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Del 11.5
Research paper on Comparison of Modes of Knowledge Creation: Peer Contribution vs. Commissioned Content for the Indian agropedia

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Short Description: The deliverable compares the efficacy of knowledge creation using disparate traditional top-down, Encyclopedia Britannica-like knowledge documentation mechanisms and contemporary web 2.0 wikipedia-like knowledge sharing mechanisms. The objective is to evaluate relative participation rates for hierarchical networks (commissioned content) as well as horizontal networks (contributed content), and compare the content quality and appropriateness for each of them. The deliverable attempts to enhance the understanding of these modes of knowledge creation first, followed by developing comparison methodologies, and applying them to the digital knowledge ecosystem (DKE) created under the aegis of agropedia

Author: Runa Sarkar, Amritesh, Kasturi Sadhu (Ghosh), Sugatha Chaturvedi

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Dependences:

Achievements*	A methodology to compare commissioned (push) content with voluntary peer contribution along multiple dimensions was developed and applied. The results from the study are inconclusive as the social network formed as a result of agropedia is still in its infancy
Work Packages	This deliverable will influence D11.9 in WP 11, as well as inform the development of WP12 in Phase III. It is complementary to the study of 'knowledge' on D 11.2 authored by NIUM and that of local adoption of a digital ecosystems described in D12.10 and D12.8 by T6-Eco and CN respectively Task 6.4 of WP6, and WP10 will also be informed by this deliverable Our partners at IPTI and SUAS are also using the data generated by agropedia to further their research in social networks
Partners	T6ECO, NUIM, CAM, UniKassel, LSE, SUAS, IPTI, WIT
Domains	Social Science Domain. The domains of knowledge management, economics and regional development have been covered by this deliverable
Targets	Domain researchers, Policy makers, Knowledge Management Consultants
Publications*	A revised (and shortened) version of Chapter 4, has been communicated to The International ACM Conference on Management of Emergent Digital EcoSystems (MEDES), Lyon, 27-30 Oct, 2009 This has also been accepted for presentation at e-Agriculture track conference of eINDIA 2009, in August at Hyderabad
PhD Students*	Amritesh – Doctoral Student in Knowledge Management
Outstanding features*	Research into convergence of content in organic systems like a digital knowledge ecosystem can inform the design and development of knowledge networks, collaborative environments for scientists and professionals and education This is a first attempt, to the best of our knowledge, other than the Wikipedia vs Britannica debate, to develop a methodology and apply it to compare commissioned (push) content with voluntary peer contribution (pull content) along multiple dimensions
Disciplinary domains of authors*	Runa Sarkar Economics, Sustainable Development Amritesh Industrial Engineer, Doctoral Student in Knowledge Management Kasturi Sadhu Ghosh Economics Sugatha Chaturvedi Industrial Relations and Business Management

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1. INTRODUCTION

1.1 BACKGROUND

When farmers have problems in their day to day business, they turn to fellow cultivators, seed sellers or local elders for advice. If they are unable to find suitable solutions, they look towards the state sponsored agricultural extension system, which is designed to take agricultural best practices from the laboratory to the field. Unfortunately, it takes unduly long for state extension workers to reach and provide them with appropriate technical assistance. Often it is too late: they lose their crops or their animals die.

This is surprising as farming is a very long-standing tradition and, throughout history, a lot of good practices have been implemented to cope with the many challenges a farmer may face. Despite existing solutions, farmers often find that they do not have access to pertinent answers at the right time. This is probably because of the fact that with the culture of oral tradition prevalent in agriculture, traditional knowledge usually gets passed around by word of mouth. If somewhere, somehow the link gets lost and the stories and practices are not told, there is no record of them. So although the oral tradition has preserved some of the farming knowledge, much of it has also been lost. An intervention using appropriate ICT tools is desirable to ensure that no further knowledge is lost and new knowledge can be created, and disseminated so that farmers have access to pertinent information at the right time. At the same time, if the farmers (users) have information to share, they could also do so using such an ICT based network.

In these networks, knowledge is a critical resource for development, and a fundamental challenge is to organize work with knowledge in a way that facilitates continuous knowledge advancement and supports the sharing of intellectual achievements among the members of the community. Therefore, a rising challenge is to build a bridge between informal learning strategies of individual experts and formal rules and routines of knowledge work.

agropedia (www.agropedia.net) is a small step towards bridging informal forms of knowledge with established and documented practices leveraging the potential of community involvement with semantically enabled ICT tools in the domain of agriculture. In particular, our first goal is to help farming communities, defined by their common interests in agriculture and agricultural practices, to create and share knowledge more effectively and efficiently, be it in the form of must-read documents or new ways to get work done. Using community-centered collaborative filtering we have tried to conceptualise and deploy locally relevant models for collaborative creation and dissemination of knowledge as well as enhance existing vertical and horizontal partnerships. The model of knowledge creation and use that we converged upon uses a combination of traditional top-down, Encyclopedia Britannica-like knowledge documentation mechanisms and contemporary web 2.0 wikipedia-like knowledge sharing mechanisms

In this deliverable, we attempt to compare the efficacy of knowledge creation using these disparate mechanisms. Our objective is to evaluate relative participation rates for hierarchical networks (commissioned content) as well as horizontal networks (contributed content), and compare the content quality and appropriateness for each of them. Thus, we attempt to enhance our understanding of these modes of knowledge creation first, develop comparison methodologies next, and finally apply them to the digital knowledge ecosystem (DKE) created under the aegis of agropedia.

This deliverable is one of many in Work Package 11, entitled Bridging Digital Ecosystems Research to Regional Development and Innovation in the Knowledge Economy. The objective of this work package was to arrive at a common view on integrating concepts related to digital ecosystems with regional development and policy, and to develop a clearer link between the two. Towards these objectives, D11.1 contained an articulation of how exactly we would work towards our task of developing a better understanding of the knowledge creation, transformation and sharing process through an action research study of the DKE developed by us called agropedia. This deliverable is the outcome of that study. This study links well with D11.2 (concept of knowledge), D12.8 and D12.10 (local adoption in a DKE) and informs results of EVESim by our partners at SUAS. IPTI, another partner, is currently using the data generated by agropedia to further its research on social network analysis.

In this introductory chapter, to start with, we present an outline of the chapters that follow in Section 1.2. Following this, as an executive summary of this deliverable, we summarise the lessons learnt over the last 18 months while when trying to motivate users to use the DKE in Sections 1.3 and 1.4. Without real users using the DKE, we would be unable to gather sufficient inputs to compare peer contributions with commissioned content. While not an expected outcome of this deliverable, these pointers are extremely useful when setting up a digital ecosystem like knowledge space.

1.2 OUTLINE

The next chapter contains some reflections on modes of knowledge creation. We zero in on a network approach to knowledge creation as perhaps the most appropriate to ensure that the fine balance between pull and push of knowledge is maintained, without stymieing innovation and yet maintaining structure and objectivity in the knowledge fragments. While the implications of chapter 2 are quite generic, we contextualise our findings, which include a review of the literature, to the case of the Indian agriculture domain. Many of the findings have in fact informed the social architecture of agropedia. While we have developed architecture for a digital knowledge ecosystem (DKE) for the agriculture domain, it is now quite easy to translate this DKE to other domains as well. In this context, some interesting parallel developments in the medical and intelligence domain are medpedia and intellipedia. Chapter 3 focuses on these developments, comparing and contrasting them with the agropedia initiative.

A methodology (and its application) to evaluate relative participation rate, content quality and appropriateness between commissioned and peer contributors forms the crux of Chapter 4. The results from this chapter are inconclusive because delays in deployment of agropedia have meant that the social networking component of agropedia (which relates to peer contribution) is yet to be officially released (as on 31st May, 2009) and a critical mass of commissioned content is yet to be reached. At the same time, our limited survey of the literature suggests that this is among the few attempts to evaluate top down versus bottom up methods of knowledge creation. The most (in) famous attempt was made by Nature (Encyclopædia Britannica, 2006) which attempted to compare Wikipedia with Encyclopaedia Britannica using the quality of their output (knowledge fragments) as a metric. Chapter 4, thus, forms the core of this deliverable.

To further supplement the results from Chapter 4, the deliverable concludes with Chapter 5, which analyses user perceptions of agropedia along multiple dimensions in an effort to gather more information on the nature of participation in the digital knowledge space.

1.3 LESSONS

A DKE is an opportunity for a user to explore something thoroughly by commenting on material and contributing to discussions, and in so doing elaborate on the knowledge that is already in the repository. Using the platform as a mechanism to debate on issues using features such as chat-rooms, wikis and blogs, bring to the table real life experiences from development work and link to continuing online discussions facilitate the collaboration necessary for active knowledge creation. The created knowledge is a social product, the process of collaborative knowledge creation also represents a form of knowledge building where individuals (learn to) share their knowledge and create new knowledge together.

Documentation is key: In knowledge sharing, documentation is key to making a record of the explicit knowledge built collectively, for which photographs, videos, copies of presentations, transcripts and documents from an activity are very important. All of these materials, whether visual, audiovisual or digital, tell the story of what happened, gather information that was shared or created, and enable us to remember what was built, as well as to tell it to others who were not present. Not all the content created needs to be 'new' or innovative. Often, the recycling of ideas and knowledge to new contexts of use and application can serve a very useful role.

It is also important to articulate and document the intent of the DKE itself. Expressed as a knowledge vision, it enables users to assess the relevance and usefulness of new knowledge that they are in a position to share, while also creating a shared vision towards which the community of DKE users progresses.

Technology needs to serve the knowledge sharing process: Technology should not be introduced in a collaborative or sharing process if it is seen as an accessory, something cool but not useful. Hence it

is important to assess first the specific needs of the project, activity or event. ICTs must always have a function, a direct relation to the achievement of the goals, and the incorporation of technology must be planned carefully so that they are relevant and not merely decorative. It is critical to choose tools that are familiar, easy to use, available and useful.

To facilitate the creation of content by participants within the community of practice or learning community, raw technology is not easy enough to really encourage creativity and innovation. Simple, intuitive and direct user interfaces not only make it easy to create content but also make it easy to manipulate it. The technology tools must convey the context in which that content exists and encourage engagement with the context of knowledge development. This also includes the recycling of ideas and knowledge to new contexts of use and application. Also, users should be free to contribute in any form whether text, images, links to documents, html pages or field notes.

Representation of social relationships: Knowledge is dynamic, relational, and based on human action; it depends upon the situation and people involved rather than on absolute truth or artifacts. Social relationships affect the way ICTs are woven into knowledge sharing. These issues range from the place of the individual within the group to the group's relationship with other groups. For example, in situations where individual participants represent groups, institutions and organizations, as is often the case, it is important to keep a balance between the inputs of individual participants and those of their networks or institutions. ICTs can help visualize relationships such that individual nodes of a system should be as real to each other as in a face-to-face meeting. The system must develop a sense of 'presence' and should help discourse and communication between people, rather than provide an extra barrier, and bring into the collective process any inputs from the larger groups that are represented, using blogs, wikis, web forums or chat groups.

Focus on the networks: Not only is there a need to represent existent social relationships for effective knowledge sharing, there is also a need to design the knowledge sharing initiative with a greater focus on fostering the creation and sustenance of the network itself, where individual nodes or sets of nodes are autonomous. This would empower actors within the network to share, collaborate and network with other peers, resulting in the formation of a shared understanding over time. Such conditions enable knowledge creation at the individual, group, organizational, or inter-organizational levels.

The engagement of facilitators or experts as active and equal participants, where different participants can play different roles as learning and knowledge development takes place, facilitates free and full knowledge exchange. Inflexible permissions systems tend to cast the role of the moderator in stone and prevent others from taking a lead in shaping group learning processes, stymieing knowledge creation. The system needs to draw of the end users' knowledge of the community of which they are part. There still remains a need for mediation; different people can take up the role of the mediator at different points of time

Local context: Localization is another important issue that refers to the adaptation of global knowledge and technology to the local cultural and linguistic context. Adapting the local visual, auditory and symbolic language is essential, not just for the sake of clarity but also relevance and familiarity. Messages and communication need to use symbols, images and wording that are relevant to the group because foreign or distant symbols may inhibit the sharing process, particularly when people face new or unknown technologies. Also we must take into account the different communication styles of each culture as well as the ways in which they handle trust, because these are key elements for collaboration.

Ownership: If we want participants to see themselves as producers, we should enable them to appropriate the process, to recognize themselves and their ideas in the media used. Materials that are too elaborate and do not allow change or intervention from participants may come across as distant or foreign. Use of means that are simple, exchangeable, easy to reproduce and multi-functional encourage ownership. Hence, participants can decide which form the media will take and what ideas they will represent.

Capacity: For participants to transform the technology itself, they need enough familiarity and technological manipulation skills, which in turn implies a previous capacity building process that is not necessarily possible in all regions. The web 2.0 experience has demonstrated over and over again that it is the users and their innovative use of available technology that makes the difference between ICT solutions that work and are used and ICT solutions that are merely good ideas.

Involve a wider audience: Although we have emphasized a focus on shared practice and local context as critical to ensure participation in a DKE, it is also important to open up the DKE to a wider audience, including those researchers, practitioners and policy-makers who have demonstrated an interest in the domain at different times. Working with a 'community of interest' with much looser ties than a 'community of practice' means it is possible to advance understanding through processes of knowledge combination, where existing knowledge is combined with new insights to create new forms of contextualized knowledge. New participants can make use of online support for a community of interest that focuses on the interweaving of guidance research and practice in a way that offers them significant advantages.

1.4 THE IDEAL DKE

An open knowledge system or digital knowledge ecosystem (DKE) is a common platform using which a community of users can reach out to each other and to newer members. Each and every user must stand to gain from participating in the DKE, and the collective participation of all in the DKE improves the quality of its services (be it the dissemination of or linking businesses in a digital business ecosystem) manifold. Since the success of a DKE is contingent on participation, "barriers to entry" must be low to ensure the widest participation. The DKE must thus be provided as a common service for all, which mean that the self registration and self authorization services must be simple to use, as must all the other software involved. Simple and intuitive user interfaces, whether to search

a knowledge repository or edit a wiki or author a blog, encourage usage of the DKE. Moreover, automated links between blogs, wikis and existing knowledge nuggets result in a quick feedback mechanism within the DKE. Access to technology is a constraint for participation, and a DKE must be designed using the technology that users are most familiar and conversant with. For example, if potential DKE users are familiar with Microsoft Word, it is important that the text editors for the wikis or blogs have similar look and feel as Microsoft Word. For the sustainability of a DKE, over time, mechanisms entrenched in the DKE should result in shared norms to enable feelings of mutual trust and reciprocity among the users. One approach towards the evolution of shared norms is the articulation of some common overall objective that the entire community in the domain in which the DKE is active believes in. This could be done by some respected members in the community authoring blogs along those lines, or having a mission statement introducing new users to the objectives of the DKE.

An ideal DKE should not need any central node to drive participation once a critical mass of users are established (Lipnak and Stamps, 1997), as the value of using the DKE can only go up as more and more users start using it. To allow interdisciplinarity, sharing and feedback, the DKE should be open to anyone with interest in the domain in which it is active. Thus, it should not be geographically or temporally bound, and should be secure and always available for use. The objects in the DKE repository must persist and the address to these objects must be permanent.

While an ideal DKE is organization independent, to start with, some resources must be devoted on a full-time basis by any one potential user of the DKE to bring the tools into full operational capability. Till a critical mass of users are established, there will also need to be some priming of the Wiki and the Blog so the content is sufficiently broad and deep to have value for potential users. This content has to be both useful and provocative, which encourages new users to share their responses and/or new ideas on this platform

We could list the properties of a DKE as follows:

1. A DKE is Self-organizing – individuals are motivated to act in similar ways in concert with each other, for their own reasons because of the underlying mechanisms built into the DKE. In addition, a critical mass of individuals is required for self-organization to happen.

2. It delivers increasing returns from participation– the whole (overall outcome) is greater than the sum of the parts, that is, the overall benefit from a DKE is more than the sum of individual “costs” to build and sustain the DKE. As a result, group behavior is distinct from individual behavior.

3.It is enabled by networks and relationships – individuals look at their nearest neighbors, or people they have links (established through the DKE) with to obtain (or share) information/ knowledge.

4. A DKE has a feedback loop in real time built into itself. The information circulates in the system, is modified by others, and then comes back to influence the behavior of the originator either as a positive (amplified) or negative (dampened) influence. The historical memory of the system is part of the feedback (amplifying or dampening) loop.

5. A DKE is “open” so that information flows in and out of the system. This new information enters into the feedback loops and influences the behavior of the individuals, and thus the overall behavior of the system adapts to the external environment. Systems that are continuously open to new information from the environment, and circulate the information within the system, continuously change in response to changes in the environment.

2. MODES OF KNOWLEDGE CREATION

2.1 INTRODUCTION

The role of knowledge in economic development, whether as a means to use existing resources better, or as a new resource itself, has become paramount in this "knowledge economy" (Drucker, 1993). Lyotard was one of the first people to link knowledge-production to economic well-being in a systemic way (Lyotard, 1984, pp. 76-77)[1]. Knowledge can be productively applied to promote technological change and facilitate a reliable and regular flow of information. ICT applications in the area of social computing and online communities have ushered a new era of the web to support knowledge acquisition, management and development and facilitate organized human endeavor in fundamentally new ways. However, till date, despite great expectations, considerable effort and even more considerable investment and expenditure in the use of ICT for knowledge creation and knowledge development have not yielded commensurate results (www.know-2.org/E_gatekeeper.cfm?FileID=801).

Current knowledge management systems focus on knowledge acquisition, storage, retrieval and maintenance, but for that knowledge to be assimilated, contextualized, operationalised and/or deployed requires learning, interaction, application and feedback. A proper understanding of knowledge creation requires a consideration of the different forms of knowledge and of the different (and wider) contexts in which sharing, learning and knowledge development take place. Any knowledge management system needs to support activity, judgment, application and evaluation, as key processes in knowledge development. Lave and Wenger (1991) emphasize that learning and knowledge development happen within communities of practice which themselves define both the boundaries of skills and knowledge for the community and the ways in which that knowledge is applied. This requires an appreciation of not only the technical developments but also what social relations are needed to build on and leverage existing knowledge for innovation, facilitating and advancing the use of ICT for learning and knowledge development.

This chapter is an effort to study and understand all activities that lead to the creation or assimilation of knowledge or documentation and protection of knowledge that is already created. While the implications of the chapter are quite generic, we contextualize our findings, which include a review of the literature, to the case of the Indian agriculture domain. In this domain, the challenge is both to create new knowledge and to make the most of the existing knowledge, which is dormant in the life and activities of farmers, more aggressively than hitherto, so as to make a positive impact on improving agricultural productivity, which in turn would lead to human wellbeing.

The chapter is organised as follows. First, we start with developing an understanding of what comprises knowledge, its nuances and attempt to categorise it. This is followed by reviewing what several experts have to say on how knowledge itself is transformed, which leads to the next section on modes of knowledge creation. Here, we zero in on a network approach to knowledge creation as perhaps the most appropriate to ensure that the fine balance between pull and push of knowledge

[1] Lyotard was referring to codified knowledge and not tacit knowledge. However we believe that both implicit and explicit knowledge have a role to play in improving economic wellbeing

is maintained, without stymieing innovation and yet maintaining structure and objectivity in the knowledge fragments. Before moving on to a discussion on specific ICT tools to catalyse knowledge sharing and creation in Sub-section 2.4.4, we contextualize our discussion with respect to Indian agriculture. Tools for knowledge creation, specifically with reference to what could be used in a digital knowledge ecosystem, are discussed next. This is followed by a short commentary on Governance Structures in a DKE to promote knowledge creation in its widest sense. A critique of Integrated Knowledge Management Systems in the next section highlights that while technology is an enabler in knowledge creation, it is the people using the IKMS that makes a difference to whether the system is successful or not. The concluding section starts with summarising the implications of our study on knowledge creation and then provides an overview of the social architecture of agropedia, based on all the insights gathered and presented in this chapter[2].

