Micro-level Drought Preparedness with Information Management and Rural Knowledge Centres: A Framework to Support Rural Farm Families

by

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Declaration

This is to certify that

1. the thesis comprises my original work towards the degree of Doctor of Philosophy in Information and Communication Technology at DA-IICT and has not been submitted elsewhere for a degree,

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This is to certify that the thesis work entitled “Mirco-level Drought Preparedness with Information Management and Rural Knowledge Centres: A Framework to Support Rural Farm Families” has been carried out by Guntuku Dileepkumar (200421002) for the degree of Doctor of Philosophy in Information and Communication Technology at DA-IICT and ICRISAT under our supervision.

Thesis Supervisors Dr V. Balaji Prof. Sanjay Chaudhary

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Abstract

Drought and desertification are serious problems that significantly affect hundreds of millions of people and ecosystems. When drought occurs, the farm communities are usually the first to be affected because of their heavy dependence on the stored soil water. If the rainfall deficiencies continue, even people who are not directly engaged in agriculture will be affected by drought. This underscores the vulnerability of entire societies to this phenomenon; this vulnerability varies significantly from one nation to another. Although crisis management approach is routinely followed approach for providing relief, the studies on drought, carried out in different parts of the world, suggested that preparedness is better than relief and information is backbone of drought preparedness. However, the efforts have been taken for generating micro-level drought assessment and early warning is least understood until recent years. It was therefore, in this study, an attempt has been made to develop a micro-level drought preparedness framework to support rural farm families.

The established practices such as Sources of Agricultural Information management (International/National/Extra-Institutional), Information and Communication Technology (ICT) Enabled Rural Knowledge Centres (RKC), Open and Distance Learning Methods, micro-level drought assessment and early Warning technique have been identified as key components in developing such framework. These components were considered as the objectives of this research study, and conducted series of studies and experiments to understand the existing approaches and needed arrangements in defining and developing proposed framework. For each finding reported in the experimental objectives, a clear chain of evidence was established supported also by interview statements. The individual micro-level drought preparedness framework components were integrated carefully, based on the series of findings, systemic analysis of the data and the continuous interpretation of the observations, to develop the proposed framework.

The study concludes that the proposed framework has shown a way to improve micro-level drought preparedness by bringing various ICT tools, information management techniques, open learning approaches, and micro-level drought assessment technique under one umbrella with an intermediary entity called ICT enabled RKCs owned and run by rural farm families. The usability evaluation studies on individual components revealed that the approaches such as these will have implications in planning micro-level drought preparedness strategies. The vulnerable rural families now have the means to estimate their own vulnerability and can use the information available at ICT enabled RKCs to make more informed decisions, which offers a sounder basis for designing drought preparedness and adaptation strategies.

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Abbreviations & Acronyms

ADL	Advanced Distributed Learning
AEO	Agricultural Extension Officer
AgWS	Agro-meteorology Warning System
AICC	Aviation Industry Computer Based Training Committee
AMS	Adarsha Mahila Samaikhya
ARIADNE	Authoring and Distribution Networks for Europe
CAM	Content Aggregation Model
CBO	Community Based Organization
CGIAR	Consultative Group on International Agricultural Research
CMS	Content Management System
COL	Commonwealth of Learning
CSC	Common Service Centre
DAATTC	District Agricultural Advisory and Transfer of Technology Centre
DAC	Department of Agricultural Cooperation
DoD	Department of Defence
DOM	Document Object Model
EDNA	Education Network Australia
FAQs	Frequently Asked Questions
FIB	Farm Information Bureau
GDPN	Global Drought Preparedness Network
GEM	Gateway of Educational Materials
GESTALT	Getting Educational Systems Talking Across Leading Edge Technologies

ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
ICT	Information and Communication Technology
ICT4D	Information and Communication Technologies for Development
IDRC	International Development Research Centre
IMD	Indian Metrological Department
IMS	Instructional Management Systems
ITC	Indian Tobacco Company
IVRC	Interactive Voice Recording System
KSITM	Kerala State Information Technology Mission
LCMS	Learning Content Management System
LMS	Learning Management System
LTSC	Learning Technology Standard Committee
MAO	Mandal Agricultural Officer
NAIP	National Agricultural Innovation Project
NGO	Non Governmental Organization
NIC	National Informatics Centre
ODL	Open and Distance Learning
PRA	Participatory Rural Appraisal
PROMETEUS	PROmoting Multimedia access to Education and Training European Society
RKC	Rural Knowledge Centre
RLO	Reusable Learning Object
RSDP	Rural Service Delivery Points
RTE	Run Time Environment
SAUs	State Agricultural Universities

SCA	Sharable Content Asset
SCO	Sharable Content Object
SCORM	Sharable Content Object Reference Model
SHG	Self Help Group
SME	Subject Matter Expert
STED	Science and Technology Entrepreneurship Development
TK	Traditional Knowledge
UNCCD	United Nations on Convention to Combat Desertification
UNDP	United Nations Development Programme
UNCSTD	Commission on Science and Technology for Development
VASAT	Virtual Academy for the Semi-Arid Tropics
VKC	Village Knowledge Centre
VNA	Village Network Assistant
VRC	Village Resource Centre

Chapter 1 Introduction

1.1 Background

Drought and desertification are serious problems that significantly affect millions of people and ecosystems. Frequent droughts, especially in developing countries result in untold economic dislocation, environmental damage, personal suffering, hunger, and even deaths among large numbers of people. When drought occurs, farm communities are usually the first to be affected because of their heavy dependence on stored soil water. This can be rapidly depleted during extended dry periods. If rainfall deficiencies continue, even people who are not directly engaged in agriculture will be affected by drought. This underscores the vulnerability of entire societies to this phenomenon [1].

The degree of vulnerability to impacts of drought varies significantly from one nation to another. However, many nations go with the crisis management approach, namely, of providing relief when drought occurs rather than looking for drought preparedness approaches. This is because drought covers large areas, and is difficult to monitor with conventional systems. On the other front, the communities' appear to forget the miseries of one drought season with the onset of good rains; and those miseries usually continue from one drought to the next. According to Kogan [2], timely information about the onset of drought, its extent, intensity, duration, and impacts can limit drought related losses of life, minimize human suffering, and reduce damage to the economy and environment. Studies on drought, carried out in different parts of the world, also suggested that preparedness is better than relief and information is the backbone of drought preparedness [3], [4]. The Disaster Management Authority of India has made it a priority to identify and develop new systems that combine early warning arrangements with access to appropriate services to avoid massive damage caused by drought [5]. The Drought Management Plan by the Department of Agriculture, Republic of South Africa, reveals that institutional arrangements, integrated institutional capacity, disaster risk assessment and reduction planning, and response and recovery are key performance areas, and information and communication; education, training, public awareness and research; and funding are the driving forces for effective drought management [6]. In the comprehensive, integrated national climate monitoring or drought early warning system of the United States a critical component of planning for drought is the provision of timely and reliable climate information, including seasonal forecasts. It aids decision makers at all levels in making critical management decisions to reduce the impacts of drought and other extreme climate events [7], [8], [9]. The plan of Agrometeorology Warning System (AgWS) of Brazil proposes to have an operational system, with at least 120 automatic weather stations, to provide information to farmers and governmental policy leaders on routine analysis of weather, climate variability, crop climate requirements, and pest management to reduce risks from drought, frost and dry spell [10]. In Greece, the government has begun to inform farmers about the potential impacts of climate change. In France drought preparedness and prevention schemes are part of the legal framework on water resource development [11]. In addition, a "Global Drought Preparedness Network" (GDPN) is providing an opportunity to the nations and regions to share experiences and lessons learned (successes and failures) through a virtual network of regional networks; for example, information on drought policies, emergency response measures, mitigation actions, planning methodologies, stakeholder involvement, early warning systems, automated meteorological networks, the use of climate indices for assessment and triggers for mitigation and response, impact assessment methodologies, demand reduction/water supply augmentation programs and technologies, and procedures for addressing environmental conflicts.

There is thus substantial International interest in utilizing knowledge and information in enhancing drought preparedness among vulnerable rural farm families. However, the meteorological departments of many developing countries at the moment are poorly equipped to function effectively for drought preparedness because of inadequate analytical tools for drought monitoring, unsuitable information products and insufficient data sharing [12]. There is a need for new institutional arrangements with modern, effective, and reliable systems to enable information flows within and between concerned governments, grassroots institutions, scientific institutions, and regional and international organizations involved in this field. Emerging pluralistic institutional arrangements and contemporary Information and Communication Technologies (ICTs) such as satellites, computers and improved communication technologies have been identified as opportunities for monitoring and disseminating critical drought-related information; promoting regional cooperation, creating networks and partnerships, methodologies to introduce techno-interventions, capacity building and information management were identified as essentials in developing such kind of systems [13] [14]. Some developing countries have made an attempt to use contemporary ICTs with new institutional arrangements such as Rural Knowledge Centres (RKC)[1] in top-down manner, for utilizing knowledge and information in enhancing drought preparedness among vulnerable rural farm families. However international experiences revealed that such top-down flow of important information must combine with a bottom-up process for its rapid and effective use by the intended recipients. The Commission on Science and Technology of the UNCCD recommended to establish such communication framework by combining both the top-down and the bottom-up approaches in information management and community mobilization [15].

A coalition of institutions anchored by ICRISAT to design and test such an arrangement was set up with the name the Virtual Academy for the Semi-Arid Tropics (VASAT). The VASAT focused on building a framework to foster drought preparedness among vulnerable rural farm families through improving their coping capacities [16]. In this study, an attempt has been made to refine the framework in terms of wider and more pervasive use of ICTs, especially using new advances in learning and content management technologies; open and distance learning methods; and drought early warning techniques.

[1] Rural Knowledge Centre is a new institution in the rural milieu. It is a one-stop centre hosted in a public space that provides public access to ICTs for educational, personal, social, and economic development.

1.2 Concept of Drought

Drought is a normal, recurring feature of climate; it is a natural phenomenon, appears virtually in all climatic regions, includes high as well as low rainfall regions [17]. Tennehill [18] describes drought is a creeping phenomenon, since the onset and end of drought is difficult to determine, and the effects of drought often accumulate slowly over a considerable period of time and may linger for years after termination of the event. Bryant [19] found that the drought ranks first among all natural hazards based on various characteristics, such as severity, duration, spatial extent, loss of life, economic loss, social effect, and long-term impact.

In spite of its severity on economic and social impacts, drought is least understood of all natural hazards due to its complex nature and varying effects on different economic and social sectors [20]. The understanding and perception of drought varies from one region to another [21]. For instance in Saudi Arabia and Libya, droughts are recognized after 2 to 3 years without significant rainfall [22] [23], while in Bali, Indonesia, any period of 6 days or more without rain is considered as drought. If the Nile does not flood any year in Egypt, it is considered as drought regardless of rainfall [24]. In India, there are two approaches in identifying drought, based on the methodology given by the Irrigation Commission [25] and the National Commission on Agriculture [26]. According to the Irrigation Commission of India, drought is a situation occurring in an area when the rainfall is less than 75 per cent of the normal; this definition is derived from the Indian Meteorological Department (IMD) definition, whereas the National Commission on Agriculture of India defines drought as an occasion when the rainfall in a week is half of the normal or less, when the normal weekly rainfall is 50 mm or more. However, in India the declaration of drought or as a scarcity affected area for providing relief to the population is done by the Revenue Department of the state government, on the basis of estimation of the prospective harvest. The assessment is based on the '*annawari system*' (crop being assessed on the basis of '*annas*'[2]). If the prospective harvest is estimated to be up to 12 '*annas*' (75 per cent) the crop is normal; and below it up to 6 *annas*, (37 per cent), the crop is below normal. A scarcity situation is declared when the crop prospects are less than 6 *annas*. Although many definitions are available on drought, none of them adequately defines drought in meaningful terms for scientists and policy makers. In most of the cases the thresholds for declaring drought are arbitrary, and they are not linked to specific impacts. These are the problems creating misunderstanding in formulating drought definitions, and lack of consideration given to the scientists or disciplines on applying these definitions in actual drought situations for impact assessment, drought declarations or revocations for eligibility to relief programs. Wilhite and Glantz [27] analyzed more than 150 definitions in their classification study, and broadly categorized droughts into four types: meteorological, hydrological, agricultural, and socioeconomic.

Meteorological Drought: "A period of more than some specified number of days with precipitation less than some specified amount" [28].

[2] Anna is a unit of currency in India in the ancient days.

Hydrological drought: Concerns with the effects of dry spells (periods without precipitation) on surface or subsurface water resources. This will result in decline in water levels of rivers, lakes, reservoirs, and ground water resources.

Agricultural drought: Occurs if the crop demand for water is not met; depends on prevailing meteorological conditions, biological characteristics of the plant, its stage of growth, and the physical and biological properties of soil. This will result reduction in crop yields significantly.

Socioeconomic drought: Relates to the features of the socioeconomic effects of meteorological, hydrological, and agricultural drought. These effects may include price inflation, famine, population migration, and political upheaval.

The significance of each type of drought to a region mainly depends on its agro-climatic and socioeconomic characteristics. However, linkages between climate and agriculture 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 [29]. However, inadequacies in current agricultural extension system and non availability of necessary and timely information on climate change often made the rural poor farm families to bear disproportionate burden of direct damage from catastrophes and climate change as concluded by most studies in developing countries [30]. Hence there is a need to examine the existing agricultural extension systems, and need to define arrangements and methods for effective drought information flows and data sharing at micro-level to prepare farm families against drought and disasters.

1.3 Expert-Farmer Information Flows: Agricultural Extension

From the ages, agricultural extension has been recognized as an essential mechanism for enabling information and Knowledge transfers among experts and farmers [31]. It was not known when the first extension activities took place, however, it was recorded in the history that Chinese officials were creating agricultural policies, documenting practical knowledge, and disseminating advice to farmers at least 2000 years ago, for instance in approximately 800 BC, the minister was responsible for agriculture under one of the Zhou Dynasty emperors by taking efforts on organizing teaching of crop rotation to farmers, leasing equipment and building grain stores and supplying free food during times of famine [32]. The birth of modern extension service has been attributed after Irish Famine[3] [33]. As on the date there are many extension models are in use to satisfy the information needs of farm communities by enabling the information and knowledge transfers among experts and farmers. Each model has its own concepts, advantages and disadvantages.

[3] The Irish famine in 1845 was result of successive potato crop failures due to potato late blight disease. Since the Irish depend on the potato, the failure of the potato crop and the insufficient and ineffective relief for stopping the outbreak of starvation and disease created a disastrous.

1.3.1 The Concept of Agricultural Extension

Extension, the term first used in England in 19^{th} Century to describe adult education programmes. The universities later adopted this to carry out their activities beyond the universities and into the neighboring community. The term was used in 20^{th} century to carry out the advisory services in many parts of the world. However during the evolution process, from 19 to 20^{th} century, the extension has been defined in many ways and concepts taken several reforms, for instance Brunner and Yang [34] reported central task of extension is to help rural families help themselves by applying science, whether physical or social, to the daily routines of farming, homemaking, and family and community living, whereas Saville [35] defines Extension has been described as a system of out-of-school education for rural people. Bradfield [36] discusses the role of extension worker is to bring scientific knowledge to farm families in the farms and homes for improving the efficiency of agriculture, whereas Maunder [37] reports that extension is a service or system which assists farm people, through educational procedures, in improving farming methods and techniques, increasing production efficiency and income, bettering their levels of living and lifting social and educational standards. In 1974, Van Den Ben first reported [38] that extension involves the conscious use of communication of information to help people form sound opinions and make good decisions. This was first published in Dutch edition by Boom, later quoted in English editions in 1988 and 2004. In 1980s Agricultural Extension has been discussed as assistance to farmers to help them identify and analyse their production problems and become aware of the opportunities for improvement [39], and use this for professional communication intervention deployed by an institution to induce change in voluntary behaviours with a presumed public or collective utility [40]. In 1990s extension concept has been recognized [41] as organized exchange of information and the purposive transfer of skills; Leeuwis and Van Den Ban added that the essence of agricultural extension is to facilitate interplay and nurture synergies within a total information system involving agricultural research, agricultural education within a total information system involving agricultural research, agricultural education and a vast complex of information-providing businesses [42]. In the recent years, the academicians working in this field argued that agricultural extension needs to be reinvented as a professional practice [42] and some have abandoned the idea of extension as a distinct concept, and prefer to think in terms of 'Knowledge Systems' in which farmers are seen as experts rather than adopters [43]. It shows how the extension has taken several forms during the evolution process. From a practical point of view, the extension aims to help both farmer and expert by enabling effective information and knowledge transfers to create sustainable forms of agriculture. However the development of extension services in modern era has differed from country to country and sometimes even within the country. This is due to the applicability, effectiveness, and farm families acceptance, which resulted several extension models all over the world.

1.3.2 Existing Extension Models

According to Carl [44], there are six extension models are being used in developing countries, they are

The National Public Extension Model was introduced by U. S. Land Grant System. This is a dominant extension model all over the world, and it has been recognized as a key institution within and reporting to the Ministry of Agriculture. The Land Grant Model discusses the coordination and management of three interlinked institutions: agricultural research, extension and agricultural higher education among responsible institution in the adopted countries. The transaction costs of the Land Grant Model are low.

The Commodity Extension and Research Model was introduced by colonial powers in Malaysia, Mali and other colonies exporting cotton, palm oil etc. The model combines research and extension.

The Training and Visit (T&V) Extension Model was launched in Turkey in the early seventies and then spread to other parts of the world under World Bank sponsorship in the late seventies and the eighties. Though the T&V model has proven to be financially unsustainable [45], some of the countries still use modified T&V extension programs.

The NGO Extension Model was introduced in the nineties, when many NGOs shifted gears and moved from providers of food aid and humanitarian assistance. Eventually the NGOs has become “agents of development”, and started recruiting extension workers, for instance in Mozambique in 2005, the NGOs employed 840 extension workers as compared with 770 public extension workers [46].

The Private Extension Model was introduced in the recent years with an expectation to pay some of the cost of extension with the hope that public outlays on extension will be reduced [47]. However there is little evidence to date that small scale farms can "buy their way out of poverty" by paying for extension advice.

The Farmer Field School (FFS) Model (Approach) emerged in Asia in the 1980s when extension workers offered advice to farmers on using IPM (Integrated Pest Management) to control pests in rice mono-cropping areas in the Philippines and Indonesia [48], [49]. Though there is spirited debate among extension experts whether the FFS is approach or a model, the model proved to be effective in reducing pesticide use by up to 80 percent on farms in these two countries. The FFS model is now being used in around 50 developing countries [44].

Apart from this, other extension models are emerging, in recent years, for enabling information and knowledge transfers among actors of the extension system, for example

The ATMA Extension Model was initiated in late 1990s in India with the World Bank support [50] when the extension specialists realized the need of decentralized national public extension systems. The Agriculture Technology Management Agency Model (ATMA) combines decentralization with a focus on agricultural diversification and increasing farm incomes and employment; and collects feedback from clients to extension specialists, researchers, policy makers and donors. Based on the feedback the decisions on extension are made by a Governing Board with equal representation between (1) the heads of the line departments, including agriculture, animal husbandry, horticulture etc. and key people in the State Department of

Agriculture; (2) research units within the districts and stakeholder representatives and (3) a cross-section of farmers, women, disadvantaged groups and the private sector. The ATMA model became operational in 2001 in 60 districts, and considered a major success in India; plans to extending the model to 600 more districts in India in next five years are under pipeline [51].

ICT Mediated Agricultural Extension Models are in experimental phase in many parts of the developing world with new institutional arrangements, public-private partnerships for enabling effective information flows within and between concerned governments, grassroots institutions, scientific institutions, and regional and international organization involved in this field. Many of these models aims to set up decentralized environments (Rural Knoweldge Centres) with a centralized knowledge base for enabling information and knowledge transfers among farmers and experts at various levels. Though most of these projects are in pilot mode, there is increased interest in the use of contemporary ICTs for enabling effective information and knowledge transfers in the existing extension approaches. Although there are many extension models are in use, most of these models fall into one of two basic categories:

1. systems of information communication that aim to change the behaviour of rural people
2. systems of information communication that aim to change the knowledge of rural people

There is, of course, a close relationship between knowledge and behaviour; changes in the former often lead to a change in the latter. If government policy-makers, project managers or researchers direct the topics addressed and projects undertaken, then the purpose of extension is to change behaviour. This approach to extension has been variously described as *directive extension*, social marketing, and propaganda.

If farmers and other rural people direct the extension towards their own needs, then the purpose of extension is changing knowledge. This knowledge helps rural people make their own decisions regarding farming practices. This approach to extension is closely related to *non-formal education.*

1.3.3 Information Communication Processes within Agricultural Extension System

The term 'extension' has been used to cover widely differing communication systems. Two particular issues help to define the type of extension: how communication takes place and why it takes place [52].

How Communication Takes Place: Top-down versus Bottom-up

Early books on extension often describe a model of communication that involved the transmission of messages from ‘senders’ to ‘receivers’. As part of this model, senders are usually people in authority, such as government planners, researchers, and extension staff, while receivers are usually farmers who are relatively poor and semi-literate (in some cases illiterate). Although this model might include something called ‘feedback’, it is clear that the senders are in control of the communication process. The transmission model of communication is closely related to the idea that extension workers are the link (i.e. message carriers) between researchers (senders) and farmers (receivers). Extension programmes based on this model have been described as 'top-down' approach; the actors in the communication process have a parent/child or teacher/student relationship.

In many developing countries, in recent years, top-down extension is gradually being replaced by more participatory approaches, in which the knowledge and opinions of farmers is considered to be just as important as that of researchers or government officials. Participatory approaches involve information-sharing and joint decision-making. Extension programmes based on this approach have been described as 'bottom-up' approach; the actors in the communication process have an interactive approach.

The development of participatory extension requires a re-examination of the communication process. At present, no single description has replaced the transmission model that is referred to above, but two ideas are becoming widely accepted:

1. Communication in the context of participatory extension cannot usefully be described in a linear manner with distinct groups of senders and receivers. Instead, extension activities take place within a *knowledge system* consisting of many actors who play different roles at different times.
2. Although some actors in the knowledge system have more authority than others, communication usually involves a negotiation rather than a transmission. What takes

place is a dialogue, with actors collaborating in the construction of shared meanings rather than simply exchanging information.

It was therefore, use of contemporary ICT tools to develop an information transmission model with a combination of top-down and bottom up approach with a community mobilization has been included as one of the components of micro-level drought preparedness framework.

1.4 Rural Knowledge Centres as Facilitation Nodes in Expert-Farmer Information Exchange

The emerging opportunities, in recent years, such as pluralistic institutional arrangements and contemporary ICTs are finding wider acceptance in rural information exchange. This is mainly because developing countries have realized the need for effective information and knowledge exchange among various sectors to engage in a wider range of issues beyond merely disseminating production-oriented technologies. Extension pluralism is at the core of information exchange and 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 (or) preparedness strategies on a large scale. Swaminathan [53], Zijp [54] , Balaji *et al.,* [55], Dileepkumar and Balaji [56] explained the use of ICTs in the process of transferring technology packages to knowledge or information packages. ICTs, in this context, is an umbrella term that includes computer hardware and software; digital broadcast and telecommunications technologies as well as digital information repositories online or offline [57] and includes the contemporary social networking aspects, read/write interfaces on the web besides file sharing systems online. 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. The term is often used in plural (ICTs) to mean a range of technologies instead of a single technology [14].

A number of pilot Rural Knowledge Centre (more popularly known as telecentres) projects in applying ICTs in rural development are in progress in many parts of the world [58]. According to Gomez et al., [59] telecentres are in different names, as per the public ICT access, varying in the clientele they serve, the services they provide, as well as their business or organizational model. Around the world, some telecentres include NGO-sponsored, local government, commercial, school-based, and university-related, and in some cases the internet access in public libraries. Each type has advantages and disadvantages when considering attempts to link communities with ICTs and to bridge the digital divide. Sood [60] considers telecentres as the rural computer centers and he categorises rural computer centers into four types:

Cybercafe, which operate as Internet café in rural areas without any direct link to government programmes or programmes of developmental organizations

Monologic Kiosk offers only one kind of service and one kind of transaction pattern to specific group of people

Information Kiosk offers wide varieties of service to different groups within a community including e-governance service

Telecentres are related to the activities of Non Governmental Organizations (NGOs) and other development agencies providing basic communication services and educational services.

However Sood had left out an important category. This fifth category is the knowledge centre. *Knowledge Centres* are centres for *facilitating* the information and knowledge management of a community in which community and organizations at local, meso and macro level interact for information and knowledge management, which would ensure livelihood security in the community. Many NGOs and international agencies, in recent years, made an attempt to use these new institutional arrangements to develop drought preparedness mechanism combined with the information services to support rural farm families. However the applications of knowledge centres in rural areas and ICTs in the context of drought preparedness are far from clear until recent years. This research work therefore includes an assessment of selected RKC project sites to understand various dimensions and dynamics involved in setting up of ICT enabled RKCs and their effective utilization in information management in general and to foster drought preparedness in particular.

1.5 Rural Knowledge Centres as Facilitators of New Learning Opportunities

Capability building and capacity development of rural stakeholders is a key component of the new framework on drought preparedness. However, given that most stakeholders have limited exposure to the classroom milieu, new methods and techniques for capacity development will be necessary in fostering drought preparedness.

In the past, capacity building at many national and international institutions has been conducted through residential, face-to-face mass training and education. This approach, although effective, is costly and has limited reach. Conventional approaches to training and education have not sufficiently met the demand of the rural stakeholders. The new approach to the capacity building envisions a world in which all stakeholders can easily access and share information, knowledge and skills they need – anywhere and anytime – in a cost effective manner.

The contemporary situation demands more innovative and efficient access to appropriate information, knowledge, and skills. This has led to increased interest in harnessing new tools and concepts in learning, information and ICTs and knowledge management to complement and supplement its present capacity building initiatives. Open and Distance Learning (ODL), in recent years, has been identified as one of the most powerful new forces influencing the direction of capacity building either through supply of distance learning technology or the demand for courses by society [61].

1.5.1 Open and Distance Learning

According to Commonwealth of Learning (COL), the term open and distance learning and its definition are relatively new in the field of education, having gained prominence only in the past 15 to 20 years. The language and terms used to describe distance learning activities can still be confusing, and geographical differences in usage. Among more commonly used terms related to open and distance learning are: *correspondence education, home study, independent study, external studies, continuing education, distance teaching, self-instruction, adult education,* *technology-based or mediated education, learner-centred education, open learning, open access, flexible learning and distributed learning.* Advances in ODL methods and contemporary ICTs in recent years helping educational organizations and training institutions to strengthen their approach by offering online and web-based courses, and practicing new generation ODL methodologies i.e., asynchronous (Internet education portals, web based learning management systems, Forums, and wiki's to name a few) and synchronous (Chat, Flash meetings, Breeze meeting, Teleconferencing and Video Conferencing to name a few) learning methods.

The distance education workers invented several theories and models, Desmond Keegan's theory, the Norwegian Model to name a few, for successful implementation of distance learning, where as some workers explained about the concepts of existing systems in their studies such as the United Kingdom's University, Vancouver's Open Learning Agency, Norway's NKS and NKI Distance Education organizations, Florida's Nova University, the University of South Africa distance learning program, the Televised Japanese Language Program at North Carolina State University [62], US. Federal government's Star Schools Program, and India's IGNOU distance learning programmes. Some workers made an attempt to look at the design considerations of distance learning programmes includes interactivity [63], [64], [65], Active learning [66], Visual Imagery [67], [68], Effective communication [69], [70], where as some discussed about the challenges of methods and strategies of distance learning programmes such as implementation strategies [71], [72], media based challenges [62], [73], [71], [64], [72], partnerships and teamwork [74], [75]; operational issues includes teacher-facilitator-learners triad [76], [77], [72], technology adoption [78], [79]; and management and policy issues [79], [77]. To give experience as much like traditional, face-to-face instruction, via interact classrooms and live two way audio-visual interaction are emerging ODL opportunities; and virtual learning communities, virtual academies are recent trends in the distance learning programmes. Restructuring distance education to include strategic management; creating learner centric, cost-effective, value-driven, high-quality services for the distance learning community; and repurposing electronic distance learning materials have been noted in the recent years as challenges of open distance learning programmes. In this research work an attempt has been made to resolve some of these issues by proposing needed arrangements for ICT enabled distance learning methods and conceptual frameworks for repurposing the content in a cost effective manner.

Combining the potential of ODL, and ICTs have been practiced by a small number of national and international agencies with an aim to build capacities and communicate information and knowledge related to drought, climate management and livelihood opportunities to mobilize the stakeholders in the drought prone regions; this is ultimately aimed at empowering vulnerable people to make better choices and have better control of their own development, particularly during emergencies. However, as on the date, most of these approaches, innovations, tools, concepts and technologies are much accessible to urban folk, none (or) very few of these technologies are accessible to rural communities that to not for education, training (or) learning purposes. A few organizations, namely VASAT project of ICRISAT, National Virtual Academy in India made an attempt to use ODL approaches to foster drought preparedness; these are routed through RKCs. However there are few studies so far that have discussed the arrangements for the effective implementation of rural capacity building programmes in the context of drought preparedness. It was therefore this has been included as one of the components of micro-level drought preparedness framework. In this study an attempt has been made to discuss the needed arrangements based on the experiences from the existing open distance learning programmes; and to derive methods and approaches based on the results of ODL experiments conducted through RKCs (as facilitating agencies in rural areas) to improve the coping capacities of rural farm families.

1.6 Motivation

Although drought causes serious economic and social impacts, the efforts have been taken for generating micro-level drought assessment and preparedness is least understood until recent years. For instance, in India, in most of the cases, the declaration of drought or as a scarcity affected area for providing relief to the population is still done by the Revenue Department of the state government, on the basis of estimation of the prospective harvest. The Indian Meteorological department is the authorized agency to generate drought predictions at country level. However, these predictions wouldn't be useful for preparing the farm communities at local level against drought and disasters. Moreover insufficient drought coping mechanisms and existing support systems at micro-local for high risk associated with low investment capacity of farmers often results in higher rate of out migration, food insecurity and poverty; in some cases, in recent years, the farmers' suicides have become one of the drought coping mechanisms. The emerging opportunities such as contemporary ICTs and pluralistic institutional arrangements have not been used effectively to develop drought assessment and support systems at local level. With this realization, the established practices such as Sources of Agricultural Information management (International/National/Extra-Institutional), ICT enabled RKC, Open and Distance Learning Methods, micro-level drought assessment and early Warnings have been identified as key components in developing a framework for micro-level drought preparedness. These components were considered as the objectives of this research study, and conducted series of studies and experiments to understand the existing approaches and needed arrangements in defining and developing proposed framework.

1.7 Objectives

The proposed research work was conducted at ICRISAT – Knowledge Management and Sharing department with following objectives.

- Assess selected RKC project sites to understand the way ICT's in development can be deployed in support of drought preparedness, and to propose a framework to deploy them.
- Propose and test an arrangement for information exchange and rural capacity building with RKCs and contemporary ICT tools to foster drought preparedness; and propose a framework for repurposing electronic learning content and its management.
- Test an ICT mediated framework to generate community level early warning mechanisms to improve micro-level drought preparedness.
- Develop an integrated framework to improve micro-level drought preparedness with information management at its core.

A series of experiments had been conducted with the financial support of the VASAT program to develop proposed framework to improve micro-level drought preparedness among vulnerable rural families with information management and rural knowledge centres.

Chapter 2 Approach and Methods

2.1 Approach

The study builds up a framework based on the investigations and observations from experimental case studies. This kind of study can be categorized as theory creating or building [80]. Mirco-level drought preparedness with Information and Communication Technology (ICT) enabled Rural Knowledge Centers (RKCS) and information management is little known in the developing countries. Thus, initially the study is exploratory, and considers the past and then investigates the present circumstances. This section discusses philosophical perspective and the methods used to carry out investigations.

According to Myers and Avison [81], there are two dominant groups of research methods in information systems – quantitative and qualitative. Although quantitative methods were originally developed in the natural sciences to study natural phenomena, they have been applied in social sciences through survey methods, laboratory experiments, formal methods and numerical methods. Qualitative methods were developed in the social sciences to enable researchers to study social and cultural phenomena. These methods are useful in understanding people and the social and cultural contexts within which they live. Qualitative methods include action research, case study research and ethnography. Each of these methods has different ontological, epistemological, axiological, rhetorical, and methodological characteristics [82], [83].

This study is more focused on social and cultural, and less on natural phenomena. The issues of using ICTs and RKCs to enable information and knowledge transfers to foster drought preparedness involves many uncontrolled variables that cannot be approached by using methods appropriate for studying closed systems. Hence the study uses the qualitative methods. One of the main areas of interest of this study is to explore the role of ICT enabled RKCs in information management to improve micro level drought preparedness. Qualitative research is believed to be good in describing and illuminating the context and conditions under which research is conducted [84]. The focus of the research is in building a context aware framework which is synonymous with the theory building; Glaser and Strauss [85] argue that this could be best approached with inductive qualitative research rather than through continual hypothesis testing. Therefore it was decided to use the qualitative research method, and identified case study method as more suitable for this study. It is the common one used in qualitative research in Information Systems research [86], [87].

2.2 Methods

As this study was attempted to cover a broad range of researchable issues to address micro level drought preparedness; as per the requirements of different objectives, case study methodology was adapted in different ways. For objective one case study methodology was used, where as for objective numbers two and three independent methods were developed in combination of case study methodology with special tools/procedures specially developed to address the thesis problem. After reporting the first series of findings, a chain of evidence was established [88] to propose a framework based on a discovery from the systemic analysis of the data and continuous interpretation of the observations to achieve objective four (Objectives were discussed in section 1.7).

2.2.1 The Case Study Method

There are several definitions of case study, but Benbasat et al., [88] present a comprehensive definition that draws from a variety of sources. They define case study as a research approach that examines a phenomenon in its natural settings, employing multiple methods of data collection to gather information from one or few entities (people, groups, or organizations) on a phenomenon that is not clearly evident at the outset. Case study is also good in research where no experimental control or manipulations of variables are involved. Compared to other approaches (laboratory and field experiments), researchers have less prior knowledge of what the variables of interest are and how they will be measured.

In support of case study, Yin [89] in his popular book on case study research, considered investigation of a contemporary phenomenon or event in its real-life context, especially when the boundaries between the phenomenon and the context are not clearly evident. In a case study, the researcher does not, or cannot, control or manipulate the situation. Case study method does not necessarily require step-by-step data analysis, and this allows of various interpretations of research data. Admittedly, interpretation could introduce bias, of multiple methods of data collection such as interviews, documentary reviews, archival records, direct and participant observations [89]. The triangulation [90] of these data sources can reduce the problem of bias. Another limitation of case study is in its generalizations of the findings, which can be addressed through the use of multiple case studies.

2.2.2 Multiple Case Studies

Yin [89] suggests that a single case study is appropriate in a situation previously inaccessible to scientific investigation, an extreme or unique case, or for theory testing purposes, while multiple case study provides general explanations that are applicable to individual cases in spite of differences in each individual case. Multiple cases also support the development of abstraction across cases and make the result more generalisable and reduce any possible bias [91], [92].

