Shaik, N., Balaji, V., Muthuraman, P., Sailaja, B., & Dixit, S. (2011). Changing Roles of Agricultural Extension: Harnessing Information and Communication Technology (ICT) for Adapting to Stresses Envisaged Under Climate Change. In B. Venkateswarlu, A. K. Shanker, C. Shanker & M. Maheswari (Eds.). Crop Stress and its Management: Perspectives and Strategies (pp585-605). New York: Springer

Changing roles of Agricultural Extension: Harnessing Information and Communications Technology (ICT) for adapting to stresses envisaged under climate change

Shaik N. Meera[1],V. Balaji[2]P. Muthuraman[3]B. Sailaja[4]and Sreenath Dixit[5]

Abstract

The linkages between agriculture and climate are pronounced and often complex. Agricultural systems are most sensitive to extreme climatic events such as droughts, floods and hailstorms, and to seasonal variability and changing rainfall patterns. The role of inadequate institutional support is frequently cited in the literature as a hindrance to adaptation.

In context of climate change, extension will increasingly face challenges of addressing vulnerability. The effectiveness of extension will be influenced by the factors such as identifying vulnerable regions, vulnerable groups, farmers having multiple stressors, areas which will be doubly exposed, for assessing and strengthening the coping strategies among vulnerable regions/groups and improve the ability for adaptive measures.

Effective and timely provision of information will play a crucial role in future extension. Despite the need for timely and well-targeted information on climatic risks, there are currently a number of gaps and challenges in providing climate information to the farmers. Of late, organisations in agriculture realised the importance of managing the Knowledge (Implicit & Explicit; Internal & External) for the dissemination purposes.

In this chapter, we have discussed at length the cases for developing insights into the contemporary initiatives of integrating ICTs and climate information in extension. In order to promote the development of appropriate community-based ICT endeavors for sharing climate change information and technology options at grassroots level, it is important that we also understand the attributes that must be considered for building more practical and broad based approaches. For the benefit of the readers, a comprehensive framework involving various components of climate change vis a vis Extension is provided. In the context of climate change, information needs assessment and strategies for strengthening

[1] Senior Scientist (Agril. Extension), Directorate of Rice Research, Rajendranagar, Hyderabad – 500 030, India email: shaiknmeera@gmail.com , +91-9000680909
[2]Director, Technology & Knowledge Management, Commonwealth of Learning, 1055 West Hastings Street, Suite 1200 Vancouver, BC,V6E 2E9 CANADA
[3] Senior Scientist (Agricultural Extension), Directorate of Rice Research, Rajendranagar, Hyderabad – 500 030, India
[4] Senior Scientist (Computer Applications), Directorate of Rice Research, Rajendranagar, Hyderabad – 500 030, India
[5] Principal Scientist (Agricultuiral Extension), Central Research Institute for Dryland Agriculture (CRIDA), Santoshnagar, Hyderabad, India

Research-Extension-Farmers linkages are discussed in this chapter. Further looking at the complexities of climate change scenario, it is proposed that ICT enabled extension framework may be tested, refined and adapted in future extension endeavours.

19.1 Introduction:

Need for improved agricultural extension throughout the developing world has never been greater. Agricultural and rural development and hence rural extension continue to be in transition in the developing world. These transitions are happening because of the forces that are driving the world agriculture today. Vulnerability of the farming in the developing world is quite evident due to forces like climate change, changes in natural resources quality (including desertification over large tracts), lack of coping strategies at micro and macro levels of decision making, coupled with globalization, emerging market forces like commodity markets, sustainability constraints etc., The challenges for rural extension are never more acute than at present.

Agricultural Extension, in the current scenario of rapidly changing world has been recognized as an essential mechanism for delivering knowledge (information) and advises as an input into modern farming (Jones, 1997). Agricultural Extension has to reorient itself beyond the narrow mindset of transfer of technology packages. Instead, it has to rejuvenate its vigour for "transferring knowledge (or) information packages" as the input for modern farming. In such case, extension will become more diversified, knowledge intensive, and demand driven. This requires extension system to be at cutting edge level and master many trades for which the ICTs can help. It is in this context, there are many possibilities for potential application of the ICTs in Agricultural Extension (Zijp, 1994).

In this chapter, "agriculture" is taken to mean both the traditional activities of agriculture (e.g., planting, harvesting, marketing, animal husbandry) and the natural resource management activities associated with agricultural work (e.g., water management, soil fertility, agro-forestry, fishery management).

Information and Communications Technology (ICT) is an umbrella term that includes computer hardware and software; digital broadcast and telecommunication technologies as well as electronic information repositories such as the World Wide Web or those found on CD-ROMs. It represents a broad and continually evolving range of elements that further includes television (TV), radio, mobile phones, and the policies and laws that govern these media and devices. ICTs are often used in plural sense (ICTs) to mean a range of technologies instead of a single technology.

ICT will bring new information services to rural areas on which, farmers, as users, will have much greater control than ever over current information channels. Access to such new information sources is a crucial requirement for the sustainable development of the farming systems. ICT when applied to the rural and agricultural conditions can improve the linkages between research and farmer sub-systems. For extension sub-system it is time of reckoning to build strong linkages between various other sub-systems of Agricultural Knowledge Information System (AKIS). ICT can help by enabling extension workers to gather, store, retrieve, adapt, localise and disseminate a broad range of information needed by farmers, thus transforming them from extension workers into knowledge workers. Emergence of such knowledge workers will result in the realisation of the much talked about bottom-up, demand driven technology generation, assessment, refinement and transfer (Shaik N. Meera et.al. 2004).

19.2. ICTs and Extension in the Context of Climate Change

The linkages between agriculture and climate are pronounced and often complex. Crops and livestock are sensitive to climate change in both positive and negative ways. Agricultural systems are most sensitive to extreme climatic events such as droughts, floods and hailstorms, and to seasonal variability and changing rainfall patterns. Against this backdrop, farmer adaptations are influenced by many factors, including agricultural policy, prices, technology research and development, and agricultural extension services (Kajfez-Bogataj, 2005). The poor often bear a disproportionate burden of direct damage from catastrophes and climate change as concluded by most studies in developing countries (IPCC, 2001).

The role of inadequate institutional support is frequently cited in the literature as a hindrance to adaptation. For example, Adger and Kelly (1999) and Huq *et al* (1999) show how institutional constraints and deficiencies affected managerial capacities to cope with anticipated natural events.

Many observers of rural development in recent times have commented on the frequent manifestations of unsatisfactory extension performance (e.g., Rivera *et al* 2001). Feder *et al* (2001) have suggested interrelated characteristics of extension systems in the developing world that jointly result in deficient performance, namely low staff morale, reduced efficiency and financial stress etc. One more such key factor is the number of clients and the vast spectrum of information/services needed to be covered by extension systems. Policy makers in the developing world have reacted to this with the deployment of more extension personnel which has continued the emphasis on a more centralized, hierarchical and top-down management systems. The requirement for combining a bottom up approach with the conventional extension process is yet to be fulfilled and the limitations on the extension process to influence issues such as credit availability, input supplies, market linkages and logistics facilitation continue without change. In effect, there has been no visible impact due to such changes within the extension system in many parts of the developing world.