2.2 A TYPOLOGY OF KNOWLEDGE

There have been myriad approaches to classifying and describing knowledge. Davenport and Prusak (1998) describe knowledge as a fluid mix of framed experiences, values, context information, and expert insight that provides a framework for evaluating and incorporating new experiences and information. Key features of knowledge, as identified by Allee (1997) include its self organising, dynamic, "messy"" and loose nature. Allee highlights that knowledge seeks community, has little hierarchy, and is deterred by the imposition of rules and systems. The importance of language as a medium to transmit and transform knowledge is underscored, while acknowledging that a particular stream or nugget of knowledge may eventually get lost, but it would spawn several new threads of knowledge given the right environment.

Researchers have recognised the importance of different types of knowledge including know-what, know-why, know-how, and know-who (Lundvall and Johnson, 1994). Master craftsmen or three-star chefs, for example, have a wealth of expertise at their fingertips, developed after years of experience (know-how), but they often have difficulty articulating the technical or scientific principles behind what they know (know what or know why). Highly subjective and personal insights, intuitions, hunches, and inspirations derived from body experience all fit into the dimension of know-what or know-how type of knowledge. Know-why knowledge on the other hand comes from the formal study of processes and systems and is codified knowledge, which can be gathered without actually performing the process of activity which the knowledge is about. Know-who knowledge is the ability to acquire, transform, and apply know-how or procedural expertise by identifying who has the know-how (Harryson, 2002). In a world of increasing specialisation know-who knowledge has become a key source of competitive advantage, which can draw global sources of invention to drive product innovation through collective and collaborative cross-functional action. Yet another "cognitive" dimension of knowledge consists of beliefs, perceptions, ideals, values, emotions, and mental models so ingrained in us that we take them for granted. Though they cannot be articulated very easily, this dimension of knowledge shapes our perception.

[2] A more detailed narration on the development of the social architecture of agropedia can be found in one of the papers presented as part of Del 11.4 – Policy Models for Developing Effective Structures of Communication and Collaboration on a Virtual Platform for Knowledge Sharing and Creation

Another, broader classification of knowledge which researchers have converged on is its distinction into explicit and tacit knowledge. The explicit dimension of knowledge is articulated, codified, and communicated using symbols, and can be readily transmitted to individuals formally and systematically as object based or rule-based in the form of data, scientific formulas, visuals, audiotapes, product specifications, or manuals. Knowledge is object based when it is codified in words, numbers, formulas, or made tangible as equipment, documents, or models. It is rule based when the knowledge is encoded as rules, routines, or standard operating procedures (Choo, 1998). Cyert and March (1992) discuss four types of rule-based procedures (a) task performance rules that specify methods for accomplishing organizational tasks and are important because they embody and facilitate the transfer of learning; (b) record-keeping rules on what records and how such records should be maintained by the organization; (c) information-handling rules that define the organization's communication system, including how to distribute and summarize internal and external information; and (d) planning rules that guide the planning process and the allocation of resources among the activities of the organization..

Tacit knowledge, on the other hand is not easily visible and expressible. It is highly personal and hard to formalize, making it difficult to communicate or share with others. Subjective intuitions and hunches fall under the rubric of tacit knowledge. Tacit knowledge is deeply rooted in an individual's actions and bodily experience, as well as in the ideals, values, or emotions that they embrace. There are two dimensions to tacit knowledge: cognitive and technical. The cognitive component refers to an individual's mental models, maps, beliefs, paradigms, and viewpoints. The technical component refers to concrete know-how and the kind of informal and hard-to-pin-down skills or crafts that apply to a specific context. The importance of tacit (as opposed to formal) knowledge for innovation and for knowledge development has been long acknowledged (Polanyi, 1958) .

Choo (1998) also discusses a third kind of knowledge, which he calls cultural knowledge. This refers to the *''assumptions and beliefs that are used to describe, and explain reality, as well as the conventions and expectations that are used to assign value and significance to new information*''. Cultural knowledge is not codified but is diffused over the ties and relationships that connect a group. An alternative approach to cultural knowledge, as taken by Nonaka and Takeuchi (1995) is to distinguish between knowledge of the individual and the collective. Individual knowledge is created by and exists in the individual according to her beliefs, attitudes, opinions, and the factors that influence her personality formation. Social knowledge is created by and resides in the collective actions of a group. It involves the norms that guide intra-group communication and coordination. For some contexts, collective knowledge could be related to cultural knowledge. This collective knowledge, based on the philosophy that the whole is greater than the sum of the parts, is what is being leveraged in the web 2.0 revolution in knowledge management. Brown and Duguid (1998) argue that a great deal of knowledge is not the property of individuals but is held collectively by people working together. They talk of *know-how* as being knowledge created out of practice and since most work is a cooperative venture most knowledge is collectively shared by work groups. Collective practice leads to shared sensemaking, distributed understanding and, finally, collective knowledge. They claim that *de facto* communities of practice will develop from these groups without the members thinking of themselves as a community. The community will influence and change practice, which in turn may reshape the community. In these communities of practice new knowledge is constantly created and shared. Moving knowledge between communities, however,

remains difficult since the social context plays such an important role. IT should therefore allow and support informal communication and participative learning rather than reinforce formal organisational structures (Brown, 1998) for effective knowledge sharing.

Having categorised knowledge into various types, it is important to underline that knowledge as a whole cannot be classified into any one category. In other words, knowledge is not either explicit or tacit, it is both explicit and tacit. Knowledge is not either know-what, know-why, know-how, or know-who, it is a combination of all types. Towards the end of their book The Knowledge-Creating Company, Nonaka and Takeuchi (1995) state that *"the essence of knowledge creation is deeply rooted in the process of building and managing syntheses"* (p. 237). Before new knowledge can be created, there are dialectic opposites such as tacit vs explicit, individual vs. society, learning by doing vs. learning theoretically, hierarchical organisation of knowledge vs. spontaneous knowledge creation etc, which require a convergence that is achieved through a spiral of divergence[3].

2.3 THE PROCESS OF KNOWLEDGE TRANSFORMATION

Knowledge is intangible, boundary less and dynamic, and if it is not used at a specific time in a specific place, it is of no value. Therefore use of knowledge requires the organic concentration of knowledge resources at a certain space and time. Knowledge develops operationally in terms of reconstruction at the level of links between the nodal institutions. Knowledge based systems do not exist in terms of stable elements, but they develop in terms of operations which can be combined and recombined in a variety of ways.

2.3.1 KNOWLEDGE ACQUISITION AND CREATION

Oinas-Kukkonen (2001) described knowledge creation as composed of four 'C's: comprehension, communication, conceptualisation and collaboration. The process of surveying and interacting with the external environment and integrating the knowledge to identify problems, needs and opportunities is defined as comprehension. Communication is defined as the sharing of experiences which leads to a reflection process articulating tacit knowledge to form explicit concepts, or conceptualisation. Finally, team interaction using the produced conceptualisation leads to collaboration. Bhatt defined this collaboration phase as knowledge adoption, which he defined as the acquisition of knowledge from other sources and adopting it for internal use (Bhatt, 2000). This definition is akin to Davenport and Prusack's (1997) mode of knowledge acquisition. They emphasise the collaboration angle of knowledge creation, both with respect to an enabling environment and a network where people share information. The five modes of knowledge creation, according to Davenport and Prusak are acquisition (from within a community or other sources), dedicated resources, fusion, adoption, and knowledge networks. The knowledge may not be new in the absolute sense but only new in the current context. Dedicated resources refer to different ways of institutionalizing creativity, or creation of an enabling environment. This aspect is

[3] Nonaka's major contribution to knowledge management is the well known SECI framework on different stages on knowledge, and this follows a spiral pathway. This is discussed in greater detail in the subsequent sections.

dealt with in greater detail in the following paragraphs where the concept of Ba is discussed. The process of fusion is broader than Oinas-Kukkonen's comprehension and involves adding complexity or even conflicts to force people to create joint solutions and synergy effects. This is the prime focus of Nonaka's SECI model of knowledge creation which is discussed later in section 2.3.3. Adoption deals with how selforganising communities react to crisis when faced with an "adapt or die" situation, the underlying premise being that success often is the enemy of innovation. Knowledge networks, finally, are defined as communities of people who share a common interest and utilise groupware, email or telephone to share expertise and collectively solve problems.

2.3.2 SYNTHESIS OF LAYERS OF KNOWLEDGE

Kusunoki et al (1998) identify three different layers of knowledge which imparts different types of capability to an organisation or community, the knowledge base, knowledge frame and knowledge dynamics. The knowledge base is the layer that includes distinctive individual units of knowledge, that is the tacit knowledge embodied in people and explicit knowledge embodies in codified processes. The knowledge frame layer captures the links between individual units of knowledge, and the knowledge dynamics layer is the dynamic interaction between the knowledge frame and base layer. The focus of a digital knowledge ecosystem must also be towards facilitating this knowledge dynamics layer so as to foster the creation and sharing of new knowledge. Conditions to encourage the process of knowledge creation include motivating the individual members of a knowledge base to accumulate, exploit and renew knowledge. Autonomy and creativity is key since new ideas usually develop at the individual level, and the individuals generating it must be given scope to follow their initiatives. This process of exploration can be encouraged by creative chaos, where flux and crisis cause people to reconsider precepts at a fundamental level. Tacit knowledge closely related to knowledge exploration. The other aspect of knowledge creation is knowledge exploitation, which is more concerned with explicit knowledge—the use and development of things already known (Levinthal and March 1993, p.105). Exploration involves discovery and experimentation—absorbing or creating new concepts or technologies, and developing new capabilities that may be outside the realm of a community's current specializations. On the other hand, exploitation is achieved through accumulating experience in a small number of specializations, and by increasing proficiency through repeated practice and the formalization of knowledge.

This dynamic synthesis of knowledge between what appear to be opposites and contradictions is created through a spiral that goes through two seemingly antithetical concepts such as tacit and explicit, chaos and order, micro (individual) and macro (environment), self and other, mind and body, part and whole, deduction and induction, creativity and control, top-down and bottom-up, bureaucracy and task force, and so forth (Andrus, 2005). The key to leading the knowledge-creating process is dialectical thinking, which transcends and synthesizes such opposites. Tacit knowledge and explicit knowledge are portrayed as polar ends, but they are not only complementary to each other, but are also interdependent. We really start to understand tacit knowledge the moment we permit ourselves to understand our explicit knowledge. The exercise of one form of knowledge requires the presence and utilization of the other form. Moreover, they are interpenetrating, that is, there is some explicit knowledge in every nugget of tacit knowledge, and some tacit knowledge in

every nugget of explicit knowledge. A community creates and utilizes knowledge by converting tacit knowledge into explicit knowledge, and vice versa. The process of knowledge conversion, when approached in this manner, has been formalised as SECI model, the SECI spiral, or the SECI process. This transformation, which is at the very heart of the knowledge-creation process, depicts how tacit and explicit knowledge is amplified in terms of quality and quantity, as well as from the individual to the group and then to the organizational level.

2.3.3 THE SECI PROCESS

Knowledge creation starts with socialization and moves through four ordered cyclic phases/stages, forming a spiral. It is amplified by moving through the four modes of conversion, which are described below. The spiral is also amplified as it moves up the ontological levels, from the individual to the group and then to the organization or community, as each mode of the SECI process involves a different combination of the knowledge creating entities (Nonaka and Takeuchi 1995).

Socialization refers to the sharing of tacit knowledge between individuals through joint activities like being together, spending time, and living in the same environment. Through formal mechanisms such as internships, tacit knowledge residing within one set of entities is transferred to another set of interacting entities. Theories of group processes and organizational culture can inform the understanding of the socialization process.

Externalization is the expression of tacit knowledge and its translation into more comprehensible forms that can be understood by others. Tacit knowledge, which is personal, context-specific, and hard to formalize and communicate to others, is articulated through dialogue and reflection and shared by using metaphors, concepts, hypothesis, diagrams, models, or prototypes, thus converting itself to explicit knowledge. What drives this process of knowledge amplification is the continuous, dynamic, and simultaneous interaction between tacit knowledge and explicit knowledge.

Combination, which is systemizing and applying explicit knowledge and information in the appropriate context, has its roots in the information-processing paradigm. The explicit knowledge is converted into more complex sets of explicit knowledge through communication, diffusion and systemization of knowledge. Tools for such combination are documents, meetings, telephone conversations, or computerized communication networks.

Internalization refers to learning and acquiring new tacit knowledge in practice. Thus, the newly created complex explicit knowledge is converted into the tacit form for a specific purpose. Tools to facilitate such learning by doing could include training programs, simulations or experiments, cross functional development teams, search and sharing of new values and thoughts, facilitation of prototyping and benchmarking, facilitation of challenging spirit, and instilling a culture where results of any initiative are shared with the entire community. In essence, the community must be enabled to transform itself into a learning community.

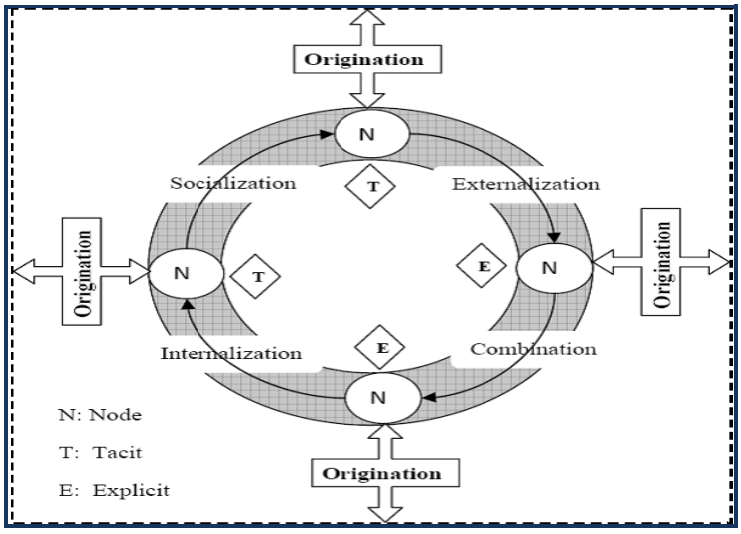


Figure 2.1. Nonaka's Knowledge Creation Framework[4]

2.3.4 THE CONCEPT OF *BA* – SHARED KNOWLEDGE SPACES

Oinas Kukkonen's comprehension and communication are similar to Nonaka and Takeuchi's internalization and socialization concepts, while conceptualization includes both externalization and combination. Davenport and Prusak's dedicated resources or Kusunoki's knowledge frame has been explored under the reference concept of *"ba",* which addresses the conditions and psycho-social locations for knowledge creation (Nonaka and Konno, 1998; Novak and Wurst, 2004). *Ba* is a shared space for emerging relationships and a platform for advancing individual and/or collective knowledge. This space can be physical, virtual, or any combination of them, which provides a foundation for creation and growth of individual and collective knowledge. Four categories of *ba* are especially suited for knowledge conversion modes: *Originating ba* is the world where individuals share feelings, emotions, experiences and mental models. *Interacting ba* is more consciously constructed, so people's mental models and skills are converted into common terms and concepts. *Cyber ba* is a place of interaction in a virtual world (where combination of explicit knowledge occurs) and *Exercising ba* facilitates the internalization phase (i.e. training with mentors or colleagues). Corno *et al*. (1999) later proposed *District ba* as the space where different organizations interact.

2.3.5 SHARING KNOWLEDGE

Knowledge represents a source of power to people. By sharing valuable knowledge, one runs the risk of diminishing one's value within an organization or community; as, potentially, one is no longer indispensable. Since time and energy are finite, an individual will take the time to help another individual if he or she is likely to receive valuable knowledge in return, either now or in the future. Moreover, that individual must have a reputation for expertise, without which the knowledge he (she) has to offer is not considered valuable. Finally, before sharing, the individual must have some assurance that due acknowledgement of the source of the knowledge will be given. Sometimes,

[4] Amritesh and Sarkar (2008)

individuals share knowledge just because they find an issue fascinating, in a process akin to self gratification. Thus, these four "conditions" for an individual to share knowledge could be referred to as reciprocity, repute, trust and altruism.

2.4 KNOWLEDGE CREATION MECHANISMS

In this section we attempt to document specific interventions involved in the creation of knowledge as reported in the knowledge management literature. Starting with the premise that knowledge creation is a dynamic process involving knowledge discovery, transformation, sharing, application etc. as discussed in the last section, we attempt to categorise modes of knowledge creation.

The modes of knowledge creation in a community are the processes that amplify, as a group, the knowledge created by individuals and crystallize it at the group level through dialogue, discussion, experience sharing, sense making, or community of practice. Self-organizing teams play central role in the knowledge-creating process. They provide a shared context in which individuals can carry on a dialogue, which may involve considerable conflict and disagreement. It is precisely such a contradiction that pushes individuals to question existing premises and to make sense of their, experiences in a new way. This kind of dynamic interaction at the group level facilitates the transformation of personal knowledge into shared knowledge. The individual is the "creator" of knowledge and the group is the "amplifier" of knowledge. But the actual context in which much of the conversion takes place is at the group or team level. The group functions as the "synthesizer" of knowledge. The more autonomous, diverse, and self-organizing the team, the more effectively it will function as a synthesizer. Table 1.1 summarises mechanisms of knowledge creation, as reported by Roth et. al (1999) for independent project related activities.

Scriven (1977) and Patton (1987) link knowledge creation mode to performance, by classifying knowledge creation modes into two types, goal-free and goal-driven. The goal-free mode asserts that creation should be carried out in a thinking space with full freedom while the goal-driven argues that the creation should be conducted under a predefined goal. Thus the goal driven mode ensures that knowledge creation is efficient as the community works towards a shared objective, but may not be effective as this might stifle original research. Thus, in addition to using old-fashioned, disciplinary hierarchical management techniques, knowledge management must also deploy loose innovation environments where actors are dynamically self-forming. Enablers of knowledge creation within a community include a shared understanding of the environment in which it functions, the fostering of an experimental mind-set among individuals, permeable boundaries around information flow so people can make their own observations and a commitment to lifelong learning at all levels. Involved leadership, which is having leading knowledge creators engaged in hands-on implementation of the community vision, and advocating the cause of knowledge sharing results in an environment which is conducive to knowledge creation. The need for a systems perspective, where the key actors think broadly about the interdependency of organizational variables leads to the final synthesis of knowledge.

Table 1.1. Mechanisms of Knowledge Creation.

Project phase	Knowledge creation within projects		Knowledge creation between projects	
	Key tasks/activities	***Mechanisms***	***Key tasks/activities***	***Mechanisms***
Planning	- Planned group composition - Avoidance of possible conflicts - Informal discussions when time and context allows	Creative environment Clear goals and purposes Mentor relationships Motivated employees Too friendly an environment	- Seek people with useful competence - Sharing knowledge with other projects knowledgeably (e.g. techniques, experiences) - Seminars or interaction over a cup of coffee - Inviting people with specific knowledge - attending seminars	- No political barriers or unwillingness - Motivation to start the project with the best knowledge available - Personal network - Rumor where to find knowledge - partial diffusion of knowledge in the organization
Execution	- Informal dialogue between colleagues ('coffee break discussions') - Contact with external consultants - Discussions when time and context allows	- Physical closeness - Clear goals and purposes - Mentor relationships	- Diffusion of knowledge only in small groups	- Limited because of time pressures - Rotate employees between projects
Evaluation	De-briefing	Learn for the following project	- Organizing seminars with the purpose to share knowledge - Involvement in other projects - De-briefing	- Motivation Incitement - Organizational structures for knowledge creation - tacit knowledge exchange through practice and association

Adapted from Jonas Roth, Henrik Florén & Anders Ingelgård (1999), Knowledge Creation in the Context of. Continuous Improvements. EIASM, Cambridge.

We have already emphasized that knowledge creation is the dynamic synthesis of several concepts (such as tacit and explicit knowledge), which appear to be opposites and contradictions. Hence it can be safe to conclude that while both the top down and bottom up modes of knowledge creation have their merit; neither of them is complete in themselves. For unfettered and efficient knowledge creation, there is a need for both modes to co-exist – perhaps as knowledge networks. In a knowledge network, the bottom up approach with its emphasis on sharing and harnessing tacit knowledge results in it evolving into a digital ecosystem, while the information processing capability endowed by a hierarchical top down approach transforms into sustainability for the system.

