OPAALS PROJECT

Contract n° IST-034824

WP 7: Community Networks and Digital Ecosystems

Del 7.3 – Indian rural case study

Digital Ecosystem for Agriculture and Rural Livelihood in India - Opportunities and Challenges for Knowledge Driven Agricultural Innovation

(A collection of case studies, field study reports and commentaries)

Project funded by the European Community under the 'Information Society Technology' Programme

Contract Number: IST-034824

Project Acronym: OPAALS

Deliverable N°: D 7.3

Due date: May 2008 (As per last amendment)

Delivery Date: May 2008

Short Description: Digital Ecosystem for Agriculture and Rural Livelihood in India - A collection of case studies, field studies, field reports & commentaries

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Partners contributed: None

Made available to: Public

Versioning

Version	Date	Name, organization
3.2	30.5.08	IIT Kanpur

Quality check

Internal Reviewers: Dr. Antonella Passani & Lorena Rivera Leon – T6 Ecosystems S.r.l.

Dependences:

Work Packages	This D 7.3 deliverable is interdependent with key OPAALS deliverables like P2P and scale free networks, distributed accountability – identity & trust and provides a test bed for open knowledge system models.
Partners	Parterners who could benefit from reading of this deliverable are: University of Kassel, London School of Economics, Create - Net, T – 6, WIT, TUT, FAO and new WP – 11 partners.
Domains	1. Knowledge mobilisation in communities through Digital Ecosystem for Change and innovation. 2. Communication and knowledge networks as complex – adaptive – self generative systems.
Targets	Domain researchers, NGOs, and policy makers for regional development.

Digital Ecosystem for Agriculture and Rural Livelihood in India

Opportunities and Challenges for Knowledge Driven Agricultural Innovation

A collection of case studies, field study reports and commentaries

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WP: 7
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Preface

Large socio-technical systems are complex but not all of them are necessarily adaptive or self organising (Monge and Contractor 2003). When one looks at the socio-technical system of agriculture in the rural hinterlands of India, one finds relations, systems and networks that have remained nearly the same for decades if not centuries. The need of innovation in this relative stasis, due to larger socio-economic policy compulsions, creates new knowledge dissemination initiatives. Those initiatives attempt to create new network linkages. So as a researcher, one becomes concerned with issues relating to 'development and change' in a large complex socio-technical system consisting of many individual components (actors) and also with the network effect on such a system when many new feedback loops are introduced.

When an old, stable, relatively closed social system, like agriculture in a village cluster, connected to few local market places, is opened up and new ICT (Information and Communication Technology) mediated networking technologies are introduced, the simultaneous interaction of many variables generate the possibilities of creating patterns of self organizing behavior.

Earlier researchers (Ashby 1964; Prigogine 1984; Maturana and Varela 1980; Capra 1997) had pointed out three types of characteristics of self-organizing socio-technical systems, first that of 'requisite variety' - on which depends- creativity, evolution and development in a system. The second common characteristics of models of self organization is that they all deal with open system operating far from equilibrium and thirdly earlier research postulated that self-organizing systems had intense non linear feedback loops.

The question of whether human social systems can self organize, self propagate, evolve, that is can be organized as a 'living system' has been attractive to many researchers. Many of them have looked at the question metaphorically but some have specifically addressed the issue of an autopoietic human social system (Fleischaker 1992; Mingers 1995).

The problem here is that the autopoiesis has been defined originally for systems in physical space and for computer simulations in mathematical spaces. Because of the inner world of concepts, ideas and symbols that arises within human thought, consciousness and language, human social systems exist not only in the physical domain but also in a symbolic social domain (Capra 1997).

Thus a village community, an agricultural cluster can be described as a biological system, defined by a web of relations, but also as a 'conceptual system', defined by roles and relationships and those roles are subject to social conventions, culture of the community and may even vary with time.

Thus the social system simultaneously exists in two domains; the physical and conceptual and so can we apply the concept of autopoiesis to a social system at all? Maturana and Varela differed on this. But some other authors (Luhmann 1990) have asserted that an autopoietic social network can be developed. Luhmann's contribution was to identify the social processes for this as communication. 'Social systems use communication as their particular mode of autopoietic reproduction. Their elements are communications that are –produced and reproduced by a network of communicators' (Luhmann 1990).

Thus a network of conversions exhibit inherent circularities and self amplifying feedback loops. The closure of the network results in a shared system of beliefs, values and possibly praxis, a context of meaning, which is continually sustained by ongoing conversation. Since all these 'self reproducing' communicative acts take place in the symbolic social/conceptual domain, boundaries like expectation, confidentiality, loyalty form.

Following this construct, the project 'Digital Ecosystem for Agriculture and Rural Livelihood' (DEAL) was structured around the concept that the creation of conversation and maintaining its circularity and self reproduction is the keystone to 'self catalysis'.

The research exploration started with the notion that old socio-technical systems like agricultural practices in dispersed villages in Northern India, particularly Eastern Uttar Pradesh, which in many ways have been stagnating (by most measures of Economic and Social Development Indexes) will exhibit rapid knowledge driven growth if ICT mediated networks create many new feedback loops and opportunities for 'conversations among communities of experts and users' are enabled and enhanced. Emancipation happens when past restrictions can be overcome by removing distortions in the communication flow (Capra 2003).

This growth will happen due to radical shifts in economic patterns generating a series of networking compulsions and that propensity of 'self propagation' will be empowered and facilitated by building autopoietic socio-technical systems, thriving on dialogues and conversations. That is our concept of DEAL.

The case studies and papers compiled in this volume are in many ways field studies based on this concept as applied to a test bed of villages. These villages are approached through five nodal points called KVKs (Krishi Vigyan Kendras - Agricultural Science Centers) all located around Eastern Uttar Pradesh in Northern India.

The conceptual issues here have been studied through deployments and observations over a period of about 36 months. The DEAL Project was inspired by the formative thoughts of the OPAALS Project but started in a small way even before OPAALS was formally initiated. In the DEAL project, a number of experts, coming from different disciplines, have looked at the phenomena from different perspectives. Thus a number of research strands have developed. The following collection chronicles those different views and lines of inquiry.

In the following few paragraphs we will now provide a general background on Indian Agriculture and the new economic compulsions and then a short overview of the cases and papers in the collection and how they connect the 'keystone' thoughts on autopoeitic socio-technical systems to the action arena of current socio-economic compulsions of Indian Agriculture.

Brief Background of Indian Agriculture

For almost fifteen years after India's independence in 1947, the country remained vulnerable to famine and hunger, particularly in villages, where almost 70% of the population lived at that time. India's first green revolution was a spectacular success from many dimensions. Volume of production went up by orders of magnitude for most crops particularly for basic food grains like wheat, rice and pulses through higher acreage under cultivation and vast areas were brought under pump irrigation. New seed varieties like dwarf wheat and dwarf rice were successfully introduced which significantly enhanced yield per hectare. Yield also improved due to wide spread usage of chemical pesticides and fertilizer. India became a net exporter of many agricultural produce and the national buffer stock for basic grains ensured India's food security.

Forty years later, at the threshold of the 21st century the situation has changed. The mismatch between supply and demand has again started widening. Spectacular rise of India's service sector followed by mining and manufacturing accelerated the Indian economy since the nineties. But the increasing standards of living in India's bustling cities, higher demand of food grains at home and around the world can not be adequately served by declining agricultural productivity at India's country side. This has initiated a complex downward spiral.

The availability of arable land has saturated, water resources are severely constrained. And to complicate the situation- over tillage, over irrigation and excessive or wrong usage of chemicals,

fertilizers and many other adverse effects of earlier technological approaches have severely impaired India's productivity across the most fertile and irrigated states (that served as India's granary). For example in the case of Rice, while India's average production per hectare is 2.4 to 2.8 Tonnes per hectare, China produces 6 Tonnes per hectare (Business Standard 11th April 2008).

To meet the growing need of food grains for a rapidly growing nation, India's policy makers have realised that new strategies are needed to enhance the agricultural growth rate to at least four percent from the current level of 1.8 to 2 percent. This level is essential to sustain a double digit growth rate for the GDP while retaining inflation at a manageable level (Chengappa 2007).

Key components of this new strategy will be knowledge driven agriculture and innovation for (non-farm) livelihood development across six hundred thousand villages of India. This goal of knowledge driven agriculture (to increase production, reduce cost, enhance agricultural profitability, to make Indian agriculture globally competitive), also needs new programmes to reduce rural poverty and inequality, to protect the environment by reversing the degradation of natural resources (like land and water). New programmes are needed towards innovating new forms of rural enterprises that will effectively manage the shift of labour forces, stem the migration to urban slums and will broaden the base of economic growth potential of rural citizens.

This knowledge driven approach to Indian agricultural reform and rural livelihood generation, has been well analysed in many Planning documents. Indian Vision 2020 states that 'The pace of India's future progress will depend to a large extend on its ability to make available the latest and most useful knowledge to vast section of the population' (Planningcomission.nic.in, Last acessed: 02 May 2008). Table 1 and 2 depicts a set of challenge and the knowledge based solutions proposed at policy level.

It was felt that 'by infusing knowledge connectivity to human agencies' critical success condition can be created to energise a resurgent rural economic infrastructure (Garai & Shadrach, 2006). In his budget speech on February 28, 2005, Mr. P. Chidambaram, the Union Finance Minister of India said that 'The National Commission for Farmers has recommended the establishment of Village Knowledge Centres (VKCs) all over the country using modern Information and Communication Technology (ICT)'.

Table 1: Economic Challenges and Knowledge Based Solutions

Economic challenge	Knowledge based solutions
India commands just 4 percent of the global fresh water resources, but supports 16 percent of world population	Creating irrigation potential, repairing system deficiencies and inefficient on-farm water management. Adapting cropping patterns according to water availability
Adverse effects of draught on production of crops	Reducing the utilisation gap, ground water extraction, watershed development, rainwater harvesting
Over-dependence on rain fall and monsoon. More than 60 percent of the cultivated area is rain dependent. The country's rainfall is not evenly distributed, but in total, it is adequate to meet the water requirement	Increasing irrigation efficiency from the present level of 35-40 percent, completion of ongoing irrigation projects. River grid developement will help rationalise the availability of water
Over-exploitation of water, especially for growing rice and sugar, has seen water tables recede	National Rainfield Authority to help conserve water

Table 2: Technological Challenges and Knowledge Based Solutions

Technological challenge	Knowledge based solutions
No new technological breakthrough in terms of high-yielding varities for foodgrain crops	Some promising candidates for pulse and rice shuold be pushed through rapidly
Soil fatigue due to over-exploitation of nutrients and organic matter in intensive cropping areas	Crop rotation and relpenishment of micro-nutrients to help restore fertility
Nutrient imbalance due to use of improper combination of fertilisers	Optimal use of fertilisers with the right NPK mix, without overdose of nitrogenous nutrient
Non-availability of quality seeds resulting in low seed replacement rates	Developement of market and infrastructure for making seeds available to farmers
Inadequate or poor harvest management infrastructure at the farm level	Making instituional credit available to farmers so they can make use of improved technology

A Brief Note to the Case Folio

The concept of ICT for rural development has always attracted media and corporate attention and therefore many multilaterally funded projects on this theme have been initiated over the last ten years across many developing countries. Most of these projects focused on establishing info-kiosks in villages and grappled with the initial problems of connectivity, power and other infrastructural issues. Some of them were oriented towards electronically delivered Government to Citizen (G2C) services; some were focused on trade, some on a range of consumer oriented services.

Our initial study during 2002-2004 of many such projects led us to believe that to ignite the agricultural and rural livelihood innovation process with knowledge flow, these rural ICT kiosks not only needed network connectivity and electrical power but also the power of appropriate content and applications. Our research hypothesis was that the process of creating a self propagating content/knowledge network and self managed knowledge repository can be enhanced by efficient networking of many conversations to build digital communities. This can then create a digital ecosystem and a dynamic system sustained by many feedback loops.

The results of these initial studies are chronicled in the first paper entitled ‘On to Action – Building a Digital Ecosystem for Knowledge Diffusion in Rural India’ in this compilation.

The challenges of content and application development that will respond to the needs of communities engaged in agriculture- who are spread across a huge country, speaking many languages and dialects and are challenged by literacy- brought us to the first research stream in the DEAL (Digital Ecosystem for Agriculture and Rural Livelihood) project of India. And that was the socio-technical challenge of developing coherence and interoperability across content coming from various sources, responding to different needs of different stakeholders at different times. Such content modules are often semantically connected but differently expressed and often recorded on different media in different formats.

This led us to the process of developing Agricultural Information Management Standards and some basic tools like a commonly agreed vocabulary (Agrovoc) that could lay the foundation for a thesaurus and then an ontology oriented service. The last two papers in this compilation deal with the technologies that we explored to construct the vocabulary and the standards (that were based on the user requirement) analysis described in the first paper.

These two paers , in a way form a ‘related’ but ‘different’ appendix to this predominantly social science oriented deliverable. But we retain these two papers for two reasons; firstly for highlighting the socio-technical and inter-disciplinary nature of IITKanpur contribution to the OPAALS Project. And also show that many social science insights develop during the search for appropriate

technology in a digital ecosystem and vice versa. Autopoeisis in the sociological domain is strongly related to the 'open ease' of the technology architecture (of the knowledge exchange network) albeit orthogonally.

The first stream of research led us to the next research problem of self sustainability and self managed evolutionary growth of ICT initiatives in the developmental sectors. The second, third & the fifth paper in this collection dwell on that theme.

Our field trips across Northern India to many Agricultural Science & Technology centers i.e., Krishi Vigyan Kendras (KVKs) brought out the fact that while there were a large number of knowledge services available to the rural citizens – very few of them were accessed or used in the existing Agricultural Extension Centers/KVKs. Even fewer such extension centers contributed such digital content to any sharable repository.

Thus we formed the research hypothesis that lack of this reciprocity creates a fragmented conversation without circularity and that creates a negative causal loop. The extension centers can not or do not access the content due to language and literacy problems but even when they do, they find the content rather general, outdated & not relevant for particular local problems. And as they do not participate or interact, the lack of their 'local knowledge' contribution, further affect the dynamic relevancy of the agricultural knowledge extension networks. The lack of such user participation and lack of contributory interest make such projects unviable & dormant as soon as funds & aids cease to flow or administrative compulsions are not enforced.

The response mechanisms to these sustainability problems are elaborated in the third, fourth & the fifth paper focusing on the process of enhancing the interdependence among the knowledge producers and knowledge consumers facilitated through digital tools, platforms & applications that initiate and catalyze conversations.

Electronic Knowledge exchange networks driven by reform agenda in the Development Sector are often lured by the ease of setting up their own dedicated communities who are better 'enabled and equipped' while bypassing the dispersed, fragmented, and resource wise 'backward' user-contributor communities like the KVKs.

This led us to the study of the KVKs and their 'agency' problem. The existing Training & Visit (T & V) and demonstration through 'model plantations' system of extension was successful during the first Green Revolution through its narrow focus on individual crops grown in favourable areas (Rao, 2003). But today this approach offers very little scope for the initiative and participation of the farmers. The extension system is not accountable to them for result & impact and there is therefore little flow of knowledge in the 'return loop', from the farmers and the extension workers in the field, to the research laboratory of the agricultural scientists. At the same time the researchers too need to shift away from individual crop-orientation and emphasis on irrigated areas towards research on crops & cropping systems that respond to highly variable agro-climatic conditions in unfavourable areas. Research needs to be more location specific with greater participation from and interaction with farmers.

The third paper on 'Competitive Indian Agriculture' explains the DEAL approach to this problem and the results of the digital ecosystem approach that can help KVKs to reposition themselves as 'conversation generators and chroniclers'.

In summary, this compilation of case studies and field reports shows the relevance of (new collaborative information and communication technologies) and the Digital Ecosystem architecture to address the regional developmental needs of India. DEAL offers a way to apply the autopoietic system philosophy in a developmental socio-technical system that is trying to utilise 'conversation network' among knowledge creators and knowledge users to accelerate the pace of the National Agricultural Innovation Programme (NAIP) of India. Although the papers have looked at the

problems from different social and technical perspectives they share some common themes and realizations:

(a) Building rigorous feedback loops at all levels enhance knowledge networks in reach and richness of content.

(b) The content, value or attractiveness of knowledge representation will not automatically enhance just because Information and Communication Technologies are used. Users and experts must bi-directionally participate to ensure quality and relevance.

(c) Knowledge ecosystem building principles must be based on interoperabillity, coherence, semantic relationships. And as far as possible modularity, (that can enhance multiple representations) should be the design approach so that 'requisite variety' can be embraced economically and efficiently.

(d) Theory of complex systems provides a rich vocabulary to describe the self-organization potential of knowledge networks.

(e) The first emphasis should be on creating digital communities of existing physical /social communities. When these component digital systems are self generative then it is easier to initiate the self regenerative process through circularity of conversation of an interdependent network of digital communities, who are related (by the same concerns) but different (in pursuing different socio-technical objectives).

(f) Autocatalysis (Luhmann 1990 and 1992) is the clue to autopoiesis in the socio-technical knowledge network.

(g) In knowledge networks that are formed on the basis of social networks for generating and sharing knowledge , there are two types of components in the system that exhibit autocatalysis, the context/knowledge itself and the people.

(h) Through semantic processes, new knowledge initiatives can be generated by the accumulation of new emergent information (tacit knowledge, *Jana gyan*) and its integration with pre-existing formalized knowledge (explicit knowledge, *Gyan dhara*).

A regenerative social network gets power from participants' need for 'recognition' and appreciation' and that attracts more participants to the network (Chan et al 2004).

Thus the socio-digital ecosystem, the living and sustainable knowledge network that can be built from the prototype design of DEAL needs a dialectic interaction for traction and motive force. And that dialectics is between 'content' and 'people' through 'sensing' (a condition for interactive openness) and an 'open knowledge system/repository' (that uses self-referentiality for internal semantic closure). That again means that the network 'understands itself' and accesses/ annotates its own accumulated knowledge using circularities of digital conversation.

Reference and Literature Surveyed

Anand, S., and Parashar, V. (2006). Integrating local and global knowledge through ICT: Implications for rural business and develeopment, *IIMB Management Review* 18, (1): 85-93.

Antweiler, C. (1998). Local knowledge and local knowing: An anthropological analysis of cultural products' in the context of development. *Anthropos* 93: 469-494.

Ashby, W. R. (1964). *An introduction to cybernetics.* London: Methnen.

Bhatnagar, S. and R. Schware (Eds.) (2000) Information *and communication technology in development.*New Delhi: Sage.

Capra, F. (2003). *The hidden connection*. London: Flamingo

Castells, Mannuel. (1999). *Information Technology, Globalization and Social Development*, Discussion Paper no.114. Geneva: UNRISD. Last accessed July 12, 2008, from INTERNET: www.unrisd.org/80256B3C005BCCF9/(httpAuxPages)/F270E0C066F3DE7780256B67005B728C/$file/dp114.pdf.

Chan, C. M. L., Bhandar, M., Oh, L.-B., and Chan, H.-C. (2004). Recognition and participation in a virtual community. Paper presented at HICSS'04: 37th Annual Hawaii International Conference on System Sciences.

Chengappa, R., and Vinayak, R. (2007, June 11). Grain drain, *India Today*, 39-54.

Coleman, J. S. (1990). *Foundations of social theory.* Cambridge: Harvard Press.

Contractor, N. S. (1994). Self organizing systems perspective in the study of organizational communication. In B. Kovacic (Ed.), *New approaches to organizational communication* (pp. 39-99). Albany: SUNY Press.

Debroy, B., and Kaushik, P. D., (Eds.) (2004), *Energizing rural development.* New Delhi: Academic Foundation.

Dijk, J.V. (1999). *The network society.* London: Sage Publications.

Dreze, J., and Sen, A. (2002). *India: Development and participation.* New Delhi: Oxford University Press.

Feather, J. (1998). *The information society*. London. Library Association Publishing.

Fleischaker, G.R. (Ed) (1992), Autopoiesis in system analysis: A debate. A special forum issue of *International Journal of General Systems* 21, no.2.

Garai, A., and Shadrach, B. (2006). *Taking ICT to every Indian village.* New Delhi: One World South Asia Publications.

Krippendorff, K. (2006). *The semantic turn.* Boca Raton: CRC Press.

Luhmann, N. (1990). *Essays on self reference.* New York: Columbia University Press.

Luhmann, N. (1992). What is Communication? *Communication Theory*, 2: 251-259.

Marca, D., and Bock, G. (1992). *Groupware: Software for computer-supported cooperative work.* Washington: IEEE Press.

Maturana, H., and Varela, F. (1980). *Autopoiesis and cognition: The realization of the living*. Dordrecht, Holland: D. Reidel Publishing Company.

Maturana, H., and Varela, F. (1987). *The tree of knowledge.* Boston: Shambhala.

Maula, M. (2006). *Organizations as learning systems.* Oxford: Elsevier.

Mekelvey, B. (1999). Self organization, complexity catastrophe and microstate models at the edge of chaos. In J.A.C. Baumn and B. Mekelvey (Eds.), *Variations in organization science.* Thousand Oaks: Sage Publications.

Mingers, J. (1995). *Self-producing systems*. New York: *Plenums.*

Monge, P.R., and Contractor, N.S. (2003). *Theories of communication networks.* New York: Oxford University Press.

Nonaka, I., and Takeuchi, H. (1995). *True knowledge creating company.* Oxford: Oxford University Press.

Norris, P., and Zinnbauer, D. (2002). *Giving Voice to the Voiceless: Good Governance, Human Development and Mass Communication*, Background paper for HRD.New York: UNDP online.

Prigogine, I., and Stengers, I. (1984). *Order out of chaos: Man's new dialogue with nature*, New York: Bantam.

Servaes, J. (2008). *Communication for development and social change*. Los Angles: Sage Pblications.

Sukumar, S., and Murthy, N. R. N. (2003). Influence of ICT on the development of India's competitiveness. In Soumitra Dutta, Bruno Lanvin, and Fiona Paua (Eds.), *The Global Information Technology Report 2002-03: Readiness for the Networked World* (pp.178-190). New York: Oxford University Press.

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On to Action – Building a Digital Ecosystem for Knowledge Diffusion in Rural India

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(This version of the paper has been presented at International conference on Knowledge Management, North Carolina, USA, 2005)

Abstract: Information and Communication technologies (ICT) have been used to deliver knowledge to support Agriculture and Rural Livelihood (ARL) for over ten years now. Yet, in India today, use of ICT to support ARL remains at an early stage. Our survey in North Indian states shows that less than 10% of the Krishi Vigyan Kendras (Agricultural Science Centers) and other extension initiatives actively 'use digital content' or 'contribute digital content' for common use. Yet there are more than a hundred active ICT initiatives towards this end across the country. This paper investigates this intriguing gap. This research identifies the need for 'easier' knowledge flow mechanisms, information exchange, storage and retrieval mechanisms that can span language and literary barriers. This paper outlines an approach towards a self-managed knowledge organization in the ARL domain.

1. Introduction

Agricultural and food security policy makers clearly see the need for knowledge connectivity from the academic/research institutes to villages and then on to the world to close the loop so that the 'best' practices can enhance India's agricultural efficiency, create the 'next' practices and create new avenues for rural livelihood. There is a national agenda for creating 'Knowledge centers' in every village. But the 'soft side' of this challenge needs more attention. There is no concerted effort to create a national agricultural knowledge repository in digital form which is alive and is nurtured daily through feeding, weeding, & pruning- or enriched by interactive usage. Lot of good knowledge nuggets remain at local level and as unstructured information or tacit knowledge.

This paper reports the need for creating and implementing tools, architecture and replicable processes to enable cross flow of knowledge ('Information + insight' linked by concepts and contexts), in the form of 'open content' for agriculture and rural livelihood. This paper chronicles the application of social networking and experiments to build a digital ecosystem for users co creation and self-management of digital contents to support agriculture & rural livelihood development activities in the hinterlands of Northern India. It highlights the need for developing an Ontology server and an Indian agricultural thesaurus in vernacular for semantic interoperability of digital content developed by different stakeholders in this domain. The paper then reports on field experiments and observations made through the 'Digital Mandi' project (www.digitalmandi.net) in the Kanpur-Lucknow region of

Northern India and findings that show a pathway to Information design for knowledge diffusion in rural India. The paper describes the research using the SAP-LAP methodology.

2. Situation (S)

In quantitative terms Indian agriculture made significant progress over the last 50 years. One can see quantum jumps in total production of most agricultural commodities in reports published by the Indian Council of Agricultural Research or the Ministry of Agriculture. From chronic shortage and famine conditions of late 1950's, India has become a successful and significant exporter of many food grains and agricultural produce. An excellent food securing buffer stock has been built. But as India approaches the new WTO regime and the vision of borderless and eventually frictionless trade in Agricultural produce, India is behind most developed nations, even behind its smaller neighbors in Asia, in terms of almost all the rural economy efficiency and yield measures. India is also a country with one of the longest distribution chain for most rural produce. For many typical agricultural produce while the farmer may receive less than ten cents per kilogram, the retail urban consumer may pay ten to fifteen times of that per kilogram. The reasons are many but many researchers (Singh 2002, Bhatnagar & Schware 2000, Kaushik & Singh 2004) have pointed out information asymmetry, lack of rapid knowledge diffusion as prominent root causes. Researchers, policymakers and experts have frequently claimed that Information and Communication technologies represent one of the most powerful tools in the struggle against poverty. These tools can enhance the efficiency & effectiveness of Indian Agricultural practices and processes, by generating newer inspirations and avenues for grass root rural entrepreneurs and innovators.

Table 1: Major Oranisations with Websites on Indian Agriculture

ICAR INSTITUTES	ICAR, IARI, CICR, CAZRI,CIRG, NBAGR, NBPGR, CIAE, IASRI, NCAEPR, IIVR, IIPR, NIRJAFT, VPKAS, NDRI, IIHR, NIANP, NRCOG, NCIPM, PDBC, IISR(SPICES), IISR(SUGARCANE), IISS, NRCM, NRCMAP, AICRPM
STATE AGRICULTURAL UNIVERSITIES	MPKV, RAHURI; PDKV, AKOLA; PAU, LUDHIANA; HAU, HISAR; KAU, THRISSUR; TNAU, COIMBATORE; GAU,NAVSARI; AAU, JORHAT; TANUVAS, CHENNAI; UAS, DHARWAD; UAS, BANGALORE; ANGRAU, HYDERABAD; UHF, SOLAN; HPKV, PALAMPUR
MINISTRY OF AGRI	NIAM, MANAGE, DARE, AGMARKNET, NHB, FPI

There are various private and public efforts to expand 'information and communication' access in rural India. It is expected that telephones, mobile phones, broad band internet, cable, community FM radio and many other forms of coverage will rapidly expand connectivity and access over the next 10 years. Technologies will continue to get cheaper, easier to use. The cost and challenges of the ICT interconnection for rural India is huge and it is receiving significant attention. But this is not the only problem. Extension services and other content providers in this domain face high cost to develop and maintain digital resources.

Often content is kept offline to protect print sales or may be accessible only at a fee. The content that is online and free, is often not updated regularly, uncoordinated with other providers, so there is lot of duplication of general information and not enough 'specific' local information, making 'pertinent

content' harder to find. Content that is live, interesting and 'in depth', interesting databases and decision- tools remain rare. This 'knowledge' side of the 'digital divide' must be addressed as vigorously as the 'access' side. Bolstering this activity may even speed up access infrastructure as the farmers & rural folks will then enhance the 'pull' effect to complement the current policy 'push'.

While there are many variables that need to come together to enhance productivity in Indian rural livelihood & agricultural activities, which may not be entirely controllable, we can at least facilitate knowledge creation & knowledge exchange to help rural citizens deal successfully with unforeseen variables.

3. Actor (A)

The challenges before Indian Agriculture are immense. This sector needs to grow at a faster rate than in the past to allow for higher per capita income and consumption. It is an accepted fact that the sound agricultural development is essential for the overall economic progress. Two thirds of Indian workforce directly or indirectly depends on agriculture. This sector generates more tha 20 percent of the GDP and over 15 percent of exports. Rising consumer prosperity and the search by farmers for higher incomes will simultaneously drive crop diversification. Export opportunities for agricultural products are also expected to continue to grow, provided India could meet the stability, quality and presentation standards demanded by foreign trade and consumers and maintain its comparative advantage as a relatively low cost producer (Source: Kisan Call Centre website: http://www.manage.gov.in/kisan/default.htm).

Given its range of agro-ecological setting and producers, Indian Agriculture is faced with a great diversity of needs, opportunities and prospects. The well endowed irrigated areas which account for 37 percent of the country's cultivated land currently contribute about 55 percent of agricultural production, whereas, rain fed agriculture which covers 63 percent of land accounts for only 45 percent of agricultural production. In these less favorable areas, yields are not only low but also highly unstable and technology transfer gaps are much wider as compared to those in irrigated areas. This is where knowledge can play a significant role to manage the critical challenge of rural poverty.

If India is to respond successfully to these challenges, greater attention will have to be paid to technology. Strengthened means of dissemination will be needed to transmit cutting edge know-how & information to farmers and rural artisans. Both technology generation and transfer will have to focus more strongly than ever before on the themes of optimization in the management of the available resources by producers, sustainability, coping with diversity by adapting technology more specifically to agro-ecological or social circumstances and raising the economic efficiency of agriculture. To make information transfer more effective, greater use will need to be made of modern information technology and communication among researchers, extension professionals and farmers (Source: NATP website: http://www.icar.org.in/natp/Intro.htm).

Public extension system requires a paradigm shift from top-down, blanket dissemination of technological packages, towards providing producers with the knowledge and understanding with which they solve their own location - specific problems. Continuous two-way interaction among the farmers and agricultural scientists is the most critical missing component of Agricultural Extension. At present, the issues are being addressed by the Extension Systems of State Departments of Agriculture, State Agricultural Universities (SAUs), KVKs, NGOs, Private Extension Services through various extension approaches in transfer of technology with the able support of Indian

Council of Agricultural Research and its many institutions as well as Technology institutes like Indian Institute of Technologies at Kanpur and Mumbai in collaboration with Medialab Asia. But limitations of the physical face to face Transfer of Technology (TOT) model continue to remain a challenge for the public and private extension systems as there are at least 400,000 medium and large villages spread over a subcontinent that need to be reached.

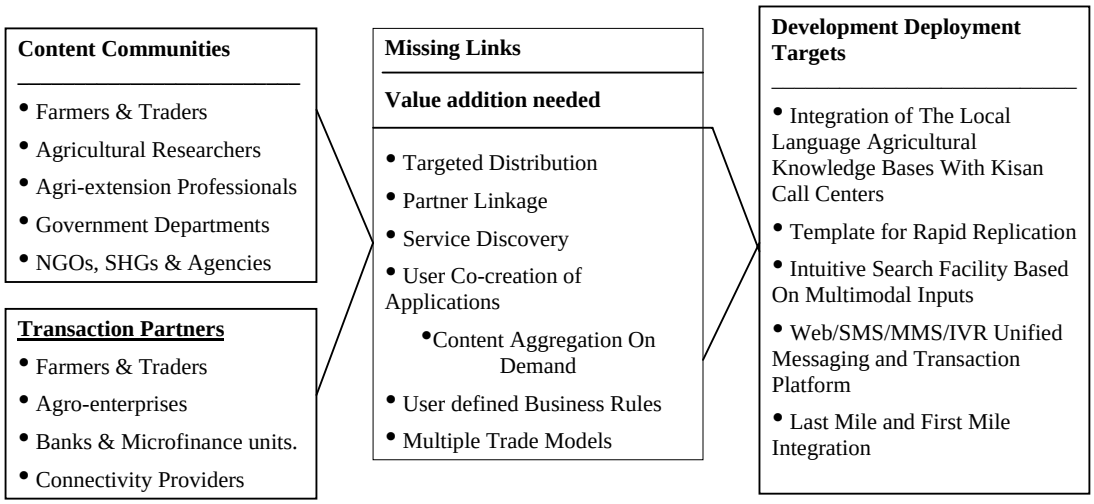

Figure 1: Missing links in a network of stakeholders

With the availability of telephone and Internet, it is now possible to bridge this gap to quite a large extent but only if an appropriate mix of technologies can deliver 'dynamic content' in response to 'user pull'. Unless the content can help farmers to take risks in venturing out to crop diversification or adopt novel processes, the TOT can not make adequate impact on alleviating rural poverty. There are many efforts today by a number of stakeholders (Figure 1) to address these issues in government, institutional and private sectors. However most of these efforts depend on project funding from the government and the business models for 'content' generation and 'digital repository' efforts in vernacular languages are not self-sustaining. Yet, valuable contents are generated everyday in the Indian agricultural domain through the physical interaction between scientists at KVKs and rural citizens.

However, in absence of a commonly agreed ontology, metadata and other conceptual standards and in the absence of 'easy to use' electronic interface and electronic exchange these physical contents remain tacit and do not contribute to a commonly accessible knowledge repository.

Policy makers want to set up a virtuous cycle of learning – innovating –implementing- evaluating and learning again for agricultural and rural development. But in a large democratic country like India, the process involves many stakeholders and many actors. Figure 2 shows the information flow diagram for rural development activities. It is obvious that an ontology driven semantic interoperability through this maze can effectively network the different actors, while they pursue their micro objectives.

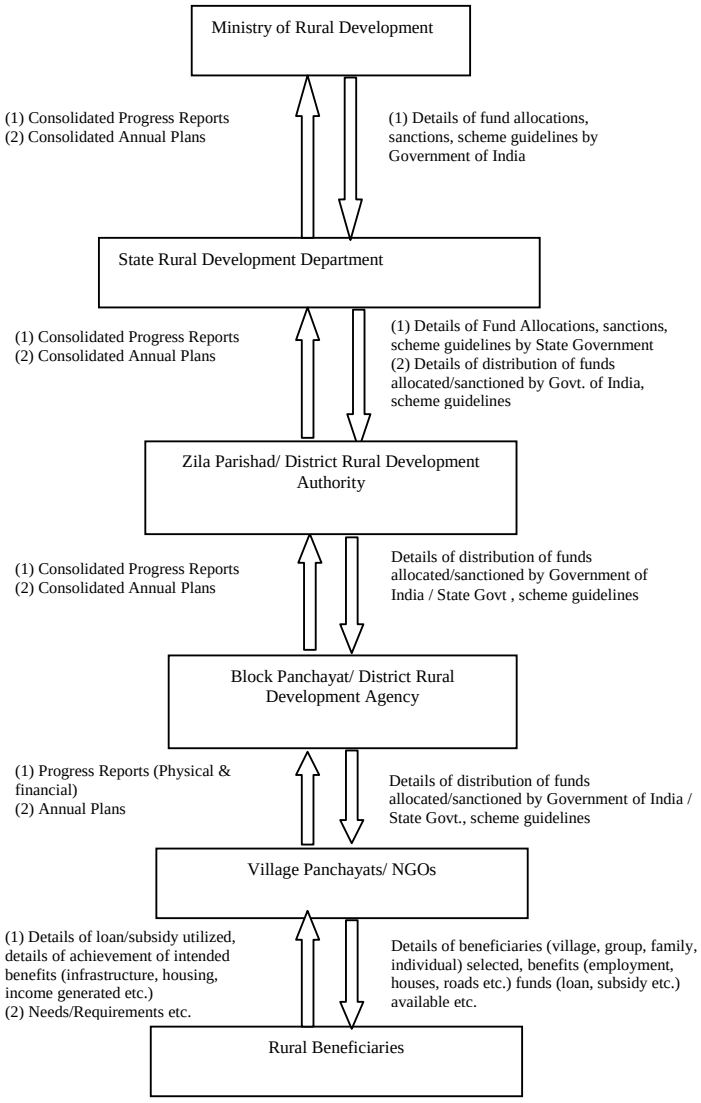

Figure 2: Typical flow of information among rural development agencies[1]
(Source: CRISP group, National Informatics Center)

4. Problem

Longitudinal discussions with extension workers, agricultural experts, researchers, NGO's and detailed analysis of 83 websites or portals which belong to Krishi Vigyan Kendras, Government departments, Agri Universities, Institutes and many web pages relating to Indian Agriculture hosted by global bodies (App. I), indicate the following requirements for a successful implementation of the knowledge system:

(a) Development of digital content from the tacit knowledge bases of KVKs & other frontline entities should be possible through multiple media like landline phone, mobile phone, audio-video recording and digitization of paper documents.

[1] Theabove Figure 2 shaded in grey (title) also appears in page 31 of this Case folio.

(b) Developing a common ontology, a semantic interoperability that facilitates knowledge storage, retrieval and exchange within the network among the various stakeholders so that a knowledge ecosystem can develop.

(c) Open content and open source optimization so that the technology tools are affordable and remain available while evolving.

(d) Developing 'citizen interfaces' to the extensive knowledge base. These could be iconic, graphical, symbolic user interfaces (that relate to the ontology) for rural citizens' ease of access. This will include but not limited to application of touch screen, text to speech, screen reader, visualization & animation, interactive voice response system computer-telephony integration and application of wireless data services like MMS.

(e) Digital content architecture and tools for easy telephone, mobile data and FM radio based interactivity and backend integration of such transactions into the knowledge base.

5. Learning (L)

There are a number of ways – some obvious and some not-so-obvious ones – in which ICT may serve the development process. For instance rural entrepreneurs can benefit because ICT help to improve access to markets or supply chains and provide a broader base for decision-making, thus making risk more calculable. Moreover, many local communities have experienced that ICT have increased bottom-up participation in the governance processes and may expand the reach and accessibility of government services and public infrastructure. In Andhra Pradesh or Karnataka Internet-based Citizen Service Centers allow for electronic bill payment, issuing of land record certificates, permits and licenses; or access to public information. The electronic village project of M. S. Swaminathan Research Foundation (MSSRF) in Pondicherry received the Stockholm award for its promise.

However, there is as yet little systematic empirical evidence of the supposed enormous 'developmental' impacts of ICT. Moreover, in many – especially rural – areas, the private sector is yet to invest significantly in ICT experiments (except for a few pioneers). This means that, if ICT access is to be expanded, public money will have to be spent – which in turn means that there are important trade-offs to be considered. In many areas, there are serious questions about how much money policymakers should spare for the build-up of ICT instead of investing further in potable water supply, roads, electricity or other physical infrastructure projects.

Given such trade-offs, there is a need to identify which kinds of ICT access and content deliver the best value for money, and how the limited resources that can be spent on it can be made to best suit the particular needs of rural India. A number of 'models' have so far been tried around the world. One popular model of ICT provision in rural areas of developing countries, and one which attempts to combine phone access with access to the Internet. These are the so-called Telecentres or Information Kiosks or the recently introduced Infothela of Media Lab Asia- Kanpur - Lucknow Hub. (www.iitk.ac.in/MLAsia).

An Infothela is a common point of access for multiple users (often an entire community), providing a range of ICT services including Internet, fax, phone, e-mail, word processing, and even specialized

information retrieval or applications for agriculture & rural livelihood. Telecenters have been established widely in the developing world, and vary in their service provision and means of funding. In Peru, the establishment of numerous 'Cabañas Públicas' created one of the highest concentrations of public Internet access and a significant reduction in prices. Nevertheless, the experience with Telecenters has so far been a mixed one. In numerous cases, usage, particularly of PCs, has been lower than expected or commercial viability was not attained. Of the over 70 Community Telecenters established since 1997 by the South African Universal Services Agency, only 40 per cent remain open today, with only 3 per cent making enough money to cover costs.

Buried at the end of the World Bank policy paper on the 'Networking revolution: opportunities and challenges for developing countries' (June, 2000) is an account of multipurpose community Telecenters (MCTs) in rural Mexico. It turns out that of twenty-three MCTs built in rural Mexico; only five were working two years later. This is a failure rate of 80 percent. The policy paper comments, 'Problems encountered included insufficient maintenance funding, inadequate political interest and will, and cultural constraints which hamper community interest in the projects'. The paper gives no hint why 'political interest and will' might have been inadequate and why community interest might have been constrained by that hold all excuse for failure, 'culture'. The paper concludes that the Mexican case 'underscores the importance of participatory design and attention to sustainability issues in the development of such programs'. This problem was identified as a key research agenda for the Digital Mandi (www.digitalmandi.net) project, which stimulates this report.