Sulaiman and Hall (2006) have described a range of extension initiatives from the public and private sectors that explain the way extension agenda is expanding as embodied in the concept of "extension plus" and have pleaded for new experiments in extension. Pluralistic institutional arrangements are emerging and are finding wider acceptance and this is mainly because developing countries have realized the need for extension to engage in a wider range of issues beyond merely disseminating production-oriented technologies. Extension pluralism is at the core of farmer adaptation strategies and ICT's can offer new advantages in enabling reliable and rapid access to expert information support which is much needed in the realization of adaptation strategies on a large scale.

19.3. Climate Change Stresses: Information Needs

Information need assessment is the simplest issue that gets little attention in modern extension management. This section describes in detail about the demand that exists amongst various stakeholders for climate change information.

Analysis of information needs of farmers in the context of climate change can be described in the following three headings.

19.3.1. Farmers: Socio-economic and livelihood variables such as age, caste, education, family type & size, operational holding, market access, migration pattern, technology utilization pattern, cosmopolitans, mass media exposure, extension contacts were etc., along with their perception about the change in climate influence future extension efforts. During a survey conducted by the authors in South Indian province, all the respondents' perceive that there is a change in the temperature in last 20 years. Overall perception of climate change was found to be low (17% to medium (77%) envisaging the need for generating the awareness on these issues.

The information requirement at individual level is pertaining to household adaptation measures they may undertake.Among the household adaptation measures, change of variety for the current season, operating from multiple & spatially separated farm plots, matching method and time of cultivation practices to seasonal climate, small scale irrigation, watersheds and embankments etc., were preferred by them. Other adaptation methods identified from the farmers were growing alternate crops (31%), growing resilient crops (72%), special care at critical stage of production (91%), soil & water conservation practices (77%), natural retention & flood control (45%) etc.,

At societal level, the information needs are something to do with Community level adaptations.To some extent community level adaptation measures were also perceived as good adaptation against climate change. Lack of community level adaptation efforts is understandable and provides various community based organizations (both governmental and non-governmental) opportunities for developing location specific and need based adaptation measures exploiting the cooperation of the farmers as reflected in the results.

19.3.2. Extension: Information required for the extension decision makers and workersis related to projected changes in land use, resource extraction, spread of non-indigenous species, pollution and pollutants, and climate in order to anticipate changes in regional vulnerability. Insights into these changes will result in better-informed decision-making by allowing evaluation of risk management options with regard to possible cumulative and aggregate impacts from multiple stressors. Methods to assess anticipated changes are critical to timely, responsive, and proactive decision-making as well as more effective response measures.

In context of climate change, extension will increasingly face challenges of addressing vulnerability. The effectiveness of extension is going to be influenced by the factors such as identifying vulnerable regions, vulnerable groups, farmers having multiple stressors, areas which will be doubly exposed, for assessing and strengthening the coping strategies among vulnerable regions/groups and improve the ability for adaptive measures. Mapping vulnerability profiles with different stressors (globalization, climate change, marginalization etc.,) for effective extension decision-making will be helpful in this regard. The existing set up of extension decision-making and the strategies are not oriented towards this. The futuristic extension may need to be supported with the ICT enabled tools for facilitating effective decision systems. The following case illustrates application of Geographic Information Systems (GIS) for addressing these needs.

A study on Regional Vulnerability Assessment of Future Scenarios in the Mid-Atlantic Region (GPRA, 2003) looks at projected cumulative impacts from multiple drivers of change across a region 20 years into the future. These results can be used to identify probable future vulnerabilities of both human and ecological populations. By identifying areas that are vulnerable to change, resource managers will be able to better protect sensitive resources and anticipate the effectiveness of risk reduction activities given changes in the cumulative stresses that are likely to occur.

Recent studies undertaken by Tata Energy Research Institute (TERI, 2003), India strongly advocate that non-ICT interventions need to be integrated with GIS tools for enabling the vulnerable communities to cope with disasters.

19.3.3. Research: Scientific organisations require climate change data pertaining to direct damage to crops and animals, higher temperatures due to climate change. These biotic stresses – including cassava mosaic disease, potato blight, rice blast, wheat stem rust, whiteflies and many others –already take a heavy toll on developing world agriculture. To anticipate and prepare for a worsening of these problems, scientists in various CGIAR Centers are examining the likely effects of climate change on major biotic stresses in agriculture.

The International Potato Center (CIP), for example, has already developed a simulation model for potato late blight, the most destructive disease of the crop worldwide. The model can be used with GIS to predict disease severity under the changes in temperature and rainfall that are likely to result from climate change. Equally important are simulation models for forecasting the expected distribution of insects transmitting viruses, such as aphids and whiteflies. Coupled with the CGIAR's large store of knowledge about disease epidemiology, these models will be critical for anticipating the effects of climate change on the spread of dangerous plant viruses worldwide.

19.3.4. Multi-stakeholder: Information requirements on climate risks are different for different stakeholders. For all aspects, there may not be a rigid set of information requirements for each of these stakeholders. Certain stakeholders are supposed to generate information and certain other making use of it. For example, short-term weather forecasts, including cyclones and flooding prediction, will help communities save lives and property. But this information may not essentially be coming from agricultural scientists. In such cases the information flow should be across the sectors and to that extent we require to have coordination across the sectors[6].

Medium-term, seasonal weather predictions can assist farmers, extension officers and development officers in preparing for famine or disease outbreaks. Long-term climate change scenarios of changing rainfall patterns, temperature and sea level rise can inform more strategic decisions about the approach and location of development.

While farmers may use short-term forecasts to decide when to plant or harvest crops, they can use seasonal climate predictions to decide which crops or cultivars to grow, and use longer term climate scenarios to plan migration, livelihood diversification or alternative land-uses. There is a also a need for clearer messages concerning short and long term climate risks, including numbers of people affected and estimated economic impacts, that enable governments' planning and finance departments to act. The quantification of financial and economic impacts is difficult, but is important in highlighting the cost-effectiveness of integrating climate risks in comparison to a business-as-usual approach.