In this context, the top-down and bottom-up models for knowledge management have long been viewed as two opposing ends of the knowledge management-process spectrum. The implicit assumption behind the top-down model is that only top managers are able to create knowledge.

Moreover, the knowledge created by top management exists to be processed and implemented by people at lower levels of the hierarchy. In contrast, the bottom-up model assumes that knowledge is created by entrepreneurial front-line employees, with very few orders and instructions coming from top management. The top-down model is primarily suited for dealing with explicit knowledge, but not tacit knowledge, while the reverse holds true for the bottom-up model These knowledge creation modes are briefly discussed next, along with a third option, the network mode of knowledge creation. Section 2.4.4 then contextualizes the modes discussed within our objective of developing a DKE for Indian agriculture.

2.4.1 THE TOP DOWN MODEL OF KNOWLEDGE CREATION

The top down model of knowledge creation, a hierarchical highly formalized, specialized, and centralized structure, is focused on combination and internalization of knowledge. From a knowledge-creation perspective, it is an efficient structure to acquire, accumulate, and exploit new knowledge and works well in conducting routine work efficiently on a large scale. Because of its permanent nature, the top down approach is quite effective in exploiting and transferring knowledge continuously and widely throughout the entire organization. Moreover, management can directly design and control the transmission of such knowledge. Such explicit knowledge, also called designable knowledge or management induced knowledge (Kusunoki et al, 1998), should display strong scholarship, sound judgment, and disciplined editorial review.

Hierarchy, however, hobbles individual initiative because of its strong propensity for control and can be dysfunctional in periods of uncertainty and rapid change. It is not suited to acquire, accumulate, and exploit tacit knowledge. Infact, Nevis et al. (1995) categorically state that the management of knowledge-creation cannot be achieved using old-fashioned disciplinary hierarchical management techniques.

2.4.2 THE BOTTOM UP MODEL OF KNOWLEDGE CREATION

Since the dawn of human-kind people have shared knowledge and collaborated with each other to achieve tasks and objectives that were out of their individual reach, to learn from the previous experience of others as well as to transmit their own learning to others. To enable such interactions, there is a need to establish trust between the people who share, create horizontal spaces where every participant's opinion is valuable because it's based on his/her individual experience; and emphasize collective creation, rather than highlighting the knowledge of the individual 'expert' (Zúñiga 2007).

The bottom-up model (also a task force approach, or group induced knowledge creation), is flexible, adaptive, dynamic, and participative, the polar opposite of the hierarchical model. Focused on socialization and externalization, this mode of knowledge creation is particularly effective in carrying out a well-defined task that needs to be completed within a certain time frame.

With the confluence of technological advances that have led to the phenomenal growth of interactions in the digital space, the scope of the bottom up mode of knowledge creation in digital form has increased exponentially. While online collaborations and community interactions existed

before on a limited scale, the web 2.0 revolution changed the size and scope of communities of participants and the nature of tasks they can perform dramatically as the cost of being online declined and the ease of using the net increased with user friendly interfaces (Parameswaran et. al, 2007) . However, emphasizing tacit knowledge alone, as is known to dominate in bottom up models, can be dangerous. For one thing, there is a danger of over-adaptation to past success. Moreover, unless the community is open to new members and new lines of thought, such a mode of knowledge exchange, used exclusively, could lead to "group think", which is a big deterrent to knowledge creation.

2.4.3 EMERGENT KNOWLEDGE – THE ROLE OF NETWORKS

It should be noted that the top down and bottom up modes of knowledge creation are inseparable when viewed from an organizational level, because the first influences the other and to some extent vice versa. Management-induced mechanisms attempt to optimize group-induced mechanisms by creating the context that nurture the mechanisms induced by the group. Examples of facilitating factors could be different settings for the exchange of ideas, arenas for dialogue and discussion (*ba*). At the same time, too much involvement by the management, by tightening procedures, policies, and action for example, could stymie bottom up knowledge creation (von Krogh 1998). A well accepted way to ensure that the fragile process of knowledge creation is driven by individuals and groups motivated to create something and to reach goals is to facilitate the process of building networks and gain a willingness to acquire and share experience.

The institutional network arrangements become a background as well as a necessary condition for producing and retaining knowledge. Scardamalia and Bereiter (1994) highlight how the growth of *'individual and communal knowledge resources can revolve around the development of 'improvable ideas'; cultivating the abilities of synthesis and reflection as the basis for a 'disposition*' towards knowledge-building; and building a discourse aimed at knowledge transformation. They link narrative accounts of participants' learning goals, achievements and self-reflections with accounts of practice through activity reports and learning logs (on a daily or monthly basis); and highlight the value of 'rise above' sessions. Knowledge-building involves learning how to find different types of knowledge and learning how to learn together with collective responsibility for developing expertise and conceptual ideas. At the same time it is important to note that knowledge is created only by individuals as he or she gains subjective insights, intuitions, and hunches from bodily experience. Therefore, there is a need to support and stimulate the knowledge-creating activities of individuals or to provide the appropriate contexts for them.

Web 2.0 intelligence, referred to in the earlier section, depends on application of emergence theory to create smart systems that learn by aggregating independent, emergent data. The creation of meaningful connected knowledge through individualized discovery facilitated by the design and support for new emergent learning networks would need to consider retrieval, sharing, collaborating and problem solving via a connected, digital environment. Successful knowledge outcomes would be demonstrated by finding information; organizing and synthesizing it; generating new knowledge from the information available; and negotiating, sharing and collaborating in its dissemination. In alignment with constructivist learning theory, this theme centers on the idea that we construct knowledge or understanding of the world through our experiences and interactions (Bruner, 1990).

Technology cannot create the gains hoped for in creating and sharing knowledge until systems designers recognize that information is dynamic, situated and socially constructed. It is vital for social knowledge – created via distributed, dynamic and collaborative work - to be encouraged (Hall & Graham, 2004; Rosenberg, 2001).

Recognized as key to effective information flow and knowledge management, social network analysis (SNA) focuses on determining the hubs or strong nodes often hidden within the network of connected actors. The questions that SNA seeks answers to include:

- Who do people go to when they need information?
- Who are the experts that people trust to give them correct information on a topic?
- How can the organization find and map this knowledge, and thus capture and disseminate what these strong nodes know?

For SNA experts, knowing the strong nodes, where to find them, and how to create access to them would become one of the design and analysis parameters of the knowledge sharing and creating environment.

Unfortunately, however, the literature provides little input towards a concrete framework for the successful design and support of emergent learning environments, even though the need is evident and its value to knowledge management well-demonstrated. It is also accepted that collective understanding and collaboration is at the heart of dynamic learning and knowledge creation, which has led to a focus on bottom up modes of knowledge creation. However, this shift in bottom-up design will succeed only if next-generation designers participate by framing top down resources while understanding their own inability to predetermine or control outcomes. Successful top down design for bottom-up learning, created by a shift to social, networked knowledge that puts the information of the world at our fingertips, depends on a better understanding of the needs and characteristics of the network actors themselves.

Digital network dynamics are centered on a "*two-way flow of power and authority based on information, knowledge, trust and credibility, enabled by interconnected people and technology*" (Husband, 1999). For unfettered participation in a vibrant knowledge management system, trust that the organization can support new ideas, risks and mistakes is a vital characteristic. Such a knowledge management system would emphasize the role of emergence in the collective or of hive mind expertise in the dynamic aggregation of new subject matter knowledge. Warkentin *et al.*(2001) describe a knowledge network as the collaborative relationship existing at the interface of two organizations collaborating in a dyadic alliance. Powell *et al.* (1996) emphasize the importance of such knowledge networks (through interorganizational collaboration) when the knowledge base in an industry is both complex and expanding and the sources of expertise are widely dispersed. In this deliverable, however, the definition (and implications) of knowledge networks are much wider and far reaching, as they apply to an open knowledge space that mimics an ecosystem. All forms of collaboration (including communities) can be regrouped under the umbrella concept of *network*, defined by Bardach (1994) as "*a set of self-organizing working relationships among actors such that any relationship has the potential both to elicit action and to communicate information in an efficient manner*".

2.4.4 CONTEXT OF THE STUDY – THE INDIAN AGRICULTURE DOMAIN

Several key institutions (knowledge nodes) in the domain of agriculture have come together under the umbrella of the National Agricultural Innovation Program (NAIP) to create a cultural and institutional proximity among them to support both intentional and unintentional sharing of knowledge. Together, they intend to create a digital knowledge ecosystem in the agricultural domain, where communities of practice associated with farming, whether farmers, corporate houses, nongovernmental organizations, or government bodies, can come together and to participate in the creation, sharing, editing, enhancing and semantic-combining of knowledge. As communities of practices from geographically and culturally disparate research and academic institutes having common interests in agriculture come together using a digital ecosystem-based IT infrastructure, it is hoped that several factors underpinning knowledge co-creation can be explored. To foster social capital there is a need for easily grasped depictions of social capital patterns in current social networks and knowledge of which alternative patterns would best foster knowledge creation and sharing. IIT Kanpur will contribute towards creating a functional e-community of practice among experts and practitioners in the agricultural domain to promote a process of social learning. Communities of practice informally exist in agriculture but it is not structured in a way to leverage it efficiently for further growth or even effective knowledge sharing among members neither is it supported by technological means. However it offers great promises for knowledge sharing by facilitating contacts between domain experts among different geographical locations, environments, organizations and even nations.

Individualism and diversity in the creation of content may undermine the ultimate goal of having a place a useful repository of knowledge. Despite its spontaneous nature and low barriers to entry, online communities demonstrate a remarkable ability to converge to objectivity in content. As the reputation of the online community grows, the quality of the generated content also improves, possibly due to rising high quality participation and refinement. In addition to good quality content another objective of the DKE is to promote a rapid convergence to the initial objective of agropedia to progress towards distributive knowledge generation. Knowledge Management tools to achieve these goals are discussed next.

2.5 TOOLS FOR KNOWLEDGE CREATION AND MANAGEMENT

Knowledge management tools are essential to achieving knowledge management strategies. Any knowledge management system must be able to capture and store knowledge nuggets, search and retrieve them, send critical information to individuals or groups, structure and navigate search requests, share and collaborate, synthesize information, profile and personalize, solve or recommend, integrate, and maintain knowledge repositories. Tools that support spontaneous meetings and the creation of CoPs include simple facilities such as hosting home pages, enabling email interaction for swift and asynchronous meetings and interactions in between members, and better known applications like chat rooms, wikis and blogs.

An authentication tool must be activated prior to granting a user access to any private information. This tool has the ability to manage permissions on creation, editing, commenting, etc. by the management of user identification via accounts and passwords. With a homepage and email

facilities, a person can get people interested in a subject, contact the author, and in this way start a virtual community

A weblog (or blog) is a site that runs via the user's Web browser, enabling journal-like entries without needing special skills or coding. Posted on a regular basis and displayed in latest chronological order, blogs allow for comments or trackbacks from the readers of the blog. A wiki is a web site that allows visitors to easily add, remove, and edit collaborative content, the most popular instance of which is Wikipedia. The Wiki and the Blog are complimentary companion technologies that together form the core workspace that allows users to share, innovate, adapt, respond, and be—on occasion—brilliant. Blogs cite Wiki entries, and often an occasional brilliant blog comment influences content on the authoritative Wiki.

The Wiki and Blog, however, while standing together, cannot stand by themselves. They draw from a knowledge repository consisting of documented knowledge, patterned after a more conventional encyclopedic repository of established knowledge. The Blog and the Wiki serve as successive refining processes for the unrefined ore (emergent knowledge) in the agricultural knowledge repository, which would subsequently find a place in the commissioned content or knowledge repository.

2.6 GOVERNANCE STRUCTURES IN KNOWLEDGE CREATION

Many virtual communities emerge spontaneously, scale rapidly and support freedom of expression and anonymity. While such communities often develop without a deliberately designed democratic structure, governance structures can play a vital role in determining the success of an DKE. Wikipedia, for example, demonstrates both elements of democracy and meritocracy; everyone has veto rights in principle, while reputation plays a role in conferring administrative status to a user. Although enforcement powers are lacking and formal rigorous contracts are not in place, the community governs itself as individual users rely on convention, social norms and collective agreement to sustain themselves as a community. The balance between individualism (personal expression) and altruism (sharing knowledge for communal benefits) is maintained because of mechanisms set up for self governance such as peer review.

Governance structures or the organizational culture, and the social networks that frame it, are often blamed for the failure of an DKE to sustain itself voluntarily, as the governance structure can design mechanisms to foster trust, mutual respect and reciprocity. It can also cater to self gratification needs by publicizing achievements such as most widely commented on blog, or most cited wiki.

2.7 INTEGRATED KNOWLEDGE MANAGEMENT SYSTEMS: PEOPLE AND TECHNOLOGY

Information workers are expected to learn, do, share, mix, combine and create new knowledge from a variety of media-rich Intranet and Internet material, but are often left on their own to determine effective use of the tools, resources and material available (Kurtz & Snowden, 2003). This is

especially true where needed information changes overnight, but an organizational understanding of dynamic knowledge and how to support just-in-time learning does not keep pace with the needs of the learners (Nissen,2006). To make sense of changing information – to continuously gather, analyze, negotiate, synthesize and share complex data - is an expected outcome at all levels of a knowledge sharing and creating community and yet a collective understanding of the framework (tools, processes, operational support and management) is missing (Allee, 2002). Building shared knowledge (or intellectual capital) includes creating an environment where individuals are supported and encouraged to build relationships, share expertise and skill sets and recognize the value of leveraging each others' experiences.

Nardi and O'Day (2000) claim that effective information ecology includes support for context-specific habitats: environments that include not just the technology, but the people, practices and values inherent in use of knowledge technologies. Creating new emergent knowledge creating and sharing models could give designers a better opportunity to tap the "full potential of interaction and community networks" that are at the core of the new social and collaborative practices found in online, informal learning environments (Irlbeck et al., 2006, p. 171). As already discussed in section 2.4, design for new organizational knowledge environments must look past the old push models of delivering content and create pull environments for finding information within individualized, self-directed learning (J. S. Brown & Hagel, 2005). Design of an DKE demands creation of environments that support just-in-time collaboration, contribution, and management of knowledge that is available whenever and wherever needed. A better understanding of the social aspects of the knowledge sharing environment and of the tools that make it possible to capture and share tacit knowledge is essential before developing the technology and tools to create a virtual community.

In the last few years, the socio-technical perspective has emerged as the dominant paradigm in the information and knowledge management system studies. Knowledge management, characterized by technological process view, has given way to new approaches that examines the social dimensions of knowledge creation, transfer, and management. Theories explain certain physical constructs like 'community of practice' (Prothmann, 2006), 'community of scholars', and virtual constructs like 'knowledge networks'(Prothmann, 2006) , 'intellectual geography' (Sawyer and Rosenbaum, 2000), 'shared values' etc that enables us to characterize the knowledge management system through IT-based as well as community based approaches. The introduction of information technology (IT) enlarges the scope of communities of practice, both temporal and spatial, which creates new and interesting possibilities. Since IT has a tendency to reinforce old, formal, hierarchical structures, care must be taken to utilise IT in such a way that it supports informal networking.

2.8 CONCLUSION

Schumpeter postulated "dynamic disequilibrium" as the economy's only stable state, and "creative destruction" on the part of innovators as the economy's central driving force. The shift to the Knowledge Society uplifted paradox from something to be eliminated and avoided to something to be embraced and cultivated. Contradictions, inconsistencies, dilemmas, dualities, polarities,

dichotomies, and opposites are not alien to knowledge, since knowledge itself is made up of two dichotomous and seemingly opposite components - namely, explicit knowledge and tacit knowledge. It is only natural then, that knowledge creation itself is the result of the constant dialectics between push and pull knowledge. The challenge in shared knowledge creation is still in the determination of practices and technology usage that would support effective participation within the vast array of tools now available (Hiltz & Turoff, 2002).

3. DIGITAL KNOWLEDGE SPACES ACROSS DIFFERENT DOMAINS: A COMPARISON OF AGROPEDIA WITH MEDPEDIA AND INTELLIPEDIA

3.1 INTRODUCTION

agropedia is a first of its kind endeavour in the agricultural domain to develop a knowledge management platform where a diverse set of players and interested actors including several communities of practice find a level playing ground to interact with and learn from each other seamlessly, while documenting and creating nuggets of knowledge as a result of the exchange. In order to evaluate the efficacy of this DKE, its governance framework, incentive mechanisms to attract and retain participation while employing two different modes of knowledge creation, we needed to compare it with other similar knowledge sharing and creating platforms. Unable to identify similar large scale endeavours in the agriculture domain, we looked at other domains to find parallel initiatives among the community of medical practitioners as well as intelligence agents. These spaces are called medpedia and intellipedia, respectively. Formally launched in February 2009, medpedia is an open knowledge space aiming to create an open access medical encyclopaedia, supported by well known schools of medicine and communities of practice among the medical fraternity. Established as a pilot project as far back as 2006, Intellipedia is a closed knowledge space, used by the Intelligence community in USA. Users are classified, and each user has differential access to the information available on Intellipedia depending on rank. As of April 2009, the overall Intellipedia project hosts 900,000 pages edited by 100,000 users, with 5,000 page edits per day (http://en.wikipedia.org/wiki/Intellipedia). In contrast, the agropedia platform is still work in progress. Its social spaces are not formally launched yet, and it is expected that the lunch will take place sometime towards the end of 2009. Some of the tools are still under development and testing, and its wiki and blog are still in the priming stage. Nevertheless, in what follows, a qualitative comparison of these three initiatives is provided, with a table summarising major features of each.

3.2 AGROPEDIA

Knowledge Models for **agropedia** (www.agropedia.net), the agricultural knowledge hub for Indian agriculture, was launched on 12th January, 2009 in Delhi. **agropedia** is a digital content base as well as the open platform for learning, sharing and creating knowledge in the agricultural domain. For socio-economic development, of a country like India it is necessary to expand and strengthen the intra and inter regional communication structure to smoothen the flow of knowledge particularly in the agricultural sector. Experts identify lack of communication and proper knowledge flow as key causes for a lack of improvement in agricultural productivity. One of the preconditions for a proper flow of knowledge is to manage widespread knowledge and information through proper networking. The success of the whole process of knowledge management depends on the network structure and adaptability power of the users which depends on the effective communication system; that again depends on the method of access to the knowledge base, form, relevance & suitability of the content which creates a social desire to attract the users. In this context, we first look at the features of the agropedia site.

In brief, agropedia is the combination of a static and dynamic knowledge repository based on a web 2.0 technology platform having features like collaborative content creation and open access. Based on the mode of origination, the created knowledge base is classified into two separate categories: 'Certified Content' (gyandhara) and 'Contributed Content' (janagyan).

The certified content provided by agricultural scientists is (relatively) static. It is classified as 'Extension Material' on the agropedia site under the subfolders 'Library' (space for certified documents), 'Crop Calendar' (month-wise information needed for different crops) and 'Dos and Don'ts' (general prescriptions and precautions for various practices). The content posted in these spaces are validated and approved by the agropedia administrator before being published on the website. This type of content is known as explicit knowledge. Here every user can search and access this knowledge space and can use the available knowledge free of cost without any permission. As this type of explicit knowledge is available in codified form, it is relatively easy to digitize, store, transfer and manage.

The other part of knowledge base consists of 'contributed content', which is present in the mental models, collective practices and past field experiences of practitioners (tacit knowledge). To capture the wide spread tacit knowledge in agricultural domain and to build an agricultural community network, agropedia provides a social networking space on the website under the section named "Interactions". In this space a user can share and exchange his knowledge and experience on the agriculture related issues through 'agrowiki', 'agroblog', 'forum' or 'agrochat'. 'agrowiki' is a free space for creating new articles and updating knowledge by editing existing wiki-content by multiple users at the same time. It facilitates a dynamic knowledge creation space and an ideal learning platform. 'agroblog' is created primarily to provide a personal space for users to express himself/herself and share personal experience with the others. 'forum' is an open space for question-answer discussion where one can get prescriptions and precautions related to crop cultivation and other agriculture practices. agrochat is the chat room allowing the agropedia users a space for discussion among themselves both publicly and privately.