This study was initially exploratory, to understand the role of ICT for Development (ICT4D) projects in improving micro-level drought preparedness. These definitely require some degree of generalisability of the findings and multiple case studies in multiple locations were thus seen from the beginning as appropriate. While the conduct of multiple case studies can require extensive resources and time, the evidence from multiple cases is often considered more compelling, and overall study is therefore regarded as being more robust. In this particular study the researcher conducted a primary study by physically visiting various RKC project sites – *Rural e-seva, Rajiv Internet Villages, MSSRF IVRP, ITC Aqua choupal Model, Kisan Call Centres*, and understood many other projects from the literature and also interviewing the primary researchers and project personnel of the sites includes – *Kisan Kerala, Warana Wired Village and Akshaya*.

Based on the learnings from the RKC project sites (objective one), an attempt has been made to conceptualize a framework to set up ICT enabled RKCs and this framework was evaluated by examining the set up in the study area. Moreover this set up was used to carry out the experiments of objective two, three and four (Objectives were discussed in section 1.7).

2.2.3 Site Selection

There is also a need for careful selection of the site(s) for case study, argues Yin [89]. The study should consider the specific objectives, which contributes in developing an integrated framework through sub frameworks, in identifying the location. In addition, the country of the location had to be a developing country, in order to ensure both possibilities of literal replications that predict similarities, and also theoretical replications that predict contradictory outcomes [89]. The study also considered access and cultural proximity as among the main criteria for carrying specific objective cases. According to Taylor and Bogdan [93], an ideal research setting is one where the observer has easy access, is able to establish immediate rapport with informants, and can gather data that is directly related to the research interests. The study also considered access and cultural proximity as among the main criteria for carrying specific objective cases. During this study, the researcher is an Indian, and has lived and worked in the state of Andhra Pradesh. However, none of the people involved at any stage of the research have any direct personal or professional stake. The objective one of the study was carried out in many selected locations of India, where as objective two and three were conducted in Addakal region (a block of 21 revenue villages in the Mahabubnagar district of Andhra Pradesh state located in South Central India), one of the two project locations of the VASAT.

Addakal is categorized as a low rainfall region and its average rainfall ranges from 425mm - 600 mm, which is similar to the other Semi Arid Tropic regions. Without any major irrigation system, agriculture depends on the scanty rainfall. There has been noticeable lack of drought-coping and support systems in the locality, and large scale out-migration has become the principal drought coping mechanism of the people in this while suicides among the farm families have started to occur since 2004 [94], [95].

The experimental set up was established following a Hub and Spokes Model [96] [95], partnering with a Community-Based Organization (CBO), with ICRISAT and coalition partners providing information and learning inputs to the CBO members on various aspects of enhancing drought preparedness at mirco-level. Towards fulfilling this purpose, experts in the ICRISAT and partner organizations have developed a number of learning modules.

The principal community-based partner organization in this study was the Adarsha Mahila Samaikhya (AMS- the Adarsha Women's Welfare Organization in English), a federation of all-women micro-credit groups that functions in the Addakal Block. It has a membership of 5200 women[4], covering all the 21 revenue villages in the locality. All 21 revenue villages were included in the study.

2.2.4 Proposed Procedures

Since the objective two and three focused on developing a methodology, special tools and special procedures were developed.

For objective two - the existing web 2.0 techniques were used to aggregate information from various sources to build a content repository (Wiki based content management system). Existing e-learning tools (*Reload Editor, Exe, Acado CMS, ATutor LCMS, Moodle CMS*), standards (*SCORM*, *IMS*), and techniques (*Need Assessment, Open Distance Learning and Instructional techniques*) were used to achieve the content interoperability, and reusability features. A framework was developed and tested in two workshops with the scientific community of International Crops Research Institute for the Semi-Arid Tropics and National Institute of Hydrology; and faculty of State Agricultural Universities. For objective three – a methodology was designed with the convergence of water budgeting technique [97] with Remote Sensing and GIS technology, rainfall predictions and web 2.0 techniques.

[4] According to the AMS records of 2006

The detailed methodology, special tools and special procedures were discussed in the chapter 5, 6, and 7 along with results and discussions.

2.2.5 Data Collection Methods

The study used several methods of data gathering; semi-structured interviews were complemented with short time on-site observations and surveys with quantified responses.

2.2.6 Data Analysis

Analysis of qualitative data depends on the capability of the researcher to integrate evidence from multiple sources [88]. The analysis may not be as mechanical as the analysis of quantitative data [98] [99], but the conclusions from these analyses are reliable. This study used both quantitative and qualitative methods of data collection. For the quantitative data, a simple weighted average that was recommended from the source of the questionnaire was followed, albeit in a flexible manner to cater for all adjustments to the original questionnaire.

Important ideas were immediately taken down in the field notes, while all the recorded tapes were later transcribed. The transcribed data was thoroughly read and particular attention was paid to discussions about issues that concerned the management of knowledge and the information technology infrastructure. Further meaning was ascribed to the salient points that emerged from these analysis based on the insight from the observation. For each finding reported in the experimental objectives, a clear chain of evidence was established [88], supported also by interview statements on the theme reported.

After reporting the first series of findings, the study proposes a framework based on a discovery from the systemic analysis of the data and the continuous interpretation of the observations through the pre-knowledge of the phenomenon.

Chapter 3 Framework for Planning and Designing of Rural Knowledge Centres

3.1 Introduction

Establishment of Rural Knowledge Centres (RKC)[5] has been spreading across the globe [100]. RKCs equipped with ICTs have become new ways of reaching people and delivering services in the developing countries [101] [59]. In the process, these centres have been acknowledged as new institutions in the global rural milieu, to empower rural communities by bringing benefits of contemporary ICTs in their reach such as e-governance, telemedicine, digital literacy, and e-agriculture. In the last decade many organizations have launched such initiatives, known as ICT for Development (ICT4D) projects, in the rural areas of developing countries, with an aim to bridge the digital divide by providing access to information and technologies; and also for poverty alleviation, policy advocacy, local governance, and educational development [102]. Today there are tens of thousands of RKCs throughout the world [103]; these are the channels that provide shared public access to information and communication technologies for meeting

[55] Now on wards the telecentre (more popular until the rural computer centres are classified) is quoted as a Rural Knowledge Centre (RKC) to avoid confusion.

the educational, social, personal, economic, and entertainment needs of the community [104], [105], [59], [106].

As most of these initiatives are relatively new, there are mixed opinions in the literature on their social and economic impacts in the communities where they are situated. For instance, the United Nations Commission on Science and Technology for Development (UNCSTD) reported, that there were many instances where the use of ICTs is bringing widespread social and economic benefits, and also there were as many instances where ICTs made no difference to the lives of people in developing countries (or) even having harmful effects [107]. Furthermore, emerging studies have shown many of the claims being made about the potential of ICTs for development are not supported, and point to possible counter-productive effects [59]. There is also lack of good understanding about a sound conceptual and theoretical framework for planning and designing of RKCs. This study seeks to fill this information gap by assessing the selected RKC project sites in rural India to understand various dimensions and dynamics involved in planning and designing of RKCs and their possible utilization in micro-level drought preparedness.

3.2 Assessment of Projects

Most of the evaluation studies of RKCs till date have focused more on their operational aspects, such as technical, financial, managerial performances and sustainability aspects [104], [108], [109], [110], [111], [112]; and a few discussed possible frameworks and approaches [105], [59], [108], [113]. Some studies reported on the role of RKCs in e-governance applications [114],

[112]. There are nil or very few evaluation studies focused on understanding various dimensions and dynamics involved in planning and designing of RKCs and their effective utilization for knowledge management and drought preparedness. In this particular study an attempt has been made to conduct an assessment study by visiting the centres, interviewing the projects personnel, users and non users and examining the records available at selected RKC project sites – Rural e-seva, Rajiv Internet Villages, MSSRF National Virtual Academy, ITC Aqua Choupal Model and Kisan Call Centres; and understood other selected projects from the literature and interviewing primary researchers and project personnel of the sites – Akshaya, Warana Wired Village, and Kisan Kerala. The case study method was used (discussed in detail in Chapter 2) to understand various dimensions and dynamics of these projects. The primary study was conducted in 2004, and later reviewed again in 2005 and 2006 by collecting information from the secondary literature and revisiting the study locations.

3.2.1 Rural E-Seva

Rural E-Seva, a district administrative initiative, was launched with 47 E-Seva centres and eighteen services in January 2003 in West Godavari district of Andhra Pradesh, India. The stated objective is to replace the traditional form of governance and its accompanying inefficiencies with a modern, more open, transparent and responsive service delivery system for empowering citizens.

The funds were mobilized by involving multiple stakeholders, and required software were designed by involving local engineering students and District National Informatics Centre (NIC) office. The project is an example of how to operationalize an ICT project with available funds and resources. The project indicates the champion's role is important in this kind of approach to ensure the involvement of multiple stakeholders and resource mobilization from various government departments.

During the study period, it was observed that the services like issuance of land records, online civil supplies allotment, telemedicine, teleagriculture, and consumable management service were not being offered. Services like forms download, access to information, mandi rates, online auctioning and bidding, matrimonial services were not being used much either. The electricity bill payments, Issuance of caste, income and nativity certificates, Filing of complaint and grievances, Applying of government schemes, e-education, and other business services (Xerox, printing, sale of soaps cheaper than market price etc.) were much used by the citizens. It shows the services much used by the citizens were either need based services such as the electricity bill payment, certificates (or) services, which were difficult to avail in the traditional systems such as filing complaints and grievances, applying govt. schemes (or) attraction to the new tools and fun such as e-education through computer in the form of games. The non-availability of content and weak linkages with the agricultural and health organizations were disabling centres to offer telemedicine and teleagriculture services.

Since the district collector was ensuring implementation of filing grievances, and issuance of certificate services, they were appearing as most used services during the study period, otherwise the government officials were not happy to delivery them without bribes which was so common in traditional systems. Hence the study indicates long term sustainability of the services dependent on the designing of services based on the user needs, support and enthusiasm of government officials (in the case of egovernance services) or concerned department personnel or reforms in the traditional systems to overcome this problem.

3.2.2 Rajiv Internet Villages

The stated objective of the Rajiv Internet Village (RIV) is that (1) every citizen in the state should be able to avail of all Government services/benefits intended for the citizens in a quick, cost effective and hassle free manner, through a single window (2) transacting with the government should be hassle free, avoiding middlemen, delays and rooting out corruption (3) alleviate poverty and illiteracy.

RIV was initially launched as Rural Service Delivery Points (RSDPs) in the year of 2003. RSDPs were born out of an idea to convert existing STD booths in rural areas into Service Delivery Points for delivering services such as collection of electricity bills, agriculture information through iKisan portal, computer education, BSNL telephone connection, access to government forms, information and certificates, agricultural prices within marketing department and AGMARKNET, IShakthi information system of HLL, Bharat matrimony services, examination results and printing of marks sheets, revenue records delivery system and electricity bill payment which was introduced in the later stages. The centres/operators were identified by taking certain criteria into consideration, i.e.,, the operator should pass 10th standard, should be a local person and own a STD booth in a permanent building. During the study period it was observed that the electricity bill payment was much used service by the users; and in some places the centres are known as electricity bill payment centres.

After change in the government, the new government wanted to close these centres since it was initiated by the earlier government. However the interest of citizens for electricity bill payment service made them to continue the centres with a change in the name. That's the way the Rajiv Internet Village were launched in the year 2005 with a revised service list such as easy access to information on agriculture, education, health etc.; market prices, cropping pattern, weather forecast, agricultural extension; quality inputs; seeds; fertilizers, pesticides etc.; agricultural marketing, getting better prices for produce; examination results and elearning; health extension, immunization, telemedicine etc.; Access to all forms, copies of land records, applications, certificates etc; collection of bills such as electricity, telephone etc.; status of application of "Rajiv Palle – bata" and computer literacy for one person in each family. The NIC designed the software. The efforts have been taken for telemedicine and e-agriculture was minimal.

3.2.3 MSSRF National Virtual Academy

The M.S. Swaminathan Research Foundation chose to impart a pro-nature, pro-poor and pro-women orientation to technology development and dissemination as its main mandate when it started functioning in Chennai, India in 1989. This main mandate has given birth to the Information Village Research Project (IVRP) in 1992, and started implementing from 1997 onwards by establishing Village Resource Centres (VRC) and Village Knowledge Centres

(VKC). After receiving successful results from IVRP pilot experiment conducted in Pondicherry, the initiative was further strengthened to the Jamsetji Tata National Virtual Academy (NVA) in the year 2003 by bringing various International and National partners, with an objective to empower vulnerable remote rural Indian communities by building skills and capacities through ODL mode, viewing that this education should reach every home and hut, and gives them a better control on their own development i.e., to make better choices, to take better decisions, and to create better livelihood opportunities.

During the study period it was observed that the NVA establishes VKCs on the basis of a needs assessment study or requests from local institutions. The NVA uses Hub and Spokes model for establishing connectivity between knowledge producing agencies and VKCs with wired and wireless technology, satellite based two-way video conferencing. The needs assessment study which uses Participatory Rural Appraisal (PRA) method helps MSSRF-NVA staff to understand existing political alignments and conflicts in the villages, caste related issues, and the history of people's interactions with *Panchayat* leaders and other government officials. Later, the NVA staff conducts group meetings with the help of village leaders, and a range of stakeholders (such as members of youth associations and self-help groups) to make agreements with village level organizations/groups on operating centres with cost sharing basis such as the community would identify and maintain a centrally located building to house the Village Knowledge Center (VKC), pay electricity and telephone charges, and identify volunteers (educated at least up to high school, 50% of who had to be women); and MSSRF would provide computer systems and other equipment required, ensure technical support and maintenance, train the volunteers and involve them in developing relevant content and services. The NVA receives major funding from the Tata trusts and other national and international agencies to meet the running costs of the project.

Although, the MSSRF-NVA approach to develop an ICT project by involving rural communities and multiple stake holders appears to be a social sustainable approach, the long-term financial sustainability of the project is not clear. During the study period it was observed most of the information and educational services being offered at VKC do not generate any revenue to meet the running costs of the centres; and the agreements with the local agencies have not been institutionalized. Moreover it was also observed that the agricultural information services at the VKCs were not much used by the users since the information provided at VKCs was not personalized to meet the information demands of the farmers. The Microsoft Unlimited Potential Programme provided computer literacy training was much used by the users at the VKCs. There were no noticeable efforts has taken for drought literacy or climate change management. The organization of information and learning content management was identified as a major challenge for NVA.

3.2.4 Aqua Choupal Model

Indian Tobacco Company (ITC) – International Business Division (IBD) launched Aqua choupal project on 7th February 2001 in Andhra Pradesh state of India. The stated objective is to use ICTs and web based platforms to provide all the latest local and global information on weather, scientific farming practices as well as market prices in regional language (Telugu); information on products and services need to enhance farm productivity; improve farm-gate price realization and cut transaction costs, also facilitate in supply of high quality farm inputs as well as purchase of shrimps at the doorsteps of Andhra Pradesh shrimp farmers, and finally made an attempt to address the shrimp export oriented problems [**115**]. The company also started soya choupals in Madya Pradesh, wheat choupals in Uttar Pradesh, and coffee choupals in Karnataka more or less in the similar time.

The Aqua choupal model consists three components: (1) Aqua Care Center solves the shrimp farmers seed quality testing problems, (2) Aqua choupals deployed around the entire coastal belt provides information to the farmers on ITC and other companies shrimp purchasing market price information, and (3) Processing unit develops a barcode mechanism for identifying specific batches to address the export oriented issues such as identifying antibiotic residual batch elimination (or) muddy and mouldy smell batch elimination. All these components are interlinked with each other and enhance the efficiency of this model by building a concept of traceability into the supply chain.

Aqua Care Centre

Highly equipped ITC Aqua Care Centre provides a facility to the farmers to test their seed samples. There are two kinds of tests are available in this center (1) Virus tests including PCR test and MBV test (2) Wet lab tests including Formaline stress, Salinity stress, and Microscopic tests. ITC provides a computer printout of test results as a proof for the virus tests with photographs.

Aqua Choupals

60 Aqua choupals were deployed in the entire coastal belt of AP, except Vijayanagaram and Visakhapatnam. Aqua choupal set up consists of one computer with windows operating system, multimedia kit, and Land line connectivity, one dot-matrix printer, and Village Prathinidhi[6] provided needful infrastructure including tables, chairs, fans and tube lights. This entire set up is either in a farmers house/his own property (rice mill or storage house) or in a rented building and maintenance costs borne out by Village Prathinidhi. ITC provides training to Village Prathinidhi on basic computer operations and troubleshooting; and also on local price determination from the generic price (international market price information) information available on the aqua choupal website. Village Prathinidhi receives 3 percent commission from ITC during procurement time.

The village parthinidhi procure shrimps based on the requests of company and approval from the regional Grader[7]; later the procured shrimps will be sent to Processing Unit (Vishakhapatnam) along with duly filled two forms, (1) Form 1 provides the information about the Rate Chart[8] and Batch No. of the material. (2) Form 2 provides the details of the grader id/farmer code and all the farmer and cultural practices details including farmer village information, type of culture followed, stocking density, pond preparation details, and chemical application in culture period,

[6] Village Prathinidhi (prathindhi is a telugu term means representative) is a choupal operator. (In Soya and grain choupals the choupal operator is known as sanchalak)

[7] ITC employed 5 Graders for the entire coastal belt. Grader checks the quality and decides whether the material meets the requirements of the suggested count or not. These Graders often change from one place to other, for avoiding to establish long term relationships between Village Prathindhi's and Grader, which facilitates transparent and corruption free system. Grader is the intermediary between Village Prathinidhi and Processing Unit.

[8] Rate Chart provides the details of the price information at the time of purchase.

hatchery source, and count number. The payment is made to the farmer immediately after procurement.

Processing Unit

Procured material from the field was being received at receiving section of the processing unit. Crates were being emptied at receiving section, and do the de-icing and washing with chlorine water. Then shrimps were moved to pre-processing unit for beheading, grading, peeling and soaking in chilled water, later the raw shrimps were processed according to the buyers requirement. Production supervisor enter all the processing details in processing unit prescribed format for tracing the material details.

ITC Traceability Model

The term "traceability" has been introduced to describe systems in which information about a particular attribute of a food product is systematically recorded from creation through marketing [116]. ISO 9000 (ISO, 2000) defines traceability as the ability to trace the history, application or location of that which is under consideration. When considering a product, the traceability can relate to the origin of materials and parts; the processing history; and the distribution and location of the product after delivery [117].

Procurement Officer of processing unit allocate code numbers to all the five ITC Graders (1,2,3,4,5). Grader allocate three digit code number (for example: 100) to the farmer at the time of procurement and write down the farmer code number and his (Grader) number in the form II and fill the other information and sends the form to processing unit along with the material. In the Processing Unit Plant In-charge give a barcode to the raw material before it go for processing

For example: 5F18-I 1/100 -801

Here 5 stands for year of processing 2005

F-stands for month June (A-January, B-February, C-March………………. L-December) indicates month of processing

18- indicates Date of processing

I- stands for ITC

1/100 – 1 is the Grader code number and 100 is the farmer code number.

801 Code Processing plant

Consumer can trace the information with the help of this barcode, for example consumer buys shrimp packed under the brand name Tastee Choice in United States and he/she wanted to track back the source of origin, then the package returned to Tastee choice. Production Manager of Tastee choice checks the code number on the package 5F18-I 1/100 :801

With the help of the 801 code, processing plant can be traced out (801 is the Jasper code given by EIA) [118]. At Jasper, Production Manager of ITC retrieves the data stored against the code 5F18.

5F18 indicates the year, month and day of manufacturing information (5-2005; F-June; 18- Day). ITC grader sends a report along with the material to processing plant, which stored against the code, gives all the details of the cultural practices.

During the study period it was observed that more than 95% of the shrimp farmers own mobiles and communicating with *village prathinidhi* over phone rather than visiting to the centre; and the ITC stopped setting up of new centres. This was the reason for no incremental in the number of aqua choupals. However in the case of soya and grain there was tremendous increment in the number (more than 5000 chouplas) since the farmers do visit the centres. Hence it is very important to consider the user preferred technology and socio-economic conditions of the users. More over from this it is evident that the ICT is not only Internet and computers, it is a combination of technologies which would works best in a given kind of situation. For example, in this particular model, the situations around the shrimp farmers forced them to adopt mobile technology as a communication tool for knowing market price information from choupal. Although, computers are useful for maintaining higher end databases and transferring the information in ICT centric projects, but integration of mobiles at user level works well in the case of aqua choupal. The observations reveal that the ICT centric solutions are not much effective, unless and until we correct the inefficiencies in the supply chain. For instance use of antibiotics at hatchery level is not corrected then it is difficult to get the successful traceability mechanism, even farmers provide correct information.

3.2.5 Kisan Call Centres

Kisan call center project, was initiated by Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India on January 21, 2004 across the country, with an aim to leverage telecom infrastructure for delivering extension services to the farming community on free of cost. The main objective of these call centers were to provide solutions to the farmers queries in the local language on dialing a toll free number 1551; and the secondary objective was to establish the linkages between the farmers and scientists. These call centers operate with an organizational structure at three levels with fresh agricultural graduates at Level I, Subject Matter Experts (SMEs) at Level II, and dedicated nodel cell experts at Level III to address farmers issues within 72 hours. All these Levels offices equipped with good quality telephone lines (128 kbps ISDN lines) with headphones and teleconferencing facility; computers with Internet connectivity, printers, and UPSs; Interactive Voice Recording System (IVRS); and CARETEL software to maintain record of queries addressed.

Kisan Call Centre – Method of Operation

The fresh graduates at Level I first receive the farmers query over phone, and responds to the call with a welcome message and enter the details about the caller (farmer name, village, problem description etc.), callers query and answer provided by the agent into the CARETEL software installed in the computer placed on the agents desk, and give a number to the farmer for future purpose. The agent contacts SME over phone, on his/her failure of addressing the query, by asking farmer to be on hold. If the SME is available, then the agents discusses the query with him/her and provide solution to the farmer, otherwise the call will be forwarded through an online system and the call get recorded on concerned SMEs desk. In rare cases the unresolved query from Level II will be forwarded to Level III (group of experts at nodel cell) to address the caller issue. This top-level organization structural set up ensures to address the farmers/caller queries. The farmers' queries, which were not addressed at the time of call, will be addressed in

72 hours either by phone/post/e-mail or fax. At the end of the month all the queries asked by the farmers and answers provided by the Level I, II, III personnel will be submitted to Director of Agriculture office for ensuring the quality of answers. Sometimes these frequently asked questions will be shared to the other state kisan call centres.

Implementation

For effective implementation of the project, the DAC has chosen various public and private organizations (idea is to encourage public-private partnership) in the selected states of India. Though the toll free number 1551 helps farmers to reach these centres virtually, the physical reach to these centres is not possible. All the designated agencies advised by the respective state authorities to do not reveal the address of the centres[9].

Findings

The Kisan call centers use combination of technologies (telephone, computers with Internet and IVRC) to provide services round the clock. During the study period, it was observed there were six agents working in two batches for Gujarat at Level I, the first batch with three works from 6 am to 2 pm, and second batch with three from 2 pm to 10 pm. After 10 pm, the IVRS records the farmer queries, which will be addressed by the agents on next day morning over phone by making calls to the respective numbers. It was noticed so far the centre has not received any calls after 10 pm. The centre receives around 200 calls per day. According to the data the highest calls received in a month so far recorded as 10,000 calls and stood first in India, and

9 Personal discussions with the agent working at the Kisan Call Centre, Ahmedabad

Maharashtra received second place with 5000 calls. Thanks to Chief Minister of Gujarat and state government for taking interest and efforts such as signboards in public places and advertisements in television channel, to help Gujarat farmers to learn about kisan call centers. According to the then Directorate of Agriculture, Gandhinagar, “Kisan call centers provide information on various agricultural and allied field issues including cereal crops, pulse crops, oil seeds, medicinal and aromatic plants, fisheries, and veterinary, dairy. It also provides information on suitable local seed varieties, information on subsidies, crop insurance etc. In short Kisan call center provides information whatever farmer wants, and our six agents at Level I, six SMEs at Level II, and group of experts at nodel cell working for addressing all the queries raised by the farmers.”

Although, Kisan Call Centre appears that the farmers gets needed information on dialing 1551, the study argues why only 10000 calls (maximum) per month?

During the study period it was observed that the state agency neither provides knowledge base to the call centre agents (except available FAQ database) nor provides training. They recruit fresh agriculture graduates and put them on job from day one onwards with a monthly salary of Rs. 3000/-. These agents receive help from the SMEs over phone (or) during their monthly meetings at nodel cell. “The SMEs do not prepare any knowledge base, whenever level I agent forward any unresolved query they use their experiences and knowledge in the respective fields for addressing the queries”, according to an agent at Ahmedabad. The agents were not happy with the remuneration, and they were always in search of better opportunities. None of the agents have more than three months experience. During the discussions agents said they would be with

Kisan Call Centres until they get a better opportunity, so far no body worked for not more than six months. From this it was evident that most of the queries handled by fresh graduates who are not much familiar with the field level issues. Since the SMEs are not full time employees of call centres, the level I fresh graduates hesitate to disturb SMEs each and every time. The SMEs are employees of a research organization or a university where they have their regular work, and they have to balance their time with this additional responsibility.

Summary

Although the kisan call centers were operationalized across the country, the impact was minimal, because of the non availability of good quality content/ knowledge base and untrained fresh graduates loosing the trust of farming community; and limited infrastructure disappointing the callers with engage tone. Hence this particular study suggests rather than establishing an extra layer with new private or public parties, using existing structures for setting up these centres in all mandal agricultural offices enhances the efficiency and quality of the system, and the trained Agricultural Officers and Agricultural Extension Officers, who are aware of the local conditions and local farmers problems, increases the reliability and trust among farming communities with their quality services. The evidences from the study suggests that there is a need of good quality content on various agriculture and allied issues includes frequently asked questions in the digital format with better search engines. Moreover it is essential to make farmers aware - from where and whom they are receiving advices, since the trust is a valuable commodity in rural areas.

3.2.6 Warana Wired Village

The Warana Wired Village Project was launched in 1998 by the IT Task Force of the Prime Minister's Office to demonstrate the use of ICT to accelerate socio-economic development of a cluster of 70 villages around Warana in the Kolhapur and Sangli districts of Maharashtra. The Warana Project is jointly executed by (1) the National Informatics Centre (NIC), the Planning Commission, GoI, (2) the Directorate of Information Technology, State Government of Maharashtra, and (3) the Warana Sahakari Dugdh Utpadan Prakriya Limited (WSDUPL), Warana Nagar, with a total cost of Rs 25 million which was borne jointly by the three agencies in a ratio of 50:40:10 [119].

The stated objectives of the Warana Wired Village are:

- To provide computerized facilitation booths in 70 villages with the range of information and services in local language including crop, market price data, government employment program and educational opportunities
- To create database of villagers on various socio-economic aspects
- To increase the efficiency, transparency and productivity of the Warana Co-operative Society

The system had provided both web-based and Intranet-based application. In web-based applications the services include agriculture market information, agricultural schemes, computer learning aids, village information systems, educational and vocational guidance systems, government documents and procedures systems, and computerization of the local cooperative market, whereas in Intranet-based systems include the wired management of sugarcane cultivation, land records, the computerization of the Warana Milk Dairy, and a Grievance Registration and Redress System.

NIC had designed, developed and implemented this project. The central hub has a system with Pentinum II with 64 MB RAM, 4.1 GB hard disk and 32xCD-ROM drive. It is linked to NIC Pune through 64 kbps bandwidth VSAT connection WAN link. Each computer booth had Pentinum with 64 MB RAM, 2 GB hard disk, printer and UPS power backup system. These booth were connected to central hub via dial-up connection with modem and telephone with a speed around 19200 BPS to 28000 PBS [120]. NIC had also developed 15 different web-based applications. They had developed applications related to agriculture produce, schemes and crop technology, land records database, GIS application, education and other application

Though the project has designed and developed with a great enthusiasm, the application which they developed had not used fully. The reasons were slow access to the Internet, insufficient awareness creation among the villagers, and the low levels of literacy in the area in spite of high levels of income. There have been problems in the implementation of computerization of land records. The GIS has become obsolete, to a large extent, due to lack of updating of the database. Microsoft Windows-based applications like crop guide, schemes of agriculture department, employment schemes and vocational guidance are non-interactive and have not been updated. The market rates of the agriculture produce have been dysfunctional and unused due to poor information management. The project remained dominated by NIC officials and technocrats, causing severe problems in community participation and management of services. The pilot project, due to its very high cost, has not been replicated anywhere in India.

3.2.7 KISSAN Kerala

In the early 2000, Karshaka Information Systems Services and Networking (KISSAN) was started by the Indian Institute of Information Technology and Management – Kerala (IIITM-K), Department of Agriculture, Government of Kerala and the Kerala Agricultural University. The stated objective is to support farmers and different agricultural related people through IT by linking them with specialized groups of agriculture consultants or experts over a knowledge management portal system. The mass media television program "Krishi Deepam" played a critical role in building network among experts and famers and agricultural related field people, and making information available in the form of audio and video to farmers through satellite based broadcasting, cable TV networks, Internet kiosks in Krishi Bhavans. Krishi Bhavans are agri-kiosks located at village panchayat level for providing web access to farmers and act as a bridge between farmers and expert team.

At the initial stage of implementation, the project has considered the views of state department personnel. However the project has got more clear definition after discussing project team with Agricultural Extension Officers (AEOs) who had substantial field experience. State Department of Agriculture was an active partner in formulating initial objectives of the Kissan project. The first phase of its services was started during the month of March 2003 and the project was officially inaugurated on November 01, 2003 (Kerala formation day).

Kissan has a multimode approach consisting of the following major components (a) Web services (b) Agri-data centre (c) Television based agricultural information dissemination system (Krishideepam) (d) Agri-information Kiosks and (e) Call centre.

One of the most important components of the Kissan project is the web service module, which offers information services over the web. The portal [121] is designed with a view to cater to the information needs of the farmers as well as government officers. The stated specific information services are (a) query management services (b) state-wide market information on various agricultural commodities (c) online agri-advisory services (d) online fertilizer recommendation services (e) weather information and forecast (f) management of crop, fertilizer, water and soil etc.(g) harvesting and processing (h) administrative information (schemes, working instructions, financial assistance etc) (i) interactive discussion forums (j) success stories, case studies, best practices (k) planting material (selection, variety, cost, etc.) (l) location specific information and recommendations. The visitors for these web portals were nearly 6,500 to 7,000 and the most accessed web pages include crop information and the query management system[10].

The query management service is one of the most important components of the Kissan project. Through the query management farmers can contact experts about their crop problems; farmers can also attach images of their crop specific problems along with their queries. When a query is

[10] Personal Discussions with the Primary Researcher, G. R. Kiran, LSE Student.

posted AEO takes initial step to answer that specific question, if in case he could not able to answer then AEO posts that question either formally or informally using any media (telephone, e-mail, etc.) to senior experts in the Kerala Agricultural University / Research stations / Department of Agriculture. The query was usually answered by the experts within two days either by sending links or by emails. Farmers can also be able to find answers to their queries through browsing the website of this project. However the query management module is available only in English.

The web portals displays the details of prices in the domestic market (inside the Kerala market) as well as prices of commodities outside Kerala and in international markets, the same information is also conveyed to the Krishi Bhavan through telephonic services. These Web portals also made updated weather information available to the farmers.

The agricultural data centre located in IIITM-K, acts as the backend for the web services of the project. It provides a single platform to aggregate available information on agriculture, helps customize the information dissemination, speeds up the content process analysis and provides an open platform for the content providers which are connected to the network environment. The data was collected from different formal and informal sources including the Farm Information Bureau (FIB), Directorate of Agriculture, Kerala Agricultural University, District Agricultural Offices, selected Krishi Bhavans, research stations, etc. The data processing and research unit continuously interact with the domain team and keep changing the structure of databases, querying methods & screens, updating video content, price information, etc.

The important element for the success of this project was Krishi Deepam which provides value added' information to farmers preferably targeting them at their own homes through the medium of television. The project was established an in-house facility for creating the relevant content for transmission over a television channel. The programme is telecast at 5.30 pm on Fridays, with a repeat telecast on the subsequent Saturday at 9 am. A second repeat telecast of the programme is done on the subsequent Mondays at 6.30 pm through a second Asianet channel called the Asianet news channel. It is estimated that the program reaches more than 20 lakh regular viewers across the country. Krishi Deepam telecasts different programs such as news about successful cases and views of experts about various crops. One of the interesting aspects of the programme is the feedback mechanism. At the end of every episode specific contact details are given for farmers to respond and clarify. The team receives on an average 130 calls and 120 e-mails a month based on the television programme. Project also provides copies of the programme in VCD format to the agri-kiosk so that the farmers who do not have a television can be viewed over the computer.

Agri-information kiosks are the extension of the web services to their field office, the Krishi Bhavans, with a view to help the bilateral flow of data and to also encourage an IT mediated interface with farmers. All the kiosks are equipped with latest multimedia computers, web cameras, network accessories and dedicated Internet connections. The operation of each kiosk is supervised by the AEO of the Krishi Bhavan and is supported by the agricultural assistants. The typical services offered through the kiosks to farmers include farm/crop advisory services, helping them with the online query management services, showing video programs and of late using online fertilizer recommendation system etc.

The Kissan Kerala project transforms the existing Krishi Bhavans to information kiosks with the use of ICTs. The project is classic example to strengthen the existing systems with the introduction of new tools and new methods rather than establishing a new layer out of the existing systems.

3.2.8 Akshaya

Akshaya, a public-private partnership project, was launched in November 2002 in Malappuram district of Kerala, India. Initially the project was originated from the district panchayat for 100% district wide e-literacy training, later this was converted into RKC project by the Department of Information Technology, Government of Kerala, with an aim to (1) set up multi-purpose community centre, one each for approximately 1000 families (2) making at least one person in every family functionally ICT literate, and (3) creation of relevant local content.

Before starting the project the District *Panchayath* conducted needs assessment survey to identify the ICT skills and existing resources in the district. Based on the survey results an e-literacy content was generated, and discussed with the Science and Technology Entrepreneurship Development (STED) for providing training and identifying the possible locations for setting up Akshaya kiosks centres. In agreement with the District *Panchayath* the local bodies identified the centre entrepreneurs to provide e-literacy for one person in each family. A training charge of Rs. 120 per person paid to the centre entrepreneur, which was borne out from the Village *Panchayath* Rs 80 and Rs 20 by the Block and District *Panchayath*[11].

[11] Personal discussions with Primary Researcher, G. R. Kiran, LSE Student, of Akshaya

Over six months (till 31 December, 2003), the centres focused only on e-literacy, with a door-to-door campaign by KSITM (Kerala State Information Technology Mission). Officially, 5.6 lakh people were given e-literacy training. Using a CD with fifteen hours of games and multimedia content, the e-literacy training focused on enabling individuals to use computers without fear or inhibition. About 65% of the people who came to study were women. Many centres began to act as a hub for community activities like women's club, children club and etc[12].