Internet and Information Kiosks exist in various kinds, each with their respective merits. First, one might distinguish between the small private sector cyber cafes on the one hand and bigger, donor-funded Telecenters like e-Seva in Andhra Pradesh or e-Village in Pondicherry on the other hand. Smaller, privately run cyber cafes are often financially self-sustaining – but are thus usually restricted to areas where they expect to be viable (usually urban centers) and are usually neither within physical nor financial reach of the poor. They are also unlikely to be able to provide local content. – By contrast, larger, often externally funded Telecenters are rarely financially sustainable but can focus more on specific 'development' – aspects, including access. They can be specifically targeted at rural communities and can focus on training and knowledge diffusion.

A second distinction is according to the institutional context they are embedded in. This often has a significant influence on the 'developmental impact' of Telecenters. Commercial telecenters and commercial franchises are usually closest to commercial viability but, as mentioned, are unlikely to have an impact on the poor outside the economic circle. Telecenters run by or with the involvement of developmental NGOs are more likely to target poor and marginalized communities and focus on much-needed additional services like training, content creation, provision of public goods without which ICT access would be of limited developmental use. Telecenters in rural institutes, village schools or Krishi Vigyan Kendra's for example as another alternative have the significant advantage that for their establishment an existing physical infrastructure only has to be extended and some of the ICT-relevant training can be cost-effectively integrated into the mainstream curriculum of these institutions. This partnership has successfully worked in the Digital Mandi project (www.digitalmandi.net).

6. Action (A)

Thus there are a number of alternatives and apparently mutually exclusive business models for ICT implementation in Rural India. On one hand it appears that kiosks run by local entrepreneurs with

localized and targeted applications will succeed on the other hand following the success model of the world wide web itself one may suggest that if an infrastructure is created and user friendly appropriate interfaces are continuously accessible then local rural folks will develop their own applications and Information Kiosks or ***Infothela*** will survive.

But there are serious barriers that impede the later possibility. Barriers to information access may be physical, economic, intellectual or technological; those impede rural users participation in the activities that add to the digital knowledge repository. The architects and system designers may actively impose the barriers or they may be allowed to continue simply through their lack of action or lack of understanding of the critical user conditions. Such critical user conditions may arise due to particular demographic, geographic, cultural, social, psychological, economic or other factors. Issues related to Information system usability such as ease of use, usefulness (Davis 1989), decision effectiveness (Mason et al. 1973), user response, user satisfaction (Doll et al. 1988) and many other aspect of usability have been studied in great detail by researchers. But interactions with focus groups at various agricultural market places around Lucknow-Kanpur showed the need of a more detailed study on Information communication barriers on a more localized set of priorities.

A general framework for web design keeping in mind the human-computer interaction theories (Pirolli 2001), web site usability principles (Huang 2003), information intensity paradigm (Palmer and Griffith 1998), e-customization models (Ansari and Mela 2003) is already in place and is assumed to sufficiently address the question of defining broad guidelines for designing any successful website. It is therefore, assumed that a website with relatively high-level of accurate, up-to-date and pertinent content, deployed in a user-friendly way, customized to particular user groups, and tailored to specific geographical needs should be universally successful and hence, accepted in India too. However many such efforts have apparently failed to achieve their targets.

The challenges to agricultural and rural livelihood website usability for rural India arise mainly due to the highly specific local needs and the great diversity in local conditions. The major challenges are:

(a) Poor literacy rate: low use of textual information in daily life and high reliance on verbal communication for knowledge transfer.

(b) Remote village locations: physical distances compounding problems of dependence on middlemen and a nexus of exploitation through information asymmetry.

(c) Absence of content in vernacular languages (both a cause and an effect)

(d) Economic, low-cost solutions: any technology solution aimed at benefiting the masses in rural India must be affordable and low-cost so that the perceived economic benefits of such an endeavor are much more than the cost of switching over to a different technological solution.[2] Mostly initial costs (set-up costs) of Digital Ecosystems are rather low paving the way to counter weight the Total Cost of Ownership (TCO) of technology solutions.

A model that inspired the Mandi team was The Kothmale Community Radio in Sri Lanka. This project has combined community radio and Internet access. It has a leased line connection to the

[2] Theabove paragraph, shaded in grey also appear in page 34 of this Case folio.

Internet and in the so-called process of 'radio browsing' Programme presenters browse the Web in the studio on behalf of listeners (who provide requests/input through phone or post). Relevant 'experts' from the community then interpret the information for listeners. Another good example of the creation of relevant local content is the 'Infoshops' in Pondicherry, India. After information requirements are identified during a trial period, volunteers from the village create a local database comprising government programs for low income rural families; cost and availability of farming inputs such as seeds and fertilizers, grain prices in different local markets; a directory of insurance plans for crops and families; pest managements plans for rice and sugar cane; a directory of local hospitals, medical practitioners and their specialties; a regional timetable for buses and trains; a directory of local veterinarians, cattle and animal husbandry programs. All these preceding experiments contributed to the Digital Mandi design. But the project soon revealed that without a self managed, evolving, ecosystem like knowledge repository, where users can co-create content and the content can be so 'tagged' that it can be recalled and reused in multiple context, the editorial over head remains high & expensive.

7. Performance (P)

The finding from the initial research at Digital Mandi has shown that the presence of a number of desired features in any ICT system design for rural India that leads to higher user satisfaction. Such features are broadly aimed at satisfying one or the other of the following immediate user objectives:

a) Ease of access.
b) Up-to-date content.
c) Layout, design, consistent themes.
d) Easy navigation.
e) Higher interactivity.
f) Access through multiple media (particularly voice).
g) Higher use of non-textual information.
h) Language options
i) Lower cost of transaction.[3]

Figures 3 and 4 show the resultant implementation techniques reported earlier (Chatterjee 2003).

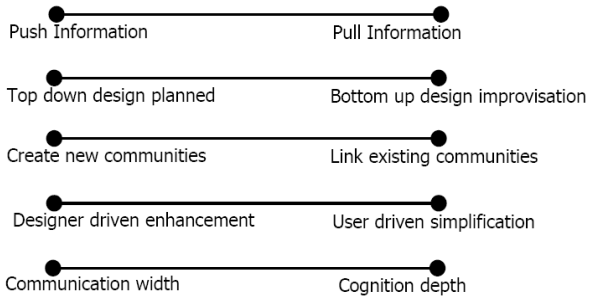

Figure 3: Flexibility Continuum of ICT Diffusion Models

[3] Theabove paragraph, shaded in grey also appear in page 34 of this Case folio.

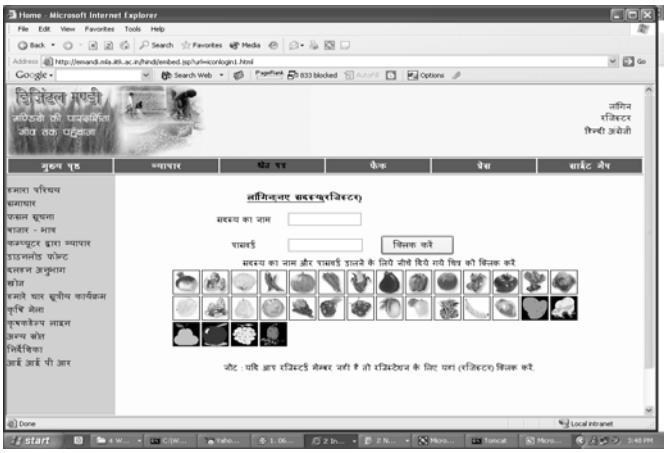

Figure 4: Iconic Login

The Digital Mandi project thus revealed that ICT tools and technologies could make knowledge and field experiences (in the form of digital content) widely available. Ethnographic observation guided design principles, which improved access and acceptance by rural citizens. But the maintenance, dynamic update and enhancement of the digital content needed regular editorial intervention and the process of finding and assembling information remained largely a manual task.[4] Several brain storming sessions of the stakeholders in the Digital Mandi project generated a conceptual architecture of the desired knowledge-net. t This is shown in figure 5. It was clear that to acquire the characteristics of a self-managed ecosystem, in this knowledge-net, the digital contents created in various forms by the stakeholders needed 'interoperability'.

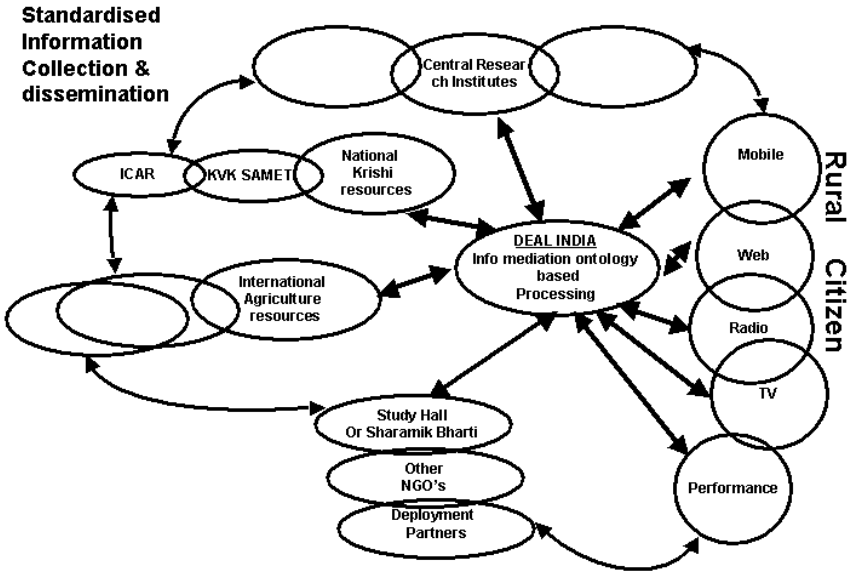

Figure 5: Conceptual architecture of knowledge-net[5]

[4] Theabove paragraph, shaded in grey also appears in page 35 of this Case folio.
[5]Theabove Figure 5 shaded in grey (title) also appears in pages 32 and 75 of this Case folio.

Interoperability provides potential for automation and systemic self-management. Initial experiments across the digital repositories of the stakeholders in the project showed that syntactic interoperability can be achieved for transfer, exchange, mediation and integration of content by adopting compatible forms of encoding and access protocols and design guidelines. Identification and naming schemas are important at this stage for pulling together related information. But while that operability may be enforceable in a corporate extra-net, in the domain of ARL it poses many problems due to the diversity of stakeholders and multiplicity of hardware/software and other socio-technical diversities existing in the network.

The goal framework in the next phase of the project thus focuses on semantic interoperability. The goal here is to facilitate context sensitive query processing over heterogeneous information sources. The current phase of this research project therefore focuses on developing an Ontology Server (OS) in the Indian ARL domain (IARL). The agenda here is to build an action oriented vehicle to provide consistent usable access to information for the rural Community searching for knowledge, as well as to assist those whose interaction (e.g. KVK scientists and farmers) create new knowledge. Firstly, the project now attempts to build the OS for IARL as a reference tool that can structure and standardize agricultural terminology in multiple Indian languages for use by different systems. This ontology will contain terms, the definition of those terms and the specification of relationships among those terms. It will start with a Thesaurus, the conversion of the Agrovoc hosted by the Food and Agriculture Organization of the United Nations in Hindi & later in other Indian language. But the aim is to work in parallel on enhancements to the Thesaurus, so that the system can provide the basic relationships inherent in the thesaurus. It will aim to capture and structure the knowledge in the ARL domain.

Figure 6 depicts select dimensions of the technology framework for this ontology driven approach to rapid deployment of laboratory knowledge for field level actions.

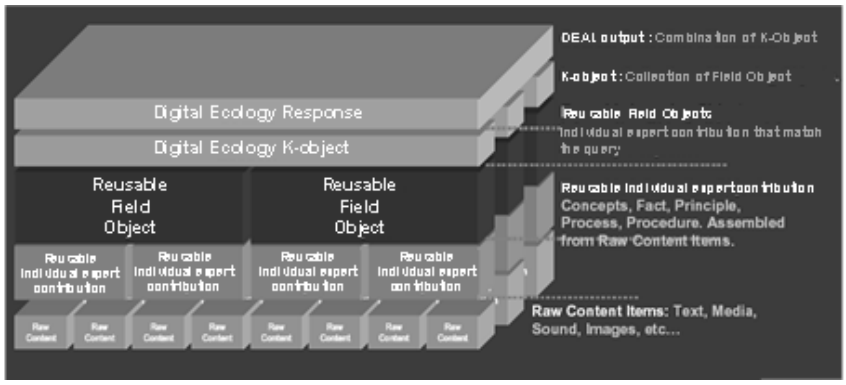

Figure 6: Ontology driven knowledge Exchange implementation

Figure 5 and 6 together represent several parallel sets of activities that are being pursued within a project framework that has been called DEAL- Digital Ecosystem for agriculture and rural livelihood support. Key clusters of these activities are:

(a) Developing a Thesaurus in Hindi based on United Nation FAO's Agrovoc as a first step. Thesaurus in all other major Indian Languages will follow. This entails consensus building among different regional subcultures and agricultural practices.

(b) Development of taxonomies, data models and ontology for collating, searching and aggregation of agricultural content.

(c) A range of easy to use interfaces for acquiring the knowledge exchange between the extension workers and the farmers from the field through voice mail, email, web log, sms, mms, photographs, video recording and even paper documents. New collaborative authoring, co-creation tools are being developed that facilitate non-textual aggregation.

(d) Intuitive UI, novel metaphors for contributing, accessing, searching and composition of knowledge objects from the field, development of metrics to monitor usage and impact.

(e) Content inputs and content delivery happen over multiple platforms, the key challenge is to manage the back end integrity, easy access but high security.

8. Conclusion

Rapid knowledge diffusion is a critical need for building up the global competitiveness of Indian agriculture. Low level of textual information usage and multiplicity of languages in the learning network of knowledge creators and knowledge users demand novel interfaces for knowledge capture & exchange. But the research project running for nearly 3 years now has a core focus on the knowledge organization system in the form of an ontology driven service because that is the only way to make the vast task of creating a digital knowledge repository, to a large extent, self-managed. The Indian agricultural ontology server will thus be at the core of the nascent digital ecosystem. However there are significant other research outcomes regarding information design both in terms of architecture and content presentation for this federated knowledge service.

References

Bhatnagar, S., and Schware, R. (2000). *Information and communication technology in develpement: Cases from India.* New Delhi: Sage Publications.

Card, S. K., Robertson, G. G., and Mackinlay, J. D. (1991). The information visualizer: An information workspace. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Reaching through Technology*, (pp.181-186). New York: ACM.

Chatterjee, J. (2004). Information communication and e-Marketing in rural India - Learnings from the Digital Mandi project. In A. Haleem (Ed.) *Innovation, flexibility and technology transfer.* India: Tata Mc-Graw Hill.

Chan, Y. E. (2000). IT value: The great divide between qualitative and quantitative and individual and organizational measures. *Journal of Management Information Systems* 16, no.4: 225-261.

Claudia, D. (2001). Corporate portals: A literature review of a new concept in Information Management. *International Journal of Information Management* 21, no.4: 269–287.

Constant, G., Jean-Pierre, H., Giovanni, P., and Asser, N. T. (1998). An architecture for the integration of internet and telecommunication services. Technical Report SSC/1998/025. Last acessed July 14, 2008, from INTERNET: infoscience.epfl.ch/record/52285/files/IC_TECH_**REPORT**_199825.pdf.

Davis, F. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly* 13, no.3: 319–340.

Doll, W., and Torkzadeh, J. (1988). The measurement of end-user computing satisfaction. *MIS Quarterly* 6, no.2: 259–273.

Hooker, N. H., Heilig, J., and Ernst, S.(2001). What is Unique About E-Agribusiness?,' *IAMA World Food and Agribusiness Symposium*, Sydney, NSW, Australia. Last acessed July 14, 2008, from INTERNET: http://ifama.org/tamu/iama/conferences/2001Conference/Papers/Area%20III/Hooker_Neal.PDF.

Huang, W. (2001) 'Using Information Technology to Enhance Communications among Agribusiness Organizations,' *IAMA World Food and Agribusiness Symposium*, Sydney, NSW, Australia. Last acessed July 14, 2008, from INTERNET: http://ifama.org/tamu/iama/conferences/2001Conference/Papers/Area%20III/Huang_Wen-Chi.PDF.

Huizingh, E. K. R. E. (2000). The content and design of Web sites: An empirical study. *Information and Management* 37, no.3: 123–134.

Kaushik, P. D., and Singh, N. (2004). Information technology and broadbased development: Preliminary lessons from North India. *World Developement* 32, no.4: 591-607.

McMillan, S. J., and Hwang, J. (2002). Measures of perceived interactivity: An exploration of the role of direction of communication, user control, and time in shaping perceptions of interactivity. *Journal of Advertising* 3: 29-42.

Mueller, R. A. E. (2001). Impacts of E-Commerce and information technology on global agricultural markets. Paper presented at *Symposium sponsored by the Economic Research Service, Farm Foundation and the University of Minnesota*, Washington, DC.

Palmer, J.W., and Griffith, D. A. (1998). An emerging model of website design for marketing. *Communications of the ACM* 41, no.3: 44–51.

Palmer, J. W., and Griffith, D. A. (1998). Information intensity: A paradigm for understanding web site design. *Journal of Marketing Theory and Practice* 6, no.1: 38-42.

Palmer J.W. (2002). Web site usability, design, and performance metrics. *Information Systems Research* 13, no.2: 151-167.

Pirolli, P., Card, S. K. and Van der Wege, M. (2001). Visual information Foraging in a Focus+Context Visualization,' *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, (pp.506-513). New York: ACM.

Schiefer G. (2003) 'New Technologies and their Impact on Agriculture, Environment and the Food Industry. *EFITA 2003 Conference* (pp.3-11), Debrecen, Hungary.Last Acessed July 14, 2008, from INTERNET: http://www.date.hu/efita2003/centre/pdf/0001.pdf.

Singh, N (2002). Information technology as an engine of broad based growth in India. In Parthasarthi Banarjee and F. J. Richter (Eds.), *The information economy in India* (pp.24-57). London: Palgrave/ Macmillan.

2

From the Policy Framework for Competitive Agriculture to a Knowledge Ecosystem Development Process-Some Empirical Findings

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(This version of the paper has been presented at Symposium on Competitiveness in the Knowledge Economy: Imperatives of Change at IMI, Delhi, November, 2006)

Abstract: Innovational competitiveness for India does not necessarily mean growth through IT and ITES or Pharma and contract manufacturing. Ensuring a thriving agricultural economy is critical for India's global competitiveness to be 'inclusive'. Agriculture directly and indirectly continues to be the occupation and way of life for more than half of India's population. A globally competitive Indian economy must be based on knowledge driven transformation of Indian agriculture because in many ways Indian agriculture has already reached the physical limits of land and water. Further sustainable enhancements in production must enhance productivity and biological yields on existing land. This necessitates the response of cropping patterns in hinterlands of India global commodity markets in real time. Indian agriculturists will need sophisticated decision support inputs to anticipate future market scenarios.

All these mean quick dissemination of technical information from the agricultural research system to the farmers. The one-way route of conventional Agricultural extension system needs rapid transformation to a 'real time and adaptive' knowledge exchange network. This network needs to build real time feedback routes from the 'fields to the laboratory' and can derive necessary traction from other industrial and business knowledge management technologies and processes like user to user exchange, expert to expert exchange and KM oriented standards for information storage, retrieval and aggregation with analytics.

Considering that there are nearly 700,000 villages (farming- hubs) in India or 6000 blocks and more than 100 million potential farmer/trader/agro-industry users of such a knowledge-network, it is surprising that this domain does not attract as yet, sufficient attention. Collaborative research attention from information science, social science, knowledge management professionals and academicians is an urgent need.

This paper reports initial empirical findings from one such collaborative project called the 'Digital Ecosystem for Agriculture & Rural Livelihood' (www.dealindia.org). The digital ecosystem entails a series of interconnected and intra-dependant digital platforms, created at key institutional levels (international, national and local/Community) augmented by technical (ICT) and social networking processes that help break down barriers to both horizontal and vertical knowledge sharing. The empirical findings show that the 'ecosystem' approach speeds up the process of identification, development and uptake of innovation. While this paper reports on the Knowledge ecosystem for

agriculture, it also generalizes the concept for a Digital Business Ecosystem that can be effective for large multi-plant enterprises or SME clusters facing similar challenges of competitiveness in a rapidly globalizing knowledge driven economy.

1. Introduction

Information and communication technologies (ICTs) are generating changes in firms, markets and economies in the developed and developing world. Whether large or small, they are present and advancing in every area of economic, social, and political activity. Due to the networking possibilities they enable, ICTs reduce transactions costs changing the structure of markets and institutions, resulting in an immediate increase in the potential value of human capital. Further they embody enormous knowledge and can serve to empower people at community and national levels.

The adoption and development of ICTs takes place via thousands of specific initiatives led by communities, development, donor, and business organizations. As it requires local knowledge, literacy, skills development, technical capability and effort, it can be a challenge to implement for a diffuse network of local innovation systems, networked only through top- down Krishi Vigyan Kendras (KVKs).

It is estimated that there are over 104 million farm families in spread over more than 590 rural districts and six lakh villages (Rai, 2006). The digital ecosystem (DE) is one approach through which diffusion and use of ICT can be made self sustaining and self enabling even in the rural sector despite technological and literacy barriers. A digital business ecosystem (DBE) is an ICT enabling technology for business networks based on a dynamic and amorphous interaction among a multiplicity of small entities to support knowledge sharing, establishment of global value chains (GVCs) and developing new business models.

Agricultural and food security policy makers clearly see the need for knowledge connectivity from the academic/research institutes to villages and then on to the world to close the loop so that the ‘best’ practices can enhance India’s agricultural efficiency, create the ‘next’ practices and create new avenues for rural livelihood. There is a national agenda for creating ‘Knowledge centres’ in every village. But the ‘soft side’ of this challenge needs more attention. There is no concerted effort to create a national agricultural knowledge repository in digital form which is alive and is nurtured daily through feeding, weeding, & pruning- or enriched by interactive usage. Lot of good knowledge nuggets remain at local level and as unstructured information or tacit knowledge. Moreover, agriculture is among the most complex commercial systems requiring inputs from myriad sources including soil, water, environment, goods, asset and labour markets.

In this paper, we document our experience from being involved in developing and implementing a DE for knowledge diffusion in rural India where sustainability of the initiative is wrought with challenges due to language and literacy barriers, resource scarcity, dominance of top-down solutions and limited existence of successful participative business models.

A DE for agriculture offers farmers from less developed and remote areas opportunities to participate in the global economy, resulting in dynamic knowledge sharing and global cooperation among the farmers and the world community fostering local economic growth. Co-creation and self-management of digital contents to support agriculture & rural livelihood development activities would result in access to the right kind of information at the right time, resulting in inclusive growth

as well as competitive agriculture. It also facilitates two way interactions among the farmers and agricultural scientists which is critical for further technological progress in agriculture.

Given that as India's largest private enterprise agriculture still sustains about 72 percent of the population and contributes to more than 20 percent of the GDP, even the smallest improvement in agricultural productivity can have a large impact on national well being. Moreover, agriculture has already reached the limits of land and water, thus future increases in food production must exploit biological yields on existing land (World Bank 1997). In this backdrop, developing the soft side of knowledge diffusion through the digital ecosystem is a significant step in improving national competitiveness.

2. A Pathway to Information Design for Knowledge Diffusion in Rural India

Ensuring a thriving agricultural economy is critical for India's global competitiveness to be 'inclusive'. A globally competitive Indian economy must be based on knowledge driven transformation of Indian agriculture because in many ways Indian agriculture has already reached the physical limits of land and water. This necessitates the response of cropping patterns in hinterlands of India global commodity markets in real time. All these mean quick dissemination of technical information from the agricultural research system to the farmers.

The one-way route of conventional Agricultural extension system needs rapid transformation to a 'real time and adaptive' knowledge exchange network. This network needs to build real time feedback routes from the 'fields to the laboratory' and can derive necessary traction from other industrial and business knowledge management technologies and processes like user to user exchange, expert to expert exchange and KM oriented standards for information storage, retrieval and aggregation with analytics.

In this section we report initial empirical findings from one such collaborative project called the 'Digital Ecosystem for Agriculture & Rural Livelihood' (www.dealindia.org). The digital ecosystem entails a series of interconnected and intra-dependant digital platforms, created at key institutional levels (international, national and local/community) augmented by technical (ICT) and social networking processes that help break down barriers to both horizontal and vertical knowledge.

India is behind most developed nations, even behind its smaller neighbours in Asia, in terms of almost all the rural economy efficiency and yield measures. It also has one of the longest distribution chains for most rural produce. While reasons for this inefficiency are many, researchers (Singh 2002; Bhatnagar and Schware 2000; Kaushik and Singh 2004) have pointed out information asymmetry, lack of rapid knowledge diffusion as prominent root causes. ICT is viewed as a powerful tool to reduce asymmetries and promote knowledge diffusion. However, the cost and challenges of the ICT interconnection for rural India coupled with the high cost to develop and maintain digital resources by governmental extension services and other content providers in this domain impede progress.

Moreover, public extension system requires a paradigm shift from top-down, blanket dissemination of technological packages, towards providing producers with the knowledge and understanding with which they solve their own location - specific problems. Continuous two-way interaction among the farmers and agricultural scientists is the most critical missing component of Agricultural Extension. Moreover, while large landholders find it easy to access better information and can employ more competitive agricultural practices, marginal landholders lose out in the process due to inefficient and

instructional extension services. Table 1 represents a quick caricature of some of the gaps in such services.

Thus, unless there is a mechanism by which the small and marginal farmer can convey his needs to the extension counter and there is an adequate perception of their circumstances, there appears no other way to improve his competitiveness. Limitations of the physical face to face Transfer of Technology (TOT) model, however, remains a challenge for the public and private extension systems as there are at least 400,000 medium and large villages spread over a subcontinent that need to be reached.

Table 1: Typical Contrasts in Agricultural Conditions for Extension Agents, Large Land Holders and Marginal Farmers

Factor	Extension Agent	Large land holder	Marginal Farmer
Topography	Flat or sometimes terraced	Flat or sometimes terraced	Often undulating and sloping
Soils	Deep, fertile, no constraints	Deep, fertile, no constraints	Shallow, infertile, often severe constraints
Hazards	Nil/few	Few, usually controllable	More common: floods, drought, animal grazing
Irrigation	Usually available	Usually available	Often non existent
Diseases, pests, weeds	Controlled	Controlled	Crops vulnerable to infestation
Production stability	high	Moderate to high	low
Farming systems	simple	Simple	complex
Use of purchased inputs	Very high	high	low

Source: adapted from P Das (2006), Converting Agro-ecosystem Information for Technology Assessment, and refinement and Demonstration of Agriculture Technology

With the availability of telephone and Internet, it is now possible to bridge this gap to quite a large extent but only if an appropriate mix of technologies can deliver ‘dynamic content’ in response to ‘user pull’. Unless the content is problem-solving oriented to help farmers to take risks in venturing out to crop diversification or adopt novel processes, the TOT can not make adequate impact on alleviating rural poverty through improved competitiveness.

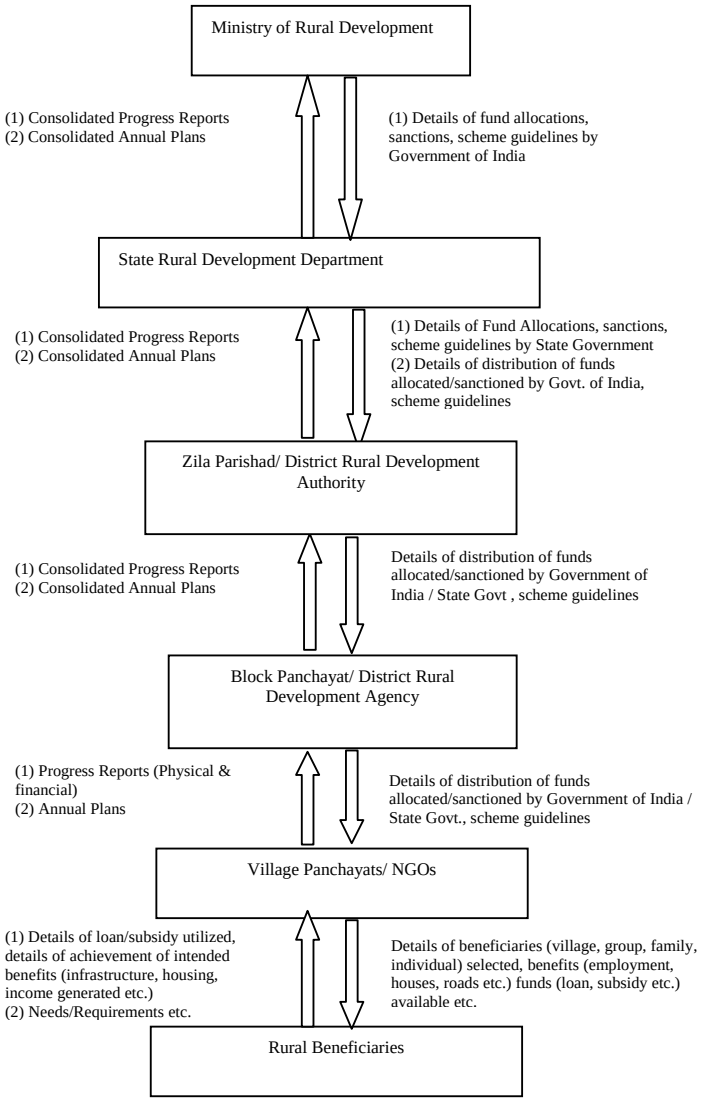

Figure 1: Typical Flow of Information among Rural Development Agencies[6]
Source: CRISP group, National Informatics Center

2.1. The Agricultural Ecosystem

An agricultural ecosystem is a unique and reasonably stable dynamic arrangement of farm enterprises that a household manages in response to the physical, biological and socioeconomic environments. There could be several interacting subsystems within this large ecosystem such as on the regional level, equally relevant non agricultural systems such as the market system, the rural credit system etc. Agricultural subsystems include the crop ecosystem, animal ecosystem, soil, weed and insect ecosystem, which of which are co-dependent. Thus, both farm related circumstances such as weather conditions, type of soil, stage of incidence or intensity of weeds etc. and socio-economic circumstances such as availability and nature of credit, costs of agricultural inputs, price of end product, farmers personal goals and resources etc. feed into the agricultural ecosystem. An ideal

[6] Theabove Figure 1 shaded in grey (title) also appears in page 18 of this Case folio.

knowledge ecosystem for agriculture would be able to capture all these intricacies and build a large knowledge sharing data base to ensure that the implicit knowledge or experience of one farmer is shared with many others without necessitating the re-invention of the wheel over geographically or temporally separated regions.

2.2. Implementation

Figure 1 shows the information flow diagram for rural development activities. It is obvious that an ontology driven semantic interoperability through this maze can effectively network the different actors, while they pursue their micro objectives.

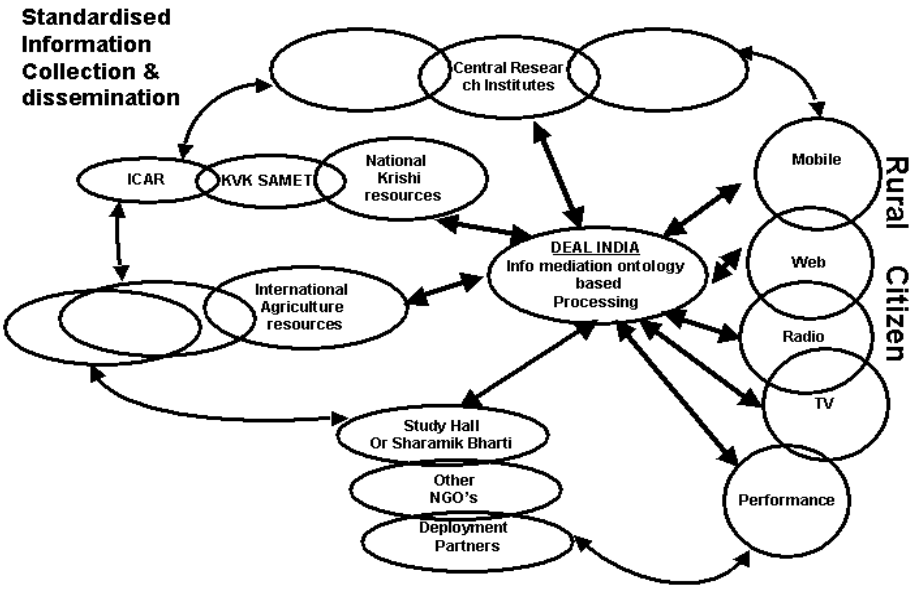

Figure 2: Conceptual Architecture of Knowledge-Net[7]
Source: Chatterjee and Prabhakar (2005)

Given this network, successful implementation of a knowledge system required development of digital content from the tacit knowledge bases of Krishi Vigyan Kendras, which are the agricultural extension counters of the Government of India & other frontline entities through multiple media like landline phone, mobile phone, audio-video recording and digitization of paper documents. There was a need to develop a common ontology, a semantic interoperability that facilitates knowledge storage, retrieval and exchange within the network among the various stakeholders so that a knowledge ecosystem can develop. This required open content and open source optimization so that the technology tools are affordable and remain available while evolving.

To bridge the language and education divide, 'citizen interfaces' to the extensive knowledge base were required. These could be iconic, graphical, symbolic user interfaces (that relate to the ontology) for rural citizens' ease of access. Technology application included touch screen, text to speech, screen reader, visualization & animation, interactive voice response system computer-telephony

[7] Theabove Figure 2 shaded in grey (title) also appears in page 23 and 75 of this Case folio.

integration and application of wireless data services like MMS. Digital content architecture and tools for easy telephone, mobile data and FM radio based interactivity and backend integration of such transactions into the knowledge base was also developed.

Partnerships were created with existing telecenters in rural institutes, village schools and Krishi Vigyan Kendras. These had an inherent advantage that an existing physical infrastructure only has to be extended and some of the ICT-relevant training can be cost-effectively integrated into the mainstream curriculum of these institutions. This partnership has successfully worked in our Digital Mandi project (www.digitalmandi.net). Several brain storming sessions of the stakeholders in the Digital Mandi project generated a conceptual architecture of the desired knowledge-net. This is shown in Figure 2.

It was clear that to acquire the characteristics of a self-managed ecosystem, in this knowledge-net, the digital contents created in various forms by the stakeholders needed 'interoperability'. Interoperability provides potential for automation and systemic self-management. Initial experiments across the digital repositories of the stakeholders in the project showed that syntactic interoperability can be achieved for transfer, exchange, mediation and integration of content by adopting compatible forms of encoding and access protocols and design guidelines. Identification and naming schemas are important at this stage for pulling together related information.

2.3. Lessons

While implementing the digital mandi project, we validated the existence of several barriers to information access, which have often been reported in literature (see Kralisch and Mandl, 2006 for example). These included physical, economic, intellectual or technological barriers that impede rural user participation in the activities that add to the digital knowledge repository.

The architects and system designers did not actively impose the barriers but they crept in through their lack of action or lack of understanding of the critical user conditions. Such critical user conditions may arise due to particular demographic, geographic, cultural, social, psychological, economic or other factors.

Although issues related to Information system usability such as ease of use, usefulness (Davis 1989), decision effectiveness, user response, user satisfaction (Doll et al. 1988) and many other aspect of usability have been studied in great detail, interactions with focus groups at various agricultural market places around Lucknow-Kanpur showed the need of a more detailed study on with a localized set of priorities.

A general framework for web design keeping in mind the human-computer interaction theories (Pirolli 2001), web site usability principles (Huang 2003), information intensity paradigm (Palmer and Griffith 1998), e-customization models is already in place and is assumed to sufficiently address the question of defining broad guidelines for designing any successful website.

It was therefore, assumed that a website with relatively high-level of accurate, up-to-date and pertinent content, deployed in a user-friendly way, customized to particular user groups, and tailored to specific geographical needs should be universally successful and hence, accepted in India too.

However, we found that the challenges to agricultural and rural livelihood website usability for rural India arose mainly due to the highly specific local needs and the great diversity in local conditions. The major challenges identified were:

(a) Poor literacy rate: low use of textual information in daily life and high reliance on verbal communication for knowledge transfer.

(b) Remote village locations: physical distances compounding problems of dependence on middlemen and a nexus of exploitation through information asymmetry.

(c) Absence of content in vernacular languages (both a cause and an effect).

(d) Unavailability of economic, low-cost solutions: any technology solution aimed at benefiting the masses in rural India must be affordable and low-cost so that the perceived economic benefits of such an endeavour are much more than the cost of switching over to a different technological solution.

Another lesson related to the sustainability of the DE in the agricultural and rural livelihood space. The project soon revealed that without a self managed, evolving, ecosystem like knowledge repository, where users can co-create content and the content can be so 'tagged' that it can be recalled and reused in multiple context, the editorial over head remains high & expensive. Such a system could also be termed as autopoietic in nature – a term originally conceived to describe the nature of living systems capable of self organisation and regeneration.

The finding from the initial research at Digital Mandi showed that the presence of a number of desired features in any ICT system design for rural India that leads to higher user satisfaction. Such features are broadly aimed at satisfying one or the other of the following immediate user objectives:

(a) Ease of access.
(b) Up-to-date content.
(c) Layout, design, consistent themes.
(d) Easy navigation.
(e) Higher interactivity.
(f) Access through multiple media (particularly voice).
(g) Higher use of non-textual information.
(h) Language options.
(i) Lower cost of transaction.[8]

Since most of the farmers are quasi-literate, content in textual form becomes a challenge, especially at content creation stage. Content in audio form is often the only way we can operate. Apart from its ease in creation it has other advantages as well – it is more natural, there is a personal touch making it more acceptable to both the creator and the listener and community 'viewing' (or in this case

[8] Theabove paragraph, shaded in grey also appears in page 21-22 of this Case folio.

listening) is easier. But indexing and search audio content poses problems and requires manual intervention.

Figure 3 gives a sample page depicting the user interface addressing some of these issues. The user ids are iconic, and so are the passwords. In other words, the alphabet consists of images of fruits and vegetables and the user can 'spell' her user name and password with this alphabet. That is, a user can choose a tomato with two onions and a potato together as the 'name' of the user and another such combination as a password.

Figure 3: Iconic Logic in the Web interface for the Digital Mandi Project

A computer based platform appears difficult to maintain for various reasons. Apart from the cost of the computer, due to the erratic power situation, one needs to think of backup power sources like batteries, un-interrupted power supplies, generating sets and so on, making the whole solution quite untenable. A mobile device, like a phone or a PDA appears to be the most workable delivery platform.

The Digital Mandi project thus revealed that ICT tools and technologies could make knowledge and field experiences (in the form of digital content) widely available. Ethnographic observation guided design principles, which improved access and acceptance by rural citizens. But the maintenance, dynamic update and enhancement of the digital content needed regular editorial intervention and the process of finding and assembling information remained largely a manual task.[9]

It was clear that to acquire the characteristics of a self managed ecosystem in the knowledge-net, the digital contents created in various forms by the stakeholders needed interoperability which would lead to automation and systemic self management. While initial experiments showed that such

[9] Theabove paragraph, shaded in grey also appear in page 23 of this Case folio.

syntactic interoperability can be achieved and enforced in a corporate extranet, prevalent socio-technical diversities and existence of a multiplicity of hardware/software in the network pose problems in the domain of agriculture and rural livelihood.

2.4. Benefits

Although the benefits accruing as a result of the digital mandi project have not been formally studied or documented, some observations in this context are in order. First, it was quite evident that the 'ecosystem' approach speeds up the process of identification, development and uptake of innovation. Second, rural entrepreneurs benefited because the DE helped to improve access to markets or supply chains and provide a broader base for decision-making, thus making risk more calculable.