For uploading any type of content and comments the agropedia users have the option to add it in audio, video or text format. The unique feature of this site is a web 2.0 enabled semantic search mechanism for the 'Library' content. Besides, the content created in the 'Interaction' web space is self organized using a folksonomy.

Knowledge Models, the graphical representation of knowledge, have been developed by the IITK agropedia team along with other partner institutions for the purpose of tagging and indexing the library content. It is very helpful for agricultural experts and students to locate the right content. Regarding content creation, there are certain important points which must be considered: a) where everyone can search the content only the registered users (free registration) are able to add content and post comment, b) the consortium partners are liable to provide certified (commissioned) contents, and c) the Knowledge Models can be created and edited by some selected agricultural-scientists and others can comment on it through a Knowledge Model Blog. The distinguishing characteristics of agropedia can be summarized as:

a. The certified agricultural-knowledge repository (Extension Material)

b. The common platform for sharing and exchanging agricultural-knowledge (Interactions) – yet to be formally launched

c. Content in audio, video or text format.

d. The first knowledge sharing platform with the semantic search feature (Knowledge Models & Library content)

At present there are around 550 registered users with 1240 pages in the agropedia site (as on 30th April, 2009).

3.3 MEDPEDIA (WWW.MEDPEDIA.COM.)

This is an initiative to connect the health care professionals and bring them together on a common interactive platform for mutual exchange of personal knowledge and experiences. "Since the announcement of the Medpedia Project in July 2008, over 110 organizations have contributed or pledged over 7,000 pages of content to the knowledge base, and thousands of people have become associated to this community." At the time of launch of version 1.0 in beta of the online Medpedia platform on 17th February, 2009, 25 health organization including American Heart Association, National Health Service of the UK, the University of Michigan Medical School, the university of California Berkeley School of Public Health, Harvard Medical School, Stanford School of Medicine and many others declared to contribute and use this network platform. Medpedia also maintains a directory of contacts and profiles of the registered users where one can search according to the type of professional expertise to connect to the people having common or relevant domain of expertise. The goal of the Medpedia Project is to create a new network model for the world to access, assemble, maintain and critique the medical knowledge created and shared by the members.

It is expected to evolve as a repository of up-to-date unbiased medical information, contributed and maintained by health care experts around the world, and freely available to everyone. Medpedia.com Inc. is funded and managed by Ooga Labs (www.oogalabs.com), a technology greenhouse in San Francisco. Medpedia is mainly providing a network space in the form of 'wiki' and 'forum' for co-creating and sharing advancing knowledge about health, medicine and the body among medical professionals and the common people seeking this knowledge. Though it is an open platform, the Medpedia community restricts itself only to the medical "professionals" to edit and create contents while others can suggest changes etc.

The Medpedia Platform includes three interrelated characteristics:

a. The collaborative medical knowledge base: The Medpedia collaborative knowledge base is developed by medical professionals. It provides medical professionals and organizations an open space to record their knowledge which also helps to reflect their field of expertise and get national and international reputation through public representation of their professional knowledge. It is the dynamic knowledge repository created and maintained physicians and researchers having PhD degrees who have the sole privilege to act like a Medpedia editor. It has two different pages for every article topic- i) plain English for the general public and ii)

clinical, using more academic, advanced language for medical professionals. Non-professionals can post articles in addition to their suggestions; but they are published in the site only after approval from the editors.

b. Professional Network and Directory for health professionals and organizations: The Medpedia Professional Network provides medical and health professionals a free communications and networking system. Here professionals are supposed to create their profile that summarizes their medical experience and accomplishments. It is a professional expertise directory, a recruiting tool for research collaborators, and a clinical referral network that helps one find peers, coworkers, colleagues, clients, and partners as well as provides an opportunity to be publicly recognized by them. The medical professionals who are part of the Medpedia professional network and directory can create different groups according to different medical colleges and hospitals, through which they can get connected with their colleagues or other medical professionals. So from this aspect it is similar to the "LinkedIn" space.

c. Communities of Interest for medical professionals and non-professionals: Any user of Medpedia can create Communities of Interest for finding and sharing information for common health issues. Anyone may create a community of interest and any individual may join any community of interest according to their own interest. This is a common platform that brings health conscious people, patients, learners and medical professionals together to share knowledge around health conditions, treatments, and lifestyle choices.

Thus, the physicians and Ph.D.s in a biomedical/health field are the contributors of the content and create a high quality knowledge base. They are the critical nodes of the entire network structure developed through Medpedia. This is a free online platform which is easy to understand, collaborative, interdisciplinary, transparent, and aims to evolve into the best available medical information providing website.

3.4 INTELLIPEDIA

Intellipedia is a project of the Office of the Director of National Intelligence (ODNI) Intelligence Community Enterprise Services (ICES) - Fort Meade, Maryland. The site was formally announced on April 2006. This is another important knowledge sharing platform developed by a host of individuals and organizations connected with U.S. intelligence community. It is an intelligence knowledge repository which is using 'wiki' and 'blogs' as the social networking spaces for knowledge creation and sharing. Intellipedia is giving more focus on search technology and feedback technology to make the site more efficient and effective for search option and to gather the different views on different topics for its continuous upgradation. It operates in three content creation and sharing modes: unclassified, secret and top secret where top secret is the most active part. It includes information on the regions, people, and issues of interest to the communities using the host networks. One of the objectives of the site is to identify the brilliant ideas and to apply it for strengthening the U.S. security forces. Presently there are 57248 user accounts and 439387 created pages which are used by individuals from the 16 agencies of IC and other national-security related organizations. But this

online platform is not open to the public as this type of information need a secured environment for the country's security to handle with.

3.5 COMPARATIVE ANALYSIS

Considering these three collaborative knowledge sharing platforms, we can make a simple comparison among them.

1. Nature of the platform: agropedia and Medpedia are open online platforms system for the agriculture and health interested people respectively. But Intellipedia is a closed platform system for the U.S. national security, defence and intelligence community. This means, while everyone can access both Medpedia and agropedia, the Intellipedia can be accessed only by its selected community members.

2. Content type: agropedia consists of both commissioned and contributed content where as Medpedia and Intellipedia consists of only contributed content. The agricultural-experts of the agropedia consortium partners provide generally the certified content, which, by nature, is explicit and static. The other agropedia users develop and enrich the knowledge base of the interaction space by their individual and collective contributions. This is basically tacit and dynamic type of content. In comparison, medical professionals are the main content contributors in Medpedia, and U.S. defense and intelligence officials are the respective contributors in Intellipedia. In all the sites the contents are dynamic but may be tacit or partially explicit.

3. Knowledge sharing mode: The agropedia users have more choices in the process of knowledge sharing as compared to medpedia or intellipedia users. They can share their information and experiences through wiki-pages, blog-contents, forum-topics, or through discussions in chat. We discussed before that all the registered users are able to add content in agropedia. The contributed content of the interaction space are shown on the website just after posting the content. The certified content (Extension Material) has to be validated through agropedia administrator and published on the site after approval. In medpedia the medical professionals are the ones who edit and create contents, others can only make suggestions which are published only after the approval from the editors. In Intellipedia the community members are divided into three classes according the sensitivity of the content: Top secret, secret and unclassified; and all of them are not able to access the whole data set of knowledge available on the website. They can share and exchange knowledge accessible to them only, which is not the entire repository. Conclusively, from the vantage point of capturing tacit knowledge and building up of a knowledge community, Intellopedia and Medpedia have low and restricted knowledge transactions across the network, while agropedia is much more effective.

4. Knowledge actors: The knowledge actors of agropedia can be divided into three groups- Content Community, Target Community, and Actual Target Community. All the institutions who are working as the explicit and certified knowledge providers, directly or indirectly, can

be called as “Content community”. The “Target Community” includes KVKs, scientists of state agricultural universities and the other deployment partners where farmers, agricultural workers, traders, retailers, self-help-group and others, related to agriculture can come to communicate for access and exchange of knowledge. The “Actual Target Community” refers to the farmers, and others who apply that knowledge in their daily practices. The people of this community are also tacit knowledge holders by their practical experiences. But due to their current literacy and language problems, agropedia has to target the extension workers and other partners who work for them to disseminate the knowledge. In addition the target group can also act to collect their practical experiences, transform their tacit and dynamic knowledge into the explicit one. Thus there is a cyclical knowledge creation and exchange path between experts and farmers and transformation path between explicit and tacit through the target community.

But in Medpedia, there are mainly two types of actors- editors and suggestion providers. The medical professionals who are the Physicians and researchers with Ph.D.s in a biomedical field are granted for editors. They build network among them through knowledge exchange and sharing from their expertise. Other users are the followers; they can search for the article pages, specialist medical professionals and their locations, develop and join community of interest. But they can only suggest changes for the article pages.

The Intellipedia is also divided their own specified users into three communities on the basis of types of contents- unclassified, secret and top secret. The 1st community has the access to all types of content including the top secret information, the 2nd community is able to access the secret and unclassified content and the 3rd community has access to only unclassified contents.

5. Users’ ability: The interactivity of the site depends on the capability of the users in handling the technical functionalities provided by the website. Most of the medical professionals and intelligence officers are comfortable with online contents but in case of agropedia a large part of the agricultural professional cannot even handle the computer system and hesitate to use the site. So when agropedia has to train and guide the users on how to handle the website and how to operate the system, the other two websites (Medpedia and Intellipedia) have faced such problems and users started to interact with their active contributions quickly after launching the sites. If we compare the number of user accounts and number of pages created in these sites (See Table 3.1), this is reflected easily. In this respect, though it is difficult to compare agropedia and medpedia with the intellipedia as it launched almost two and half years before, we can simply see it for agropedia and medpedia. Medpedia launched after agropedia, but the number of users’ accounts and number of pages created are far more than agropedia. The difference in participation may also be because health is a common interest area and the each and every class of the society wants to access the medpedia site; while only a certain part of the society is interested to take part in the agropedia community. So there always be a chance that the number of user account will be remained less for the agropedia site.

6. Network structure: We have discussed before that with respect of creation and sharing of knowledge, there are two ways of knowledge transaction (contributive and receptive) among all the actors in agropedia community. In Medpedia, same nature of knowledge transaction happens, but only within the professional community of users having edit permissions. Rest of other users have the choice of only one way (receptive) knowledge transaction and partially contributive (with administrative barriers). All members of each group in agropedia can act as both sender and receiver, can create content and can communicate with each other when required. In Intellipedia there are both way interactions within the communities but conditional and specified transaction between the communities. Therefore, while developing the digital platform, agropedia is focused on the concept of digital ecosystem, Medpedia is trying to develop a community network and Intellipedia is in the process of creating networked communities among the already existing intelligentsia.

   Secondly, the agropedia and the Medpedia communities are the combination of both formal and informal network, while that of the Intellipedia is only formal according to the security needs. In agropedia, Content community and the Target community are formally constructed within themselves; the Actual target community, the locally based informal networks, predominantly based on trust and commitment. Similarly, for Medpedia, the editor community is formally organized as they need to have medical expertise associated with some formal organization, and the others are organized into informal networks. In case of Intllipedia, of course, only the defense and intelligence officials are able to be a member of the community and so have a formal network structure.

   But always there is a problem in the context of 'open access' and 'content security implication' which needs to be balanced for every open access website. The open access is necessary to promote the effusion and sharing of knowledge where the security is necessary to restrict the undesired diffusion of knowledge and trustworthy. In agropedia the content community and in Medpedia the editors mainly act as a creator and controller of the knowledge flows and the others are mainly the users of the created content. Every node has to posses certain conditions to enter into that network and for using it. The conditions are determined by the Content community in agropedia and by the administrative body for the Medpedia. The agopedia is more liberal in terms of knowledge sharing as compared to the other two. The Intellipedia deals with US defence and security, so content security become a big issue for this site. Therefore it is a closed platform having three communities classified on the basis of types of contents. Here the 1st community can access and share any type of knowledge, but the other communities have their own limits for accessing the information; they are unable to access the most sensitive portions of the intelligence repository. So we can say there is lateral links within the communities and vertical hierarchy across the communities in the knowledge network for all three types of websites depending upon their inherent roles and characteristics.

   The summary of the above comparative analysis is presented in the following table.

Table 3.1 Comparative Figures according to the latest available Information

	agropedia	**Medpedia**	**Intellipedia**
Initiated By	Redesigning the farmer extension agricultural research/education continuum in India with ICT mediated Knowledge Management, NAIP	Ooga Labs, a technology greenhouse in San Francisco.	Office of the Director of National Intelligence (ODNI), Intelligence Community Enterprise Services (ICES)
Focused domain	Agriculture	Health Care	Defense and Intelligence
Focused community	Agri-community including scientists, academicians, students, extension workers, traders, sellers and farmers in India	Medical professionals, Common public	U.S. Defense intelligence community and national security related organizations
Objective	Agriculture-knowledge Management for smoothening the knowledge flow	Expanding the knowledge network among medical professionals	Searching brilliant ideas for national security and spreading awareness
Aim	Pro-poor regional economic development	Increase health consciousness and Extend Healthcare services	Strengthen the national security environment
Launching date	January, 2009	February, 2009	April, 2006
Platform	Online, open	Online, open	Online, closed
Content nature	Static + Dynamic	Dynamic	Dynamic
Content Creation	Commissioned and Contributed	Contributed	Contributed
Content Type	Certified and Uncertified	Certified	Strictly Certified
Mode of Contribution	Wiki, Blog, Forum(Q/A), Chat	Wiki, Discussion Forum	Wiki, Blog
No. of Knowledge communities	2 (Research Professional and Field Practitioners)	1 (Medical Professionals)	3 (Top Secret holder, Secret holder, unclassified)

	agropedia	**Medpedia**	**Intellipedia**
Nature of Knowledge Transfer	Fully contributive and Fully Receptive	Partially contributive and Fully Receptive	Fully Contributive and Partially Receptive
Network Structure	Digital Ecosystem (Predominantly Informal)	Community Network (Formal and Informal)	Networked Community (Entirely Formal)
Distinct feature	Knowledge models and the semantic search option for the certified content	Networked Community of Scholarship	Highly secured knowledge network
No. of registered users	550	Users from 110 organizations (July, 2008)	57248
No. of pages	1240	above 7000 (July, 2008)	439387

3.6 CONCLUSION

All the three websites are gaining in importance in their own fields. They have their own driving rules and guiding objectives according to which they have to set their digital features. **agropedia** wants to extend and smoothen the knowledge flows in the agricultural domain, Medpedia wants to build up a medical knowledge repository through developing a knowledge network among medical professionals, and Intellipedia aims to strengthen the national security environment in U.S.. From our limited comparison it appears that **agropedia** is presenting a knowledge sharing platform with more flexibility and user friendliness to capture the widespread knowledge and manage it properly for the better use of the pro-poor development of a developing country like India. However, it stands to learn from Medpedia that it must garner support from leading organizations in agriculture so that it results in a sustainable endeavour.

While Medpedia, Intellipedia and agropedia are all unique examples of digital knowledge spaces, neither can be classified as an “ideal or near-ideal” digital ecosystem that is open, easily accessed by all and decentralized. Intellipedia fails on the count of openness, while the other two knowledge spaces are still being driven centrally. Also, both Medpedia and Intellipedia do not have semantic organization capabilities, despite a well structured vocabulary in both the fields. However, a study of these three knowledge spaces are useful to understand user behaviors’ and to be able to design effective open knowledge spaces that have the potential to transform into digital knowledge ecosystems in the future.

4. KNOWLEDGE CREATION IN AGROPEDIA: TOWARDS A METHODOLOGY TO COMPARE PEER CONTENT TO CERTIFIED CONTENT

4.1 INTRODUCTION

Creating knowledge based economy, where knowledge is the key resource, is one of the important regional development strategies which have been seriously adopted by most of the countries as their major economic development agenda. Knowledge economy is innovation economy in nature and is learning economy with respect to the process (Xiaobin and Xuejun, 2007). To drive the economy in this line of development, it is essential to promote the process of collective learning and continuous innovation together by providing appropriate technological infrastructure in the higher priority in the state's development policy. Along this line of thought, Lisbon strategy formulated by European Commission [Nachira, 2002; Knowledge anywhere anytime, 2004] in the year of 2000 pushed a similar policy initiative in this direction which has been implementing the philosophy of 'digital ecosystem' to foster sustainable regional development of SME business. A digital ecosystem (DE) is characterized by an organization of networked entities possessing associative and autopieotic features, capability of self organization, self sustenance, capacity to enlarge its boundary through heightened inclusion of heterogeneous actors, and diversified scope of the network [Rajagopalan and Sarkar, 2008]. The concept of DE is already adopted and applied for sharing information and knowledge in business networks [Nachira, Nicolai, Dini, Louarn and Leon, 2007].

This knowledge based approach can also be applied in non-business domain, such as agriculture innovation and development processes running under the protection of government. In this context, among the core set of activities in a digital ecosystem, one of the most fundamental is knowledge co-creation and sharing and create a ICT based open knowledge space [OPAALS Wiki]. The DKE provides the highest level of accessibility potential to all the networked members and encourages them to construct, share and use the collectively contributed knowledge on a sophisticated knowledge sharing infrastructure. It can foster mutual co-operation between the participating entities in a digitally networked environment and encourages collaborative exchange of knowledge for their collective growth.

The precondition to form an DKE is to connect to the interested individuals and communities from different locations on a common online network where anyone can interact freely with any other without any system bias or restrictions. Interest when provided sufficient resources, has the potential to convert into practice which can further influence more similar entities to instill similar nature of interest which can convert into practice. It potentially makes a self perpetuating cycle which is similar to the autopieotic feature of a digital ecosystem, and provides a source and reason for its sustainability. Connecting people having shared domain of interest and practice with the help of ICT infrastructure forms a community network [Rajagopalan and Sarkar, 2007]. Such a network potentially evolves into a knowledge network [Prothman, 2006] where the common interest and practices lies around creation and sharing of knowledge, and the actors are the active participants of the system. Knowledge network integrated on a web2.0 enabled collaborative platform of content creation (e.g. wikipedia) and driven forward by the active participants can breed a digital knowledge ecosystem (DKE) [Amritesh and Sarkar, 2008] where the knowledge actors participate either as knowledge producer or knowledge users, or sometimes simultaneously play both the two and can

be named as 'produsers' [Bruns, 2007]. The strategically designed DKE motivate actors' participation and accounts for the sustenance and growth of their DKE environment. In this system, the knowledge actors initially networked and forms a community of interest [Bimrose, Barnes, and Brown, 2004] having their common domain of thoughts, which can later evolve into a community of practice [Wenger, 1998] for continuous creation and sharing of knowledge and becomes the reason of their self sustainability.

In order to increase the intelligence and capacity of the digital ambience, collaborative web space is a unique initiative of its kind along this line to create and share the knowledge among the scientists, experts, students, and practitioners of a particular domain, bringing the research and practice together and facilitating mutual interaction to promote innovation and invention. The finest example of collaborative we space knowledge creation is 'Wikipedia' with a core group of 2000 volunteers having close to four million entries in 200 different languages [Berinstein, 2006]. Wikipedia exemplifies an ideal phenomena of user led content creation and has gradually increased the content quality to such a level which is adequate enough to be compared against its counterpart Britannica, a more reliable, established and formally certified knowledge base [Special Report (Nature), 2005][Encyclopædia Britannica, Inc, 2006]. Such a knowledge space is characterized by unrestricted entry or exit of actors voluntarily contributing in any desired form, either in collaborative way (e.g. wiki) or in a personalized way (e.g. blogs). Although there are differences in the way a user choose to contribute, but there are no differences in the way the created knowledge are disseminated on the web space. Any knowledge seeker can access any part of collective creation space (wiki) or a personalized creation space (blog) without any administrative biases.

