

REVIEW OF LITERATURE

This chapter reviews three main research areas. Firstly, it traces the agricultural problems, technology adoption role and issues through extension services particularly in India and in the world in general. Secondly, by finding the factors that are affecting the extension services through proper use of ICTs or determining the factors of transfer of technologies. By doing so, this chapter helps build the fundamental concepts of ICT and decision making at all levels of agricultural decision making process. Lastly, it presents a comprehensive review of various models used by previous researchers in facilitating the information content concerned with farmers in retrieving the information needed in their decision making process.

2.1 Agriculture Problems, Technology Adoption and Extension Services

Birkhaeuser et al (1991) summarized several studies regarding extension services impact on farmer's knowledge, technology, farm practices, farm productivity/ efficiency, technology adoption, farm output supply and demand. Researcher found the problem of inaccessibility of the extension services to all the farmers and presented a solution by capturing extension activities at village or area level. A total 36 out of 48 cases had a significant and positive effect but there exists a lack of extension impact in these instances also. Some hypothetical explanations can be offered e.g. lack of relevant technology to be diffused, a temporarily depressed agricultural economy or ineffective extension activities. Attention should also be paid to the possibility that the allocation of extension efforts by governments is not random across areas or communities.

Deininger (1997) examined the role of public and private sector extension system. Extension system could play an important role in diffusion of improved technologies and sustainable farm practices. Poor performance of some public extension programs as reflected by slow adoption has spurred search for alternative approaches to improve extension services. Many extension programs lacked a consistent link both with farmer

and agriculture research sector and faced continued problems arising from a failure to address the needs of farmers and inadequate human resource etc. On the other hand, private sector has the ability to diffuse information quickly.

Garforth and Lawrence (1997) explored extension approaches and methods in technology transfer. They briefly discussed some policy matters such as encouragement of local development or adoption of technologies, farmer to farmer extension, diversification of extension system to public, private, NGOs, and agricultural organizations, mass media coverage, facilitation of decision making and technology adoption. The study pointed out the problem solving approach towards climate change and uncertainty, soil erosion, weed management etc. that aroused due to lack of information dissemination. Farmers rely more on traditional knowledge in farming although green revolution has occurred. The reason was lack of technological reach because of informal communication network which did not cross socioeconomic boundaries. The mass media can be a powerful tool for exchange of sharing of views and information within a rural population to make them proficient in decision making. The study suggested the decentralization of extension system as to devolution within public administration of powers.

Chapman and Tripp (2003) highlighted the role of private extension approach in solving the needs of commercial farmers and at the same time of subsistence farmers too. This study covered extension activities related to contract farming, agriculture input firms, and contribution of producer cooperative. A tie-up of agricultural information with private extension could support input decisions specifically to the field of an individual farmer. A shift towards privatized extension strategies can only be justified if it improves the efficiency of service and meets the needs of the majority of the farming population. In developing countries, privatized extension systems will have to be structured so that the majority of resource-poor farmers receive better service than they do under the poor performance of many public extension systems. They should be more responsive to farmers priority needs. Communication should be two ways to get the feedback from the farmers.

Davis and Place (2003) discussed the different approaches of NGOs in agriculture extension. It broadly categorized as transfer of technology (TOT) and farmers first. They discussed their strengths and weaknesses and proposed a coalition model that combined

research and extension players such as farmers, universities, private companies, community-based organizations and cooperatives can add their strengths to the mix.

Croppenstedt et al (2003) observed that fertilizers adoption was restricted in Ethiopia. The lack of well-functioning credit markets was another barrier in adoption of new technologies. This study found that farmers could not adopt new technologies because of lack of funds although they got high profit.

Lodhi et al (2006) conducted a study on the effectiveness of the public sector extension system under a decentralized extension system in Pakistan. There were many factors due to which traditional extension system abolished such as ineffective transfer of technology among researchers, farmers and extension worker etc. The results of the present study reported that among agricultural extension activities undertaken by efficient farming system (EFS) under decentralized extension system crop production related information was disseminated in a very good manner followed by post harvest, marketing and farmers training meetings. In mass contact method only print media fell in good category. Study formulated that government should take serious steps to the policy side of agriculture extension for the involvement of maximum number of extension workers.