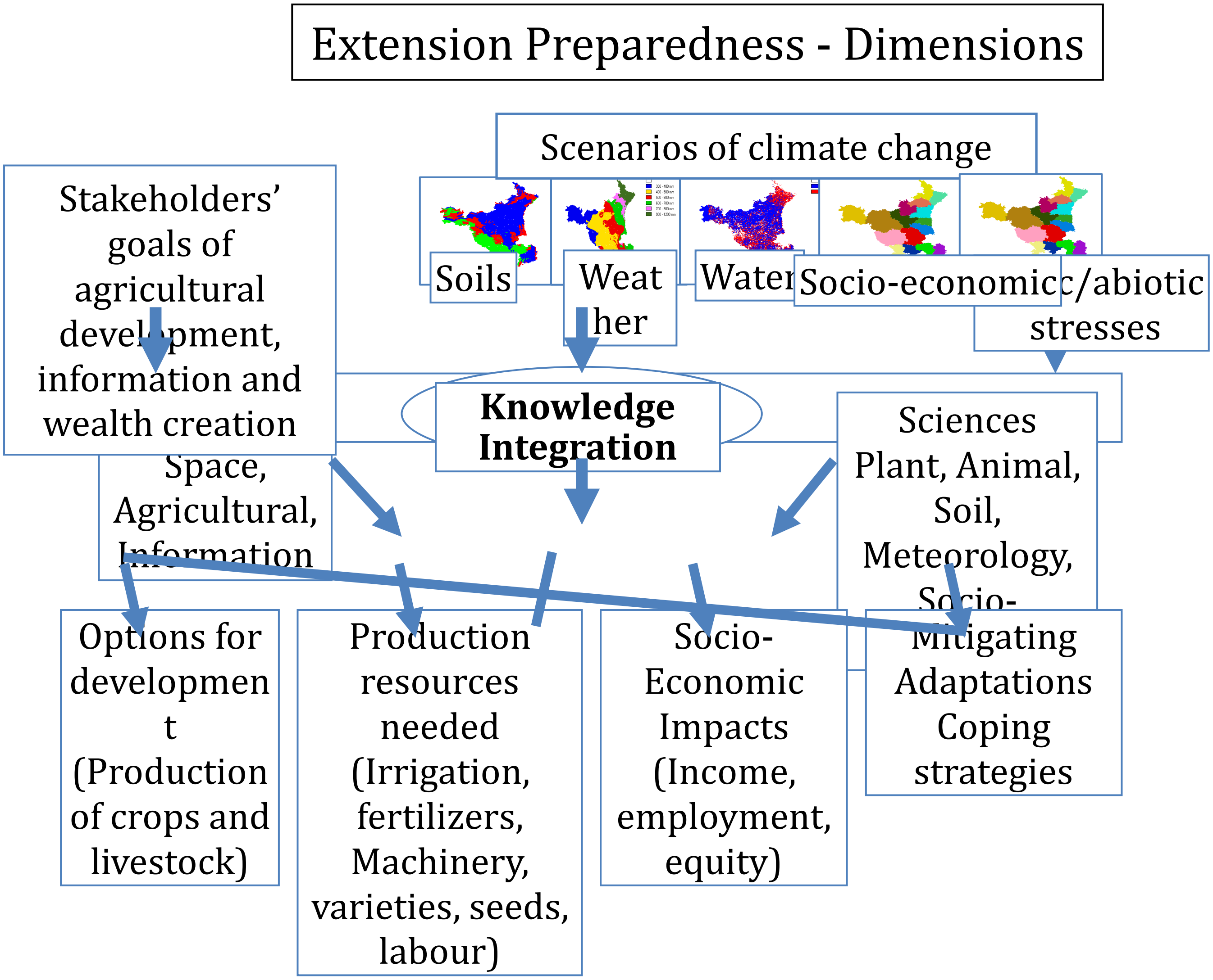
19.4. What ails information provision?[7]

Effective and timely provision of information is going to play crucial role in future extension. At the same time documenting critical contributions of communities to understand the wider context of shocks andstresses they experience, and by specifying thetype and form of climate information that couldhelp them to manage climate shocks andvariability. Communities can also provide vitalinformation in 'ground-truthing' forecasts andproviding surveillance data. There needs to beimproved dialogue between informationproviders and policy-makers so that climateinformation can be demand-driven andcorrectly interpreted.

Fig. 19.1. Extension Preparedness: Dimensions

[6] Adapted for extension context from (DFID 2004).

[7] Adapted for extension context from (DFID 2004).



19.4.1. Preparedness of Extension

Despite the need for timely and well-targetedinformation on climatic risks, there arecurrently a number of gaps and challenges inproviding climate information to the farmers. First amongst them is non-preparedness of extension organisations in terms of climate change. Most of the extension organisations in the developing world are completely unaware of climate change impacts on agriculture. Preparedness in terms of documenting climate change scenarios at grassroots level, extent of adaptation (individual/community level), mapping vulnerable regions, sustainable indicators, access to real time data, effective synthesis & interpreting, better decision making for a climate change scenario etc., are missing at present. For most of the extension organisations, climate change means seasonal aberrations. Integrating the multi-disciplinary and multi-sectoral information into a meaningful extension material is beyond the expectations of traditional extension systems.

19.4.2.Data Interpretation

In most of the developing countries, data pertaining to climate variability and its impact on biotic and abiotic stresses is lacking. Even in some cases, data & information on climate variability is available, but the process and the capacity for integrating this information into vulnerability and capacity assessments, to feed into poverty reduction strategies and sectoral planning, is lacking.

19.4.3.Information Targeting

An increasing amount of climate information(in the form of weather forecasts, seasonalforecasts and climate change scenarios) isavailable and could be used for a range ofstakeholders and timeframes. However,information is not always delivered to potentialend-users (strategic decision-makers,communities or individuals) in an accessibleway so that they can interpret its relevance orbe aware of its use.

19.4.4.Risk assessments

Adapting to current climate variability is anessential first step in adapting to future climatechange. However, rather than focusing on thenear future (i.e. the 5-10 year period favouredfor strategic and financial planning cycles ingovernment), most climate-risk assessmentslook to the distant future (i.e. 20, 50 or 80years ahead).Most of the studies in agricultural research institute’s focus on long term effects of climate change rather than on short term adaptations (such as developing a variety that thrives well, if monsoons get delayed by 10 days). It is this kind of lack of information/ technology that makes extension efforts more complicated. (In case of climate change scenarios, there are no low hanging fruits for extension).