Moreover, it has been reported by several researchers that many local communities have experienced that ICT have increased bottom-up participation in the governance processes and may expand the reach and accessibility of government services and public infrastructure (Dossani, Misra and Jhaveri 2005). We have not been able to test this in the digital mandi project yet, primarily because the mandate of the project was more focused on creating a self sustaining ICT platform rather than conducting a social experiment.

3. Conclusion

A digital business ecosystem as a platform to foster business networks based on a dynamic and amorphous interaction among a multiplicity of firms to support knowledge sharing and skill development is a self sustaining mechanism of ICT adoption and development. This paper reported on the learnings from using semantic web technologies to construct agricultural portals to address the need for customization and localization at the rural level. By activating and/or strengthening knowledge, skill, technology and market links, thereby increasing the returns on investment for farmers, such a DBE would be instrumental in preserving and nurturing the wisdom of the farmers while improving agricultural competitiveness at the same time.

References

Bhatnagar, S. and Schware, R. (2000). Information and communication technology in development: Cases from India. New Delhi: Sage Publications.

Chatterjee, J. and Prabhakar, T. V. (2005). On to action - Building a digital ecosystem for knowledge diffusion in rural India. Proceedings of the 2005 International Conference on Knowledge Management, North Carolina, USA. Last acessed July 14, 2008, from INTERNET: www.cse.iitk.ac.in/users/tvp/papers/vof_pasadena.pdf.

Davis, F. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly* 13, no.3: 319–340.

Doll, W., and Torkzadeh, J. (1988). The measurement of end-user computing satisfaction. MIS Quarterly 6: 259–273.

Dossani, R, Misra, D.C. and Jhaveri, R (2005). *Enabling ICT for rural India*. Asia Pacific Research Center, Stanford University and National Informatics Centre. Last Acessed July 14, 2008, from INTERNET: http://iis-db.stanford.edu/pubs/20972/ICT_full_Oct05.pdf

Huang, W. (2001) 'Using Information Technology to Enhance Communications among Agribusiness Organizations,' *IAMA World Food and Agribusiness Symposium*, Sydney, NSW, Australia. Last acessed July 14, 2008, from INTERNET:

http://ifama.org/tamu/iama/conferences/2001Conference/Papers/Area%20III/Huang_Wen-Chi.PDF.

Kaushik, P. D., and Singh, N. (2004). Information technology and broadbased development: Preliminary lessons from North India. *World Developement* 32, no.4: 591-607.

Kralisch, A., and Mandl, T. (2006). Barriers to information access across languages on the internet: Network and language effects. *Proceedings of the 39th Hawaii International Conference on Systems Science* (HICSS-39): 1-10.

Palmer, J. W., and Griffith, D. A., (1998). Information intensity: A paradigm for understanding web site design. *Journal of Marketing Theory and Practice* 6, no.1: 38-42.

Pirolli, P., Card, S. K. and Van der Wege, M. (2001). Visual information Foraging in a Focus+Context Visualization,' *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* (pp.506-513). New York: ACM.

Singh, N (2002). Information technology as an engine of broad based growth in India. In Parthasarthi

Banarjee P., and F. J. Richter (Eds.), The information economy in India (pp.24-57). London: Palgrave/Macmillan.

World Bank. (1997). Rural development: From vision to action. Environmentally and socially sustainable development studies and Monographs series No. 12. Washington D.C: The Internatioan Bank for Reconstruction and Development.

3

Digital Ecosystems – Community Networks or Networked Communities?

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(This version of the paper has been presented at OPAALS 1st International Conference, Rome, 2007)

Abstract: The role of information in promoting development has been well researched and documented, and there has been much interest in harnessing ICT (Information & Communications Technology) for this purpose. At the same time, the need to create projects that are successful as well as sustainable is recognized. We propose that adopting a more community centric design for ICT interventions can improve their sustainability and lead to the evolution of a more complex and multi functional ICT enabled socio-technical system. The digital ecosystem (DE) is one such paradigm. A DE describes an ICT enabled network that displays associative and autopieotic properties capable of self sustenance and of expansion through heightened inclusion and growth. We explore how such a system can be developed, and how this evolution can be understood in terms of whether the emphasis is on increasing individual access to ICT, or on transplanting social relations into the digital space. To illustrate this point, we briefly review a selection of current ICT interventions in India, and contrast it with the DEAL (Digital Ecosystem for Agriculture and Livelihood) project, a rural development initiative in agriculture in Northern India.

Keywords- Digital ecosystem, Community Networks, Agriculture Social Capital

1. Introduction

There has been a change in the perceived role of Information communications Technology (ICT), from its purely technical to a human development centric one, and consequently its increasing significance in the service deployment of various development initiatives in the service of human welfare. To promote human welfare, an ICT works on two angles, one of economic growth, i.e., the increases in a country's output of goods and services which can take place only when individuals participating in the economy engage in productive activities, and the other is social inclusion; the positive action taken to include all sectors of society in planning and other decision-making. The importance of inclusion is underscored in development policies. If economic growth alone was targeted, then there is a danger of certain sections of people remaining isolated from the benefits of progress.

Most importantly, for these interventions to have a long term impact, they must develop into self sustaining systems that do not collapse when the promoting agencies withdraw. To make an ICT intervention for development financially and socially sustainable, it is necessary to design a model where monitoring and continual support is not required. Instead, these functions are performed by the participants themselves, keeping the system more decentralized and flexible. In this paper, we discuss

a possible solution to the sustainable deployment of ICT for development incorporating several such characteristics using the Digital Ecosystem (DE) approach and how the paradigm of increasing community participation in ICT projects to better leverage common resources is reflected in its design. In this context, we examine how a digitally enabled community evolves into a DE, and the conceptual difference between a networked community and a community network. To further illustrate this point, we undertake a brief review of some ICT aided development interventions in India, before presenting the DEAL (Digital Ecosystem for Agriculture and Livelihood) project, a rural development initiative in agriculture in Northern India discussing an evolving DE in an existing community network.

2. The Digital Ecosystem Approach

Definition and Suitability for development projects

Formally defined, Digital Ecosystem (DE) describes an ICT enabled network that displays associative and autopieotic properties. In other words, DE not only is a so defined network capable of self sustenance, but also of expansion through heightened inclusion (i.e., increasing heterogeneity in the network composition) and growth (i.e., increase in the size and scope of the network). In simple terms, a DE is a web of interconnected and interdependent ICT enabled users who transact in the digital mode resulting in synergistic benefits for all. The strength of this system is that it enables a resilient, multi- user exchange relationship capable of adjusting to change. The natural system metaphor, employed by several schools (Rothschild 1990; Moore 1997; Tapscott 2000; Power and Jerjian 2001) to digital ecosystem as a 'digital' environment populated by 'digital species' which could be software components, applications, services, knowledge, and 'agents' or the actors in this ecosystem (individuals, SMEs, and Governments). True to it's biological antecedents, the design of a DE aims to mimic a natural ecosystem to encourage autopoiesis whereby a system produces its own organization and maintains and constitutes itself in a space.

A DE for a social system needs to deal with heterogeneity and greater variations in actor's abilities and resources to participate in the network. As seen in the case of rural ICT deployment, differences in participants are induced by social and economics factors (caste, income group), level of education and exposure and so on. The vision of a DE as network that finally evolves into an 'agents-based, loosely coupled, domain-specific and demand driven interactive communities which offer cost-effective digital services and value-creating activities that attract agents to participate and benefit from it' (http://www.ieee-dest.curtin.edu.au/2007/), makes it capable of accommodating these variations by encouraging the co-existence of different species. This description also underscores the critical importance of participation to the success of a DE – in terms of growth, sustainability and inclusion. Participation here refers to both content sharing and creation. Sustained growth and heightened inclusion are the keys to successful development. Thus it is essential that rather than making recipients of assistance dependent on the provider, the providers should create the right digital environment where recipients can exercise their choice on the nature and extent of assistance they require. A big asset of a DE, in this context, is that it is intrinsically designed to be self sustaining. A DE functions independent of the entry or exit of individual actors. This is achieved by functioning as a platform fostering various economic (business) and social networks involving a multiplicity of actors engaged in dynamic and amorphous interactions. There is no single entity guiding or directing activities and information flows. Instead, all actors share the responsibility of running the network, by sharing information, resources and interacting with others, making the

system robust and less resource intensive in contrast to some of the other ICT implementations discussed earlier.

Evolving a DE

In this context, we briefly examine a possible evolution graph for a social digital ecosystem. The biological entity analogy is invoked once again when discussing the setting up of a digital ecosystem. The system has to evolve gradually from a collection of single cells to a complex organism, which will function even as some cells die out and new ones are created. The system evolves through the following stages:

Stage 1: Physical Communities

Members from various offline communities begin adopting basic e-tools like internet, email, online search engines and so on. There is no significant change in the flow of information between members neither of the community nor in the operations.

Stage 2: Electronic Communities

Adoption of e-technologies by members forms the next step in transferring the information flows to the digital domain. With more participants using e-tools, online services start evolving which require two way information flow, or at least permit online information access, like in the various e-governance services. In this stage, the network evolution is sustained by a promoting agency, like various Government departments, NGO sponsors etc., which acts as a central authority – financing and monitoring the project.

Stage 3: Digital Ecosystem

The evolution of the network breeds a dynamic cooperation between the players which encourages the online communities into greater sharing of knowledge and resources, while providing more opportunities for economic and social development. At this stage, the need to sustain the network by the promoting agenct diminishes as participating nodes become more willing to bear responsibilities to maintain and sustain the network. The role of the promoting agent, or central node diminishes to one having as much (or as little) power as any of the other nodes in th network. Local content is created and shared throughout the network. New services evolve online instead of different agencies developing services to meet member needs, increasing the types of players involved.

These benefits encourage other members of physical communities to join the network. Most of all, the responsibility of sustaining network is shared by all the participants and the role of the e-champion is reduced. The ultimate aim to create a participative society, which supports economic inclusion, empowers the creativity and participation of all potential action (public and private organizations, communities, individuals) in open socio-economic processes.

Having discussed a possible evolution model for a DE, we ask the question: is gradually networking a community enough to ensure that it eventually becomes a DE? In other words, does providing digital access transplant communities into the virtual domain where their interactions mimic complex real world transactions? To tackle this question, we discuss a cross section of ICT interventions adopted so far in India.

One objective common to all ICT programs is that of attaining self sustenance. We propose to examine in the following programs, where the focus has been on providing increased computing and digital facilities to the community members, and see how successful they have been in becoming independent and self sustainable.

3. Evaluation of Other Entrenched Development Solutions

The earliest appraisal of the potential of computers in rural development in India was done by academics during 1975-80 (Patel 1979). Initially, computers were seen as effective monitoring tools of existing projects (Bhatnagar and Patel 1988), but gradually, with declining hardware prices, their use became more widespread and non-specific. Under the patronage of Rajiv Gandhi, the pace of IT use at the district level gained momentum and many programmes, like DISNIC (District Information System of National Informatics Centre) which promoted computerization of all district level offices and CRIS (Computerized Rural Information Systems Project) which developed software for planning and mentoring of IRDP (Integrated Rural Development Programme) laid the groundwork for future ICT enabled projects. Government interest has however been more marked in supporting e-governance initiatives to make governance more transparent and delivery of certain essential services corruption free, as responsible governance will automatically encourage economic growth and social development. We now discuss selected ICT enabled development programmes and examine the performance of each in context of the goals they were set to achieve. We draw on the extensive reports by DIT and Infosys (2005), APARC and NIC (2005) etc, comparing the various ICT projects and evaluating their aggregated performance.

Some Selected Schemes

1. Gyandoot

In the Dhar district of Madhya Pradesh, Gyandoot— a government-owned computer network—has been trying since January 2000 to make government services more accessible to villagers. Gyandoot aims to reduce the amount of time and money people spend trying to communicate with public officials and seeks to provide immediate, transparent access to local government data and documentation through a network of 38 telekiosks or soochanalayas.

Gyandoot aims to create a cost-effective, replicable, economically self-reliant and financially viable model for taking the benefits of Information and Communication Technology (ICT) to the rural masses. The purpose of this network is to combat poverty, illiteracy and social backwardness by promoting awareness and participation by citizens/government in community affairs through creative uses of ICT and also encouraging greater inclusion by ensuring equal access to emerging technologies for the oppressed and exploited segments of the society (Rajora 2002). Information and services offered include online applications for caste, income, and domicile certificates and the access to the list of people living below the poverty line, prices of several agricultural products in various cities beyond the local market. Additionally, a public complaint line for reporting government-related problems, broken irrigation pumps, unfair prices, absentee teachers, and other problems is also available

(a) ***Model of Operation:*** The information collection and dissemination is done though the tele-kiosks. These are different from telecenters in that they are have only a single computer manned by a facilitator or a ‘soochak’ who helps clients browse or download, while

telecenters have personal computers where clients browse on their own (Best and Maclay 2002) There are two models of ownership of these tele-kiosks. The panchayat (village committee) and the private models. In both models, individuals from the village community are handed the running of the kiosks, thus fostering entrepreneurship. In the panchayat model the village committee pays for the telekiosk's capital expenditures (space, hardware). Operators have to bear telephone expenses and do not receive a salary, but get to keep 90% of earnings after remitting 10% to the panchayat. For appointing kiosk operators, panchayats select three people who are sent for training, and one is finally selected after interviews and a practical examination. In the private model the soochak is the owner of the telekiosk. The entrepreneur who has the capital, or is able to get a loan, gets the job. An annual payment of Rs.5,000 to the project committee aside, the rest of the earnings accrue to the kiosk operator.

(b) ***Overview of Performance:*** Based on World Bank's Governance Knowledge Sharing Program (GKSP) (supported report by CEG-IIMA 2002) we make the following observations on Gyandoot :

1) High service satisfaction but low usage villagers who had used the Gyandoot kiosks were satisfied with the service level offered but they did not advocate it to others. Out of 38 Gyandoot telekiosks, the CEG-IIMA survey found that 10 were not operational. Many telekiosks serve only a handful of people (1–4) each day. The average for 18 telekiosks calculated over a two-year period was 0.62 users per day.

2) Despite the publicity initiatives undertaken by the project committee, there was a lack of awareness about the facilities offered by the project. Distance and infrequent power supply were two other reasons for people not using the kiosk.

3) Services provided as a response to a need, yet many services underutilized: The Gyandoot project aimed to provide a whole host of services, including access to educational and health facilities by linking up with schools and local hospitals. Survey results indicate that most of the services were not used at all by villagers. Of the 20 services offered, only a handful are really demanded (CEG-IIMA 2002).

4) Low local content creation: lack of involvement and contribution from local players. Basic nature of project is that of a G2C network, but to achieve the stated aims would require participation of other actors (partnering with private players, NGO's, research institutes) to provide additional services for which there was not sufficient scope.

(c) Financial feasibility: The cash flows generated by the services provided are not sufficient to help operators sustain. The CEG-IIMA survey found that total revenue from Gyandoot services was approximately Rs. 150 per month per telekiosk over a period of 2 years. The Gyandoot Intranet was set up at a total cost of Rs. 2.5 million. The average cost incurred to establish a telekiosk is Rs. 75,000 and operational costs are estimated at Rs. 1,000 per month (Bhatnagar and Vyas 2001). Clearly, there is no incentive for more kiosks to be set up or for individuals to continue in the project.

Issues with existing administrative set-up– cost escalation due to new modes of corruption and bribery: Gyandoot has computerized only the front-end of government services; in most cases, citizens submit applications online and have to go back to the telekiosk for a response.

Back-end processes, at government department levels, are not computerized. Printouts of the applications, requests, and grievances are sent to government departments for further action, except for a couple of departments that are accessible by e-mail. This leaves loop holes for new forms of corruption.

2. IVRP

The Information Village Project in Pondicherry, India started up in 1998. The project was initiated and managed by the Madras based M. S. Swaminathan Research Foundation with the support of the Canadian Government. The objective was to assist sustainable agriculture and rural development by making relevant generic information locale specific and delivering it to the community. The thrust was on involving woman, BPL families and members of the so called backward castes. The project implementation was planned in three phases.

(a) ***Model of operations:*** The project uses a donor-grant based community centric model. Village Knowledge Centres (VKCs) are set up in order to provide rural communities with access to Internet and training on ICTs. In each case, the participating community provides rent free access space to set up and 2 to 4 volunteers. These volunteers are compensated by the community and care is taken to involve the marginalized sections in volunteering. In turn, the project provides all the needed equipment, training and data. Wireless radios were used for data and analog voice transmissions between a semi-urban hub center and eight village centers. Information gathering follows a Hub and spoke model—Hub gathers and distributes information to the Centers. Volunteers are trained in the basic operations of a personal computer: sending messages, composing documents and so on, using local language tools etc. They maintain the VKC and feed relevant content garnered from other sources like newspapers, local news etc to the network. In each phase there is an updation in the ICT tools used and phase III of the project is looking to experiment with the following: wireless fidelity (WiFi); 2.5G mobile technology (includes mobile telephones enabled to transmit data via General Packet Radio Service); Global Positioning System (GPS) for fisher people to improve knowledge of fishing zones and potential ocean hazards etc. VKCs were first created in seven hamlets in rural Pondicherry, and the number has gone to twelve centers, with an average of 25 users daily.

(b) ***Overview of performance:*** The success of IVRP has been in terms of local content creation and dissemination. Small groups of volunteers independently picked extra expertise (HTML coding, transmitting voice files) to improve content creation. The information gathered at the telecentres is also feeding more traditional media. A volunteer-run, twice-monthly, community newspaper, Namma Ooru Seithi, was launched in early 2002 to reach those beyond the knowledge centres' ambit. Its articles cover topics of local interest such as agriculture, traditional health care, jobs, coming training programs, recipes, child care tips, and village-specific news.

IVRP illustrated the 'bottom-up' approach to ICT based implementation of development projects. Evolution of the IVRP network infrastructure was gradual, based on demand for services by the community and its willingness to manage and volunteer for the infokiosks. Interestingly, the project offers very few e-governance based services.

(c) ***Financial Feasibility***: IVRP is dependent solely on its donor institution to be kept running. The project does not seem designed for self sustenance. Most services are information provision based and available free of cost.

While the Gyandoot is a government supported ICT initiative meant primarily for delivering e-governance applications and development opportunities, the IVRP network sought to fulfill the same objectives using a more community focused, less e-governance centric service portfolio. We next discuss the case of the Wired Warana project, again a government sponsored initiative, where the core services were more aligned to the operations of the village co-operative.

3. Warana Wired Village

The Warana Village information kiosk was originally conceived as a MIS initiative to assist the Warana Group of Cooperatives (WGC) in make information about the yearly registration for plantations, issuance of harvesting permits and salary payment information available to the co-operative employees via Internet. Initiated by the Prime Minister's Office Information Technology Task Force, the goal of the Warana 'Wired Village' project, in addition to increasing efficiency and productivity of the sugar cane cooperative, is to provide a wide range of information and services, in the local language, to 70 villages around Warana., including crops and agricultural market prices, employment schemes from the government of Maharashtra, and educational opportunities.

(a) Model of operations: The different participants involved in the project are: The Warana sugar and Diary co-operatives, Warana Co-operative bank, the Warana engineering college and the Mahatma Gandhi medical trust. The project follows a hub and spoke model. The Sugar Administrative Building (SAB) of the sugar factory and the engineering college for the main hub centre. The business centers and IT centres are the value- adding tier of the structure where data entry takes places. Village level facilitation kiosks provide connectivity down to the village level. The kiosks have a PC with a printer and most are connected to CAB via wireless telephony.

(b) Overview of performance and comments: Implementation of the initiatives having a direct bearing on the operations of WGC proceeded smoother than those intended for community development. The information flows and delivery mechanisms were easier to map.

Top down implementation left lesser scope for community participation. Though the union was supportive, the lack of local staff participation in the software development and implementation process, which was done by a central nodal agency in Delhi. This may explain why some applications are not reflective of community information requirements, as in the case of information resources on sugar cane growing and agricultural prices which is lying unutilized and un-updated since 1998.

Rapid deployment of the different services of the project, without spending some time in training the community in the use of developed software may have been counterproductive. A more phased implementation, as seen in the case of IVRP would have been more appropriate. Not too many e-governance services are offered through the project. This is surprising considering the strong Central government involvement (NIC, PMO) in the setting up of the project.

Financial feasibility: Since this was a project promoted by the government, almost no informatiion is available on whether the project was financially sustainable.

The Wired Warana project is an example of community development schemes integrated into a ICT initiative built for improving business operation's efficiency. A comparable project is that of ITC's eChoupal, the only difference being that the promoter in this case is not a government agency but a private player.

4. ITC eChoupal

Started in 2003 with soya growers in the villages of Madhya Pradesh, eChaupal is a nation-wide e-procurement network set up by ITC Limited. The objective was to cut across layers of intermediaries and deal directly with the farmer, increasing the efficiency of the supply chain and at the same time, ensuring that the farmers received a fair price for their produce. Innovatively combining technology, sociology, and the incentives of the various players involved, the eChoupal provides farmers with effective methods of price discovery, honest trading, and information sharing to the benefit of all in the channel. The project presently covers 9 states and 38,000 villages and has enlarged its scope to cover shrimp farmers and coffee cultivators.

(a) Model of operations: E-choupal follows an info-kiosk based franchisee model. The following is brief description of the soyabean procurement system. Selected farmers, called sanchalaks, host the computer in their houses. This computer is linked to the Internet via phone lines or, increasingly, by a VSAT connection. One node serves an average of 600 farmers in 10 surrounding villages within about a five kilometer radius. The previous day's mandi (local market) closing price is used to determine the benchmark Fair Average Quality (FAQ) price at the e-Choupal. The benchmark price is static for a given day. This information and the previous day mandi prices are communicated through the e-Choupal portal. Farmers can also check prices at several nearby mandis and even track global trends. Thus the farmer is empowered to make the critical decision of when and where to sell his crop. To initiate a sale, the farmer brings a sample of his produce to the e-Choupal.

The sanchalak inspects the produce, performs prescribed quality tests and based on his assessment gives the farmer a conditional quote. If the price is agreeable to him, the farmer takes the note from the sanchalak and proceeds with his crop to the nearest ITC procurement hub where further tests are conducted on crop sample. These tests are however conducted after the sale has been finalized and have no bearing on the price. After the inspection and weighing are complete, the farmer then collects his payment in full at the payment counter. All operations at the procurement hub are handled by operators called 'Samyojaks'. The emphasis at the hubs is on professional handling of all transactions, with speed and accuracy.

(b) Overview of performance and comments: E-choupal is primarily a revenue generating initiative. The purpose of investing significant time and resources in this venture was to improve ITC's supply chain management. Like in the case of the Warana project, backbone services are related to the core business and other additional services come next. The benefit of this approach is that it keeps the project sustainable. The focus is however, understandably not centered on development.

(c) **Financial feasibility:** Th e-chaupal project is a resounding success in terms of the business goals acheived, and has spawned several such models among rival private sector firms.

Thus, while the community benefits from the project through access to better earning opportunities, there are no services to address the needs of the minority sections, women or landless workers. The project unintentionally discriminates among the local population.

The project while providing many economic benefits to farmers doesn't necessarily change the social framework they operate in. Studies have pointed out that in many cases, sanchalaks are farmers from the forward communities and so members of the backward castes are not allowed to enter the house in which the eChoupal is located. E-governance initiatives are underrepresented in the project. Part of the reason is ITC's hesitation to partner with governments given the uncertain quality of response. The whole initiative is completely dependent on ITC. All training provided to operators in handling the ICT tools are company specific. This doesn't automatically translate to making users self reliant. Table 1 (See Appendix) provides a ready reckoner for these projects.[10]

Overall Observations

In the ICT enabled development schemes discussed above, we note that the solutions were not as effective as intended. All of them required constant supervision and involvement by their project promoters. The schemes required making large capital investments as well as meeting continuous recurring expenses. Each of the schemes are identified with their promoters and the participants engage because of trust in the principle mover, not in the system itself. This has a significant bearing on sustainability, in that, should the promoter withdraw financial or technical support from a project at anytime, other participants may not step in to continue its functioning.[11] Moreover, though all the projects operate in rural, primarily agriculture based communities none of the systems actively and robustly involves research institutes or agricultural domain agencies. Except in case of IVRP, there has been emphasis on creating and assimilating locally relevant content. Over all, given the wide variety of facilities, there has been a marked improvement in communication and awareness and in some instances, a positive effect on restrictive social norms. While incomes have improved in some village communities (IVRP and eChoupal) this has been more due to better recognition of market opportunities rather than a direct positive effect on yield. The success or failure of a project aimed at fostering development by increasing the information capital, whether a Government undertaking or otherwise, depends not only the efficiency of the applications provided, but also on involving communities collectively and not just individuals. Successful adoption of new technologies requires collective action and co-operation, which social capital helps secure. Research indicates that in the Indian rural agriculture sector social capital is pivotal in mobilizing resources and bringing about market unsupported outcomes. This phenomenon has been documented for adoption of new seed or production technology, as well as for dissemination of information to other rural communities, in the absence of official channels (Chopde and Parthasarathy 1999).

There is a need to distinguish between a networked communities and a community network. A networked community is one where all members have access to internet and computers; the emphasis may not be on whether the entire community is interacting online. A community network represents

[10] Theabove paragraph, shaded in grey also appear in page 62-68 of this Case folio.
[11] Theabove paragraph, shaded in grey also appear in page 68 of this Case folio.

the links between different members and different groups in a community, forged through various media, both digital and in person. In the ICT interventions discussed, the attempts focused on bringing as many community members online as possible, to directly access the information digitally available. Though kiosks and other common access points have been established and staffed to assist farmers to use different tools, the services, like email, online complaint registration, etc are aimed at the individual and not the community. The effectiveness of these services is diluted as many farmers using the ICT program may not be capable of navigating through the system, and instead of asking constantly for help, they avoid it altogether. Unless a networked community evolves into an online community, the existing social capital does not get transferred to the new system, and therefore, as soon as the supporting node withdraws, the sustainability of the project is compromised. When understanding how ICT can be integrated in development projects, it is reasonable to expect that outcomes are dependent on 'social contexts of design, implementation and use' (Rosenbaum, 1999). Studies have shown that outcomes of ICT implementation and use in different real world settings, be it in an organization or a educational community, are difficult to predict or replicate, and that the 'contextually dependent nature of ICTs suggests that similar ICTs can have different outcomes in different situations' (Kling,et al. 1994).

Along the similar lines, the impact of ICT on a community is also important. Conflicting views abound – whether social capital is harmed or enhanced by information technology. Studies have shown that ICT facilitates in the formation and maintenance of 'weak' ties and may be harmful to strong ties (Sabatini 2005), or alternatively, ICT helps maintain strong ties, like those with close family , over distances through the use of email, chat etc. Weak ties in the network have been traditionally associated with enhanced economic activity (Granovetter 1985). This makes ICT interventions very attractive for economic development. Another school of thought (Kali, Farmer) is that decreasing social involvement and community participation as detailed by Putnam (2001) is further exacerbated by ICT, as users becomes more disconnected from their immediate community. Given the positive role of weak ties on enhancing economic growth, and the propensity of ICT to promote these ties, the contention is that proliferation of weak ties moves the individual out of the ambit of his immediate social group and alienates him from his surroundings. Also, when dealing with members outside one's community, the basis for trust is reduced, and the effectiveness of social capital does not translate directly online.[12] The evolution of institutions is required to retain coordination. This isolates the economic sector from the social one, and the dynamics are so poised that development in one sector can have a negative impact on the other. Empirical evidence available is not sufficient to conclusively prove either claim, though there is strong evidence of technology promoting some weak ties. One learning, however, is that regardless of whether ICT is viewed as social capital enhancing or depleting, ICT in itself is not context independent and ICT interventions can be suitably designed to use existing social relations and meld them into the digital network, broadening their scope and reach at the same time.

4. The DE Approach in a Community Network: The Case of the Indian DEAL Project

The DEAL (Digital Ecosystem for Agriculture and Livelihood) project is a step in towards addressing these issues by assembling a technology enhanced agricultural extension intervention in a DE framework. Conceived by IIT K and Media Lab Asia, DEAL is a ICT enhanced network built on an existing framework of tele-centers in rural institutes, village schools, village level agriculture

[12] Theabove paragraph, shaded in grey also appear in page 59 of this Case folio.

extension centers (KVKs) and other deployment partners. The project aims to create a digital knowledge base by involving the various actors in the existing system in the content creation process and making this knowledge accessible to farmers and other agricultural practitioners. The entire process of content creation and dissemination is self generating, node independent and self sustaining using an electronic medium. The moderating node in this system is IIT Kanpur providing the collaboration and collation technology platform, skills and resources to assist knowledge flows through the network. The presence of Government agencies helps build trust in the network. The agricultural experts and educational institutions are responsible for verification of content generated. The field deployment of the project was between December 2006 and June 2007. A study was conducted at 4 KVKs in Sept 2007, to assess the effect DEAL has had on information flows. The following network diagram, prepared in NetDraw[1], represents the ties that were present before the implementation of DEAL (A detailed description of the methodology and output is disscussed in paper 'The Impact of DEAL on Community Networks: A Case Review' of this case folio.)

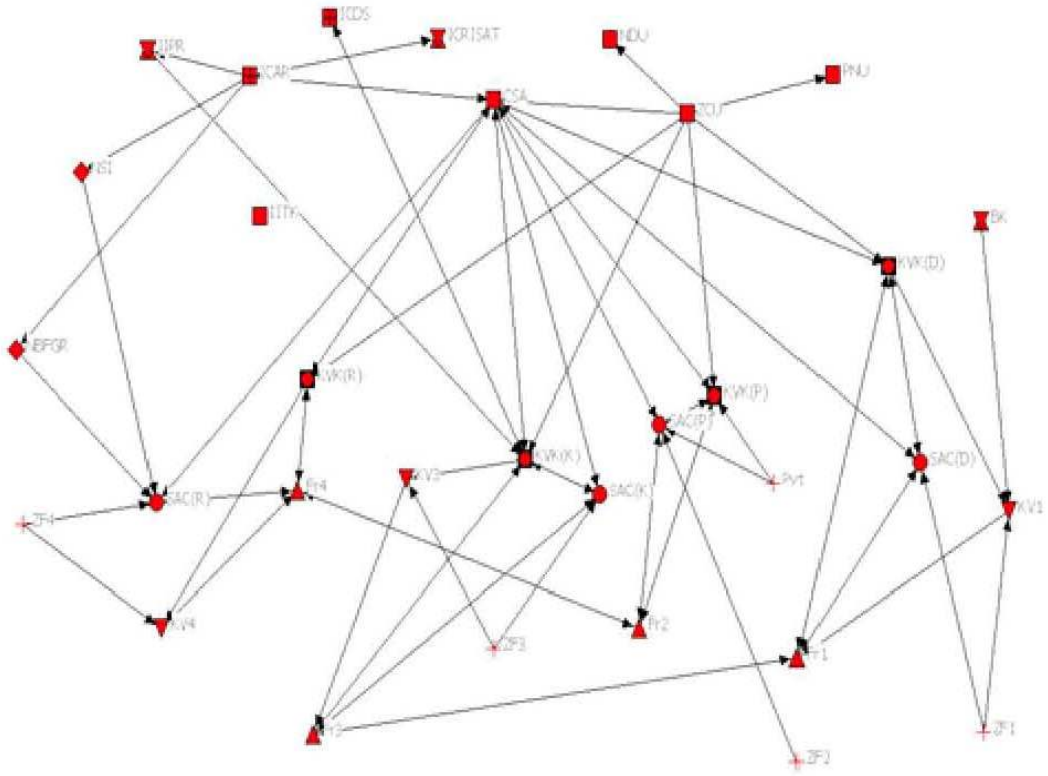

Figure 1: Network Ties before DEAL[13]

The shapes of actors in the network are based on their role, i.e. KVKs, Research Institutes, Government agencies, etc. The thickness of lines between agricultural experts within the same KVK, or between a farmer and his respective KVK are examples of strong ties, while links between KVKs and NGOs are examples of weak ties. The network shows the information flows within and across community. Here, the community is understood in terms of the village unit. So, within community linkages are those between actors in the same village – for eg, between the farmer of a village and the respective village KVK. Across groups links include links between actors from different villages –

[13] Theabove Figure 1 shaded in grey (title) also appears in page 82 of this Case folio.

like the link between farmers of different villages. Another classification of group is in terms of the strata of operations the actor belong to – IITK is a member of the educational institutions group, KVK are part of the villages level functionaries, and the ZCU, ICAR are all implantation and monitoring agencies. In this above network diagram, we have represented the different sources of agricultural information and the interrelations, both formal and informal, between them. Formal links are characteristic of the reporting relationship between actors – for instance, in the case of a KVK and the ZCU (Zonal Co-ordination Unit), and informal links are characteristic of the social relations between actors – like relations between farmers of adjoining villages.

Figure 2 represents the ties after implementation of the DEAL project. IITK is the only completely new actor being introduced into the framework and its integration into network, as well resultant increase in information flows is evident.

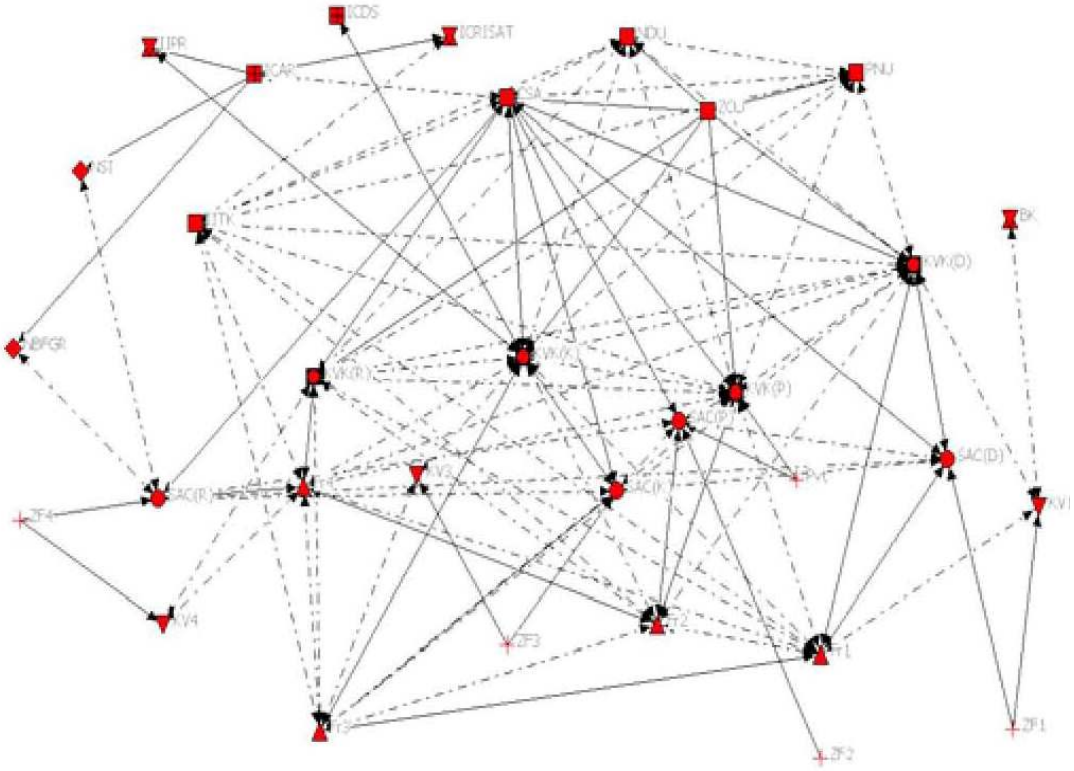

Figure 2: Network Ties post DEAL[14]

Note: Software from Analytic Technologies
A detail of study is available at IITK Deal site.

The dotted lines represent ties that have been formed due to content co-creation and sharing by partners facilitated by IITK through DEAL, while the solid lines represent the preexisting network ties. Linking together all the actors in dynamic relationships helps retain both strong and weak ties. We present here a few results from the analysis done using Ucinet. The total number of ties increased

[14] Theabove Figure 2 shaded in grey (title) also appears in page 84 of this Case folio.

from 77 to 183, and no old ties were displaced. New ties between existing partners, for instance between the KVKs, has decreased the degrees of separation between them while also increasing the network density from 0.0726 to 0.1615 showing a significant increase in cohesion between members. Another indicator of this increased interaction is the group reciprocity measures increasing from 0.3585 to 0.7745. From accessibility point of view, by using DEAL, farmer of all 4 KVKs are at a maximum 3 degrees of separation from any actor in the network. While these early reports are in some measure indicative of positive network externalities, more field reviews are needed to confirm these results. Since social change is an evolutionary phenomenon requiring time in the order of decades to manifest significantly, this is an area for further investigation.[15]

DEAL is different from a networked community like the Seattle community network (SCN), for example, in that the focus is not on promoting individual web presence, but more or extending reach of information flows while reducing the degrees of separation between members. This is done by using both digital and non-digital media. For instance, at the village level, the farmers, lacking access to computers or internet, have been introduced to the DEAL portal by the village KVK scientists. The idea is that using DEAL, they are able to use the online databases to address their problems – for instance, the picture particular kind of pest can be picked out from the common pests' database to search for the right insecticide, or the details of different rice varieties can be to find the appropriate fertilizers. A tool called the 'Kisan Blog' helps access the experiences recorded by members with respect to practical applications – grade of seeds, fertilizer or pesticides used etc. The endeavor is to make information flows and not the online network the focus of the project. This way, participants are 'won over' to use and 'socialise' the use of the system, and as prevalent infrastructure problems are resolved, the community network, with its social capital in place, makes a transition to the digital medium, that is a networked community, which is also a digital ecosystem.

5. Conclusion

For an ICT intervention to evolve into a DE, there are several necessary and sufficient conditions. This paper has tried to demonstrate that while establishing adequate infrastructure for a networked community is necessary, it is by no means sufficient for a DE. The associative and autopoetic nature of a DE necessitates the need for embeddedness of the intervention in existing social structures, which would grow through weak links to strengthen social capital and create new norms and networks. Thus, a digital ecosystem could be described as a community network of networked communities, which can grow in quality and quantity without any external assistance. The Indian implementation of the DEAL project illustrates the formation of a community network in the agricultural knowledge space. Here, the enabling parameters for developing into a DE are in place and with time (and adequate infrastructure) the transformation is inevitable.

References

Ben-Porath, Y. (1980). The F-connection: Families, friends, and firms and the organization of exchange. *Population and Development Review* 6, no.1: 1-30.

Bhatnagar, S., and Vyas, N. (2001). Gyandoot: Community-owned rural intranet kiosks, E-Government Case Studies. Last Acessed July 14, 2008, from INTERNET: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUN

[15] Theabove paragraph, shaded in grey also appear in pages 84-85 of this Case folio.

ICATIONANDTECHNOLOGIES/EXTEGOVERNMENT/0,,contentMDK:20486032~menuPK:1767268~pagePK:210058~piPK:210062~theSitePK:702586,00.html.

Bhatnagar, S., and Chawla, R. (2005). Bhoomi: Online delivery of record of Rights, Tenancy and Cultivation to farmers in Karnataka. In W. Habibullah and M. Ahuja (Eds.), *Land Reforms in India - Computerization of Land Records* (pp. 47-77). New Delhi: Sage Publications.

Bhatnagar, S., and Patel, N (1988). Decentralized computer for rural development. *Omega* 16, no.1:165-170.

Borgatti, S. P., Everett, M. G. and Freeman, L. C. (2002). *Ucinet for Windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Buskens, V. (1998). The social structure of trust. *Social Networks* 20: 265-289.

Chatterjee, J. and Prabhakar, T. V. (2005). On to action - Building a digital ecosystem for knowledge diffusion in rural India. Proceedings of the 2005 International Conference on Knowledge Management, North Carolina, USA. Last acessed July 14, 2008, from INTERNET: www.cse.iitk.ac.in/users/tvp/papers/vof_pasadena.pdf.

Cecchini, S., and Raina, M. (2004). Electronic government and the rural poor: The case of Gyandoot. *Information Technologies and International Development* 2(2): 65–75.Last Acessed July14, 2008, from INTERNET: http://www.mitpressjournals.org/doi/abs/10.1162/1544752044193434.