Glover (2007) studied farmer's participation in agriculture extension services and reviewed the Training and visit (T&V) approach and compared the participation and accountability of farmers between public and private sectors. The private sector was more efficient to benefit farmers as compared to public sector. The researcher did a case study of Monsanto SHP which is providing services like improved seed technology, crop production techniques, fertilizers and conservation tillage practices, training to use of safe and efficient technology packages. Study found that farmer's decision influenced the adoption of agricultural technologies in collaboration with private sector.

Kalla (2008) visualized the role of traditional and cyber extension in agricultural development in India. Sustainable agriculture, agribusiness and contract farming were the new emerging paradigms witnessed in post green revolution. Yield saturation is the main problem faced by certain crops that could be resolved by integrating extension services and ICTs. The advances in information and communication technology (ICT) are on the edge to harmonize extension efforts for transfer of technology. The extension is now required to consider farmer, as an active partner in technology generation and validation rather than a passive recipient as end user.

Ghosh and Ghosh (2009) studied the initiatives taken by the Government of India (GoI) as well as premier institutions and non-governmental organizations in the area of information literacy, life-long learning and knowledge repository development. This study briefly discussed the policies initiated by GoI such as the setting up of Rural Knowledge Centers or Community Informed Centers for lending books, web-based services such as e-learning, banking and insurance, Panchayat level information, e governance, community information, content and database creation. Study concluded that a closer relationship amongst the entire range of stakeholders (e.g. health librarians, social workers, health professionals and the patients) will develop a better understanding and acknowledgement of the particular needs of community.

Mathur et al (2009) studied the role of ICT sector for human development in India by enabling access to information, creation of employment, improving the quality of life, better livelihood opportunities in rural areas, growth of agriculture, and the related issues. ICT has reduced information asymmetry and a gap between rich and poor. The ICT density is continuously moving up in the rural areas facilitating agricultural information to rural people. They discussed relationship of telecom expansion, growth and need for further expansion of ICT in order to meet the rising demand of farm sector, small industries, irrigation, water supply and bank credit mainly to meet out marketing needs. There has been an increased productivity in remote rural areas through substitution of pricey mode of traveling to access the markets with low priced and reliable telephone usage. Farmers have enormously been benefited through better information flow on agricultural prices, products and attributes. Extension of ICT services into India's rural economy has invigorated the market functioning. Well-functioning markets have facilitated the commercialization and diversification of farming and they have a vital role in efficiently bringing food and agriculture products to domestic and international consumers. At last there is a need of coordinated policy of ICT and other sectors.

Joshi (2012) discussed the need for application of science and technology in Indian agriculture sector. Its absence is the major cause of declining production, lack of institutional finance, crisis in irrigation facilities, collapsing agriculture extension, problems in agricultural marketing, degradation of land resources and climate change. The major revolution in India constitutes a gene revolution for modifying crops before their commercial use in the market. IT has revolutionized the delivery of extension services in rural India. Study recommended that there should be alliance of business,

NGO and government sector to overcome the problems. Internet, mobile telephony, FM radio could be the enabling tools for accessing information related to agro inputs, crop production technologies, agro processing, market support, agro finance, agro clinics and agribusiness through integrated use of these technologies.

Pray and Nagarajan (2012) presented a comparative study on the development, use and research innovations in agribusiness in India. Study based on secondary data of seeds, pesticides, machinery etc. for the time period of 1990-2010, showed an increase in cultivars of wheat, rice, maize to the tune of roughly two-fold where as cotton cultivars got tripled. Agricultural machinery, veterinary medicine, agricultural processing industries also adopted more innovations. Researchers discussed major policies in agribusiness research and innovations. Modern inputs like fertilizers, tractors etc. showed an enhanced consumption pattern. This research showed that agricultural innovations in India have dramatically increased since the 1980s. Quantitative data show that in 1990s and in the first decade of this century, the number of new seed cultivars registered in maize, wheat, and rice grew by at least 60 percent and probably doubled. Private sector involvement caused major factors such as market demand of agricultural goods in India and the globe, policy liberalization and advances in basic science and engineering (biotechnology and information technology). It recommended government actions to encourage the growth of rural business hubs and supply chains consolidation to promote supermarkets and the agricultural processing industry, which supply technology and market opportunities to poor farmers and job opportunities to landless laborers.