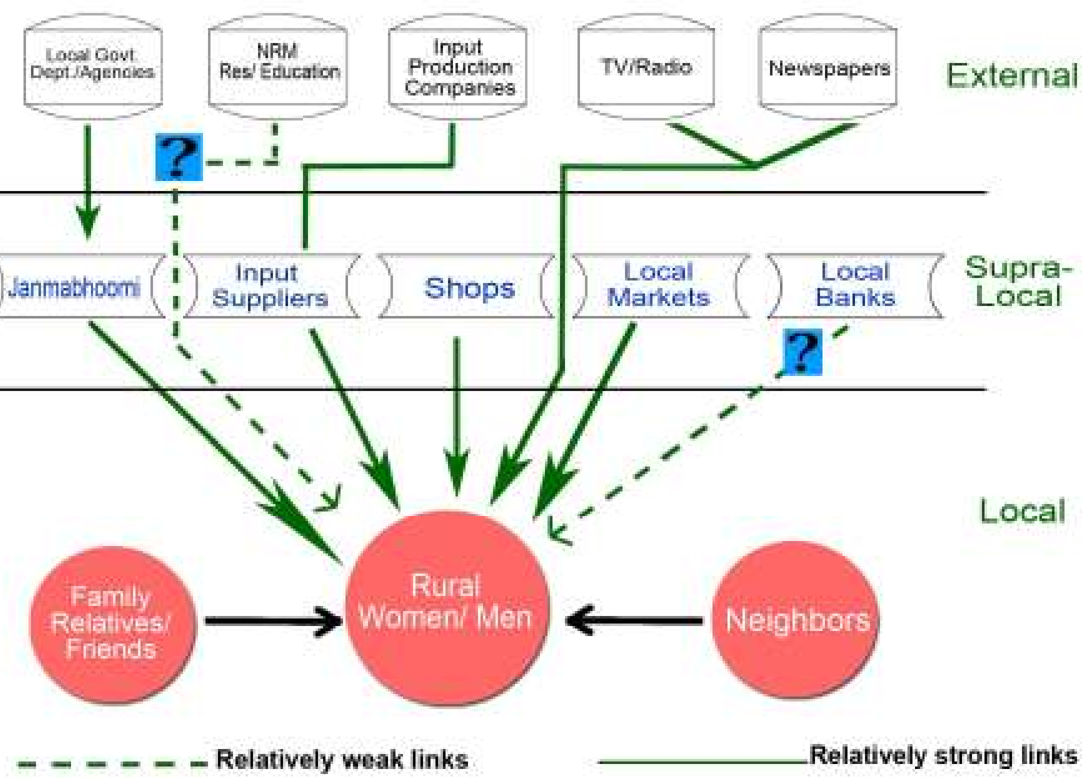
19.5. Driving the ICT use: Tech driven Need or Need Driven Tech?

The variety of new ICT tools for agriculture is impressive, but the tools need to be placed in an overall context of agricultural information and service needs. By looking at the critical information needs of agriculture and farming communities, the focus can move away from a compendium of “neat gadgets” and their individual applications towards understanding of their overall role in promoting productive, equitable, and sustainable agriculture.

The key framework for this is the *Agricultural Knowledge System* (AKS), consisting of the organizations, sources of knowledge, methods of communication, and behaviors surrounding an agricultural process. Knowledge is not the same as information: knowledge includes information, understanding, insights, and other information that has been processed by individuals through learning and thought. Conventional extension (TOT models) concentrated mainly on providing advisories without coordinating the services required to implement the advisories in the farmer’s fields.

As farmers make critical decisions throughout the year (e.g., credit applications, crop selection, tillage methods, pest control, harvesting, post-processing, marketing), a typical household will rely on its own accumulated experience and the support of local organizations (e.g., producer associations, input suppliers, rural credit agencies, extension services, NGOs, schools and others). The household may also receive radio and television broadcasts from more distant sources. Together, these form the local knowledge system accessible to a small farmer.

Fig 19.2. Information flow and Linkages in VASAT



Information exchange in the local knowledge system is generally by non-digital means: face-to face discussions, printed pamphlets, videocassettes, radio broadcasts, etc.. Local communities may

lack affordable power and communication systems to drive ICTs, or they may need investments in human capacity to maintain them. The complexities involved in decision making, multitude of key players and service coordination required at the field level demand a tools like ICTs that can handle the requirements in a multi-modal delivery system.

19.6. ICTs in work – Process of Combating Stresses: A Case of VASAT

Virtual Academy for the Semi-Arid Tropics (VASAT) was implemented across South Asia and Sub Saharan Africa to cover a few of the most drought-prone areas of the Semi-Arid Tropics.

We discuss the process to bring out learnings gathered from the South Asia information hub, keeping in mind the contemporary opportunities and challenges of extension.

VASAT was positioned as a technology-mediated extension and knowledge-sharing program partnering with a wide range of organizations including community organizations in rural areas to supplement the organized inter-institutional learning projects of ICRISAT.

From 2002 onwards ICRISAT got involved in a major development programme in Addakal block, supported by the Andhra Pradesh Rural Livelihood Project (APRLP) of Government of Andhra Pradesh in South India. A major community based organization called *Adarsha Mahila Samaikya* (AMS), a federation of women Self-Help Groups (SHGs) in the block became an important stakeholder in the project. ICRISAT in consultation with AMS created certain basic ICT infrastructure facilities at AMS such as a PC-based computer network, low-cost satellite access to the internet, printer etc and later with the help of Indian Space Research Organization, video conferencing facilities. A *hub and spokes* model was planned with AMS being the hub and certain number of villages in the block as *spokes*. On the request of villagers, ICRISAT extended the services to three nearest villages (within 5 km radius). In the initial stage, ICRISAT did not install the computers. AMS moved the available extra computers in the hub center to these 3 villages.ICRISAT conducted a preliminary study to find out the information linkages operating in the area of agriculture. This study yielded very interesting results, which showed that macro and meso level knowledge development organizations have limited reach with the village community. Televisions and radios, local government agencies, agricultural input organizations etc showed strong linkages. Natural resource management based education and research institutions and local banks have weaker linkages. However the strongest linkage was between villager to villager indicating the role of horizontal transfer of knowledge. Input suppliers and other agricultural traders are the other important source of information. Market, climate, employment and wages are some the important information needs of the community. Each village under AMS has certain number of SHGs and in order to coordinate between the SHGs and federation, AMS has created a cadre of Village Network Assistant (VNA). ICRISAT felt that VNAs in addition to coordinating the micro finance at the village could also play a role in extension and knowledge management. AMS & Villagers requested the VNAs, who are handling the SHGs and account books since from the inception of AMS, to act as kiosk operators. As the ICT based initiatives progressed, these VNAs evolved as knowledge intermediaries. It was then realized that ICT mediated approaches are more effective in rural areas if mediated through trained knowledge intermediaries.

AMS has a paid-coordinator at the headquarters who is now involved in managing the IT in hub. This person is viewed as a Para Extension Worker (PEW) who could help in converting the generic information into locale specific knowledge and act as a bridge between ICRISAT and AMS. The para extension worker and three VNAs were trained by ICRISAT in various types of ICT management. ICRISAT mobilized its expertise and made attempt to reach the villages of Addakal through AMS and the ICT network.

19.6.1.Usage Patterns, User Profile and Absorption Pattern

AMS has emerged as a self-sustaining, self-generating grassroot organization. Its saving and credit turnover is around Rs. 10 million per annum. Over 5000 women members from 23 villages are actively involved in saving and credit management. In addition to micro finance, AMS is also involved in income generating activities such as dairy industry, Highway Restaurant, Super Market etc and it is encouraging entrepreneurship among its members. It has been able to build infrastructure facilities using various government programs.