Coleman, J.S. (1988). Social Capital in the creation of human capital. *The American Journal of Sociology* (Supplement 1): 95-120.

Dini, P., and Nachira, F. (2005). The paradigm of structural coupling in digital ecosystems. Last Acessed July 14, 2008, from INTERNET: www.nachira.net/franz/**Structural_Coupling**_s.pdf.

Dossani, R, Misra, D.C. and Jhaveri, R (2005). *Enabling ICT for rural India*. Asia Pacific Research Center, Stanford University and National Informatics Centre. Last Acessed July 14, 2008, from INTERNET: http://iis-db.stanford.edu/pubs/20972/ICT_full_Oct05.pdf

Fahey, L. and Prusak, L. (1998). The eleven deadliest sins of knowledge management. *California Management Review* 40, no.3: 265-76.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *The American Journal of Sociology* 91, no.3.: 481-510.

Grover, V., and Davenport, T. H. (2001). General perspectives on knowledge management: Fostering a research agenda. *Journal of Management Information Systems* 18, no.1: 5-21.

Keniston, K., and Kumar, D. (Eds.) (2004). IT experience in India: Bridging the digital divide. New Delhi: Sage Publications.

Koert, R. V. (2000). 'Providing Content and Facilitating Social Change: Electronic Media in Rural Development Based on Case Material from Peru ' First Monday 5(2).

Krishna, A. (2003).Understanding, measuring and utilizing social capital: clarifying concepts and presenting a field application from India. CAPRi Working paper No. 28. Last Acessed July 14, 2008, from INTERNET: http://www.capri.cgiar.org/pdf/CAPRIWP28.pdf.

Krishnan, R., Smith, M.D., et al. (2003). The economics of peer to peer networks. *Journal of Information Technology Theory and Application* 5, no.3: 31-44.

Kwok, J. S. H., and Gao, S. (2004). Knowledge sharing community in P2P network: A study of motivational perspective. *Journal of Knowledge Management* 8, no.1: 94-102.

Markus, M. L. (2001). Toward a theory of knowledge reuse: Types of knowledge reuse situations and factors in reuse success. *Journal of Management Information Systems* 18, no.1: 57-93.

Owen, A. L. and J. Videras, J. (2007). Trust, cooperation, and implementation of sustainability programs: The case of local agenda 21.Last Acessed July 14, 2008, from INTERNET: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID976074-code1908.pdf?abstract_id=976074&mirid=1.

Parthasarathy, D., and Chopde V. K. (n.d.) Building social capital: Collective action, adoption of agricultural innovations, and poverty reduction in the Indian Semi-Arid Tropics.Paper for the research theme ‘Escaping Poverty’. Last Acessed July 14, 2008, from INTERNET: http://www.gdnet.org/pdf/776_D.pdf.

Rajora, R. (2002). *Bridging the digital divide*. New Delhi: Tata- McGraw Hill.

Sen, A. (1997). Maximization and the act of choice. *Econometrica* 65, no.4: 745-779.

Appendix 1

Table 3.1: Select ICT Interventions in Rural India - An Evaluation

Project	Goals	Services	Model of operations	Overview of performance
Gyandoot *Government, Village level committees*	-To make government services more accessible to villagers -To promote awareness and participation by citizens/government in community affairs through ICT,	-e Governance services : government services (eg : online caste , income and domicile certificates) and official information -Agriculture support information -Communication facilities like e bulletin boards, email etc	-Dissemination of information through telekioskes (only one PC used by a *facilitator*) Total of 38 kiosks -Two models of ownership Private entrepreneur: owner puts in capital, makes annual payment to village committee Village committee : committee pays for the telekiosk's capital expenditures (space,hardware). Operators bear telephone expenses and do not receive a salary. Instead they keep 90% of earnings after remitting 10% to the panchayat. For appointing kiosk operators, panchayats select three people who are sent for training, and one is finally selected after interviews and a practical examination.	-High service satisfaction but low usage.CEG-IIMA survey (2002) reported that 10 of 28 kiosks were not operational -Many services under-utilized-users very unaware of many of the service offerings. -Low local content creation: This is indicative that there was no significant engaging of different actors in collaborative efforts. Low word of mouth publicity for the project within service district despite campaigns also surprising. -Low ROI to kiosk owners (private and committee) – not financially tenable. -New modes of corruption: computerized only the front-end of government services; Back-end processes, at government department levels, are not computerized. This leaves loop holes for new forms of corruption.
IVRP *MSSRF with support of the Canadian Government. Village level committees*	-To assist sustainable agriculture and rural development,involve marginalized sections of the community. -To provide rural communities with access to Internet and training on ICTs.		-A donor-grant based community centric model. -Information dissemination follows Hub and spoke model. Village knowledge centres (VKCs) are set up in order to provide rural communities with access to Internet and training . MSSRF provides all the needed equipment, training . The participating community provides rent free access space to set up and 2 to 4 volunteers Volunteers are trained and maintain the VKC, feed relevant content garnered from other sources like newspapers, local news etc to the network -VKCs were first created in seven hamlets in rural Pondicherry, and the number has gone to twelve centers, with an average of 25 users daily.	-Successful local content creation and dissemination. Small groups of volunteers independently picked extra expertise (HTML coding, transmitting voice files) to improve content creation. The information gathered at the telecentres is also feeding more traditional media. -A volunteer-run, twice-monthly, community newspaper, Namma Ooru Seithi, was launched in early 2002 covering topics of local interest such as agriculture, traditional health care, jobs, coming training programs, recipes, child care tips, and village-specific news -'Bottom-up' approach to ICT based implementation of development projects., based on demand for services by the community and its willingness to manage and volunteer for the infokiosks. -Dependent solely on its donor institution to be kept running.. Most services are information provision based and available free of cost

WWI *WGC overnment of Maharshtra*	-To assist the Warana Group of Cooperatives providing a large range of information and services.	-Information and services, in the local language, to 70 villages around Warana., including crops and agricultural market prices, employment schemes, and educational opportunities.	-Hub and spoke model. The Sugar Administrative Building (CAB) of the sugar factory and the engineering college for the main hub centre. The business centers and IT centres are the value-adding tier of the structure where data entry takes places. Village level facilitation kiosks provide connectivity down to the village level. The kiosks have a PC with a printer and most are connected to CAB via wireless telephony.	-Top down implementation left lesser scope for community participation. Though the union was supportive, the lack of local staff participation in the software development and implementation process, which was done by a central nodal agency in Delhi. -Rapid deployment of the different services of the project, without spending some time in training the community counterproductive. some applications are not reflective of community information requirements, as in the case of information resources on sugar cane growing and agricultural prices which is lying unutilized and un-updated since 1998. -Offers few e-Gov services.
eChoupal *ITC Ltd, Farming communities across*	-To promote an e-procurement network -To empower rural agricultural community, increase modal incomes and service agriculture, healthcare, education, gender and community needs	-Information (weather, prices, news), -Knowledge (farm management, risk management) -Sales of Farm Inputs & Consumption goods (screened for quality, price) & alternative output marketing	-Info-kiosk based franchisee model. Farmers track agricultural prices on the Internet available at a facilitator's (also a farmer) residence in the village To initiate a sale, the farmer brings a sample of his produce to the e-Choupal. After inspection and quality tests, a conditional quote is generated. If the price is agreeable \the farmer proceeds with the nearest ITC procurement hub After the inspection and weighing are complete, the farmer then collects his payment. –The emphasis at the hubs is on professional handling of all transactions, with speed and accuracy.	-Major cost savings to company and farmers. Increased incomes, with increasing participation from farmers. -The project while providing many economic benefits to farmers doesn't necessarily change the social framework they operate in. eGgovernance initiatives are under represented in the project. -The whole initiative is completely dependent on ITC. All training provided to operators in handling the ICT tools are company specific. This doesn't automatically translate to making users self reliant

4

Social Capital, Sustainability and a Digital Ecosystem: A Case Review

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(This version of the paper has been presented at ICT, Transparency and Social Responsibility Conference, Lisbon, November 2007.)

Abstract: -The role of knowledge in promoting development has been well researched and documented, and there has been much interest in harnessing ICT (Information Communications Technology) for this purpose. This paper explores how the dynamics of this transfer depend on social capital and how the synergies generated by social capital can positively impact the co-ordination between member-nodes leading to the evolution of a more complex and multi functional ICT enabled socio-technical system.

A crucial impact of ICT is on the sense of morality of individuals. A brief review of information ethics literature, with emphasis on transparency, is undertaken to provide a basis for understanding how a socio-technical system can be understand in terms of information Examining a selection of ICT implementation schemes in the Indian rural sector, we review the degree of success achieved by these in terms of their information dissemination objectives and the impediments to successful knowledge resource creation. One issue in this context could be the network inefficiencies caused insufficient participation, lack of financial sustainability and free riding.

Networked nodes that only draw from the system for their gain without participating in a two way exchange process are defined as free riders. Any ICT enabled network will always have its share of free-riders which can adversely impact network sustainability. In the Indian rural sector, for instance, free riding is sometimes a consequence of the inequality of the participating nodes – in terms of size, access to resources and individual capacity to contribute to the network. These constraints on the participating nodes induce inefficiencies that could burden the network. We propose that by adopting a more community centric approach to these interventions can improve their sustainability.

We then present the digital ecosystems concept as potential conduits of ICT to the masses. A digital ecosystem (DE) describes an ICT enabled network that displays associative and autopieotic properties capable of self sustenance and of expansion through heightened inclusion and growth. These features of DE support bridging the digital divide and stimulating development. The sustenance of a DE depends on co-operation between member-nodes of the network. This closely reflects the social capital embedded in community relationships. In addition to providing a working definition for a DE and suggesting means through which an ICT enabled network can evolve into a DE, this paper contributes some new insights into the extent of community involvement necessary to

make a DE sustainable. The case of the DEAL (Digital ecosystem for Agriculture and Livelihood) project is then presented as an illustration of the digital ecosystem model outlined in the paper.

Key words: Information, Development, ICT Social capital, Digital ecosystem

1. Introduction

In this paper, we first discuss the change in perceived role of Information Communications Technology (ICT) in supplementing development, its increasing significance in the service deployment of various development initiatives and consequently, how the transfer of benefit can take place in these initiatives.

For long, economists had isolated man's economic decision making function from his social relations and obligations. Sociologists on the other extreme, held that all of mans decisions were influenced by the community he was part of. With the shifting of the focus from either extreme to the view that social relations, that is the formal and informal networks an individual is part of, researchers became interested in the link between the structure of social relationships and information flows. Trust, reciprocity and cooperation became key points in the discussion of how information was used to affect transactions. Into this mix came technology. Initially, technology was seen as process enhancing and nothing more; a mere tool to speed up the transaction without altering the structure or nature of relationships.

Studies of different ICT (Information and Communication Technology) implementations indicate that outcomes of ICT implementation and use in different real world settings, either in an organization or an educational community, are difficult to predict or replicate, and contextually dependent nature of ICT's suggests that similar ICT's can have different outcomes in different situations. Technology alters and in altered by the social system. Given the lack of direct contact in online relations, and the difficulty in tracing offenders, individuals are unable to see the immediate cause effect relationship between a morally offensive act and its repercussion, thus blurring the right between right and wrong. To counter this, a new code of ethics is necessary. We proceed to develop on the topic of emerging Information Ethics (IE) literature, and the strength of there percepts in addressing issues Cases of different ICT enabled projects aimed at rural development are briefly discussed in terms of objectives, mode and level of ICT involvement, results achieved and limitations. As a possible solution to overcome these lacunae, we put forward and describe the digital ecosystem (DE) approach to ICT implementation. Impeding factors for a DE and the possible role of the Government are then discussed and the DEAL (Digital Ecosystem for Agriculture and Livelihood) project, a rural development initiative in agriculture in Northern India is presented as a DE illustration.

2. Development goals and ICT

The concept of human development has undergone a paradigm shift over the course of its evolution. Initially, human welfare was understood through certain aggregative economic measures – like GNP, GDP, income etc, and development was seen as an improvement in these indices. However, practitioners and academics alike were dissatisfied by these definitions as they felt these figures by themselves have no meaning and gained it only when understood in terms of human wellness.

A broader view of development thought evolved as articulated in Dreze and Sen (1997), whereby the focus shifted to the person from the program and the human being took center stage. Promoting human welfare entails:

(a) Economic growth: This term refers to the increases in a country's output of goods and services. These increases can take place only when individuals participating in the economy engage in productive activities. In other words, for the sum total output to increase, apart from major technological advances, the economy needs to increase the employment opportunities

(b) Social inclusion: The positive action taken to include all sectors of society in planning and other decision-making. The importance of inclusion is underscored in development policies. If economic growth alone was targeted, then there is a danger of certain sections of people remaining isolated from the benefits of progress.

Most of all, the aim of development is to remove impediments to decision making provide users both the tools and information, while enabling them to exercise their right to choose; underlining the philosophy that the individual freedom of choice is central to well being (Sen et al, 1999). Today's world is driven by information and success depends not only on finding and using information, but on doing so fast. Agriculture, manufacturing, and business- all are now wired. Technology is no longer an end in itself, but the means to achieving greater economic success and social connection. Information and communication technology (ICT) provides a delivery system flexible enough to accommodate the interaction of many participants across geographies while being identity neutral; thus curbing discrimination against users based on gender, caste, religion or other social labels. Thus, while the potential of ICT applications in health care, education, e-governance and so on is huge, the true contribution of ICT is that it would enable the 'marginalized' and weaker sections (the recipients) to decide how best they wish to be benefited, as equals. This it does by maximizing information sharing and knowledge flows. At the same time, it may seem incongruous to talk about computers and the internet to people living below the poverty line, in dire need of basics: nutrition, health, education. However, squared off against this is the fact that IT is a great leveler removing constraints imposed by geography, it has created countless opportunities for employment and entrepreneurship.

It is in this light that the Human Development Report (UNDP 2001) says that 'Technology is like education – it enables people to lift themselves out of poverty'. Postponing IT access till other goals are achieved means increasing the digital divide and further marginalizing the underprivileged by denying them the right to choose their way to a better life.

Having said that, the pertinent question next is what is the transfer mechanism by which ICT passes on these benefits to the targeted end users. Identifying needs and designing of appropriate technologies is just a part of the task, the real challenge lies in getting communities to adopt and use them. It is in this context, that the community in which targeted individuals reside becomes important. In the next sections, we tackle these questions

2.1. Social Capital and Development

When understanding how ICT can be integrated in the development projects, it is reasonable to expect that outcomes are dependent on 'social contexts of design, implementation and use' (Rosenbaum, 1999). Studies have shown that outcomes of ICT implementation and use in different

real world settings, be it in and organization or a educational community, are difficult to predict or replicate, and that the 'contextually dependent nature of ICT's suggests that similar ICT's can have different outcomes in different situations' (Kling et al. 1994). Thus, the 'social context' has emerged as a key component in understanding the relationships between people, ICT and digital information, and the setting in which these relationships evolve.

Social context as a determinant variable in transactions started with a shift in economists' perception of 'man' and what he brought into market transaction. A basic premise in traditional market transactions is that they are perfectly 'replicable' and 'impersonal', i.e., identity is not a determinant of market relations. Buyer A will transact with any seller offering the market clearing price. Whether in a repeated game, he transacts again with the same seller depends on a favorable outcome in the first interaction. It is however been observed that in the real world, transactions are not so atomistic. The identity of the transacting parties, by inducing trust, secures co-ordination and brings about certain transactions that might not have taken place other wise (Ben Porath 1980). In the light of this debate, economists tried to keep identity from entering the market equation, by using it explain more non-market transactions, for examples, those occurring within kinship groups and families. In other words, identity was seen to matter only in 'affective' relationships – those involving emotions. Real world transactions have shown not to conform to this categorization. Baker (1983) showed that how, even in the highly rationalized market of the Chicago Options.

Exchange, relations among floor traders develop, are maintained, and affect their trades. Coleman (1988) talks of the Kahn El Khalili market of Cairo, where traders provide extended services to customers by linking with other competing or complementary traders, based on personal relationships. These examples bring out the importance of identity in a market transaction, in terms of inspiring trust. As Arrow (1969) observed 'It is useful for individuals to have some trust in each other's word. In the absence of trust, it would become very costly to arrange for alternative sanctions and guarantees and many opportunities for mutually beneficial cooperation would have to be forgone'. This observation has been especially borne out by the game formulation of Flood and Dresher (1958), which became known as the Prisoner's Dilemma, which showed that while cooperation could lead both players to a mutually beneficent outcome, lack of trust in the others player dictates individual maximization strategies of the players that would lead them to defect.

Identity of an individual cannot be understood in isolation, but only in terms of his placement in society – what roles he plays and relationships he is part of. It is this societal sanction that induces trust- members transacting with a particular individual, will process information about his identity with reference to the social network he is part and then decide to trust him or not (e.g.- traders belonging to same clan). Thus, as Portes (1998), observes, for individuals 'whereas economic capital is in bank accounts and human capital is inside their heads, social capita inheres in the structure of their relationships' The importance of social networks is best exemplified in interesting paradox remarked by Granovetter (1985), of how economists abstract social ties away from transactions and assume social order as given, when in reality social order depends on trust, and trust can exist only in the presence of the ties which economists have assumed away. His work has shown that in economic decision making the social context is important and social ties as source of trust. Social capital, manifested in social networks, can make transactions that can't happen in a free make possible, by lowering the transaction costs – costs of information collection, monitoring, negotiating and enforcing.

2.2. ICT interventions: Objectives and Implications for Social Capital

The role of information communication technology can then primarily be to enhance this social capital. Conflicting views abound – whether social capital is harmed or enhanced by information technologies. Studies have shown that ICT facilitates in the formation and maintenance of 'weak' ties and may be harmful to strong ties (Sabatini 2005),while maintaining strong ties, like those with close family, over distances through the use of email, chat etc. Weak ties in the network being traditionally associated with enhanced economic activity (Granovetter 1985), ICT can in this context be seen as positively impacting community welfare through economic development and social relations.

Another school of thought (Kali, Farmer) is that decreasing social involvement and community participation as detailed by Putnam (2001) is further exacerbated by ICT, as users becomes more disconnected from their immediate community. Accepting the role of weak ties on enhanced economic growth, and the propensity of ICT to promote these ties, the contention is that proliferation of weak ties moves the individual out of the ambit of his immediate social group and alienates him from his surroundings. Also, when dealing with members outside of one's community, the basis for trust is reduced, and the effectiveness of social capital does not translate directly online.[16] The evolution of institutions is required to retain coordination. This isolates the economic sector from the social one, and the dynamics are so poised that development in one sector can have negative impacts on the other. Empirical evidence available is not sufficient to conclusively prove either claim, though there is strong evidence of technology promoting some social ties. One learning, however, is that regardless of whether ICT is viewed as social capital enhancing or depleting, ICT in itself is not context independent.

An ICT intervention provides the community both wider and richer access to information. Greater infusion of information into social networks has seen the evolution of an information society, which depends heavily on computer technologies, a substantial knowledge sector work force and increasing division of labour. Initially, technology was viewed as context neutral, and seen to affect the social network only through the economic sector. Growing research has displayed contrary indications. The use of information communication technologies does shape the social structure it is introduced into, for enhanced economic benefits, but it is in turn, affected by the social context it is part of. Thus, technology becomes embedded into the social network – the basic premise of the socio-technical approach to social networks.

2.3. Information ethics: Moral Code of a Digital World

Conceptualizing an ICT enabled social network in this manner blurs the line between the 'real' and the 'artificial' communities, and brings with it attendant concerns of governing principles, or in other words, the ethics of operation of this network. The need for a robust code of ethics in this new information age is most relevant in understanding and resolving the moral issues that arise from ICT implementation, especially the much documented Digital divide. Given the lack of direct contact in online relations, and the difficulty in tracing offenders, individuals are unable to see the immediate cause effect relationship between a morally offensive act and its repercussion, thus blurring the right between right and wrong. To counter this, a new code of ethics seemed necessary, to serve as a good touchstone for users to test if their actions are 'right' or 'wrong'.

[16] Theabove paragraph, shaded in grey also appear in page 47 of this Case folio.

This view, while praiseworthy in terms of providing a new direction in understanding the nature of the effects on ICT on social networks, is yet an evolving one and has been the subject of extensive review and comment (Siponen 2005, Himma 2006) especially with regards to its definition of moral agents in the infosphere and contention that different agents are shown different levels of respect. Nevertheless Information Ethics provides a framework to evaluate the 'ethical' suitability of an ICT intervention, in terms of its impact on the 'infosphere'.

Here we discuss the information ethics perspective described and discussed by Floridi and Sanders (2004). According to an information ethics perspective, the world of data, information, knowledge and communication, made possible by ICTs, is best approached ecologically, as a new environment, the 'infosphere'. The infosphere is not a geographical, political, social, or linguistic space. It is the semantic space of education, sciences, cultures, and communication, a global environment that is essentially intangible and immaterial, but just as significant as the material world populated by biological entities. In other words, the theory argues for a transition of situating ethics from a anthropocentric to infocentric one. The theory is aimed at challenging the fundamentals of moral thinking, especially redefining the concept of what constitutes moral agency, the nature of the entities occupying the infosphere and how entities deserving moral respect should be treated. A Moral Agent is anything that can be held responsible -- credited or blamed -- for decisions or behavior. It is moral agents who have rights and responsibilities. This does not presuppose that moral agents always take the right decision, but only that they have the ability to distinguish between right and wrong.

In the real world, all adults are termed to be moral agents (there is a very exhaustive discussion of how animals, infants as well as non sentient objects are not moral agents). The IE posits goes a step further and defines entities in terms of information. Thus IE is an Environmental Macroethics based on the concept of data entity rather than life (Floridi and Sanders 2003). By 'infocentric' Floridi means that a key element of IE is the concept of information entity. Every existing entity, 'which is a consistent packet of information, and does not contain a contradiction in itself', is an information entity (Floridi 1999).

Moral thinking in IE establishes that information entities may require respect even if they do not share human or biological properties, and the rules to morally evaluate an action in the infosphere, that is, decide if it is right or wrong are as follows:

(a) Information entropy ought not to be caused in the infosphere;

(b) Information entropy ought to be prevented in the infosphere;

(c) Information entropy ought to be removed from the infosphere; and

(d) The infosphere ought to be protected, extended, improved, enriched, and enhanced.

2.4. Transparency, free riding and the digital divide

From our discussion on information ethics, Floridi's percept that more the information added to the infosphere, more it is beneficial to users. But the benefit arises only if the information is available to all. Thus transparency becomes an ethical necessity than an option. Transparency, as used in information ethics, implies openness, communication, and accountability. Transparency in design serves many purposes. By making all sources and transactions public, it puts a check on corruption

primarily (Sturges 2004) there is another, more subtle contributor to the digital divide – information free riding.

The less than optimal level of participation which results from the presence of free riding poses a type of moral hazard problem, as when some nodes absorbing more information without sharing resources on the network, there results a lack of transparency which potentially endangers the interests of the sharing node. Networked nodes that only use the ICT resources for their gain without participating in a two way exchange process are understood here as free riders. Any ICT enabled network in a P2P mould will always have its share of free-riders. This is 'morally wrong', by Information ethics percepts, because Free-riding in this context is more nuanced in the sense that it is brought on not necessarily by the game theoretic rationale typified in the Prisoners dilemma game, but more of real world technical and social constraints to information sharing. In other words, members may not voluntarily choose to free-ride, but it is still manifested. For instance, in the Indian agricultural sector which is predominantly populated by rural communities, free riding is sometimes a consequence of the inequality of the participating nodes – in terms of size, access to resources and individual capacity to contribute to the network. These constraints on the participating nodes induce inefficiencies that burden the network. We examine this facet of knowledge sharing in current agriculture domain specific ICT programs.

Another reason for unequal participation is paradoxically the 'digital divide' – the very problem that a ICT enabled network is designed to eliminate. The digital divide is a term used to refer to the gap between those who benefit from digital technology and those who do not. To understand this paradox, we must step away from the conventional explanation that the information asymmetry induced 'digital divide' is just a question of access (Hongladarom, 2004). That is, it is not a simple problem of some sections having too much information and some too little, but rather, incomplete access. Many of the so called information poor – for example rural communities in different countries, do possess vast stores of native information that has been coded into their culture and practices. As they lack means of making this available for others to access, they are unable to reap the benefits of possessing the resource.

Thus transparency can have two fold effects on reducing free riding - making more information available in the infosphere, as well as information about information – as in the sources of information.

In social capital literature, transparency of information, in terms of locating relevant sources and information about the sources was a function of the links in the network. ICT networks which are cognizant of this structure and work to strengthen and build on the social links already existing could ensure that data transparency is built in. While further work is needed in this area, to advance more conclusive theories, in this paper, we look at this angle of ICT networks, in relation to existing initiatives, and the Digital Ecosystem model.

3. ICT Entrenched Development Solutions: the India story

The earliest appraisal of the potential of computers in rural development in India was done by academics during 1975-80 (Patel 1979). Initially, computers were seen as effective monitoring tools of existing projects (Bhatnagar and Patel 1988), but gradually, with hardware prices declining, their use became more widespread and non-specific. Under the patronage of Rajiv Gandhi, the pace of IT use at the district level gained momentum and many programmes, like DISNIC (District Information

System of National Informatics Centre) which promoted computerization of all district level offices and CRIS (Computerized Rural Information Systems Project) which developed software for planning and mentoring of IRDP (Integrated Rural Development Programme) , laid the groundwork for future ICT enabled projects. Government interest has however been more marked in supporting e-governance initiatives to make governance more transparent and delivery of certain essential services corruption free. E-governance refers to 'the process of enabling transactions between concerned groups and the government through multiple channels by linking all transaction points, decision-points, enforcing/implementation points and repositories of data using information and communication technologies, to improve the efficiency, transparency, accountability and effectiveness of a government' (Bhatnagar 2004). The vision is that effective and responsible governance will automatically encourage economic growth and social development. In this context, it is interesting to note that very few ICT projects are exclusively e-governance projects. We now discuss selected ICT enabled development programmes and examine the performance of each in context of the goals they were to set to achieve. We draw on the extensive reports by DIT and Infosys (2005), APARC and NIC (2005) etc, comparing the various ICT projects and evaluating their aggregated performance.

1. Gyandoot

In the Dhar district of Madhya Pradesh, Gyandoot— a government-owned computer network—has been trying since January 2000 to make government services more accessible to villagers. Gyandoot aims to reduce the amount of time and money people spend trying to communicate with public officials and seeks to provide immediate, transparent access to local government data and documentation through a network of 38 telekiosks or soochanalayas.

Gyandoot aims to create a cost-effective, replicable, economically self-reliant and financially viable model for taking the benefits of Information and Communication Technology (ICT) to the rural masses. The purpose of this network is to combat poverty, illiteracy and social backwardness by promoting awareness and participation by citizens/government in community affairs through creative uses of ICT and also encouraging greater inclusion by ensuring equal access to emerging technologies for the oppressed and exploited segments of the society (Rajora, 2002).

Information and services offered include online applications for caste, income, and domicile certificates and the access to the list of people living below the poverty line, prices of several agricultural products in various cities beyond the local market. Additionally, a public complaint line for reporting government-related problems, broken irrigation pumps, unfair prices, absentee teachers, and other problems is also available.

***(a) Model ofOoperations*:** The information collection and dissemination is done though the tele-kiosks. These are different from tele-centers in that they are have only a single computer manned by a facilitator or a 'Soochak' who helps clients browse or download, while tele-centers have personal computers where clients browse on their own (Best and Maclay (2002). There are two models of ownership of these tele-kiosks- the panchayat (village committee) and the private models. In both models, individuals from the village community are handed the running of the kiosks, thus fostering entrepreneurship.

In the panchayat model the village committee pays for the telekiosk's capital expenditures (space, hardware). Operators have to bear telephone expenses and do not receive a salary, but

get to keep 90% of earnings after remitting 10% to the panchayat. For appointing kiosk operators, panchayats select three people who are sent for training, and one is finally selected after interviews and a practical examination. In the private model the soochak is the owner of the telekiosk. The entrepreneur who has the capital, or is able to get a loan, gets the job. An annual payment of Rs.5,000.00 to the project committee aside, the rest of the earnings accrue to the kiosk operator.

(b) Overview of Performance and Comments: Based on World Bank's Governance Knowledge Sharing Program (GKSP)((supported report by CEG-IIMA (2002)) we make the following observations on Gyandoot :

1) High service satisfaction but low usage: Villagers who had used the Gyandoot kiosks were satisfied with the service level offered but they did not advocate it to others. Out of 38 Gyandoot tele-kiosks, the CEG-IIMA survey found that 10 were not operational. Many tele-kiosks serve only a handful of people (1–4) each day. The average for 18 tele-kiosks calculated over a two-year period was 0.62 users per day.

2) Despite the publicity initiatives undertaken by the project committee, there was a lack of awareness about the facilities offered by the project. Distance and infrequent power supply were two other reasons for people not using the kiosk.

3) Services provided as a response to a need, yet many services under utilized. The Gyandoot project aimed to provide a whole host of services, including access to educational and health facilities by linking up with schools and local hospitals. Survey results indicate that most of the services were not used at all by villagers. Of the 20 services offered, only a handful are really demanded (CEG-IIMA, 2002)

4) Low local content creation: lack of involvement and contribution from local players. Basic nature of project is that of a G2C network , but to achieve the stated aims would require participation of other actors (partnering with private players, NGO's, research institutes) to provide additional services for which there was not sufficient scope.

(c) Financial Feasibility: The cash flows generated by the services provided are not sufficient to help operators sustain. The CEG-IIMA survey found that total revenue from Gyandoot services was approximately Rs. 150 per month per telekiosk over a period of 2 years. The Gyandoot Intranet was set up at a total cost of Rs. 2.5 million. The average cost incurred to establish a telekiosk is Rs. 75,000 and operational costs are estimated at Rs. 1,000 per month (Bhatnagar & Vyas, 2001). Clearly, there is no incentive for more kiosks to be set up or for individuals to continue in the project.

Issues with existing administrative set-up- cost escalation due to new modes of corruption and bribery: Gyandoot has computerized only the front-end of government services; in most cases, citizens submit applications online and have to go back to the tele-kiosk for a response. Back-end processes, at government department levels, are not computerized. Printouts of the applications, requests, and grievances are sent to government departments for further action, except for a couple of departments that are accessible by e-mail. This leaves loop holes for new forms of corruption.

An interesting contrast to Gyandoot is the Bhoomi project, which is discussed next. It is similar to Gyandoot in that it is also a state government led ICT implementation to deliver on-line land records. The results achieved by Bhoomi have been more satisfactory that that by Gyandoot.

2. Bhoomi

The Bhoomi project of on-line delivery of land records in Karnataka demonstrates the benefits of making government records more open so that citizens are empowered to challenge arbitrary action. The objective was to stem corruption in the land management system using automation to restrict powers of civil servants at the operating levels.

***(a) Model of Operations*:** The Department of Revenue in Karnataka has computerized 20 million records of land ownership of 6.7 million farmers in the state. Over 30 kiosks reaching most talukas in Karntaka have been set up. Previously, to obtain a copy of the Record of Rights, Tenancy and Crops (RTC) -- a document needed for many tasks such as obtaining bank loans, or to file 'mutation' requests (to alter land records upon sale or inheritance of a land parcel) farmers had to approach the Village accountant. The importance attached to that functionary thus created opportunities for corruption; a typical bribe for a certificate could range from Rs.100 to Rs.2000, sometimes going up to Rs.10,000.00. With the implementation of Bhoomi, a printed copy of the RTC can be obtained online by providing the name of the owner or plot number at computerized land record kiosks in 180 taluk offices for a fee of Rs.15. Farmers submit online application for a mutation request and can track the status of the application on a Touch Screen. The automation process put curbs on the discretion, or rather, the in-discretions of public officials.

***(b) Overview of Performance and Comments*:** Different studies of the Bhoomi project (Bhatnagar, 2005 et al) have found it to be modestly successful in its objective of tackling corruption in the land management system. It is being used as model project by DIT (Department of Information Technology) to initiate similar systems in Kerala, West Bengal, Sikkim etc. Some relevant features of Bhoomi are highlighted below:

High usage key to success: During a 12 month period nearly 5.5 million farmers have paid Rs 15 and collected their RTCs from the Bhoomi kiosks. Positive feedback from users enhanced trust in the system. A recent evaluation by an independent agency indicates that in the perceptions of the farmers Bhoomi has improved service and lowered corruption (Lobo and Balakrishnan, 2002).

It is important to note that in contrast to Gyandoot, where only the front end operations were computerized, in Bhoomi the entire land management system was automated and relevant legislation passed to make the online record system the only available option for land record enquires and other transactions. This being said, it should be noted that automation is not a substitute for good management in eradication corruption. For instance, under the Bhoomi project, as there is no change in the role of Revenue Inspector in passing the mutation order, corruption in the mutation process may not necessarily reduce. Reports on overdue mutations can point to such errant behavior which supervisors must examine and take appropriate action.

No community development schemes: Bhoomi is first and foremost a land management system. Unlike Gyandoot, it does not offer any other services. The involvement of the community required is thus lesser than that required for sustenance by Gyandoot. Dedicated E-Champion: Many efforts at computerization of land records in India have failed in the past. Bhoomi succeeded because there was a champion in the departmental head who worked a 15-hour day for over 12 months, devoting 80% of his time to the project. This fact rings true in the case of Gyandoot as well, where the project was made possible because of a strong e-champion and his removal significantly compromised the efficiency of the project.

To study the contrast further, we next discuss the case of the Pondicherry Information village; a non government ICT enabled rural agriculture and livelihood enhancement initiative.

3. IVRP

The Information Village Project in Pondicherry, India started up in 1998. The project was initiated and managed by the Madras based M. S. Swaminathan Research Foundation with the support of the Canadian Government. The objective was to assist sustainable agriculture and rural development by making relevant generic information locale specific and delivering it to the community. The thrust was on involving woman, BPL families and members of the so called back-ward castes. The project implementation was planned in three phases.

(a) Model of Operations: The project uses a donor-grant based community centric model. Village knowledge centres (VKCs) are set up in order to provide rural communities with access to Internet and training on ICTs. In each case, the participating community provides rent free access space to set up and 2 to 4 volunteers. These volunteers are compensated by the community and care is taken to involve the marginalized sections in volunteering. In turn, the project provides all the needed equipment, training and data. Wireless radios were used for data and analog voice transmissions between a semi-urban hub center and eight village centers. Information gathering follows a Hub and spoke model—Hub gathers and distributes information to the Centers. Volunteers are trained in the basic operations of a personal computer: sending messages, composing documents and so on, using local language tools etc. They maintain the VKC and feed relevant content garnered from other sources like newspapers, local news etc to the network. In each phase there is an updating of the ICT tools used and phase III of the project is looking to experiment with the following: wireless fidelity (WiFi); 2.5G mobile technology (includes mobile telephones enabled to transmit data via General Packet Radio Service); Global Positioning System (GPS) for fisher people to improve knowledge of fishing zones and potential ocean hazards etc. VKCs were first created in seven hamlets in rural Pondicherry, and the number has gone to twelve centers, with an average of 25 users daily.

(b) Overview of Performance and Comments: The success of IVRP has been in terms of local content creation and dissemination. Small groups of volunteers independently picked extra expertise (HTML coding, transmitting voice files) to improve content creation. The information gathered at the tele-centres is also feeding more traditional media. A volunteer-run, twice-monthly, community newspaper, Namma Ooru Seithi, was launched in early 2002 to reach those beyond the knowledge centres' ambit. Its articles cover topics of local interest such as agriculture, traditional health care, jobs, coming training programs, recipes, child care tips, and village-specific news

IVRP illustrated the 'bottom-up' approach to ICT based implementation of development projects. Evolution of the IVRP network infrastructure was gradual, based on demand for services by the community and its willingness to manage and volunteer for the info-kiosks. Interestingly, the project offers very few e-governance based services.

(c) Financial Fieasibility:IVRP is dependent solely on its donor institution to be kept running. The project does not seem designed for self sustenance. Most services are information provision based and available free of cost.

While the Gyandoot and Bhoomi project are government supported ICT initiatives meant primarily for delivering e-governance applications and development opportunities, the IVRP network sought to fulfill the same objectives using a more community focused , less e-governance centric service portfolio . We next discuss the case of the Wired Warana project, again a government sponsored initiative, where the core services were more aligned to the operations of the village co-operative.

4. Warana Wired Village

The Warana Village information kiosk was originally conceived as a MIS initiative to assist the Warana Group of Cooperatives (WGC) in make the flowing information available to the co-operative employees via Internet:

(a) Yearly registration for plantation, when supervisors from WGC record mutations (changes to land property).

(b) Issuance of harvesting permits.

(c) Payment information.

Initiated by the Prime Minister's Office Information Technology Task Force, the goal of the Warana 'Wired Village' project, in addition to increasing efficiency and productivity of the sugar cane cooperative, is to provide a wide range of information and services, in the local language, to 70 villages around Warana., including crops and agricultural market prices, employment schemes from the government of Maharashtra, and educational opportunities.

(a) ***Model of Operations:*** The different participants involved in the project are: The Warana sugar and Diary co-operatives, Warana Co-operative bank, the Warana engineering college and the Mahatma Gandhi medical trust. The project follows a hub and spoke model. The Sugar Administrative Building (CAB) of the sugar factory and the engineering college for the main hub centre. The business centers and IT centres are the value- adding tier of the structure where data entry takes places. Village level facilitation kiosks provide connectivity down to the village level. The kiosks have a PC with a printer and most are connected to CAB via wireless telephony.

(b) ***Overview of Performance and Comments:*** Implementation of the initiatives having a direct bearing on the operations of WGC proceeded smoother than those intended for community development. The information flows and delivery mechanisms were easier to map for the Top down implementation left lesser scope for community participation. Though the union was supportive, the lack of local staff participation in the software development and

implementation process, which was done by a central nodal agency in Delhi. This may explain why some applications are not reflective of community information requirements, as in the case of information resources on sugar cane growing and agricultural prices which are lying unutilized and un-updated since 1998.

Rapid deployment of the different services of the project, without spending some time in training the community in the use of developed software may have been counterproductive. A more phased implementation, as seen in the case of IVRP would have been more appropriate. Not too many e-governance services are offered through the project. This is surprising considering the strong Central government involvement (NIC, PMO) in the setting up of the project.

The Wired Warana project is an example of community development schemes integrated into a ICT initiative built for improving business operation's efficiency. A comparable project is that of ITC's eChoupal, the only difference being that the promoter in this case is not a government agency but a private player.

5. ITC eChoupal

Started in 2003 with soy growers in the villages of Madhya Pradesh, eChaupal is a nation-wide e-procurement network set up by ITC Limited. The objective was to cut across layers of intermediaries and deal directly with the farmer, increasing the efficiency of the supply chain and at the same time, ensuring that the farmers received a fair price for their produce. Innovatively combining technology, sociology, and the incentives of the various players involved, the eChoupal provides farmers with effective methods of price discovery, honest trading, and information sharing to the benefit of all in the channel The project presently covers 9 states and 38,000 villages and has enlarged it's scope to cover shrimp farmers and coffee cultivators.

(a) Model of Operations: E-chaupal follows an info-kiosk based franchisee model. The following is brief description of the soya bean procurement system. Selected farmers, called sanchalaks, host the computer in their houses. This computer is linked to the Internet via phone lines or, increasingly, by a VSAT connection. One node serves an average of 600 farmers in 10 surrounding villages within about a five kilometer radius.

The previous day's mandi (local market) closing price is used to determine the benchmark Fair Average Quality (FAQ) price at the e-Choupal. The benchmark price is static for a given day. This information and the previous day mandi prices are communicated to the through the e-Choupal portal. Farmers can also check prices at several nearby mandis and even track global trends. Thus the farmer is empowered to make the critical decision of when and where to sell his crop. To initiate a sale, the farmer brings a sample of his produce to the e-Choupal. The sanchalak inspects the produce, performs prescribed quality tests and based on his assessment gives the farmer a conditional quote. If the price is agreeable to him, the farmer takes the note from the sanchalak and proceeds with his crop to the nearest ITC procurement hub where further tests are conducted on crop sample. These tests are however conducted after the sale has been finalized and have no bearing on the price. After the inspection and weighing are complete, the farmer then collects his payment in full at the payment counter. All operations at the procurement hub are handled by operators called 'Samyojaks'. The emphasis at the hubs is on professional handling of all transactions, with speed and accuracy.