Ferroni and Zhou (2012) discussed the purpose of extension with respect to farmers 'in dissemination of knowledge. Farmers experienced a knowledge gap of services and quality inputs, information of price and markets, post harvest management, quality production and safety standards. Extension can generate the best and desired outcomes. This paper discussed the convergence of agriculture extension, role of ICT and mass media, farmers and market led extension system. The "market-driven" approach has clearly succeeded when farmers organize themselves into groups or cooperatives, access knowledge and needed resources, and sell profitably into predictable supply chains. But mostly it converged into supply-led approach to meet the challenges of timely information and to reach all the farmers. Study focused on some models like ATMA model from public extension. Private extension has been categorized into input and technology providers (Hariyali Kisan Bazar, Tata Kisan Sansar etc.), extension by

aggregators and processors (HLL, Rallies, syngenta foundation for sustainable agriculture etc.), extension by NGOs (Basix, PRADAN, and BAIF), mobile application in extension (Digital Green, IFFCO Kisan Snachar Ltd., Nokia Life Tools, Reuters Market Line etc.). They concluded that mobile application could communicate and inform farmers when tackled by innovative actors. NGOs and private players were found growing rapidly as compared to public extension.

Dethier and Effenberger (2012) reviewed the economic literature on land markets, research on seeds and inputs, agricultural extension, credit, rural infrastructure, connection to markets, food price and such other aspects. Agriculture faces mainly two challenges; the first one is to increase food productivity and production in developing countries. The other one is extension services etc. Green revolution in the country has led to sustained increases in yields, intensive mode of agriculture and adoption of new varieties by farmers, improved irrigation and a massive use of fertilizers. But some challenges, which prevented reaping the benefits, are missing markets for insurance and credit, low education levels, limited market access and market information etc. Further the role of extension services in addressing the problems in reaching the rural people (caused due to lack of accountability of extension agents) can efficiently be solved by ICTs such as mobiles. Finally, they concluded that HYVs, integration of small farmers into modern value chains and the use of communication technology in extension services could nurture technology adoption and profitable cultivation among farmers.

2.2 Factors Affecting Adoption of ICTs

Riesenberg and Gor (1989) discussed the problems about stagnation in farming operations with reference to previous studies related to extension services, agents and research centers. Information on practices on farming was not disseminated because of lack of information sources. Researchers advocated the transformation of traditional interpersonal methods of information to mass media like print material, TV, computer etc. for effective gain in potential of practitioners. The study identified the sources of information and their effective use in disseminating information on innovative farming practices. Data was collected of 321 farmers in the districts of USA and results were drawn by respondents' preferences of method of agricultural information using two way ANOVA statistics. Also one way ANOVA and the Mann-Whitney U were applied for the analysis. Study also suggested that farmers prefer interpersonal method of information on

innovative farming practices. Age is the important factor as 20-35 age group prefers the mass media method most.

Mohammad and Garforth (1999) empirically identified the sources of information and their effectiveness on adoption of agricultural information among farmers in Pakistan. Lack of technical knowledge is the prime factor responsible for low productivity in the agriculture production at farm level. Agriculture extension services facilitate farmers to a variety of information sources, which showed farmers interest in farming. The respondents were selected as contact farmers and non contact farmers (CFs). Study found that neighbors/ friends/ relatives (NFRs), radio and print media were the major sources of information as realized by the farmers. However, field assistants and agricultural officers lay far behind the expectations as only 18.3 % were reported as source of information and were also the least effective. But print media could impact positively among literate farmers which are regarded as most effective sources of information. The role of CFs and NFRs as information source was found to be almost nil.

Omekwu (2003) observed that value of the data, their reliability and quality can be maintained by an information system for valuable decisions related to agricultural inputs. The reliability, quality and usefulness of information from the system will depend on the reliability, quality and value of the information the system had received as inputs. The information requirement of users should be analyzed and synthesized to ensure the inclusion of only need based information.

Chandrasekhar (2003) discussed the diffusion of information technology in India. In 2001 only 31.5 percent rural Indians and 74.1 percent urban Indians had accessed information through home based or community TV sets by Doordarshan's network. Tele-density is a simple measure used to assess the diffusion of information technology that had touched 5 per 100 inhabitants as on 31 March 2003. This growth in connectivity could increase interactive communication between distant centers, allow improved governance through the more well-organized delivery of information and bring in a social change in rural areas as well as get bigger access to the internet and its benefits.

Rao (2004) indicated that ICTs promoted greater transparency and sped up the decision-making processes of governments, and thus empowered rural communities by expanding their use of government services. In India many of the ICT initiatives were in running phase and diversified information was a great need of farmers.