Initially AMS and ICRISAT did not have well defined strategy for interacting with the community on ICT platform. The visitors to the AMS who come there for the purpose of micro finance were attracted towards the ICT activities. Gradually ICRISAT started evolving structured approach for interaction through PEW and VNA. The establishment of *spokes* in three villages has helped to strengthen the structured interactions. Initially VASAT platform and emails were used for interaction between ICRISAT and Addakal. Later with the introduction of the video conferencing, the pattern of interaction changed substantially. The three VNAs and the Para Extension Staff regularly collect the queries and issues from the villagers and interact with the experts at ICRISAT using video conferencing facilities. The feedback from ICRISAT is communicated back to the villagers. In addition, ICRISAT also organized structured training programmes using *Technology Mediated Open and Distance Learning* (TechMODE) approach in subjects such as coping with drought since drought is the most serious problem in the area. The role played by the VNAs and the PEW was recognized by MSSRF-Tata National Virtual Academy for Rural Prosperity when some of them were selected as National Virtual Academy (NVA) Fellows.

The three VNAs pass on the queries to PEW, and PEW process the query further if required and send it to ICRISAT either on mail or through video conferencing. The replies are collected and passed on to the villagers. The PEW converts the responses in a multi-media format in local language, Telugu and stores them in the Content Management System developed by ICRISAT. They use the CMS for building a question and answer repository for long-term usage. Initially the questions from the villagers were not clear to the experts at ICRISAT, which resulted in delays in response. Hence, ICRISAT trained the VNAs and PEW on agro-advisory in distant mode which focused on “appropriately reframing the questions of the villagers” which would help the experts to quickly respond. According to a paper (Dileep Kumar et al, 2006) a typical question before the training was like this:

I observe flower dropping in my castor field, please advise me

After the training the VNAs and PEW were able to rephrase the question;

In the 3- month old castor crop in my 4- acres land, I have observed two kinds of flowers, red and green; only the red ones turned into fruit and the green flowers dropped down, please advise me’

The evolution of village level intermediaries has helped to reduce the time lag between the questions from the villages and the answers from the experts. The paper from ICRISAT (Dileepkumar et al, 2006) points out, through a table the impact of the training the village level intermediaries;

Table 19.1.: Analysis of the (questions) data collected during ICT-mediated agro-advisory process

Date	No. of questions received	Repeated questions	New questions	Un-answered	Date of answers provided	Process duration
1st October	8	3	-	0	7th October	6 days
2nd October	6	4	-	0	7th October	6 days
14th October	17	14	3	0	18th October	4 days
After training						
24th October	2	0	2	0	24th October	8 hours
4th November	17	12	5	0	5th November	31 hours
14th November	24	16	8	0	15th November	26 hours

Within a short span of time, ICRISAT's initiatives have created continuous learning cycles among villagers particularly among women. The hub and spokes model has also initiated "IT Literacy Training Programme" and in each of the three villages 15 to 45 persons have attended the program. This program, according to the VNAs, is attracting students and youths in the villages.

19.6.2.Insights for Extension

VASAT was conceived as an ICT project that would provide a holistic solution to the poor farmers of Semi Arid Tropics. It adopted a systematic approach to content and capacity building at grass-roots level. It recognized the need for multi-modal delivery and adapted cost-effective approaches such as hub and spokes model. It allowed sufficient time for the community to evolve a convenient and reliable source of information. VASAT encouraged rural youth and women to emerge as information volunteers and recognized their role as credible local source of information.

19.7.ICT Enabled Extension for Climate Change: Towards a Comprehensive Framework

Based on the review and analysis of existing ICT initiatives to address climate change challenges, a comprehensive framework can be developed.

19.7.1. ICTs in Local Decision Making[8]

Angelica (2011)explained the factors that play a role in adaptive decision making, and provides a good basis to reflect on the potential of ICT tools -and innovative approaches- within farmer's adaptive decisions. Based on the findings of the report, the following areas of ICT potential in decision-making can be identified:

19.7. 1.1. *ICTs helping Farmers Transition from Short-term to Long-term Planning*

By facilitating the production and access to climate models and projections, ICTs can contribute to the identification of future and emerging risks and opportunities associated with climate change. Local decision-making can be informed by alternative scenarios, and the diversification of livelihoods, farming practices, or skill sets required to deal with change can be considered as part of long-term planning.

19.7. 1.2. *ICTs helping to Bridge the Gap between Researchers, Advisers and Farmers*

By making climate change-related information more accessible and relevant to the local actors (e.g. through Web-based materials designed in the local language and addressing local priorities, or through text messages with simple, strategic content delivered to farmers' cell phones) ICTs can contribute to improve the information and knowledge sharing between key stakeholders.

19.7. 1.3. *ICTs helping to Strengthen the Links between Scientific and Traditional Knowledge*

By providing a platform to document and share both scientific and traditional knowledge through blogs, audio-files or community videos, among others, ICTs can help to strengthen adaptive practices, learning and social identity.

19.7. 1.4. *ICTs helping to Foster Inclusion and Connectedness*

By enhancing participation, monitoring and exchange between community members and broader networks, the use of ICTs can help to 'give a voice' to groups and individuals that could be, otherwise, excluded. The use of tools such as mobile phones and the Internet can contribute to community-based environmental monitoring, while ICT-capacity building can strengthen local-empowerment and the ability to self-organise in response to external climatic disturbances.

In sum, providing relevant information for long-term planning, building on multi-level and multi-sectorial synergies, linking both new and traditional knowledge, and facilitating more

---

[8] Angelica Valeria Ospina. (2011)

inclusive processes, are some of the areas in which ICT tools can contribute to local decision-making, helping vulnerable groups -such as farmers- to adapt more effectively to the impacts of climate change.

19.7.2. ICTs in Regional Planning:

ICTs can strengthen the capacity of national organisations working on climate change by enabling better informed and more participative decision making processes. The use of ICT tools can help Ministries and development departments to coordinate actions and implement regional

Campaigns, andfacilitate the provision of locally appropriate mechanisms of prevention andresponse. For instance, Crop Pest Surveillance Advisory Programme (CROPSAP) is developed by National Centre for Integrated Pest Management (ICAR) that aims at On-Line Monitoring System for major pests in Soybean & Cotton throughout Maharashtra,India. This kind of initiatives require huge amount of datasets both primary and secondary. ICT tools will help in effective regional extension planning.

Further, ICT applications (e.g. geographic information systems) are increasinglyembeddedin mapping different climate change scenarios and contingency planning for appropriate input supplies.

19.7.3. ICTs on Personalised Interventions[9]:

In near future, it is expected that personalised interventions/ decision making is possible using wireless sensor technology. As the transformation from web 2.0 standards to 3.0 standards, data servers catering to the mobile applications/ sensor applications may go up. For example, a preliminary study carried out under shed-net condition to observe climate change scenarios on tomato crop. Wireless Sensor Network (WSN) technology was used in the studies to monitor climate parameters (temperature, humidity and CO2 concentration) continuously under micro-climatic conditions. WSN Devices used for the studies were: FieldServer and Agrisens. DSSAT (Decision support for Agrotechnology Transfer) simulation software tool was used to determine scenarios of crop yield under different CO2 and Temperature conditions. In addition, coping strategies were also studied to combat the change scenarios. OpenSource/Free GeographicalInformation and Communication Techniques (Geo-ICT) tool was used for sensor web enablement and for dissemination to the rural community.