Knowledge sharing under a digital ecosystem can also be analyzed from knowledge management perspective and observed under the knowledge transformation framework of Nonaka's Knowledge spiral [Nonaka & Konno, 1998]. Apart from this observational framework, the knowledge creation and sharing must need an empirical dimension for its performance evaluation. Approaching to the same line Best, Hysong, Mc Ghee, Moore & Pugh (2002) proposes a mixed empirical framework consisting of both qualitative and qualitative domains for the evaluation of knowledge transfer within a healthcare organization. Analogous to actors and system as the prime facilitating agents, the framework has emphasized 'individual's commitment' and 'organizational intention as the two major knowledge enablers to be considered as survey instrument while evaluating the knowledge flow from individual tacit understanding to the organizational shared vision. This survey instrument was later come out insufficient to explain the knowledge creation and sharing process and suggested a further development of the measuring scale. Nevertheless, the qualitative interview data indicated that few of the components of those knowledge enablers like autonomy and intention work better in a high performing environment and fosters the spirit of knowledge creation and sharing in the organization. Therefore an environment of digital ecosystem is supposed to be an ideal space for encouraging individual traits and knowledge enablers for the desired purpose. We also try to develop alternative set of metrics to evaluate the knowledge creation modes and participation rate of the knowledge actors.

4.2 MODES OF KNOWLEDGE CREATION

Transformation in the nature of participants from the interested entities (receptive knowledge actors) to practicing entities (contributive knowledge actors) transforms the process characteristics through which knowledge is created, store and shared. The process of knowledge creation happens in different modes according the role and the level of intensity of participation of knowledge actors. Knowledge initially created in the human minds through a continuous process of learning. Literature describes two different learning modes: DUI (learning by doing, using and interacting) mode and STI (learning by science, technology and innovation) mode [Xiaobin and Xuejun, 2007] and corresponds to tacit and explicit forms of knowledge [Nonaka, I. & Konno, N. 1998] respectively. STI mode can be assumed close to theoretical learning (i.e. learning with codified documents/literatures etc.), while the DUI mode can be assumed to be a practical learning (i.e. learning by practice). STI modes of learning normally expected to produce explicit knowledge while the DUI mode of learning creates implicit form of knowledge most of the part of which can be converted into explicit forms. The knowledge created by such modes of learning can be converted into explicit form and brought on the systematically designed online platforms supported by many social computing applications like blogs and wikis [Redecker, 2009]. Such online platforms also act as a knowledge repository which again facilitates STI mode of learning. Thus it drives the complete cycle of learning—>knowledge creation—>knowledge storage and dissemination—>learning, and accounts for the self sustainability of the created digital knowledge ecosystem. These online spaces can further be advanced to form a collaborative digital environment which has the features of both: collaborative content creation like Wikipedia, and commissioned content creation like Britannica. At the initial stages the features of Britannica provides an initial momentum which is expected to motivate the participation of external entities in the collaborative space of Wikipedia. This collective space is also supplemented by additional features to have separate personal space having his/her sole identity e.g. blog etc. Additionally spaces for ‘queries’ and ‘chat rooms’ can accommodate various other ways of social expressions and collective interactions according to the users’ needs and interests. The quality characteristic of the created knowledge depends upon the process of creation and the intelligence of the digital ambience where it is systematically made to be created.

4.3 CONTEXT: ‘agropedia’, A DIGITAL KNOWLEDGE ECOSYSTEM

Following the fundamental philosophy behind the Digital Ecosystem, agropedia is an attempt to create a Digital Knowledge Ecosystem where individuals and groups can come together and maneuver their efforts towards collective practices of the knowledge creation and sharing. The initiative is aimed to create an associative and autopieotic system where participants from geographically dispersed location come together to form a networked community and have the potential to create similar other networks in order to maintain its sustainability. This is expected to assist in regional economic development through creating an open access environment of knowledge sharing where everyone can get equal opportunity to participate in knowledge co-creation and its usage for mutual benefits. The initiative is aimed to connect the Indian agriculture extension services to agriculture research Institutions and also to the farmer’s end.

As a part of National Agriculture Innovation Project[5] (NAIP), 'agropedia' is an attempt to create a collective and multipurpose online space (with audio-visual features) to bridge the gap between knowledge creators and knowledge users of agriculture domain and bring them inside a networked environment where one can contribute, innovate, access and receive knowledge content according to their will and need. In addition to functioning as an encyclopedia like a structured knowledge repository, agropedia also aims to connect various local and geographically distributed communities of agricultural practitioners in a 'Wikipedia' or a 'Facebook' like social network platform. The users involve scientists, researchers, extension workers, farmers etc. from various specific domains e.g. crop research, horticulture, soil science etc and map them into various online spaces like agro-blogs, library, discussion forums etc. for creative interactions. 'agropedia' is envisaged and launched by IIT Kanpur team with the support of seven other consortium partners[6] (UASD, GBPUAT, ICRISAT, IIITMK, IITK, IITB, NAARM) and FAO as its collaborator. It has a strong potential to evolve into a networked knowledge community and act as a dynamic repository of knowledge in the agriculture domain. The digital structure and online space of communication is specifically designed to promote collective learning and innovation within the ambience of a 'digital knowledge ecosystem' (DKE) with easy and free access to the knowledge repository for all the users. This DKE contains spaces for both kinds of knowledge content: 'certified content' and 'contributed content'. These are described as follows:

a) Certified Content (Gyandhara):

Certified content is initially created by the consortium partners but later on it is also expected to be created by other registered experts who will be approved by the content management system governed by the consortium partners. Such content is placed under the section 'Extension Material' on the agropedia website. At present it contains agriculture based information under the sub-sections 'library', 'crop calendar' and 'dos & don'ts' for nine different crops. Directives issued at the central and state government levels are also a part of the certified content. To enable the semantic searching within certified content, 'Knowledge Models', which are relational representations of crop specific information, are used.

b) Contributed content (Janagyan):

To breed innovative ideas and capture latent practice based knowledg, agropedia provides interaction spaces under the section 'Interaction' which has sub-sections 'agro-wiki', 'agro-blog', 'user's discussion', 'Q&A Forum'. Such spaces are created to promote and harness the collective intelligence of field practitioners, interested individuals and students. People can register here to express their opinions, comments, queries etc. related to agriculture and see them published on the web instantly. Besides textual messages, one can also add audio-visual content in the same space and increase the effectiveness of interactivity. User discussion forum provides an online real time chatting cum discussion web interface which can have the potential to become a source of novel

[5] A World bank funded development project of government of India (http://www.naip.icar.org.in/)

6 USAD: University of Agriculture Sciences Dharwad; GBPUAT: Govind Ballabh Pant University of Agriculture and Technology; ICRISAT: International Crops Research Institute for the Semi-Arid Tropics; IIITM: Indian Institute of Information Technology and Management; IITK: Indian Institute of Technology, Kanpur; IITB: Indian Institute of Technology, Bombay;; NAARM: National Academy of Agricultural Research and Management; FAO: Food and Agriculture Organization of the United Nations.

ideas and encourage experimentation and sharing of results for the collective benefits of all. To understand and improve the quality of knowledge models, 'agropedia' provides interaction space for user's discussion on knowledge models. Users are also encouraged to form their own knowledge models specific to their area of expertise and upload it on the website. The web spaces are launched and modified in a phased manner. As a part of initial content creation, only 'knowledge models' and library content were released at the time when agropedia was launched. This was followed by the launch and development of peer group 'Interaction' spaces. One of interaction spaces 'Chat Session' is launched recently along with the overall change in the appearance of user interface. The social networking tools are still under preparation phase which would be expected to become the most dominant feature of knowledge co-creation under agropedia web space. The chronology of creation and major development of web spaces are as follows:

Table 4.1. Phased Development of agropedia interaction spaces

	Web space development	Date
i.	Formal launch of Knowledge Models and Library content	12th Jan'09
ii.	Introduction of agro-blog /wiki / Q&A forum	14th Jan'09
iii.	Location tagging in Library	26th Jan'09
iv.	User Defined tagging (Folksonomy)	2nd Feb'09
v.	Interaction space for discussion on Knowledge Models	23rd Feb'09
vi.	Content Tree (user friendly search overview)	5th March'09
vii.	Launch Chat session	21st April'09
viii.	New web interface	21st April'09
ix.	Social Networking Tools	Under Preparation
x.		

4.4 SOCIALIZATION OF 'agropedia'

In order to convert its potential into practice and to build capacity, a series of national workshops and local training sessions has been initiated well before the launch of agropedia and it is still going on in high frequency at many places in India for increasing the awareness and encouraging participation among the users. The target users were consisted of agriculture scientists from the consortium partners, agriculture universities, government institutes, farmers etc. First range of workshops was carried out to understand the user's need for the development of agropedia. The second range of workshops was focused at launch of 'Knowledge Models' and motivating the users to visit the agropedia site and familiarizing themselves with that. The third range of workshops is still to be launched which is supposed to train the users about the 'Interaction' space and motivate them to participate in knowledge co-creation. The prime focus of workshop would be to train the users to interact with the agropedia web space, help them to create and store the knowledge content at appropriate categories, and to train them to make their own knowledge models using 'concept-map'

software tool. Details of nature and participation in few of the workshops and trainings are mentioned in the following table:

Table 4.2. Details of important training and workshops

Date and place of Workshop	Nature and Focus	No. of participants
31 July-2 Aug 2008, GBPUAT	Train the scientists of GBPUAT & KVK experts about Knowledge Model	25
23 Oct, 2008, GBPUAT	Content Management System of agropedia	30
28 Nov, 2008, IIT K	Technical training of IITK team-members about functionalities of Drupal Platform	20
8-12 Dec, 2008, ICRISAT	Training-workshop on Digital Content Creation & Management for Crop Specific Information at ICRISAT	20
15-16 Dec, 2008, Raichur, Dharwad	Training on Knowledge Models	25
2 Jan, 2009, SVPUA&T	Training programme on agropedia	28
12-13 Jan, 2009, NAAS, Delhi	Workshop on crop knowledge model and agropedia	64
17 Jan, 2009, IIT K	Training-workshop on Digital Content Creation & Management for Crop Specific Information at ICRISAT	20
3-6 Feb, 2009, GBPUAT	Awareness building about agropedia portal	43
4 Feb, 2009, IIT K	The training workshop on 'ICT Intervention in Agriculture with Special Reference to Marketing'	42
12 Feb, 2009, CSAUAT-Kanpur	Training program on agropedia	25
14-16 Feb, 2009, IIPR Kanpur	Awareness building program on agropedia	46
19-20 Feb, 2009, ICRISAT	Training program on agropedia	26

'**agropedia'** has presented itself as showing great potential to produce, collect, nurture and innovate agriculture based knowledge with the help of user's participation. IIT Kanpur is the central node in

this DKE in agropedia, and it has been working towards evangelizing agropedia among various stakeholders. It attempted to extend the outreach through connecting to private firms (e.g., Tata Chemicals, Canopus Consulting etc), development journalists and institutions working under the guidance of consortium partners. All such efforts are expected to lead to higher degree of socialization of agriculture communities and results are expected in terms of greater participation rates, more content creation and increased interaction through the virtual online space of agropedia. It is essential to observe the outputs created by this intensive effort and measure it with the expected output. This kind of feedback mechanism will certainly help to unleash the true potential of agropedia, while ensuring that corrective actions are taken.

4.5 PARTICIPATION ASSESSMENT

We will collectively analyze the two kinds of interactive participation: receptive and contributive. Based on the data collected by the website administrator of agropedia and another set of complementary data generated by Google Analytics between 12 Jan 2009 (date of formal launch of 'agropedia') to 12 April, 2009, we characterize the quantity of participation by number of visits observed per unit time of the website and the quality of participation by geographical outreach, length of visit, depth of visit, bounce rate etci.

Geographical Outreach

'agropedia' has attracted attention of thousands of people all across the world during the aforesaid period. The website has recorded 12,664 visits from 9 continents and 135 countries in three months, i.e. about 140 visits per day. Coming to the region wise break up, a highly polarized picture comes over the surface. About 15% of the total visitors are from Americas and Europe which are considered the most developed places and have highest level of ICT usages in the world. Nevertheless, it can be seen as a great achievement for agropedia to touch almost each and every part of this world and make its presence felt among the global agriculture community. Following table shows the web popularity of agropedia among top five countries according to the average time spent on the website (length of visit). In these countries, the users are not viewing more number of pages per site visit (depth of visit), but the corresponding length of visit is high which implies that users are reading few pages quite seriously and perhaps finding good quality content over there.

Table 4.3 Top five countries having more overall length and depth of visits[7]

Name of the country	Number of users	Depth of Visit	Length of visit
Estonia	9	3.78	0:13:40
Italy	45	6.42	0:09:10
Indonesia	17	3.47	0:06:32
United Kingdom	35	4.86	0:05:54
Pakistan	55	3.16	0:05:12

[7] Refer to the end note for details of the terms 'Length of Visit' and 'Depth of visit'

83.14% of the total visitors are observed from Asia and India alone has recorded about 76.67% (9710) of the total number visits. Within India, although the degree of polarization reduced over time, the figures are still skewed. Kanpur alone has recorded about 34% (3287 out of 12664) of the total visits in India and constitutes a huge chunk of (26% of the total) global visit during the above specified period. More than 70% of the site visit has been observed from the regions near the premises of consortium partners of the NAIP project. This has happened because most of the awareness camps, training and workshop sessions were organized at those locations which went on attracted huge share of national participation to interact with agropedia. The details of approximate share of interactive participation within India are given in the Figure 4.1.

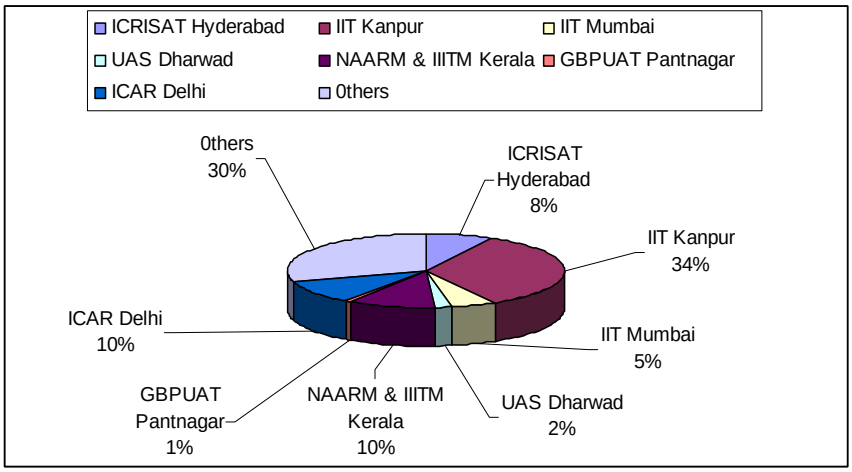


Figure 4.1 Share of participation from the location of Consortium partners and their neighboring locations

Visit Quality

The first impact of the website can easily be assessed on the basis of visits per day that it receives. Out of 140 visits per day that it receives, it has received 8019 unique visits, i.e., about 90 unique visits per day. That amounts to about 64% of the total daily visits that are new and unique and represents a continuously increasing global outreach. But it is also critical to observe how many visitors stay and return to the site. agropedia website has shown an average bounce rate[8] of 41.23% over the period. In the month of Jan-Feb'09 the bounce rate was at around 39%, which went up over 40% in the month of February' 09 and crossed 50% mark in the month of April'09. Figure 4.2 below shows two trend lines: one is of '% new visits', and other is of 'bounce rate'. It is evident from the figure that the two line are highly correlated, which implies that perhaps new visitors don't find the website interesting enough to read the homepage and delve deeper into it by clicking on the other pages.

[8] The term 'Bounce rate' is defined in the end note of this paper

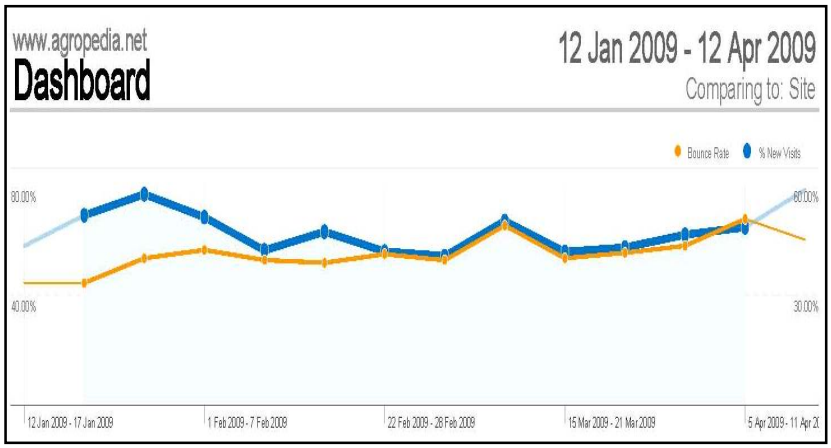


Figure 4.2. Highly Correlated Percentage of New Visits and Bounce Rate

These conclusions are informed further by the figures of 'traffic source overview'9. The data indicates that search engines lead the users even 50% of the time to agropedia. These users may have been looking for something different which accounts for the bounce rate. When looked at collectively, the data implies that most of the users coming to the 'agropedia' website guided by search engines revert from the first page as if they don't find relevant information which they are searching for. The prime objective of 'agropedia' is to provide a digital platform for the creation and sharing of agricultural knowledge, which itself requires 'user's interactive participation' as the fundamental driver to get success. A low interactive participation trend indicated by the bounce rate can impede the autopieotic features posing barriers for evolution to a knowledge ecosystem.

Visitor's behavioral characteristic

From the perspective of individual frequency of visit we find that agropedia's bounce rate of over 40% is a cause of concern however these are still early days for it, as phase 3 of its launch is yet to take off. After visiting once, a major chunk of users didn't return to the website. The return rate of the users is recoded as 37%. Over 76% of the users have visited the website not more than three times during last three months (12 Jan'09-12 April'09). There are only 16.4% (2081out of 12664) of the total visitors who have come to the website more than 9 times, and above all, only 3.04% of the total visitors (i.e. 385) came to the website more than 50 times. This implies that there are few people who are find this website highly relevant to their concerns. At the same time the data can interpreted as within three months, 'agropedia' has attracted more than two thousand users (22 users per day or approximately one user per hour) who returned to the website over 50 times. Such visit pattern represents the visitor's loyalty towards the site, and one can say that agropedia is generating one loyal visitor per hour since last three months whose visit are considered to be significant and have the potential to become content contributors. Once these visitors become contributive participants, the autopieotic features of agropedia are expected to multiply this effect, to motivate and create more similar contributive users to maintain the sustainability of this evolving digital knowledge ecosystem. The loyalty of visitors can be further traced by looking at the trend of

[9] Traffic Source overview: This is a data representing the referring web pages like search engines, blogs, paid campaigns etc which guides the user to the home page.

'length of visit (average time spent on the site)' and 'depth of visit (average number of pages viewed per site visit)'. Such parameters show the degree of extensive interaction by the users.

Length of visit: This is denoted by average time spent on the site, which is found to be 12.25 minutes during the period of analysis. From figure 2, it is obvious that 58% of the visitors spend less than a minute on the site and 19% visitors spend more than 10 minutes. This section of visitors is a space for having potentially loyal user of agropedia, who extensively browse through the content and find it relevant for their usages. Looking at the weekly trend between the specified periods (Figure 4.3), it is found that initially visitors were spending on an average 52 minutes per visit, which gradually declined to less than 10 minutes per visit.

Visitors spending smaller durations on the site are much larger than visitors spending larger duration and the average length of visit came out to as 12.25 minutes. After simple algebraic calculations it is found that, Kanpur, (perhaps due to the presence of IIT Kanpur) which is the main promotional driver of agropedia, has seen a substantially large length of visit, and is found to be 25.91 with 26% share of total visitors. This leaves the other visitors to have a length of visit as small as 7.45 minutes.