Kaushik and Singh (2004) drew some preliminary lessons about information technology and broad based development in north India. In rural India, farmers make important transactions and access to sell their crops and buying inputs, matrimonial alliances for their children and job seekers identified as potential users of internet based matching services. They compared the two ongoing projects namely Tara haat and Drishtie (NGO based models of same geographical and economical location), which are providing information to the rural people. They recommended that constructive innovation can be achieved through the use of hybrids of commercial and non profit organization with the partnerships of local and state government agencies.

Khaiser et al (2004) discussed the overview of Indian ICT scenario and found that ICT played a significant role in supporting livelihood by catering information on better use of natural resources, markets and commodity prices. They discussed several ICT initiatives which were providing mandi rates, land details etc. to its users. This study drew a prerequisite for the success of the projects by creating information content in local languages. The scope of IT must be seen as reaching not beyond that of computers and internet but to include radio, TV, microchip technology etc.

Rao (2005) discussed the overview of several ICT initiatives in India which were providing diversified services to the people such as reservation, prices of agricultural inputs and outputs, market services (export potential etc.), governments information, banking, health care, transport, weather etc.

Rao (2005) discussed the role of ICTs in reaping the benefits in rural communities. Several factors were highlighted which restricted rural communities in accessing ICTs and technological innovations. These factors include lack of awareness about the benefits of ICTs, in accessing ICT facilities, language barriers in internet use, non-availability of online government information etc. He discussed selected community and rural initiative projects in India which were acting as a key element in poverty reduction and sustainable development by creating information rich societies.

Kasigwa et al (2005) examined that developing countries (DCs) were lacked in fulfilling the capacity building of rural people by the use of ICTs. They critically analyzed the role of ICTs in socioeconomic development among least developing countries (LDCs). The challenges of creating sustainable ICT projects/ initiatives and ultimately the community development in LDCs were explored. One of the reasons in the failure of some initiatives

was due to supply-driven nature of ICTs, failed to address local and cultural impediments and opportunities. This study recommended the exploitation of new opportunities in content development and its applications to ensure the community's sustainability goals through innovative use of models. Several measures were found in the study such as community involvement in deciding, planning and evaluating the projects and adopting a learning approach through evaluation cycles.

Ommani and Chizari (2006) studied the use of information technology by extension agents in Iran. The real challenges were not to produce or store information but to make it available for efficient use. IT has decreased the cost of information flow, disseminated information and facilitated the large amount of information to all participants in agriculture sector. The productivity and competitiveness of farmers can be achieved by providing them with expert advice. They found that farmers used computer, WWW, E mail etc. in getting agriculture related information. This study recommended that integration of IT in agriculture would help any country to regulate its overall economy and trade and a strong need has been felt to develop electronic communication in agriculture and rural areas by orientating farmers with some IT skills.

Rao (2007) studied the aspects of knowledge management and evaluated several ICT initiatives in India like n logue, MSSRF foundation etc. on mainly two issues. The first one was supply side that concerned with issues related to access of ICT-based services in rural areas such as technological and organizational aspects. Technological aspects included connectivity of computer; telephone etc. whereas the corporate agribusiness (organizational aspect) mode was the public sector or non-government organization (NGO). Farmers' decisions included input activities from crop varieties to pesticides, market transactions, farm operations, post harvest operations, storage, transport, marketing, processing and many others. The demand side was concerned with the information-dependent nature of farming and related decisions. He also defined ICT models according to their wide range of opportunities to deliver information in agriculture development and proposed three models (a closed vertical chain network for private agribusinesses; an open chain network model for public and nongovernmental/multilateral institutions).

Butt et al (2008) discussed the roll of mass media for enhancing potato production. The production level was not sufficient to feed that was due to several major factors such as non availability of disease free seed of high yielding varieties, poor agronomic practices,

indigenous weeding methods, lack of proper plant protection measures for the control of insect/pests and diseases, defective marketing system and lack of information. Information on newly developed technologies can add a value in solving the above issues. They found that provision of information was not sufficient. Mass media played important role in creating awareness about new agricultural technologies among farmers in comparison to personal contact. They suggested that different mass media were not fully utilized in the area stalling awareness level of the respondents which affected the adoption level of latest potato production technologies. The most effective mass media were radio followed by meeting, agriculture departments, TV, internet.