19.7.4. Integrated ICT approaches:

We may not have exclusive ICT projects/ interventions for climate change information. Whatever is discussed in this chapter will have to be a part of bigger picture of ICT enabled extension approaches providing a cafeteria of services.There is no single optimal or best model for providing need specific, purpose-specific and target-specific extension services[i]. This holds

[9]Arun J et. al., (2010)

good for the ICT enabled extension approaches as well. The ultimate choice of the ICT Enabled agricultural extension approach depends on (1) the ICT policy environment, (2) the capacity of potential ICT service providers, (3) the type of stakeholders ICT approaches wish to target, and (4) the nature of the local communities, including their ability to cooperate and various e-readiness parameters.

Different agricultural extension approaches can work well for different sets of frame conditions. In order to use extension approaches that best fit a particular situation, the agricultural extension system has to be sufficiently flexible to accommodate the different options. To this end, the recent agricultural-sector reforms have been geared toward creating a demand driven, broad-based, and holistic agricultural extension system

19.7.5. Knowledge Management (KM):

Of late, organisations in agriculture realised the importance of managing the Knowledge (Implicit & Explicit; Internal & External) for the dissemination purposes. Substantial review has been made on opportunities provided by ICTs, which have formed the basis for the recent knowledge management strategies[10].

There are several issues related to implementation of KM strategies in agriculture with special reference to climate change. We are of the opinion that these issues, if addressed properly would make extension system effective in tacking the climate change challenges.

19.7. 5.1. Communication Issues

- Communities of Practice - bring people together, often from different departments, to share ideas. This methodology involves the process of sharing tacit knowledge and development of informal networking.
- Question and Answer Forums - bring people together, often geographically dispersed, but with similar jobs, usually through email or chat rooms, to solve problems. This methodology involves the sharing of tacit knowledge and also storage of knowledge as the exchanges are usually archived for future use.

19.7. 5.1. Storage and retrieval Issues

- Knowledge Mapping - performing an audit to discover the knowledge resources within/ outside an extension organizations and providing location information for these knowledge resources. This methodology involves the discovery of tacit knowledge in order to facilitate eventual sharing

[10]Meera, Shaik N.(2008)

- Expert Databases- similar to mapping of knowledge, these maps experts by identifying knowledge of each expert and providing a guide map to help employees find those experts. This methodology may involve discovery if performed by others and may just facilitate the sharing of tacit knowledge if, as in many cases, it is up to the employees to provide his of her own expert profile.

- Knowledge Databases- explicit knowledge is stored in databases similar to standard document databases. This methodology facilitates the storage and sharing of explicit knowledge.

19.7. 5.1. Dissemination Issues

- News Information Alerts- provide for the distribution of selected information and explicit knowledge

- Organizational Learning- acquisition of new knowledge by individuals through training, continuing education

19.7.6.Extension Policies- Reorientation

If scientific research related to climate change is to achieve a real impact on farm productivity and livelihoods, new methodologies for dissemination of information have to be developed or adapted. The main direction of reform in agricultural extension should be towards learning rather than teaching paradigm. This learning approach should incorporate new methodologies and approaches of climate change information that are demand-driven and increase the real, interactive participation of local people at all levels of decision making in an extension delivery network. These methods require that the roles and responsibilities of researchers, extensionists, and local people be re-defined and shared.

However, it is imperative that individual countries make situational analyses of the social, political, technical, economic and natural conditions prevalent in their areas before adapting any method, approach, or strategy. An integrated approach (comprising of different strategies) is recommended in diverse socio-cultural, economic and political situations in order to achieve the desired goals. Generally, a sound agricultural extension policy is indispensable to achieve success in transferring knowledge to farmers. What exists now in most developing countries like India does not meet the climate change preparedness. We need extension policies that are cognizant of climate change scenarios and give way to innovative extension strategies.

19.8. From Tactical Methods to Practical Approaches

We have discussed at length the cases providing us with insights into the contemporary initiatives of integrating ICTs and climate information in extension. In order to promote the development of appropriate community-based ICT endeavors for sharing climate change information and technology options at grassroots level, it is important that we also understand the attributes that must be considered for building more practical and broad based approaches. They could be:

- Engage in ongoing dialogue with local people about the role and impact of ICTs in terms of their climate change information needs, attitudes towards the technologies, applications and products, and possible impacts, both positive and negative.
- Local people and their information needs should be the driving force behind ICT initiatives and not the technology.
- Promote dialogue and debate on who has control of information and their possible effects on community power dynamics.
- Engage local people in the validation of the various communication tools and let them identify the most useful medium to meet their needs. Same is the case with climate change information as well.
- Climate change extension programme design should reflect an understanding of the different ways in which individuals and groups learn, communicate and use information; without incorporating this understanding, programmes are likely to fail.
- Shift from technology driven approaches to a more holistic approach in which the wider systemic economic, social and communication aspects of communities are central concerns. In rural areas, ICT efforts should cover all the multi-faceted aspects of rural livelihoods, including agriculture, non-farm employment, environment, health, sanitation, family planning, education and literacy.
- Provide need-based ICTtraining at all levels, but especially to youth, women and marginal groups.

19.9. Research-Extension-Farmers Linkages in Climate Change Scenario

For the benefit of the readers, let us have a comprehensive model involving various components of climate change vis a vis Extension. The model describes various dimensions of formulating extension strategies with respect to the climate change based innovations. It is generally assumed that farmers will adapt to climate change, with climate resilient technologies generated by Research subsystem. But there are complex issues related to adoption of such technologies. Seldom, these issues are taken into consideration. The linkage matrix given below describes some of steps for formulating effective extension plans.

From the research sub system, the research material needs to be synthesised into extension material. As in case of any other technology research data while transforming into extension information, message distortions take place. As we all know-climate change data, information and knowledge differ from one region to other. Knowledge varies between contexts and emerges from the flows of information around the system. Knowledge includes data and information within a particular context. When a scientists' knowledge moves into an extensionist's context, it is relegated to information and it is the practitioner that has to do the work of making this information into new knowledge. Agricultural Research knowledge is just another piece of information to be incorporated into the knowledge of an extensionist. Of course this works the other way. When we think of multiple stakeholders in the agricultural value chain, the interaction between the data, information and knowledge gets much complicated. Using the traditional knowledge flow mechanisms, it is not possible to facilitate different processes (from collection to decision making) at various hierarchical levels. The KM practices using ICTs are emerging fast as viable solutions.