In January 2004, all centres were provided with high-speed internet. A CD called e-vidya was designed and provided by the project team in April 2004. It contain lesson on using word-processing and spreadsheets and they charges Rs 450 per person. This was success in most of the kiosks and mostly youngsters and school children were the users during April and May month.

Since the state government had been playing a facilitation role from the beginning of the project, the Akshaya is a classical example to show the role of local governments (Panchayats), the participatory approach and local implementation approaches in an ICT project.

3.3 Observations and Recommendations

Although ICT enabled RKCs opened up new avenues and brought many benefits to the rural communities, the degree of their effectiveness and framework for successful implementation of information services is uncertain; and analytical understanding of the relationship between the

[12] Personal discussions with Kiran

enhanced deployment of ICTs and development outcomes is unclear or ambiguous. Following are observations from the assessment of the RKC project sites:

- There is prevalence of top-down approaches with few attempts to reflect the end users preferences and needs.
- Production advisory services and market information access do not go together in all such efforts.
- In almost all the projects, the participation of agricultural education and research institutions appears to be marginal.
- In almost all the projects, the efforts taken for addressing the climate change issues appears to be marginal.
- Localization and customizability of content are still not practiced on a significant scale.

The study further states that ICT and techno-infrastructure should consider judicious blend of traditional and modern technologies depending on what would works best in a given kind of situation. The efforts should be made to develop medium to high level of farmers' faith in ICT enabled services. It is also suggested that Participatory Rural Appraisals and Rapid Rural Appraisals should be carried out to know about information needs of the farmers, and also to learn about the user preferred technology. Identification of the typical community problems would be the first step to start any kind of ICT mediated innovation (or) application. Emphasis should be given to define methodologies for transforming generic datasets into locale specific information for their effective use.

The study recommends to understand and anlyze influencing factors such as socio-cultural, technical, economical and political factors and functional factors such as content and capacity building while designing and planning Rural Knowledge Centres. Based on these observations a framework was proposed for planning and designing of ICT enabled RKCs.

3.4 Existing Frameworks for RKC Projects

Most of the studies on RKCs till date have focused on the operational and sustainability aspects. Theoretical or conceptual framework for planning and evaluation has largely been missing from the debate [122]. Roman [122] has provided a very cogent theoretical and conceptual framework for telecenters using theory of diffusion of innovations [123]. He describes three principal attributes of innovations which could be very useful in RKC research; relative advantage, compatibility, and complexity. He also underscores the importance of socio-structural environment in innovation, diffusion and adoption. In one of the early attempts to understand RKCs within the diffusion framework, Johnson [124] examines how incorporating a gender dimension into RKC design can enhance their diffusion among women. According to Roling, Neils, [125], the evolution of rural knowledge centre is a function of 7 C s, i.e., Connectivity, Content (Static and Dynamic), Context, Cash, Culture, Community and Communication. Ensuring the 7 Cs requires a process of Mobilization, Organization, Capacity Building, Technology Incubation, Technical Support, System Management. Though Neils analyzed these aspects well, he forgotten to include the factors influences the process. Since there are not many frameworks, and existing few frameworks give little idea on planning and designing of rural

Knowledge Centres, the study made an attempt to propose a framework to distinguish between processes, functions and influencing factors; and discussed in detail how these relate with each other during the evolution of RKCs.

3.5 Proposed Framework for Planning and Designing of Rural Knowledge Centres

Setting up of a computer centre in a village does not constitute a knowledge centre. The translation of a rural computer centre into a knowledge centre requires an intensive social process. A rural computer centre evolves into a knowledge centre only when modern ICT facilitates transfer of information into knowledge. A rural computer centre providing market price is an information centre. A rural computer centre, which enables the rural community to understand the differential mechanisms through which prices are influenced and determined, is a knowledge centre.

Most of the rural ICT projects focus on providing information services, rather than looking at the knowledge management strategies. In agriculture and rural development, the importance of uneven distribution of knowledge in explaining variations in Total Factor Productivity (TFP) is being increasingly recognized [126]. Mere information in the form of flow of messages may not be able to address the problem. Knowledge as the creative result of a flow of messages anchored on the commitment and beliefs of the actors involved in the process and resulting in human action is needed. Environment in which knowledge is built; capacity building and empowerment processes, social mobilization and organization are the important factors which have to be taken into consideration while transforming a rural computer centre into a knowledge centre. Freire [127] argued in the case of the pedagogy of oppressed vis-à-vis literacy programmes, the need for dialogues and discourses among learners to understand the world instead of mere understanding of words. Similarly in the process of knowledge management, dialogues and discourses of among rural community are essential. Modern ICT, if properly defined can help to broaden the canvass for dialogues and discourses among the rural community.

3.5.1 Information Vs. Knowledge

The differences between information and knowledge are being spelt out in many books and papers in recent times. Many authors have described the progressive processes from data to information to knowledge to wisdom in terms of purposes and contexts. *Data refers to raw materials such as facts and figures that could be collected by an information system. Information refers to analysed data often presented in a form that is specifically designed for a given decision-making task, and transmitted to/received by decision makers. Knowledge refers to subsequent absorption, assimilation, understanding and appreciation of that information* [126]. Pomeroll and Brezillon [128] quoting Newell and Simon [129] argue that *knowledge is information incorporated in an agent's reasoning and made ready either for active use within a decision process or for action. It is the output of a learning process. Thus the roles of knowledge are to: (1) transform data into information, (2) derive new information from existing ones, and (3) acquire new knowledge pieces*. Wisdom is considered as meta-knowledge, knowledge mobilized to acquire new knowledge and update it. From a philosophical angle wisdom refers to the evaluation of knowledge vis-à-vis the norms, values and morality [128]. Knowledge management focuses on definition of the context and validation of the information. It also increases the *connections among people (who have knowledge) that would likely not occur without the help of a knowledge management system* [130]. The process of searching answers for the following questions characterizes the dimensions of knowledge management;

Who created the information?
What is the background of the creators of information?
Where and when was it created?
How long will the information be relevant, valid and accurate?
Who validated the information?
Who else might be interested or has similar knowledge?
Where was it applied or proved to be useful?
What other sources of information are closely related?
How to test and validate some of the concepts?

In the context of rural community, the presence of traditional knowledge is another important dimension of knowledge management. The social construction of traditional knowledge and the blending of the new knowledge with traditional knowledge are the components of knowledge management. Thus knowledge management necessitates a participatory management in which the rural community plays a crucial role of absorption, validation, critical evaluation, assimilation, understanding and appreciation of information. A paradigm shift in the concept and practices of extension will occur only when the community develops its own framework for knowledge management.

According to Marwick [131], knowledge management takes place at four levels: *Socialization* in which exchange of tacit knowledge taking place within a community; *Externalization* in which a set of tacit knowledge is converted into explicit knowledge; when the explicit knowledge is shared, the process of *combination* takes place; and finally *internalization* in which socialization, externalization and combination lead to further set of new tacit knowledge. Through such a process the community plays a crucial role in converting a generic information and knowledge into locale specific knowledge. Such a system requires both vertical (between macro and meso organization and villager) and horizontal transfer of knowledge (between villager to villager) in which the knowledge creators at the macro and meso level interact with the community and through an interactive learning process, both the stakeholders define the roadmap for knowledge management. The ICT enabled RKCs enhance the socialization process through broadening the horizontal transfer of knowledge. The creation of databases based on local knowledge and traditional knowledge represents the process of externalization in which tacit knowledge is converted into explicit knowledge. ICT also facilitates exchange of explicit knowledge within and between communities leading to a process of combination. Finally internalization of explicit knowledge into tacit knowledge represents the framework of knowledge management. *Thus in a knowledge centre villagers are not mere consumers of information but partners in knowledge management.*

The various dimensions of Rural knowledge centres vis-à-vis knowledge management are

Centres of human resource management
Centres of Information such as weather, trade, market, transport etc
Centres of governance for delivering development with least social and economic transaction cost.

Centres blending traditional wisdom with frontier sciences

The community ownership is crucial. The various sections of the community (vis-à-vis caste, class, gender, age, religion and region) should be involved in the entire process of developing the programmes, content, delivery methodologies, learning processes, and assessment, and in the use of innovative technologies. Such a participatory approach is necessary for ensuring the relevance of contents and technologies within the social context in which the knowledge centre is operating.

3.5.2 Proposed Framework

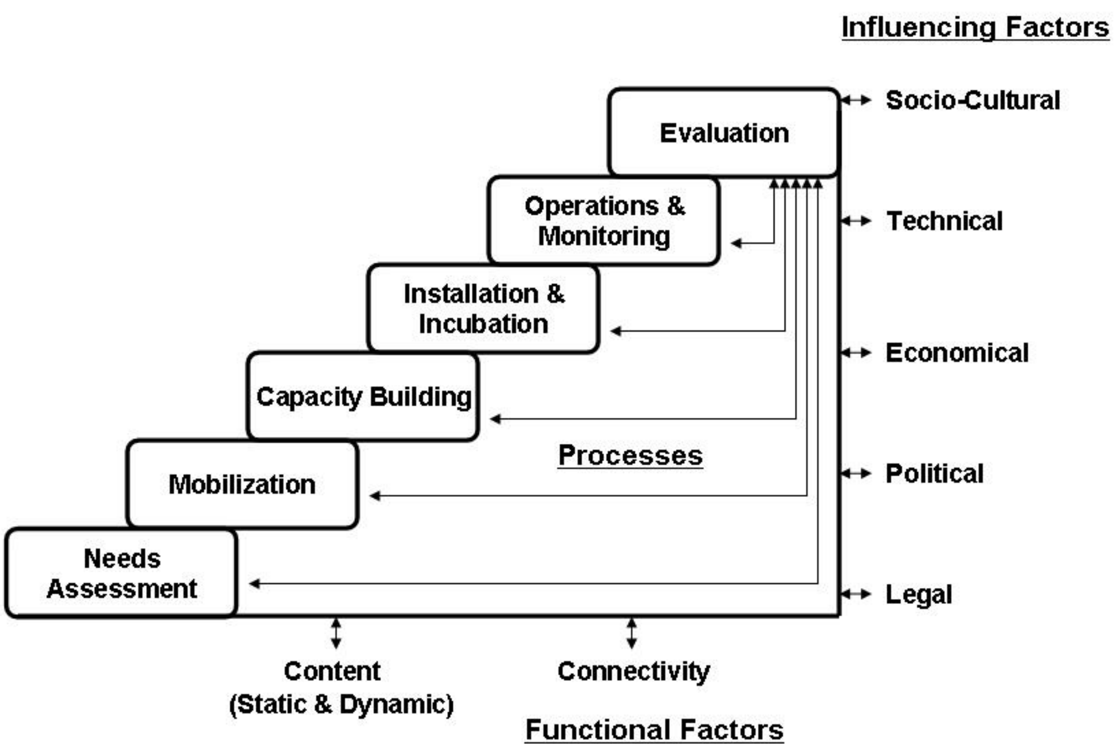


Figure 1: Framework for Planning and Designing of Rural Knowledge Centres

Process in evolution of a Rural Knowledge Centre

Needs Assessment: Rural communities have own social dynamics, and wide diversity of interests. The solutions to their problems will be highly local and highly specific. So identification of their needs, problems and technology preferences is a first step to start RKC in any location. After identification, analysis is required to provide relevant information resources through user preferred communication techniques for satisfying their information needs.

In most of the government projects, Rural E Seve, Rajiv Inernet Villages, the government officials assumed that they know what is needed at the grassroots, and established the infrastructure for starting the activities without making any committed involvement of the local communities. That's why most of the projects even kick started the activities very well but in the long run they lost that tempo, and resulted failure in achieving the long-term sustainability. In the case of ITC e-choupals, though the project personnel made efforts in identifying the needs of users, they didn't consider the user preferences in technology identification. This resulted to look for alternative mode of communication in the case of coffee and Aqua choupals. From this it clearly emerges, instead of following top-down approach, RKC project should follow combination of bottom-up and top-down approaches with community mobilization to ensure the long-term sustainability of the project.

Mobilization: Community mobilization and resource mobilization are essential for ensuring the long term sustainability of the RKC project. Involve the communities in each and every evolution process of RKC, includes needs assessment, identification of the user preferred technology, and resource mobilization; and give sense of ownership. Once the communities realize that the RKC project is being operated by them and for their benefit then the operation will go long-way with the faith and motivation of involved communities. During the resource mobilization, make the communities to share the project costs in terms of community buildings, electricity, and human work hours. Motivate them to identify and establish linkages with local knowledge producing agencies, and their role in RKC operations; and make them to realize the information need and knowledge management process and pattern; and make them to understand structural differences in the community i.e., caste, class, religion, region, gender, and age; and realize them need of allowing users to use facilities of RKCs irrespective of structural differences for achieving the development.

Capacity Building Capacity Building is often defined in the literature as a process to develop a certain skill or competence to enable individuals (or) organizations to perform effectively. In this context capacity building is essential to both communities (individual level) and RKC (organizational level) for long term execution of activities effectively. Capacity building is continuous long term process as reported by United Nations Development Programme (UNDP). It was therefore, since inception of the project continuous capacity building to the communities and RKCs is essential on various areas includes (1) Organization - Capacitate the communities on identification of organization types, build organizations, planning programmes through their organizations, linking the organization with the macro, meso and local organizations for horizontal and vertical transfer of knowledge, facilitating the organizations to define the self-sustainable interventions, developing contractual arrangement between various stakeholders, organization management, and conflict resolution (2) Literacy – the focus of first phase should be on digital literacy includes literacy training on new software and basic trouble shooting, and the focus of second phase is on subject matter literacy training includes use of technical skills for gaining subject matter literacy; and ICT enabled knowledge management includes content creation, consolidation and delivery.

Installation and Incubation: After ensuring the communities are mobilized and capacitated, install services, and introduce them by creating awareness. The period in between installation and implementation is known is incubation period.

Operations and Monitoring: In the initial stages monitor each and every service, the way it is offering and the way communities are receiving.

Evaluation: After certain period of time, there is a need to conduct an evaluation study to understand various insights and dynamics of a project. Each learning experience should be fed back into the system to make a project sustainable.

Functional and Influencing Factors

The functional factors such as content and capacity building play a vital role in ensuring the long term sustainability of RKCs. The economical, political, socio-cultural, technical and legal factors need to be considered carefully while planning and designing of RKCs. The case studies discussed in Section 3.2 explains the role of functional and influential factors and their importance in establishing RKCs, for instance ITC Choupals case discusses the need of user preferred technology for their various choupal models, whereas the Rajiv Internet Villages discusses the way the political factors influence the RKCs.

3.6 Rural Knowledge Centres and Drought Preparedness

In spite of the tremendous potential of ICTs, the developing countries have not adopted a sound strategy to utilize the ICTs and ICT enabled RKCs. The application of ICTs in drought mitigation efforts is far from clear. The broad issues identified by Commission on Science and Technology for Development (UNCSTD) on ICT opportunities for developing countries, includes new types of learning and education to bring awareness, a ‘wired’ civil society, new forms of commerce and trade, among others, all provide hints of tremendous potential. New types of learning and education to bring awareness on several aspects including education on drought require a paradigm shift from traditional classroom based education to flexible open learning environments. Providing open learning opportunities to the rural farm communities who are away from the classroom milieu is not an easiest approach, which requires to address several issues including (1) continuous production of locale specific demand driven digital content (2) development of innovative capacity building mechanisms for making communities to adapt modern learning and educational approaches. Hence there is a need to define a strategy to look at local level institutions and the role of ICT enabled RKCs in developing suitable methodology and mechanisms for knowledge acquisition and delivery to address open learning approaches on drought preparedness for farm communities live in different agro-climatic region.

National and International experiences reveal that drought can be managed – by being in a state of readiness to combat it, by forecasting, by mitigating its impact on humans and animals. Prior to independence, measures to tackle famine and minimize deaths due to starvation were evolved and followed. At that time there were no mechanisms to monitor droughts scientifically and technologically. But now the ICT enabled RKCs help in developing, and coordinating an institutional mechanism to monitor/predict/warn occurrence of drought at local level, for which a methodology need to be defined to generate coping mechanisms or support systems at local community level.

Chapter 4 Experimental Setup at the Addakal Rural Hub

4.1 Study Area

Addakal (latitude- 16^0 28' to 16^0 41'; longitude- 77^0 2' to 78^0 2'), is categorized as a drought prone area with an average rainfall of 391 mm to 542.6 mm. It is one of the poorest regions of south central India, located in Mahabubnagar district of Andhra Pradesh state [Figure 2]. It has 21 revenue villages spread over an area of 19,397 ha; 15% of this area is covered by irrigated land while 60% is rainfed, and the remaining 25% is considered as 'waste land.' Without any major irrigation system, agriculture depends on the scanty rainfall. Most of the tube-wells, open wells and tanks in this area go dry often due to low and erratic rainfall. Over 75% workers are engaged in agricultural, dairy farming and allied activities. High risk associated with low investment capacity of farmers often results in higher rate of out migration, school dropouts, food insecurity and poverty. There has been noticeable lack of drought-coping and support systems in the locality, and large scale out-migration eventually has become the principal drought coping mechanism of the people, in this while suicides among the farm families have started to occur since 2004 [17] [19] [20] [Table 1].

The experimental set up was established following a Hub and Spokes Model [18] [19] partnering with a Community-Based Organization (CBO). ICRISAT and coalition partners provide information and learning inputs to the CBO members in various aspects of enhancing drought preparedness at mirco-level. Towards fulfilling this purpose, experts at the ICRISAT and partner organizations have developed number of learning modules [Table 2].

Total Population	46380 (Male : 23596, Female : 22784)
Total number of houses	8639
Literacy Rate	35 % (Male : 66 % ; Female : 34 %)
Government Hospital	1
Veternary Hospital	8 (One doctor is available for all the hospitals)
Post Offices	10
Telephone Connections	998
Government Junior College	1
Government High Schools	9
Government Elementary Schools	21
Anganvadi Kendras (Govt. Baby Care Centres)	1
Women Diaries	10
Library	1
Banks	2 (Sangameswar Graameena Bank , Moosapeta; Mahila Bank, Moosapeta)

Table 1: Profile of Addakal[13]

[13] Population census data (2001)

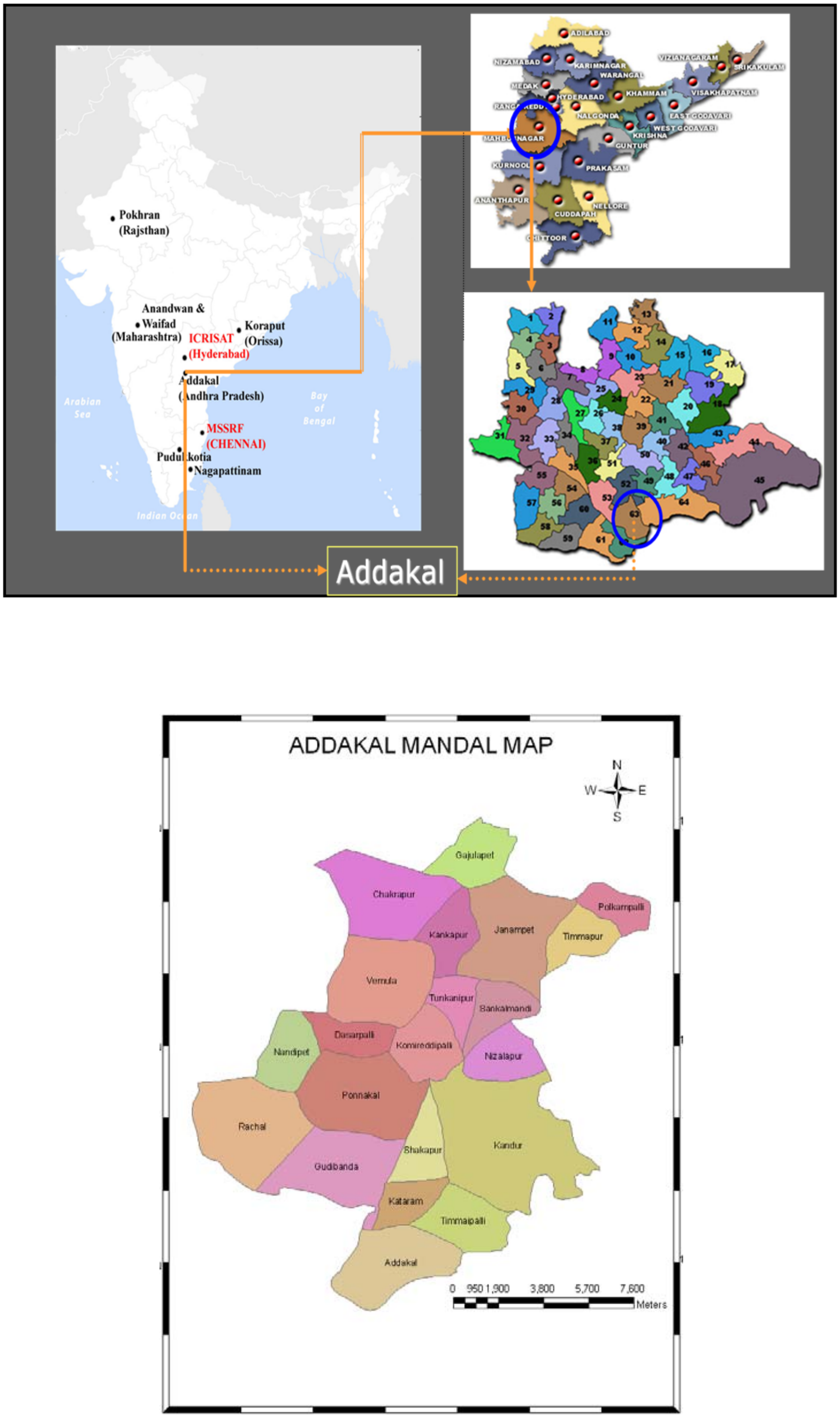


Figure 2 Geographical location of Study Area, Addakal

Name of the Learning Modules	Collaborators
Coping with Drought	ICRISAT, CRIDA, BRAOU
Chickpea Production Practices and Pests	ICRISAT
Pigeonpea Production Practices and Pests	ICRISAT
Groundnut Production Practices and Pests	ICRISAT
Micronutrient	APRLP, ICRISAT
Vermicomposting	APRLP, ICRISAT
Crop – Weather Relationship	ICRISAT
Soil Health	ICRISAT
Frequently Asked Question on Manures and Fertilizers	ICRISAT
Frequently Asked Questions on Soil Testing	ICRISAT
Water Scarcity	IWMI
Animal Diseases	ILRI
Animal Health	ILRI
Livestock – Management Issues	ILRI
Fodder Issues	ILRI, CRIDA

Table 2: Learning Modules

4.2 The Community Based Partner Organization

The principal community-based partner organization in this study was the Adarsha Mahila Samaikhya (AMS- the Adarsha Women's Welfare Organization in English), a federation of all-women micro-credit groups that functions in the Addakal Block. It has a membership of 5200 women, covering all 21 revenue villages in the locality. Being a legal entity, the AMS has strict procedures for executive elections to select their general body. The elections of the organization take place every year regularly, and the elected members of general body runs organizational activities, along with Village Network Assistants (VNA) at each village. All these members get paid every month for their services. The AMS has accepted the ICRISAT-VASAT invitation in 2004 to partner with it and work towards drought preparedness through improving coping capacities of communities in selected villages with information empowerment. According to the partnership agreement, the roles and responsibilities of ICRISAT-VASAT and AMS are given in Table 3.

Roles of ICRISAT-VASAT	Roles of AMS
Provide basic ICT equipment	Support hub activities by providing space, staff; and running costs.
Build capacity of AMS local member	Create local database with local resources
Make information and learning modules available at Hub and Spokes	Contact users, collect their queries, and communicate expert advice to users
Facilitate education and training to the community by the experts	Provide feedback to the experts on various activities includes testing of VASAT learning modules

Table 3 : Roles of ICRISAT-VASAT and AMS

4.3 Experimental Setup

The Hub and Spokes model was used for planning and designing of experimental setup. Learnings from the “Framework for planning and designing of Rural Knowledge Centres” were well incorporated while creating the experimental setup.

4.3.1 Hub and Spokes Model

The Hub and Spokes model works like hub and spokes on a bicycle. There is one central transshipment hub in the geographical center of the experimental location and the sender/receiver depots are connected to it like spokes (Figure 3). In this context, the hub is a set up with reasonable computing facility with good connectivity. The trained youth and women with college level education operate the hub. One of the main tasks of the hub centre is to derive the locale specific information from the generic datasets collected from the global networks. The Rural Knowledge Centres (RKC), access points at village level, connected to the hub with socially accepted ICT tool. The concept involved in this model is to establish RKCs (ICT infrastructure and tools to support connectivity to centrally located hub and to other RKCs) within the selected locations to achieve development in that location using Information and Communication Technologies. This is ultimately what we can say ICT for Development (ICT4D). The “ICT4D hub-and-spoke” system of operation provides mutual support and learning opportunities as well as fostering partnerships with information brokers, both researchers and village volunteers, who act in a creative and pro-active manner in developing information channel that can deliver benefits to the communities.

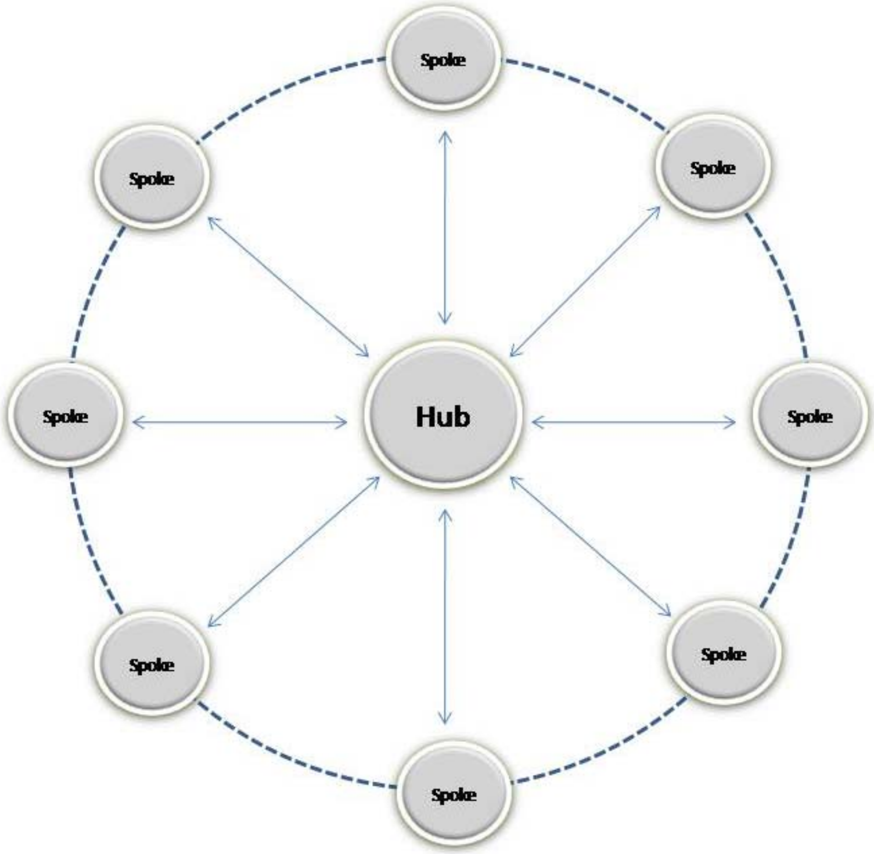


Figure 3: Hub and Spokes Model

In this experiment, the hub was installed in the AMS office premises at Moosapet village, and the spokes (RKCs) were installed in the community buildings of selected three villages Jaanampeta, Vemula and Kommireddypalli. These three villages broadly represent the cluser of hamlets in the Addakal block. The distance of these three village RKCs ranges from 5-10 kms from the central hub, and serve as spokes to the central hub. The AMS nominated persons at hub and spokes centres work for executing the activities (Figure 4).

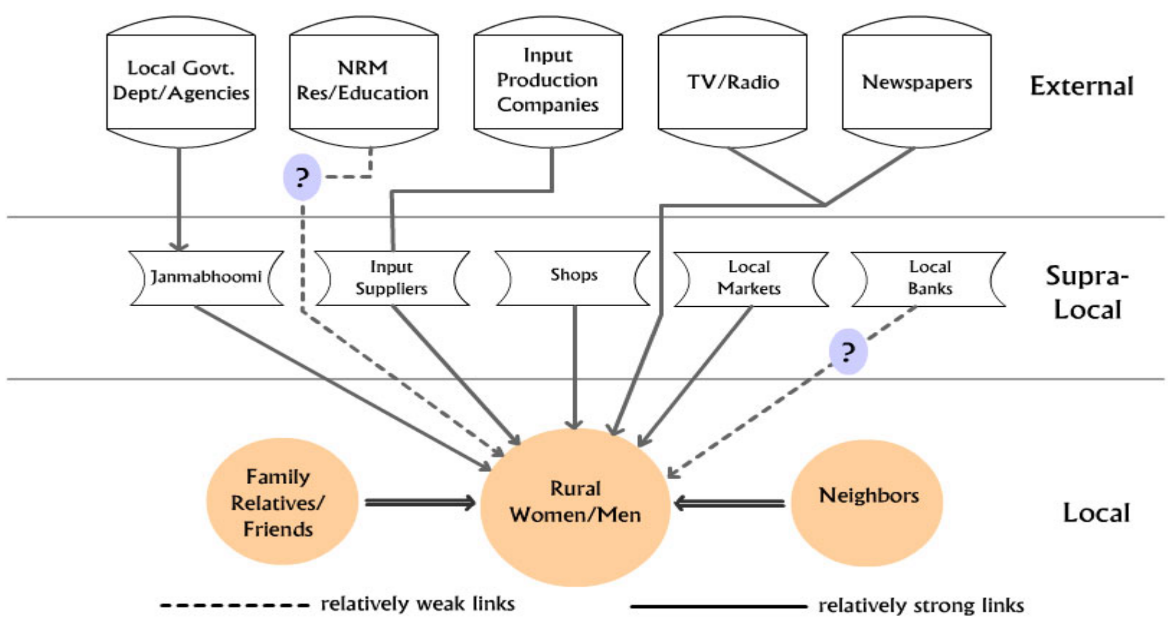
Figure 4: Experimental Setup at study area

The hub was provided with one extra computer with a deskjet printer, supplementing what the AWS/AMS had on their own. Because of undependable local lines VSAT-based Internet access was provided by the project on a cost-sharing basis with three other ICRISAT projects. Existing community buildings are being used for setting up the Rural Knowledge Centres in these villages.

4.4 Early Experimentation

4.4.1 Information Needs Analysis

The Village Network Assistants (VNA) of AMS acted as information collectors in this experiment. This exercise involved local volunteers collecting information from different sources, such as the nearby markets, government departments and traders. With the help of the AMS, a participatory rural appraisal was organized, and the results are presented diagrammatically in Figure 5.



Information Flow and Linkages in Addakal Mandal (AP, India) as perceived by Rural Women and Men

Figure 5: Information Flow and Linkages in Addakal Mandal (AP, India) as perceived by Rural Women and Men **[**95**]**

The figure shows that most of the information needs of a typical rural resident are met by approaching family members, neighbors or friends (who themselves are not well informed in most cases). At a secondary level, the farm input suppliers; local shops and markets act as important and credible sources of information. Technical information on agriculture, available with a range of agencies is not easy to access by most rural families. This compounds the problem of information poverty in particular. As an outset it was decided to strengthen the access to crop-related information.

The other conclusions derived from this information needs analysis study are - 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. Local government departments including agricultural department through programmes like Janmabhoomi also play a role. Market, climate, employment and wages are some of the important information needs of the community. Keeping the structures and functions in view, the methods were developed to carry this research work to improve vertical information flows with the use of ICTs and RKCs for better information management to foster drought preparedness.

4.4.2 Mobilization

All the required resources, for executing RKC activities, were mobilized at both the organizations (ICRISAT and AMS). From the inception of the project, a sense of ownership has given to the AMS staff, VNAs and Village Volunteers. They were encouraged to participate in each and every activity.

4.4.3 Capacity Building

The village volunteers, VNAs and AMS staff personnel were capacitated with the help of onsite training programmes in two phases. The first phase of the training was focused on computer literacy training and the focus of the second phase was on subject matter literacy training, maintenance of RKC records, organization management, conflict resolution and mobilization of local resources including contractual arrangements with various stakeholders and local institutions.

Computer literacy training computers attracted the attention of most of the rural communities irrespective of their age groups (Figure 6). Two kinds of training programs were offered:

1. computer literacy training program to elders without leading to certificate
2. computer literacy training program to school-going children with certificate awarded by a district level agency.

In the first category, the trained operators from the hub provided training to interested elders (above 25 years) on basic computer operations daily for an hour. On the basis of educational qualification and involvement in the farm operations names of 45 rural women and youth from the three villages (15 from each village) of study area were short listed for the training course. All the selected participants had formal education up to tenth grade.

In the second category, a tutor from a private institute located at the district headquarters visited centre daily and provided training to the students on MS Office package. At the end of the course, certificate was provided by the institute to the successful participants in the examination conducted by the course instructor. A nominal charge was collected from the participants to provide honorarium to the instructor. The rural families expressed their happiness about the training for instance the woman veterinary assistant of Jaanampeta village says, “Though I had a strong desire to work on computers, I couldn’t do that; now I am encouraging my son to learn computer courses.”

Figure 6: Rural Women and Youth undergoing basic computer literacy training

4.4.4 Installation and Incubation

After ensuring the communities are mobilized and capacitated, the services such as *Agro-advisory on locally cultivated crops*, *computer literacy training*, *subject matter literacy training* (on coping with drought, drought tolerant crops and their cultivation etc.), *Education to children* (partnering with Azim Premji foundation[14] for educational CDs), *weather information* (daily and weekly weather information derives from accuweather website [132], and make it available to the rural farm families), *Market Price Information*, *Technology Transfer Training* (partnering with local natural resource management agencies) were designed and installed at the RKCs.

4.4.5 Operations and Monitoring

The AMS staff, VNAs, and Village Volunteers were advised to ensure the implementation and availability of all these services to all the rural families irrespective of their age, sex and religion. The following monitoring mechanism was developed to understand different scenarios while implementing the services.

The AMS staff, VNAs and Village volunteers were advised to

- record all the questions posed by the farmers and answers provided by the experts.
- record the name of the person visited to the centre; purpose of his/her visit and time spent at RKC; and feedback and suggestions given by them.
- record displayed weather information data.

[14] Azim Premji Foundation

- record visitors (researchers, students, government officials etc.) details, purpose of the visit, their suggestions, and feedback.

Three visits in a month helped to ensure the data collection, and to check the reliability and validation of the information provided by the AMS staff, VNAs and Village Volunteers.