(b) Overview of Performance and Comments: E-chaupal is primarily a revenue generating initiative. The purpose of investing significant time and resources in this venture was to improve ITC's supply chain management. Like in the case of the Warana project, backbone services are related to the core business and other additional services come next. The benefit of this approach is that it keeps the project sustainable. The focus is however, understandably not centered on development. Thus, while the community benefits from the project through access to better earning opportunities, there are no services to address the needs of the minority sections, women or landless workers. The project unintentionally discriminates among the local population.

The project while providing many economic benefits to farmers doesn't necessarily change the social framework they operate in. Studies have pointed out that in many cases, sanchalaks are farmers from the forward communities and so members of the backward castes are not allowed to enter the house in which the eChoupal is located.

E-governance initiatives are underrepresented in the project. Part of the reason is ITC's hesitation to partner with governments given the uncertain quality of response. The whole initiative is completely dependent on ITC. All training provided to operators in handling the ICT tools are company specific. This doesn't automatically translate to making users self reliant.[17]

In the five ICT enabled development schemes discussed above, we note that the solutions were not as effective as intended for one or more of the following reasons:

(a) All of them required constant supervision and involvement by their project promoters. The schemes required making large capital investments as well as meeting continuous recurring expenses. Moreover, each of the schemes are identified with their promoters and the participants engage because of trust in the principle mover, not in the system itself. This has a significant bearing on sustainability, in that , should the promoter withdraw financial or technical support from a project at anytime, other participants may not step in to continue its functioning.[18]

(b) Networks though target at the local communities, don't seem to utilizing available social capital to expand networks. For instance ,in the eChoupal network, attempts of the program to undermine caste based discrimination were undermined as these did not flow from the community to the network IVRP has however demonstrated significant community involvement. Village elders were involved in setting up the different centers, and gender sensitizing efforts were successful.

(c) The effect of the interventions was more on the strong ties than on weak ones. Gyandoot focuses on a set of villages, eChoupal on farmers in designated regions and so on. Emphasis on strong ties tends to limit the variety and quality of information available on the network as ab initio the target audience is the designated 'information' poor. The interventions seem to have not had much of an effect on weak ties. The various review studies indicate that while all the ICT

[17] Theabove paragraph, shaded in grey also appear in page 41-46 of this Case folio.
[18] Theabove paragraph, shaded in grey also appear in page 47 of this Case folio.

projects provided rural participant s with email facilities, in most cases these services were among the least used.

(d) Creation of local content was a challenge faced commonly by all the projects. In IVRP, center operators actively collect and feed information from newspapers and the local villagers into the system. In other projects, the promoting agency undertook the responsibility to maintain repositories. While illiteracy and resource constraints are ostensibly the reason for this lack of transparency , it could also be an effect of weak social ties outside the local geography

To make an ICT intervention for development financially and socially sustainable, it is necessary to design a model where monitoring and continual support is not required. Instead, these functions are performed by the participants themselves, keeping the system more decentralized and flexible. A possible solution is the deployment of ICT for development incorporating several such characteristics using the Digital Ecosystem (DE) approach discussed in the next section.

4. The Digital Ecosystem Approach

The concept of a DE was first discussed in Europe as a response to how best the EU could assist the SMEs (Small and medium enterprises), traditionally the back bone of the European economy, to adopt ICT applications more effectively (Nachira et al, 2002). The emphasis on ICT as a driver of economic growth and business efficiency reflects Europe's experience in the mid 1990's when the sluggish EU labour productivity growth which could be 'attributed equally to lower investment per employee and to slowdown in the rate of technological progress' (Kok report, 2004) and that 'forty per cent of the productivity growth in the EU between 1995 and 2000 was due to ICT' [The EU Economy: 2003 Review,' COM (2003)]. Concerns arose as it became clear that SMEs, which constitute 99.7% of total enterprises in the EU-25, were not ready to use e-business tools and the Internet as intensively as their American counterparts.

These took a tangible manifestation at the Lisbon summit in March 2000, where EU representatives set the goal of 'becoming the world's most dynamic and competitive knowledge-based economy by 2010 and to address the issues if the digital divide in the adoption of Internet and e-business use' The digital ecosystems concept aims at fulfilling the Lisbon objectives by providing an innovative approach to support the adoption and development of ICT. This it does by helping SMEs accesses applications and services that are tailored to suit their local needs. The various components of the e-business system, provided by different organizations scattered around Europe or the World, are recombined and used to create situation specific solutions.

In simple terms, a DE is a web of interconnected and interdependent ICT enabled users who transact in the digital mode resulting in synergistic benefits for all. The strength of this system is that it enables a resilient, multi- user exchange relationship capable of adjusting to change. From applying the DE concept to the business system evolved the Digital Business ecosystem. Formally defined, Digital ecosystem describes a ICT enabled network that displays associative and autopieotic properties. In other words, not only is a so defined network capable of self sustenance, but also of expansion through heightened inclusion (i.e., increasing heterogeneity in the network composition) and growth (i.e., increase in the size and scope of the network).

The natural system metaphor, employed by several schools (Rothschild 1990; Moore 1997; Tapscott 2000; Power and Jerjian 2001) to describe the business system, gives us the digital business

ecosystem as a ‘digital’ environment populated by ‘digital species’ which could be software components, applications, services, knowledge, and ‘agents’ or the actors in this ecosystem.(individuals, SMEs, Governments). The agents use different digital species to formulate transactions with other agents. There interactions are all open and flexible – any agent can interact with other agents by joining the ecosystem and the interactions depend only on the actors.

The ecosystem environment encourages ‘loosely coupled’ ties – synchronous with our understanding of ‘weak’ ties or unstructured ties. This property allows information to disseminate throughout the ecosystem. This however does not mean a DE weakens or disregards strong ties. It simply allows actors from across the ecosystem to discover and pursue opportunities in areas of mutual. This domain clustering can happen within the same geography as well as across, and thus it preserves existing strong ties while encouraging more extensive weak ties Most importantly , the actors in a DE are expected to be self organising -independent, self-empowered, self-prepared and capable of survival without external aid or intervention. True to it’s biological antecedents, the design of a DE aims to mimic a natural ecosystem to encourage autopoiesis, whereby a system produces its own organization and maintains and constitutes itself in a space.

These properties extend from our definition, i.e., a system displaying these properties will automatically be associative and autopieotic. The DE phase was seen a logical progression in the process of IT integration in business (Dini, Nachira; 2004). A DE for a social system, while retaining the objectives and structure of a DBE, differs from it in the composition of the actors. There is more heterogeneity in a social system than business one and greater variations in actors abilities and resources to participate in the network. As seen in the case of rural ICT deployment, differences in participants are induced by social and economics factors (caste, income group), level of education and exposure and so on.

Also, while in a business system all actors are basically oriented towards profit maximization, in a social system, there are actors present whose behaviour is guided by altruistic goals, like NGOs or Governments. The vision of a DE as network that finally evolves into an ‘agents-based, loosely coupled, domain-specific and demand driven interactive communities which offer cost-effective digital services and value-creating activities that attract agents to participate and benefit from it’ (IEEE DEST 2008), makes it capable of accommodating these variations by encouraging the co-existence of different species. This description also underscores the critical importance of participation to the success of a DE – in terms of growth, sustainability and inclusion. Participation here refers to both content sharing and creation.

A DE is suitable to achieve the development goals of inclusion and growth, as it is capable of implementing ICT interventions engaging heterogeneous participants in a self generating, self validating and self-distributive content system fulfilling the requirements of both speed ad scope of sharing, because of the knowledge flows it generates. By involving a wider variety of actors, both organizations and individuals who may be geographically dispersed, and enabling access to key and reliable information, it stimulates production and delivery of goods and services. This is the property of technology that policy makers wish to harness in development projects.

Sustained growth and heightened inclusion are the keys to successful development .Thus it is essential that rather than make recipients of assistance dependent on the provider, the providers should create the right digital environment where recipients can exercise their choice on the nature

and extent of assistance they require. A big asset of a DE, in this context, is that it is intrinsically designed to be self sustaining.

A DE functions independently of the entry or exit of individual actors. This is achieved by functioning as a platform fostering various economic (business) and social networks involving a multiplicity of actors engaged in dynamic and amorphous interactions. There is no single entity guiding or directing activities and information flows. Instead, all actors share the responsibility of running the network, by sharing information, resources and interacting with others, making the system robust and less resource intensive in contrast to some of the other ICT implementations discussed earlier.

5. Challenges in Developing a Digital Ecosystem

Having proposed the DE as a model for sustainable development, there is a need to assess the feasibility of its implementation. Evolving a DE is neither a purely social nor a technical process-the right technical systems have to be developed while simultaneously mapping relationships between the different actors. When the attempt is to evolve a DE from an existing social network, the actors have to be in a sense 'won over' into trying out the new system for it to be sustainable. Similarly, the DE will have to absorb current structures in some places while discarding them in others, like in the case of the Bhoomi project – where the use of ICT has changed the service delivery pattern, but retained the same power structure. Any proposed ecosystem, regardless of the sector it is operating in, would have three key actors:

(a) The members actively engaged in the specific sector. In an agricultural ecosystem, for instance, the community would include farmers, traders, input vendors etc.

(b) Research and innovation centers like universities.

(c) The local government and public administration.

ICT applications in the rural set- up have found that participation by the users , such as farmers (called member nodes) tends to be lesser than the desirable level, as highlighted in the previous section This could cause distortions in the results obtained from the network.

At a technical level, a DE is a computer network which operated a knowledge sharing system on it. Multiple computers are connected together using a telecommunication system for the purpose of communicating and sharing resources. The choice of network architecture is determined by the objective of enabling content creation and sharing. Previous studies have shown that a centralized network is ineffective for knowledge sharing (Fahey and Prusak, 1998; Markus, 2001) as it is resource intensive, error prone and more crucially, does not potentially encourage re-deployment of the stored content. The best solution for effective content creation and sharing is a decentralized network supported by peer-to-peer (P2P) technology. Peer-to-Peer network is defined as a collection of heterogeneous distributed resources which are connected by a network (S. Wray; T. Glauert et al 1994) where the participants share a part of their own hardware resources (processing power, storage capacity, network link capacity, printers) necessary to providing the service and content offered by the network which are accessible by other peers directly, without passing intermediary entities (W. Kellerer, 1998).

This network architecture enables a non resource intensive, decentralized knowledge sharing system on which load on each participant or node is balanced, so that the workload of a dedicated group of knowledge producers can be dramatically reduced (Parameswaran et al., 2001). Abstracting a DE for development to a P2P network , we could subdivide the participants (nodes) into two classes : Correct Nodes or nodes that participate in the network to their fullest potential (confirm to the anticipated level) and in accordance with the role specified for them ; and Faulty nodes or nodes that deviate from the anticipated behaviour – in terms of participation. Differences in terms of size of members, access to resources and individual capacity could result in the existence of faulty nodes.

For example, bounded rationality – where a node that is constrained by communication or capability limits may fail to pick up the best strategy that maximizes its expected utility or the free-riding problem - where a node benefits from content access but opts not to contribute to the group's common welfare by not adding to the information pool.

Policy makers and experts are aware of both these problems. The assumption has been that when resource constraints are removed (requisite infrastructure, superior internet connectivity) and the nodes have evolved through sufficient training and skill enhancement, these problems recede on their own. Additionally, with the growth of the network, a node would be motivated to participate and contribute knowledge if confident that 'one will subsequently receive useful help in return, increasing of reputation and status through contribution' (Kollock 1999). Given these constraints, implementing a DE for development using a pure P2P would not be effective, and thus a modified (or Hybrid) P2P structure is suggested. Hybrid Peer-to-Peer network is one which requires a central entity to provide parts of the offered network services. Hybrid P2P networks differ from the centralized networks discussed earlier because the feature of the nodes to share resources is substantial in 'Hybrid' P2P networks (Schollmeier 2002). The slack in the system caused by the faulty nodes is taken up by a moderating node. This node takes up two critical activities:

Content creation: Gathering and codifying content and sharing it on the network. Here we define content as both information and knowledge. Information can be defined as 'organized data' (Saint-Onge 2002) or as 'data endowed with relevance and purpose' (Drucker 2001) while knowledge can be defined as a mix of fluid experiences, values, contextual information and intuition that provides a structure to evaluate and incorporate new experiences and information (Davenport & Prusak 1998). Both these components are crucial to decision making and the network is capable of supporting both. For instance, in DEALS – a rural agricultural network initiative, a tool called the 'Kisan Blog' feature contains the experiences recorded by members with respect to practical applications – grade of seeds, fertilizer or pesticides used etc (www.dealindia.org).

Verification: authenticating the information shared on the network by other nodes. Normally, in a fully functional DE, any erroneous information would be flagged by the nodes that notice the discrepancy. Another solution in a P2P is clearly indicated authorship (Kung 2003).Members can evaluate the information provided by various contributors and decide to trust certain sources given their past experience. These are not yet feasible solutions in a rural system In addition; the moderating node may also provide direction by introducing new services/schemes aimed at making the network more attractive to others, thus encouraging growth and greater inclusion.

5.1. Moderated Networks

A review of various ICT based projects reveals that there are three types of service on offer (Enabling ICT for India report, 2004):

(a) Informational services disseminate generic (non-customized) information, such as agricultural practices, weather forecasts, and contact information.

(b) Transactional services involve an exchange of specific (or customized) informational services or funds between two or more parties using the ICT infrastructure. Examples include e-commerce and email.

(c) E-Governance services refer to transactional services that involve local, state, or national government. Providing land records, submitting complaints to local officials, and confirming a user's presence on electoral rolls are examples.

E-Governance initiatives in which the respective agencies are primary drivers of the network, with all other service providers would be incidental has inbuilt centrality and precludes the possibility of other participants load sharing along the network.

Information and Transaction based services, on the other hand, are amenable to a DE deployment on two counts. One, the nature of services encourages multiple sources. The presence of more providers in the network signals competition and would in fact improve the quality and accuracy of information and services provided. Second, a DE makes collaboration between nodes easier and helps customize content for local consumption: a service feature which needs decentralized information flow along the network.

While a moderating central node is needed in the 'e-championship' stage, in the long run, persistence of the central node may stifle development and sustenance of a network providing informational or transactional services. In the initial stages however, there is need for a central node to deal with the content creation and validation problems discussed earlier. For the network to function the node must be acceptable to all other participants; must inspire trust. The positive role of trust in networks supporting economic exchanges has been of considerable interest to researchers and policy makers alike (Ees and Bachmann 2006). Trust stimulates economic investment and growth (Knack and Keefer 1997) while strengthening sustainability (Owen and Videras 2007).

An actor taking up the position of a central node must give other participants confidence to be part of the network. The government is thus a good choice as it is an agency which all other nodes will trust given its non competitive nature. Another function of the network is to stimulate weak ties. More members across geographies associating with a DE widen the access of members to information. As the network develops and moves to a more P2P setup, more sophisticated reputation management systems develop (Kollock 1999; Keser 2002). At this stage, if a moderating node persists, it interferes with the formation of weak ties by limiting scope of network to its own capacity and increasing dependence. The purpose of a digital ecosystem framework is defeated when sustainability is undermined if other nodes do not have enough initiative or expertise to take on this role.

Having discussed in detail the modalities and challenges of a DE based deployment of development initiative, we now illustrate how such a DE can be developed in rural agriculture through the case of the DEAL project.

6. The DEAL Project: Prototype for a Development DE

The role of information and consequently of ICT in Indian agriculture gained significance with increasing acceptance of agricultural extension as a key input to increasing agricultural efficiency and productivity. The goal of extension (Van den Ban and Hawkins 1996) is to stimulate desirable agricultural developments by transferring knowledge from researchers to farmers and empowering the farmers to take decisions.

By focusing on building competencies of farmers, this approach is capable of initiating a bottom-up and more robust improvement in agricultural practices. The generic problem with extension projects is in ensuring sustainability. Given that much of the information disseminated by extension is a 'public good'[19] and that dissemination costs are not easily recoverable from individuals, there is generally a dependence on public funding to support these projects (Feder, Willett, and Zijp 1999). Motivating participating actors to contribute content to a knowledge network and evolving peer review mechanisms for assimilated content are other challenges. Review and validation is especially important in an agricultural context given the risks associated with following incorrect information.

A greater challenge, however, is to get communities to adopt and benefit from the improved agricultural techniques made available to them. This is where the role played by social capital is invaluable. Successful adoption of new technologies requires collective action and co-operation, which social capital helps secure. Research indicates that in the Indian rural agriculture sector social capital is pivotal in mobilizing resources and bringing about market unsupported outcomes. This phenomenon has been documented in case of new seed and production technology adoption, as well disseminating of this information to other rural communities, in the absence of official channels (Parthasarathy and Chopde 1999). Thus, a meaningful ICT enabled project must aim to provide both extension and social capital augmenting services through the electronic medium. The DEAL (Digital ecosystem for Agriculture and Livelihood) project is a step in towards addressing these issues by assembling a technology enhanced agricultural extension intervention in a DE framework.

Conceived by IIT K and Media Lab Asia, DEAL is a ICT enhanced network built on an existing framework of tele-centers in rural institutes, village schools and Krishi Vigyan Kendras (KVKs) and other deployment partners. The project aims to create a digital knowledge base by involving the various actors in the existing system in the content creation process and making this knowledge accessible to farmers and other agricultural practitioners. The uniqueness of this initiative is in the attempt to make the entire process of content creation and dissemination self generating, node independent and self sustaining using the electronic medium. With the infrastructure already in place, the challenge is to use ICT tools to collect and disseminate relevant local content by enabling critical information flows between partners and create a user friendly interface that would make the network more accessible. The intended content creation process in DEAL can be depicted as follows:

[19] Stiglitz (World Bank) have used general theory of pure public goods developed by Samuelson and extended it to the concept of Global Public Goods (GPG). GPG are said to have the properties of pure public goods (non-rivalrous and non-excludable) but are universal by nature. Knowledge was identified as a GPG.

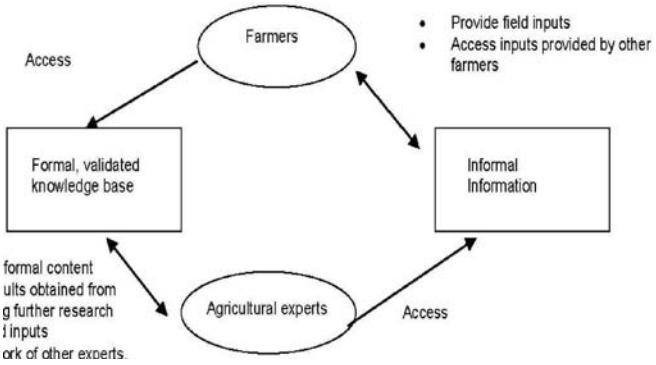
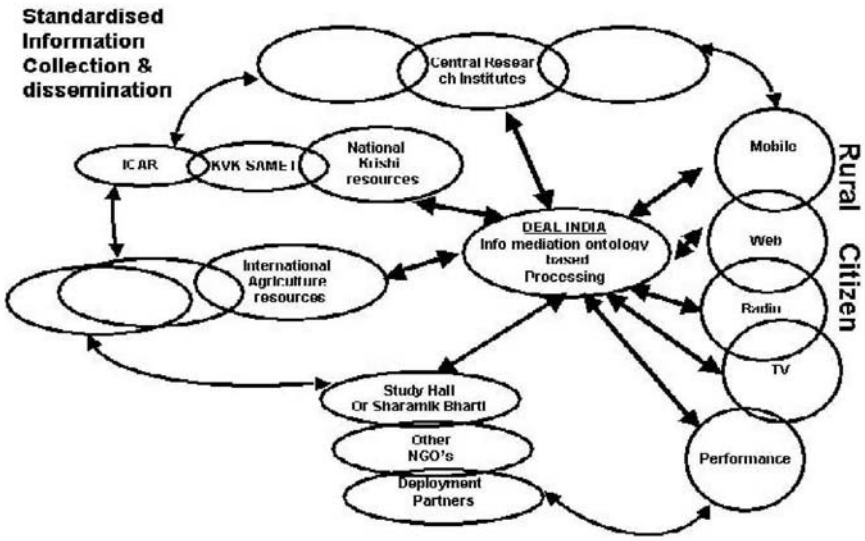


Figure 1: Intended content creation process

The key to evolving a sustainable content creation loop is to give currency to the information that is contributed by members. In this case, agricultural experts have an incentive to share their research results and update the database, if they are able to avail of field inputs from farmer which is difficult and time consuming to obtain on their own. Given below is the schema of the conceptual architecture



for a knowledge network:

Figure 2: Conceptual Architecture of Knowledge-Net[20]
Source: Chatterjee and Prabakhar (2005)

Thus, when members rationale for participation is satisfied by the network objectives, there can evolve an autopiotic and associative network that is capable of delivering the benefits of agricultural extension to its members. The moderating node in this system is IIT Kanpur- providing the basic infrastructure, skills and resources to assist knowledge flows through the network. Diverse set of

[20] Theabove Figure 2 shaded in grey (title) also appears in pages 23 and 32 of this Case folio.

actors are involved; Government agencies, agricultural experts, educational institutions, NGOs. The presence of Government agencies helps build trust in the network. The agricultural experts and educational institutions are responsible for verification of content generated.

The moderating node provides hosting and training services, while also co-coordinating the content assimilation from different participants. Linking together all the actors in dynamic relationships helps retain both strong and weak ties. The links between agricultural experts within the same KVK or bureaucrats within the same organization are examples of strong ties, like links between KVKs, and those between KVKs and NGOs are examples of weak ties. By keeping the structure loosely coupled, DEAL facilitates direct interactions between the nodes, and this in turn aids transparency as all nodes can access the information lodged with others. The vision of DEAL is to become a dynamic knowledge repository – language and medium independent, with in built interoperability. Greater interoperability increases ease of content creation and assimilation. The moderating node will be gradually phased out with the responsibility for sustaining the network becoming distributed.

7. Conclusion

There has been growing consensus that information technology is fast becoming as essential as education, health etc. The rationale behind ICT gaining importance in developmental projects is that it contributes significantly to the accretion in human wellness by enabling economically and socially marginalized sections to exercise their right of choice. This is demonstrated in the design of the various ICT initiatives aimed at eliciting community participation. The role of community, not just as the recipient of technology based solutions, but also a affective element was examined by a elaborate discussion social capital and social embeddedness of economic transactions as well as technological innovations. The need for a new code ethics in this context and the emergence of information ethics was then touched upon. A brief review of select ICT projects in India indicated that while there are tangible benefits to the community from these, overall success is limited because lack of sustainability and low penetration. Given the financial and structural constraints, the concept of a digital ecosystem was put forward and its suitability as possible ICT delivery system was discussed. The establishment of a DE as a network of flows building a self generating and a self sustaining knowledge ecosystem promoting rapid diffusion, absorption and creation of relevant content for local communities was examined in some theoretical detail. Possible challenges in developing such a system were identified. The impact of involving the an actor, either Government, private entity or otherwise, as a trust inducing actor in the initial setting up of the ecosystem and the subsequent phasing down of its importance in the framework was debated on. Finally, the DEAL project model was presented as an illustration of the digital ecosystem framework, highlighting the transformed information flows and its beneficial effect on the various actors as envisioned by the project.

References

Bell, T. (2006). Village computing: A state of the field reflections on the village computing consultation. Grameen Foundation. Last accessed July 14, 2008, Available from INTERNET: http://www.villagecomputing.org/docs/A_State_of_the_Field.pdf.

Ben-Porath, Y. (1980). The F-connection: Families, friends, and firms and the organization of exchange. *Population and Development Review* 6, no.1: 1-30.

Bhatnagar, S. (2004). E-Government: From vision to implementation. New Delhi: Sage Publications.

Bhatnagar, S., and Chawla, R. (2005). Bhoomi: Online delivery of record of Rights, Tenancy and Cultivation to farmers in Karnataka. In W. Habibullah and M. Ahuja (Eds.), *Land Reforms in India - Computerization of Land Records* (pp. 47-77). New Delhi: Sage Publications.

Bhatnagar, S., and Patel, N. (1988). Decentralized computer for rural development. *Omega* 16, no.l: 165-170.

Bhatnagar, S. and R. Schware (Eds.) (2000) Information *and communication technology in development.*New Delhi: Sage.

Bhatnagar, S., and Vyas, N. (2001). Gyandoot: Community-owned rural intranet kiosks, E-Government Case Studies. Last Acessed July 14, 2008, from INTERNET: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/EXTEGOVERNMENT/0,,contentMDK:20486032~menuPK:1767268~pagePK:210058~piPK:210062~theSitePK:702586,00.html..

Butcher, S. (2003). Social capital in economics: Why social capital does not mean the end of ideology. *The Drawing Board: An australian Review of Public Affairs* 3, no.3: 181-203.

Cecchini, S., and Raina, M. (2004). Electronic government and the rural poor: The case of Gyandoot. *Information Technologies and International Development* 2(2): 65–75. Last Acessed July14, 2008, from INTERNET: http://www.mitpressjournals.org/doi/abs/10.1162/1544752044193434.

Cecchini, S. and Prennushi, G. (2002). Using information and communications technology to reduce poverty in Rural India. *World Bank PREM Notes.*1-4.

Centre for Electronic Governance, Indian Institute of Management, Ahmedabad (CEG-IIMA). (2002). Gyandoot: Rural cybercafes on Intranet. Dhar, Madhya Pradesh, India. A Cost-benefit evaluation study. Last Acessed July 14, 2008, from INTERNET: http://www.iimahd.ernet.in/egov/documents/gyandoot-evaluation.pdf.

Chatterjee, J. and Prabhakar, T. V. (2005). On to action - Building a digital ecosystem for knowledge diffusion in rural India. Proceedings of the 2005 International Conference on Knowledge Management, North Carolina, USA. Last acessed July 14, 2008, from INTERNET: www.cse.iitk.ac.in/users/tvp/papers/vof_pasadena.pdf.

Coleman, J.S. (1988). Social Capital in the creation of human capital. *The American Journal of Sociology* (Supplement 1): 95-120.

Dini, P., and Nachira, F. (2005). The paradigm of structural coupling in digital ecosystems. Last Acessed July 14, 2008, from INTERNET: www.nachira.net/franz/**Structural_Coupling_**s.pdf.

Dini, P., et.al. (2005). The digital ecosystems research vision: 2010 and beyond. Last Acessed July 14, 2008, from INTERNET: www.digital-ecosystems.org/events/2005.05/de_position_paper_vf.pdf.

Dossani, R, Misra, D.C. and Jhaveri, R (2005). *Enabling ICT for rural India.* Asia Pacific Research Center, Stanford University and National Informatics Centre. Last Acessed July 14, 2008, from INTERNET: http://iis-db.stanford.edu/pubs/20972/ICT_full_Oct05.pdf

Dreze, Jean, and Sen, Amartya, (Eds). (1997). *Indian development: Selected regional perspectives*. New Delhi: Oxford University Press.

Ees, H.V., and Bachmann, R. (2006). Transition economies and trust building: A network perspective on EU enlargement. *Cambridge Journal of Economics* 30, no.6: 923-939.

European Commission. (2003). European economy 2003 review.Luxemberg: Official Publication of EC. Last Acessed July 14, 2008, from INTERNET: http://ec.europa.eu/economy_finance/publications/publication7694_en.pdf.

Fahey, L. and Prusak, L. (1998). The eleven deadliest sins of knowledge management. *California Management Review* 40, no.3: 265-276.

Feder, Gershon, Willett, Anthony and Zijp, Willem. (1999). Agricultural extension: Generic challenges and some ingredients for solutions. World Bank Policy Research Working Paper No. 2129. Last Acessed July 14, 2008, from INTERNET: SSRN: http://ssrn.com/abstract=620481.

Floridi, Luciano, and, J. W. Sanders, J.W. (2004). On the morality of artificial agents. *Minds and Machines*.14, n0.3: 349-379.

Garai, A., and Shadrach, B. (2006). Taking ICT to every Indian village: Opportunites and challenges. Last Acessed July 14, 2008, from INTERNET: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID897910_code509287.pdf?abstract_id=897910 &mirid=1

Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory* 1: 201-233.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *The American Journal of Sociology* 91, no.3: 481-510.

Grover, V. and T.H. Davenport, T. H. (2001). General perspectives on knowledge management: Fostering a research agenda. *Journal of Management Information Systems* 18, no.1: 5-21.

Gustavo, Esteva and Prakash, M. S. (1998). Beyond development, What? *Development in Practice* 8, no.3.

Heeks, R., (2005). ICTs and the MDGs: On the wrong track? In Development Studies Association Conference. University of Manchester, UK.

Hongladarom, S. (2004). Making information transparent as a means to close the global digital divide. *Minds and Machines* 14: 85-99.

Huener L, von Krogh, G, and Roos J. (1998). Knowledge and concept of trust. In G. von Krogh, J. Roos, and D. Kleine (Eds.), *Knowing in firms, Understanding, Managing and Measuring Knowledge.* London: Sage Publications.

Illich, Ivan. (1973). Tools for conviviality. Last Acessed July 14, 2008, from INTERNET: http://opencollector.org/history/homebrew/tools.html.

Institute of Information Technology (2005). Information and Communications Technologies for Development: A Comparative Analysis of Impacts and Costs from India. Bangalore: International Institute of Information Technology. Last Acessed July 14, 2008, from INTERNET: http://www.iiitb.ac.in/Complete_report.pdf.

Keniston, K., and Kumar, D. (Eds.) (2004). IT experience in India: Bridging the digital divide. New Delhi: Sage Publications.

Koert, R.V. (2000) Providing content and facilitating social change: Electronic media in rural development based on case material from Peru. *First Monday* 5, no.2.

Krishnan, R., Smith, M. D, and R. Telang, R. (2003). The economics of peer-to-peer networks. *Journal of Information Technology Theory and Application* 5, no.3: 31-44.

Kwok, J. S. H., and Gao, S. (2004). Knowledge sharing community in P2P network: A study of motivational perspective. *Journal of Knowledge Management* 8, no.1: 94-102.

Latouche, Serge. (1997). Paradoxical Growth. In Majid Rahnema and Victoria Bawtree (Eds.), *The Post-Development Reader*. London: Zed Books.

Latouche, Serge. (1996). *The westernisation of the world.* Cambridge, United Kingdom: Polity Press.

Latouche, Serge. (1993). *In the wake of an affluent society: An exploration of post-development*. London: Zed Books.

Lobo, Albert, and Balkrishnan, S. (2002). Report card on service of Bhoomi Kiosks: An assessment of benefits by users of the computerized land records system in Karnataka. Bangalore: Public Affairs Centre. Last Acessed July 14, 2008, from INTERNET: http://www1.worldbank.org/publicsector/bnpp/Bhoomi.pdf.

Markus, M. L. (2001). Toward a theory of knowledge reuse: Types of knowledge reuse situations and factors in reuse success. *Journal of Management Information Systems* 18, no.1: 57-93.

Matthew O. Jackson, A.W., (1996) A Strategic Model of Social and Economic Networks. Journal of Economic theory 71: 44-74.

Nachira, Francesco, et al. (2002). Towards a network of digital business ecosystems fostering the local development (Discussion paper). Last Acessed July 14, 2008, Available from INTERNET: http://www.digital-ecosystems.org/doc/discussionpaper.pdf.

Owen, A. L. and J. Videras, J. (2007). Trust, cooperation, and implementation of sustainability programs: The case of local agenda 21.Last Acessed July 14, 2008, from INTERNET: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID976074-code1908.pdf?abstract_id=976074&mirid=1.

Parameswaran, M., Susarla, A., and Whinston, A. B. (2001). P2P networking : An information sharing alternative. *Compute* 34, no.7: 31-38.

Parthasarathy, D., and Chopde V. K. (n.d.) Building social capital: Collective action, adoption of agricultural innovations, and poverty reduction in the Indian Semi-Arid Tropics.Paper for the research theme 'Escaping Poverty'. Last Acessed July 14, 2008, from INTERNET: http://www.gdnet.org/pdf/776_D.pdf.

PriceWaterhouseCoopers. (2004). Rethinking the European ICT agenda: Ten ICT-breakthroughs for reaching Lisbon goals. Ministry of Economic Affairs, The Netherlands: The Hague.Last Acessed July 14, 2008, from INTERNET: http://ec.europa.eu/information_society/eeurope/i2010/docs/events/rethinking_the_european_ict_agenda.pdf

Rajora, R. (2002). *Bridging the Digital Divide*. New Delhi: Tata- McGraw Hill.

Rothschild, M. (1990). *Bionomics: Economy as ecosystem.* Salt Lake City, UT: Henry Holt and Company.

Sabatini, F. (2005). The role of social capital in economic Development: Investigating the causal nexus through structural equations models. 2005. Last Acessed July 14, 2008, from INTERNET: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID901361-code492973.pdf?abstract_id=901361&mirid=1.

Schollmeier, R. A. (2001). Definition of Peer-to-Peer networking for the classification of Peer-to-Peer architectures and applications. *Proceedings of the First International Conference on Peer-to-Peer Computing (P2P'01)*. Washington, DC: IEEE Computer Society.

Sen, A. (1997). Maximization and the act of choice. *Econometrica* 65, no. 4: 745-779.

Sen, A. (1999). *Development as freedom*. New Delhi: Oxford University Press.

Simon, H. (1957). *Models of man*. New York: Wiley.

Smith, M., and Kollock, P. (Eds.) (1999) *Communities in cyberspace*. London: Routledge.

Sood, A. D. How to wire rural India? A survey of the problems and possibilities of digital development. *Economic and Political Weekly*, 35, no.43.

UNDP. (2001*). Making new technologies work for human development*, Human Development Report. New York: Oxford University Press.

Woolcock, M. (1998). Social capital and economic development: Toward a theoretical synthesis and policy framework. *Theory and Society* 27: 151-208.

5

The Impact of DEAL on Community Networks: A Case Review

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Abstract: The DEAL (Digital Ecosystem for Agriculture and Livelihood) project is a step towards addressing issues related to designing an ICT intervention that leads to sustainable development. This paper studies the impact of DEAL on existing community networks in the field agricultural extension in rural areas around Kanpur. We find that while DEAL has not led to a rapid expansion of the network, it has successfully deepened ties and created new weak links between existing actors. As a result, it is expected that this intervention would positively affect social capital and lead to the formation of a digital ecosystem in the agricultural knowledge domain.

Keywords- Digital Ecosystem, Weak links, Community Networks, Agriculture

1. The DE Approach in a Community Network: the Case of the DEAL

The DEAL (Digital Ecosystem for Agriculture and Livelihood) project is a step in towards addressing related to designing an ICT intervention that leads to sustainable development by assembling a technology enhanced agricultural extension intervention in a DE framework. Conceived by IIT K and funded by Media Lab Asia, DEAL is an ICT enhanced network built on an existing framework of tele-centers in rural institutes, village schools, village level agriculture extension centers (KVKs) and other deployment partners.

The project aims to create a digital knowledge base by involving the various actors in the existing system in the content creation process and making this knowledge accessible to farmers and other agricultural practitioners. The entire process of content creation and dissemination is capable of self generation, node independence and self-sustainability using an electronic medium. The moderating node in this system is IIT Kanpur providing the collaboration and collation technology platform, skills and resources to assist knowledge flows through the network. The presence of Government agencies helps build trust in the network. The agricultural experts and educational institutions are responsible for verification of content generated.

Field deployment of the DEAL project was between December 2006 and June 2007. Following this, a study was conducted at 4 KVKs in September 2007, to assess the effect DEAL has had on information flows. A total of 20 agricultural scientists from across KVKs and 5 project team members from IIT Kanpur were interviewed. We elicited responses from actors how exposure and use of different facets of the DEAL project altered their relationships with existing nodes, or if there

was a deletion/addition of new nodes. Each KVK scientist were asked to describe the existing links each KVK had with different actors in the extension system, and how they viewed the potential of the DEAL in enhancing their access to information flows in the network. The questions about DEAL were open ended and unbiased, and respondents were encouraged to give their honest impressions and opinions about the project, its strengths and weaknesses, the potential for forming new associations, the benefits thereof and lacunae in implementation. Table 1 lists the members who are part of the network (actors), both before and after the DEAL intervention with their respective role.

Table 1: Participating Nodes

NODE	ROLE PLAYED
ICAR	Government Body
ICDS	Government Body
ICRISAT	Research Institute
IIPR	Research Institute
NSI	Research Institute
CSA	Educational Institution
NDU	Educational Institution
ZCU	Zonal Co-ordination Body
KVK(P)	KVK (agricultural extension centres)
KVK(D)	KVK
KVK(R)	KVK
KVK(K)	KVK
SAC(P)	Scientific Advisory Committee
SAC(D)	Scientific Advisory Committee
SAC(R)	Scientific Advisory Committee
SAC(K)	Scientific Advisory Committee
ZF1	Zilla (Ditrict) Line Functionaries
ZF2	Zilla Line Functionaries
ZF3	Zilla Line Functionaries
ZF4	Zilla Line Functionaries
IITK	Educational Institution
PNU	Educational Institution
Fr1	Farmers
Fr2	Farmers
Fr3	Farmers
Fr4	Farmers
KV1	Kisan Vidyalaya (village school)
KV3	Kisan Vidyalaya
KV4	Kisan Vidyalaya
Pvt	NGO
NBFGR	Research Institute
BK	Bank

The following network diagram, prepared in Net Draw, represents the ties that were present before the implementation of DEAL.

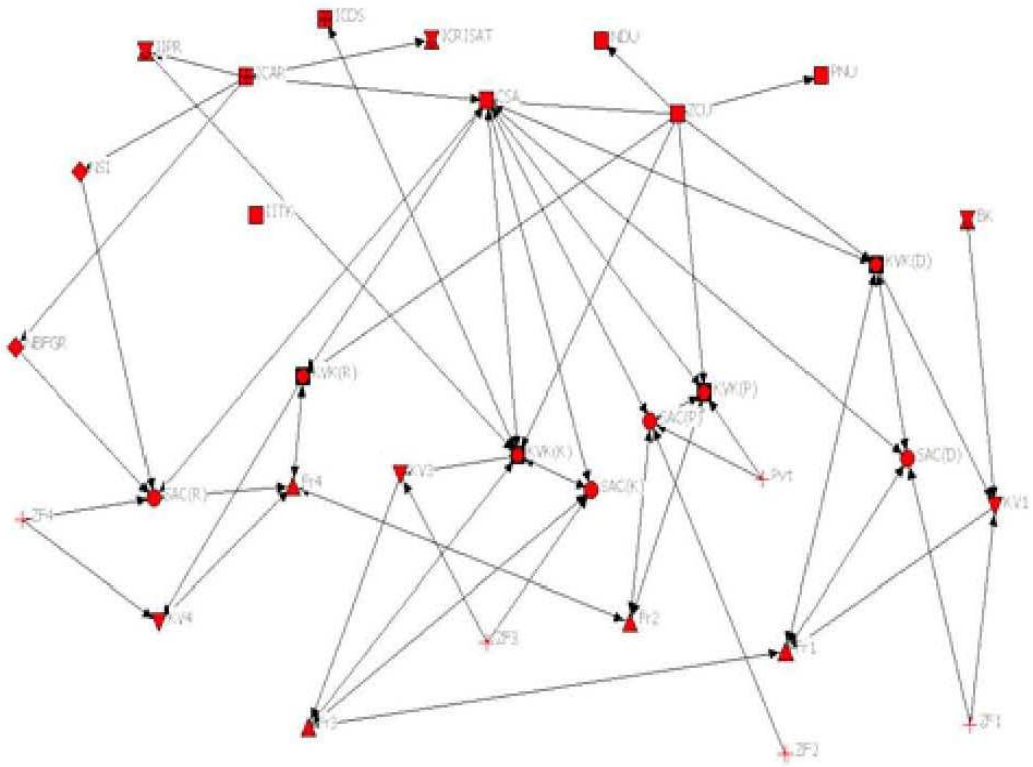

Figure 1: Network Ties before DEAL[21]

The shapes of actors in the network are based on their role, i.e. KVKs, Research Institutes, Government agencies, etc. The thickness of lines between agricultural experts within the same KVK, or between a farmer and his respective KVK are examples of strong ties, while links between KVKs and NGOs are examples of weak ties. In the course of the analysis, we refer to preexisting structure based links that individual nodes supply information to or draw information from (or both), as the 'strong ties.' By this definition, all links sanctioned by the structural framework of the agricultural extension system can be denoted as strong links. However in practice, most of these channels are too infrequently used by nodes to be significant.