Rao (2008) evaluated the status of ICTs in India, the role of telecenter in social development by taking an over view of selected current initiatives. The study concluded that several ICT initiatives were not equipped with appropriate technologies and lacked in designing of comprehensive plan in addressing the target population. The researcher proposed that telecenter model could work effectively by involving multi-stakeholder partnership (government, private players and development agencies).

Gollakota (2008) evaluated the service provided by EID parry initiative. The kiosks users were categorized on the basis of company operated and franchise based. The physical and infrastructure were the most important problems faced by farmers. The various stake holders like farmers, banks, insurance agents, farm input providers and commodity traders could come together to create a nodal centre for accessing of information and operations. Exam results, loan facilities, insurance, sales, telephones were the services accessed by the users. This study reported that most of the farmers were not involved in getting information directly from computers rather than they accessed it by extension officers of EID Parry. He concluded that farmers want information content in a well organized format.

Patil et al (2008) evaluated the main constraint in the adoption of ICTs and information needed by farmers, extension agents and research personal. Integration of information technology, agriculture and cyber revolution can alleviate significant strides in the development. The study evaluated several factors of ICTs use in context with farmers, extension workers and research personal. Unfamiliarity with technology, lack of training and illiteracy were the main barriers in effective decision making. They also identified several limiting factors such as poor infrastructure, insufficient power supply, telecommunication and ICT maintenance facilities etc. Demonstration and training

facilities at centers created closer relations among beneficiaries. Various incentives and updated services were the major needs of Indian farmers. This study recommended that there was a need to involve all the stakeholders (farmers, extension workers, policy makers, scientists, business communities, IT firms and NGOs) in research, development and technology transfer activities. Linking Village Knowledge Centers, KVKs and agri-clinics could provide single window solution system to farmer's problems.

Kannabiran (2008) studied RASI project (an internet based government-private initiative) which was initiated to foster e-governance services. He analyzed several factors in accessing and using of services offered by this project. There are generally three types of kiosks, the first one was used in dissemination of information, second for interactive requirements and the last one for carrying out business activities and financial transactions. The use of appropriate application, physical access and infrastructure, language selection and customized services etc. were the prime factors in better implementation of kiosks. This study also discussed some public and private sector ICT based initiative like E-choupal, Gyandoot, EID parry etc. Location of kiosk, low fees and variety of offered services influenced the usage pattern of these models. Net browsing, off line services and matrimonial were mostly used by the people. The satisfaction level of using internet and agricultural services showed a marked decline. The study also found that provision of e-governance and agricultural related information could add value in the working of these models. Connectivity was the major problem in effective exploitation of ICTs. Citizen centric approach should be taken into consideration for implementation and sustainability of the projects.

Sudaryanto and Soekartawi (2009) evaluated several factors that influenced ICT adoption among Java agribusiness. ICT made information freely, easily and quickly accessible to farmers at anytime and anywhere in world. Logit Regression Model was used to test the factors of internet adoption. Among several factors ICT literacy was the important one regarding the adoption of ICT among farmers. They also suggested that future research could be extended to evaluate ICT adopting and non adopting firms.

Ani and Baba (2009) evaluated the utilization of mass media methods in the delivery of agricultural information in Nigeria. Mass media could reach to wide audience at a very fast rate. They were helpful in notifying farmers about new developments and emergencies. Six mass media outfits were selected on simple random basis of 120 respondents. This study identified various major constraints associated with the utilization

of electronic mass media in agricultural information delivery. Qualification, gender, age and income were the factors affecting the adoption of mass media and agricultural information. The major source of agricultural information was radio, followed by extension agents and TV. They found that electronic mass media was more popular than direct contact method among farmers. Power supply, farm income etc. were the major obstacles faced by the respondents.

Hua et al (2009) studied small and medium enterprises in Malaysia and explored the extent of electronic communication use by SMEs. This study empirically analyzed the internal factors of firm and owners which were influencing EC adoption among smaller businesses in Malaysia. The methodology and results of this study might be applicable to other developing countries. The owner's, gender and education were found to be significant in EC adoption.

Maumbe et al (2010) compared the application of ICT in agriculture and rural development of South Africa and Kenya. Vast success in application of ICT in agriculture can be achieved by addressing impediments to adoption and diffusion. Such impediments in the use of ICTs included lack of awareness, low literacy, infrastructure deficiencies (e.g. lack of electricity to charge electronic gadgets), language and cultural barriers. This paper also reviewed successful applications of ICT in agriculture and suggested the larger use of ICT-based interventions in agriculture.