4.4.6 Evaluation

It was decided to take up an evaluation study at the end of the season to understand the role of RKCs and the impact of their services. Moreover the evaluation study should focus on provide inputs for betterment of the RKC role in the local development.

Chapter 5 Rural Knowledge Centres as Facilitators in Farmer-Expert Information Exchange and Rural Capacity Building

5.1 Existing Scenarios at the Study Area

The Mandal Agricultural Officer (MAO) is a local agricultural expert provides advice, education and technical information to the local farming community. He/She is assisted by two field staff known as Agricultural Extension Officers (AEO), to satisfy the information needs of farm communities lives in their jurisdiction. In this study, AOs jurisdiction (study area) is 21 revenue villages. He/She is well connected to variety of agriculture knowledge producing agencies, and plays a pivotal role in the state agricultural extension system[15] (Figure 7). Subject to the

[15] The Agricultural Extension work was reorganized from Department of Agriculture in 1960s based on Crop Development Schemes designed by the Government of India. It was again re-organised into two wings, ie, Extension and Inputs in 1976. The extension wing transfer technology from research communities at lab to farm communities at field level by preparing the plans right from Farm level, Village level to District level. Input wing assess the farm input requirements and handle department godowns. For better span of control and enforcement of quality control orders, this was again reorganized in 1993 by introducing subject matter specialists with key supervisory cadre, Assistant Directorate of Agriculture, for geographical agriculture sub divisions comprising 2–8 mandals. Yet 254 offices were deployed in Andhra Pradesh. Agriculture officer and Agriculture Extension Officer were appointed at Mandal level for solving village farming community problems. (source : http://agri.ap.nic.in/, Last visited Dec 2005).

necessity, the MAO and AEOs do visit farmer fields to better understand the problems. Apart from this they do routine administration work such as developing reports on input requirements, proper distribution of seeds and subsidies according to the guidelines of the state commissioner of agriculture. However, it is not that easy for an MAO assisted by two AEOs to provide need based timely advices by visiting 21 village farmers fields physically (understanding the problem for providing right advice). As pest and disease outbreaks are more or less in similar time in almost all villages, farmers need right advice from the extension department at critical stages. However current public extension systems are in a state of disarray to satisfy the information needs of farmers. In most of the cases the information needs of farmers are met by either family friends (who are not very well informed about the modern agricultural practices) or pesticide shop owners (who never bother about the welfare of farmers). A recent ICAR publication reported that expert-farmer ratio is 1:2000 and each farmer receives only 43 min. of AO time in a year. The virtual mode of extension services through contemporary ICTs and Rural Knowledge Centres would resolve some of these issues and develop alternative avenues for strengthening the existing system. In this study, an attempt has been made to conduct a study to identify the arrangements needed for proper use of ICTs and Rural Knowledge Centres (RKC) to enable effective information transfers between farmers and experts. The study results of ICT mediated Asynchronous and Synchronous mode of information transfers presented in following paragraphs.

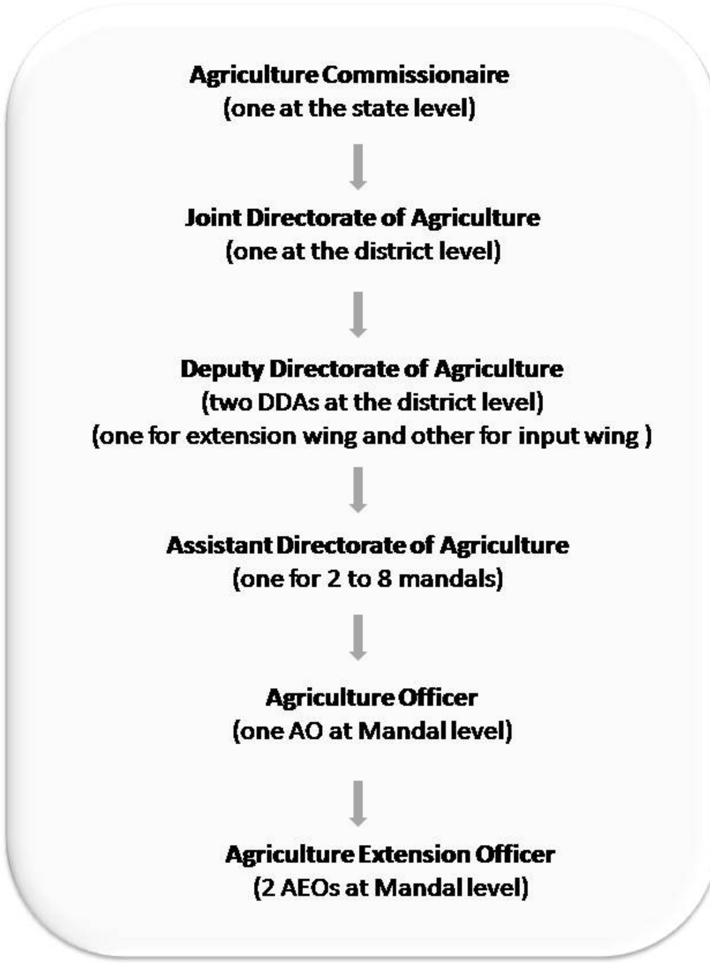


Figure 7: State Extension Department Administration structure in Andhra Pradesh

5.1.1 Case 1: Information Exchange in Asynchronous Mode

As an outset of the study, a web based content management system (Figure 8) was developed, and training was provided to the ICRISAT experts and Village Net Work Assistants (VNAs) on the use and operation of the CMS. The resources were mobilized which includes human resources (both ICRISAT experts and VNAs agreed to carry out this service for the benefit of the farm communities), available information, and records (onsite and electronic) to keep track of the farmer visits and feedback. The VNAs and Village Volunteers distributed pamphlets (Figure 9) in local language (Telugu) to bring awareness about the service in the local farm communities. The method has been defined to carry out the agro advisory service such as the VNAs either collect the questions from the farmers (or) farmers come and post their questions at RKC. The questions were transmitted through web-based content management system by VNAs for the experts' advice. The experts receive the question by accessing the web-based content management system and provide solutions on the same. The VNAs receives the answers and informs to the respective farmers; and also write down on the black board positioned outside of the RKC (Figure 10). Both the VNAs (record books maintained at RKC) and web-based content management system keep track of all the question and answers and feedback collected from the users. It was decided that the service should be open to everyone irrespective of age, sex, religion, caste and level of literacy.

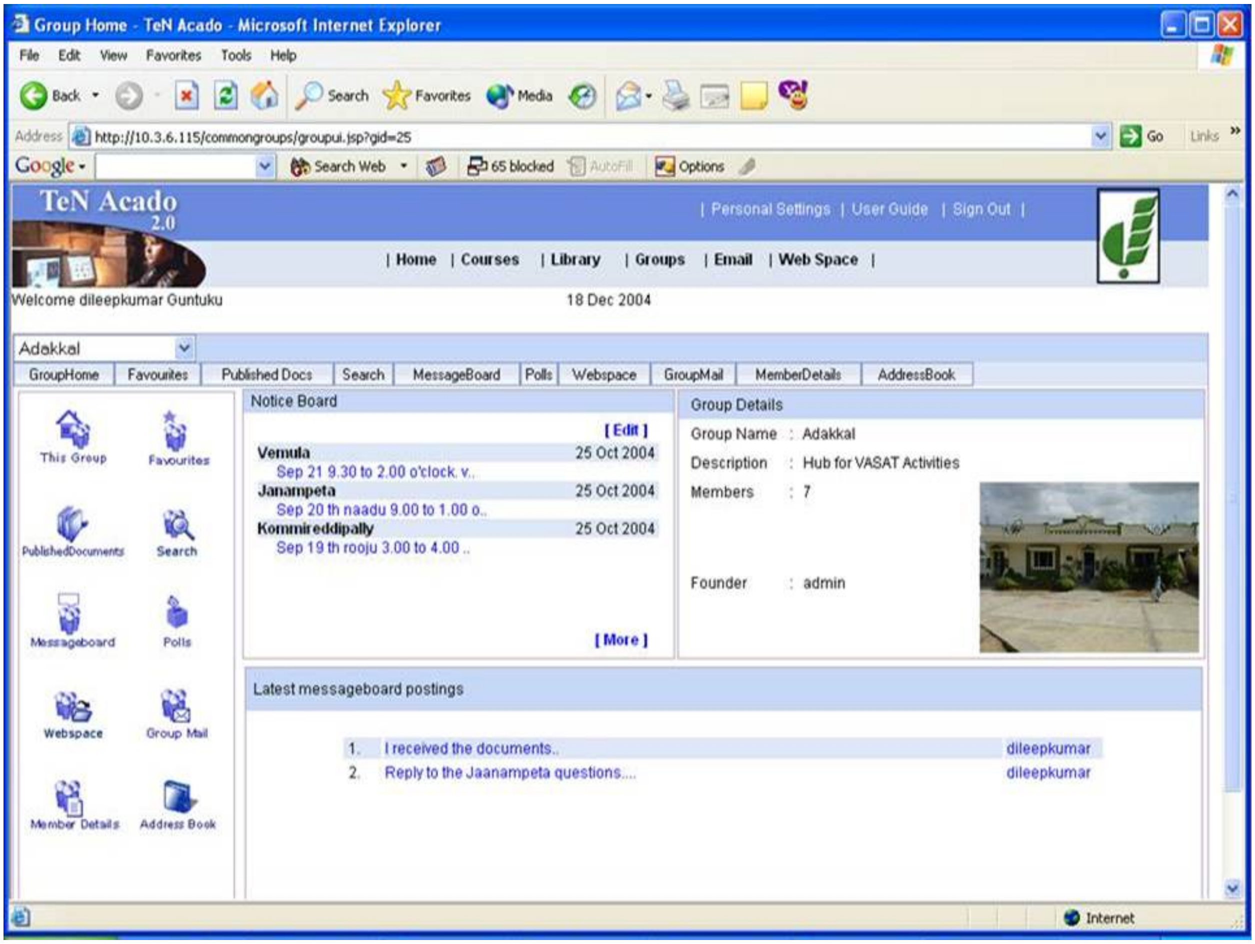
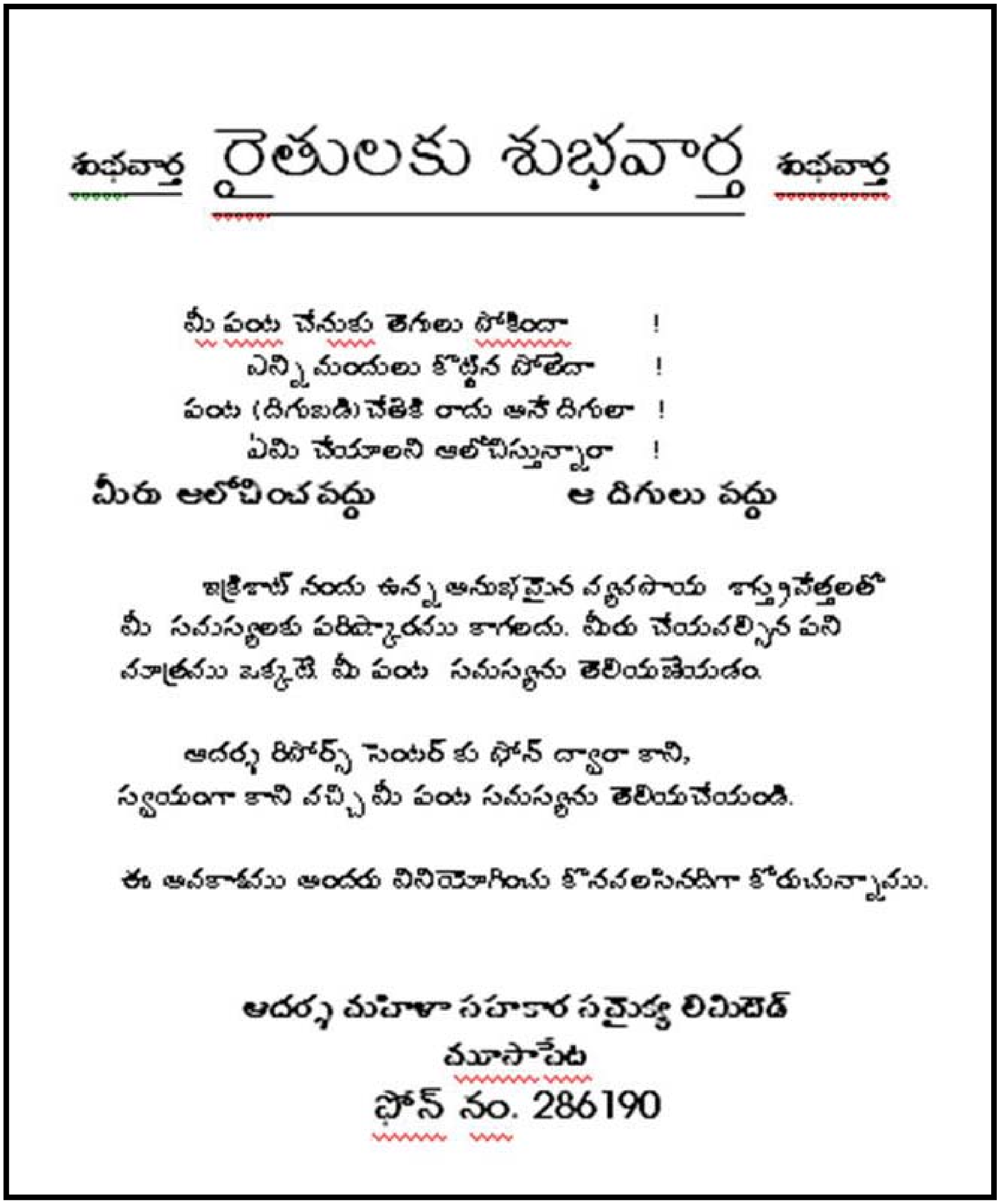


Figure 8: Web Based Content Management System



శుభవార్త రైతులకు శుభవార్త శుభవార్త

మీ పంట చేనుకు తెగులు సోకిందా !
ఎన్ని మందులు కొట్టిన పోలేదా !
పంట (దిగుబడి) చేతికి రాదు అనే దిగులా !
ఏమి చేయాలని ఆలోచిస్తున్నారా !

మీరు ఆలోచించ వద్దు ఆ దిగులు వద్దు

ఇక్రిశాట్ నందు ఉన్న అనుభవమైన వ్యవసాయ శాస్త్రవేత్తలతో మీ సమస్యలకు పరిష్కారము కాగలదు. మీరు చేయవల్సిన పని మాత్రము ఒక్కటే. మీ పంట సమస్యను తెలియజేయడం.

ఆదర్శ రిసోర్స్ సెంటర్ కు ఫోన్ ద్వారా కాని, స్వయంగా కాని వచ్చి మీ పంట సమస్యను తెలియచేయండి.

ఈ అవకాశము అందరు వినియోగించు కొనవలసినదిగా కోరుచున్నాము.

ఆదర్శ మహిళా సహకార సమైక్య లిమిటెడ్
మూసాపేట
ఫోన్ నం. 286190

Figure 9: Pamphlet distributed to bring awareness on the ICT mediated distance agro-advisory service

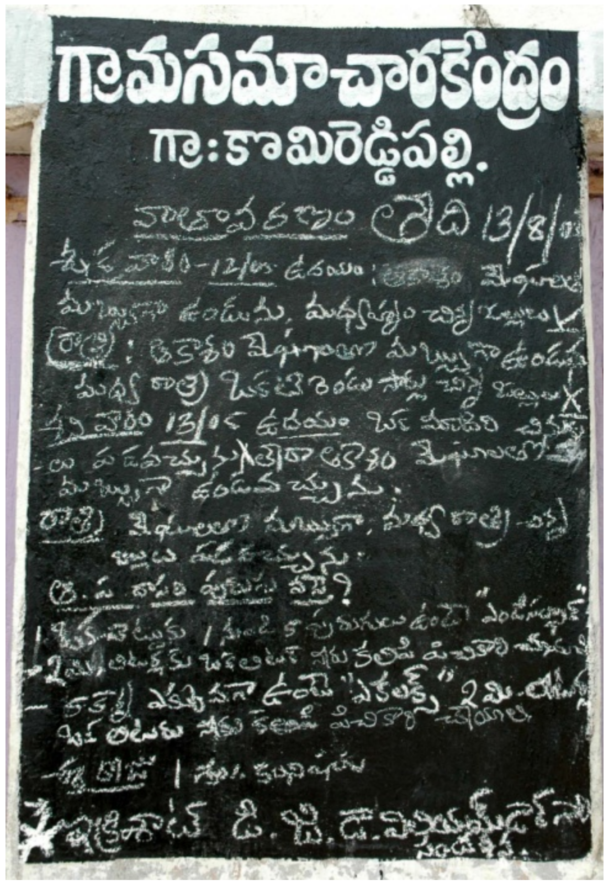


Figure 10: Blackboard for information dissemination

The first set of questions received (transliterated from Telugu to English) on 1 October 2004 and provided answers on 7 October 2004 (Table 4). The data revealed that the questions were not clear, for instance *"I have pest problem in my field"*, and the ICRISAT experts were forced to seek several clarifications from the VNAs over phone for problem diagnosis. Consequently the whole process was delayed. After analyzing these details, it was decided to train the VNAs on ICT mediated agro-advisory process. The details of the onsite training program conducted for three days are as follows:

Day One**:** The VNAs were requested to observe the process of *collection of questions – processing of questions – transmitting them to the experts*. During this process the responses were received on the same day, because the trainers have also asked questions (on the stage of the crop, previous crop, kind of problem, and period of plant's sickness) before receiving a question from the farmers. At the end of the day, the trainers have explained to the VNAs and Village Volunteers, the way the answers were received immediately, and made them clear for receiving answers to the questions posted in a distant mode should have adequate information for diagnosing the problem.

Day Two**:** The VNAs and Village Volunteers were requested to practice the Day One process for conducting the ICT mediated distant agro-advisory service. The critical observations were made during the practicing sessions, and shared with them at the end of the day. The VNAs and Village Volunteers received answers at the end of the day from the experts for the questions posted by them. They have realized the need of processing questions before sending them to the experts. During the process it was found that the processing of answers are also required at receiving end to make them more localized for effective usage.

Day three**:** The VNAs and Village Volunteers were requested to repeat the Day One process with needed correction on Day two to make them more habituated to the process.

Observations

- Most of the farmers were not able to read and write; they were not aware of the details an expert would need to diagnose a problem.
- It was observed that 80% of the questions were related to pest and disease problems (sometimes it reached to 100%), 20% were related to information about locally suitable varieties, seed availability, water scarcity issues etc.
- Prior to the training, the VNAs and Village Volunteers were transmitting the farmers' questions to experts without any value addition. For example:

  Before training: ICRISAT experts received a question 'I see flower dropping in my castor field, please advise me' from Sivaramulu, 32 years old, resident of Jaanampeta village.

  ICRISAT experts' response: *E*xpected more details to understand the problem before providing the solution, because of their concern for reliability. Most of the ICRISAT experts were not familiar with local terms (localization is a serious issue in agricultural extension, because local names vary from one location to another even within a province. Experts often used scientific names in their discussions).

  After training: The same question was repeated - 'In 3- month old castor crop in my 4-acres land, I have observed two kinds of flowers, red and green; only the red flowers turned in to fruit and the green flowers dropped, please advise me' from Shantamma, 35 years old, resident of Vemula.

Advice of ICRISAT experts: Green flowers were male flowers, after fertilization male flowers dropped, and the red female flowers turned into fruit. This is natural phenomenon and there was no need for taking up any measure.

- After the training program, the confidence levels of the VNA's have been increased, and farm communities started receiving solutions within 48 hours.
- The farm community expressed satisfaction with the service available at the RKC.

Satyanarayana Reddy, 45 years old literate but poorly informed farmer, resident of Jaanampeta village, says 'earlier we used to take the advice from the pesticide shop dealers on random mixing of the pesticides. Now with the help of this service we are able to figure out the accurate dosage. It saves money.'

Chandrakala, 30 years old, a resident of Kommireddypalli village, says 'we are happy with the service, I brought quinolphos for a pest problem in my field, and it worked. Earlier, I used to buy mono (monocrotophos), on the advice of pesticide dealer for any problem in my field. I used to get mixed results'. The experiment showed that ICT-enabled hubs would be useful in creating a para-extension worker out of a rural youth with only marginal investment. This would be valuable in a situation where the public sector extension has become weak or unavailable.

Conclusion

A number of emerging ICT mediated agricultural extension model projects consider fulfilling farmer-queries as a key service, and use variety of ICT and techno infrastructure ranging from telephone to web based interfaces to enable information exchange between farmer and expert. The findings of this study reveals that there is a need of intelligent intermediaries to make remarkable difference in farmer-expert information exchange, and adding an element of learning among the credible "info-mediaries" might lead to more effective and satisfactory (from the farmer's point of view) responses than design of interfaces on telephone or PC-based platforms.

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

Table 4: Analysis of the (questions) data collected during ICT-mediated agro-advisory process

In the experiment, it was observed that the time-to satisfactory response declined from about 6 days to less than 24 hours, going down to as low as 8 hours with the help of trained intermediaries. There is remarkable difference before and after training in refining farmers queries before passing to the experts; and refining answers from the experts before passing to the farmers routed through an online content management systems and email communication system [133]. From this study it is evident that there is a need of rural capacity development for handling the effective information and knowledge transfers and information management.

5.1.2 Case 2: Information Exchange in Synchronous Mode

In this study, a two-way video-conferencing facility (donated by the Indian Space Research Organization in association with the M S Swaminathan Research Foundation) was used to examine and observe the effectiveness of synchronous platform (no time delays with Video Conferencing) with Asynchronous platform (time delays with web based online content management system).

Infrastructure for Video Conferencing (VC) was installed at both the Addakal hub centre (AMS office) and the ICRISAT-VASAT office. The timing for video conferencing was scheduled between 1400 – 1600 hrs on the request of rural farm families. Followed by training to the AMS staff and VNAs, the study was conducted for Kharif 2005 i.e., June – November 2005. Druing the VC time the AMS staff and the ICRISAT-VASAT staff act like facilitators to enable the communication between the farmers and experts. Since it was a new experience for both experts and farmers in the initial sessions the time spent for the communication adjustments and technical adjustments were more than the time spent for agro-advisory, however, over a period of time they overcome the problem by maintaining few communication protocols, and habituated to the whole process.

Observations

- Farmers found it as good as face-to-face interaction with the experts, and they appreciated the tool as it provided them with a wider reach and better impact.
- Experts were able to examine the affected specimens displayed by farmers via video and diagnose with a fairly high degree of accuracy. They however admitted that a short training on how to interact via video would facilitate better articulation with their remote clients.
- Employing videoconferencing for facilitating farmer-experts interaction has brought out several additional benefits. The questions and answers recorded during the VC serve as high quality content. These offer excellent opportunities to develop need-based content such as FAQs on groundnut and livestock management that could be immediately distributed through CDs to all RKCs for future usage.
- The VC sessions organized with the centers located in other parts of India encouraged farmer-farmer interactions.
- The VC session organized with the then President of India, and then Chief Minister of Andhra Pradesh encouraged taking policy level decisions in favour of farming community.

Conclusion

The videoconferencing process required certain adjustments in communication habits because of high latency in connection (resulting in delay in voice reaching the destination). Except the cost factors, the VC found better than the asynchronous mode of communication for enabling effective information and knowledge transfers between and across rural communities, scientists, educators, administrators, health care providers, technology enablers for improving the agro-ecological and socio-cultural conditions of each village. Based on their experiences, experts of ICRISAT recommended that the VC is an effective tool for rural capacity building through open learning methods.

Figure 11: Farmer-Expert Communication: Synchronous Mode

5.1.3 Case 3: Video Conferencing as a tool for Rural Capacity Building

After a refreshing training to the AMS volunteers on basic computer operations, Telugu (local language) digitization, and Video Conferencing (VC) operation, virtual classes were organized from January 2006 on day to day agricultural practices and advisories on Groundnut crop (Figure 12). At the request of farming communities and the AMS volunteers (from farming community family) the classes organized from 1400 – 1600 hrs. During these sessions the women noted down the important points relevant to them. The recorded sessions CDs were provided to the volunteers. Following the virtual classes the trained rural women were organized farmers meetings in their respective villages in the evening hours and shared their notes with them. The questions from the farmers were reviewed during the sessions. Moreover the volunteers digitized the content and prepared power point slides in local language (Telugu) for future usage. The AMS volunteers, trained rural women, with higher secondary level school education and farm community background, developed locally relevant information from the ICRISAT generic learning modules on groundnut by following experimental ICT mediated open distance framework. It was observed that the learning modules were rich in locally accepted words (Figure 13), and this method was widely used in later stages by the VASAT coalition partners for generating locale specific content from a generic content pool [134], for instance Maharashtra Knowledge Corporation Limited and Pune University adopted (in Marathi Language, Local Language of the region) the ICRISAT-VASAT content and trained 30,000 rural youth.

Figure 12: ICT mediated ODL approach for Rural Capacity Building

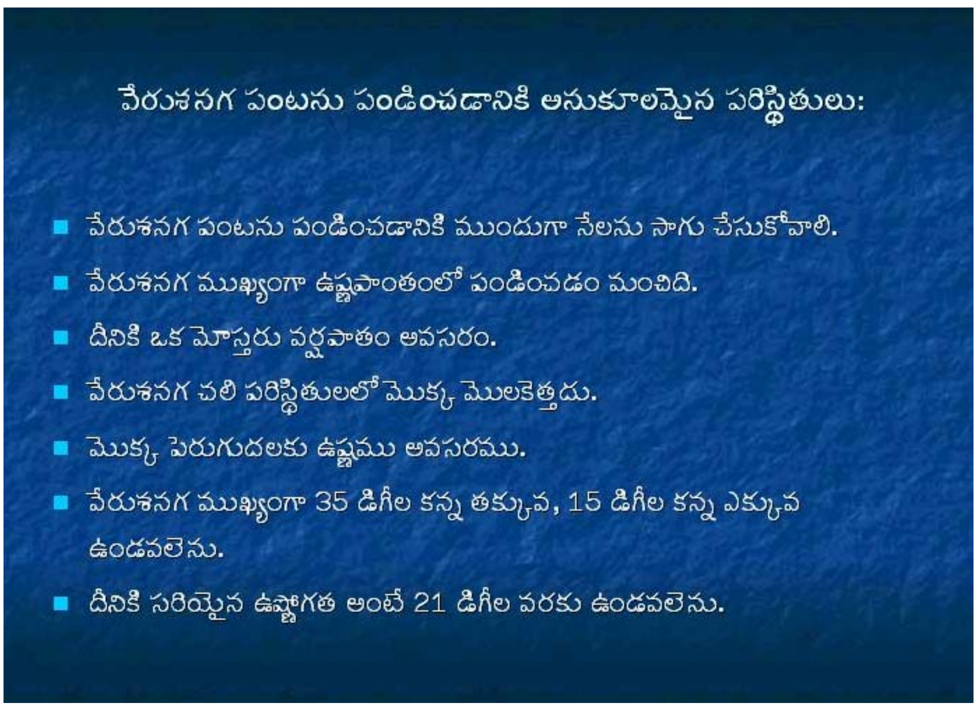


Figure 13: Content Created by Rural Women

5.2 Evaluation

An evaluation study was conducted in between July – August 2006 at the end of the season, by interviewing the rural farm families in the study area and results were presented in the following sections.

Interviews with 80 women and 60 men who underwent the ICT based training programmes showed that all of them learnt certain new dimensions in drought management. Ms. Punnyamma of Nandipet village said that she learnt that she should focus on low water requirement crops such as sorghum and millet. In the village of Janampetta, Vimalamma, the VNA, said that she learnt about crop rotation in the ICT based training programmes over video conferencing. She talked about the crop rotation in her Self Help Group meetings, which has led to large scale planting of “groundnut after paddy” as a system of crop rotation. According to her over 200 farm families in and around her village took up such crop rotations. Ms. Vimalamma has been able to obtain answer through video conferencing for queries raised by 75 farmers during last 6 months, in her village, which has around 500 households. She said that most of the farmers who approach her for solutions are small and marginal farmers who come from marginalized sections of the society. The medium and large farmers do not approach the *spokes* or *hub* as they have access to government extension officers. Thus RKC was able to have a positive bias towards small and marginal farmers who had little or no access to organized extension services, and served very well to cater to such information demand emanating from the small and marginal farmers. Similar viewpoints were presented by the VNA at Vemula who said that small and marginal farmers from the marginalized sections of the community visit her and seek solutions. The on-farm trial experiments and supply of micronutrients and biopesticides provided by the ICRISAT-VASAT project have further added value to the role of RKC and she wanted the establishment of NPV production centre in her village. The centre at Komireddypalli has been attracting small and marginal farmers numbering 30 to 40, who meet once in a week in the centre and discuss various aspects. According to the VNA, she receives 15 to 20 questions per week from the farming community in her village.

An attempt was made to build a profile of the users based on the RKC register of Janampeta and Vemula (Table 5).

Details	**Jaanampeta July 2005**	**Vemula July 2005**	**Vemula December 2005**
Number of Visitors	32	23	13
Number of Male visitors	8	3	10
Number of Female Visitors	24	20	3
Number of Small and Marginal Farmers	27	10	13
Number of Medium and Large Farmers	5	13	0

Table 5: Profile of Visitors at Rural Knowledge Centre

The data of the first month of the season and last month of the season of Janampeta and Vemula were analyzed for understanding the profiles of the user patterns. During July 2005, both

Jaanampeta and Vemula had large number of female visitors. However during December 2005, the profile changed completely at Vemula, which was visited by more males. Similarly, during July, most of the visitors to Vemula were medium and large farmers whereas the visitors during December were mainly small and marginal farmers. The discussions with the farm families in the later seasons revealed that the reason for this change is because of the changes in the cropping season. The ICT mediated Agro-advisory in both asynchronous and synchronous, rural capacity building through VC, and other services being offered at RKC won the faith of the rural families residing in the villages.

Within a short span of time, the ICT enabled RKC initiatives have created effective information flows and continuous learning cycles between experts and rural farm families; and among villagers particularly among women. Since the AMS is women federation, the hub operators and VNA (spoke) operators playing a role of facilitators and info-intermediaries.

5.2.1 VNAs as Knowledge Intermediaries and Gender Issues

AMS being a women's organization, focuses on woman as "development agent". The integration of these development agents in the predominately "male farmer's" world has resulted in certain interesting premises. When enquired whether male farmers accept their role as knowledge intermediaries the three VNAs of Jaanampeta, Vemula and Komireddypalli said that small and marginal farmers from the "lower" caste groups do not have problems in accepting women as knowledge intermediaries, since women play a major role in decision making in agriculture. On the other hand medium and large farmers belonging to “upper” castes do not respond to women as knowledge intermediaries since gender differentials are strong in these groups in agriculture decision-making. In the village of Komireddypalli, some of the farmers during discussions referred VNAs as *agricultural officers* and they said that they visit AMS to get agricultural advices.

When the video conferencing was taking place between the President of India and AMS, some of the males protested outside saying that they should have a lead role in the entire process. AMS was able to resist their demand and at the same time obtained apologies for their behavior. The introduction of the ICT in the AMS has helped to keep its accounts and financial transactions transparent. Some of the senior members of the organization have to leave the organization, when the members, through computerizing the accounts, found evidences of mismanagement.

The huge financial transactions and the control over credit have empowered these women. Their ability to face conflicts and capacity to negotiate in the political platforms has been further strengthened with the introduction of ICT enabled RKCs.

5.2.2 Institutional Linkages

The study pointed out that the AMS has established strong linkages with ICRISAT as per their agreement, however, the AMS staff and VNAs found it difficult to have linkages with Agriculture Department, Animal Husbandry Department, Commercial Banks and Agricultural University. According to ICRISAT experts, and VNAs the district administration and the local level officers of various departments have been regularly invited for various programmes. While one of the field officers claimed that he had never visited the hub at the AMS office, the VNAs showed photographs of the officer interacting with VNAs in the hub. Some of the officers felt that if ICRISAT could enter into formal agreement with their departments there would be a sustained interaction between the departments and project.

In the village of Vemula, some of the small and marginal farmers felt that agriculture department still plays a major role in the district's agriculture. However there is only one officer for the mandal who is assisted by two personnel to cover 7500 farmers in 28,000 acres. Thus, there is one extension agent per 3750 farmers covering 14,000 acres. This ratio is inadequate and even if it is assumed that these persons have less administrative responsibility and more time for extension work, it would be physically impossible to answer problems, facilitate linkages, supply inputs, distribute subsidies, convey information and act as knowledge brokers. They require support from para extension workers such as VNAs and Village Volunteers and continuous flow of information. At present they do not have access to these resources. The field officers of the Department of Agriculture agree that if their department is appropriately integrated with ICT enabled RKCs, their role as extension agents could be further strengthened.

It was observed that the input suppliers and traders are the main source of information to farmers all over India. Addakal is no exception to this practice. However, this *market influenced information* offers little scope for knowledge platform. The VNAs pointed that before the introduction of the ICT in Addakal, the farmers were the silent passive listeners to the information supplied by traders. After the introduction and interaction through ICT, the farmers have started debating with the input traders, the relevance of their information. The debates, dialogues and discourses, which are the important components of community based knowledge management, have been strengthened with the introduction of ICT enabled RKCs.

Andhra Pradesh has also been experimenting *Raitu Mitra Groups(RMG)*, an SHG movement exclusively for farmers. Though this movement is not as strong as women's SHGs, in some places RMG are playing active role. In Addakal, though there are more than 150 RMGs, only 30 RMGs are functioning. The members of RMG now and then visit the *hub and spokes* as individual farmers, but RMG as a group do not have formal linkages with the ICT enabled RKCs.

The State Agricultural Universities (SAUs) offer scope for continuous information flow and facilitate knowledge management process. There is a scope for linking the Regional Agricultural Research Station at Palem and the District Agricultural Advisory and Transfer of Technology Centre (DAATTC) of Acharya N.G.Ranga Agricultural University (ANGRAU). DAATTC usually consists of four to five scientists from the field of agronomy, entomology, extension and fisheries. This centre closely interacts with the agricultural department at the district level and facilitates the transfer of technology. It trains the departmental staff and farmers and regularly facilitates the transfer of technology after refining it to suit the local condition. This unique institutional arrangement is considered as a step towards capacity building and continuous learning among the departmental staff. In a year it conducts training covering more than 3000 officials and farmers. Exploring such relationship between the ICT enabled RKCs and these institutions would help to improve the interactions between farmers and extension officials of the State Government. Similar efforts should be made in the case of animal husbandry also.

Moreover the linkages with private sector can also contribute substantially in providing information and market linkages.

Realizing the need for such an institutional approach, ICRISAT has taken certain steps to bring various partners into consortium mode. The mission of the Consortium is to contribute to improvements in the livelihood, income and food security of farmers through provision of new generation knowledge, learning and information services, and to offer enhanced capacity strengthening and continuing education services to course developers, extension personnel, university students and rural learners.