To tighten our definition of strong ties, the agricultural scientists at each KVK were asked to indicate which of the available structural links were mandatory. Apart from that, they were asked to list the nodes in the said network that they had received information inputs from. In theory, though all KVKs can, by the extension structure, seek the help or advice of any national research or educational institute that are in the same zone, through the Zonal co-ordination unit. Thus, the potential for extended links is inherent in the system, but without frequent use these remain links only on paper. For instance, IIPR is linked to all the KVKs through the Zonal coordination unit, but only one KVK (at Daleep Nagar) has directly consulted with experts from the institute. Similarly, there exist links between the KVKs and educational institutes like PNU and NDU, but these links are more or less dormant.

The network shows the information flows within and across community. Here, the community is understood in terms of the village unit. So, within community linkages are those between actors in

[21] Theabove Figure 1 shaded in grey (title) also appears in page 48 of this Case folio.

the same village – for e.g.; between the farmer of a village and the respective village KVK while across groups' links includes links between actors from different villages – like the link between farmers of different villages.

By the strata of operations classification, information flows between members of the same functional role also qualify– IITK is a member of the educational institutions group, KVKs are part of the villages' level functionaries, and the ZCU, ICAR are all implantation and monitoring agencies. In this above network diagram, we have represented the different sources of agricultural information and the interrelations, both formal and informal, between them. Formal links are characteristic of the reporting relationship between actors – for instance, in the case of a KVK and the ZCU (Zonal Co-ordination Unit), and informal links are characteristic of the social relations between actors – like relations between farmers of adjoining villages.

We can characterize the reporting relationships between members into different layers – administrative, academic and functional. One observation here is that while there are well established and clearly defined relationships between members from the different layers, there are very few formal ties between the members of the same layer. For example, the relationship between the ZCU and a KVK, or between a KVK and farmer close and well directed, but there exist no direct links between the 4 KVKs. Communication is routed through the ZCU, and is conducted face to face at periodic zonal meetings.

Table 2: Explanatory Note

ICAR	INDIAN COUNCIL OF AGRICULTURAL RESEARCH
ICDS	Integrated Child Development Services
ICRISAT	International Crops Research Institute for the Semi-Arid Tropics
IIPR	Indian Institute of Pulses research
NSI	National sugar Institute
CSA	Chandra Shekar Azad Agricultural University
NDU	Educational Institution
ZCU	Zonal Co-ordination Body
KVK	Krishi Vigyan Kendra
KVK(P)	KVK at Pratapgar
KVK(D)	KVK at Dileepnagar
KVK(R)	KVK at Rae Barelli
KVK(K)	KVK at Kannauj
SAC(P)	Scientific Advisory Committee
IITK	Indian Institute of Technology Kanpur
PNU	Pant Nagar Agricultural University
KV1	Kisan Vidyalaya
NBFGR	National Bureau of Fish Genetic Resources

Fig 2 represents the ties after implementation of the DEAL project. As is evident, IITK is the only completely new actor introduced into the framework. Its integration into the network is represented by the arrows between it and other nodes, signifying an increase in information flows.

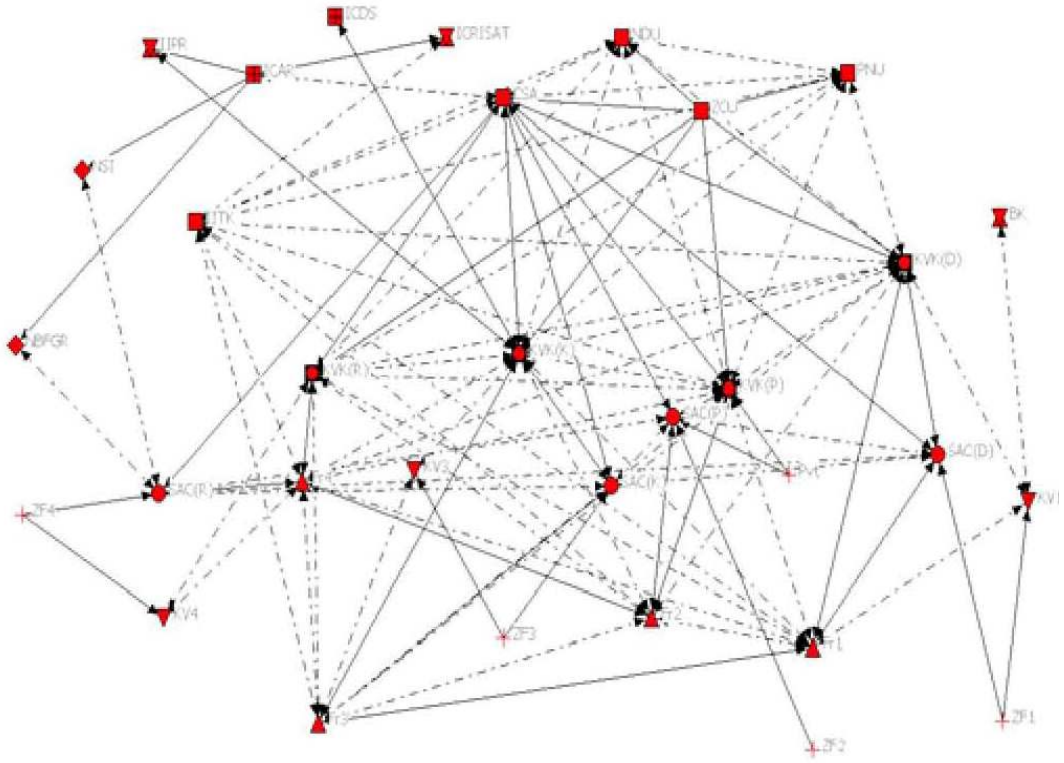

Figure 2: Network Ties post DEAL[22]

The dotted lines represent ties that have been formed due to content co-creation and sharing by partners facilitated by IITK through DEAL, while the solid lines represent the preexisting network ties. By implication, ties formed through DEAL are mostly weak links. These are voluntary clusters of members who are from different groups.

Groups in the network can be understood at 2 levels – one, at the geographic level, which consists of members of different types (farmer, KVK , research institute) at a specific location , and the other is related to functional relationships. These could include academic ties, administrative reporting relationships (financial flows) or operational ties, for example, between KVKs. Linking together all the actors in dynamic relationships helps retain both strong and weak ties. We present here salient results[2] from the analysis done using Ucinet[3]. The total number of ties increased from 77 to 183, and no old ties were displaced. No old actors in the network were deleted after implementing the DEAL, while only one completely new node (IITK, the implementer) was added. What was observed was that several weak links were introduced between existing nodes, signifying greater interaction (and hence innovation), and a deepening of community relations. Thus, the ICT intervention has led to the enhancement of social capital (Granovetter, 1985, Coleman, 1988)

[22] Theabove Figure 2 shaded in grey (title) also appears in page 49 of this Case folio.

Another indicator of this increased interaction is the group reciprocity measures increasing from 0.3585 to 0.7745 from the pre DEAL to the post Deal scenario. Figures 3 and 4 depict the state of reciprocal ties between members across different layers. The red lines denote reciprocal ties and the blue lines the non reciprocal ties.[23]

In the pre-DEAL scenario, except for the informal links between farmers of neighboring villages, the other links represented in the network are structurally determined. There are very few reciprocal ties between members of the same layer – for instance, the links between PNU and IIPR are both indirect and non-reciprocal. This lack of reciprocity across layers reflects the top-down nature of the reporting ties between actors from different layers – like in the relationship between the ZCU and a KVK. While a top-down approach is time and cost effective for information[24] dissemination, in an extension setup it causes the network to become more centralized.

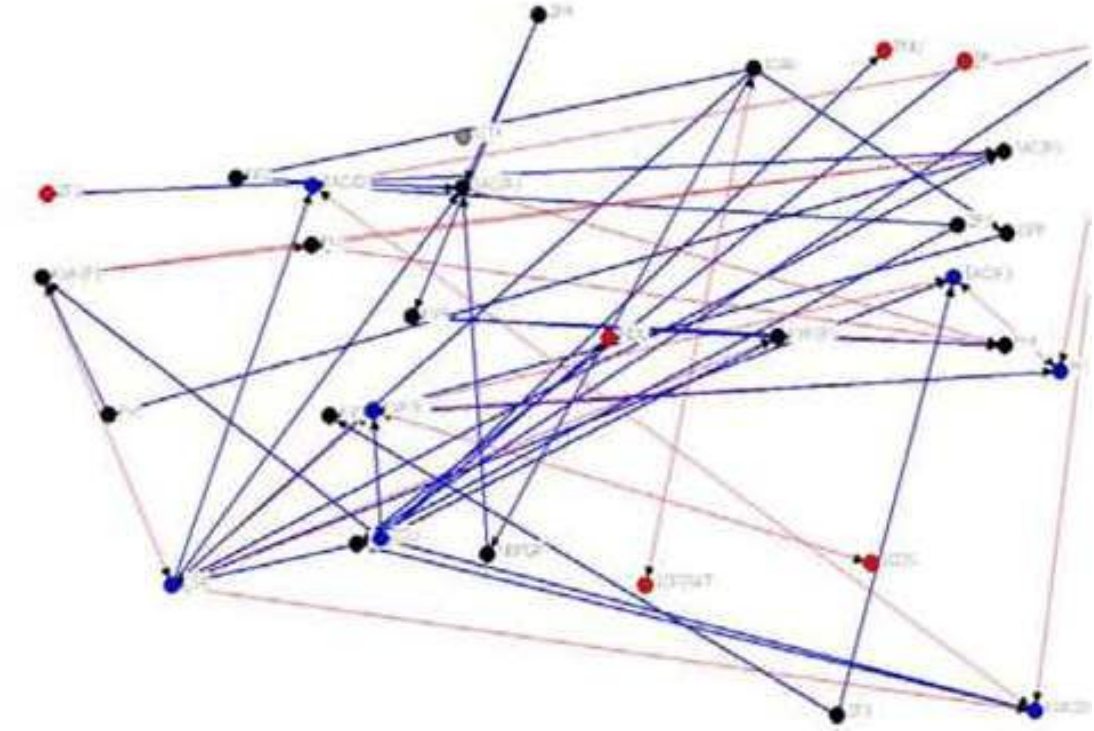

Figure 3: Reciprocal Ties pre DEAL

However, studies in network architectures have shown that a centralized network is ineffective for knowledge sharing (Fahey and Prusak, 1998; Markus, 2001) as it is resource intensive, error prone and more crucially, does not potentially encourage re-deployment of the stored content. In the Indian context, with the Government reducing public investment in agricultural extension as well as privatizing its input system, there is a need to make extension and the overall technology transfer system more demand-driven and responsive to farmer needs. To achieve this, a more bottom-up

[23] Theabove paragraph, shaded in grey also appear in pages 49-50 of this Case folio.
[24] The term information rerfers to verified data sets stored for further use. Knowledge involves a subjectivity understanding of information. However for practical purposes in this case folio both have been used interchangeably.

approach is needed which empowers farmers and allows them to more effectively articulate their problems and needs to the research-extension system.

This is an issue that the DEAL aims to assess by providing opportunities for weak ties formation. The DE design of the system places special emphasis on voluntary participation, and as more members access the network the number of weak ties increases, and as these ties are mutual and voluntary, the reciprocal ties between the members of the same layer are positively affected. Figure 4 shows the reciprocal ties that have developed after the implementation of DEAL. Here again, the red lines denote reciprocal ties and the blue, non reciprocal ties. Details of study available at IITK Deal site.

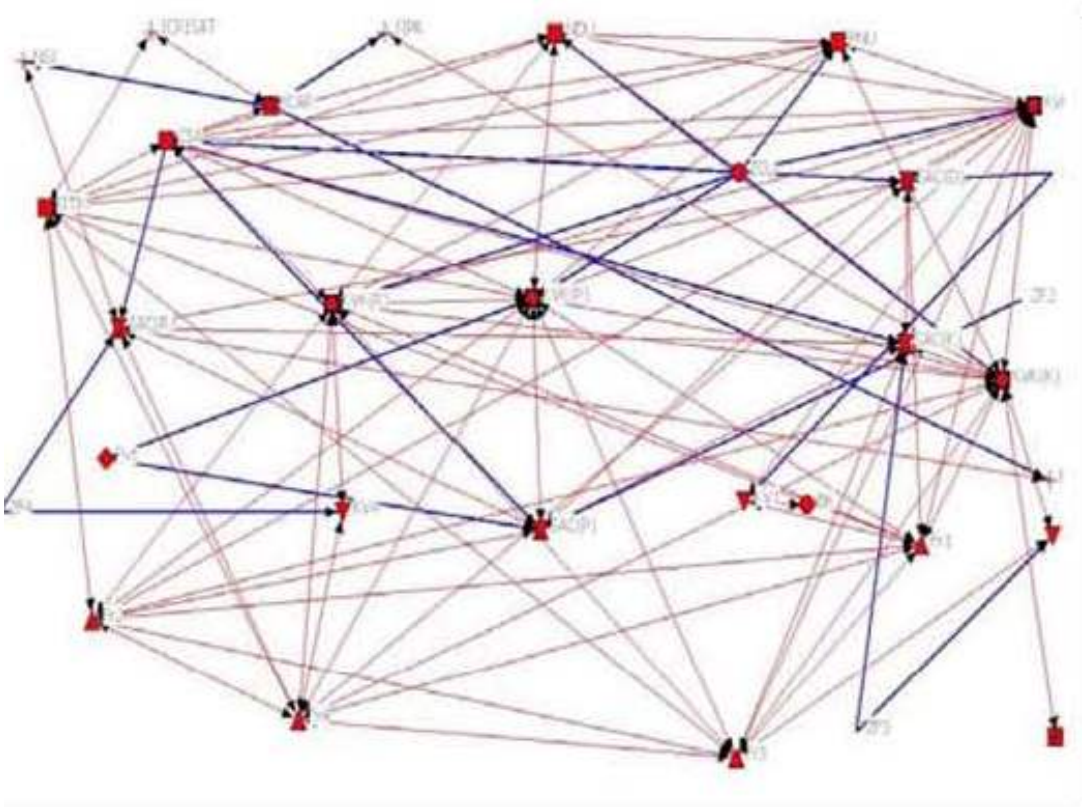

Figure 4: Reciprocal Ties post DEAL

As seen in the figure, there is an increase in reciprocal ties, with a simultaneous decrease in the number of non reciprocal ties. Increased reciprocity has a positive impact on content creation, while increased collaboration between members further enhances reciprocity.

We have seen how DEAL has increased the opportunities for reciprocal ties. We know observe the effect of DEAL on information flows within groups and between groups. Here, we make a further note on the ties within and between the different layers. Unlike conventional ICT interventions , which adopt either a top-down or bottom- up approach, DEAL focuses on increasing ties between members in the same layer, while also building links across the different layers. Figure 5 illustrates the links within and between groups in the pre DEAL scenario. The blue lines represent ties within groups and the red show ties between groups.

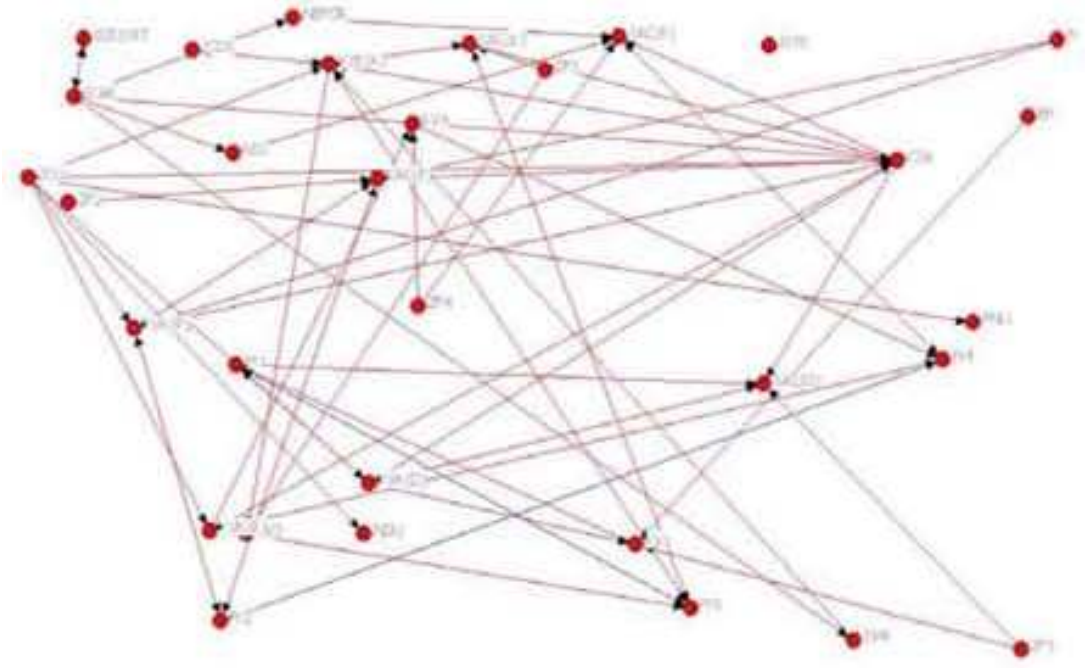

Figure 5: Pre DEAL links within and between groups

In the pre DEAL scenario, one feature of existing extension framework is that there are few links between members of the same layer. For instance, as the interviews revealed, there are very few direct informal links between individual KVK. Majority of the relationships that a node has is with members from the same geographic community, but very ties with members having the same role in the network. Thus, the local social capital stays locked into the local loop keeping it out of the network.

Figure 6 shows the effect of DEAL on the links within and between groups, that is horizontal information flows in the post-DEAL scenario. There can now be seen several weak links between different nodes, which are at the same horizontal level. For example, DEAL had provided a platform for different KVKs to share their extension experiences with each other through hosting a website for each of them. Horizontal ties between farmers from disperse geographical areas are enhanced through the use of the kissan blog for sharing agricultural experiences. This is a distinguishing feature of a digital ecosystem as creating these ties lead to shared norms and values which make ICT interventions successful. In the case of DEAL, this would fulfil the goal of sustained and voluntary content co-creation.

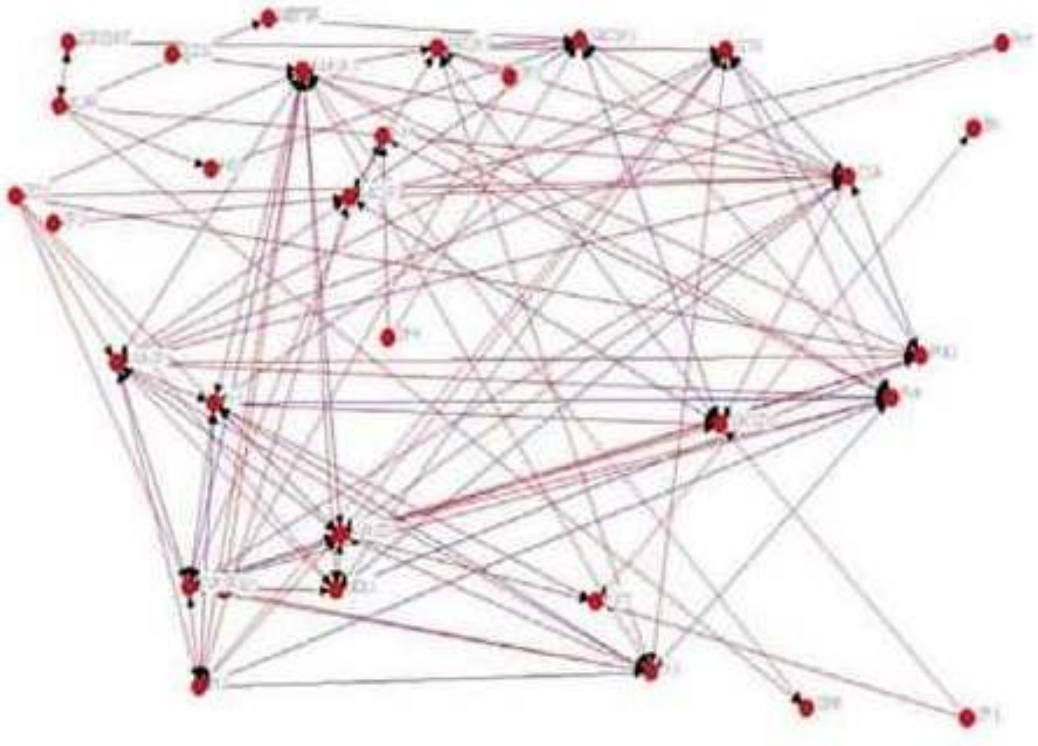

Figure 6: Post DEAL links within and between groups

2. Conclusion

This paper was an attempt to study the impact of DEAL on existing community networks in the field agricultural extension in rural areas around Kanpur. A lot of the theoretic background for the study was derived from the work reported in Deliverable 7.1 by Create-Net and T6, partners in this work package in OPAALS Phase I (OPAALS Project, WP 7, Del. 7.1). Through analyzing reciprocal ties between the various actors, we found that while DEAL has not led to a rapid expansion of the network, it has successfully deepened ties and created new weak links between existing actors. We expect that since this intervention has led to increasing ties both between levels as well as among levels, it would positively affect social capital and lead to the formation of a digital ecosystem in the agricultural knowledge domain.

References

Ben-Porath, Y. (1980). The F-connection: Families, friends, and firms and the organization of exchange. *Population and Development Review* 6, no.1: 1-30.

Borgatti, S. P., Everett, M. G. and Freeman, L. C. (2002). *Ucinet for Windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Chatterjee, J. and Prabhakar, T. V. (2005). On to action - Building a digital ecosystem for knowledge diffusion in rural India. *Proceedings of the 2005 International Conference on Knowledge Management*, North Carolina, USA. Last acessed July 14, 2008, from INTERNET: www.cse.iitk.ac.in/users/tvp/papers/vof_pasadena.pdf.

Coleman, J.S. (1988). Social Capital in the creation of human capital. *The American Journal of Sociology* (Supplement 1): 95-120.

Fahey, L. and Prusak, L. (1998). The eleven deadliest sins of knowledge management. *California Management Review* 40, no.3: 265-76.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *The American Journal of Sociology* 91, no.3.: 481-510.

Markus, M. L. (2001). Toward a theory of knowledge reuse: Types of knowledge reuse situations and factors in reuse success. *Journal of Management Information Systems* 18, no.1: 57-93.

OPAALS Project. (2008). *Del 7.1 – Policy and business models for the regional developement of community networks*, Project funded by the European Community under "Information Society Technology Programme. Licensed under Creative Commons.

Parthasarathy, D., and Chopde V. K. (n.d.) Building social capital: Collective action, adoption of agricultural innovations, and poverty reduction in the Indian Semi-Arid Tropics.Paper for the research theme 'Escaping Poverty'. Last Acessed July 14, 2008, from INTERNET: http://www.gdnet.org/pdf/776_D.pdf.

6

Mediating the Dialectic Relations between Indigenous Knowledge and Identity: Lessons from DEAL Project

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Abstract: The world today is confronted with large scale issues around indigenous knowledge. The growing interest in the indigenous knowledge is primarily due to the uncertainties surrounding everyday life which has challenged unbridled belief in scientific knowledge and rationality. The thirst to assimilate indigenous knowledge to formal knowledge has resulted to a situation where identity and culture of the indigenous are threatened.

Under these conditions the ICT has a greater role in both accommodating these knowledge into formal knowledge system as well as in maintain the culture and identity of the indigenous. Based DEAL observations we argue that an ICT facilitated architecture such as Kisan Blog has potential socio-technical features to accommodate such knowledge in to formal knowledge by maintaining the identity and culture of the indigenous. A technology which best support the normative structure is likely to bring more acceptability and benefits to the community who uses it.

Keywords: Indigenous Knowledge, Identity, ICT, Digital Ecosystem, Audio Blog

1. Introduction

The world today is confronted with large scale issues around indigenous knowledge. The unprecedented quest for the production of wealth has given rise to profound uncertainties in all spheres of life (Beck 1996). The continuing production of uncertainties has challenged unbridled belief in scientific knowledge and rationality. Indigenous knowledge has gained attention as an

alternative form of approach for reorienting the knowledge system. From being marginalised in the dominant development paradigm, the indigenous are now at the centrestage of debates that surround their knowledge systems. This has affected the indigenous peoples. While at one hand it has given them recognition in the form of an acceptance of the indigenous knowledge; on the other hand, this has raised questions about their cultural survival or identity. This assumes great importance, as knowledge of particular group has become the tool for cultural identification in today's world (Pattanaik and Jha 2007). Historically indigenous knowledge based on an indigenous worldwide has been under the control of indigenous peoples. Traditionally these knowledge are passed down from generation to generation through oral histories, story telling, picture writings songs and ceremonies (Barnes and Danard 2007).

2. On the Concept of Indigenous

Around the world, indigenous people today face difficulties in gaining adequate recognition. Furthermore, indigenousness as a concept fails to attain the status it deserves (Miller 2003). Maybury-Lewis (2002) observes that there is no clear cut distinction between indigenous people? 'The term is ambiguous because a majority of the peoples are 'indigenous' in the sense of having been born [there] and descended from those who were born [there.]'

Most of the definitions describe indigenous peoples as those social groups that are culturally identified and maintain historical continuity with their ancestry. This continuity is in the forms of their organization, culture, self-identification, and languages (Dei 2000a, 200b; Semalio & Kincheloe 1999). There are other definition which describes them as descendants of those who have been marginalized by major powers and dominant groups, the Basarwa of Botswana and the Maasai of Kenya and Tanzania represents such indigenous people (Mammo 1999; Maybury Lewis 2002; McGovern 1999; Wangoola 2000). However in general the term refers to those group of people who have maintained a lifestyle that sets them apart from the rest of society, and have traditionally been subordinated and marginalized by unequal economic, political and social structures (Wangoola 2000). In this paper we use the term indigenous more congruent with the definition given by United Nations (UN) and from an ecological perspective. The term in the UN context essentially refers to 'those who maintain a collective identity through association with specific territories' (McIntosh 2000). According to UN:

> Indigenous communities, peoples and nations are those which having a historical continuity with pre-invasion and pre-colonial societies that developed on their territories, consider themselves distinct from other sectors of the societies now prevailing in those territories or parts of them. They form at present non-dominant sectors of society and are determined to preserve, develop and transmit to future generations their ancestral territories, and their ethnic identity, as the basis of their continued existence as peoples, in accordance with their own cultural patterns, social institutions and legal system (UN 1996).

One of the risks associated with the concept 'indigeneous' is, in fact, that of representing indigenous groups and knowledge as archaeological remains that perpetuate the past and an idealistic vision of their relationship with nature (Cliford 1988, 1997, 2001; Canclini 1995, Hannrez 1992; Greetz 1986, Chow 1994). Yet ecological perspective views the indigenous people as 'the original stewards of the environment, holding the land of their ancestors in trust for future generations' (McIntosh 2000). In the Indian context whereas the Minas of Rajasthan, who are also dominant in their area, can be referred to as a tribe, the Todas of Tamilnadu, or the Santals and Kondhs of Orissa can be described

as indigenous people. ‘Some of the indigenous people might be more “advanced” than others, but what makes them distinct is their closeness to nature and comparative geographical isolation’ (Pattanaik and Jha 2007).

3. On the Concept of Indigenous Knowledge

Like the term indigenous peoples, indigenous knowledge (IK) also has multiple descriptors. A majority of them refer IK as the unique, local knowledge existing within and developed around the specific conditions of local people resulting from their long-term geographical residence. This knowledge is part of their cultural heritage and histories. It portrays their way of life and serves social interests. Such knowledge systems are cumulative and represent generations of experiences (Kinuthia 2007).

In general usages, two terminologies are employed to characterise local knowledge: traditional and indigenous. They are often used interchangeably; however, there is a difference between the two. Though there is no agreed definition of traditional knowledge, it may be seen as a subset of indigenous knowledge (Pattanaik and Jha 2007).

Traditional knowledge is generally expressed in the communities and encompasses expressions of folklore, religion (e.g. sacred places, plants, animals), crafts (e.g. developments of technologies for producing textiles, food), agriculture (e.g. management of ecosystems, development of plants and animals with specific properties), and medicines (e.g. herbal products). However indigenous knowledge is no different from traditional knowledge except that the holders are indigenous people rather than non-indigenous communities embodying traditional life styles (WZB: nd).

Gernier defines indigenous knowledge as the unique, traditional and local knowledge existing within and developed around specific conditions of people indigenous to a particular geographic area. Indigenous knowledge innovates from within and internalises. By and large it is context specific and uses and adapts external knowledge to suit the local situational needs (Nuffic 2000).

The characteristics of indigenous knowledge may be summarised in the following manner. It is generated within communities. It is location and culture specific. It is the basis for decision-making and survival strategies. It covers the critical issues of primary production, human and animal life, and natural resource management. It is dynamic and based on innovation, adaptation, and experimentation. It is oral and rural in nature. It is not systematically documented (Nuffic 2000). Further, the other qualities that separate indigenous from other forms of knowledge is their custodial rights, i.e., equity in sharing, collective ownership and rules governing secrecy and sacredness (Puri 2000). In general, indigenous knowledge refers to the cultural and intellectual heritage of the indigenous people (McIntosh 2001).

Recognition of the embedded nature of culture to the situational, historical and political context supports the argument that both the term ‘indigenous’ and ‘indigenous knowledge’ are not a detached concepts. It can then be inferred that the ability to use these knowledge forms is pertinent to peoples’ understanding of themselves and their world, and have an influence on their identity and everyday practices (Dei 2000a; 2000b; Robyn 2002; Semali 1999).

The history of colonization and Western world view of what constitute knowledge during the recent past has led to instances where indigenous populations were excluded and deprived of their right to

this knowledge (Wangoola 2000). This has led to many ethic based identity struggle during recent past.

4. Knowledge: Competing World Views

Broadly there are two paradigms of knowledge: one that can be referred as Northern techno-centric; and the other that exists within local or indigenous communities. Within a Northern techno-centric paradigm, knowledge is seen as a commodity, which can be valued and traded. The concept of commodity is primarily based on scarcity that emphasises individual ownership and long-term planning. Contrary to it, within indigenous communities, knowledge is seen as integral part of existence. Indigenous knowledge is based on theories of abundance, subscribing to the idea that nature has capabilities to fulfil all human needs. Further, in these societies, property including knowledge is held communally under a custodianship (Manek and Lettington 2001). The Northern Techno-centric orientation to individual ownership and long-term planning in the domain knowledge are considered meaningless (Pattanaik and Jha 2007). However modernity in its quest for rationalisation has resulted in various forms of crises. The uncertainties in all spheres of life have demonstrated the limitations of formal scientific knowledge. This has led to an unbridled quest for alternative forms of knowledge. According to Todd:

> Western culture seems to want everything, to go everywhere. Wants that seem endless….The desire to know, seek new experience, take new journeys, create light, has somehow grown from a flame to a forest fire that burns everything in its way …..Of course, in a world with a legacy of colonialism, the hunger of western culture is threatening and frightening. We have had to feed that hunger, with the furs of animals and flesh of fish and the gold and silver of our lands and ourselves as fearsome mysteries in the West's drama of itself (Todd 1996).

Most of this knowledge today is taken out of their cultural context. There are large scale appropriation of indigenous knowledge and symbols for the purpose of wealth accumulation through various means ranging from commercial art markets to internet. Indigenous knowledge and symbols in this new world order become commodities. This control of indigenous knowledge and symbols at the one end limits the expression and perception of indigenous worldviews, while at the other it threatens their cultural survival. In addition, these controlled representations deprive the indigenous from their right to their knowledge system and symbols (Barnes and Danard 2007).

5. Relevance of Indigenous Knowledge

The World Conference on Science (Budapest 1999) recommended that scientific and traditional knowledge should be integrated in interdisciplinary projects dealing with links between culture, environment and development particularly in the areas of the conservation of biological diversity, management of natural resources, understanding of natural hazards and mitigation of their impact. Similarly the UN Conference on Environment and Development has also emphasised on the practice and knowledge of indigenous people for better environmental management to achieve sustainable development (UN 1992). There is a growing consensus around the world that indigenous knowledge system can be utilised as an alternative method for sustainable regional development (Cox 2000).

There are two views regarding the use of indigenous knowledge. While the first paradigm accepts the supremacy of Western scientific notion of knowledge the second rejects hierarchical division of knowledge (Sharma 2001). Within the first paradigm all forms of knowledge including indigenous

knowledge which does not follow the assumptions of formal scientific notion are considered as irrational and 'deserves to be lost' within the civilizational mission of the modernity (O'Neil 2000). The second view on the contrary accepts possible alternatives and recognises indigenous knowledge as one of the possible alternatives. It lays emphasis on equity of knowledge, that is, an integration of indigenous knowledge with formal science (Sharma 2001). According to this view, equity of knowledge not only serves the purpose of conservation of biological diversity and preservation of traditional knowledge but it provides empowerment, security and opportunity to the indigenous people.

The World Bank has pointed out that in the emerging global knowledge economy, a country's ability to build and mobilise knowledge capital is equally essential for sustainable development as the availability of physical and financial capital (World Bank 1997). The basic component of any country's knowledge system, more so in the case of developing countries, is its indigenous knowledge. It encompasses the skills, experiences and insights of people, applied to maintain or improve their livelihood. It is also the social capital of the poor, their main asset in the struggle for survival, to produce food, to provide for shelter or to control of their lives (Nuffic 2000). It would perhaps then be correct to say that adopting indigenous knowledge will provide security to not only to the formal scientific knowledge but also to the nation-state as a whole. By capitalising on the collective wisdom of formal and traditional sciences, we shall be able to help people address the problem of declining common property and to manage the risk they face in everyday life because of the destruction of the resource base (Pandey 2000).

Localized relevance of IK, therefore, has significant bearing on the organization of knowledge and ICT can play a crucial role in its incorporation and preservation (Dei 2001b; McGovern 1999; Sillitoe 2002). However three broad aspect of the indigenous knowledge potentially complicate their integration: (a) the uniqueness of IK in a particular culture does not imply consensus with other knowledge structures; and (b) in this highly transient 'global' lifestyle, it is not uncommon for IK to be influenced by non-indigenous knowledge; (c) above all use of IK as commodity threatens their cultural survival/identity.

6. Conflict at the Frontier of Cultural Identity

In a discussion on culture and identity, Laroui has defined cultural identity: 'Sometimes it is race, sometimes language, sometimes religion, sometimes nationality, sometimes it is culture in the anthropological sense sometimes it can even be dress. Cultural identity then is what differentiates' (Laroui 1998). As indigenous knowledge is different from formal knowledge system, it sets the indigenous people apart and gives them a separate identity. (Pattanaik & Jha 2007).

The process of modernisation is dialectical in nature. It both universalises inside and outside the society as well as differentiates socially and psychologically at all levels of everyday life. In this course of differentiation cultural identity has become an exiting fact for everyday life. The individuals as well as groups become conscious of their cultural identity. It manifests itself profoundly where there is competition, or any form of dominance (Pattanaik & Jha 2007). Cultures sought to be defended are defined, analysed and neatly categorised to fit the situation or agenda (Laroui 1998). By and large indigenous communities around the world are economically poor and socially disadvantaged. They continue to exist in what may be described as colonial situations. Under these circumstances they are most likely to assert their identity. One of the ways through which they can do it is by conforming to their knowledge system (Pattanaik and Jha 2007).

Generally this knowledge is tacit in nature. Traditionally such knowledge systems have been the property of the community. Most of these communities live in geographically isolated areas. This gives them a form of political and cultural autonomy where community gatherings and participation remain important. It is important to note that knowledge systems within these communities are considered as their sacred ancient past, it is a part of their survival mechanism and also constitute an important element of what is regarded as their own self. Traditionally, the elders of the community play the role of the guardian of this knowledge. Only certain community members adhering to the principles of the community have access to it in this way it is preserved and passed down from generation to generation (Chapin 1991).

In the recent past the growing concern over indigenous knowledge system has made them conscious of protecting their knowledge systems. There are movements all around the world to protect their symbols and knowledge system. Many of these movements are a reaction to the process of modernisation. Examples of organisations that have led some of these movements are the Australian Aboriginal Progressive Association and the Association of the Indigenous people of the North (Bannister and Barrett 2001).

The reaction to the process of modernisation is due to two main reasons. Firstly, in many cases this knowledge is utilised without giving any credit to the indigenous people. In addition some of this knowledge that is acquired by the outsider is subsequently brought into modern world and traded as commodities (Bannister and Barrett 2001). Hence the sacred character of this knowledge that the indigenous people ascribe to it is threatened or lost. Secondly, modernity in its own virtue creates spaces for one to assert oneself or one's community. Thus with the penetration of modernisation the indigenous people today become more conscious about their identity. Since the knowledge system is a part of their identity they tend to guard it from encroachment. These factors have given rise to a situation where indigenous people pull back from sharing the knowledge with the outside world. As on out come of the overall process the integrative force that modernisation seeks to promote is checked (Pattanaik & Jha 2007).

7. A few Observations from Past Experiences

Evidence from all around the globe indicates that indigenous peoples are increasingly uncomfortable sharing cultural knowledge outside their communities due to uncertain negative consequences (Chapin 1991). This is both profound in physical arena as well as in ICT facilitated interfaces.

The experience of Kuna gives an insight to the difficulties that are experienced at the physical interface. In the early 1980s an internationally funded project was undertaken among the Kunas of Panama for the management of the forest area of the Kuna territory. One of the basic aims of the project was to integrate indigenous knowledge with formal scientific knowledge. Traditionally the elders of the Kuna are the guardians and custodians of the Kuna knowledge system. The elders neither showed an interest in the project nor did they share their knowledge with the project. The reasons for this were two-fold. 'First, for the Kuna, the knowledge was the "Way of the Great Father", which is sacred, and this 'sacred lore is a soul of their identity'. They did not want to part with this. Secondly, the invasion of modernisation has fragmented the Kunas: 'the difference between the young and the old had already become wide'. There were disagreements over the sacred character of the tradition among the young and the old. The elders accused the young of not being 'genuine'. The young people consider these as curious folklore whereas for the elders these are living

documents about their world in which they live. As a result, the older generations separated themselves from the rest and kept the knowledge system confined to themselves (Chapin 1991). Where tradition is strong, people see no need to preserve esoteric knowledge. They simply live their culture. But the process of modernisation has challenged and even eroded the traditions among the Kunas (Pattanaik & Jha 2007).

The observations at the ICT facilitated interfaces show more of similar picture. ICT broadly refers to computers, software, networks and related systems that allow users to access, analyze, create, exchange and use data, information and knowledge. If successfully implemented and maintained, the infrastructure brings together people in different places and time zones with the multimedia tools for data, information and knowledge management (Herselman & Britton 2002).

There has been effort to capture IK through the use of ICT tool; however the use of ICT has shown its own limitations. Firstly it does not provide the opportunity to know the ways indigenous knowledge continues to live in the lives of the present generations and those of the future. Secondly, many websites which has been developed to promote indigenous knowledge and symbols ignore the importance of the indigenous people's traditional roles in taking care of these knowledge and being responsible for protecting and transmitting their knowledge and history (Barnes and Danard 2007).

Indigenous peoples have always seen themselves as connected to all of life and all of relations. The contemporary use of knowledge and symbols of the indigenous in the cyberspace today fabricates this connection. The artificial structure of cyberspace reflects primarily Western thought, which is fragmented and disconnected, and strives for dominance over humanity to find meaning (Todd, 1996).