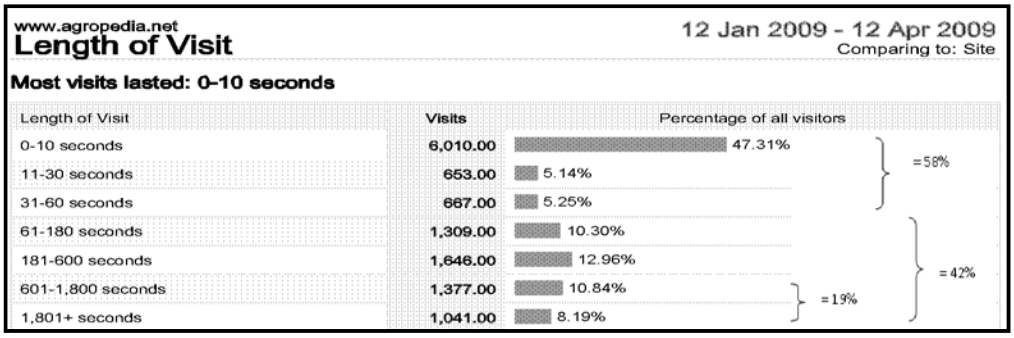


Figure 4.3 Length of Visit with respect to the % of visitors

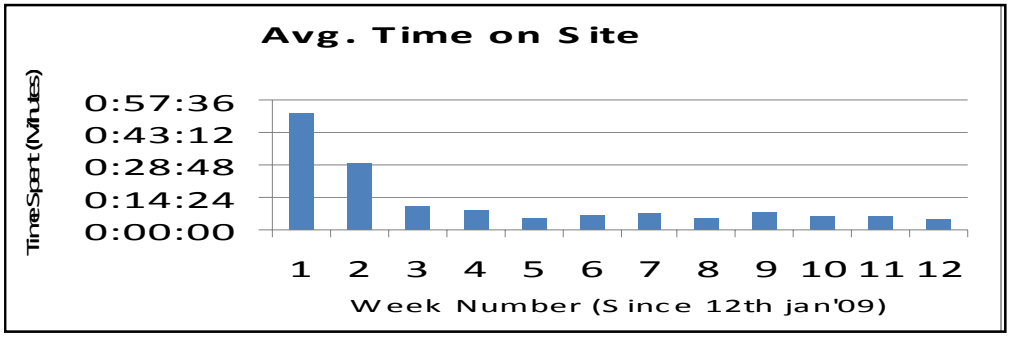


Figure 4.4 Weekly trend of participation time

Depth of visit: This is measured by the number of pageviews per site visit, which is found to be 5.96 during the specified period of analysis. Figure 4.5 shows that 65% of the users (which include a high bounce rate of 41%, i.e. return after single pageview) are not taking interest in the site and

return back after visiting less than 3 pages. The other significant set of users (21%) who are visiting 4 to 10 pages per site visit, are primarily finding the site useful and interesting and could be liked by them. 13.5% of the top visitors have more than 10 pageviews per visit, which shows their substantially higher interest in the site and they may have the potential to convert into content creator. Figure 4.6 shows that out of 75000 total pageviews, 90% is attributed to India. Kanpur's visitors alone constituted above 40% (about half of the total pageviews in India) of the total global page views.

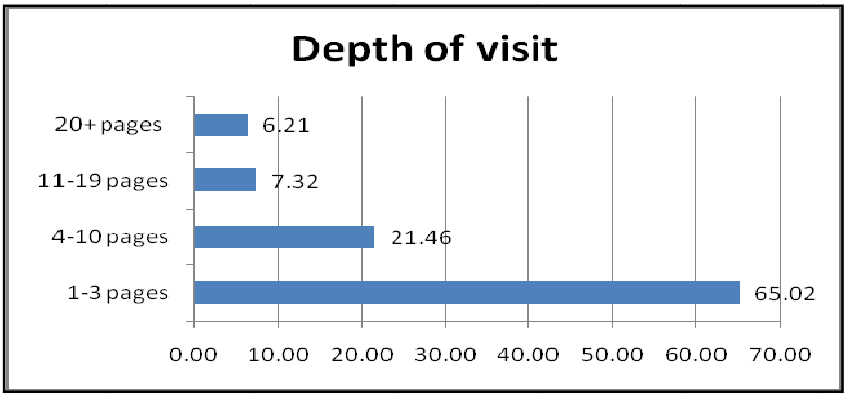


Figure 4.5 Depth of visit with respect to % of visitors

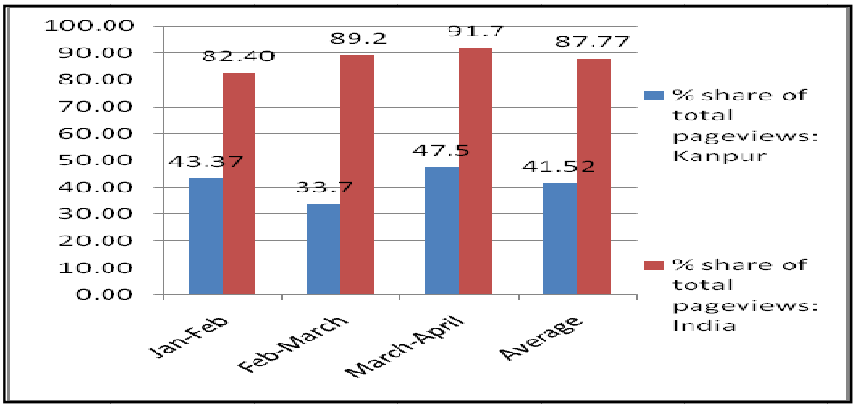


Figure 4.6 Local share of (depth of visit)

4.6 MODES OF CONTENT CREATION

The basic purpose of agropedia is to create and share knowledge in a digital knowledge ecosystem where the user can participate in knowledge co-creation and sharing activities. In order to fulfill this goal, agropedia has created many different types of online interaction spaces designed for

contributive and receptive interactions e.g., user to web content, peer to peer, etc. In these interaction spaces, the users can either use the available knowledge on the website (receptive participation) which may or may not be created by him, or even upload information and knowledge content on the website (contributive participation). Such spaces often create separate set of users who participate in both modes: receptive and contributive. Such users can be termed as produsers [Bruns, 2007] having power to customize and individualize the content according to their capability and requirements during the phase of creation and usage respectively.

In agropedia any user desiring to become a contributive participant, he/she must register. The registration process requires the user to create his/her login where he/she has to provide his/her personal details, designation, specialization, work experience etc. After registration and user validation, the user is free to add content and publish it on the website. It is found that of about 500 people, who have registered, only 36 of those have added any kind of knowledge or information to the website during the period of observation. Although this appears to be small in number, their persistent contribution has a huge potential to develop a large knowledge base in the digital platform. In this section, our objective is to examine and analyze the content creation. Here we attempt to develop and apply a preliminary method to compare the 'certified' and 'peer contributed' content.

For the purpose of analysis, we have classified the content creators in three different categories:

i. Agriculture scientists from IIT Kanpur team,
ii. Member from the Institutions of the consortium representatives for agropedia,
iii. External users.

The partner institutions (more specifically agriculture colleges) are primarily responsible for creating an initial knowledge base for the agropedia. This type of content is put under the class of 'certified content (gyandhara)' and is placed under the section 'Extension material' on the web space. This part of the content is the mandate of these Institutions within the project, and is what we also refer to as 'certified content' or 'commissioned content'. Agriculture scientists from IIT Kanpur can also contribute towards 'certified/commissioned content' under 'Extension Material'. Knowledge coming from external users or peer groups working or studying their respective branch of agriculture is put under the class of 'contributed content (janagyan)' and is placed under the section 'Interaction' on the web space which contains agro-wiki, blog, Q&A forum and chat session.

As stated earlier there are 36 users of agropedia who have contributed towards creation of any kind of content. These users have created a total of 218 content nodes between 12th Jan'09 (Launch of agropedia) and 12th April'09. 67% of the entire content nodes can be classified as 'certified content', and the rest of 33% are under 'contributed content'. Certified content are created by paid scientists working at partner institutions. The content is validated by the editors who are subject matter experts. Hence their process of knowledge creation is similar to the traditional encyclopedia (Britannica) style of knowledge collaboration methodologies. The share of 'contributed content' depicts the natural interest of external users and peer groups who are not paid for creating the knowledge content for agropedia. Within this short span of time, it is highly appreciable to see external users extensively contributing to the website.

Figure 4.7 maps the share of content creation with the corresponding type of users. All the NAIP consortium partners including IIT Kanpur team members (21 contributors) have created about 68% of the knowledge content. 15 (41%) external users have contributed 22% of the total content creation in the last three months. The numbers of total external users, who have contributed in some way to the website, seem to be too small in a small period of three months. But this level of contributive participation can not be considered really low at this initial stage when compared with a similar participation survey statistics of Wikipedia about four years after its formal launch, which is published as: Nature surveyed more than 1,000 Nature authors and found that although more than 70% had heard of Wikipedia and 17% of those consulted it on a weekly basis, less than 10% help to update it [Nature, 2005].

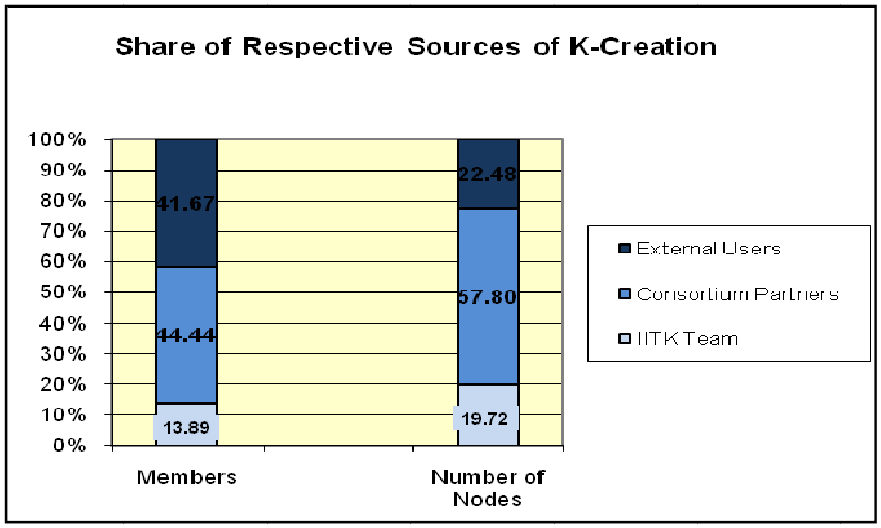


Figure 4.7 Respective shares of Knowledge Co-creation

Transformation of actor's roles to create a Digital Knowledge Ecosystem: We can look at the framework developed in the following table. The two types of contributors: 'commissioned agents' and 'peer-contributor' are creating two different types of knowledge: 'certified' and 'contributed', under the agropedia web spaces 'Extension Material' and 'Interaction' respectively. Therefore we have four different knowledge creation modes with their respective compositions:

C1: Commissioned agents creating certified contents

C2: Commissioned agents creating contributed contents

P1: Peer-Contributors creating contributed contents

P2: Peer-Contributors creating commissioned contents

Table 1.4. Transformation of user's role during content contribution

Knowledge Producing Agent	Type of created content	
	Certified (Gyandgara)	Contributed (Janagyan)
Commissioned	C1	C2
Peer-Contributor	P2	P1

Initially the 'commissioned agents' which include agriculture scientists from IIT Kanpur and members form consortium institutions, were expected to create 'certified contents' (This is the C1-mode knowledge-creation). Peer-contributors from all across the world were expected to create the 'contributed content' (This is the P1-mode knowledge-creation) in the 'Interaction' spaces (e.g., blogs, wiki, Q&A forum etc). But is has been observed that the 'commissioned agents' are also participating in the 'Interaction' space of agropedia and creating the contributed content (This is the C2-mode knowledge-creation). When agropedia evolve into a knowledge based ecosystem, the peer-contributors are also expected to take the leading role and contribute to create certified contents (This is the P2-mode knowledge-creation). C1 mode and C2 mode are simultaneously happening in the beginning to inspire the P1 mode of knowledge-creation. P1 mode is also expected to transform into the P2 mode gradually over the time. The knowledge ecosystem is focused to converge all the modes of knowledge-creation so as creation and sharing happens simultaneously among all the users of agropedia.

4.7 CONTENT QUALITY

The quality of the existing and created content can be assessed in various ways. We have chosen following three parameters to explain the quality characteristics of content:

1. *Source of Creation:* This is a critical parameter to evaluate the created knowledge content on the agropedia. This parameter addresses the level of risk of creation of bad quality content. The premise here is that some content provided may not be serious and issues of vandalism in wikipedia are one of its examples [Fatally Flawed, Britanica 2006]. It is obvious from the Figure 4.7 that about 77.5% of the content is created by IIT Kanpur team and consortium partner institutions, which forms an authentic and well recognized source of content and reduces the quality risk. Other 22.5% of the content is created by external users, whose contributions is not known to the web administrator of agropedia, and carries a high risk of being low quality. More the quality risk, more checks are required before publishing, and more time and labor consumed by the domain experts to validate it. Depending upon the content quality, there may be a need to introduce checks on the content in the wiki or blog spaces.

2. *Relative Visit Frequency:* This parameter attempts to judge the quality of content on the basis of user's interest to read that page. This is assessed by looking at the number of page views/reads that agropedia has received during the specified period. It is found that the content stored under 'library' has received comparatively higher number of visits (= 3813), followed by 'knowledge-model' which has received second highest page-views (=2303). 'Knowledge Model' are visual maps which abstract relation and concepts and are useful in providing semantic attributes to all the knowledge nodes. These pages contain rich agriculture information which is attracting attention of agriculture community from all across the world. The landing page of 'agro-wiki' and 'blog' meant primarily for those who want to contribute in knowledge creation, received comparatively 2132 & 1898 pageviews.

Table 4.2 Relative visit frequency

Pages	Page Views
/?q=content/library	3,813
/?q=content/knowledge-	2,303
/?q=content/welcome-agrowiki	2,132
/?q=blog	1,898

3. *Interactivity*: This can be expressed in term of number of responses one has received on any particular content, e.g., the number of received comments in case of a content uploaded under 'blog', number of edits recorded in case of 'agro-wiki', number of answers/comments on those answers received to the raised question in case of Q&A forum etc. in the interaction space. To calculate the interactivity, we have divided the total number of users' responses (in form of comment, answer to any querry, Edits in the agro-wiki etc.) to total number of content nodes at which responses are received. Looking in the 'Interaction' space from this perspective, we have found that agro-wiki had got the highest interactivity (=1.4), followed by 'Q&A forum' and 'blog' (0.96 and 0.29 respectively). A high response rate or interactivity creates an environment of knowledge-innovation and can produce further high quality content. Blogs are assumed as personal space for expressing ones ideas and therefore it has the lowest interactivity, but it is far better than having absolutely no-interactivity. Some blogs have not get comments and others have got multiple comments. There has been no content addition under the commissioned space of agropedia during our period analysis (12th Jan'09 to 12th April'09). Content was created under both the sections: 'library' and 'knowledge model', before the launch of agropedia, and nothing has been added till 12th April'09. However, to promote interaction, agropedia has a separate section containing 'Discussion on Knowledge Models', which has received 5 comments so far. No content has been added to the 'Library' during that period, and neither has it received any response or comments from the users. In the earlier section we distinguished the users as commissioned agents (IIT Kanpur and other consortium partners) and contributing agents (External users) according to their expected roles. Although the 'Interaction' space is meant for

'contributing agents', but the commissioned agents are also participating here. The 'wiki', 'blog' and 'Q&A forum' under the section 'Interaction' of the website has also got contribution from the 'commissioned agent'. This can be viewed as a source of encouragement and training for the external users for increasing their participation. Therefore the interactivity of web space in agropedia promoting the users to transform themselves and encourage them to play multiple roles which is in line with the 'associative' feature of the digital ecosystem.

Table 4.3 Interactivity of created content

Web Space	Commissioned Space		Interaction/Contributed Space		
	Knowledge	Library	Wiki	Blog	Q&A forum
Content (New Topic): X	--	0	20	37	28-
Comments/Edits/Answers: Y	5	0	28	11	27-Answers
Interactivity: (Y/X)		0	1.4	0.29	0.96

4. *Expert Evaluation:* We approached two agriculture scientists: Dr. Vivek Singh, and Dr. Sharwan Shukla, who are specialists (PhD) in 'plant pathology', and 'grain quality' respectively and who have been working for the past few months on agropedia content creation and validation to help us assess the content quality in agropedia. We have got their collective evaluation of all the knowledge nodes created during the specified period of analysis. They have evaluated all the content based on a certain set of parameters and mapped them into a five point ordinal scale which is described as follows:

Table 4.4. Scale Description

Scale Name	Judgment parameters of content quality
Bad	Nothing present except Title of the content, Irrelevant Matter/argument
Satisfactory	Matter if relevant and Informative
Good	Matter is relevant, informative and recent
Very Good	Matter is relevant, informative, recent, and shows high degree of completeness in the respective domain
Excellent	Matter is relevant, informative, recent, complete and also well presented to attract the readers

As mentioned earlier, two third of the total created content are 'commissioned' by IIT Kanpur team and the consortium partners, and one third are 'contributed' by external users and peer groups. After getting the collective evaluation, we have presented it the pie chart in the Figure 4.8. The picture coming out of it clearly says that more than half of the 'certified' content is of very good quality where as the corresponding proportion in the 'contributed' section is merely one third. Share of 'Excellent' content are 6% and 4% respectively in the both section, which reflects that content is obviously of good quality and presented well. This can happen only if the content creator is a domain expert as well as technically sound to use the web space and content editor windows of agropedia. The main difference between users creating 'Excellent' content and those creating 'Very good' quality content is found to be their difference in technological skill of using computers and internet, as this difference is related to how attractive the matter is. According to our content evaluation experts, the agriculture scientists working at GBPUAT are not able to add 'excellent' content due to their lack of computer operating skills. This difficulty can be overcome by increasing the frequency of strategically designed workshops and training sessions at respective centers of content creation. This will help to transform the transform the content quality from 'very good' to 'excellent' level.

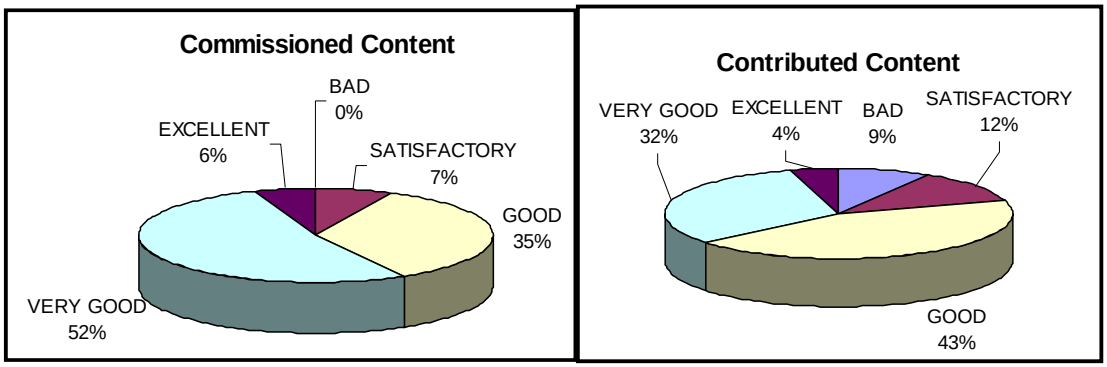


Figure 4.8 Quality of the created content

The other set of quality transformation from 'good' to 'very good' require proficiency in domain expertise and it solely depends upon the self motivation of the individuals. Since 93% of the content created by 'commissioned' agents is of 'good' quality and above, most of which are placed under the section 'Extension Material' of agropedia web space, therefore there is no question of the reliability and usability of such knowledge. Looking at the quality composition of 'contributed' content which composes 22% of the total created content, 'bad' and 'satisfactory' quality level are high in terms of risk of usability, and proper disclaimer needs to be added before recommending such content for the purpose of application.