5.3 Conclusion

Dialogues and discourses at vertical and horizontal levels are the important components of knowledge management at a community level. There are evidences that the ICT initiatives at Addakal have enlarged the canvass for dialogues and discourses particularly at vertical level. The interaction between the scientific community and the village community has been strengthened. During these interactions the villagers are able to debate about the scope and problems of new interventions. Participatory research through on-farm trials has enabled the village community to play a major role in knowledge management. The feedback from the village community has helped ICRISAT to further strengthen its research.

However, there is a need to strengthen the interaction at the horizontal level. ICRISAT [135] points out that the *peoples living in desertification-prone areas hold local technology and knowledge (TK) resources that are critical in the search for solutions. Traditional TK interacting* *with contemporary TK can help partners think 'outside the box' to come up with new practices that are appropriate to their conditions. But finding practical means for engaging such intensive, ongoing dialogue across time, distance, and cultural gaps remains a challenge.* ICT enabled RKC based initiatives of this kind can help in building ongoing dialogue across time, distance and cultural gaps. Such a process requires a stronger interaction between the community in knowledge management and consolidation of traditional knowledge.

5.4 Recommendations

In a research and development process, it is essential that the target group for whom the research is being conducted should be consulted and the feedback is integrated in the research for improving the knowledge, product or services. Many organizations do not have institutional mechanisms for completing this loop. ICT enabled RKCs offers such a platform through which scientists can test the relevance of their activities vis-à-vis the user group. In this context ICT enabled RKC strategy could serve as a strategy not only for ICRISAT but also for all other CGIAR and agricultural research institutions in addressing the "last mile problem" of lab to land programmes.

Since many countries are investing less and less resources in extension, National Agriculture Research and Extension Systems (NARES) are looking for cost effective, socially acceptable, "outcome oriented" extension system. Evolution of various extension models, as action research is important to support NARES. Hence this approach could be integrated in NARES through capacity building and policy advocacy.

Recently, CGIAR in its *Desertification, Drought, Poverty and Agriculture; Building Livelihoods, Saving Lands* has identified *Breaking Technology and Knowledge Barriers: Increasing Impact with an "ICT for Development" Strategy* as an important theme. According to the study results "the Rural Knowledge Centre strategy" has shown great promise when appropriately implemented, providing an information exchange platform that can benefit the poorest farm families in villages".

Chapter 6 Framework for Learning Content Management

6.1 Existing Scenarios

In many parts of the world, dissatisfying experience in information and knowledge services available at the Rural Knowledge Centres (RKCs) [136], have induced search for more appropriate ways to deal with the complexity of the issue. This is because, till the beginning of this decade more focus was given on providing the technological infrastructure to help people get connected, but not so much on relevant content [137]. With increasing unsatisfactory experiences, in recent years, in the implementation of information and knowledge services put the development of appropriate and locally relevant content as a major issue in the RKC projects [138], [139]. Several other studies have also pointed out the importance of locally relevant content in spreading the benefits of Information and Communication Technologies (ICTs) widely among local communities [140], [141]. As a result different technology mediated approaches were emerged for satisfying the learner needs such as delivery of content via internet, intranet/extranet, audio and videotape, satellite and CD-ROM. Such applications are called as open and distance learning approaches *i.e.*, computer-based learning, web-based learning, virtual classrooms and digital collaboration (discussed in detail in section 1.5.1).

The contemporary ICTs, specifically Multimedia, Networking, and Software Engineering have promoted the apparition of a huge amount of learning resources. However, most of these approaches are context and technology specific, which many a times demand content designers and developer to rework on the existing content again, to take little modifications, considering the users need and technical preferences. This has been viewed as an expensive and time consuming process. Hence development of content and enables it to be packaged as Reusable Learning Objects (RLOs) is carving a new path for research on reusing, and repurposing content.

It was therefore, the research work includes to develop a framework for rapid generation of locally relevant and appropriate content from a generic available Reusable Learning Objects (RLOs) pool, and its management in an affordable way at minimal required infrastructure.

6.1.1 Reusable Learning Objects

Reusable Learning Object (RLO) is a specific chunk of digitized instructional content that can be reused in many different learning content modules. According to Dahl and Nygaard [142], Learning Objects are elements of a new type computer-based instruction grounded in the object-oriented paradigm of computer science; Object-orientation highly values the creation of components (called “objects”) that can be reused in multiple contexts. Reigeluth and Nelson [143] suggest that when teachers first gain access to instructional materials, they often break the materials down into their constituent parts, and then reassemble these parts in ways that support their individual instructional goals. This is the fundamental idea behind RLOs: instructional designers can build instructional components that can be reused number of times in different learning contexts. These RLOs can be tailored according to the specific needs and deliverable over the Internet, meaning that any number of people can access and use them simultaneously. Moreover, those who incorporate learning objects can collaborate on and benefit immediately from new versions.

To facilitate the widespread adoption of the learning objects approach, the Learning Technology Standards Committee (LTSC) of the Institute of Electrical and Electronics Engineers (IEEE) formed in 1996 to develop and promote instructional technology standards [144]. Without such standards, universities, corporations, and other organizations around the world would have no way of assuring the interoperability of their instructional technologies, specifically their RLOs.

6.2 Existing Technologies and Standards

The learning technology standardization process is an active, continuously evolving process that will last for years to come, until a clear, precise, and generally accepted set of standards for educational-related systems is developed. The main contributors to this effort are the IEEE's Learning Technology Standardization Committee (LTSC) [145], the IMS Global Learning Consortium [146], the Aviation Industry CBT Committee (AICC) [147], the US Department of Defense's Advanced Distributed Learning (ADL) initiative [148], and projects Alliance of Remote Instructional Authoring and Distribution Networks for Europe (ARIADNE) [149], Getting Educational Systems Talking Across Leading Edge Technologies (GESTALT) [150], PROmoting Multimedia access to Education and Training in EUropean Society (PROMETEUS) [151], European Committee for Standardization, Information Society Standardization System, Learning Technologies Workshop (CEN/ISSS/LT) [152], Gateway to Educational Materials (GEM) [153], and Education Network Australia (EdNA) [154]. The IEEE's LTSC is the institution that is actually gathering recommendations and proposals from other learning standardization institutions and projects. Specifications that have been approved by the IEEE go through a more rigorous process to become ANSI or ISO standards.

Although many standards are available Sharable Content Object Reference Model (SCORM) specifications has been widely used. In this study SCORM specifications has been examined and adapted for developing a framework to reuse (or) repurpose learning content and its management.

6.3 Sharable Content Object Reference Model (SCORM)

Sharable Content Object Reference Model (SCORM) is a suite of technical standards and speciation given by ADL, that enable web-based learning systems to find, import, share, reuse, and export learning content in a standardized way. The purpose of SCORM is to achieve interoperability, reusability, accessibility and durability.

The SCORM is a conceptual model describing how to manage, package and deliver learning information so that it can be easily shared on the Internet. This means that if a course is packaged adhering to the SCORM, this course can be shared with other people. In addition, parts or sections of the course can be shared with other people without having dependencies on other parts of the course. According to the SCORM specifications, this is assuming that there is a SCORM implementation available and that the course to be shared has been packaged correctly.

SCORM is an initiative funded by the US military and was started with the desire to train military personnel all over the world on different platforms easily. The Department of Defence (DoD) established the Advanced Distributed Learning (ADL) initiative in 1997 to develop a DoD wide strategy for using learning and information technology to modernize education and training. They released the first version of SCORM 1.0 on 31st January 2000 named as Sharable Courseware Object Reference Model. They updated this version and released SCORM version 1.1 on 16th January 2001 and changed the name from courseware to Sharable Content Object Reference Model and they released SCORM version 1.2 on 1st October 2001 by introducing the content packaging idea. They released SCORM version 1.3 on 31st January 2004.

ADL initiative has defined high-level requirements for learning content to leverage existing practices, promote the use of technology-based learning and provide a sound economic basis for investment.

Accessibility

The ability to locate learning content in multiple locations and deliver it to multiple locations.

Interoperability

Operate across a wide variety of hardware, operating systems and web browsers.

Durability

The ability to withstand technological changes (or) do not require significant modifications with new versions of system software.

Reusability

The flexibility to deploy content in multiple applications.

The main advantage of SCORM is that it allows for sharable learning content. For example a lecturer was running a course on OpenACS and in that course was a lesson on TCL, someone else could include this section in their course on, say, scripting languages. This can be accomplished due to the strict guidelines for packaging a course, as well as the standard Run-time Environment Model across all platforms.

SCORM includes both a **Content Aggregation Model** and a **Run-time Environment Model**. The Content Aggregation Model has several parts, the content model, metadata, content packaging and a sequencing model. These parts describe the necessary contents of the learning information, how to describe it using metadata, how to package it all together and how to sequence it. The Run-time Environment Model explains how to start learning resources, the mechanism for learning resources to communicate with an LMS (Learning Management System) and the language forming the basis for communication.

6.3.1 SCORM Content Aggregation Model

The content aggregation model explains the process of creating, discovering and gathering together simple assets into complex sharable learning objects and organising those learning objects into a predefined sequence for delivery. This section gives a brief explanation of these processes, the official SCORM documentation goes into more detail.

SCORM Content Model Components

The Content Model Components are the base level parts of a course. The SCORM defines three types of content model components, Assets, SCOs and SCAs. Each of these components must be completely self sufficient in order to allow sharing ability without any other dependencies.

Asset

An Asset is the simplest form of learning content. An Asset is any file that can be delivered to a client browser, for example an image, video file, audio file or an XML document.

Sharable Content Object (SCO)

An SCO is a collection of one or more Assets that use the SCORM Run-Time Environment to communicate with a Learning Management System (LMS).

Sharable Content Asset (SCA)

The SCA is a new addition to the SCORM, it was added as a new learning object in SCORM version 1.3. Like an SCO, an SCA is a collection of Assets forming a sharable learning resource which can be launched by an LMS. The one simple difference between an SCO and an SCA is that an SCA makes no calls to a LMS via the API Adapter. This means that there is no need for the SCA to be dynamic or store any data. An SCA could be something like a lesson composed of a standard HTML page containing images.

Content Aggregation

Content Aggregation is a map which links activities together. An Activity is a collection of, or individual SCOs or SCAs (it could be a course, module, chapter, lesson etc.). An Activity can contain other Activities, which contain other Activities and so on. For example a course could contain chapters, which contain sections, which contain quizzes and lessons. A base level Activity is either an SCO or an SCA.

SCORM Meta-data Components

This section describes meta-data and explains how it is used to describe SCORM Content Model Components to allow for component searching and reuse. The official SCORM specifications give further detail on applying meta-data to learning resources. Meta-data is data about data; it provides a common way for learning resources to be described. Learning resources that have been described by meta-data can be searched for and retrieved for use and reuse. The SCORM provides guidance for applying meta-data to Assets, SCOs, SCAs, Activities and Content Aggregations. Following is a description of the different types of meta-data for each of the Content Model Components.

Asset Meta-data provides descriptive information for an Asset. This allows for search and discovery of that Asset from within repositories.

SCO and SCA Meta-data describes an SCO or SCA (being a collection of Assets) in order to allow for discoverability of that SCO or SCA from within a repository. These two types of meta-data are essentially the same due to the similarity between SCOs and SCAs.

Activity Meta-data is a new addition to the SCORM as of version 1.3. Activity Meta-data describes the Activity as a whole and is intended for discoverability of that Activity from within a repository.

Content-Aggregation Meta-data describes the structure of the Content- Aggregation as a whole. This meta-data is intended for the discoverability of Content-Aggregations from within a repository.

The SCORM Meta-data Information Model is broken up into nine categories.

1. The ***General*** category groups the general information that describes the resource as a whole.
2. The ***Lifecycle*** category groups the features related to the history and current state of this resource and those who have affected this resource during its evolution.
3. The ***Meta-metadata*** category groups information about the meta-data record itself (rather than the resource that the record describes).
4. The ***Technical*** category groups the technical requirements and characteristics of the resource.
5. The ***Educational*** category groups the educational and pedagogic characteristics of the resource.

6. The ***Right*** category groups the intellectual property rights and conditions of use for the resource.
7. The ***Relation*** category groups features that define the relationship between this resource and other targeted resources.
8. The ***Annotation*** category provides comments on the educational use of the resource and information on when and by whom the comments were created.
9. The ***Classification*** category describes where this resource falls within a particular classification system.

Content Packaging

Content Packaging defines how learning content should be packaged on disk to facilitate sharing learning resources. Basically a packaged course is stored in the form of a *.zip* file in a specific way. Each *.zip* file has to include an *IMSManifest.xml* file that explains how the whole course fits together. There are many SCOs (Sharable Content Objects) in a course; they are basically sections of a course, or lessons. Each of these SCOs needs to be completely independent, so that it can be used in other courses without having any other dependencies.

The IMSManifest file is an XML file that maps each Asset with each SCO or SCA and defines the order in which the SCOs and SCAs are to be delivered. The SCORM defines the structure of the XML file and details how the course should be packaged in order to deliver a complete learning experience.

The role of the Run-time Environment is to deliver learning content to the user in the correct order and allow the learning content to store and retrieve data. The JavaScript API is the mechanism for which the Run-time Environment (RTE) does this.

Through the API, SCOs make calls to the LMS. The LMS responds to the SCO with an appropriate response. The API adapter in this case is a Java Applet embedded in the clients' browser that facilitates this connection between the SCOs and the LMS.

Sequencing

Sequencing is the navigation between learning resources (SCOs, SCAs and Assets). The sequencing is necessary to create a desired course package by tailoring learning resources according to the predefined order. The official SCORM documentation gives a complete description affecting sequencing behaviour in a complete learning experience.

The SCORM Run-time Environment must be able to navigate between learning resources in the correct order. The content aggregation is described by the *IMSManifest.xml* file. Sequencing is more complicated than simply supplying a link from each SCO to the next SCO. The sequencing can be dynamic. If for example the user fails a quiz, they may have to go back and repeat some previous lessons and then take the quiz again. However, if they were to pass the quiz, they would have been passed to the next lesson. Criteria such as this can be stored in the *IMSManifest.xml* file and this will be converted to a content aggregation.

The SCORM Run-time Environment must provide the user with a navigation window that allows for navigation between learning resources. SCOs can also set navigation events so that the user is automatically forwarded to a specified resource after completing that SCO.

It is the Learning Management System's responsibility to perform the sequencing between learning resources. The LMS must record the location of each user within an Activity and also the Content Aggregation so that it knows what resource comes next. This is implemented by something called a sequencing engine.

6.3.2 SCORM™ Run-time Environment Model

This research work did not focus on developing the SCORM Run time environment model directly from the scratch, however the research work develops run time environment by configuring open source LMS and LCMS and test the reusability of learning resources feature with the existing commercial software suits such as Acado. However, in this section the SCORM Run-time environment is examined and discussed briefly to learn about the working mechanism. The official SCORM document gives further detail on applying meta-data to learning resources.

A SCORM compliant LMS is required to implement an API consisting of 8 Functions (Section 3.3 of the SCORM official document provides full details) that content may access to communicate with the LMS.

LMSInitialize ()

LMSFinish()

LMSGetValue()

LMSSetValue()

LMSCommit()

LMSGetLastError()

LMSGetErrorString()

LMSGetDiagnostic()

This API is implemented by what the SCORM calls an API Adapter. The API Adapter must reside in a window that is a parent window or a parent frame of the window that contains the content. This means that the LMS may launch the content either in a new window or in a frameset. The API Adapter must be an ECMAScript (JavaScript) object named "API" that is accessible though the DOM (Document Object Model). The Adapter must implement the 8 functions listed above.

All communication between the content and the LMS is handled by this adapter, thus the content author does not need to worry about communicating with the server, he/she only needs to be able to find the API Adapter and make the appropriate JavaScript calls. This separation of client and server is essential to the SCORM in that it ensures the portability of content by forcing it to run on a standard platform (the web browser).

For minimal SCORM compliance, the only thing that a piece of content needs to do is call LMSInitialize() when it starts and then call LMSFinish() when it exits. It can be that simple.

In the real-world though, we want a much richer interaction, we want to be able to report test results, track time, bookmark our last location etc. This is where the next 3 functions come in to play. The SCORM defines a data model consisting of data elements which the content can read and write to facilitate this kind of functionality (Section 3.4 of the SCORM official document provides the list of data elements). LMSGetValue() retrieves a data element from the LMS, LMSSetValue() writes a data element to the LMS and LMSCommit() is called after any values are set to ensure that the data is saved.

The other three functions allow the content to trap and intelligently deal with errors. Implementing this API in the LMS is a little more involved, it has to implement all of the API functions and support most of the SCORM data model. The tricky issue involved with implementing a SCORM compliant LMS is how to handle the browser-to-server communication. Most people choose to do this with a Java applet, but others have been successful using Flash, ActiveX controls and pure JavaScript.

LMS/LCMS for hosting and delivering the learning objects

The LMS deals with managing content (sequencing, content packaging) and users (adding users, keeping track of user variables), as well as managing all communication between the content and the users.

6.4 Proposed Framework

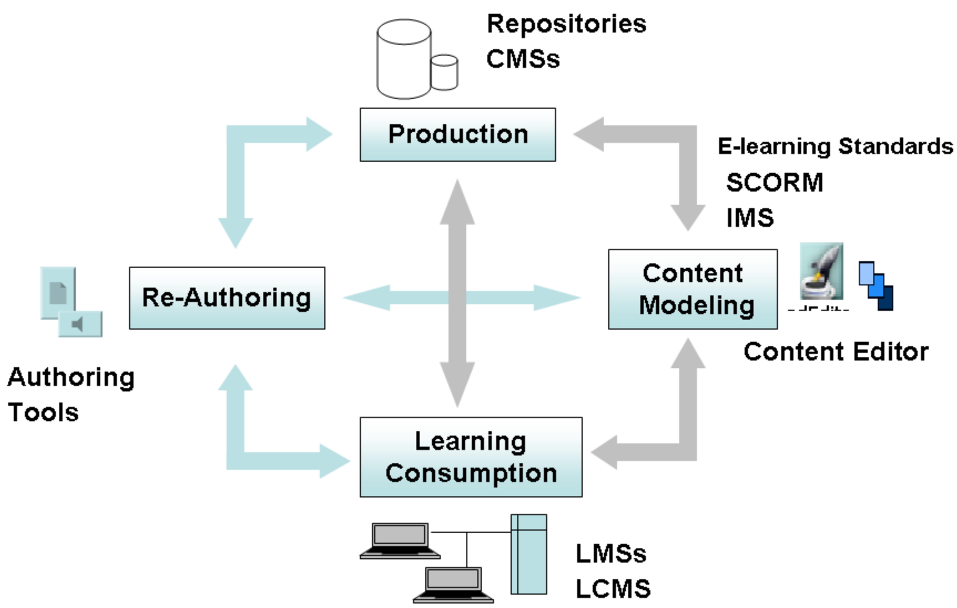


Figure 14: Framework for learning content management with RLOs

Repository: The repository, in this context, refers to a server/computer where RLOs are organized and stored. The newly created RLOs will be continuously added to this repository in an organized way. In this work, MediaWiki software (an open source software) was configured to develop wiki based content management system.

The Wiki based Content Management System (CMS) was developed at the ICRISAT-KMS department. The XAMPP (Apache Web Server with MYSQL, and PHP) open source software was downloaded from [155], and official installation procedure [156] was followed to configure the server. The MediaWiki software was downloaded from [157], and official installation procedure [158] was followed to configure the Wiki based CMS (Fig 15).

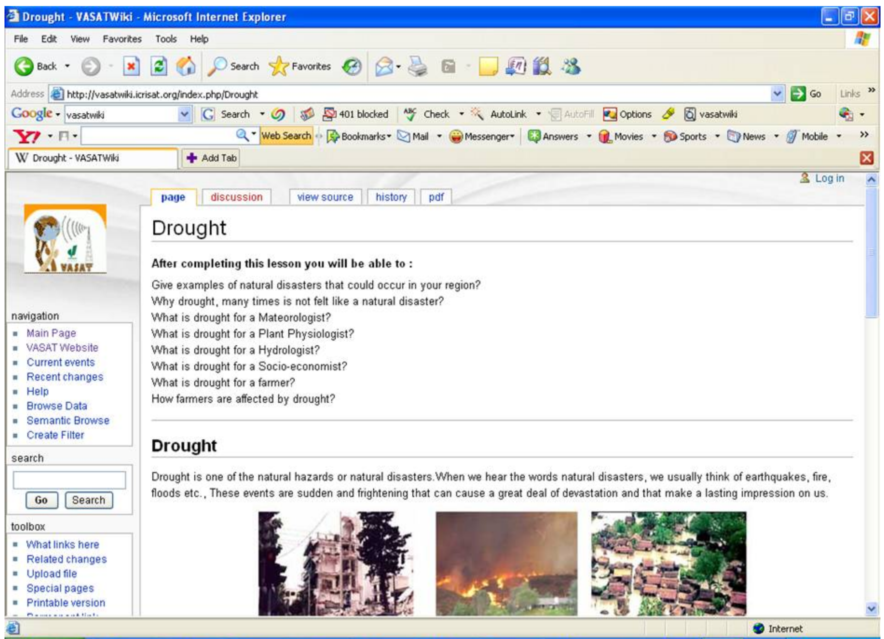


Figure 15: Customized Wiki based Content Management System as a Repository for RLOs (http://vasatwiki.icrisat.org/index.php/Drought)

Content Modelling: The customized Wiki based CMS allow users to contribute content in any technical formats. However the content needs to be validated and converted into SCORM based RLOs for repurposing, reusing and sharing across multiple locations. The entire process is known as content modeling. The SCORM learning standard specifications (discussed in section 6.3) were followed for content modeling.

Creation of RLOs An RLO could be created with the available instructional objects in the repository or by new user defined objects. In this work, the pedagogy and SCORM specifications were followed to design and development of RLOs. For instance, *Aphid* is an RLO created with simple assets (two images and text). This Aphid RLO delivers specific instruction on Aphids such as Aphid description, damage symptoms and management of aphids with images (Fig 16).

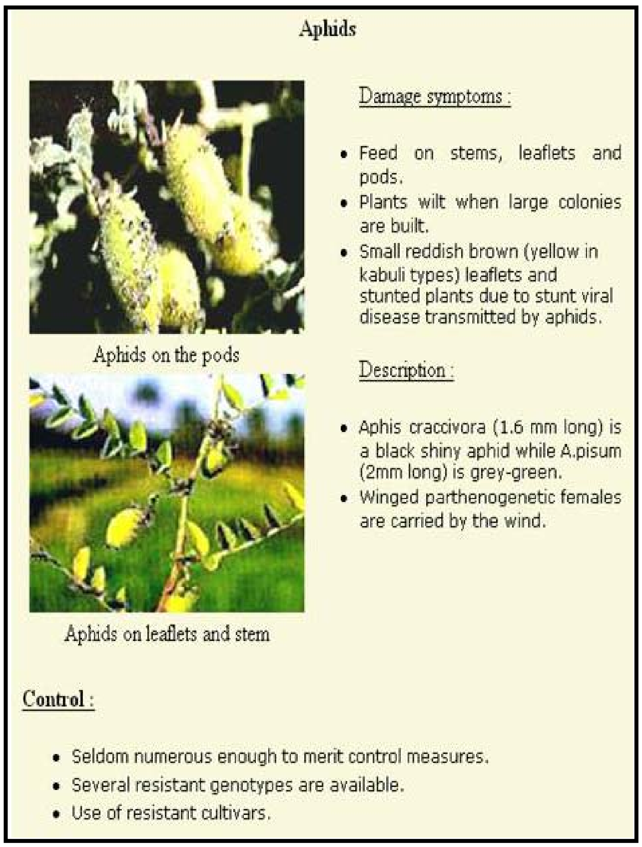


Figure 16: Aphid RLO

Linking RLOs: According to the course organization RLOs could be tailored or linked by writing a code or using any editor such as *RELOAD Editor* (Reusable Elearning Object Authoring and Delivery Editor) [159] or *eXe (*elearning XHTML editor*)* [160], to name a few.

Method 1: Customization of RLOs directly from Wiki repository (or) multiple sources

The eXe editor could be used to absorb RLOs directly from Wiki repository. The authors could search and select desired RLOs from Wiki repository and tailor them according to the need to generate a desired learning content package with needed changes. Moreover the eXe allows content from external sources as well, if required. As show in the figure the left pan of eXe has several options to accept content from Wiki and other external sources to create a desired learning content package (Fig 17).

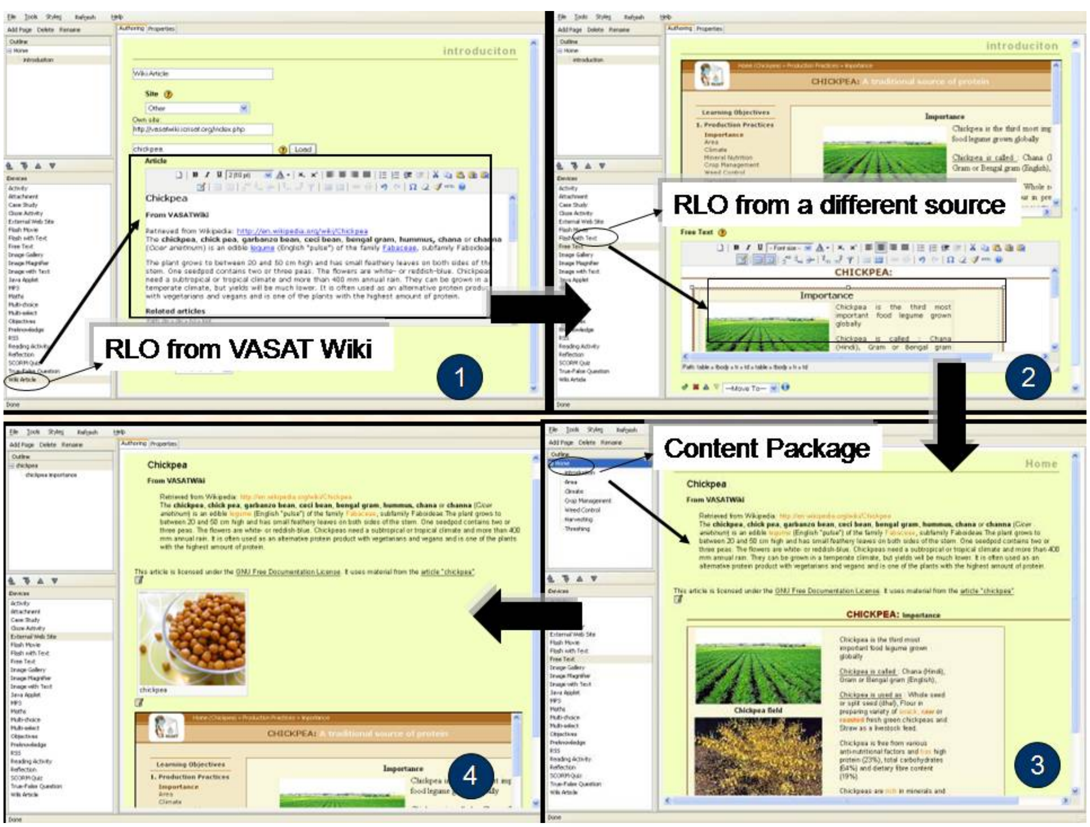


Figure 17: Customization of RLOs directly with eXe editor

Method 2: Customization of RLOs from an RLOs pool collected from Wiki repository (or) multiple sources with RELOAD editor

The RELOAD editor provides flexible platform to generate desired learning content package from an RLO pool. As shown in the figure 18, the Reload Editor has three frames (1) resource pan (left frame) (2) manifest pan (right top frame) (3) attribute pan (right bottom frame). The editor allows to open all the available resources from a repository collected from wiki and external resources. The organization could be added for a new course by right click on the organization available at manifest pan, and change the organization name according to the course title by renaming at attribute pan. The RLOs could be drag and drop from resource pan to manifest pan to create a desired learning content package (Fig. 18).

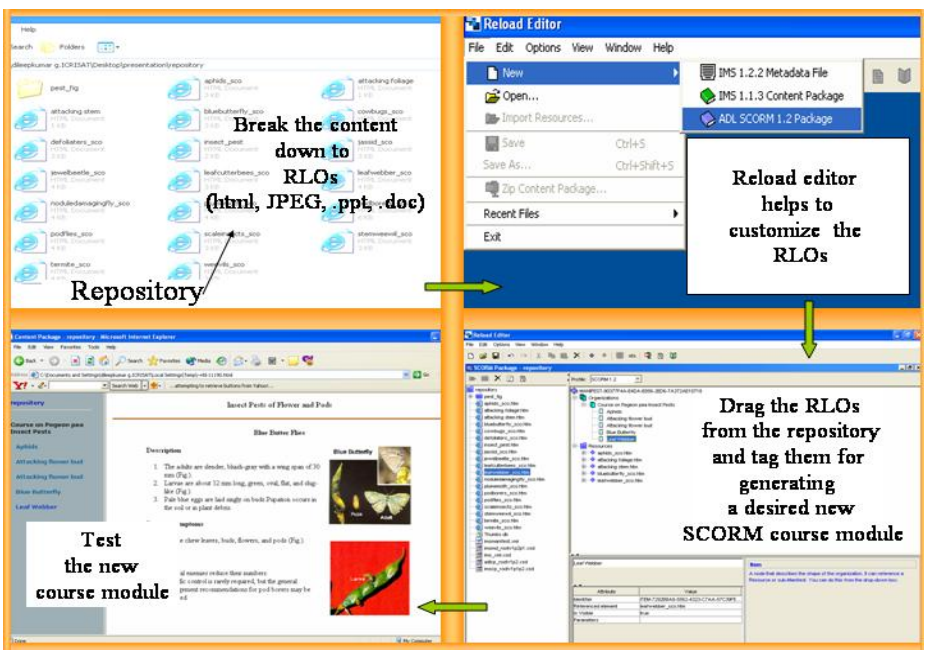


Figure 18: Customization of RLOs with Reload Editor

Learning Consumption: The SCORM compliance learning content packages could be delivered to learners by uploading them into SCORM compliance Learning Content Management Systems (LCMS), Learning Management Systems, Course Management Systems (CMS) (or) develop an API to provide RTE. The complete content package or part of the package can be playable in all the SCORM compliance LMS (or) LCMS (or) CMS.

Re-authoring: The RLOs designed with SCORM specifications lasts for several years. The RLO available in the repository could also be changed according to the need and requirements, which generates a new RLO (Fig. 19). The generation of new RLOs from the available RLOs and content authors designed new RLOs uploaded into the repository allow repository to grow continuously.

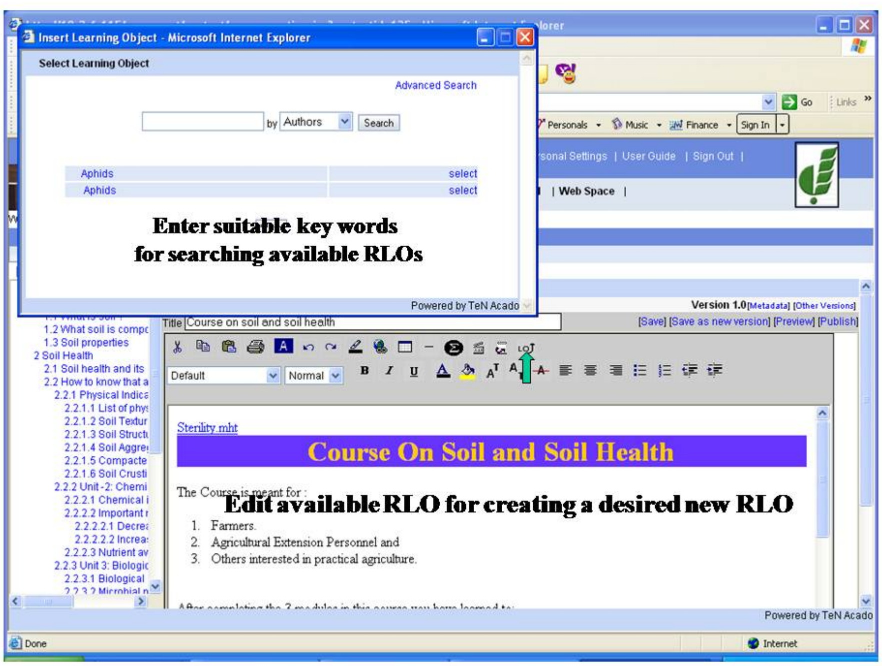


Figure 19: Creation of a new RLO from the available RLOs of repository

6.5 Evaluation

The proposed framework was tested, and usability of the framework in the real world scenarios was evaluated. Details are discussed in the following paragraphs.

The SCORM compliance learning content packages were created both on eXe and RELOAD Editor from the resources available on the Wiki RLO repository. These packages were tested on ATutor LCMS (configured an open source software, official installation document was available at [161]) (Fig. 20) and TeN ACADO CMS (configured a commercial software [162]) (Fig 21).