'The Web' fundamentally embodies this alienation of Western thought (Barnes and Danard 2007). Information presented on the internet is distanced from its context. Perhaps this lack of context makes it appear neutral. This supposed neutrality possibly makes the information more acceptable. But for indigenous peoples, who are represented and defined by non-indigenous peoples on the internet, the information is not neutral or acceptable when it is filtered through perspectives which promote bias and reinforce stereotypes (Barnes and Danard 2007).

Colonization and its ongoing practice in society and through information technology, produces distance between the individual and their environment, between those doing the representing (mainstream) and those being represented (indigenous people), between indigenous peoples and their communities, between indigenous peoples and their knowledge and art, and between indigenous peoples and their sense of self in all aspects including physical, emotional, mental and spiritual. The outcome is that the history, culture, identity and knowledge of indigenous peoples are being eroded, erased and reconstructed. The genuine loss of indigenous knowledge and diversity of thought is perhaps shifting the world towards a singular hegemonic structure. The value of life is being replaced by the value of commodities and resource accumulation for the dominant society.

Misapplied ICT tools can led to repercussive consequences; when it is introduced to indigenous groups it brings along mass media, popular culture and global languages that can potentially conflict with local traditions. Yet paradoxically, the same technologies also provide users with new tools that can be used to preserve, promote and strengthen their culture and identity (Lieberman 2003). The challenge with ICT is to make aware the users about the potential benefits and alternatives available

in ICT facilitated interface (McGovern 1999; Sillitoe 1999). Successful participation is impractical when potential users do not know the alternatives and benefits (Herselman and Britton 2004).

8. Suggestion for Indigenous Knowledge Integration

The question then is how best to access and integrate these knowledge systems for the betterment of humankind? A developmentalist approach emphasises a 'melting pot' framework. In this approach different group are assumed to submerge under a greater collective force. Smaller groups are expected to sacrifice their interests in the larger interest of the society. Development alone becomes the key issue (Pattanaik and Jha 2007). In contrast, a rights-based model emphasises progress rather than unprecedented development. This model focuses on development along with the rights of the groups involved in it intact. A right-based approach emphasises the creation of a public space. Policies are made on the basis of mutual agreement of all the actors involved in it. From this perspective appropriation of indigenous knowledge is based on the approval of the indigenous people, safeguarding their rich cultural heritage and maintaining their identity (Pattanaik and Jha 2007).It is on this context that the ICT has a potential towards integrating indigenous knowledge to the formal knowledge structure by maintaining their right and identity along with their cultural heritage.

It can be argued that socio-technical processes that address the needs of indigenous peoples are bound to be more effective and meaningful to the indigenous people. Thus, transferring and sharing of knowledge should not be about coming up with technological fixes to [their] problems, or passing along ICT for [them] to adopt. It should be about acknowledging that they have their own effective knowledge, resources and practice management systems (Sillitoe 1998). Incorporating IK into larger domain of knowledge assumes that coexistence of different knowledge structures is conceivable, and that they can complement each other. To avoid fallacious dichotomization of knowledge structures, it is important to understand that the past continues to influence the present and the present influences the narration of the past. Because different knowledge systems represent different points on a continuum, it is necessary to work toward synthesis of the different systems, both indigenous and non-indigenous. ICT dissemination should be a continuous search for jointly negotiated advances rather than as a top-down imposition. It should seek systematic accommodation of IK into formal knowledge system. While this is not an easy task, it is one that requires formulation of strategies that meet demands and challenges (Sillitoe 1998; Viergever 1999). DEAL experience of using ICT tool to accommodate tacit knowledge provides a path towards this.

9. Role of ICT in Promoting Identity and Rights of the Indigenous

An application of ICT that could have particular usefulness for indigenous peoples is a system for cultural preservation. According to Dillon (2004) and Jones (2001) ICT can serve the following purposes when applied to indigenous communities in right way, (a) intrinsic individual development, (b) improving the economy of the people, and (c) immersion into a culture. As part of the cultural immersion, technology needs to be introduced in a fashion so that the user can understand it and be able to participate in it at some level. Technology in this way can stands along the side of the culture of the indigenous. The socio-technical issues involved in it must ensure that the users are exposed to processes that acknowledge the sources of empowerment and disempowerment in society. It should create space and capacity for the users to engage in self reflective knowledge production. Above all the ICT interface should allow users to produce and control knowledge about themselves and their communities. As a result they will be able to resonate with their culture and traditions and contribute

to a universal knowledge system in a process that is viewed as both intergenerational and holistic (Cavallo 2000; Mosha 1999; Reiser 2001).

10. Lessons from DEAL: Insights to Resolving the Dialectic between Identity, Rights and Knowledge

Facilitating meaningful interface at the ICT front is likely to have a positive impact on the process of integration of indigenous knowledge and conflict of identity. This requires that there should be provision for reciprocal flow of ideas, information and mutual decision-making (Mundy and Compton 1995; Grenier 1998; Viergever 1999). The ICT has an inherent capability of preserving explicit knowledge; it has difficulty with how to treat tacit knowledge. ICT output, no matter how well represented, is usually one-dimensional. Digital archiving of information encompassing text, audio, graphics and video is only the first step to cultural preservation. The second is placing the information in a meaningful knowledge management system where it can be used and maintained by the community (Michael and Dunn 2007). DEAL experience provides some insights towards this.

The focus of DEAL project was to create a digital knowledge base on agriculture and rural livelihood domain by involving various actors in the co-creation of content process. It also aimed at building a social network through the facilitation of ICT tools among various actors working in the domain. DEAL assumed that enablement of a co-creation of content process will eventually constitute a social network leading to an electronic community and finally to a self-sustaining community network in the agricultural domain in the condition that, the infrastructural facilities require to construct community network will be available to the actors as time proceeds. With this framework it involved various agricultural scientist, village level extension worker and experts, agricultural universities, research institutes, Non-Governmental Organizations (NGOs), international bodies working in agriculture and rural livelihood domains.

The broad objective of the project was to initiate recursive, reflexive and self-reinforcing knowledge creation and network building process. DEAL tried to resolve the complexities within the structure of knowledge at its initial stages of inception. Creating a knowledge space and content management system in the domain required that both the explicit and tacit form of knowledge are captured and integrated. It conceptualized the two streams of knowledge (explicit and tacit) as ‘Gyandhara’ and ‘Ganagyan’. The Gyandhara was based on the assumption of formal-scientific knowledge, where as Ganagyan focused on all the localized, everyday and context based knowledge which is tacit in nature.

In order to create a content management system in the stream of Gyandhara, DEAL solicited the participation of a few KVKs working in the region. With the help of the Zonal Coordination Unit IV of ICAR five KVKs of the region (KVK Daleep Nagar, Kannauj, Pratapgarh, Raibareily and Unnao) were selected to participate in the project. The aim was to promote a space where experts of the domain are expected to participate in sharing and exchange their knowledge in a digital architecture. It was proposed that the scientist at the KVKs will provide the content for the portal and use the content of other experts and scientists working in the domain (particularly of other participating KVKs) that will be available at the portal which will be enabled through internet. This it self was a barrier as only two of the KVKs has internet connection (one with high band width and the other low).

As an alternative an agricultural scientist was deployed at each KVK by DEAL to facilitate the process of content creation. The agricultural expert of the DEAL manually and verbally collected the content which was then edited and added to the portal. It was proposed that the agricultural scientist will update the content at the KVKs computer manually through data transfer in a CD. The process at the beginning worked smoothly. But as the complexity of the portal grew the agricultural scientist found it difficult to update. Thus a computer expert was appointed to update the content at the KVKs. At present the content is collected from the agricultural scientist at KVK by the agricultural experts manually and the updating of the portal at the KVK are done manually.

However what interest most to us and to the IK is the content management system that was developed to capture and digitize tacit knowledge Ganagyan. Due to its very nature Ganagyan contrary to the Gyandhara required different orientation. The first and foremost task in this venture was to collect the tacit knowledge from the local actors. For this the agriculture expert of DEAL visited the local actors and in the beginning collected them in the text format.

It is noteworthy to mention that a majority of the local actors when visited queried about solutions to their difficulties in everyday practices relating to agriculture and livelihood issues. Looking at this complexity DEAL decided to develop a blog at its portal, where the users can put their questions and get answers to it. Simultaneously it was felt that developing a text based blog might not be of much help to the local actors as majority of them have no skill in computer. Thus it was decided to develop an audio blog for the same purpose. The Figure 1 shows the architectural design of the audio blog named as Kisan Blog at DEAL portal.

Figure 1: Architectural Design of the 'Kisan Blog'

The Kisan blog is based on audio interface. A person interested to put up any question, can do the same either by recording it in an electronic device or directly through a microphone attached to a computer linked with internet. At the top of the page a link is provided containing information on how to use the blog.

For posting any query the user has to log on into the page. It can be done by clicking on the option login at the webpage. It has a fixed login and a password for common user which is given at the bottom of the login page.

Each participating KVKs has been allotted with separate logins. This has done to ensure their identity. Once a user login to the page he can post his query either directly or can upload a file already recorded on an electronic device. The usual time period for direct recording is 250 sec, for upload the audio file has to be below 2mb in size. The Figure 2 below shows the recording procedure step 1at the Kisan Blog.

Figure 2 Recording Procedures Step - 1

Figure 3 Recording Procedure Step - 2

After the recording is done, the user can check the same for quality, clarity etc. by clicking in the option play. There are additional features to improve the quality of recording which can be accessed by clicking the right mouse button. Once the recording is done the user can submit the same by clicking the submit button. Hence a new page appears where the user can give a title to his audio clip and any other additional information relation to it on text format.

An on screen key board (in Hindi) is available for the same purpose. He also can provide identity such as name, place etc in text format. This supplementary information appears at the blog in text format along with the audio clip when it is transmitted in air. When this is done it is automatically stored at the server of DEAL. However to be on air it requires an administrators permission.

The administrator has separate login id and follows the same login procedure. He then filters the question and puts it on air. The filtering is usually done by the agricultural experts of DEAL. This has been done with an intention to ensure that the questions asked and the answers provided are valid. Once on air the query appears on the blog site with title, identity and the audio.

Users interested in answering the query can do so by clicking on the option 'number of suggestions' which appears at the bottom left of the query. To answer a query one can follow the same recording method. Answer a query does not require any login. The names of the most recent users along with their identity who provide suggestions are categorized and appear at the top of the main page of the Kisan Blog. This both ensures authenticity of the suggestion as well as it protects the identity of the persons and provides a form of recognition to them.

11. Implications for Indigenous Knowledge

If developed an audio blog such as Kisan Blog has potential capabilities to capture and digitize indigenous knowledge simultaneously protecting the identity and culture of the indigenous due to following reasons: (a) it allows capturing the tacit knowledge in its pure form. The distortion of the knowledge does not occur as it is mostly in audio format and is directly added to the portal (b) it is based on easy to use and easy to learn mechanism (c) it guarantees the identity of the content providers and gives recognition to them.

12. Conclusion

ICT facilitated content management provides access to a wider range of extending possibilities. It has ability to draw more peripheral participants, and provide access to a wider set of peoples. However one can not deny the importance of infrastructural resources, social structures and norms where the both the actors and socio-technical processes operate. Cultural preservation cannot be achieved by ICT alone: it also requires the spiritual element behind the history to be actively reinvigorated into a community to make its presence felt in a long-lasting manner. Culture is something that is alive and ever-changing. In brief, it is not machinery that transforms society, repairs institutions, builds social networks or produces democratic culture; it is people who make this happen. What has been presented in this paper is a way forward. Only by getting communities involved in the development of applications, ICT adoption is likely to bring its myriad benefits to the everyday life we live in.

Acknowledgement: We greatly acknowledge the help rendered by Sugatha Chaturvedi, Project Associate, for going through the manuscript and collecting materials for the paper. We appreciate Anupam Bhattacharya, Project Associate, who has developed and conceptualized the Kisan Blog. All the images presented in the paper are provided by him.

References

Bannister, Kelly and Barrett, Katherine. (2001). Challenging the status quo in ethnobotany. *Cultural Survival Quarterly* 24, no.4: 10-13.

Beck, Ulrich. (1996). *Risk society*. London: Sage Publications.

Canclini, Nestor Garcia. (1995). Hybrid cultures: Strategies for entering and leaving modernità. Minnesota: University of Minnesota Press.

Cavallo, D. (2000). Emergent design and learning environments: Building on indigenous knowledge. *IBM Systems Journal* 39, no.3-4: 768-781.

Chapin, Mac. (1991). Losing the way of the great father. *New Scientist*, 131, no.1781: 40-44.

Chow, Rey. (1994). Where have all the natives gone? In A. Bammer (Ed.) Displacements: Cultural identities in question. Bloomington: Indiana University Press.

Clifford, James. (2002). *The predicament of culture: Twentieth century ethnography, literature, and art*. Harvard: Harvard University Press.

Clifford, James. (2001). Indigenous articulations. *The Contemporary Pacific* 13, no.2: 468-490.

Clifford, James. (1997). *Routes: Travel and translation in the late 20th century*.Harvard: Harvard University Press.

Cox, Paul Alan. (2000). Will tribal knowledge survive the millennium? *Science* 287: 44-45. This paper is also avaible from INTERNET: http://www.sciencemag.org/cgi/content/full/287/5450/44.

Dei, G. J. (2000a). Rethinking the role of indigenous knowledge in the academy. *International Journal of Inclusive Education* 4, no.2: 111-132.

Dei, G. J. (2000b). African development: The relevance and implications of 'Indigenousness.' In G. J. Dei, B. L. Hall, and D. G. Rosenberg (Eds.), *Indigenous knowledge in global contexts: Multiple readings of our world* (pp. 70-86). Toronto, ON: University of Toronto.

Dillon, P. (2004). Trajectories and tensions in the theory of information and communication technology in education. *British Journal of Engineering Education* 52, no.2: 138-150.

Geertz, Clifford. (1986). The uses of diversity. *Michigan Quarterly Review* 25, no.1: 105-123.

Grenier, L. (1998). *Working with indigenous knowledge: A guide for researchers*. Ottawa, ON: International Development Research Centre.

Ulf Hannerz, Ulf. (1992) Cultural complexity: Studies in the social organization of meaning. Columbia: Columbia University Press.

Herselman, M., and Britton, K. G. (2002). Analysing the role of ICT in bridging the digital divide amongst learners. *South African Journal of Education* 22, no.4: 270-274.

Iske-Barnes, Judy, and Danard, Deborah. (2007). Indigenous knowledges and world view: Representations and the internet. In L. E. Dyson, M. Hendricks, and S. Grant (Eds.), *Information Technology and Indigenous People* (pp. 27-37). London: Information Science Publishing.

Jones, A. (2001).: Developing research in technology education. Theme issue of *Research in Science Education* 31: 3-14.

Kinuthia, Wanjira. (2007). Instructional design and technology implications for indigenous knowledge: Africa's perspective. In L. E. Dyson, M. Hendricks, and S. Grant (Eds.), *Information Technology and Indigenous People* (pp. 3-57). London: Information Science Publishing.

Laroui, Abdallah. (1998). Cultural identity and modernity. *International Social Science Journal* 118: 551-559.

Lieberman, A. E. (2003). *Taking ownership: Strengthening indigenous cultures and languages through the use of ICTs*. Retrieved January 2, 2005, from INTERNET: http://learnlink.aed.org/Publications/Concept_Papers/taking_ownership.pdf.

Mammo, T. (1999). *The paradox of Africa's poverty: The role of indigenous knowledge - Traditional practices, and local institutions: The case of Ethiopia*. Lawrenceville, NJ: The Red Sea.

Manek, Mita and Lettington, Robert. (2001). Indigenous knowledge rights: Recognizing alternative world views. *Cultural Survival Quarterly* 24, no.4: 8-9.

Maybury-Lewis, D. (2002). *Indigenous peoples, ethnic groups, and the state* (2nd Ed.). Boston: Allyn and Bacon.

McGovern, S. (1999). *Education, modern development, and indigenous knowledge*. New York: Garland.

McIntosh, Ian S. (2000). Are there indigenous people. *Cultural Survival Quarterly* 24, no.3: 4-7.

McIntosh. Ian S. (2001). Intellectual property responsibilities. *Cultural Survival Quarterly* 24, no.4: 4-5.

Michael, Katina, and Dunn, Leone. (2007). The use of information and communication technology for the preservation of aboriginal culture: The Badimaya people of Western Australia. In L. E. Dyson, M. Hendricks, and S. Grant (Eds.), *Information technology and indigenous people* (pp. 170-174). London: Information Science Publishing.

Miller, B. G. (2003). *Invisible indigenous: The politics of nonrecognition*. Lincoln, NE: University of Nebraska.

Mosha, R. S. (1999). *The heartbeat of indigenous Africa: A study of Chagga educational system*. New York: Garland.

Mundy, P., and Compton, J. L. (1995). Indigenous communication and indigenous knowledge. In D.M. Warren, D. Brokensha, and L. Jan Slikkerveer (Eds.), *The cultural dimension of development: Indigenous knowledge systems* (pp. 112-123). London: Intermediate Technology.

Nuffic. (2000). About indigenous knowledge. Last Acessed July 14, 2008, from INTERNET: http://www.nuffic.nl/ik-pages/about-ik.html.

O' Neil, Jim. (2000). Scientific Method vs. 'Knowledge'. Last Acessed July 14, 2008, from INTERNET: http://www.sciencemag.org/cgi/eletters/287/5450/44.

Pandey, Deep Narayan. (2000). Equity of knowledge. Last Acessed July 14, 2008, from INTERNET: http://www.sciencemag.org/cg1/elleters/28//5450/44.

Pattanaik, Debashis and Jha, Munmun. (2007). 'Knowledge and identity among indegeneous people. *The Oriental Anthropologist* 7, no.2: 199-212.

Puri, Kamal. (2000). Is traditional or cultural knowledge a form of intellectual property? O*xford Electronic Journal of Intellectual Property Rights.* Last Acessed July 14, 2008, from INTERNET: http://www.oiprc.ox.ac.uk/EJWPO100.pdf.

Reiser, R. (2001). A history of instructional design and technology: Part II: A history of instructional design. *Educational Technology Research and Development* 49, no.2: 57-67.

Robyn, L. (2002). Indigeneous knowledge and technology. *American Indian Quarterly* 2, no.6: 198-220.

Semali, L. M., and Kincheloe, J. L. (1999). Introduction: What is indigenous knowledge and why should we study it? In L. M. Semali and J. L. Kincheloe (Eds.), *What is Indegenous Knowledge: Voices from the Academy* (pp. 3-57). New York: Falmer.

Sharma, Shailendra. (2001). Should the local knowledge survive? For whom? Last Acessed July 14, 2008, from INTERNET: http://www.sciencemag.org/cgi/content/full/287/5450/44.

Sillitoe, P. (2002). Globalizing indigenous knowledge. In P. Sillitoe, A. Bicker, and J. Potteir (Eds.), *Participating in development: Approaches to indigenous knowledge* (pp. 108-138). London: Routledge.

Todd, L. (1996). Aboriginal narratives in cyberspace. In M. A. Moser and D. Macleod (Eds), *Immersed in technology: Art and virtual environments* (pp. 179-194). Cambridge, MA: MIT Press.

United Nations. (1996). Standard Setting Activities: Evolution of Standards Concerning The Rights of Indigenous People. Economic and Social Council, E/CN.4/Sub.2/AC.4/1996/2., Last Acessed July 14, 2008, from INTERNET: http://www.unhchr.ch/Huridocda/Huridoca.nsf/e06a5300f90fa0238025668700518ca4/2b6e0fb1e9d7db0fc1256b3a003eb999/$FILE/G9612980.pdf.

United Nations. (1992). Declaration on environment and development. General Assembly, A/CONF.151/26 (Vol. I). Last Acessed July 14, 2008, from INTERNET: http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm.

Vierger, M. (1999). Indigenous knowledge: An interpretation of views of indigenous people. In L.M. Semali and J. L. Kincheloe (Eds.), *What is indigenous knowledge: Voices from the academy* (pp. 333-343). New York: Falmer Press.

Wangoola, P. (2000). Mpambo, the African multiversity: A philosophy to rekindle the African spirit. In G. J. Dei, B. L. Hall, and D. G. Rosenburg (Eds.), *Indigenous knowledge in global contexts multiple readings of our world* (pp. 265-277). Toronto, ON: University of Toronto Press.

World Bank. (1997). What is indigenous knowledge? Last Acessed July 14, 2008, from INTERNET: http://www.worldbank.org/afr/ik/basic.htm.

7

ICT Facilitated Agricultural Extension Services in India

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(This version of the paper has appeared as an article in Page No: 37 of January 2008 Issue of Agriculture Today)

Abstract - The advance in communication and information technology provides opportunity to transform the input based agriculture to knowledge based agriculture. The revolution in communication and information technology has many implications for extension. Digital archiving of information encompassing text, audio, graphics and video is only the first step to cultural preservation. The second is placing the information in a meaningful knowledge management system where it can be used and maintained by the actors participating in it. One such effort for a meaningful knowledge management system in the agriculture domain has been developed by the DEAL Project. This paper examines some of the issues related to the relevance of such knowledge management system in agriculture deomain.

1. Introduction

The agriculture extension services in India primarily aim at enhancing agricultural productivity and food security. Like many other developing countries, extension services in India have been traditionally funded through public funds available from the government and delivered through a separate agency created for this purpose. Organised efforts towards extension services started only in the post independent India. Pre-independent efforts were mostly voluntary attempts, based on

humanitarian ideas of a few individuals and organisations. The premier project in the field was the Etawah experiment. The idea of starting this project was conceived in 1947. It was put into action with head quarters at Mehewa village about 17 miles from Etawah of UP in 1948. The pilot programme included introduction of improved agriculture practices, public health education, literacy campaign, improvement of cottage industries, training in repairing and evolving simple agricultural implements. The remarkable achievement of this project was that the entire area under improved wheat crops. The area under vegetables was extended and disease like Rinderpest and Haemorrhagic controlled.

However, until 1950s extension programmes in India were largely funded through external aid for agricultural development and were primarily facilitated through two important programs, the Community Development (CD) and the National Extension Service (NES) along with other services such as agriculture, health, animal husbandry and education to all. In 1953 a central office under the administration for CD, which later on became the Ministry for CD and Panchyati Raj and co-operative was created. Yet until 1960s there was very little progress on the agricultural front. Special attention to agriculture was realized only in 1960s and since then many new programmes has been adopted to promote agricultural services in the country. In early 1960s agricultural district programme was started followed by Intensive Agricultural Area Programme, the High Yielding Varieties Programme in 1966-67, the Farmers Training and Education Programme in 1966-67 and the Small and Marginal Farmer's Development Programme in 1969-70.

In 1966 The Indian Council of Agricultural Research (ICAR) started participating in extension activities. With the National Demonstration Programme, ICAR's involvement increased considerably. One of most significant development in the 1970s was the introduction of training and visit (T&V) management system. However the T&V system failed to address the diverse context specific needs of the Indian farmers.

Under the policy reform the single discipline based, commodity oriented approach of T & V system has been replaced by Farming system approach and Multi agency extension service approach. The FS approach considers farm, farm household and off farm activities in a holistic way. FS considers interdependencies of the components under the control of members of the household as well as how these components interact with the physical, biological and socio-economic factors not under the household control. The FS approach emphasizes that research and extension agendas should be determined by explicitly defined farmers' need through an understanding of the existing farming system rather than perception by research scientists or extension functionaries. Along with it there is also a growing recognition that public extension by itself can not meet the specific needs of various regions and different classes of farmers. Thus the new extension regime recognizes the role of multi-agency dispensation comprising different strengths. During the 1990s with the initiation and spread of Krishi Vigyan Kendras (Farm Science Centres, KVKs) ICAR also initiated programmes such as the Lab to Land Programme and the Operational Research Programme in collaboration with the KVKs.

2. Indian Agriculture at the Cross Road:

The present agricultural scenario has been summarized in the following points:

(a) Stagnation of yield of major crops.

(b) A high level of yield gaps in several crops.

(c) A decline in returns per kg on high cost inputs like fertilizers.

(d) Soil problems due to unbalanced use of fertilizers and mono cropping and over use of irrigation.

(e) Increase in plant protection problems especially in high value crops like cotton and vegetables.

Currently the diversifications of farm enterprises are mostly due to farmers own initiatives. Extension efforts to promote diversification are lacking. The present extension service is not able to cope up with rapid changes in agriculture. Along with the challenge of increasing food demand the country also faces problems related to sustainability. Sustainable technologies are knowledge intensive as against input intensive nature of green revolution technologies.

3. Moving Beyond the Current Dilemmas:

The advance in communication and information technology provides opportunity to transform the input based agriculture to knowledge based agriculture. The revolution in communication and information technology has many implications for extension. Some of the new roles that the extension system has in this context relates to (a) development of a comprehensive policy on use of technologies for extension services (b) development of information packages on different crops, animals and other enterprises and make them available to the actors engaged in the domain in the digital format (c) establishment of electronic extension centers at district, block and village level, (d) training of extension personnel and farmers on use of different information technologies (e) development and promotion of local community managed agricultural Services using modem communication technologies (f) development of interactive information network catering to the needs of extension professionals, researchers, students, farmers and entrepreneurs (g) provision of online information on weather, pest and disease, price and market situations.

Many of the extension services that are in operation largely failed to address communication issues. The basic philosophy of communication for development aims at access and flow of information among development agents towards the betterment of society. As a resource, Information and Communication Technologies (ICTs) can provide the base to provide access to information and training of development workers on communication. Broadly ICTs consist of electronic and digital means of capturing, processing, sharing, storing and retrieving information for broadcasting by using radio and television; and transmission of speeches, data and images using telephones, faxes, e-mail and Internet through fixed, wireless and/or satellite networks. Among ICTs electronic mail is the most commonly used followed by the World Wide Web, which enables people to access information from other computers in cyber space.

The cravings for ICTs for extension are due to their characteristics that have the potential to positively influence the extension systems. ICTs hold the key to rural development as they are capable of reaching many people simultaneously, overcoming geographic boundaries, providing frequency and repetition of contact, storage of information on-demand access, capturing the reality of events by depicting them geographically and in real time, and greater efficiency (lower costs) in sending and receiving information. The overall development of rural areas is expanding in new

directions as ‘traditional societies’ are being transformed into ‘knowledge societies’ all over the world. The link between development and the increased use of ICTs in development is based on two assumptions: that a new kind of economy is emerging – an information economy; and secondly, that the main constraint to development is knowledge or information gaps. Agricultural extension, whether public or private, cannot properly function without a continuous flow of appropriate innovations from a variety of sources (local and foreign). The assertion that a knowledge gap is an important determinant of persistent poverty and that many developed countries already possess the knowledge required to assure a universally adequate standard of living, suggests the need for policies which encourage greater communication and information flows within and between countries. ICTs have actually been applied in many development efforts to bridge the information gap. ICTs have been used as tools and a source to provide knowledge and information to service providers (extension professionals), reach a wider audience (farmers), and to solve rural development problems. Moreover, ICTs have been used to provide relevant information to farmers to improve their productivity, increase yields, and obtain better prices for their products. The most significant ICT applications are providing efficient access to useful information; securing adequate feedback for learning; providing tailor made advice; exchanging of similar experiences of people elsewhere; and providing inventory and/evaluation of opinions.

A major initiative to use ICT tool for the promotion of agricultural extension activities in India has been done by the ICAR through Agricultural Research information System (ARIS). The aim of ARIS is to modernize and bring information management culture in national agricultural Research system. The goal of ARIS is to strengthen information management culture using modern tools within the Indian NARS so that agriculture research becomes more efficient and effective. The major objectives are (a) to put information close to the managers and scientist, (b) to build capacity to organize, store, retrieve and use of relevant information into the agricultural research infrastructure (c) to share information over NARS and to improve the capacity to plan, execute, and monitor research programmes. Through this initiative a minimum hardware and software is given to 49 ICAR institutes, 10 project Directorates, 27 National research centers, 28 state agricultural universities and 120 zonal research stations. This has enabled these institutions to get electronically connected. Beside these the SAUs are encouraged to create local Area Network (LANs) in their campuses.

The ARIS has three operational information modules namely: agricultural research personnel information system (ARPIS), agricultural research financial information system (ARFIS) and agricultural library information system. In addition, there is agricultural research information Center as the central source of information on all research projects and schemes financed by ICAR. The ARPIS includes a data base about the details of ICAR scientists, technical and administrative personnel at a central place so as to provide easy access to different types of information, which help management in planning personnel, man power planning, identification of subject matter specialist in various field, research work being undertaken on different commodities with respect to agro climatic zones and resources used.

The ARFIS software package has been developed for computerization of accounts with the details of ICAR scientists, technical and administrative personnel at a central place so as to provide easy access to different types of information, which help management in planning personnel, man power planning, identification of subject matter specialist in various field, research work being undertaken on different commodities with respect to agro climatic zones and resources used.

Agricultural research library information system is to facilitate on-line access by Indian agricultural scientist to the international data base and scientific literature, new data base on Indian agricultural and socio-economic research and development and external data base available through the internet. The Agricultural Resource Information Centre (ARIC) is maintained at the Directorate of Information and publication of agriculture of ICAR and serves as the national input centre for the AGRIS data base of International Information System for the Agricultural Sciences and Technology of the FAO.

4. Paradigm for the Future: DEAL

ICT output, no matter how well represented, is usually one-dimensional. Digital archiving of information encompassing text, audio, graphics and video is only the first step to cultural preservation. The second is placing the information in a meaningful knowledge management system where it can be used and maintained by the actors participating in it.

The focus of DEAL project was to create a digital knowledge base on agriculture and rural livelihood domain by involving various actors in the co-creation of content process. It also aimed at building a social network through the facilitation of ICT tools among various actors working in the domain. DEAL assumed that enablement of a co-creation of content process will eventually constitute a social network leading to an electronic community and finally to a self-sustaining community network in the agricultural domain in the condition that, the infrastructural facilities require to construct community network will be available to the actors as time proceeds. With this framework it involved various agricultural scientist, village level extension worker and experts, agricultural universities, research institutes, Non-Governmental Organizations (NGOs), international bodies working in agriculture and rural livelihood domains.

The broad objective of the project was to initiate recursive, reflexive and self-reinforcing knowledge creation and network building process. DEAL tried to resolve the complexities within the structure of knowledge at its initial stages of inception. Creating a knowledge space and content management system in the domain required that both the explicit and tacit form of knowledge are captured and integrated.

5. DEAL: Conceptual Model

It conceptualized the two streams of knowledge (explicit and tacit) as '*Gyandhara*' and '*Janagya*n'. The Gyandhara was based on the assumption of formal-scientific knowledge, where as Ganagyan focused on all the localized, everyday and context based knowledge which is tacit in nature.

In order to create a content management system in the stream of Gyandhara, DEAL solicited the participation of a few KVKs working in the region. With the help of the Zonal Coordination Unit IV of ICAR five KVKs of the region (KVKs of Daleep Nagar, Kannauj, Pratapgarh, Raibareily and Unnao) were selected to participate in the project. The aim was to promote a space where experts of the domain are expected to participate in sharing and exchange their knowledge in a digital architecture. It was proposed that the scientist at the KVKs will provide the content for the portal and use the content of other experts and scientists working in the domain (particularly of other participating KVKs) that will be available at the portal which will be enabled through internet. This it self was a barrier as only two of the KVKs has internet connection (one with high band width and the other low). As an alternative an agricultural scientist was deployed at each KVK by DEAL to facilitate the process of content creation. The agricultural expert of the DEAL manually and verbally

collected the content which was then edited and added to the portal. It was proposed that the agricultural scientist will update the content at the KVKs computer manually through data transfer in a CD. The process at the beginning worked smoothly. But as the complexity of the portal grew the agricultural scientist found it difficult to update. Thus a computer expert was appointed to update the content at the KVKs. At present the content is collected from the agricultural scientist at KVK by the agricultural experts manually and the updating of the portal at the KVK are done manually.

Due to its very nature Janagyan on the contrary required different orientation. The first and foremost task in this venture was to collect the tacit knowledge from the local actors. For this the agriculture expert of DEAL visited the local actors and in the beginning collected them in the text format. It is noteworthy to mention that a majority of the local actors when visited queried about solutions to their difficulties in everyday practices relating to agriculture and livelihood issues. Looking at this complexity DEAL decided to develop a blog at its portal, where the users can put their questions and get answers to it. Simultaneously it was felt that developing a text based blog might not be of much help to the local actors as majority of them have no skill in computer. As an out come of this the DEAL developed an audio blog (Kisan Blog) for the same purpose. The blog with its easy operability provides facilities to the users to post their queries and knowledge in both audio and text format and get response to it in the similar way.

The DEAL project faced some of the structural constraints. Infrastructural barriers were a major problem in all the KVKs, which hindered the process of co creation of digital content. Beside it a majority of the scientist lack skills in computer literacy which is a barrier in self reinforcing knowledge creation tool at the KVKs. Yet the experience of DEAl shows that once the opportunities are given the participating KVKs has taken personal initiatives to train the man power in computer literacy.

Currently though the Government has taken initiatives to promote the use of ICT in agricultural domain yet digitization of agricultural services and knowledge base is not a structured agenda of the agricultural extension in India. A sustainable ICT project at technical front requires the followings: computer literacy programme, infrastructure and organized network. ICT facilitated extension services provides access to a wider range of extending communication possibilities. It has ability to draw more peripheral participants, and provide access to a wider set of contacts. Formation of such wider set of contacts promotes individual’s knowledge base, and helps to take advantage of new opportunities However this largely depends on the infrastructural resources, social structures and norms where the actors operate.

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Sociology of Digital Communities – Select Dimensions and Research Questions on Agency

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(An earlier version of the paper was presented at OPAALS Workshop, IIT Kanpur, Feb 2008 entitled 'Locating Agency in a Digitally Facilitated Knowledge Architecture'. This Version of the paper has been communicated to COMNET 2008, 3rd International Workshop on Wireless Community Networks)

*The research on which this paper is based is funded by OPAALS Project of the European Union. However the findings, interpretations and conclusions expressed in this paper are entirely those of authors.

Abstract: A majority of Indian farmers are challenged by literacy, language and social barriers when accessing knowledge of scientists. This constrains their ability to use the expert knowledge for solving emerging problems. Thus there exists a wide gap in terms of theory, research and practice in the agriculture domain. But on the other hand contemporary digital technology provides a way to the farmers to explain their problems in an easy and convenient way to the scientists in their laboratory and get feedback. Cultivating digitally facilitated knowledge and skill networking is a highly potent strategy to achieve the goals of productive, profitable, stable and globally competitive agriculture.

This paper aims at understanding some of the key sociological issues involved in facilitating digital technology in agriculture and rural development domain. Highlighting theoretical understandings of 'structuration' theory and 'social becoming' in conjunction with the empirical observations from the DEAL project we propose that digital technology has potential capabilities in transforming the agency and building praxis in agriculture domain. But this has to be approached with judicious socio-technical strategy.

1. Emerging Digital Communities in Indian Agriculture

The educational experiments show that many Indian farmers do not have the ability to explain and interpret the expert knowledge that is available through official publications and scientific journals, though the farmers themselves are practicing experts.

Digital technology can give farmers the choice to get right options at real time in a right way. It is widely recognized that the development agriculture today is mostly dependent on the effectiveness of agricultural extension, because new pests, new diseases need new solutions and new methods can

significantly enhance yield. Rapid growth of digital technology and use of knowledge as a basic power to deal with global competitiveness have revolutionized all learning systems. Cultivating digitally facilitated knowledge and skill is a highly potent strategy to achieve the goals of productive, profitable, stable and competitive agriculture (Chatterjee, et al., 2006).

But while digital technologies can resolve barriers it needs newer forms of knowledge representation. Our research showed that while on one side there were large scale efforts to develop digital technology infrastructure at the other end hardly there were any digital content available in the agriculture domain to use. The importance of digital content in agriculture domain is clearly reflected in the 11th five year plan policy framework of India. One of the major objectives of the proposed plan is to build capacity of the extension education professionals for increased use of digital technology in virtual learning environment. Keeping the structural constraint in mind the policy frame work argues for wider user base, increasing applications and greater dependency on digital technology in National Agricultural Research System and calls for more intensive efforts in this direction. Specific activities highlighted in the policy frame work relate to strengthening of 'ICAR-Net', secured Intranet, National Agriculture Research Portal, Content development, Knowledge management, e-learning, e-Library, Financial Management System, Management Information system and an effective Communication and Public Awareness system. The Plan proposal firmly argues for digitization of existing agricultural knowledge base which includes development of e-library*:* Support for union catalogue, digitization of old journals, books, thesis, dissertations, local publications and other resources (11th Plan Policy, Government of India).

The technical issues related to the digital documents are not the subject matter of this paper. In the present paper our aim is to understand the process of agency and agency construction in a digital technology facilitated knowledge architecture in agriculture and livelihood domain. Before understanding the process of agency construction let us explore the term 'agency' and 'agency construction' according to sociology literature.

2. Agency , Agency Construction and Praxis

The appeal of information and communication networks, as a toolset for bringing about socio-technical change in a community is seductive. But earlier research (Cibora 1996) has shown that such technologies often tend to 'drift' when put to use. Drifting implies 'a slight - or some times significant - shift of the role and function of usage in concrete situations' (Cibora 1996). Our objective in the following section is to present a frame work to understand in terms of agency and praxis the phenomenon of 'drift' as an out come of two interactional processes. Drifting occurs through two intertwined processes; one through the openness of technology on the other hand through the unfolding of the actors. All social actors know a great deal about the situations and consequences of what they do in their everyday life. Thus actors colour the entire system of life cycle through a continuous stream of reflective activity.

Since long people have been seeking to answer the ultimate causes of events i.e., agency. At the beginning it was placed outside the human and social world, in the domain of supernatural. In this context agency was always operating from without, shaping and controlling individuals and collective life. The next stage brought down the agency to earth, primarily focusing on natural forces. In the third stage the agential powers were ascribed to human beings first primarily to great men who created new social orders by deviating from the already established norms (Weber 1968, Freund 1968). For example Dharendorf considered deviance as a social process. According to him 'deviance

occurs for sociologically – that means structurally unknown and knowable reasons. It is the bacillus that attacks the system from the dark depths of the individual psyche or the nebulous reaches of the outside world' (Dahrendorf 1968).

The latter stages saw the agency located squarely within the society. Society was considered largely as a self regulating and self transforming whole. Great men were of course the agents however their exceptional powers were equated as an emanation of society (Baumgartner 1976). The next step was attribution of agency to social role particularly those roles which have potential capabilities to enforce change. The most crucial step was taken when the idea of agency was extended downward, and agency was attributed to all people. The greatest contribution to this was made by Merton thorough his contribution of latent and manifest functions (Merton 1968).

The world today however is manifested in a more complex relationship where technology plays a crucial role along with human beings in its creation and organization. Current digital technology can not be separated from the on going everyday practices. The agency today is to certainly shaped by the technology that surround it along with real agents of social life; human beings (Latour 2005).

3. On Social Reality

Broadly social reality consists of two levels; the level of individualities and the level of totalities. The first level is made up of people where as the latter consists of abstract social wholes. The social wholes are interpreted as structures and social individuals as bounded agents. There are two modes of existence of social reality; the mode of potentialities and the mode of actualities. The former relates to the inherent tendencies such as; capabilities, abilities, powers etc, while the latter refers to the processes, development and activities. Structures embrace agents yet they posses their own specific properties and normative patterns. In similar way agents though their act based on their structural locations they have certain degrees of autonomy to act (Giddens 1979). In between the two there exists a third level, conceptualized as praxis; the actual manifestation of social fabric. Praxis is where operation and action meet each other, the place of confluence where the potentialities of the agents and actualities of the structure are realized (Marx and Engles 1968, Lukacs 1971).

Praxis is what stands for the constitution of social life. In more simplistic sense it is the manner in which all aspects, elements, and dimensions of social life, from simple everyday act to the most complicated of collectivities are generated through performance of social conduct (Cohen 1989).