4.8 CONCLUSIONS

In an attempt to form a digital knowledge ecosystem and promote knowledge sharing, agropedia has given the agriculture community a systematically designed online open web space where anyone can participate irrespective of any kind of discrimination and express oneself individually of

collectively either as a knowledge contributor, knowledge innovator, or as a knowledge user. Actor's autonomy created by the digital organization, is slowly giving birth to self intentions to create and share knowledge. Within the short duration of three months, it has drawn attention of entire global community without any international advertisement Working on the principle of inclusive knowledge economy it is providing opportunity to all kinds of users, by bridging the gap between 'haves'(knowledgeable) and 'havenots'(learning) and promotes the co-operative development strategy all across the global agriculture community. Even .at this nascent phase, it has been encouraging to see that the quality of the shared knowledge base is measured as substantially well and some of the excellent quality knowledge is created by non paid external users whose persistent contribution and consistent interest to the portal conferring them as loyal members. .agropedia is yet to launch its advanced version having the features of social networking. This is supposed to create more loyal members who further drive the entire system of knowledge creation and sharing, and consequently creates a self sustainable digital knowledge ecosystem for agriculture infrastructure development.

5. USER PERCEPTION ABOUT 'AGROPEDIA' ALONG MULTIPLE DIMENSIONS

5.1 INTRODUCTION

Any initiative has a certain purpose, and it is important to measure to what extent the purpose is actually met at the end of the day. The effort invested is intended to get converted into social value for the target users who are also part of feedback mechanism to evaluate the impact of the delivered value on the basis of degree to which it has been able to fulfill their expectations. The broader vision of agropedia was set according to the commonly understood need of the various stakeholders of agriculture. The structural features and functionalities offered must map and satisfy all the essential needs of the involved entities at the receiving end. The digital set up of online space for agropedia is structured in such a way so that it can serve those needs by incorporating most of the commonly available features of latest networking technology and creating the potential to incorporate the social networking space of other initiatives like Orkut, Facebook, and LinkedIn etc. It is however essential to undertake a critical evaluation of the produced features with respect to the acceptance level of the agriculture community, whose participation rate depends upon the degree of fulfillment of their initial expectations and other unspoken but desirable requirements which are revealed gradually with the development of agropedia. To know the user's perception about agropedia we collected user response at different points of time with the help of a structured questionnaire. To increase awareness about agropedia in the agriculture community and to guide and train them to use the agropedia website and knowledge model, IIT Kanpur has arranged different workshops and training sessions all across India. Through the training and workshops and published knowledge models (unique knowledge presentation of its kind) agropedia team has been able to get connected with many agro-scientists, experts and others having different specializations and from various agricultural institutes, organizations and KVKs (Kisan Vigyan Kendra) of India and collected their feedbacks about the further need and direction of its development. The training workshops were held all across India targeted particularly at agricultural and research universities and institutes which includes consortium partner member institutions[10] e.g. UAS Dharwad, ICRISAT-Hyderabad, IIITM-Kerala, NAAS-Delhi etc. as well as other non-member institutions like SBPUAT-Meerut, CSAUAT-Kanpur, IISR-Calicut, UAS-B, TNAU, DOR-Hyderabad, NBPGR-Hyderabad, MANAGE-Hyderabad, CRIDA-Hyderabad, and ANGRAU etc. Feedback was also collected from small awareness creation camps organized by IIT Kanpur at various other places like IIPR-Kanpur, ZCU-Kanpur, and GBPUAT-Pantnagar etc. It was also noticed that we got comparatively more proactive participation and response from users from South India. Some of agriculture related business organizations like Du-Pont, Pesticides India Pvt. Ltd. etc. are also showing interest on agropedia by sending their employees to the training programs.

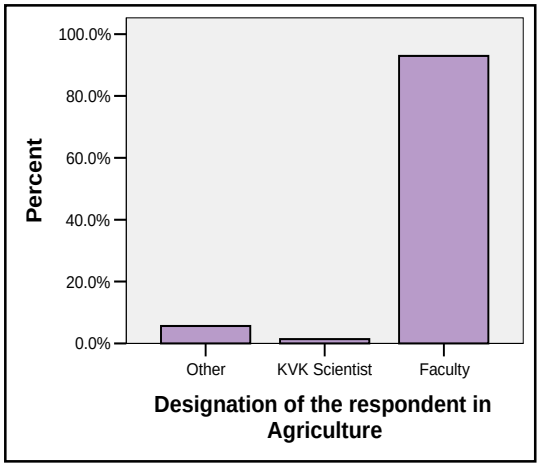
Through such promotional cum training activities, IIT Kanpur team tried to find out the requirements of the agriculture community and collected feedback on the functionalities available on agropedia website and kept incorporating those over the various phases of its development. In the latest (beta) version of agropedia, IIT Kanpur team has incorporated many features demanded by the users during the different training sessions to make the site more user-friendly and informative. agropedia

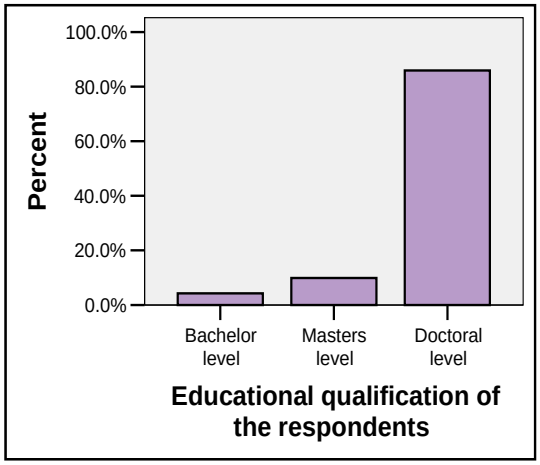
[10] Members of National Agriculture Innovation Project: A regional Development initiative by Government of India

website with version beta 0.1 was initially launched on 12 January, 2009 at NARS, New Delhi. In this analysis we are considering the data collected during the training sessions using the beta version of agropedia starting from the agropedia launch workshop. We would first analyze the characteristics of the respondents who participated in the survey and given their feedbacks on agropedia. Their age, educational qualifications, field experience and ICT skills etc are the distinguishing features which can influence the overall nature of response and feedbacks upon agropedia. The next section describes the requirements of the agriculture community who are the users of agropedia, which can act as the basis to evaluate the performance and functional features of agropedia and suggest a future direction of it development. Following that, the subsequent section describes the nature of feedback given by the respondents on agropedia so that one can check the current suitability and plan for future modifications in agropedia according the real time needs.

5.2 USER CHARACTERISTICS

From the demographic data collected during the revelation of agropedia, it has been found that 93% of the total respondents were faculty from various agriculture universities having expertise in different branches of agriculture viz. horticulture, agronomy, soil science, genetics & plant breeding, plant pathology, animal science, entomology. Some of them were computer programmers, lab technicians, JRFs (Junior Research Fellows), SRFs (Senior Research Fellows), students, research scholars, research associates, agriculture engineers, agriculture economists and extension workers. So, most of the respondents were having a highly qualified background. Evidently, the data shows 85.9% of total participants have a doctoral degree, and more than 94% of the participants prefer English as their medium of communication in addition to other regional languages.





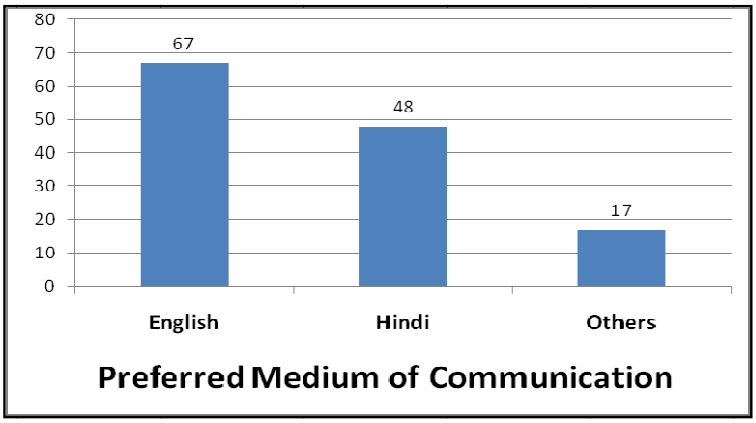


Figure 5. 1. User's Characteristics: Set A

About 82.5% of them had teaching, research or work experience of more than 5 years. This set of data reveals a substantially high level of qualitative understanding and adoption potential among the majority of respondents. More than half of the participants fall in the age group 35-40 (56.3%) and with 36.6% lying in the age group of 'above 50'. This can be mapped with their lack of exposure to ICT when young, and their reduced interest in agropedia as it was related to learning and using computers. On the other hand, it was also found that they look forward towards implementing ICT based development in agriculture as well as in their professional life.

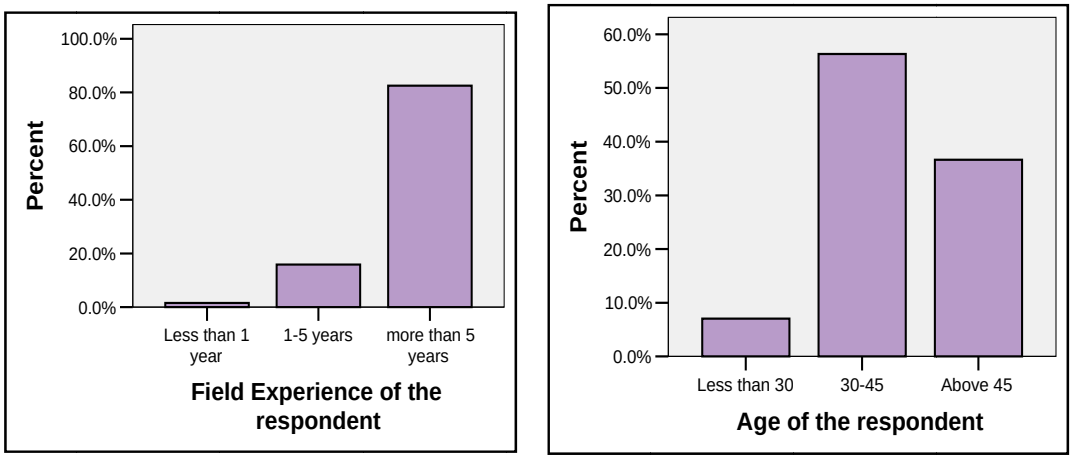


Figure 5.2 User's Characteristics: Set B

This implies that though there is a chance that 40% participants of the higher age group don't have much computer knowledge but they can develop interest and support in this type of innovative initiative and encourage their juniors and youngsters to follow this. From the large agriculture community, the only disappointing factor that came out is the remarkably low participation and responses of females (only 7%) and KVK scientists (just 1.4%).

5.3 USER REQUIREMENTS

If we want to know how much has the agropedia website been effective to serve the current needs of the agriculture community and to what extent it will be able to build a proper knowledge network among the community members; then the first thing to observe is whether users can have the accessibility to ICT resources, and whether they are able to use the agropedia website and freely interact with it. Since agropedia is an ICT based platform for knowledge management, therefore skill in computer is the must know factor to use it. Among the respondents, 81.7% have the computer accessibility for acquiring agriculture information and 60.9% have training on personal computer skill. Moreover, 76.5% participants have the opportunity to get help from the computer experts. Despite having the computers and related skills to use it, only half of the respondents had shown their interest to use computer 'most of the times'. That means agriculture community has computer accessibility, computer skill and help from computer experts but substantially low level of interest to use computer for acquiring agriculture information and knowledge. One of the reasons may be that they don't get much relevant and necessary information about agriculture through the other websites before the launch of agropedia, or it is difficult to find out the desired information from the available online resources. This data reveals that the online content should map the comprehensive domain requirement of the agriculture community and it should be presented through a user friendly interface.

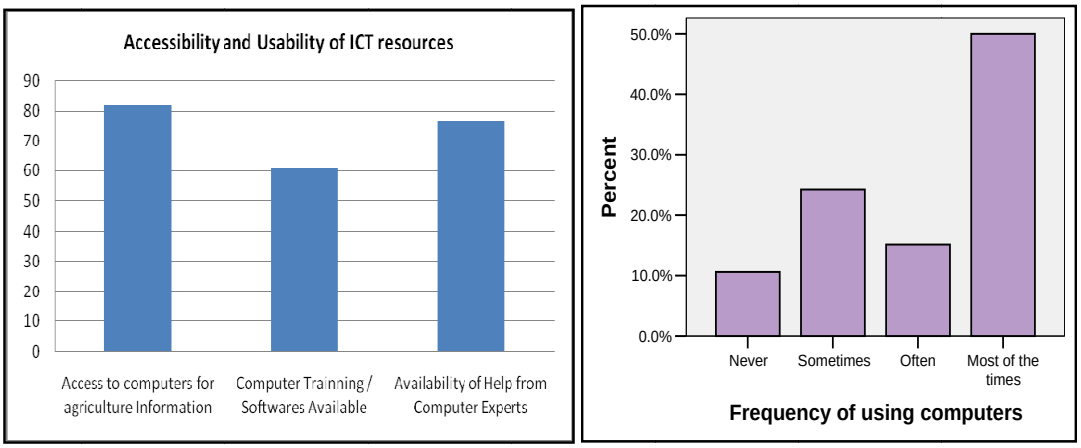


Figure 5.3. User's Requirements: Set A

Therefore our second focus is how much need they have for the information and what type of information they require at different times. Farmers are at the receiving end of all the agriculture information what they can put into practice. Considering the assessment of their needs, one can get the data from the KVKs (Kisan Vigyan Kendra) and nearby agricultural institutions/universities where farmers generally come to get the solution of their problems arising at different times. Around 44% of the respondents of our training sessions answered that the farmers visit KVK on daily basis, 38.2% agreed that the farmers used to visit KVK and agriculture universities only when there is a necessary. Most of the respondents agreed that the farmers visit agricultural institutions to solve their queries as their only offline resource.

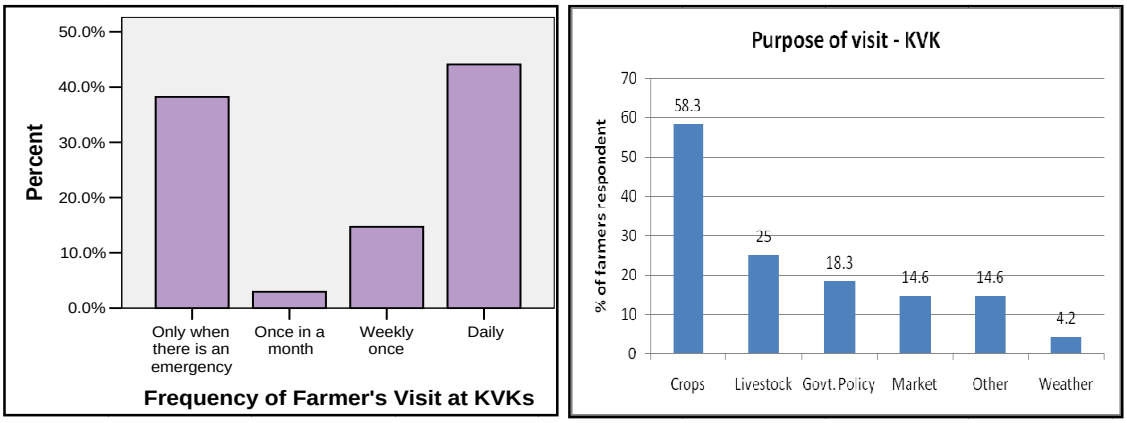


Figure 5.4. User's Requirements: Set B

Among the various types of information need, farmers need most of their queries regarding the crops. In addition they also need information regarding livestock, govt. policy, and market. 58.3% of the respondents said that farmers come for crop related information, 25% of them said the information need is also for livestock, 18.3% agreed that farmers also want to know about various government policies regarding agriculture and allied activities. 14.6% of they informed about the information need of farmers regarding market conditions. According to some of the agriculture experts, farmers are also interested to other types of information viz. agriculture machineries, weedy issues, soil fertility, plant protection etc.14.6% of the respondents expressed that farmers need such generic information which are not covered in the given choices of the questionnaire. Only 4.2% participants argue that they come for the weather information. The reason may be availability of many other sources to get information on weather; the radio or television is the traditional and commonly used medium for this purpose.

Need of information always driven by the commonly faced problems at the regional level. Our empirical study we see that most of the agricultural regions are suffering from the disease problem. Drought, water logging, sodic land, leaching though create much problem in farming but still now not as much as like diseases and pests. As implied by the data (Figure 5.5), 64.6% of the problems in agriculture are arising from crop dieses, 52.1% are arising from pests, 27% are from drought, 22.9% are from water logging, 20.8% are from sodic land 2.1% are from leaching. Other unknown factors accounts for 27.1% of the agriculture related problems. So, farmers also have quarries on these types of problems. In summary, the farmers need the information mostly on crop and diseases and other information related to their regional conditions and problems. When we see the responses upon main purpose of getting agriculture information of agriculture community most of whom are faculties and researchers (among our respondents), we found that 65% of them need data for the research, 55.9% for teaching/learning purposes. About one third of them access information for self-improvement (33.3%), marketing (31.9%) and community education (27.5%). They also require information for the processing of primary products (24.6%), primary production (20.3%), economic advancement (20.3%) and policy development (17.4%).

On the other hand, the commonly used method to disseminate agricultural information was seminars as agreed by 64.3% respondents. They also use the advisory services (57.1%) and publications (55.7%) for this purpose. Apart from that, Internet (38.6%) and Public Education (35.7%)

are the other preferred methods to disseminate agriculture information. Presently, the other methods they are following for sharing knowledge are digital document, electronic references, community building, institutional building, in-house reference etc.

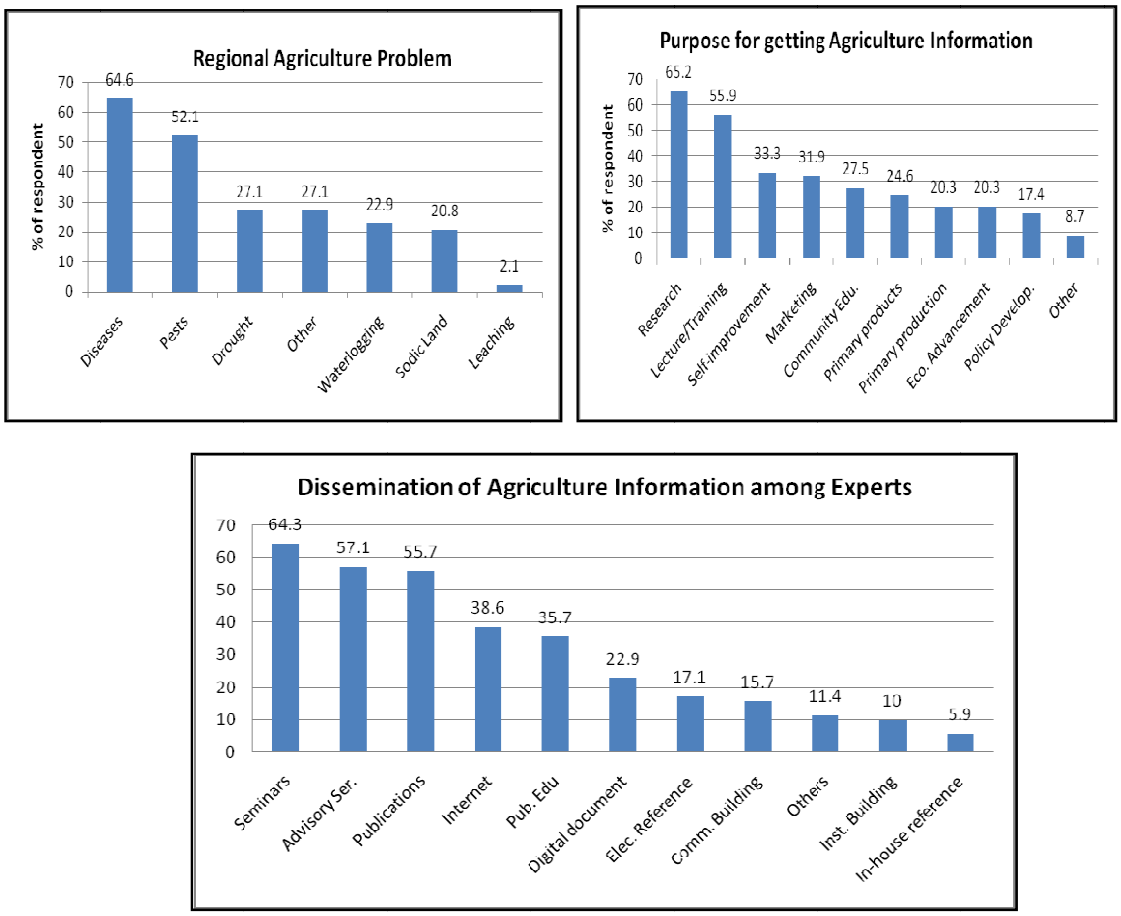


Figure 5.5 User's Requirements: Set C

5.4 FEEDBACK ON AGROPEDIA

agropedia in developed towards building an open access knowledge sharing platform by creating a knowledge network among the different actors of the agricultural community. To capture, manage and share the widespread knowledge through this platform, agropedia has been designing and creating various features by keeping in mind the different nature and preference of its users, so that every knowledge actor can share knowledge with his own preferred way. The distinctive feature of agropedia is the technologically efficient semantic search mechanism based on knowledge models. Knowledge models help in indexing and tagging the certified contents which is being created and uploaded on the website. It helps the users to search the appropriate and relevant certified content with minimum hassle. Now we will look at the data from a different perspective to evaluate whether agropedia is user-friendly and at the same time efficient to fulfill its aim.