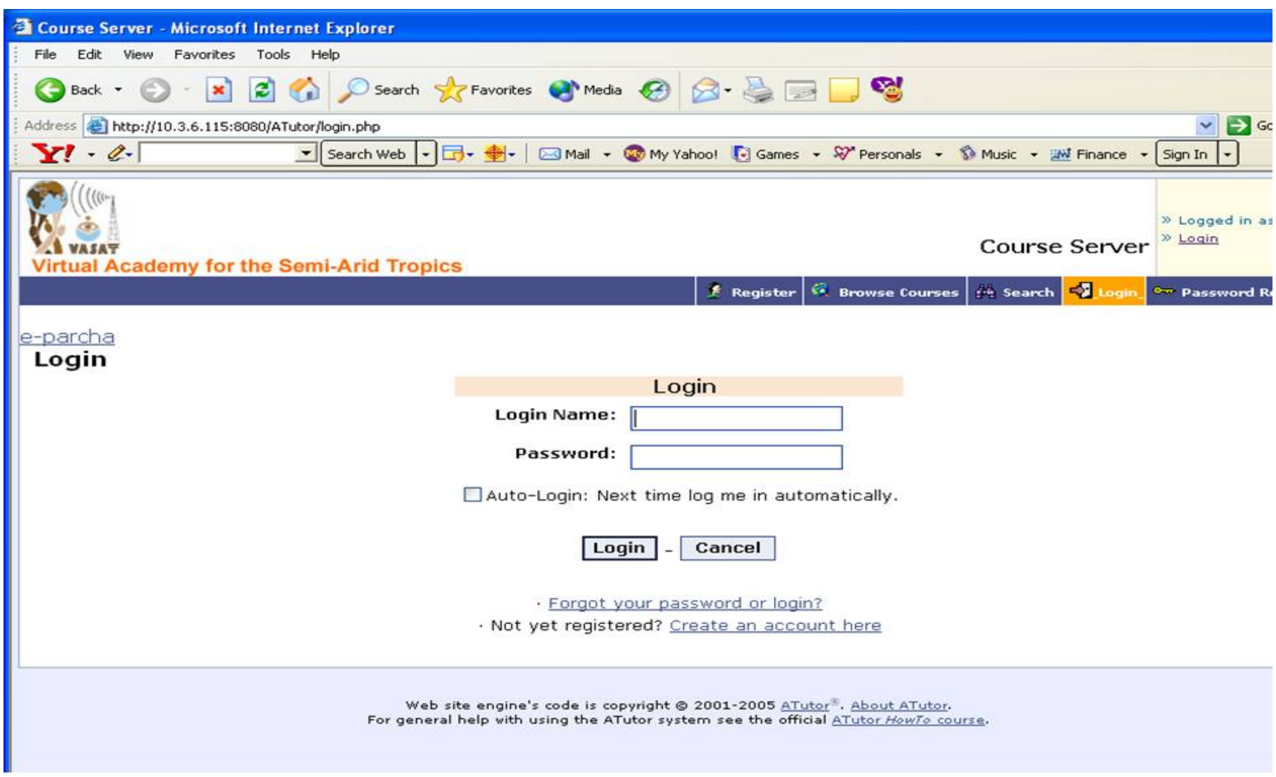


Figure 20: ATutor, A Learning Content Management System

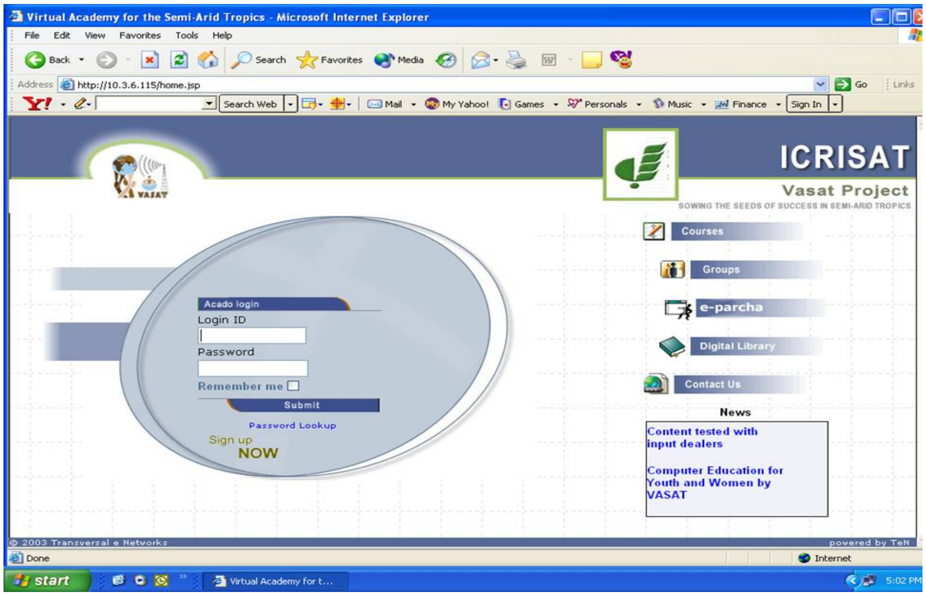


Figure 21: Acado, Course Management System

The compatibility of content packages was tested on both ATutor and Acado. The SCORM compliance RLO content packages were downloaded from ATutor and played in ACADO as a new learning content module with minor modifications. For instance, the chickpea learning content package (consists production practices, insect pests, and diseases) was downloaded from ATutor and uploaded in to ACADO for creating a chickpea insect pest course. In ACADO the production practices and diseases sections were deleted, and edited the insect pest sections to create a new course “Chickpea Insect pests”. This approach shows that the SCORM compliance content packages could be playable in any standard open source and commercial CMS (or) LMS (or) LCMS. Since the entire process took only few minutes time, the proposed framework is useful for creating relevant content rapidly by customizing the available RLOs in the repository. The ICRISAT Virtual Academy for the Semi-Arid Tropics adapted this approach for creating their electronic distance learning modules [163].

The user friendliness of the proposed framework was tested in two workshops with scientists of NIH and ICRISAT (Appendix I- 9 participants); and with State Agricultural University faculty Appendix II - 23 participants). The focus of the workshops was to give them an orientation on content packaging and development of CMS, LMS and LCMS; and hands on session to execute the proposed framework. In both the workshops, the participants were requested to take the exercises individually and in small groups. At the end of the workshop feedback was collected on their comfort levels in executing the framework. The standard instrument developed by the Knowledge Management Sharing department of ICRISAT was used to collect the feedback from the workshop participants.

6.5.1 Observations

In both the workshops, the participants expressed their ease to develop content packages with RELOAD and eXe editors, and uploading them into LMS. One scientist in workshop 1 and three faculty members of agricultural universities in workshop 2 expressed that the designing of RLOs require command on domain knowledge. A professor from Tamil Nadu Agricultural University of Coimbatore said that the techniques taught in the workshop are useful and have shown a direction to resolve content management issues what I had been facing for long time in executing open distance learning courses. Another participant stated that the proposed framework is very useful for sharing knowledge resources among agricultural universities irrespective of technology and systems what they are using.

Chapter 7 Micro-level Drought Assessment Technique

7.1 Proposed Technique

The proposed technique includes three steps (1) generation of colour coded maps (2) rainfall predictions (3) training to the village communities.

7.1.1 Generation of Colour Coded Maps

The method developed by Nagarajan and Kishore [97] was used for generating colour coded maps. According to the method, the water budgeting technique is base for estimating drought scenarios in each village. The data derived from water budgeting technique such as water availability (or) deficit is useful for generating colour coded maps.

Estimation of Surface Water Availability

Availability of surface water for each village was estimated for different rainfall scenarios (ranging from 200mm – 900mm), for which the surface area of the village (Table 6) and amount of runoff carried into the water tanks were estimated. The spatial and temporal variations of different tanks (*cheruvu in Telugu)*[16], positioned in 21 revenue villages of Addakal (study area), were assessed for finding their degradation status and feasibility of restoration. The topographic maps of 1:50000 scale (sheet no. 56 H/14 developed in 1959-60; 56 L/2 developed in 1966-67) obtained from survey of India and remote sensing data were used for executing this method. Status of degradation was assessed in terms of surface area, silt thickness, encroachments on the reservoir bed and infestation of vegetation. The Global Positioning System (GPS) was used to carry out the ground truth verification.

According to Nagarajan and Kishore [97], 30 percent of rainfall runoff is stored as surface water bodies (or) tanks. For instance, in case of 200mm rainfall the estimation of surface water availability for each village was calculated by multiplying 30 percent of the total rainfall runoff with village surface area. Based on the data, availability of water for different rainfall scenarios such as 200mm, 300mm, 400mm, 450mm, 500mm, 550mm, 600mm, 650mm, 700mm, 750mm, 800mm, 900mm was estimated (Table 12,13,14).

Estimation of Water Requirement

Water requirement scenarios for each village were estimated by calculating the human (Table 7), livestock (Table 8), and crop-irrigational requirements (Table 9, 10). Human and animal population data was collected from 2001 census and their water requirements were taken as 120 lts/day and 80 lts/animal [97]. The data on the type of crops cultivated, and cultivated area of each crop in each village was collected from Addakal Mandal Office and their water

[16] Tanks are major surface water bodies in each village

requirements were calculated [164] (Table 11). Kankapur village was eliminated from the study, since the livestock and cropping data of village was not available.

Water Balance

Water Balance of each village was done, with water budgeting, on the basis of water availability and water requirements.

Water Balance = Water Availability – Water Requirement

The Percentage of Water Balance was calculated by using below mentioned formula suggested by Nagarajan and Kishore [97] (Table 12, 13, 14). Based on the Water Balance (%) the maps were generated for different rainfall scenarios (Fig. 22-33).

$$\text{Water Balance (\%)} = \frac{\text{Water Availability} - \text{Water Requirement}}{\text{Water Availability}} \times 100$$

Village	Area in Acre	Area in sq m
Addakal	3258	13184656.85
Timmaipalli	1547	6260486.232
Kataram	973	3937590.888
Gudibanda	2651	10728215.26
Shakapur	1270	5139507.12
Rachal	4320	17482417.92
Kandur	6717	27182731.75
Ponnakal	3111	12589769.02
Nizalapur	1233	4989773.448
Dasarpalli	1173	4746962.088
Nandipet	1863	7539292.728
Komireddipalli	1846	7470496.176
Sankalmandi	2056	8320335.936
Tunkanipur	689	2788283.784
Vemula	3084	12480503.9
Timmapur	493	1995100.008
Kankapur	839	3395312.184
Polkampalli	2670	10805105.52
Janampet	3502	14172089.71
Chakrapur	2695	10906276.92
Gajulapet	2502	10125233.71

Table 6: Surface Area of the Villages in the Study Area

Village	Total Population	Water Requirement (lts/day)
Addakal	4384	526080
Timmaipalli	1418	170160
Kataram	911	109320
Gudibanda	2300	276000
Shakapur	1798	215760
Rachal	3194	383280
Kandur	4490	538800
Ponnakal	2791	334920
Nizalapur	3113	373560
Dasarpalli	1086	130320
Nandipet	1065	127800
Komireddipalli	1850	222000
Sankalmandi	3315	397800
Tunkanipur	868	104160
Vemula	3465	415800
Timmapur	1326	159120
Kankapur	186	22320
Polkampalli	2131	255720
Janampet	3519	422280
Chakrapur	1443	173160
Gajulapet	2959	355080

Table 7: Population and Human Water Requirement of Each Village

Villages	Cows	Poultry	Pigs	Dogs	Sheeps	Goats	Buffalos
Addakal	468	1210	165	110	2836	640	290
Thimmaipalli	1001	1727	0	225	320	644	102
Kataram	219	1013	32	74	996	440	76
Gudibanda	281	1040	20	57	3932	1	144
Shakapur	215	1228	34	30	1294	224	122
Rachala	386	1452	10	67	4350	264	261
Kandur	354	2429	45	52	9410	540	248
Ponnakal	238	1523	42	43	5906	149	315
Nijalpur	213	1810	0	65	2984	396	169
Dasarpalli	162	900	59	77	0	150	274
Nandipet	227	1560	9	61	3200	0	253
Kommireddypalli	162	888	26	26	40	175	205
Shankalmandi	202	2606	72	55	2888	497	226
Thunikanipur	108	756	52	35	0	215	56
Vemula	341	2188	0	105	10555	694	210
Thimmapur	120	816	0	53	0	86	55
Polkampally	261	1620	48	207	5670	212	158
Kankapur	0	0	0	0	0	0	0
Janampeta	307	664	55	48	4481	686	383
Gajulpet	387	1429	51	15	1137	427	253

Table 8: Livestock data of Addakal collected from Mandal Office, Addakal

CROP WISE AREA SHOWN PARTICULARS DURING KHARIF 2007-2008 in Acres															
VILLAGE NAME	**P**	**J**	**M**	**R**	**RG**	**CAS**	**COT**	**P_water / acre**	**J-Water / acre**	**M_water / acre**	**R_water / acre**	**RG_water / acre**	**Castor_W / Acre**	**Cotton_W / Acre**	**Total Kharif Water Requirement**
NANDIPET	120	55	24	0	25	132	4	485632.8	222581.7	97126.56	0	47561.5	240383.2464	8093.712	1101379.518
DASARPALLY	75	40	125	2	35	195	6	303520.5	161877.6	505867.5	3844.5132	66586.1	355111.614	12140.568	1408948.395
VEMULA	175	180	170	0	35	325	15	708214.5	728449.2	687979.8	0	66586.1	591852.69	30351.42	2813433.71
CHAKRAPUR	185	80	12	0	45	128	20	748683.9	323755.2	48563.28	0	85610.7	233098.9056	40468.56	1480180.546
GAJULAPET	75	95	0	0	25	90	65	303520.5	384459.3	0	0	47561.5	163897.668	131522.82	1030961.788
POLKAM PALLY	175	42	23	0	15	70	63	708214.5	169971.48	93079.62	0	28536.9	127475.964	127475.96	1254754.428
THIMMAPUR	150	15	0	0	35	30	25	607041	60704.1	0	0	66586.1	54632.556	50585.7	839549.456
JANAMPET	205	45	15	3	25	175	5	829622.7	182112.3	60704.1	5766.7698	47561.5	318689.91	10117.14	1454574.42
THUNIKINIPUR	35	32	14	0	15	85	0	141642.9	129502.08	56657.16	0	28536.9	154792.242	0	511131.282
SANKAL MADHI	52	5	13	0	35	250	4	210440.88	20234.7	52610.22	0	66586.1	455271.3	8093.712	813236.912
NAIJALAPUR	595	0	0	0	5	4	15	2407929.3	0	0	0	9512.3	7284.3408	30351.42	2455077.361
KOMI REDDY PALLY	105	10	0	0	12	45	0	424928.7	40469.4	0	0	22829.52	81948.834	0	570176.454
PONNAKAL	275	55	13	2	35	290	20	1112908.5	222581.7	52610.22	3844.5132	66586.1	528114.708	40468.56	2027114.301
RACHALA	343	45	0	0	86	475	15	1388100.4	182112.3	0	0	163611.56	865015.47	30351.42	2629191.17
GUDIBANDA	105	45	18	5	25	350	4	424928.7	182112.3	72844.92	9611.283	47561.5	637379.82	8093.712	1382532.235
SHAKAPUR	35	35	16	10	25	123	10	141642.9	141642.9	64751.04	19222.566	47561.5	223993.4796	20234.28	659048.6656
KANDOOR	335	40	79	4	35	235	8	1355724.9	161877.6	319708.26	7689.0264	66586.1	427955.022	16187.424	2355728.332
THIMAI PALLY	35	75	40	2	20	315	25	141642.9	303520.5	161877.6	3844.5132	38049.2	573641.838	50585.7	1273162.251
KATAVARAM	28	25	10	0	10	35	0	113314.32	101173.5	40469.4	0	19024.6	63737.982	0	337719.802
ADDAKAL	82	42	15	2	15	205	0	331849.08	169971.48	60704.1	3844.5132	28536.9	373322.466	0	968228.5392

Table 9: Total Kharif Crop Water Requirement for each village (P-Paddy; J-Jowar; M-Maize; R-Ragi; Red Gram; Castor, C-Cotton)

ILLAGE NAME	PADDY	G.NUT	RAGI	ONION	VEGITABLES	P_W / Acre	G_W / Acre	R_W / Acre	O_W / Acre	V_W / Acre	Total Rabi Water Requirement
NANDIPET	32	92	0	3	0	129502.08	174989.52	0	4248	0	308739.6
DASARPALLY	35	120	4	3	0	141642.9	228247.2	7689.024	4248	0	381827.124
VEMULA	225	320	5	16	15	910561.5	608659.2	9611.28	22656	60704.1	1612192.08
CHAKRAPUR	63	187	0	4	3	254957.22	355685.22	0	5664	12140.82	628447.26
GAJULAPET	43	28	0	3	15	174018.42	53257.68	0	4248	60704.1	292228.2
POLKAM PALLY	120	50	30	3	2	485632.8	95103	57667.68	4248	8093.88	650745.36
THIMMAPUR	30	10	4	2	2	121408.2	19020.6	7689.024	2832	8093.88	159043.704
JANAMPET	210	185	0	6	5	849857.4	351881.1	0	8496	20234.7	1230469.2
THUNIKINIPUR	30	80	0	5	4	121408.2	152164.8	0	7080	16187.76	296840.76
SANKAL MADHI	30	55	0	6	5	121408.2	104613.3	0	8496	20234.7	254752.2
NAIJALAPUR	62	10	2	2	0	250910.28	19020.6	3844.512	2832	0	276607.392
KOMI REDDY PALLY	72	83	0	5	0	291379.68	157870.98	0	7080	0	456330.66
PONNAKAL	75	110	8	3	3	303520.5	209226.6	15378.05	4248	12140.82	544513.968
RACHALA	92	135	0	2	3	372318.48	256778.1	0	2832	12140.82	644069.4
GUDIBANDA	80	120	4	3	2	323755.2	228247.2	7689.024	4248	8093.88	572033.304
SHAKAPUR	15	20	2	2	0	60704.1	38041.2	3844.512	2832	0	105421.812
KANDOOR	205	313	4	10	5	829622.7	595344.78	7689.024	14160	20234.7	1467051.204
THIMAI PALLY	110	230	4	4	3	445163.4	437473.8	7689.024	5664	12140.82	908131.044
KATAVARAM	2	25	0	0	0	8093.88	47551.5	0	0	0	55645.38
ADDAKAL	80	120	4	4	3	323755.2	228247.2	7689.024	5664	12140.82	577496.244

Table 10: Total Rabi Crop Water Requirement

Name	Water requirement in m3		Total Water Requirement
	Human & Livestock	Crops	
Addakal	243575.1945	1545724.783	1789299.978
Timmaipalli	106744.4362	2181293.295	2288037.731
Kataram	56737.12935	393365.182	450102.3114
Gudibanda	132793.3145	1954565.539	2087358.854
Shakapur	100930.4351	764470.4776	865400.9127
Rachal	184435.6899	3273260.57	3457696.26
Kandur	256358.8341	3822779.536	4079138.37
Ponnakal	164922.1074	2571628.269	2736550.377
Nizalapur	169473.5515	2731684.753	2901158.304
Dasarpalli	67193.8355	1790775.519	1857969.355
Nandipet	73590.935	1410119.118	1483710.053
Komireddipalli	101681.2401	1026507.114	1128188.354
Sankalmandi	181053.9357	1067989.112	1249043.048
Tunkanipur	47932.9972	807972.042	855905.0392
Vemula	207835.4311	4425625.79	4633461.221
Timmapur	66420.8677	998593.16	1065014.028
Kankapur	NA	NA	NA
Polkampalli	128846.168	1905499.788	2034345.956
Janampet	202601.3968	2685043.62	2887645.017
Chakrapur	87547.19545	2108627.806	2196175.001
Gajulapet	166823.5311	1323189.988	1490013.519

Table 11: Total Water Requirement for Human, Livestock and Crops of each village

Village	Available water for different rainfall				Water Requirement	Water Balance				Water balance in percent			
	200mm	300mm	400mm	500mm		200mm	300mm	400mm	500mm	200mm	300mm	400mm	500mm
Addakal	527386.3	791079.4	1054773	1318466	1789300	-1261914	-998221	-734527	-470834	-239.277	-126.185	-69.6385	-35.7108
Timmaipalli	250419.4	375629.2	500838.9	626048.6	2288038	-2037618	-1912409	-1787199	-1661989	-813.682	-509.121	-356.841	-265.473
Kataram	157503.6	236255.5	315007.3	393759.1	450102.3	-292599	-213847	-135095	-56343.2	-185.773	-90.5151	-42.8863	-14.3091
Gudibanda	429128.6	643692.9	858257.2	1072822	2087359	-1658230	-1443666	-1229102	-1014537	-386.418	-224.279	-143.209	-94.5672
Shakapur	205580.3	308370.4	411160.6	513950.7	865400.9	-659821	-557030	-454240	-351450	-320.955	-180.637	-110.478	-68.3821
Rachal	699296.7	1048945	1398593	1748242	3457696	-2758400	-2408751	-2059103	-1709454	-394.453	-229.636	-147.227	-97.7814
Kandur	1087309	1630964	2174619	2718273	4079138	-2991829	-2448174	-1904520	-1360865	-275.159	-150.106	-87.5795	-50.0636
Ponnakal	503590.8	755386.1	1007182	1258977	2736550	-2232960	-1981164	-1729369	-1477573	-443.408	-262.272	-171.704	-117.363
Nizalapur	199590.9	299386.4	399181.9	498977.3	2901158	-2701567	-2601772	-2501976	-2402181	-1353.55	-869.035	-626.776	-481.421
Dasarpalli	189878.5	284817.7	379757	474696.2	1857969	-1668091	-1573152	-1478212	-1383273	-878.504	-552.336	-389.252	-291.402
Nandipet	301571.7	452357.6	603143.4	753929.3	1483710	-1182138	-1031352	-880567	-729781	-391.992	-227.995	-145.996	-96.797
Komireddipalli	298819.8	448229.8	597639.7	747049.6	1128188	-829369	-679959	-530549	-381139	-277.548	-151.699	-88.774	-51.0192
Sankalmandi	332813.4	499220.2	665626.9	832033.6	1249043	-916230	-749823	-583416	-417009	-275.298	-150.199	-87.6491	-50.1193
Tunkanipur	111531.4	167297	223062.7	278828.4	855905	-744374	-688608	-632842	-577077	-667.412	-411.608	-283.706	-206.965
Vemula	499220.2	748830.2	998440.3	1248050	4633461	-4134241	-3884631	-3635021	-3385411	-828.14	-518.76	-364.07	-271.256
Timmapur	79804	119706	159608	199510	1065014	-985210	-945308	-905406	-865504	-1234.54	-789.691	-567.269	-433.815
Kankapur	135812.5	203718.7	271625	339531.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polkampalli	432204.2	648306.3	864408.4	1080511	2034346	-1602142	-1386040	-1169938	-953835	-370.691	-213.794	-135.345	-88.2764
Janampet	566883.6	850325.4	1133767	1417209	2887645	-2320761	-2037320	-1753878	-1470436	-409.389	-239.593	-154.695	-103.756
Chakrapur	436251.1	654376.6	872502.2	1090628	2196175	-1759924	-1541798	-1323673	-1105547	-403.42	-235.613	-151.71	-101.368
Gajulapet	405009.3	607514	810018.7	1012523	1490014	-1085004	-882499	-679995	-477490	-267.896	-145.264	-83.948	-47.1584

Table 12: Water Budgeting to Estimate Water Balance for 200 mm, 300mm, 400 mm, 500 mm Rainfall Scenarios

Village	Available water for different rainfall				Water Requirement	Water Balance				Water balance in percent			
	600mm	700mm	800mm	900mm		600mm	700mm	800mm	900mm	600mm	700mm	800mm	900mm
Addakal	1582159	1845852	2109545	2373238	1789300	-207141	56551.98	320245.1	583938.3	-13.0923	3.063733	15.18077	24.60513
Timmaipalli	751258.3	876468.1	1001678	1126888	2288038	-1536779	-1411570	-1286360	-1161150	-204.561	-161.052	-128.421	-103.04
Kataram	472510.9	551262.7	630014.5	708766.4	450102.3	22408.6	101160.4	179912.2	258664	4.74245	18.35067	28.55684	36.49497
Gudibanda	1287386	1501950	1716514	1931079	2087359	-799973	-585409	-370844	-156280	-62.1393	-38.9766	-21.6045	-8.09289
Shakapur	616740.9	719531	822321.1	925111.3	865400.9	-248660	-145870	-43079.8	59710.37	-40.3184	-20.2729	-5.2388	6.454399
Rachal	2097890	2447539	2797187	3146835	3457696	-1359806	-1010158	-660509	-310861	-64.8178	-41.2724	-23.6133	-9.87853
Kandur	3261928	3805582	4349237	4892892	4079138	-817211	-273556	270098.7	813753.3	-25.053	-7.18828	6.210255	16.63134
Ponnakal	1510772	1762568	2014363	2266158	2736550	-1225778	-973983	-722187	-470392	-81.1359	-55.2593	-35.8519	-20.7572
Nizalapur	598772.8	698568.3	798363.8	898159.2	2901158	-2302385	-2202590	-2102795	-2002999	-384.517	-315.301	-263.388	-223.012
Dasarpalli	569635.5	664574.7	759513.9	854453.2	1857969	-1288334	-1193395	-1098455	-1003516	-226.168	-179.573	-144.626	-117.445
Nandipet	904715.1	1055501	1206287	1357073	1483710	-578995	-428209	-277423	-126637	-63.9975	-40.5693	-22.9981	-9.33166
Komireddipalli	896459.5	1045869	1195279	1344689	1128188	-231729	-82318.9	67091.03	216501	-25.8493	-7.87086	5.613	16.10044
Sankalmandi	998440.3	1164847	1331254	1497660	1249043	-250603	-84196	82210.7	248617.4	-25.0994	-7.22807	6.175434	16.60039
Tunkanipur	334594.1	390359.7	446125.4	501891.1	855905	-521311	-465545	-409780	-354014	-155.804	-119.261	-91.853	-70.536
Vemula	1497660	1747271	1996881	2246491	4633461	-3135801	-2886191	-2636581	-2386971	-209.38	-165.183	-132.035	-106.253
Timmapur	239412	279314	319216	359118	1065014	-825602	-785700	-745798	-705896	-344.846	-281.296	-233.634	-196.564
Kankapur	407437.5	475343.7	543249.9	611156.2	NA	NA	NA	NA	NA	NA	NA	NA	NA
Polkampalli	1296613	1512715	1728817	1944919	2034346	-737733	-521631	-305529	-89427	-56.897	-34.4831	-17.6727	-4.59798
Janampet	1700651	1984093	2267534	2550976	2887645	-1186994	-903552	-620111	-336669	-69.7965	-45.5398	-27.3474	-13.1976
Chakrapur	1308753	1526879	1745004	1963130	2196175	-887422	-669296	-451171	-233045	-67.8067	-43.8343	-25.855	-11.8711
Gajulapet	1215028	1417533	1620037	1822542	1490014	-274985	-72480.8	130023.9	332528.5	-22.632	-5.11317	8.02598	18.24532

Table 13: Water Budgeting to Estimate Water Balance for 600 mm, 700mm, 800 mm, 900 mm Rainfall Scenarios

Village	Water Requirement	Water Availability				water balance				Water balance in percent			
		350mm –t	450mm -t	550mm -t	650mm -t	350	450	550	650	350	450	550	650
Addakal	1789299.978	1384389	1779928.7	2175468.4	2571008.1	-404911.01	-9371.3032	386168.4	781708.11	-29.248356	-0.5264988	17.751046	30.404732
Timmaipalli	2288037.731	657351.05	845165.64	1032980.2	1220794.8	-1630686.7	-1442872.1	-1255057.5	-1067242.9	-248.06938	-170.72063	-121.4987	-87.42197
Kataram	450102.3114	413447.04	531574.77	649702.5	767830.22	-36655.268	81472.459	199600.19	317727.91	-8.865771	15.326623	30.721782	41.379969
Gudibanda	2087358.854	1126462.6	1448309.1	1770155.5	2092002	-960896.25	-639049.79	-317203.34	4643.1214	-85.3021	-44.123855	-17.919518	0.2219463
Shakapur	865400.9127	539648.25	693833.46	848018.67	1002203.9	-325752.67	-171567.45	-17382.238	136802.98	-60.363888	-24.727469	-2.0497471	13.650214
Rachal	3457696.26	1835653.9	2360126.4	2884599	3409071.5	-1622042.4	-1097569.8	-573097.3	-48624.765	-88.363193	-46.504706	-19.867486	-1.426335
Kandur	4079138.37	2854186.8	3669668.8	4485150.7	5300632.7	-1224951.5	-409469.58	406012.37	1221494.3	-42.917707	-11.158216	9.0523684	23.044312
Ponnakal	2736550.377	1321925.7	1699618.8	2077311.9	2455005	-1414624.6	-1036931.6	-659238.49	-281545.42	-107.01241	-61.009654	-31.735171	-11.46822
Nizalapur	2901158.304	523926.21	673619.42	823312.62	973005.82	-2377232.1	-2227538.9	-2077845.7	-1928152.5	-453.73414	-330.68211	-252.37627	-198.1645
Dasarpalli	1857969.355	498431.02	640839.88	783248.74	925657.61	-1359538.3	-1217129.5	-1074720.6	-932311.75	-272.76359	-189.92724	-137.21319	-100.7189
Nandipet	1483710.053	791625.74	1017804.5	1243983.3	1470162.1	-692084.32	-465905.54	-239726.75	-13547.971	-87.425697	-45.775542	-19.270898	-0.921529
Komireddipalli	1128188.354	784402.1	1008517	1232631.9	1456746.8	-343786.26	-119671.37	104443.51	328558.4	-43.827809	-11.866074	8.4732123	22.554257
Sankalmandi	1249043.048	873635.27	1123245.4	1372855.4	1622465.5	-375407.77	-125797.7	123812.38	373422.46	-42.970767	-11.199485	9.0186031	23.015741
Tunkanipur	855905.0392	292769.8	376418.31	460066.82	543715.34	-563135.24	-479486.73	-395838.21	-312189.7	-192.34745	-127.38135	-86.039287	-57.41786
Vemula	4633461.221	1310452.9	1684868	2059283.1	2433698.3	-3323008.3	-2948593.2	-2574178.1	-2199763	-253.57709	-175.0044	-125.0036	-90.38766
Timmapur	1065014.028	209485.5	269338.5	329191.5	389044.5	-855528.53	-795675.53	-735822.53	-675969.53	-408.3951	-295.41841	-223.52416	-173.7512
Kankapur	NA	356507.78	458367.14	560226.51	662085.88	NA	NA	NA	NA	NA	NA	NA	NA
Polkampalli	2034345.956	1134536.1	1458689.2	1782842.4	2106995.6	-899809.88	-575656.71	-251503.55	72649.62	-79.310821	-39.463972	-14.106886	3.4480196
Janampet	2887645.017	1488069.4	1913232.1	2338394.8	2763557.5	-1399575.6	-974412.91	-549250.21	-124087.52	-94.053112	-50.930198	-23.488344	-4.490137
Chakrapur	2196175.001	1145159.1	1472347.4	1799535.7	2126724	-1051015.9	-723827.62	-396639.31	-69451.002	-91.779033	-49.16147	-22.041203	-3.265633
Gajulapet	1490013.519	1063149.5	1366906.6	1670663.6	1974420.6	-426863.98	-123106.97	180650.04	484407.05	-40.150888	-9.0062461	10.813071	24.534137

Table 14: Water Budgeting to Estimate Water Balance for 350 mm, 450mm, 550 mm, 650 mm Rainfall Scenarios

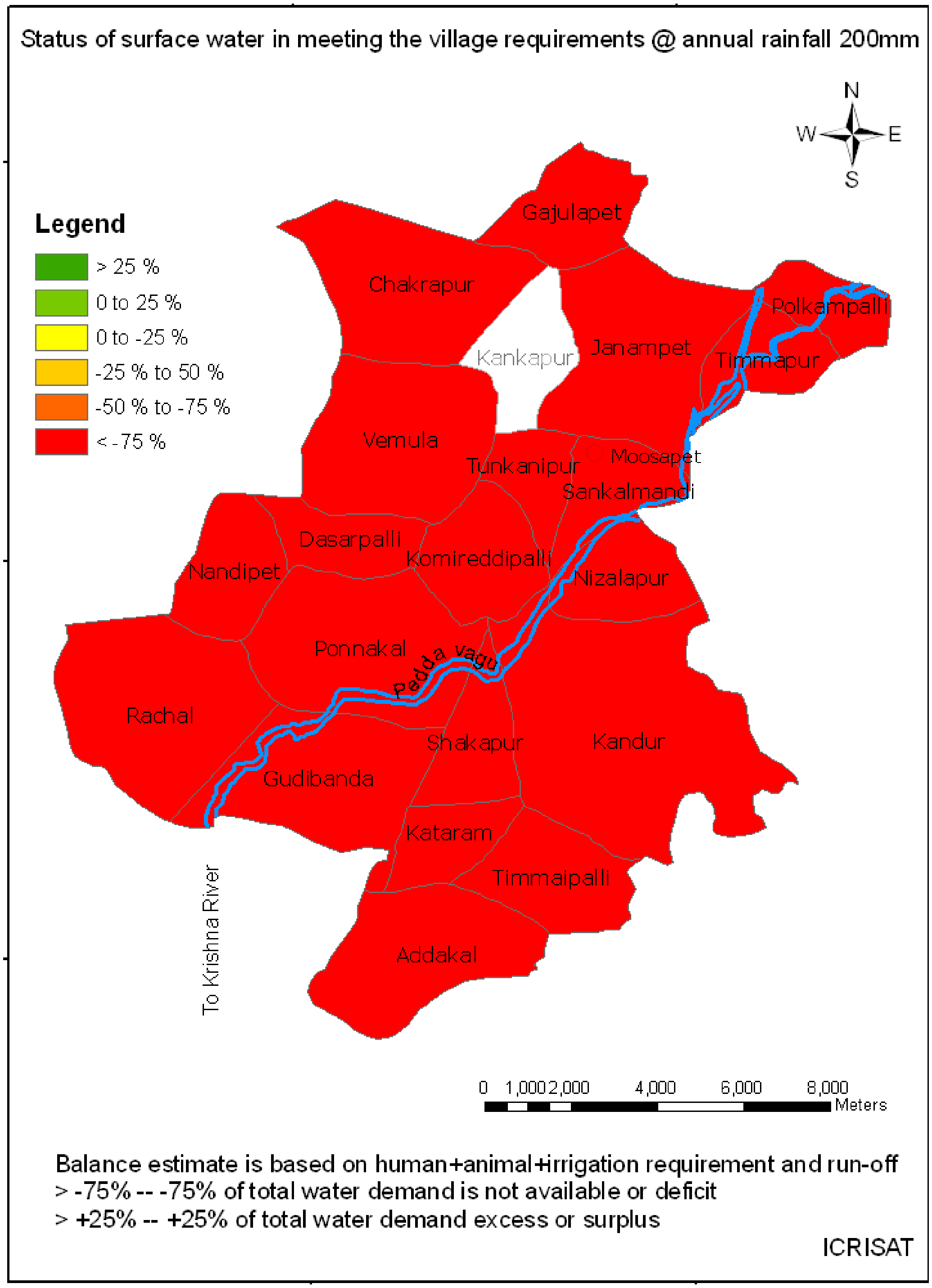


Figure 22: Colour coded map for micro-level drought vulnerability assessment @ 200mm