Armstrong (2010) developed a framework to support decision making of farmers. The development of this framework followed earlier attempts to identify agricultural information dissemination frameworks and discussed the delivery process of location specific expert agricultural knowledge to farming communities in India. Internet and mobile technologies could better contribute in providing appropriate knowledge to farmers. Farmer Knowledge Decision Support Framework (FKDSF) was created by using Unified Modeling Language to support the delivery of cropping information under different circumstances. This study found that traditional farmers were not prompt to access internet as compared to innovative farmers. He suggested further elaborating of information flow and decision making processes among farmers.

Okello et al (2010) developed a framework to analyze the role of ICT on agricultural commercialization and empirically tested the factors to reduce the marketing cost for farm households. Characteristics of extension models such as personnel contact method;

training and visit model (T&V model) were also discussed. Modern ICTs deliver information on time and at low cost to improve market access and agricultural credit etc. They reported that ICT application in agriculture could increase farmer's participation in market and would help to achieve the food security issues of farmers. Awareness and willingness of farmers to participate in an intervention were the basic assessment criterion of any projects. Asset poverty which encompassed poor infrastructure, lack of human, financial, social/ physical capital was prevalent factors in smallholder production system. They recommended that investment in physical infrastructure and efficient access to inputs/ assets were important issues which should be taken into consideration by the governments.

Narula and Arora (2010) compared the functioning of two ICT models, one from the public sector (Gyandoot) and the second from private sector (E-Choupal) in rural areas of MP state in India. The respondents were included from both the users and non users group of two initiatives. Information content related to agriculture, i.e. agri input prices, markets arrivals and prices, weather information were valued most by the farmers followed by e-governance services (land records, caste, domicile, ration card, PAN card etc.). This study reported that farmers need timely and relevant information on electronic commodity auction, logistics, agricultural credit and agri-inputs (seeds, fertilizers and pesticides). They suggested that different user group farmers specifically need customized information such as crop specific, region specific etc. in the varying climatic conditions and crop diversity scenario.

Chisita (2010) discussed the impact and scope of ICTs in dissemination of agricultural information and production among Zimbabwean small scale farmers. Farmers access improved quality of agriculture information through modern media (internet and mobile). Social media, telecenter and other ICT driven communication devices have also immense potential to share knowledge and experience among small scale farmers. He suggested that integration of ICT with agriculture could promote Zimbabwe as a leader in agriculture production.

Ali and Kumar (2010) empirically analyzed the role of E-choupal initiative in enhancing farmer's decision making capabilities. Data was collected on five point likert scale and ANOVA technique was used to analyze the data. The impact of socio economic profile of users and non users on the decision making behaviour of farmers were analyzed. Education, social category, income level and land holding size were the important factors

affecting the agriculture decision making process of farmers at planning, post harvest and marketing stage. Users of ITC E-choupal showed significantly better decision making aptitude. Post harvest loss minimization and marketing of the product at optimum price had increased the farmer's income. Higher education levels of user and non user group showed significantly different results in seven activities which include production planning (crop rotation and multiple cropping), cultivation (certified seeds and irrigation practices), post harvest and marketing (record keeping, sorting, grading and marketing information). This study showed that moderate education would help in making better decision on some activities. Large land holders and socially empowered groups were in better position to acquire knowledge and information. The study suggested that ICTs enabled initiatives, especially the ones which focus on providing transactional services, need to be further expanded and strengthened. The model needs to be designed keeping in view the demographic profile of the users. Content as well as user interface need to be tailored to suit the user group. Some efforts need to be made to increase the level of education of the user groups. Provision of financial services need to be given particular attention so that resource poor farmers were also able to make use of the information and knowledge being given to them.

Aker (2011) discussed the potential mechanism through which ICT could smooth the progress of technological adoption and prerequisite of extension services in developing countries. Technological adoptions depend on mode of technology, wealth, education, complementary inputs, access to information and learning. This study reviewed the role of mobile and integrated facilitator of extension services. ICT based applications and services in agricultural sector provided information on market prices, weather, transport and agricultural practices via voice delivery/ SMS (mobile based), radio and internet. The important barrier in adoption of technology was information asymmetry. By providing information on variety of issues at each stage of agricultural production processes would reduce communication cost of farmers. This study briefly discussed on some issues such as scope of traditional extension, best suited information for extension services and their demand, potential sustainability and cost effectiveness.