With respect to the known needs of the respondents, 85.7% of them opined that current provisions are not adequate to address the information needs of the extension agents and they need another suitable approach to fulfill those. Therefore there is a desperate need to have some alternative information and knowledge sharing system in place to address their concerns. Looking at agropedia as such an alternative, the survey evaluation reveals that 35.7% respondents agree that 'agropedia is the most suitable approach possible at present' to cater to the respective concerns. 64.3% of the respondents suggest further improvements in current functionalities of agropedia in order to widen its scope of application in future. This data reveals that at the initial stages agropedia has set itself to walk on the suitability parameters and attracting huge expectations to serve the information needs and bridge the information gap among the agriculture community.

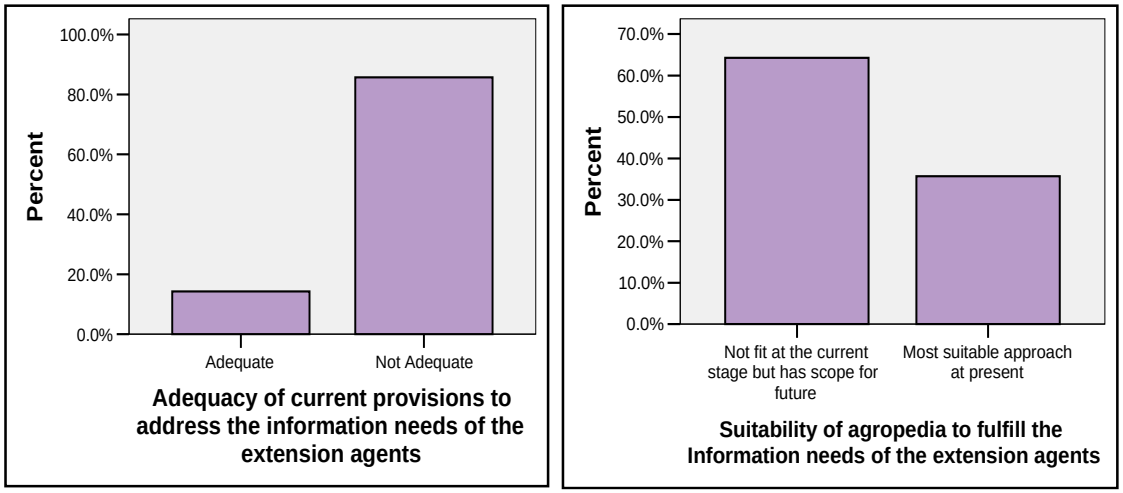


Figure 5.6. Feedback on agropedia: Set A

Knowledge Models (KM) are one of the distinct features of agropedia which helps the agriculture community to create, understand and learn and present agriculture concepts and helps effectively knowledge creation process. Initially it is developed by the commissioned agents, but the attempt is to encourage other agriculture researchers and practitioners to build their own knowledge models according to their interest and expertise. Analysis of the users' feedback on knowledge models published on agropedia gives quite encouraging results. About 90% of the first time users Knowledge Models applauded the approach and emphasized that it is an effective and useful tool to develop a concept. 60.6% of the respondents agreed that KM is the best medium to understand agriculture concepts. Though knowledge model is a new concept to the participants but 53.5% of them get attracted by that concept during the short training period and they felt it is the most useful and easy medium to comprehend and develop an agri-concept. 45.1% were agreed that it is easy to develop after little training and hands-on practice on the KM-development software. Although 43.7% of them suggested some improvement in the existing knowledge models.

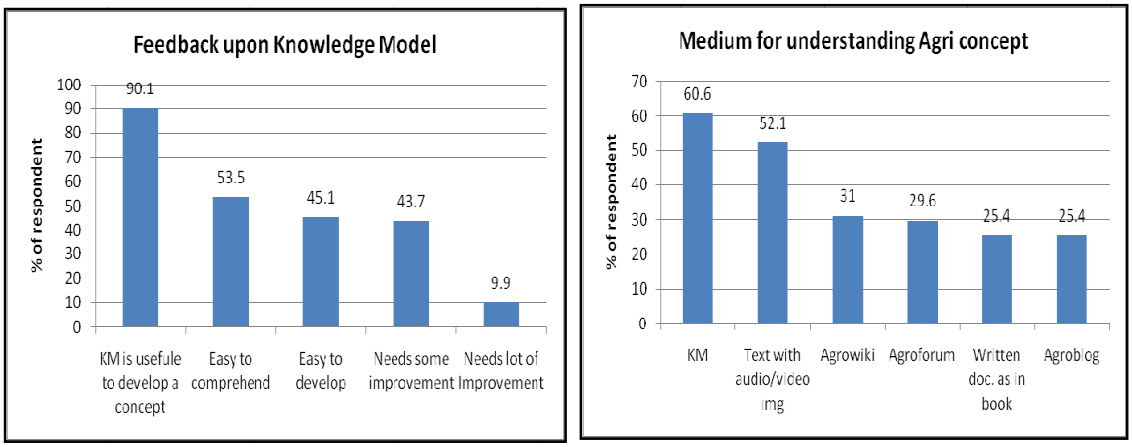
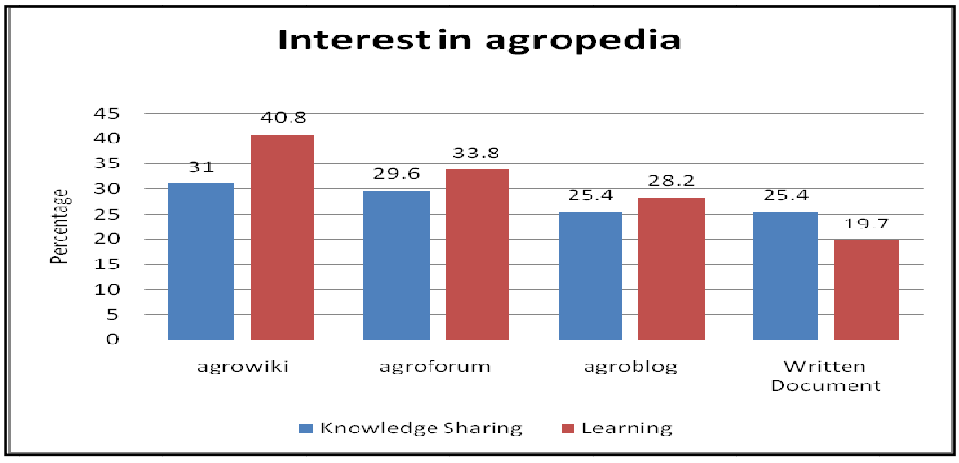


Figure 5.7. Feedback on agropedia: Set B

52.1% of the respondents preferred 'text with audio and images from a digital library' for sharing information and learning through the shared information. agrowiki and agroforum are the web spaces also liked by the respondents with a respective share of 31% and 29.6% weights for knowledge sharing as well as for learning purposes. There are adequate interests in agroblog and written documents for the same purpose.

When it comes to the participation in the digital spaces provided by agropedia, learning and knowledge sharing are the main activities to be observed upon. agrowiki, agroforum, and agroblog comparatively felt better for the purpose of collective learning as compared to knowledge sharing, while written documents are preferred more for knowledge sharing than as a learning space. Following figure plots the concerned data regarding the interest in agropedia.



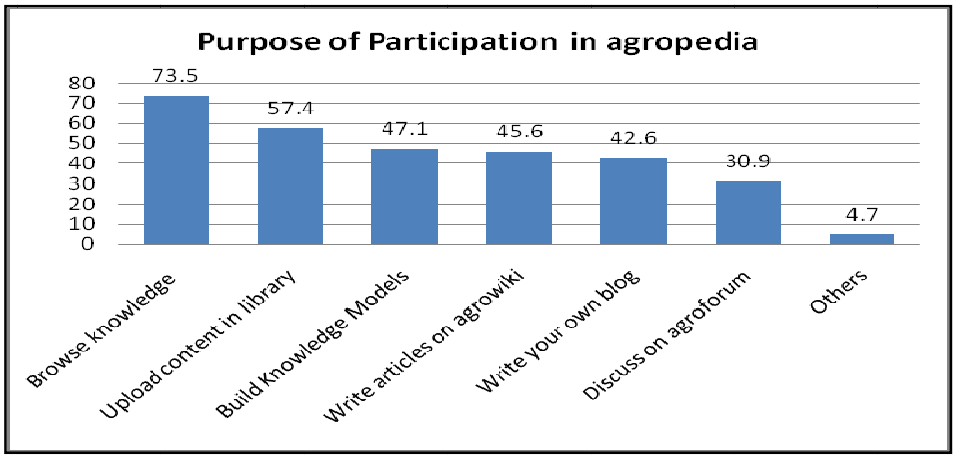


Figure 5.8. Feedback on agropedia: Set C

While observing the 'purpose of participation' of the experts and others in agropedia, it is found that 73.5% of them want to participate for content browsing and using knowledge available at agropedia, 57.5% of the respondents would like to share knowledge by uploading certified content in library, and 47% waned to build their own knowledge models for agropedia. When it comes to contributive participation in the interactive spaces like wiki, blog and forum, the response rates were 45.6%, 42.6% and 30.9% respectively. This indicates that within the short period, agropedia has attracted users not only to receive knowledge, but also to contribute and share contents to the website.

agropedia allows images, audio and video clips with the textual content as the digital modes of knowledge transactions. Given such features, around 51% of the respondents express their comfort while uploading images, voice and movie files. 29.9% of them expressed their difficulties while using this, and 7.5% are completely unable to understand and use this feature. Small training and workshops sessions developed learning interest among them and appeared fruitful for making them use this functionality. Moreover, 64.3% respondents felt a digital technology enabled knowledge service like agropedia is extremely beneficial for them, though 18.6% said it is useful for research purpose only, and 15.7% said it is helpful to some extent for extension purpose only.

To promote the collaborative content creation process, when respondents were asked about the motivation factors to for driving participation, non-monetary incentives were came out as dominating driving forces as compared to the monetary rewards. In addition, 57% of the users suggest offering a letter of appreciation for promoting the participation rate of experts in a collaborative content creation for agropedia. 39.1% said that disseminating personal details of the content provider after small intervals are one of the senses of appreciations. 29% of the respondents also agree to rate the content by peer reviewer and get appreciations. Some of them (about 25%) also wish to have some sort of monetary reward for content creation.

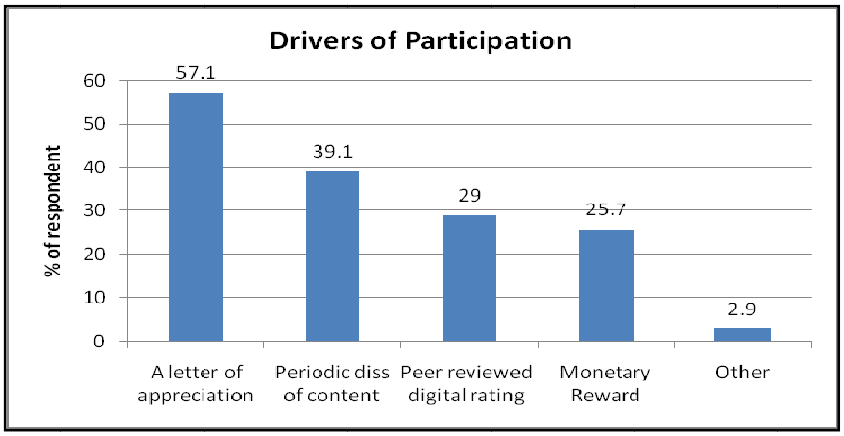


Figure 5.9. Feedback on agropedia: Set D

All these indicate that the experts and other users are quite interested to join in this collaborative knowledge sharing process and they need it. But for that if they demand for some appreciation or recognition that is quite reasonable. However, on the whole, the agropedia received its most desired acknowledgement by most of the participants (92.5%), as a user-friendly and informative source of information.

5.5 CORRELATION ANALYSIS AND INTREPRETATION

Based on the data collected from the structured questionnaire, out approach is now to look for the possible correlations among the individual variables as well as among the logically constructed meta variables derived from the existing ones. Few of the relevant meta variables are constructed for by combining the individual variables of similar nature. Illustratively, 'Perceived Ease of Use' is the measure of comfort in contribution to the website viz. uploading text, image, audio, video etc. 'Perceived Benefits' is a measure of possible advantages of agropedia delivered to the users in future. This variable is constructed by combining two different variables 'Whether the current agropedia project appropriate to the extension needs of the extension agents' and 'Do you find digital technology enabled knowledge service agropedia in the domain is benefitted'. 'Perceived Degree of Future Use', which is a measure of sustainability of agropedia, is derived from the response variable 'Use of agropedia in agricultural research and extension is preferable'. Similarly, 'Resource Availability' is a measure of accessibility and usability of ICT resources to the agropedia users. This meta variable is constructed by combining the three variables 'Do you have access to computers or how you acquire agricultural information', 'Training in personal computer skills and / or software available' and 'Do you have help from computer expert '. 'Adequacy of Information' provided by agropedia is determined by the response variable 'agropedia as a user friendly and useful source of information'. The output given by the software for statistical analysis (SPSS 16) is presented as follows in the Table 5.1.

The respondents' qualification has a significant correlation coefficient of 0.240 with the 'Perceived ease of use' and implies that an educated individual can use the agropedia more comfortably than the others. This also means, agropedia either needs people having sophisticated technical skills to

Table 5.1 Correlation Analysis

			Age	Education	Field Experience	Resource availability	Perceived benefits	Perceived ease of use	Perceived degree of future use	Adequacy of information
Spearman's rho	Age	Correlation Coefficient	1.000	.284*	.310*	-.175	.131	-.160	-.100	.088
		Sig. (2-tailed)	.	.016	.013	.153	.300	.201	.417	.477
		N	71	71	63	68	64	66	68	67
	Education	Correlation Coefficient	.284*	1.000	.017	.077	.319*	.240	.186	.078
		Sig. (2-tailed)	.016	.	.894	.533	.010	.052	.128	.528
		N	71	71	63	68	64	66	68	67
	Field Experience	Correlation Coefficient	.310*	.017	1.000	.156	.106	-.182	.100	.281*
		Sig. (2-tailed)	.013	.894	.	.229	.432	.168	.442	.030
		N	63	63	63	61	57	59	61	60
	Resource availability	Correlation Coefficient	-.175	.077	.156	1.000	.001	.191	.292*	.072
		Sig. (2-tailed)	.153	.533	.229	.	.992	.134	.018	.569
		N	68	68	61	68	62	63	65	64
	Perceived benefits	Correlation Coefficient	.131	.319*	.106	.001	1.000	.071	.230	.145
		Sig. (2-tailed)	.300	.010	.432	.992	.	.589	.073	.269
		N	64	64	57	62	64	60	62	60
	Perceived ease of use	Correlation Coefficient	-.160	.240	-.182	.191	.071	1.000	.193	.258*
		Sig. (2-tailed)	.201	.052	.168	.134	.589	.	.129	.043
		N	66	66	59	63	60	66	63	62
	Perceived degree of future use	Correlation Coefficient	-.100	.186	.100	.292*	.230	.193	1.000	.136
		Sig. (2-tailed)	.417	.128	.442	.018	.073	.129	.	.276
		N	68	68	61	65	62	63	68	66
	Adequacy of information	Correlation Coefficient	.088	.078	.281*	.072	.145	.258*	.136	1.000
		Sig. (2-tailed)	.477	.528	.030	.569	.269	.043	.276	.
		N	67	67	60	64	60	62	66	67

reach the extension workers and farmers, or the users need to be trained properly to use the networking and knowledge sharing features of the website. The consequent effect of education is on 'perceived benefits' having their correlation coefficient 0.319, the highest among all in the given

comparison table. This is also quite logical to believe that only well educated agriculture community can use the agropedia to share their knolwege in a collaborative content creation digital environment. The future uses of agropedia are significantly correlated with resource availability having a correlation coefficient of 0.292. Since ICT infrastructure and concerned resources are the backbone to sustain this kind of initiative, therefore the participation and productivity of knowledge on agropedia critically depends upon the accessibility to the ICT resources. Another set of variables having high correlation coefficient (0.281) are 'Adequacy of Information' (delivered by agropedia) and 'Field Experience' (of the respondents). Both the variables doesn't show any logical relationship between each other and their correlation coefficient is not much of any relevance in our analysis and it is better to ignore their significance.

5.6 CONCLUSIONS

The feedback documented in this chapter has limited relevance in light of the composition of "users" whose feedback was sought. At this preliminary stage of agropedia where the social space has yet to be launched, and we are yet to conduct a workshop of reasonable scale only for agricultural extension workers, we cannot expect to get feedback from a set f users that best match our target set. For example, our target community may have lower academic qualifications and will be more aware of the ground realities in agriculture. Notwithstanding these limitations, however, this analysis of user perceptions on agropedia have guided, and continue to guide the development of technology tools for promoting social involvement in the digital knowledge ecosytem as suggested in the previous chapters. Responses regarding the potential of agropedia from a diverse set of users have been extremely reassuring, and are a reassertion that the project is progressing along the right path. Finally, users seem to accept the choice of two diametrically opposite modes of knowledge creation within agropedia without any element of resistance or even surprise, suggesting that this was possibly a natural choice for the agricultural domain.

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[i] ***End notes***

(Taken from Google Analytics Help:
http://www.google.com/support/analytics/bin/answer.py?answer=60127&topic=15337)

Bounce rate: It is the percentage of single-page visits or visits in which the person left your site from the entrance (landing) page. A high bounce rate generally indicates that site entrance pages aren't relevant to your visitors. The more compelling your landing pages, the more visitors will stay on your site and convert.

Loyalty: Loyal visitors are frequently highly engaged with your brand and a high number of multiple visits indicate good customer/visitor retention. A high number of new visitors indicate strong visitor recruitment.

Recency: The frequency with which visitors return to your site can indicate their level of engagement with your brand and their readiness to buy. On this histogram, visitors are categorized according to

the number of days that have elapsed since their last visit. For example, new visitors are included in the "0" bar at the left of the histogram. Visitors who last visited the site more than one year ago are included in the 366+ bar.

Length of Visit: Length of visit is a measure of visit quality. A large number of lengthy visits suggest that visitors interact more extensively with your site. The graph allows you to visualize the entire distribution of visits instead of simply the 'Average Time on Site' across all visits. Keep in mind that 'Average Time on Site' is skewed by visitors leaving browser windows open when they are not actually viewing or using your site. You can see whether a few visits are skewing your 'Average Time on Site' upward or whether most visits to your site have a high average time.

Depth of Visit: Depth of visit is a measure of visit quality. A large number of high page views per visit suggest that visitors interact extensively with your site. The graph allows you to visualize the entire distribution of visits instead of simply the average page views per visit. You can see whether a few visits are skewing your average page views per visit upward or whether most visits to your site result in a high number of pages being viewed.