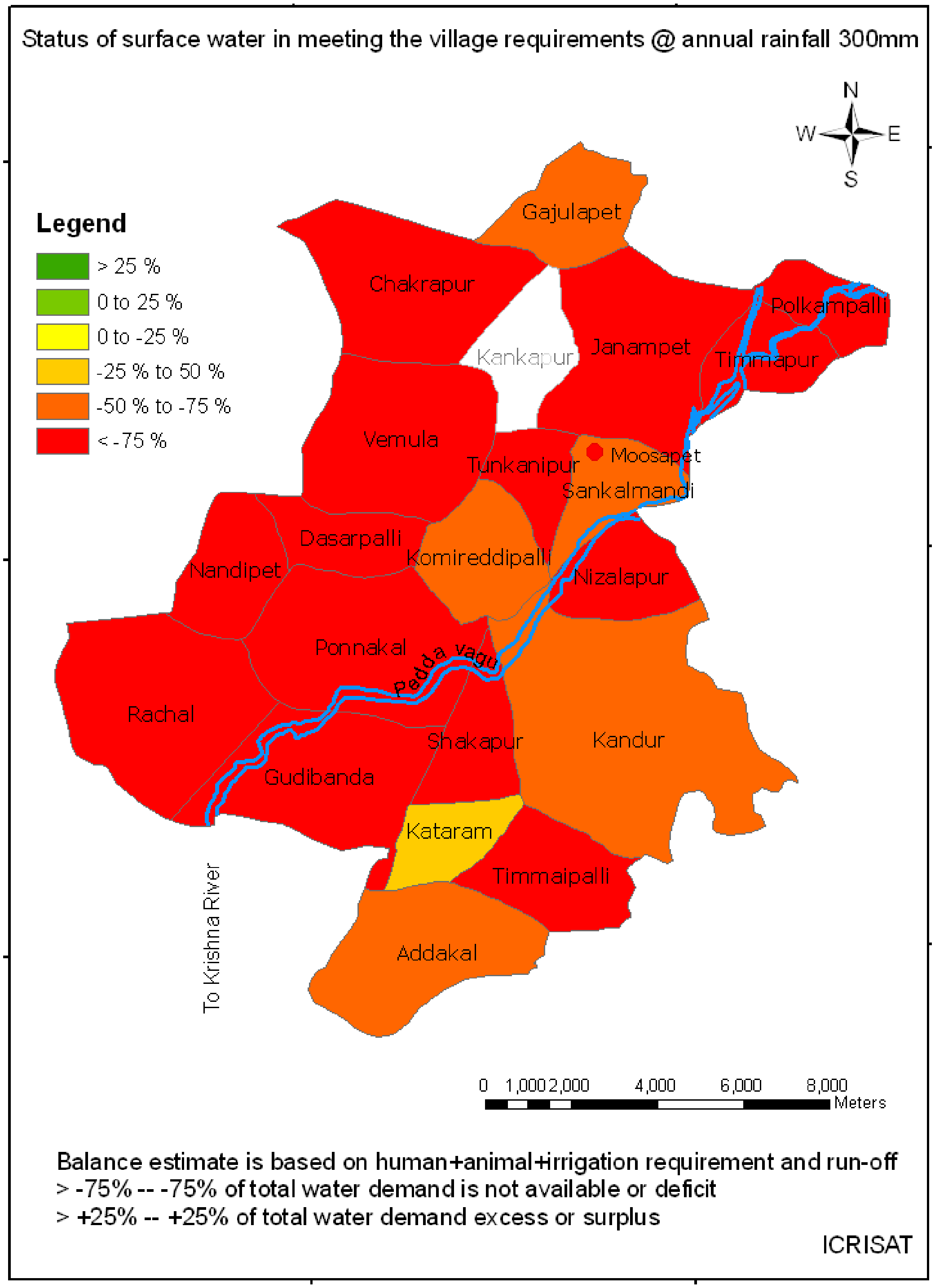


Figure 23: Colour coded map for micro-level drought vulnerability assessment @ 300mm

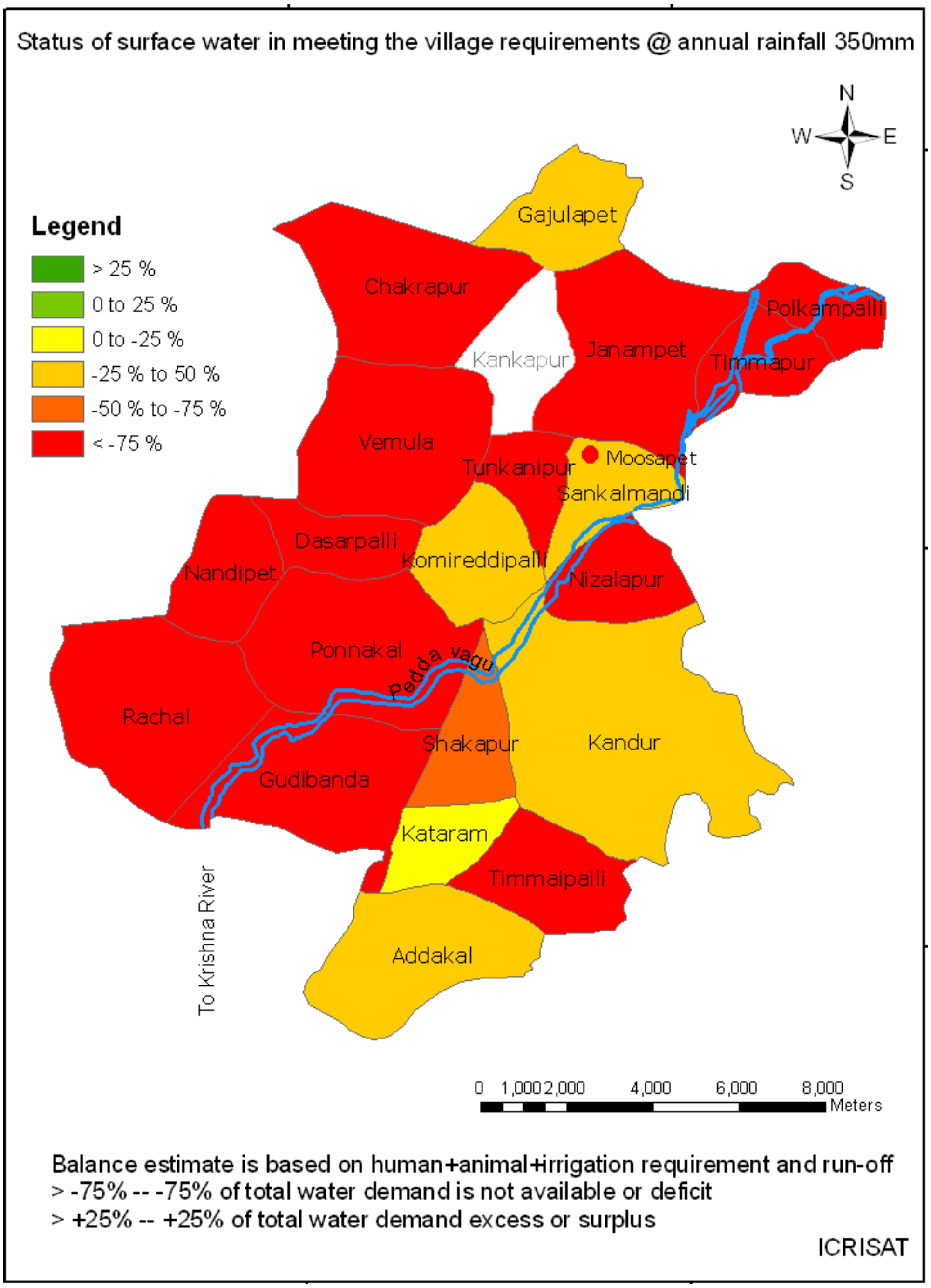


Figure 24: Colour coded map for micro-level drought vulnerability assessment @ 350mm

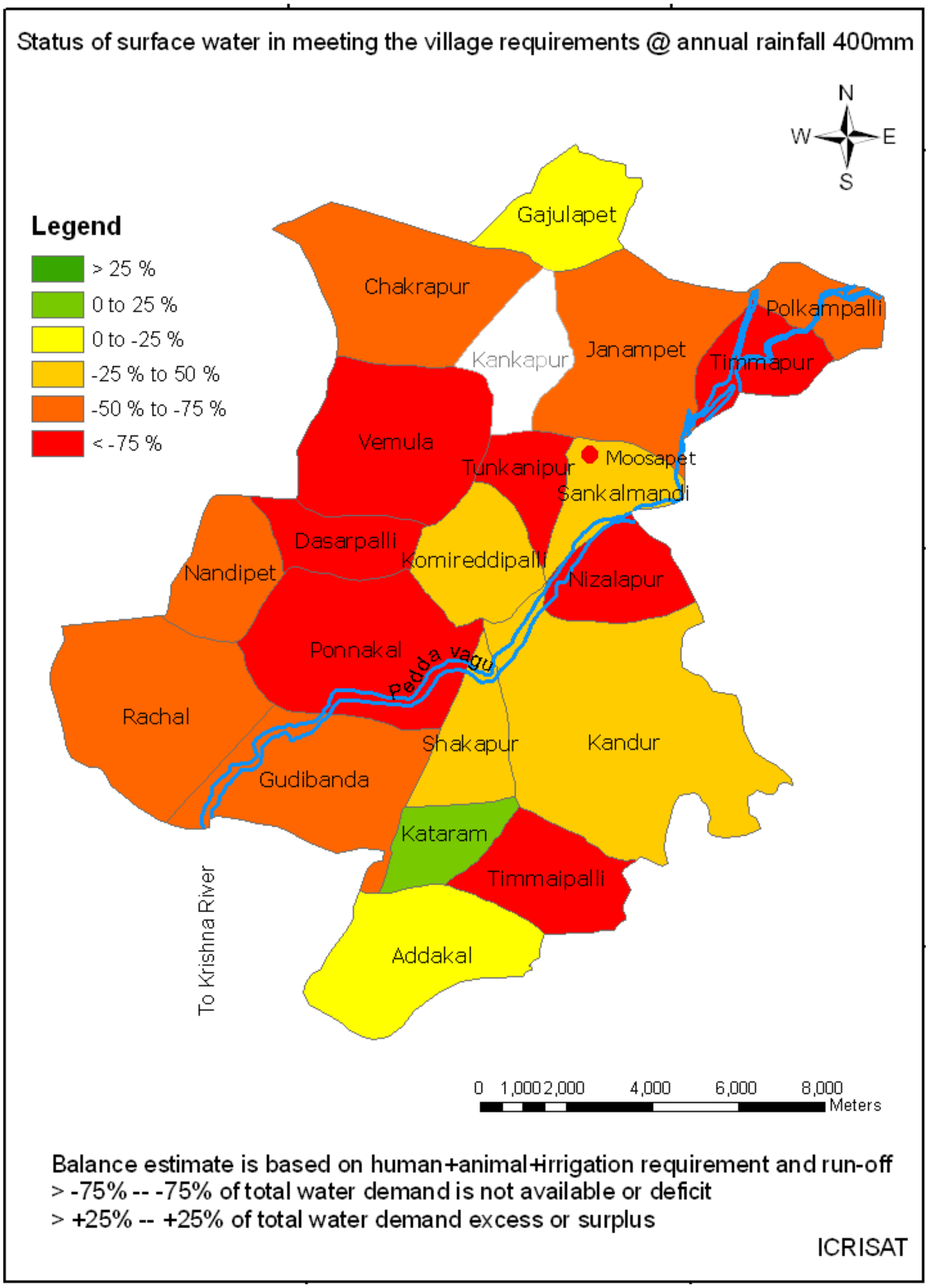


Figure 25: Colour coded map for micro-level drought vulnerability assessment @ 400mm

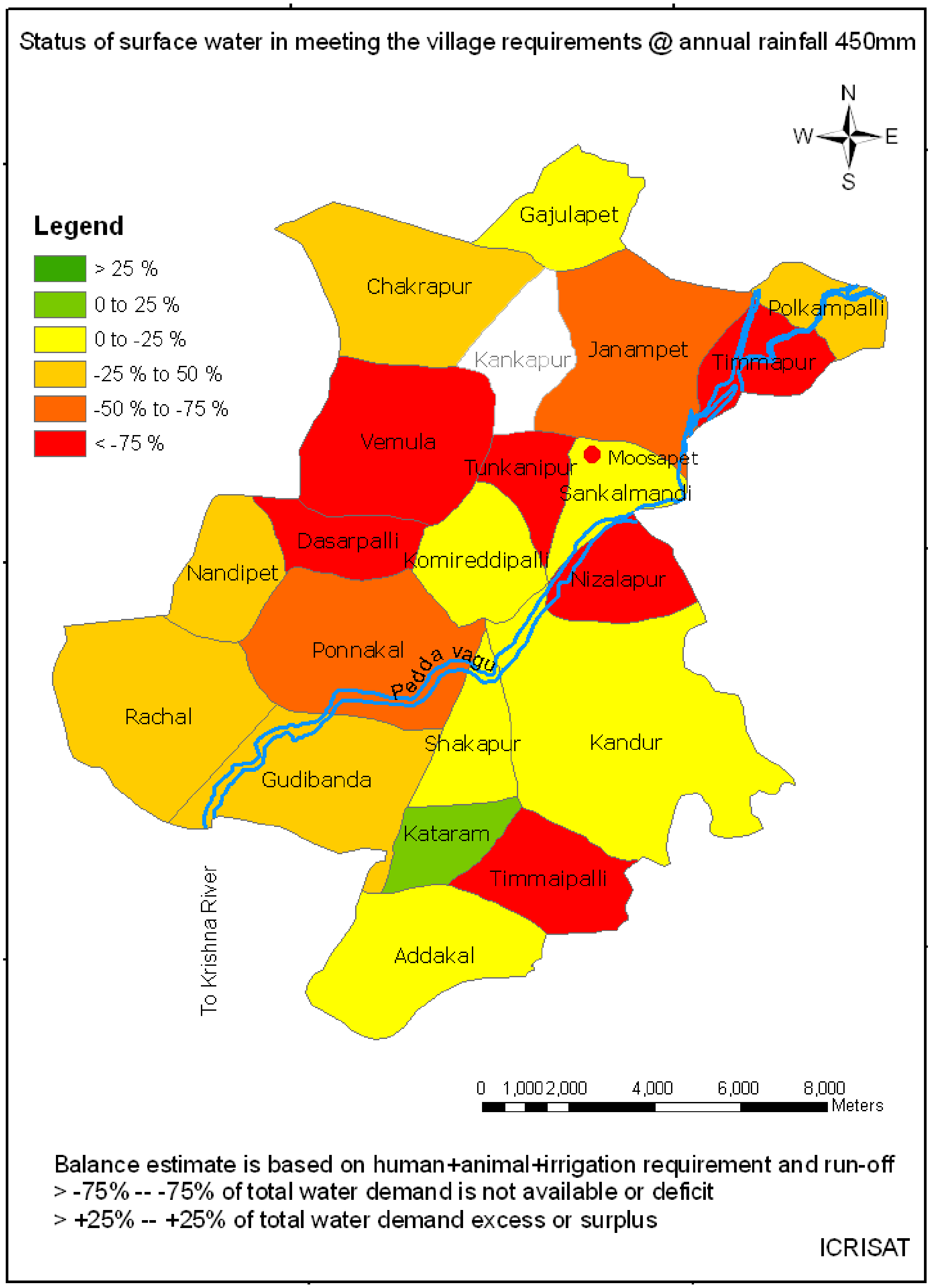


Figure 26: Colour coded map for micro-level drought vulnerability assessment @ 450mm

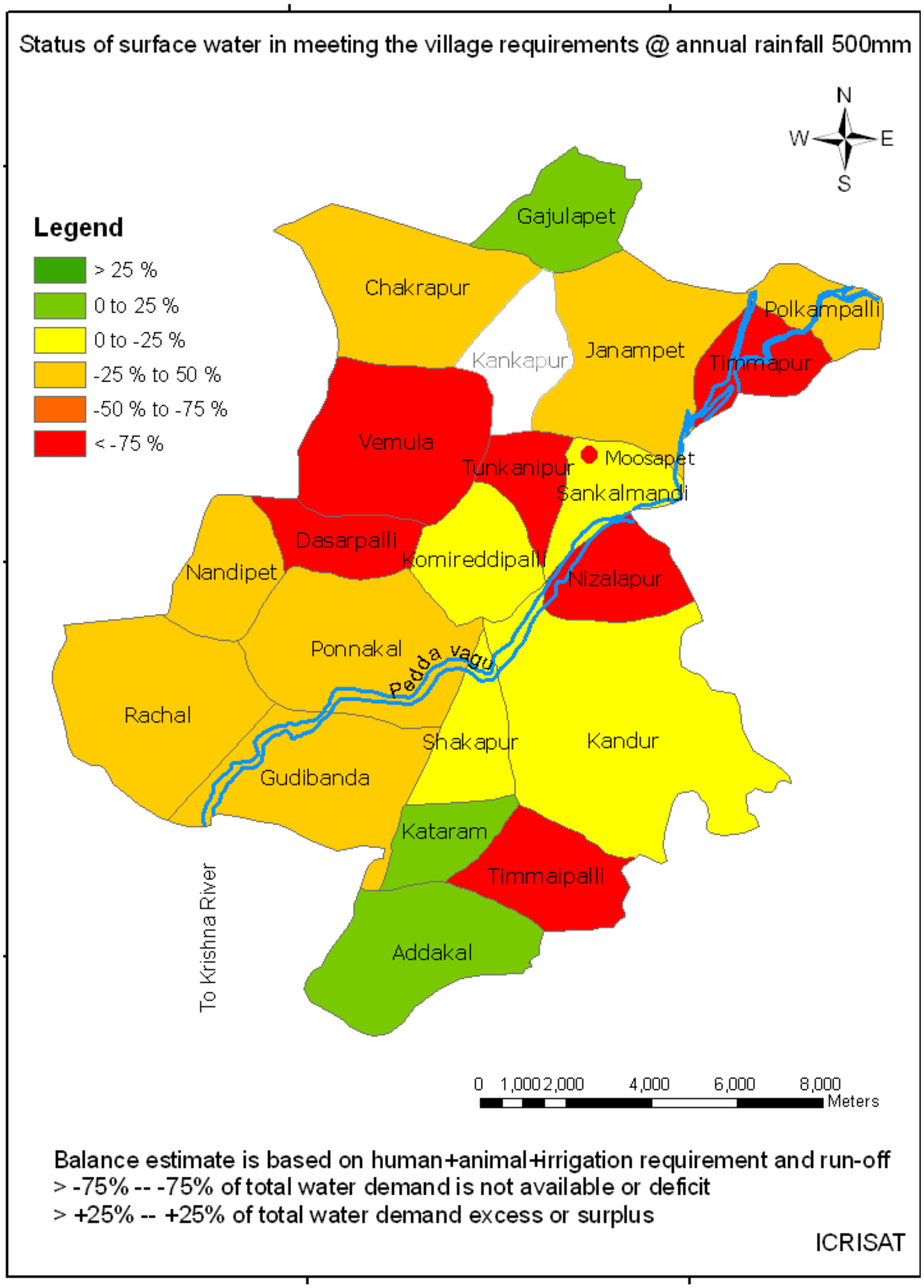


Figure 27: Colour coded map for micro-level drought vulnerability assessment @ 500mm

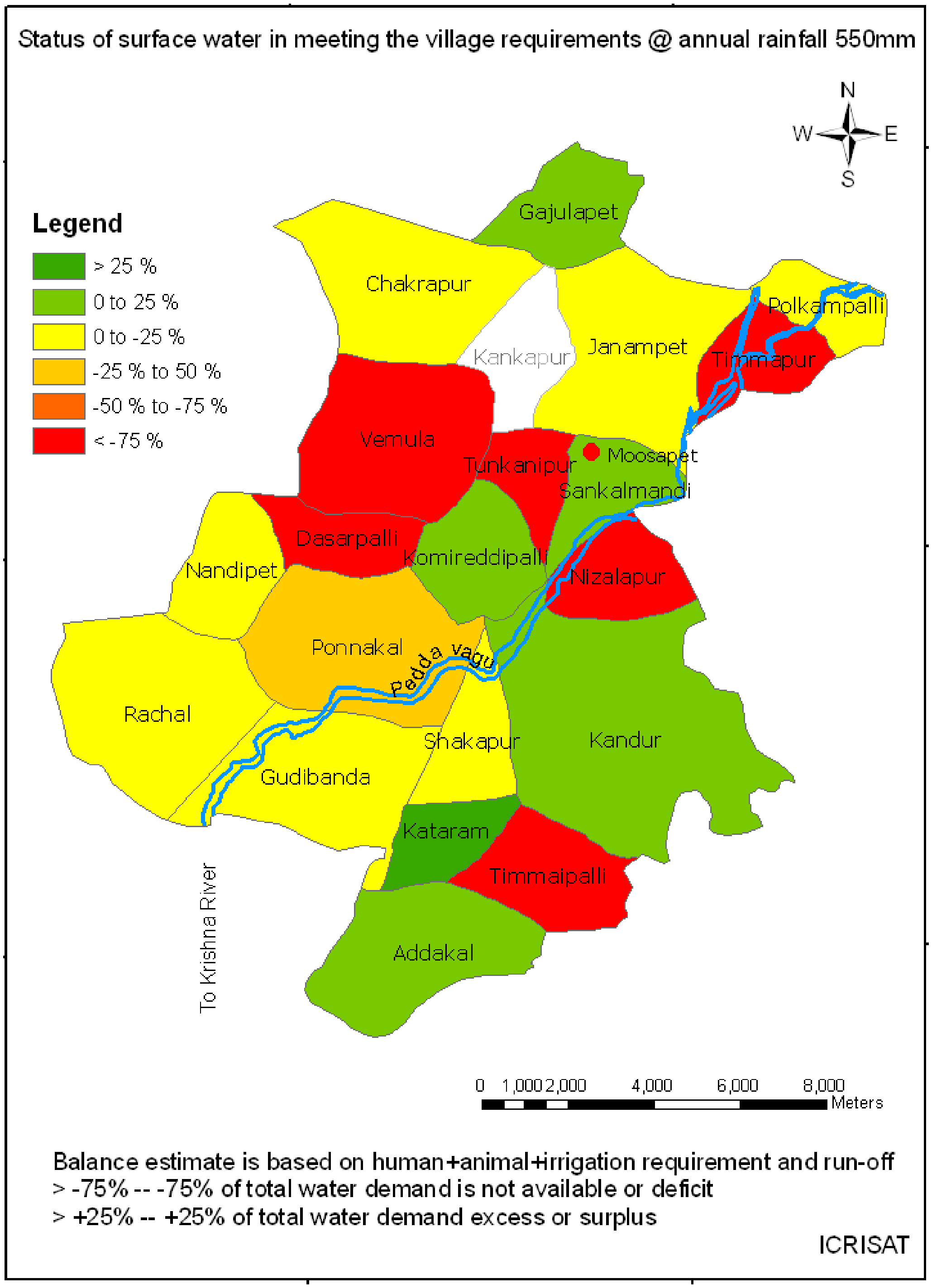


Figure 28: Colour coded map for micro-level drought vulnerability assessment @ 550mm

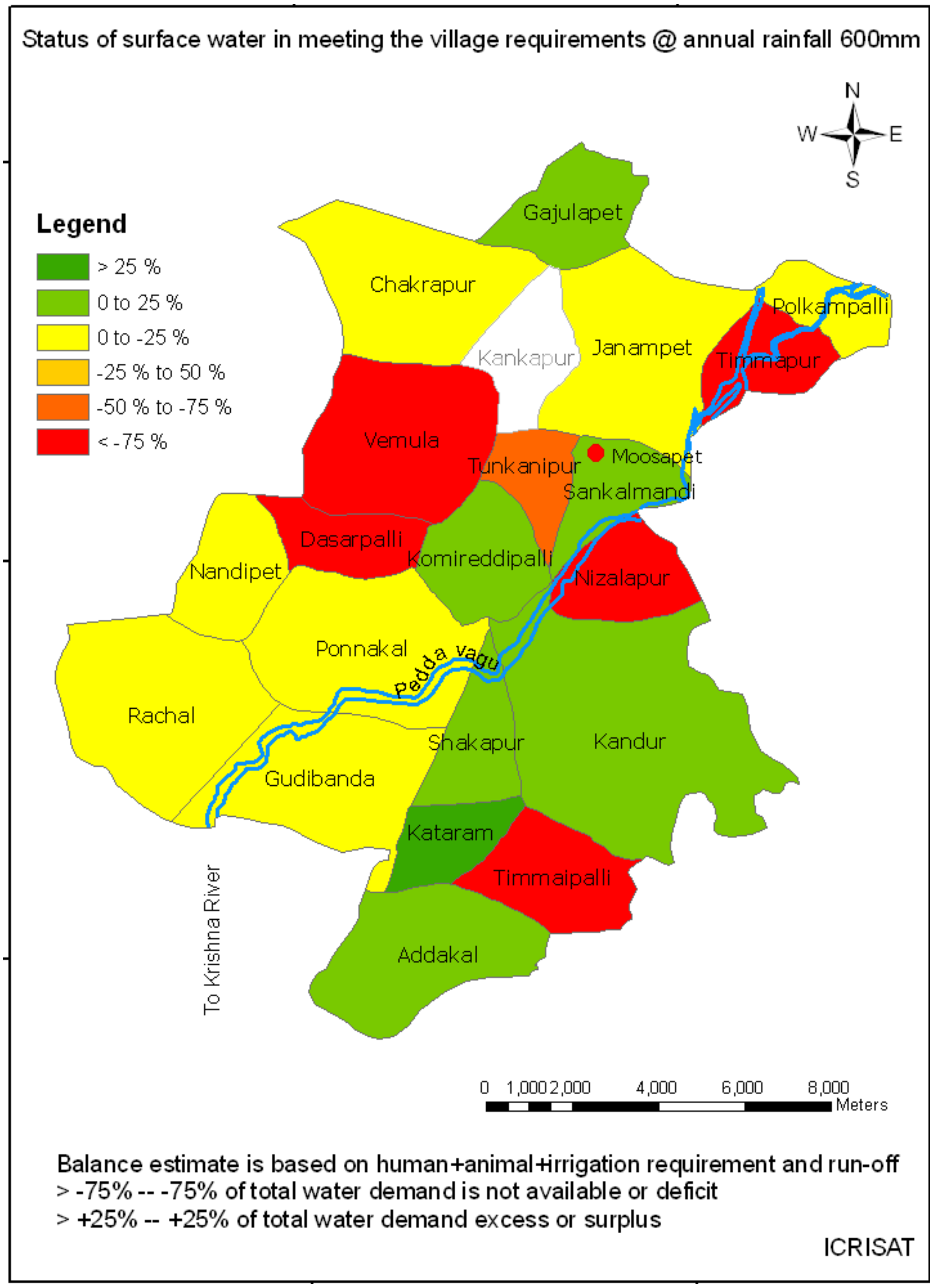


Figure 29: Colour coded map for micro-level drought vulnerability assessment @ 600mm

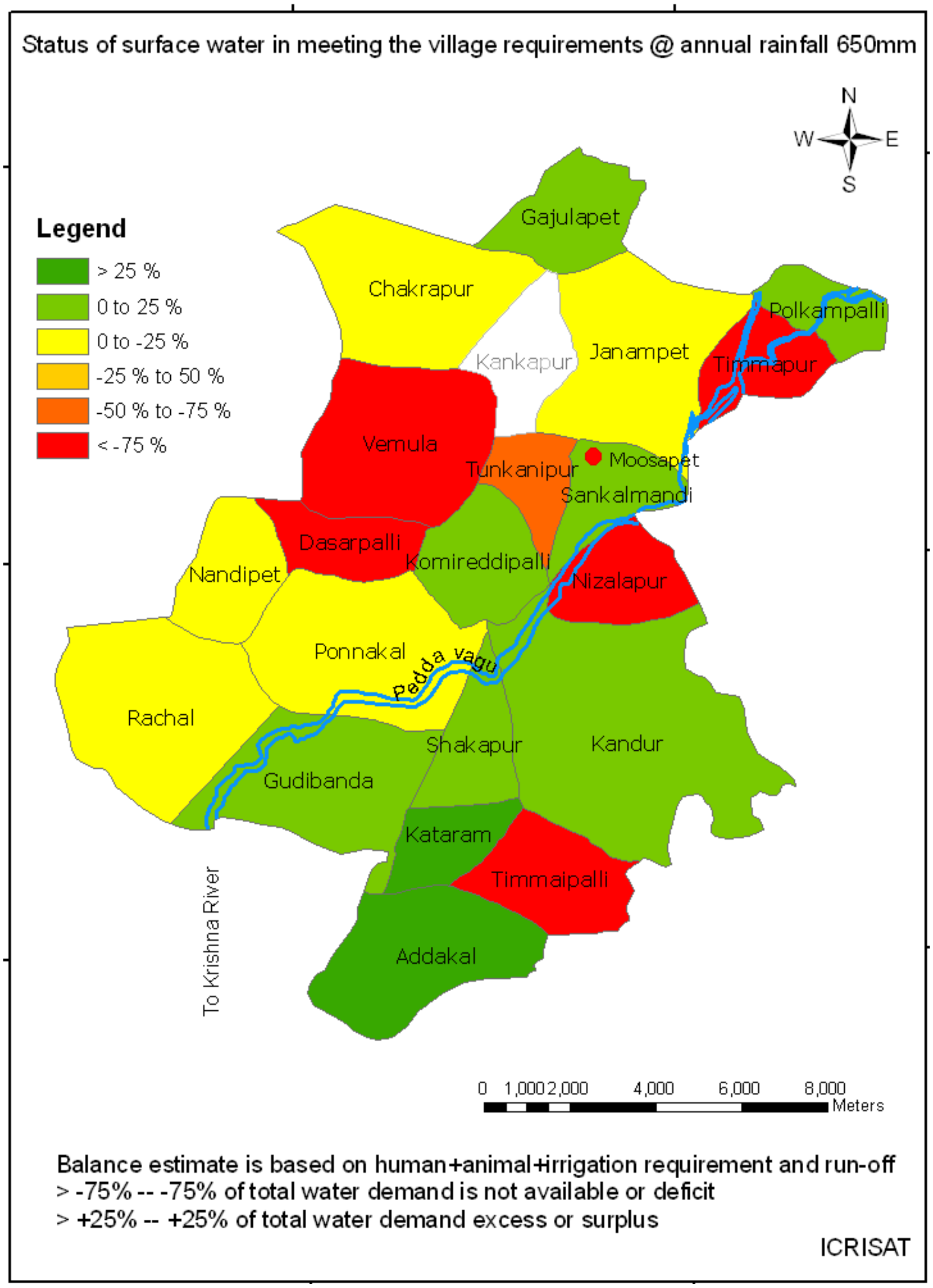


Figure 30: Colour coded map for micro-level drought vulnerability assessment @ 650mm

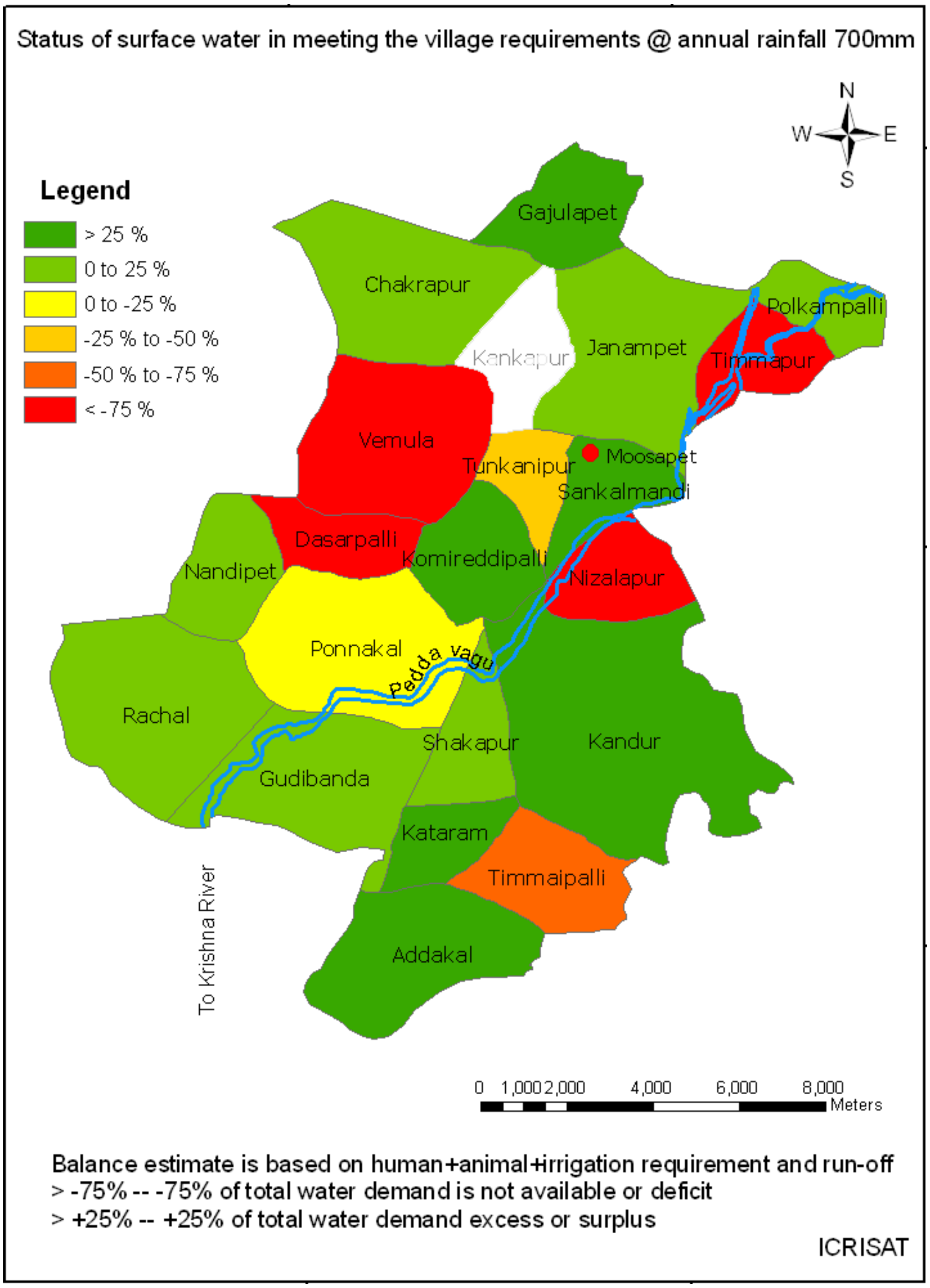


Figure 31: Colour coded map for micro-level drought vulnerability assessment @ 700mm