Alek et al (2011) critically evaluated the impact of socio augmented parameters (lifestyle, age and gender) on the effective adoption of ICT by small-scale agribusiness operators in Southeast Nigeria. Low yield and productivity were the major issues colligated with Nigerian agriculture and which was caused by various factors such as low ICT adoption,

social factors, inefficiencies in supply chain etc. Researcher drew a light on adoption of ICT that imparted the shortening of supply chain. Three types of models were discussed in this study; DOI (diffusion of innovation), TAM (technology acceptance model) and SNT (social network theory). Authors argued that a combined exploration of these three frameworks would go a long way in addressing extension problems faced by farmers. This study found that ICT adoption process was greatly influenced by social imperatives.

Lwoga (2011) investigated the application of ICTs in the improvement of farming activities in rural areas of Tanzania. The relevant issues are information and knowledge needs, their access and use. Quantitative, qualitative and participatory methods were used for the collection of data in six districts of Tanzania. Respondent's selection was based on the presence of ICTs such as telecenter, community radio and cellular phone networks in respective districts. He considered several parameters in the study such as soil classification, crop varieties, crop planting, irrigation, agricultural tools, animal feeding, animal breeding, credit/ loan facilities, land preparations, soil fertilization, value added agricultural marketing, animal housing, control of plant diseases, pests and control of animal diseases. The major information and knowledge gaps were identified in this study such as control of plant and animal diseases, marketing, credit and loan facilities. He also found that the major sources of agricultural information were local medium (neighbors, friends and family) followed by public extension services. Apart from radio and cell phones, advanced technologies (i.e. internet and e-mail) and printed materials were used at lower rate in spite of their existence in rural communities. Farmer's information needs varied across gender group. Oral communication channels were effective way in delivering information and knowledge in the surveyed local communities in comparison to ICTs.

Islam and Tsuji (2011) discussed the community information centers (CICs) to bridge the digital divide in Bangladesh. Internet was the most effective technology used in reducing the information gap. This study had discussed the problems and prospects of CICs. Commodity prices, weather information, crop planning, literacy programs, exam results, health information, school curriculum, government notifications, downloadable forms etc. were the services offered by CICs. It had helped in easily access of e-governance facilities such as birth and death registration, voter lists, passport and other government's form. Most preferred services were e mail, chatting, agricultural information, academics and updated knowledge. Power supply failure and low internet

speed were the major problems faced by users of CICs. However poor literacy rates, language barrier, lack of IT skills, unawareness of modern technologies were the major problems faced its users. They recommended that awareness promotion, use of modern network technologies, focused content management, cooperation among government and NGOs should be considered as important steps for the advancement of CICs.

Kameswari et al (2011) discussed the information seeking behavior of farming community. The National Commission on Farmers had noted that knowledge deficits constrain agricultural productivity in India. It added that use of ICTs in agricultural extension was the one way to address information needs of farmers. This study found some issues such as time lag, high cost, low technological literacy, infrastructural problems, absence of linkage with other input agencies (input, fertilizers, and pesticides) that hindered the efficient use of rural knowledge centers. This study had been carried out in Garhwal and Kumaon region. Television was the most preferred source in comparison to radio because of its visual nature and diversified content. Agriculture information disseminated via internet would be feasible only under an effective institutional structure and arrangement. Though farmers accessed wide range of sources of information, they mostly relied on middlemen, local and official sources. This study recommended that entire agricultural supply chain can be made more effective by the use of ICTs.

Ali (2011) discussed the role of mass media in farmer's decision making of vegetable growers in Uttar Pradesh and empirically analyzed the factors affecting the adoption of information. This study analyzed the factors like socio demographic, farm and market characteristics using logistic regression model. This study found that information on input decisions and production techniques such as high yielding seeds, fertilizers, pesticides were primarily adopted from input dealers followed by local/ mandi, progressive farmers and relatives. Market price information was obtained from local/ mandi and input dealer whereas farmers got information on government policies largely from input dealer followed by mass media. Small land holdings, irrigation facility and using hired labor at their vegetable farms were more likely adopt mass media information. He indicated that only 22 percent vegetable growers intended to use mass media. The vegetable growers largely belong to socially backward and asset poor segment, the mass media based extension system needs to be designed keeping in mind the opportunities and challenges faced by these vegetable growers.