This is coupled with technology inventory and analysis of alternative technologies for different regions. From this cafeteria of technologies, extension system has to choose three paths. These paths are based on adaptation cost- or risk factors associated with it.

Nocost to low cost/ risk(like change planting, harvest dates): This is an effective, low-cost option. Major risk is that there is no inventory of technologies available among extension organisations. If technological options are available, this information may go directly to farmers' subsystem.

Low Cost to Moderate Cost/Risk: (like change varieties grown)Usually a low cost option if R&D Organisations support initially. In some cases seed for new varieties is more expensive, adjustment in cultural practices. In most cases there are no suitable new varieties available. This kind of information can go to six step model for technology assessment and refinement.

Medium Cost/Risk and High Cost/Risk: (like change crop species or livestock produced or diversification). This could bring new profits, but also a risky option because there are no guarantees that there will be the necessary infrastructure and a market for the new crops or livestock products.

This kind of complex information has to harness ICTs and knowledge management strategies. At the end of the ICT interventions, we need to follow conventional six step model before such information is released to farmers' subsystem. The framework of ICTs and KM is separately in the next figure.

Fig. 19.3. Research-Extension-Farmers Linkages in Climate Change Scenario

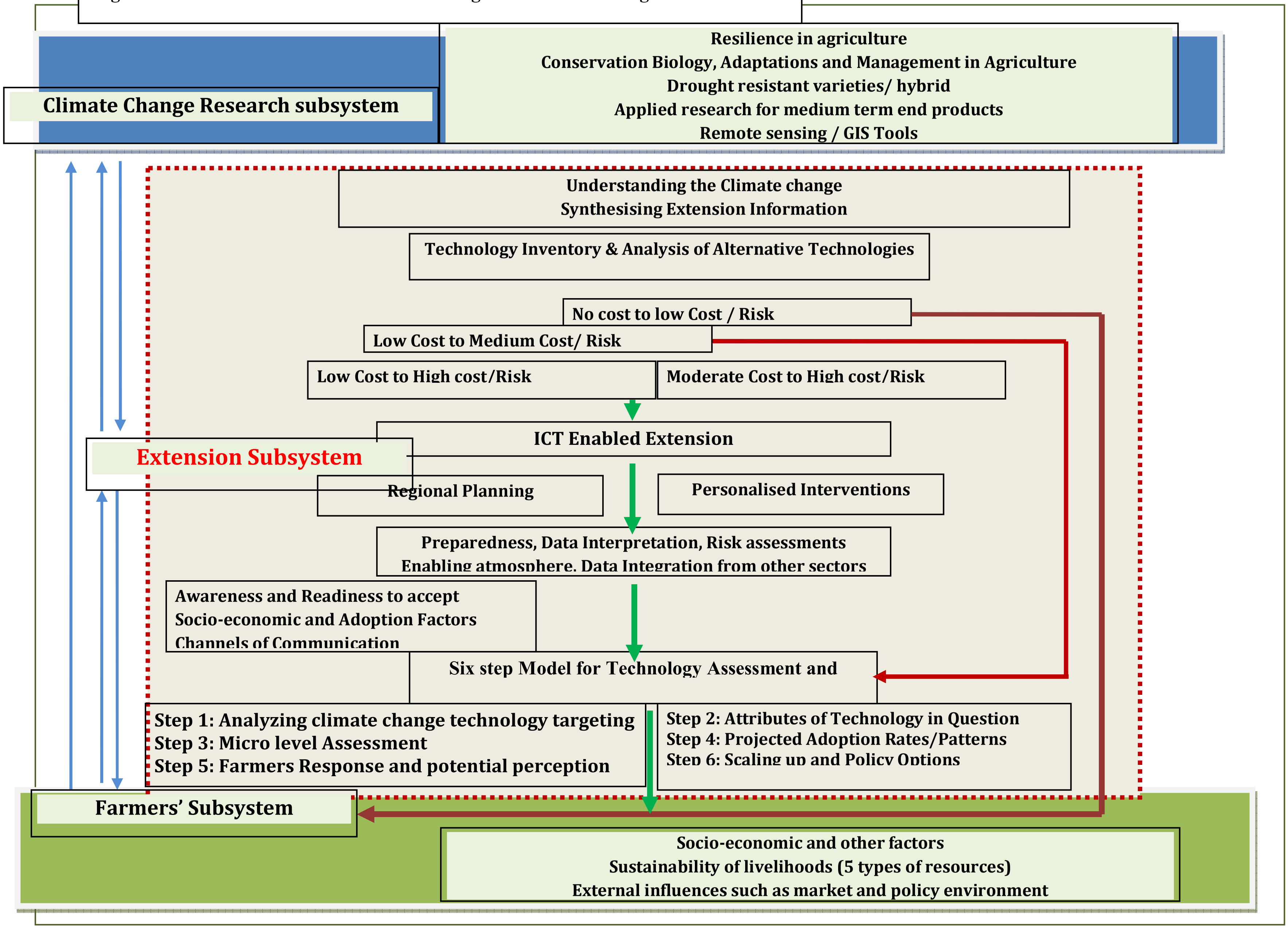
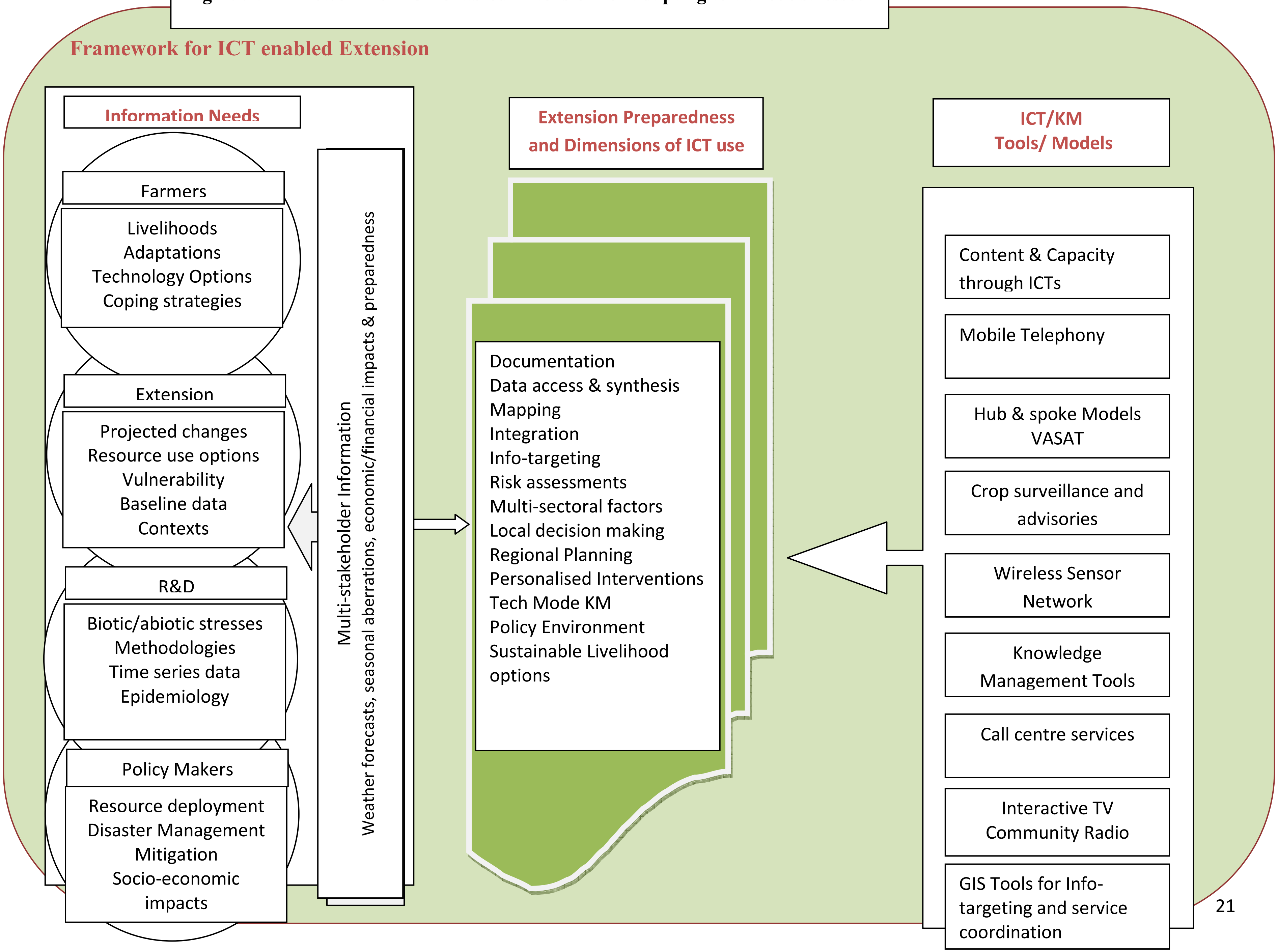


