)
12. Heeks, R.: Do information and communication technologies contribute to development? *J. of International Development,* 22: 625–640 (2010)
13. IFAD Strategic Framework: Enabling the rural poor to overcome poverty. EB 2006/89/R.2/Rev.1. 89th Session, Rome (2007)
14. Kerlinger, F. N.: *Foundation of behavioural research*. S. S. Chabra Publishers, Delhi, India. pp: 151-153 (1983)
15. Kretschmer, T.: Information and communication technologies and productivity growth: A survey of the literature", *OECD Digital Economy Papers, No. 195,* OECD Publishing (2012)
16. Kuriyan, R., Ray, I. and Toyama, K.: Information and communication technologies for development: The bottom of the pyramid model in practice. *The Information Society,* 24 (2): 93–104 (2008)
17. Lio, M. and Liu, M.: ICT and agricultural productivity: evidence from cross-country data, *Agricultural Economics,* 34: 221-228 (2006)
18. Mbarika, V. W. A., Okoli, C., Byrd, T. A. and Datta, P.: The neglected continent of IS research: A research agenda for Sub-Saharan Africa. Journal of the AIS, 6 (5): 130-170 (2005)

19. McNamara, K. S.: Information and communication technologies, poverty and development: Learning from Experience. *A Background Paper for the InfoDev Annual Symposium,* Geneva, Switzerland (2003)
20. Mendoza, G. A. and Prabhu, R.: Qualitative Multi-criteria Approaches to Assessing Indicators of Sustainable Forest Resources Management. *Forest Ecol. Manag*. 174: 329-343 (2003)
21. Meso, P., Datta, P. and Mbarika, V.: Moderating information and communication technologies influences on socioeconomic development with good governance: A study of the developing countries. *J. of the American Society for Information Science and Technology,* 57 (2): 186-197 (2006)
22. Musa, P.F.: Making a case for modifying the technology acceptance model to account for limited accessibility in developing countries. *Information Technology for Development,* 12(3), 213–224 (2006)
23. Pade-Khene, C., Mallinson, B. and Sewry, D.: Sustainable rural ICT project management practice for developing countries: Investigating the DWESA and RUMEP projects. *Information Technology for Development,* 17 (3): 187-212 (2011)
24. Parkins, J. R., Richard, C. S. and Varghese, J.: Moving towards local-level indicators of sustainability of forest-based communities: a mixed-method approach. *Social Indicators Research,* pp. 43–72 (2001)
25. Promila: Gender analysis in dairy and crop production in Kangra district, Himachal Pradesh. Ph.D. Thesis, NDRI, Karnal, Haryana (1994)
26. Raju, K. A.: A case for harnessing information technology for rural development. *The International Information and Library Review,* 36: 233–240 (2004)
27. Ramamritham, K., Bahuman, C. and Bahuman, A.: aAQUA: ICT-enabled Knowledge Services to Farmers in India. M. Hazelman and S. Attaluri's edited book on 'Success Stories on ICT/ICM in AR4D in Asia and the Pacific Region', FAO (2011)
28. Rao, N. H.: A framework for implementing information and communication technologies in agricultural development in India. *Technological Forecasting and Social Change,* 74: 491–518 (2006)
29. Rao, S. S.: Social development in Indian rural communities: Adoption of telecentres. *International J. of Information Management,* 28: 474–482 (2008)
30. Sah, A. K.: A descriptive study of existing dairy farming practices and constraints in adoption of improved dairy practices among dairy farmers in Banka district, Bihar. M.Sc. Thesis, NDRI, Karnal, Haryana (1996)
31. Singh, Nirvikar: ICT and rural development in India, UCSC working paper (2007)
32. Tacchi, J., Slater, D., and Lewis, P.: Evaluating community based media initiatives: An ethnographic action research approach. Paper *presented at the meeting of the Information Technology for Development Conference,* Oxford, UK (2003)
33. Unwin, T.: *ICT4D: Information and Communication Technology for Development,* Cambridge university press, Cambridge, UK (2009)
34. Upton, D. M. and Fuller, V. A.: The ITC e-Choupal initiative (Case No. 9-604- 016). Boston, MA: Harvard Business School (2004)
35. Wadkar, S. K., Singh, K., Kadian, K. S., Malhotra, R. and Garde, Y. A.: Comparative study on effectiveness of the aAQUA e-Agriservice among dairy farmers of Maharashtra, *Indian Journal of Dairy Science,* 68(4): 408-411 (2015)
36. World Commission on Environment and Development: *Our common future,* Oxford university press, Oxford (1987)
37. www.aaqua.org
38. www.agrocom.co.in