Naik et al (2012) discussed about the sustainability of rural telecenter. Farmers could reach their information needs by accessing e-governance facilities through telecenter. The number of services that could be delivered in rural areas through CSC varied according to the needs of the various stakeholders i.e. citizen and government. CSC could be a market creator in disseminating agricultural needs of the farmers which include crop, seeds, fertilizers and marketing information. Clustering, integrating and ensuring completeness of services in telecenter can be a sustainable move to deliver information between government and citizens. They found that telecenter were providing e-governance facilities to rural citizens in an efficient manner although there exist low e-literacy, low penetration of individual ownership of computer and internet.

Saeed et al (2012) discussed about the relationship between the governance and ICT. Various CICs were implemented to facilitate e-governance services in rural India. This study analyzed the activities of CIC in one of the district in India having rural and tribal mix and investigated the demand-supply matching of e-governance services embedded in CIC model in the perspective of providers, users and community people. The gap had been found between the level of demand and the level of supply. They recommended that this gap can be filled by understanding the needs of target population. The positive message was that there existed a high level demand of e-governance service in rural as well as tribal areas.

Islam and Zabed (2012) reviewed selected research studies on information needs and information seeking behavior of rural dwellers in many selected developed and developing countries. They stated that in earlier studies, rural dwellers need day-to-day living information such as health, occupation, income generation, self-governance, agriculture, education, religion, recreation and current affairs. More attention should be given to existing organizations which were engaged in disseminating information to its users. Internet and mobile should be considered as an alternative channels to provide information services in rural areas. In developing countries, oral and traditional methods played an important role in information transfer. Integration of NGOs with extension and government organizations can be the best solution to cater the information needs of rural dwellers.

Glendenning and Ficarelli (2012) evaluated the content development and management processes of six well known ICT projects in India. Relevant and timely information empowered farming community by creating and sharing of knowledge. This study

addressed the availability, relevancy, mechanism, needs and demand of information content disseminated by ICT projects. Selection of initiatives was based on their handling on content management and delivery processes. Three of them (IKSL, RML and Lifeline) used mobile phones to deliver the information where as other three (Digital Green, e-Sagu, and a-Aqua) were internet based service providers. All the ICT projects share similar goals although, they had different ICT approaches and pathways. Localization of content can be improved by facilitating Q&A services to the end users. They recommended that the integration of ICT platforms with existing public agricultural institutions could ensure the sharing of expert tacit knowledge with farmers.

Kiiza et al (2012) discussed the factors affecting access to ICT based market information and its intensity of adoption. They argued that access to ICT-based market information is crucial in the adoption of seed technologies. A significant influence was found on the adoption of seed technologies while accessing market information. This study selected several parameters such as FM radio stations, farmer cooperatives, market information centers which were providing ICT-based market information.

Armstrong et al (2012) discussed the impact of ICT among rural farmers of Ratnagiri district. More than one hundred randomly selected farmers were surveyed to gather information on the use of ICT. This study suggested that the income was key constituent in adoption of ICTs where as age, education etc. did not affect significantly. Large farmers were more interested to use ICTs. Farmers were most interested in obtaining market price information and it could be achieved by establishing information centers and telecenter.

Ali (2012) discussed the factors of ICT adoption at all the stages of agriculture supply chain (crop planning and production, post harvest and storage, sales and marketing). He selected several parameters such as socio demographic profile (age, income, social category, education and secondary income), farm characteristics (land holding size, leased land, number of crops grown), business orientation (farming as business, awareness on MSP, social networking). This study was conducted in eight districts of Uttar Pradesh and the respondents were categorized as the user and non-user group of e choupal. The Poisson Count Regression Model (PCRM) was used to analyze the factors influencing the adoption of ICT-driven information on various agricultural practices. Educated farmers were more inclined to use ICTs for their farming decisions. It gave implication that ICT models should be designed according to the needs of less educated

and more educated group. Socially higher classes and secondary source of income were positive factors which influenced better adoption of ICT. Large land holders and leased land farmers were less likely to adopt ICTs based information as compared to small one whereas diversified multiple crop growers showed significantly higher adoption. Farmers who perceive farming as business and awareness of minimum support price (MSP) were more likely to adopt ICT based information. Farmers who were associated with self help groups (SHGs) have no effect in ICT driven information adoption.