Fig. 19.4. Framework for ICT enabled Extension for adapting to various stresses



19.10. Conclusion:

The vulnerability of agriculture and rural life in the developing world is compelling extension to think beyond transfer of technology and perform better under pressure. Access to ICTs implies access to channels and new modes of communication that are not bound by barriers. In this context a paradigm shift is required from 'technology' to 'knowledge'; 'research centric' to 'farmer centric' and 'top-down' to 'bottom-up' solutions and finally 'ICT-centric extension' to 'extension centric- ICTs'. In order to revitalize agriculture in the developing world it is time that we started engaging ourselves in evolving ICT enabled extension pluralism. By knowledge empowerment of key players in extension and rural communities, many of the agrarian challenges can be addressed better in the developing world.

In the context of climate change, information needs assessment and strategies for strengthening Research-Extension-Farmers linkages are discussed in this chapter. Further looking at the complexities of climate change scenario, it is proposed that ICT enabled extension framework given by the authors may be tested for refining the framework. While we have attempted to review certain cases where in ICTs are effectively harnessed in addressing climate change challenges, empirical evidences need to be gathered on harnessing ICT/KM strategies in near future.

19.11. References:

Adger WN and Kelly PM. (1999) Social vulnerability to climate change and the architecture of entitlements. Mitigation and adaptation strategies for global change, 4(3-4): 253-266.

Angelica Valeria Ospina.(2011) Notes on ICTs, Climate Change and Development. http://niccd.wordpress.com/2011/03/29/icts-and-farmers-decision-making-new-tools-for-climate-change-adaptation/ accessed 24 May 2011.

Arun J et. al., (2010) Climate Change Scenarios with Wireless Sensor Network - ISPRS http://www.isprs.org/proceedings/XXXVIII/8-W3/B3/B3-2-68.pdf Accessed 24 May 2011.

Davison, RM, Harris RW, Qureshi S, Vogel DR, and de Vreede GH (Eds.). (2005) Information Systems in Developing Countries: Theory and Practice, City University of Hong Kong Press, 289pp.

DFID. (2004) Adaptation to climate change: The right information can help the poor to cope: Factsheet series (07) - Iimpact of climate change on poverty, and exploring tools for adaptation to climate change UK.http://www.povertyenvironment.net/node/1240 Accessed on 24 May 2011

Dileepkumar G, Dixit S and Balaji V. (2005) Agricultural Extension with Information and Communication Technology (ICT) Mediated Open Distance Learning (ODL) Methods: A Case Study From Rural South India. Published in Proceedings of Community Informatics Research Network 2005 (CIRN 2005, http://www.cirn2005.org/) Conference held at Cape Peninsula University of Technology, South Africa.

Feder, G., Willet, A. and Zijp, W. (2001). Agricultural extension: Generic challenges and the ingredients for solutions. In S. Wolf and D. Zimmerman (eds.), Knowledge Generation and Technical Change: Institutional Innovation in Agriculture. Boston: Kluwer, pp. 313- 356.

Huq S, KarimZ, AsaduzzamanM, and Mahtab F (eds.). (1999) Vulnerability and adaptation to climate change in Bangladesh. J. Kluwer Academic Publishers, Dordrecht, The Netherlands, 147p.

IPCC. (2001) The Regional Impacts of Climate Change: an assessment of vulnerability. Cambridge University Press, UK.

Jones Gwyn E. (1997). The history, development and the future of Agricultural Extension in Improving Agricultural Extension -A reference manual by Burton E Swanson et.al., FAO, Rome.

Kajfez-Bogataj L. (2005) Climate change and agriculture vulnerability. Acta Agriculturae Slovenica. 85 (1): 25-40

Meera Shaik N. (2008) ICTs in Agricultural Extension: Tactical to Practical. Ganga Kaveri Publishing House, Varanasi, India. Pp 248.

Rivera WM, Qamar MK and CrowderLV. (2001) Agricultural and rural extension worldwide: options for institutional reform in developing countries. FAO, Rome.

Shaik N.Meera, Jhamtani A and RaoDUM (2004). Information and Communication Technology in Agricultural Development: A comparative Analysis of Three Projects from India. AgREN Network Paper No.135, ODI, January 2004. 20p. www.odi.org.uk/agren/papers/agrenpaper_135.pdf

Sulaiman, R. and Hall, A. (2006) Extension policy analysis in Asian nations: In A. Van den Ban and R.K. Samanta. Changing Roles of Agricultural Extension in Asian Nations. B.R.Publishing, Delhi. pp 23-54.

TERI. (2003)www.**teri**in.org/coping/policy.htm accessed 24 May 2011.

Van den Ban AW and Samanta RK. (2006) Eds. Introduction: In Changing Roles of Agriculture Extension in Asian Nations, B.R. Publishing, Delhi, pp 1-10.

Zijp W. (1994) Improving the transfer and use of agricultural information – a guide to Information Technology. Washington DC: World Bank.