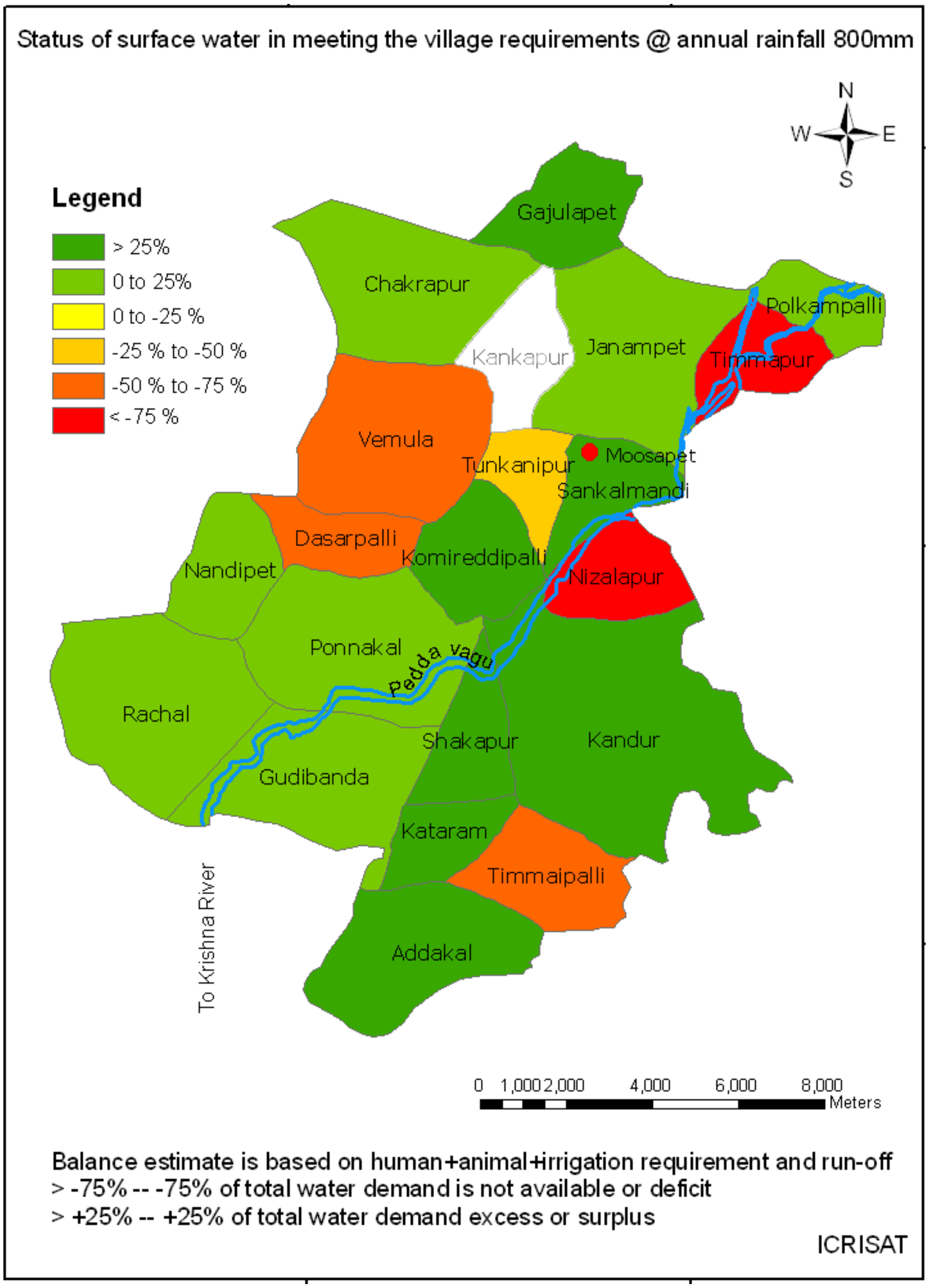


Figure 32: Colour coded map for micro-level drought vulnerability assessment @ 800mm

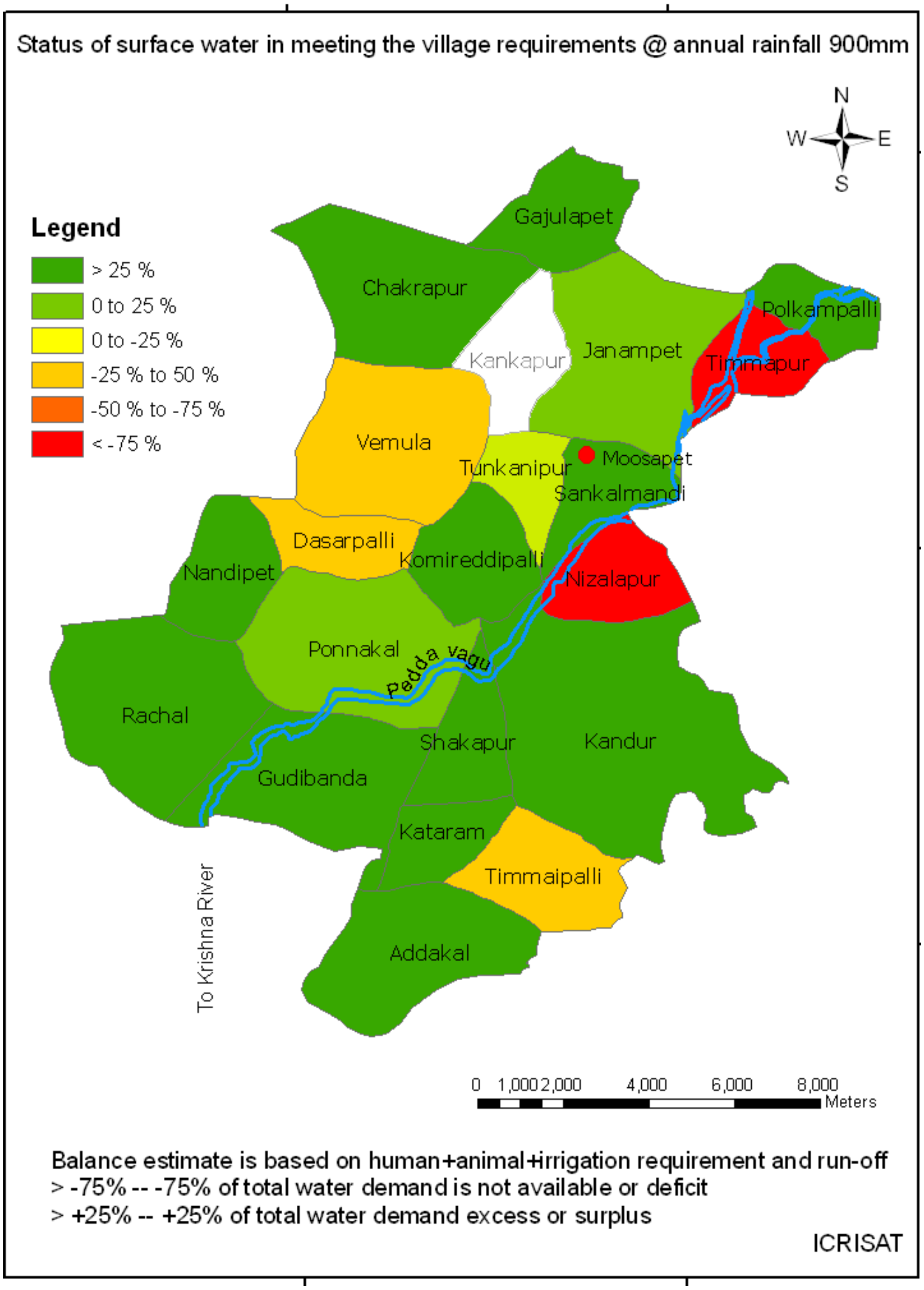


Figure 33: Colour coded map for micro-level drought vulnerability assessment @ 900mm

7.1.2 Rainfall Predictions

The rainfall predictions are essential to make use of developed colour coded maps. Moreover rainfall predictions at the beginning of the season helps to chose a map suitable for the season to take decisions to prepare for drought scenarios.

An analog method suggested by the ICRISAT experts[17] was used to prepare the rainfall predictions for the year 2006 and the same was disseminated to the farmers in the first week of June 2006. Analogue Method is one of the several methods that can be used to prepare a seasonal forecast. The Analogue Method involves critically examining the past several years' data to identify the weather scenario, which looked very similar to the existing conditions and try to forecast the weather for the future period with assumption that the weather in this forecast will behave the same as it did in the past. The limitation is that it is virtually impossible to find a perfect analog. Also, even if the match is perfect, the weather that follows could be significantly different during the forecast period.

Annual (40 years), monthly (10years) and daily (5 years) rainfall records[18] were used in understanding the rainfall intensity and time series pattern. The southwest monsoon normally sets over Addakal area by the first week of June and withdraws by the end of October. Normal annual rainfall for Addakal *Mandal* is about 600 mm received in 41 rainy days. Normal seasonal (Jun-Oct) rainfall is about 535 mm received in 36 rainy days. About 89% of the annual rainfall

[17] Discussions with Dr Kesava Rao, Visiting Scientist, ICRISAT and his team members.
[18] The rainfall data includes annual (1960-2004); monthly rainfall (1996-2000); daily rainfall (1996-2000) obtained from the District Collector Office, and Mandal Revenue Office were used.

was received in this season. Year-to-year variations in onset, amount and distribution of monsoon rainfall have major impacts on water resources and rain fed crop production in the area.

Based on the daily rainfall data for the past 34 years of Addakal area, various statistics like average, standard deviation, coefficient of variation for weekly, monthly, seasonal and annual rainfall were computed. Rainfall that can be expected at different probability levels was also estimated. The India Meteorological Department's (IMD) operational Long Range Forecast for the 2006 Southwest Monsoon season (Jun-Sep) was that "The rainfall for the country as a whole is likely to be 93% of the Long Period Average with a model error of ± 5 %". The IMD issued this long-range forecast on 24 April 2006. It was observed that Addakal was receiving below normal rainfall for the previous 8 years (except for the year 2005). Depending on the rainfall distribution for the first five months (Jan-May 2006) and rainfall of the previous years, good match analogues were identified. After repeated analysis and observation, most optimum analogues were filtered out. Based on the analogues, statistical values, long-range forecast of the IMD and to some extent on intuition, two scenarios were developed with the predicted seasonal rainfall of 450 and 500 mm each with different monthly distribution. The prediction error assumed was ±50 mm. for both the scenarios. Raingauge (certified by the Indian Meteorological Department) was installed at Addakal and the data was regularly monitored. Rainfall as measured at the Addakal *Mandal* office was also collected for comparison and for correcting the data as measured by the farmers in the initial period (Table 15).

The scenarios of rainfall predictions are shown in the graphs (Fig 34).

Category	Month	Normal	Predicted	Observed	Comment
Scenario -1	June	68	50	107	Usable
	July	145	125	39	Fail
	August	122	50	80	Usable
	September	103	125	180	Usable
	October	97	100	15	Fail
	Season	**535**	**450**	**421**	**Successful**
Scenario -2	June	68	50	107	Usable
	July	145	100	39	Fail
	August	122	150	80	Fail
	September	103	150	180	Usable
	October	97	50	15	Usable
	Season	**535**	**500**	**421**	**Usable**

Table 15: Usefulness of Predicted Rainfall in Comparison with uploaded by Rural Volunteers

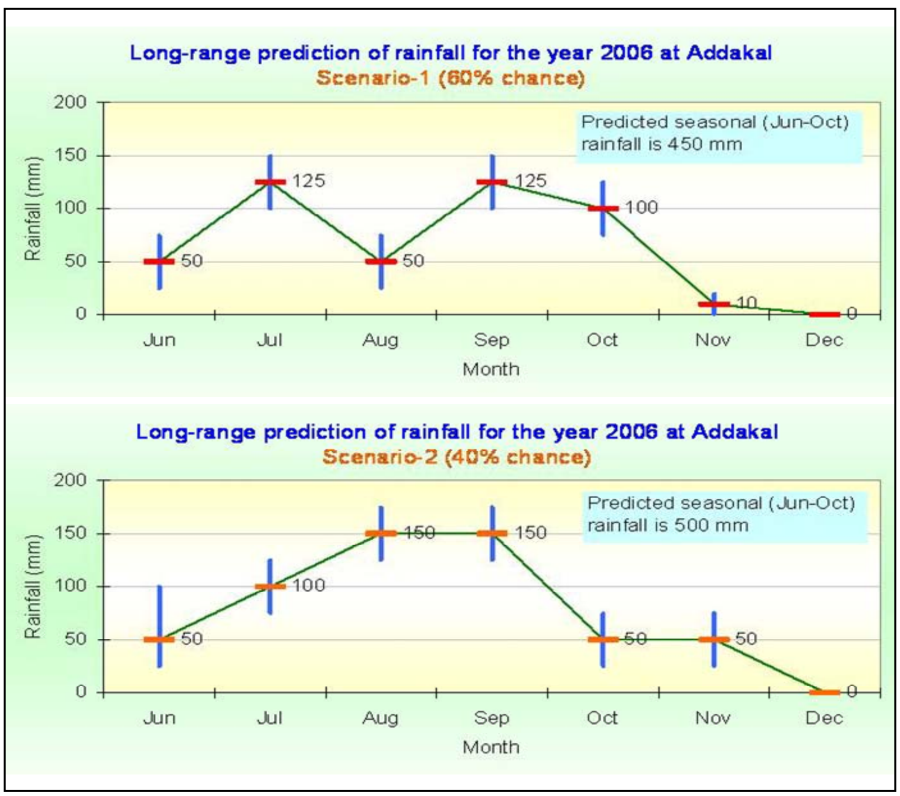


Figure 34: Seasonal Rainfall prediction for the Addakal region (2006)

7.1.3 Training to the Rural Knowledge Centre Operators

One week training was given to the Rural Knowledge Centre (RKC) operators and village volunteers in two phases in both onsite and virtual mode (through Video Conferencing). The focus of the first phase was on the data collection with a Rainguage (Fig 35) and uploading data into a wiki based Content Management System (Fig 36). The focus of the second phase was on the interpretation of the maps to generate decision, and methods to make the vulnerable communities to prepare for drought scenarios.

Figure 35: Rural volunteers trained in rainfall measurement

Figure 36 : Rainfall data uploaded by rural volunteers on VASAT wiki

7.2 Evaluation of the Maps

In June 2006, the discussions were made with the RKC operators and village volunteers about the use of the proposed technique and their willingness to participate in the experiment. The RKC operators and village volunteers agreed to participate in the experiment; in fact they expressed their happiness. The RKC operators and village volunteers stated that generating vulnerability assessment and drought warning information is useful for decision making on the selection of crop for the season or finding a livelihood opportunity other than agriculture. They further stated such information is useful for preparing themselves well in advance for outmigration to other areas in the worst scenarios. The interpretation of the maps was discussed with the RKC operators and village volunteers, for instance it was said that the red colour indicates the villages more volunerable to the drought and green indicates no drought. With this realization, for the predicted rainfall (450 mm) for the forth coming season the RKC operators and village volunteers selected the 450mm colour coded map and identified villages more vulnerable to the drought, and started recording scenarios and their observations; simultaneously looking for approaches for preparing the farm families against drought scenario.

In December 2006, an assessment study was conducted to understand the use of the colour coded maps and proposed technique in the real world scenarios; 210 villagers (10 in each village) were interviewed in addition to the observations recorded by the RKC operators and village volunteers. Observations were made such as village conditions and comparisons with the previous seasons; agricultural production scenarios; rural families experiences; and availability of water for various purposes. It was observed that 190 respondents felt that the projections derived from the colour-coded maps were useful, and 192 of 210 interviewed felt that this tool would be useful in making decisions on continuing or abandoning cultivation. For instance, a farm labour from Nijalpur village said that she had to travel 3-4 kms daily for getting drinking water. It is observed no farmer in this village had taken up agriculture; most of the men migrated to Hyderabad (or) Bombay in search of livelihood opportunities. The predicted scenarios for this village were scarcity of water, which was reflecting from the findings. Similar situation was observed in other severely affected villages. For example, a farmer and resident of Kandur village expressed failure of his paddy crop, as he didn't listen to the RKC operator though they have advised them to not go for paddy, in the next season he wanted to follow the advices given by the RKC operators. A milk vendor further stated that feeding his dairy cattle became difficult for him, as his village was affected by drought and he had to go either Koththakota (or) Jandcherla to get feed at high cost.

Unlike these conditions, the residents of villages, which were predicted, to be relatively free from drought, expressed that they did not have any drinking water problem; they even had sufficient agriculture produce. The personal observations helped to notice the differences between the villages which were affected by drought and which were not affected by drought. Based on the observations, the study came to a conclusion that the maps were useful.

7.2.3 Conclusion

The results of the experiment has shown the proposed technique is useful in identifying the drought vulnerable areas by generating early warnings with a combination of top-down and bottom approaches and community mobilization. The results further suggested that the village volunteers, (intelligent intermediaries or an interface between the communities and natural resource management agencies) play a key role in executing micro level drought preparedness techniques. Based on the results, the study concludes now there are opportunities to make decisions at two levels for avoiding the adverse impacts of drought, they are

1. *At district administration level:* If the district authorities would be made aware of the villages vulnerable to the drought, they could take up the coping measures well in time.
2. *At community level:* If the rural families would aware that their village is get affected by drought in upcoming season, they could take up measures to mitigate ill effects of drought. For instance the rural families could change their cropping pattern (or) they could go for non-agricultural options.

The study recommends the joint decisions, in some cases, would work well for drought preparedness methods in vulnerable drought areas.

Finally, the experiment concludes that the maps and technique appear to be effective, the predictions on rainfall in an upcoming season, suitable corrections in the predicted rainfall with regularly gathered ground level data play a vital role for long term and effective usage of the colour coded maps. The experiment further suggests that this technique should be carried carefully in a cluster of villages not at district, state (or) national level.

Chapter 8 Framework for Micro-Level Drought Preparedness

Since the main aim of this research work is to develop a framework for micro-level drought preparedness, sources of agricultural information management (International/National/Extra-Institutional), ICT Enabled RKCs, Open Learning methodologies, and drought early warnings have been identified as key components in developing such a framework (based on the experimental findings discussed in Chapter 3,5,6,7). In the following sections, a clear chain of evidence was established between these components to propose a new framework as mentioned in Chapter 1.

8.1 Expert-Farmer Information Flows

The farm families that live in drought prone areas have an easy access to the Traditional Knowledge (TK) resources and information resources provided by family friends, neighbours and pesticide shop owners (horizontal information flows), but not information resources provided by the expert systems (vertical information flows from international, national, state and local agricultural agencies). However, the horizontal information flows and TK resources are not always critical in search for solutions, which require advice and inputs provided by the expert systems developed on the basis of scientific approaches. The research at expert level needs to incorporate farmers' feedback for defining new solutions and adaptations. Finding practical means for engaging such intensive, ongoing dialogue across time, distance, and cultural gaps remains a challenge; the emergence of contemporary ICTs and RKCs (discussed in Chapters 3 and 5) can make a difference. The experimental findings discussed in Chapter 5 have shown the effectiveness of ICT-enabled RKCs in enabling improved information flows between the scientific community and the village farm community, and further enlarged the canvass for dialogues and discourses. Moreover it has provided new avenues for enabling interactions among farmers from different locations. Hence this has been incorporated as one of the components of mirco-level drought preparedness framework (Fig 37).

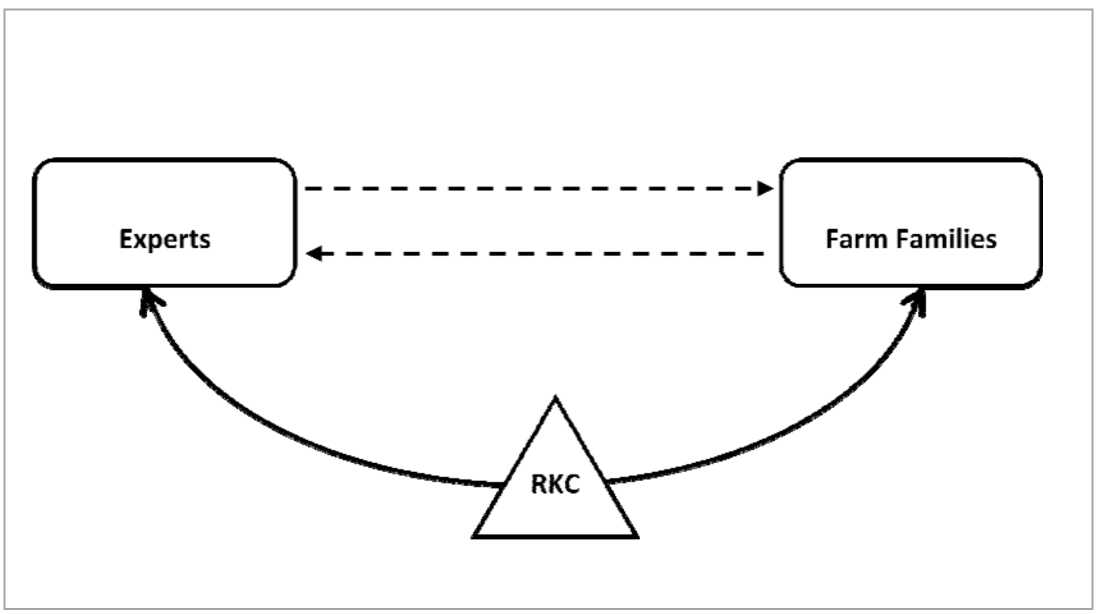


Figure 37: Farmer-Expert Information flows strengthened through ICT enabled RKCs

8.2 Open and Distance Learning

The processes for capability building and capacity development of farm families that live in drought prone areas are among the components of the new framework on drought preparedness. The traditional approaches of the capacity building are costly and have limited reach. Moreover, given that most stakeholders have limited exposure to the classroom milieu, new methods and techniques for capacity development will be necessary in fostering drought preparedness. It was therefore the new approach to the capacity building envisions a world in which all stakeholders can easily access and share information, knowledge and skills they need – anywhere and anytime – in a cost effective manner. The contemporary situation demands more innovative and efficient access to appropriate information, knowledge, and skills.

The experimental results discussed in chapter 5 and 6 have shown needed arrangements, methods (Open and Distance Learning), and contemporary ICT tools and concepts (for multi modal delivery, learning content sharing and management) to complement and supplement present capacity building initiatives in an affordable way. The evidence has shown that the RKCs act as facilitators in novel learning opportunities; and experimental results suggested that this is feasible and more effective than the conventional systems in terms of cost and wider reach. Hence this has been incorporated as one of the components of the micro-level drought preparedness framework (Fig. 38).

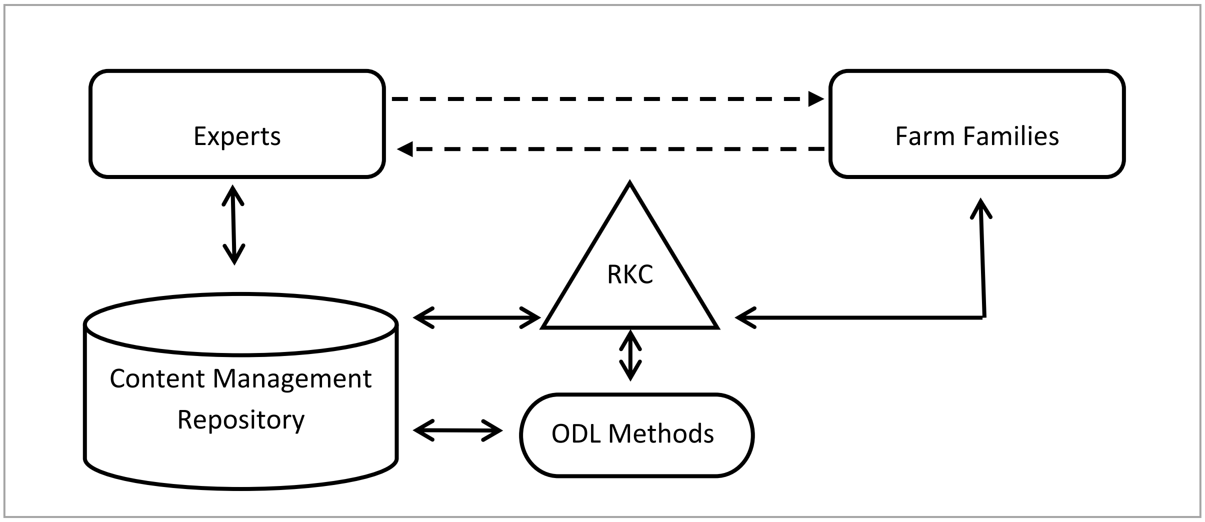


Figure 38 Expert-Farmer Information Flows, Content Management and Capacity Building

8.3 Early Warnings at Micro-level

The experimental findings discussed in chapter 7 have shown a technique to estimate drought at local level, on the basis of water budgeting technique. The colour coded maps generated based on the proposed technique is proven to be useful, it was therefore the technique has been incorporated as one of the components of micro-level drought preparedness framework. In this approach the ICT enabled RKCs have been identified as new institutional arrangements for collecting local rainfall and generating decisions to cope with drought scenarios at micro-level (Fig. 39).

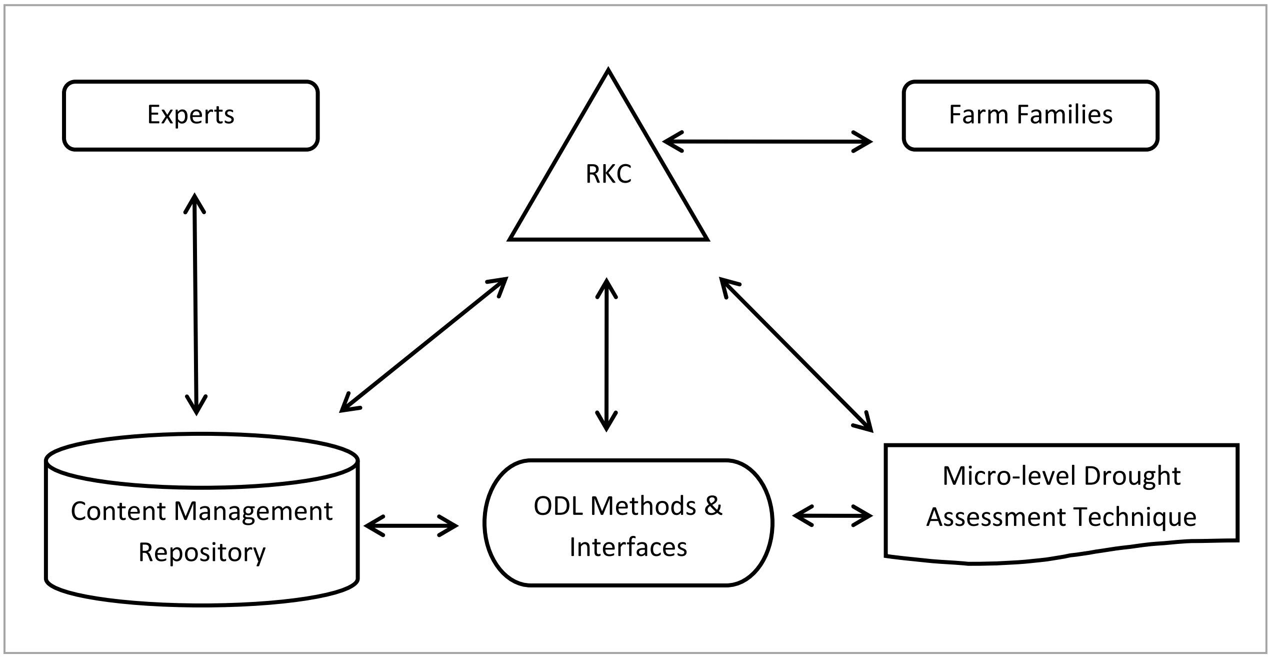


Figure 39 Expert-Farmer Information Flows, Content Management and Capacity Building, and Micro-level drought assessment

8.4 Proposed Framework

The hub and spokes model was used for integrating individual components to develop proposed framework for micro-level drought preparedness (Fig. 39). The expert system (or) the local arrangements for collecting information from expert systems hosted at hub, and the spokes (RKCs) are connected to the hub with wide variety of wireless (or) wired connectivity. The hub derives the locale specific information from generic information and disseminate through ICT enabled RKCs. The vulnerable rural families now have the means to estimate their own vulnerability and can use the information available at ICT enabled RKCs to make more informed decisions, which offers a sounder basis for designing drought preparedness and adaptation strategies.

Chapter 9 Conclusion and Future Work

The focus of this research work is to develop a framework to support rural farm families against drought. With the convergence of Information and Communication Technology mediated Rural Knowledge Centres, Open and Distance Learning, Information Management and drought early warning mechanisms the study proposes a framework to improve drought preparedness at micro-level for supporting vulnerable rural farm families. With this the proposed research work achieves the study objectives and made following contributions.

9.1 Contributions

9.1.1 Framework for Planning and Designing of ICT Enabled RKCs

The present study examines existing frameworks and classifications of rural computer centres, (Discussed in section 1.4 and 3.4), and finds the need of Rural Knowledge centres (RKCs), and their place in the classification of rural computer centres. The study assess the selected existing rural computer centre projects i.e., *Rural e-sev, Rajiv Internet Villages, MSSRF National Virtual Academy, ITC Aqua Choupal Model, Kisan Call Centres, Warana Wired Village, Kisan Kerala,* and *Akshaya* (discussed in section 3.2 and 3.3), for examining the needed arrangements to set up a Rural Knowledge Centres, and realizes setting up of a computer centre in a village does not constitute a knowledge centre; establishing a rural knowledge centre requires an intensive social and knowledge management process. The study discusses an intensive social process, *Needs Assessment – Mobilization - Capacity Building - Installation & Incubation - Operations & Monitoring - Evaluation*, and its requirement for planning and designing of RKCs. The study further recommends the influencing factors such as *socio-cultural, technical, economical, political and legal*; and functional factors such as *content and capacity building* need to be considered for ensuring the long term sustainability of the RKCs. Based on the lessons from the multiple case studies, the study discusses the need of ICT enabled RKCs and their role in the micro-level drought preparedness framework (discussed in Section 3.5 and 3.6). The study further examines the role of ICT enabled RKCs by developing innovative approaches in the study area (discussed in Chapter 4), and finds these new institutional arrangements equipped with modern, effective, and reliable systems enables effective information flows and knowledge management within and between concerned governments, grassroots institutions, scientific institutions, and regional and international organizations involved in monitoring and disseminating critical drought-related information.

9.1.2 Rural Knowledge Centres as Facilitators in Farmer-Expert Information Exchange and Rural Capacity Building

The study finds there is substantial international interest in utilizing information and knowledge in enhancing drought preparedness among vulnerable rural farm families (discussed in Section 1.1), and the drought preparedness at micro-level requires a component of information transmission mechanism which combines top-down and bottom up approach with community mobilization. Since the evidences suggest that the agricultural extension is an essential mechanism for enabling information and knowledge transfers, the current research work examines the existing agricultural extension models (discussed in Section 1.3) to understand the existing information flows and knowledge transfers. On the examination of existing information flows the study finds that the information needs of a typical rural farmer, in most of the cases, met by either approaching family members, neighbors and friends (who themselves are not well informed in most cases), or local farm input shop owners (who never bothered about the welfare of the farmer communities); but not from the designated natural resource management agencies (discussed in Section 4.4.1). The study finds the main reason behind this was inadequate infrastructure and human resources in the existing natural resource management agencies. The study proposes a strategy with ICT enabled RKCs to overcome these inadequacies. The experimental results reveals that the proposed strategy requires intelligent intermediaries and continuous rural capacity building programmes for continuous effective information and knowledge transfers among natural resource management agencies and farm families (discussed in Chapter 5).

The study finally recommends that the ICT enabled RKC strategy should link with current National Agricultural Research and Extension System for managing Desertification, Drought, Poverty, and Agriculture (DDPA).

9.1.3 Framework for Learning Content Management

The study finds that the existing digital learning content creation approaches are context and technology specific, which many a times demand content designers and developers to rework on the existing content again, to take modifications, considering the users need and technical preferences. This has been viewed in many times as an expensive and time consuming process, often resulted non availability of locally relevant content at RKCs.

The current work examines the existing electronic learning standards, and open source software tools. Based on the findings the current work proposes a framework for repurposing available electronic learning content for generating locally relevant content in short span of time in an affordable way. The framework was tested and usability of the framework in the real world scenarios was evaluated by organizing workshops with the scientists and researchers of National Institute of Hydrology and ICRISAT; and faculty members of agricultural universities. The participants in the workshops expressed that the proposed technique is useful in which development of content packages with open source tools (Reload Editor, eXe Editor) are very easy and development of run time environments using (CMS, LMS, and LCMS) open source software packages are easy and affordable. The study results further revealed that the content packages can be playable in any electronic learning standard compliance system for effective management and sharing of the content across multiple platforms (discussed in Chapter 6).

9.1.4 Micro-level Drought Assessment Technique

Although drought causes serious economic and social impacts, the efforts so far have been taken for generating micro-level drought assessment and early warning is least understood until recent years. The study finds, in India in most of the cases, the declaration of drought or as a scarcity affected area for providing relief to the population is still done by the Revenue Department of the state government, on the basis of estimation of the prospective harvest. The evidences suggested that the drought prevails in any region is mainly because of lack of surface water bodies affected by rainfall, for instance the national commission on agriculture of India estimates the drought, on the basis of rainfall in a week is half of the normal or less, when the normal weekly rainfall is 50mm or more. The study finds that the Indian Meteorological department is the authorized agency to generate drought predictions at country level. However, these predictions are not useful at micro-level for preparing the farm communities at local level against drought and disasters.

The proposed technique in this study have shown an approach to estimate drought at local level, on the basis of water budgeting technique and rainfall predictions; and further suggests capacitating the rural communities is essential for executing this technique effectively. The assessment study revealed that although the technique appeared to be effective, the predictions on rainfall in an upcoming season, suitable corrections in the predicted rainfall, regularly gathered ground level data play a vital role for long term usage of the colour coded maps. The usability study further suggested that this technique should be carried carefully in a cluster of villages but not at district, state or national level (discussed in Chapter 7).

9.1.5 Framework for Micro-Level Drought Preparedness

The established practices such as sources of agricultural information management (International/National/Extra-Institutional), ICT Enabled RKCs, Open Learning Methodologies, and Drought Early Warnings have been identified as key components in developing a framework for micro-level drought preparedness to support rural farm families. For each finding reported in the experimental objectives, a clear chain of evidence was established, supported also by interview statements (discussed in Chapter 3,5,6,7). Finally for developing drought preparedness framework at micro-level, the study integrates these components carefully, based on the series of findings, systemic analysis of the data and continuous interpretation of the observations (discussed in Chapter 8).

9.2 Conclusion

The study concludes that the proposed framework has shown a way to improve micro-level drought preparedness by bringing various ICT tools, information management techniques, open learning approaches, and micro-level drought assessment technique under one umbrella with an intermediary entity called ICT enabled Rural Knowledge Centers owned and run by communities. The usability evaluation studies on individual components revealed that the approaches such as these will have implications in planning micro-level drought preparedness strategies.

9.3 Future Work

The future work can be pursued in the following areas:

- Integration of ICT enabled RKCs with NARES requires conducting of pilot studies in multiple locations to take policy decisions.
- Future scope to do an advanced research on the use of AGROVOC and semantic web techniques (RDF and Topic Map) for enhancing the effective use of RLOs repository with semantic searches and query management facilities to enable effective drought advisory and education functionaries.
- The study opens a room for communication research to explore dimensions and dynamics of three way communication method *i.e.,* Farmer-intermediary-expert.
- Future scope for studies on incorporating ICT mediated ODL element for mass training and education; and learning content management for enabling information and knowledge transfer across governments, grassroots institutions, scientific institutions, and regional and international organizations involved in monitoring and disseminating critical drought-related information.
- Future scope for testing the usability of the colour coded maps, and comparisons between the Rabi and Kharif seasons and their effectiveness need to be tested.

Since the Government of India approved for establishment of the Common Service Centres (CSC - worth Rs. 5742 crores out of which Rs. 4093 crores would come from Private Sector) 100000 + CSCs across rural India, on a public-private partnership model to deliver Government, Private, and Social sector services to the rural citizens of India [165]. Hence the results and recommendations generated from this work can be tested in multiple locations to take maximum advantage for designing micro-level drought preparedness strategies to support rural farm families.

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Appendix I

Orientation Workshop on

Instructional Design and Learning Management Systems

11-15 April 2005

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Appendix II

Workshop on the Use of
Learning Management Systems for TechMode partners

6-10 December 2005

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