Essentially social life is constituted through social practices. For sustainability, firstly it is required that 'knowledgeability' is associated with practices carried out in a collectivity beyond the life time of any agent or any cohort of agents. A second pre-requisite is the designation of means where by mutual knowledge is preserved and transported across time and space between situations where such practices are reproduced (Cohen 1989). Agents in social situation are conditioned by structures of power relations which are based on resource domination. This provides agents two kinds of facilitating capabilities. At one side the 'allocative resources', capabilities that can be used to generate power over naturally constituted world and at the other side 'authoritative resources' that supply administrative capabilities to control over the socially constructed world (Giddens 1981 and 1984). Thus essentially structures on which the agents operate are conditioned by two types of structural resources. However in reality of social life, agents operate on multiple structures what Merton speaks of as 'role set'. Merton says that a particular individual operates not on a single associated role but an array of associated roles (Merton 1968). For example the single status of

agricultural expert in our context entails not only the role of a scientist but also an array of other roles relating to other experts in the domain and the authorities. Each of these structural positions of the agents in terms of multiple role sets is conditioned by the relations of power of each structure. Agents' actions are regulated by power relations as well as established normative structural orders.

In real terms praxis is the actuality, the manifestation of social fabric and agency is the thing which is actualized, or manifested. However both are conditioned by structures of power relation. In general it is the tendency in the social fabric allowing praxis to emerge. Thus agency is correlative to praxis located at same level but refers to a different mode of existence i.e., the potentiality for praxis. Agency implies the properties of social fabric. It is where structures and agents meet. It is double conditioned both from above by the balance of constraints and limitations as well as resources and facilities provided by existing structures and power relations and from below by abilities and knowledge of social members.

However it is not reducible to either of the two rather it makes up a new emergent quality. Beside its vertical relations agency is also linked to the structures and agents horizontally in terms of its association with praxis. The horizontal link between agency and praxis is coded as 'eventuation'. It is a convergence of actualizations going on at other levels; a combination of the unfolding of structures and mobilization of agents. Thus it is conditioned from above as well as from below and also represents an emergent quality. It is important to note that eventuation is only a possibility not a necessary condition (Sztompka 1993).

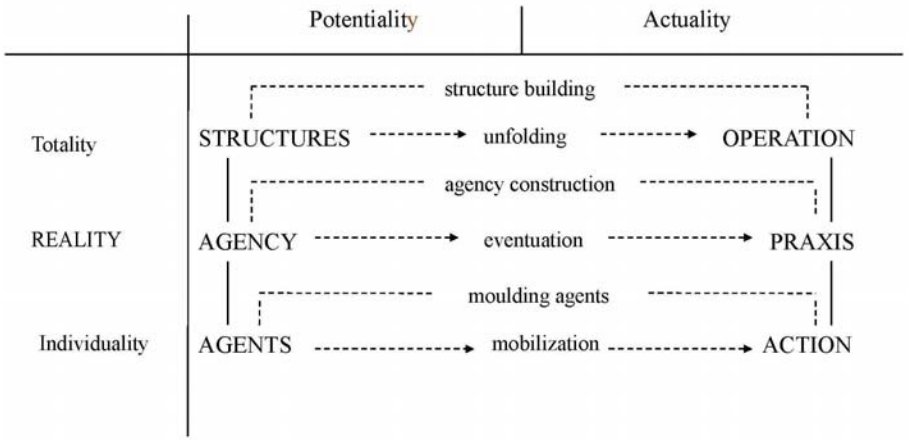

Figure 1: Agency Construction
Source: Pitor Stzompka 1991

In most simplistic way relations between potentialities and actualities are treated as linear. But in reality social life is constituted in social practices. 'Structure is both medium and outcome of the reproduction practices. Structure enters simultaneously into the constitution of . . . social practices, and "exists" in the generating moments of this constitution' (Giddens 1979). Thus there is duality of structure, in similar way there are duality of agents. This relates to the issue of feedback in the model. The first is the self modifying propensities of structures; those reshaped by their own operation representing the process of structure building. The second relates to the self modifying propensity of agents, those reshaped by their own action i.e., moulding of agents. Applying the same idea to the mediating level of structural agential reality will present the process of agency construction implying agency is significantly reshaped by praxis (Figure 1).

4. Agency in a Digital Technology Facilitated Architecture: The DEAL Case

Ensuring a thriving agricultural economy is critical for India's global competitiveness to be 'inclusive'. A globally competitive Indian economy must be based on knowledge driven transformation of Indian agriculture because agriculture which engages more than 60 percent of Indian population has already reached the physical limits of growth. This necessitates that the response of cropping patterns in hinterlands of India respond to global commodity markets in real time. All these mean quick dissemination of technical information from the agricultural research system to the farmers and an effective feedback system. The one-way route of conventional agricultural extension system needs rapid transformation to a 'real time and adaptive' knowledge exchange network. This network needs to build feedback routes from the 'fields to the laboratory'.
The Digital Ecosystem for Agriculture and Rural Livelihood (DEAL) project in India sought to derive traction from business knowledge management technologies and processes like user to user exchange, expert to expert exchange and Knowledge Management (KM) oriented standards for information storage, retrieval and aggregation. With this view the DEAL project was stared as a collaborative work involving several stakeholders working in agriculture domain.

4.1. Need For Collaborative Practice

In general community is essential to human condition. In the sociological tradition community has been known since the time of Tönnies's writing as Gemeinschaft and Gesselschaft. However modern society is caught in contradictory self- representation- antimony of individualism and community, with neither side sufficient to ground relation in an increasingly interdependent and dynamic society. Thus the thick Gemeinschaft trust are comforting but stifling; the thin forms of Gesellschaft trust are liberating but alienating; and their combination is unstable, with the latter progressively corroding the former. Thus there is a dialectical synthesis between the two (Adler and Heckscher 2007).

In general there are three primary principles of social organization; hierarchy, community and economic services. When the dominant principle of social organization is hierarchy, community takes the form of Gemeinschaft. When the dominant principle is economic services it takes the shape of Gesellescfat. However, when the dominant principle is community itself it takes a different form transforming the whole structure to a different form demanding more collaboration (Adler and Heckscher 2007). The society in the current transformative era is passing through an age of great transition where a dialectical synthesis of the traditional opposites Gemeinschaft and Gesellschaft is eroding away leading to new forms of collaborative structural organizations.

Looking at this process of great transformation the DEAL project took a collaborative approach for its action plan. The actors involved in the project consist of several national, international and local agencies working in the domain. Knowledge nuggets and inputs are from them. To develop a semantically interoperable knowledge repository, inputs are gathered from the World Agricultural Information Centre at FAO, Rome and ICRISAT in Hyderabad, India. The project is deployed through existing KVKs of the agricultural extension system.

5. From Theory to Understanding Agency

The purpose of the paper is to understand the agent, agency and praxis in digital technology facilitated architecture by understanding the process of information sharing between several actors

working in the domain. Tonnies suggests that through his Gemeinschaft and Gesselschaft distinction that evolution drived by economic needs leads to Gesellschaft. However among the contempoary digital communities the structure embodies of collaboration. This structire of colloboration itself meets its praxis though both duality of the structure and agency itself leading to “freedom” for the agents. The following section of the paper are furher elaboration of this process through practical example of DEAL project. Modern society is caught in contradictory self- representation- antimony of individualism and community, with neither side sufficient to ground relation in an increasingly interdependent and dynamic society. Thus the thick Gemeinschaft trust are comforting but stifling; the thin forms of Gesellschaft trust are liberating but alienating; and their combination is unstable, with the latter progressively corroding the former. Thus there is a dialectical synthesis between the two (Adler and Heckscher 2007).

For the purpose of study we have conducted field based observations of five participating KVKs, ICAR and the DEAL. Our study shows that in a pre DEAL scenario, in the absence of proper channel most of the scientist of the KVK operated in isolation and hardly had any opportunity to gain the information and knowledge about other scientist working in her/his area in another KVK even at the local level.

For example in the KVK at Dhaura all the scientists shared reciprocal relationships with an expert of Horticulture as he was the administrative head of the KVK. But on the other hand many individual scientists operated with minimal links with others (Figure. 2). Particularly the expert of Animal Husbandry and Home Science operated in isolation where as the Agronomist, Plant Pathologist, Farm Manager and Soil Scientist had unitary information sharing. These forms of spares relationships fail to meet the rapid changing context that affects agriculture.

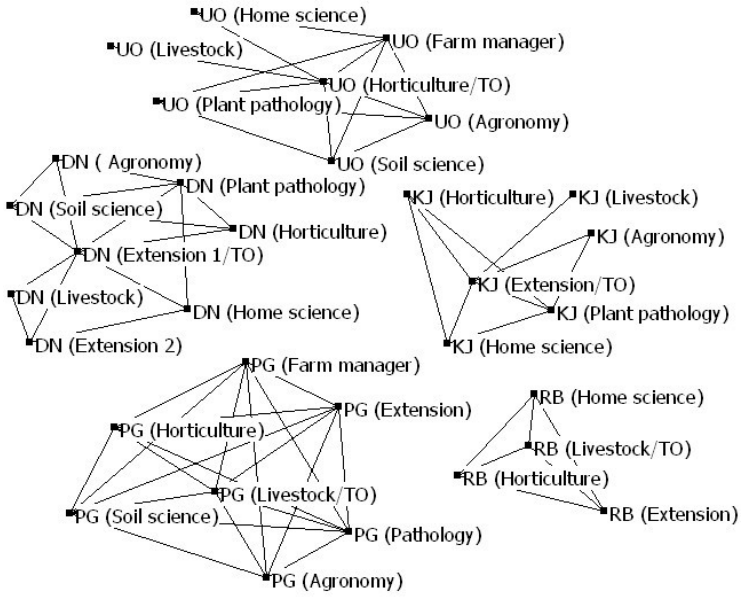

Fig 2: Information sharing in Pre DEAL Scenario without any intermediary.

The only scenario that connects one KVK to another is through ICAR mediation. In order to upgrade the subject matter knowledge and understanding of the scientist, she/he is expected to participate in various training programmes organized through ICAR at different agricultural institutions. However in reality it is either the Training Officer of the KVK or the experts of extension attend these

programmes. Thus a majority of the SMS rarely benefit from these training programmes. Individual scientists at the KVK hardly have any opportunity to share information with other scientists at another KVK. Yet such training programmes provide some opportunity for the KVKs to interact with each other and form knowledge networks (Fig 3).

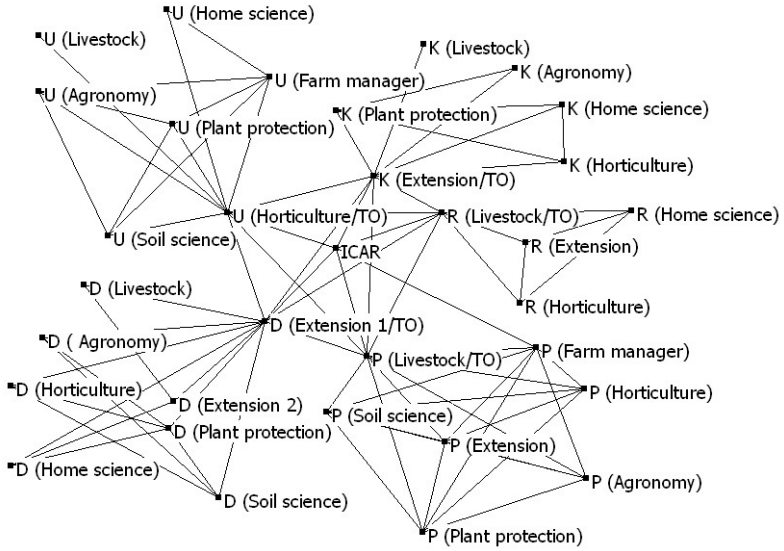

Fig 3: Information sharing in through ICAR mediation.

The thick lines in the diagram above represent reciprocal knowledge sharing developed among various experts of the KVKs through ICAR mediation, while the solid lines represent the pre-existing network ties. The lack of reciprocity among experts of different KVKs also reflects the current top-down approach of information dissemination in agricultural extension in India. Studies in network architectures suggest that centralized networks are ineffective modes of interaction for information sharing (Fahey and Prusak, 1998; Markus, 2001). In contrast to it a participatory bottom-up approach allows information sharing and communication more effectively.

The structural positioning and the inspired mode of praxis construction in a DEAL scenario is presented in Figure 4. The ICAR and DEAL represents the structural totality of the system in the figure.

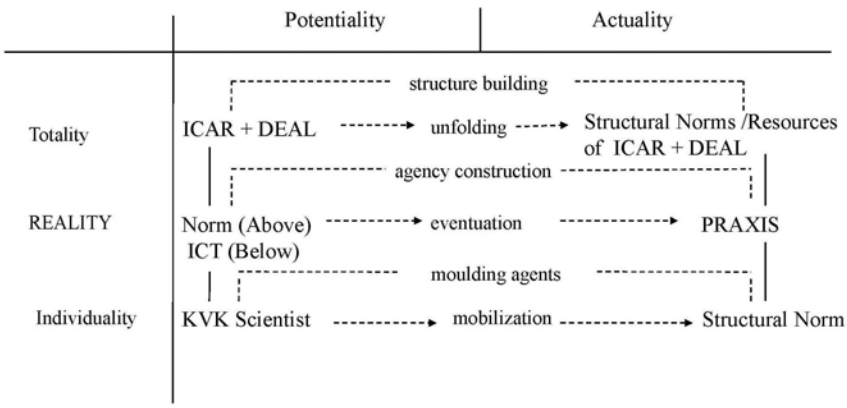

Figure 4: Agency Construction the DEAL Scenario

The process of Agency construction thus here has two modes of structure building: (a) constructed by the structural norms and resources of the ICAR which is regulated by formal norms allowing little degrees of freedom to the actors to operate and (b) DEAL capabilities providing emancipatory opportunities to the actors to realize their capabilities. This creates conditions of mobilizations for the actors to construct agency and praxis based on both structural norms of ICAR and degrees of freedom created by DEAL. The DEAL in this case provides a double conditioned mode of freedom to the actors to meet praxis, i.e., freedom to and freedom from. In terms of 'freedom to' the DEAL facilitates actors ample space to act in a digital technology facilitated architecture by providing multiple opportunities. The Figure 5 shows the network relations developed among various scientists in a post DEAL scenario.

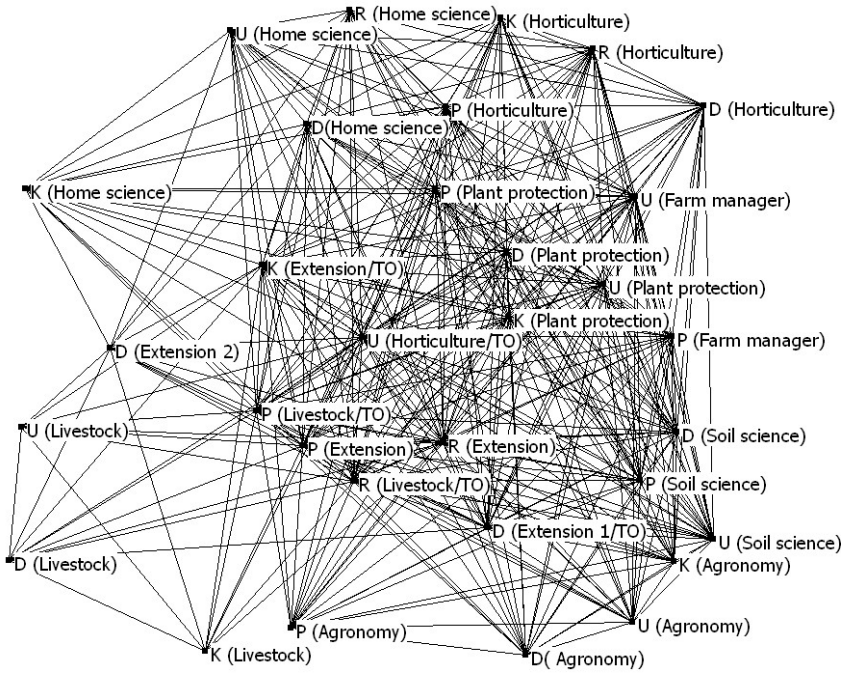

Fig: 5 Information shariong among scientist in a post DEAL scenario

6. Conclusion

The DEAL project has been somewhat successful to create a network of relationship among various scientists and extension workers for information sharing. There is a constant information flow among both within the groups and between groups. This has been done by creating a platform for different KVKs to share their extension experiences with each other through their interconnected web based knowledge repositories. We observed that the theoretical assumption that digital technology has emancipatory capabilities to actualize agency and praxis holds true to certain degree in the case of DEAL Project. The process of Agency construction thus here has two modes of structure building: (a) constructed by the structural norms and resources of the ICAR which is regulated by formal norms allowing little degrees of freedom to the actors to operate and (b) DEAL capabilities providing emancipatory opportunities to the actors to realize their capabilities. This creates conditions of mobilizations for the actors to construct agency and praxis based on both duality of the structure and degrees of freedom created by DEAL through the mechanisms of drift. The DEAL in this case provides a double conditioned mode of 'freedom' to the actors to meet praxis, i.e., freedom to and freedom from. In terms of 'freedom to' the DEAL gives the actors ample space to act in a digital technology facilitated architecture by providing multiple opportunities. By limiting the barriers towards a community network it facilitates freedom from constraints for the actors in question.

Reference

Adler, Paul. S., and Heckscher, Charles (2007). Towrds collaborative community. In Charles Heckscher and Paul S. Adler (Eds.), *The firm as a collaborative community: Reconstructing the trust in a knowledge economy*. London: Oxford University Press.

Baumgartner, Tom, Buckly, W., Burns, T. R. and Schuster, P. (1976). Meta power and the structuring of social hierarchies. In T. R. Burns and W. Buckley (Eds.), *Power and control*. Beverly Hills: Sage.

Cibora, Claudio. (2004). Encountering information systems as a phenomenon. In Chrisanthi Avegerou, Claudio Cibora and Frank Land (Eds.), The social study of Information and Communication Technology: Innovation, Actors and Context. Oxford: Oxford University Press.

Latour, Bruno. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press.

Chatterjee, J., Runa Sarkar and T. V. Prabhakar (2006). 'From the Policy Framework for Competitive Agriculture to a Knowledge Ecosystem Development Process-Some Empirical Findings,' n.d. (Digital Document).

Cohen, Ira J. (1989). *Structuration theory: Anthony Giddens and the constitution of social life*. Newyork: St. Martin Press.

Dahrendorf, Ralf (1968). Essays in the Theory of Society. Stanford University Press, Stanford.

Fahey, L. and L. Prusak (1998). 'The Eleven Deadliest Sins of Knowledge Management.' California Management Review 40(3): 265-76.

Freund, Julien. (1968). The Sociology of Max Weber. Random House, New York.

Giddens, Anthony. (1979) Central Problems in Social Theory. Macmillan, London.

Giddens, Anthony. (1981) A Contemporary Critique of Historical Materialism: Vol 1: Power Property and the State. MacMillan London.

Giddens, Anthony. (1984) The Constitution of Society: Outline of the Theory of Structuration. Polity Press, Cambridge.

Kinuthia, Wanjira. (2007). Instructional Design and Technology Implications for Indigenous Knowledge: Africa's Perspective. In L. E. Dyson, M. Hendricks and S. Grant (Eds.), *Information Technology and Indigenous People* (pp. 3-57). London: Information Science Publishing.

Lucas, Gyrogy. (1971) History and Class Consciousness. MIT Press, Cambridge MA.

Markus, M. L. (2001). 'Toward a Theory of Knowledge Reuse: Types of Knowledge Reuse Situations and Factors in Reuse Success.' Journal of Management Information Systems 18/1(Summer): 57-93.

Marx, Karl, and Engles, F. (1968) Selected Works. Progress Publishers, Muscow.

Merton, Robert K. (1968) Social Theory and Social Structure, New York, Free Press.

Stzompka Pitor (1993) The Sociology of Social Change. Blackwell, UK.

Weber, Max. (1968) On Charisma and Institution Building. The University Press Chicago, Chicago.

Appendix 1

Acronyms

DEAL: Digital Ecosystem for Agriculture and Rural Livelihood
FAO: Food and Agriculture Organization
ICRISAT: International Crops Research Institute for Semi-Arid Tropics
ICAR: Indian Council of Agricultural Research
KVK: Agricultural Science Centers

9

A Topic Map driven Portal for Agriculture Information

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Abstract - Topic Map is a new semantic web technology which separates semantic connectivity from content and can be applied in conceptual navigation systems. In this article, we describe a methodology to build topic map driven portals and our ongoing effort to make such topic map driven portals for Agriculture information in Indian languages to help the farmers of India.

1. Introduction

Data in a data source are useful because they model some part of the real world, its subject matter (or application, or domain of discourse). The problem of data semantics is establishing and maintaining the correspondence between a data source and its intended subject matter. Future information systems will have to support smooth interaction with a large variety of independent multi-vendor data sources and legacy applications, running on heterogeneous platforms and distributed information networks. Metadata will play a crucial role in describing the contents of such data sources and in facilitating their integration.

The advent of the web has changed a lot of things around us. Databases today are made available, in some form on the web where users, application programs, and users are open-ended and ever changing. In such a setting, the semantics of the data has to be made available along with the data. For human users, this is done through an appropriate choice of presentation format. For application programs, however, this semantics has to be provided in a machine processable form. Hence the call for the Semantic Web.

The term *Semantic Web* comprises of techniques that promise to dramatically improve the current WWW and its use. The aim of the Semantic Web is to allow advanced knowledge management systems. The key features of such systems would be as follows:

(a) Knowledge will be organized in conceptual spaces according to its meaning.

(b) Automated tools will support maintenance by checking for inconsistencies and extracting new knowledge.

(c) Keyword-based search will be replaced by query answering: requested knowledge will be retrieved, extracted, and presented in a human friendly way.

(d) Query answering over several documents will be supported

Several technologies has been developed from the day call for Semantic Web came from Berners-Lee to fulfill the vision of semantic web. Some of the standardized Semantic Web technologies along with their features are:

(a) XML provides a surface syntax for structured documents, but imposes no semantic constraints on the meaning of these documents.

(b) XML Schema is a language for restricting the structure of XML documents.

(c) RDF is a data model for objects (‘resources’) and relations between them, provides a simple semantics for this data model, and these data models can be represented in an XML syntax.

(d) RDF Schema is a vocabulary for describing properties and classes of RDF resources, with a semantics for generalization-hierarchies of such properties and classes.

(e) OWL adds more vocabulary for describing properties and classes: among others, relations between classes.

Portal development has always been a hard task: it consumes time and resources. What is new today is normally taken as granted tomorrow by users. This is to say that users always want more. Today they want up to date information and they want to access it to access it according to their point of view or particular preferences. To cope with these demands, websites must be dynamic and must be able to reconfigure automatically their structure, content and appearance. This scenery has favored the creation of tools for automatic generation and management of portals. In this paper we propose not a new tool of this kind but a new approach to the problem. In our approach we consider two layers. A physical layer that we call the resource layer, composed by HTML documents, directory sub trees, and whole sort of files you can think of to represent your information. A metadata layer called the knowledge layer, that provides a view to those resources. We found that Topic Maps fit suitably into this solution and decided to use them for developing Agriculture information portals in Indian language to help the farmers.

2. Topic Maps

A topic map is a formalism to represent knowledge about the structure of an information resource and to organize it in topics. These topics have occurrences and associations that represent and define relationships between them. Information about the topics can be inferred by examining the associations and occurrences linked to the topic. A collection of topics and associations is called a topic map.

Topic maps can be seen as a description of what is about a certain domain, by formally describing topics, and by linking the relevant parts of the information set to the appropriate topics.

A topic map expresses someone’s opinion about what the topics are, and which parts of the information set are relevant to which topics. Charles Goldfarb usually compares topic maps to a GPS (Global Positioning System) applied to the information universe.
Enabling to create a ‘virtual map’ of information, the information resources stay in its original form and so they are not changed. Then the same information resource can be used in different ways, for

different topic maps. As it is possible and easy to change the map itself, information reuse is achieved.

Topic map architecture also allows merging between topic maps without requiring the merged topic maps to be copied or modified.

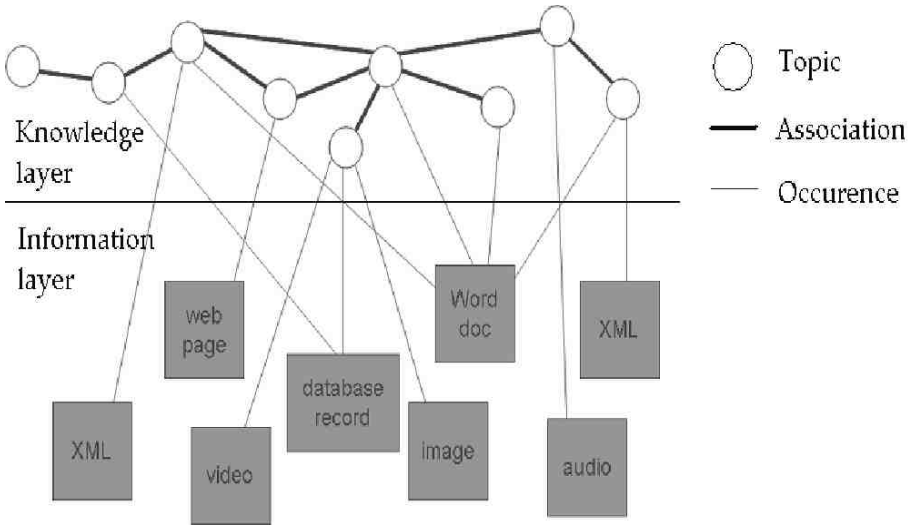

Figure 1: A Sample Topic Map

3. The characteristics of Topic Maps Model

Topic: *Topics* are the main building blocks of topic maps. In its most generic sense, can be anything. A person, an entity, a concept, really anything regardless of whether it exists or has any other specific characteristics. It constitutes the basis for the topic maps creation. It can be seen as a 'multi-headed link that points to all its occurrences'. This 'link' aggregates information.

Each topic has a topic type or perhaps multiple topic types. *Topic Type* could be seen like a typical class-instance relationship. Types represent the classes in which topics are grouped in, i.e., the category of one topic instance. Topic types are also topics (by standard definition).

Occurrence: A topic can have one or more occurrences. One or more addressable information resources of a given topic, constitutes the set of *Topic Occurrences*. It might be a monograph devoted to a particular topic, for example, or an article describing the topic; it could be a picture, audio or video describing the topic, a simple mention of the topic in the context of something else, or any of a lot of other forms in which an information resource might have some relevance to a topic. The occurrences can be an Universe Resource Identifier (URI). A topic occurrence represents the information that is specified as relevant to a given subject.

The separation in two layers of the topics and their occurrences is one of the great features of Topic Maps. Occurrences establish the routes from the topics to the resources, enabling also to provide the reason why that route exists. Among all occurrences of a given topic, a distinction can be made among subgroups. Each subgroup is defined by a common role. Occurrence role can be used to distinguish graphic from text, main occurrences from ordinary occurrences etc. 'The occurrence roles

are user-definable and therefore can vary for each topic map'. The standard also defines occurrence roles as topics.

Association: Topic Associations are almost ordinary links, except that they are constrained to only relate topics together. Because they are independent of the source documents in which topic occurrences are to be found, they represent a knowledge base, which contains the essence of the information that a someone is creating, and actually represents its essential value.

The power of topic maps increases with the creation of topic associations because that way, it is possible to group together a set of topics that are somehow related. This is of great importance in providing intuitive and user-friendly interfaces for navigating large pools of information.

As topic types group different kinds of topics and occurrence roles supports occurrences of different types, associations between topics also be grouped according to their type (Association *type*).

It is important to refer that each topic that participates in an association has a corresponding association role which states the role played by the topic in the association. Association roles are also regarded as topics in the topic map standard.

The UML diagram given below clearly explains the various components of a topic map from a software architect point of view.

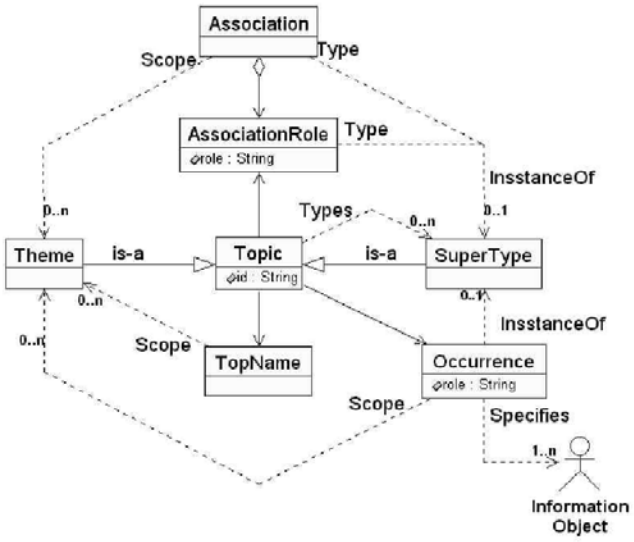

Figure 2: Components of a Topic Map

4. Topic Map driven Portal

A topic map separates semantic connectivity from the content and can be nicely applied in conceptual navigation systems. Topic map can be considered as GPS of the information universe, rightly said by Charles Goldfarb, offers powerful ways of describing universe of interconnected resources and HTML offers an excellent way to deliver browsable information via the web. So, there

is a perfect match between both of them. Apart from this there are several advantages of going for Topic Map driven portals. Some of them are listed below:

(a) Site search: faster searching, improved search / browse cycle, semantic enrichment of search queries.
(b) Platform and software independence
(c) Ease, simplicity and beauty
(d) Facilitate structuring information, management of sitemap and metadata
(e) Easily merge-able with other topic map based websites
(f) Maintenance of large, complex websites will become fairly simple
(g) Consistent look and feel throughout entire website

Generally, the heart of every topic map application is what is known as the *topic map engine*, which is roughly equivalent to an RDBMS database engine, but designed for topic maps. This component knows how to import and export various topic map syntaxes, store, update, and query topic maps, and so on. The application that implements a topic map-driven portal will sit on top of this engine and use it to access and query the topic map. The step by step procedure for building a topic map driven website is as follows:

(a) Topic Mapping: One has to identify the subjects of interest and the relationship between them.

(b) Topic Map creation: Create the topic map using any topic map editor having nice user-friendly GUI like Topic Map designer, TM4L to name a few. There will be only one Topic Map document whatsoever that contains and controls content and structure of the whole portal.

(c) Topic Linking: Every *topic link* is rendered as a separate page. There is no more than one page for a topic.

(d) Web page layout: Fix the layout of the webpage and prepare a style sheet accordingly. In this way there will be consistent look and feel throughout the portal.

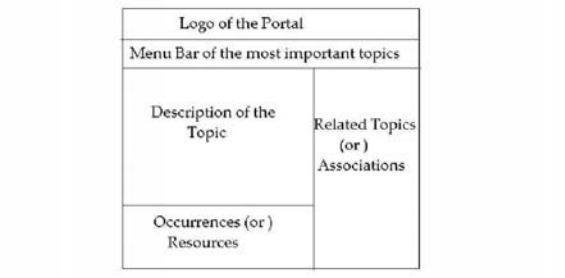

Figure 3: Sample layout of the webpage

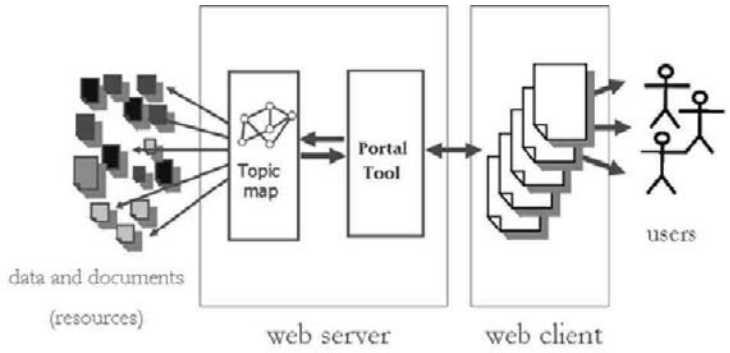

Figure 4: Topic Map Driven Portal Architecture

There are two ways of generating the web pages of the portal using the tool namely:

(a) **Portal generating tool:** Normally topic maps are stored in XML due to the advantages it has when compared to other storage formats. A portal generating tool and the topic map resides at the web server as shown in fig 4. It extracts all the information regarding a particular topic from the topic map like the related topics with their associations, its various occurrences and renders a webpage for the topic according to the layout fixed.

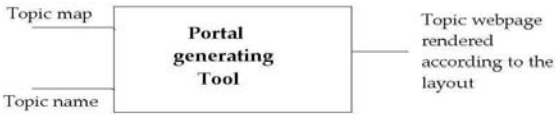

Figure 5: Portal Generating Tool

Static: This is an off-line process in which the tool is run on every topic and the corresponding topic web pages are generated. All requests by the clients are served by the web server without any delay as all the web pages are readily available, there by reducing the load on the web server. In this case the portal is good as a normal website serving static pages, the only difference being all the web pages are automatically generated by the tool. The only disadvantage being that, if topic map is modified the tool has to be run once again on every topic to keep the portal up-to-date.

Dynamic: This is an on-line process in which the requested webpage is dynamically generated on-the-fly by running the tool on that particular topic. The main disadvantage of this method being, with the increase in clients connected to the web server, the load on the web server increases drastically. Where as, the advantage is that, as the web pages are generated dynamically on-the-fly when they are requested, any changes done in the topic map are reflected in them and the portal is up to date.

Having mentioned the advantages and disadvantages of both the methods, the choice is left to the administrator to decide between them. However, we prefer the ‘Static’ method for obvious reasons. Once we have such portal generating tool in our hand then it is just a matter of running that tool on the topic map to generate the topic map driven portal and can be nicely reused to save both time and money in developing such portals.

5. Preliminary Results

We have developed a portal generating tool in C language using the UNIX utilities LEX and YACC as part of our mission which generates the web pages of a topic map driven portal from the topic map. We have tested this tool on some sample topic maps and got satisfactory results. We will make this tool publicly available for download along with the source code after testing it rigorously. Our Agriculture Scientists at Media Lab Asia, IIT Kanpur are working on developing topic maps and up to date digital content in various Indian languages for agriculture products like pulses, cereals, rice, wheat, vegetables, fruits, poultry etc. Once the topic maps and digital content are created, we will run the portal generating tool to generate the web pages and upload them at URL:
http://emandi.mla.iitk.ac.in/deal/tmportal/index.html.

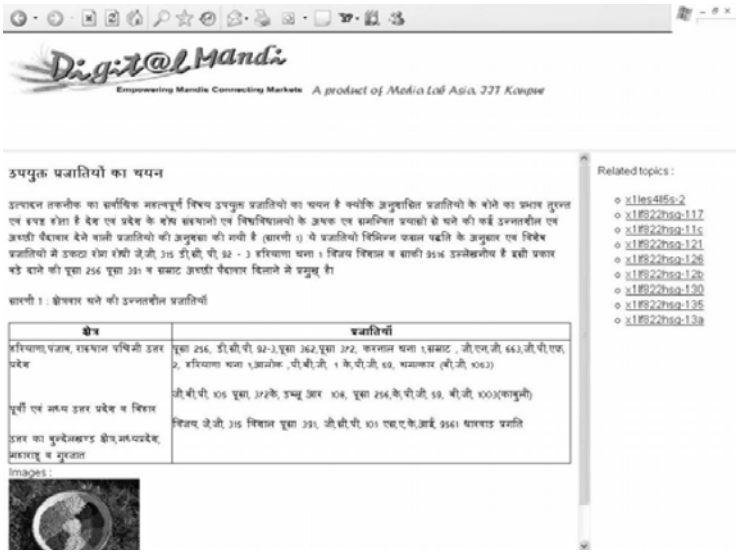

Figure 6: Snapshot of a Sample Web Page

6. Conclusions and Future Work

Topic Map is a new semantic web technology which separates semantic connectivity from content and can be applied in conceptual navigation systems. . In this article, we described a methodology to build topic map driven portals. We have developed a portal generating tool which generates topic map driven portal from the topic map. We are working on building topic map driven portals for Agriculture information in Indian languages to help the farmers of India. We are planning to use this tool to modify our existing Digital Mandi portal and Gita Supersite portal to make them topic map driven. We are working on a relational model for Topic Maps (if the topic map grows XML file would no longer be the proper way to store it).

References

Berners-Lee, T., (1999). *Weaving the Web: the original design and the ultimate destiny of the World Wide Web by its inventor*. San Francisco: Harper.

Goldfarb, Charles F. and Paul Prescod, P. (2001) *XML Handbook*, 4th edition. USA: Prentice Hall.

Park, Jack, Hunting, Sam, and Engelbart, Douglas C.(2003). XML topic maps: Creating and using topic maps for the Web.USA: Prentice Hall.

Pepper, Steve. (n.d.) *The TAO of Topic Maps-finding the way in the age of info glut*. Last Acesed July 14, 2008, from INTERNET: http://www.ontopia.net/topicmaps/materials/tao.html.

Pepper, Steve and Moore, Graham (n.d.) XML Topic Maps (XTM) 1.0. TopicMaps.org specification, Last Acessed Last Acesed July 14, 2008, from INTERNET: http://www.topicmaps.org/xtm/1.0.

Web Sites

http://emandi.mla.iitk.ac.in/index.htm
http://www.gitasupersite.iitk.ac.in/
www.topicmaps.org
www.ontopia.net/omnigator/

10

Building Multilingual Agriculture Thesaurus in Indian Languages

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Abstract: The paper discussed the process of building multilingual agriculture thesaurus in Indian Languages. Thesaurus, being one of the most important instruments in information retrieval has a special role in scientific research. Its importance increases proportionally to the preciseness of the users request. Dissemination of agriculture information in rural areas needs a seriously formulated thesaurus. In this article, we descried a methodology to build multilingual data repository for computer based ontology creation for Agriculture in Indian Languages.

1. Introduction

The Indian agricultural sector is leveraging the Information and Communication Technologies (ICT), to explore the great challenges in information retrieval for scientists as well as for farmers. As one of the most important instruments with the great demand for proper and prompt information, subject thesaurus emerges with its dual role in scientific research as both a scientific subject and a scientific tool at the same time. Its importance increases proportionally to the preciseness of users' requests. Thesaurus as a descriptor language, a controlled and dynamic documentary language containing semantically and generically related terms, requires professional and continual supervision with the aim of giving corrections and extensions in time. Treating problem of thesaurus in this way means that only team work of similar specialists can provide well formulated and structured thesaurus which is for serious use and also relatively easy.

After establishing the thesaurus, it needs permanent redaction of terminological corpus, replacing old and introducing new actual terms, coordination of various linguistic and language versions as well as analysis of efficiency and usability of basis. The percentage of positive answers to users requests is the best indicator of thesaurus validity.

As early as 1985 International Standardization Organization (ISO) had issued ISO 5964 standard on the formulation and revision rules in multilingual thesaurus. Then, many countries compiled their thesauri on different domains. We have decided to convert Multilingual Agricultural Thesaurus (AGROVOC) to build Multilingual Indian Agricultural Thesaurus.

2. Introduction to AGROVOC

Food and Agriculture Organization (FAO) published the first edition AGROVOC in 1982, and then published the second, third and fourth editions in 1988, 1995, and 1999, respectively. And FAO had issued the network edition in 2000. The current edition had five languages, namely English, French, Spanish, Chinese and Arabic. AGROVOC has a total number of 16 700 descriptors, and 10 758 non-descriptors, which are specific descriptors and terminological terms used in agricultural science.

Initially, AGROVOC was used for indexing information materials produced within the international cooperative information systems AGRIS and CARIS, and for data retrieval from those systems. Nowadays, AGROVOC is used more widely to retrieval agricultural information materials all over the world.

Technical Details about Agrovoc database:

Total Agrovoc English terms: 27,898

Term without BT relations: 1560

Term without NT relations: 7

Term with NT and BT relations=23

Term without relations = 0

Term with relations=15176

Non-Descriptor with USE relations=10801

Non-Descriptor with SEE relations=0

Non-Descriptor without relations=158

Proposed term=0

AGROVOC version=1

Deleted term=172

1. Domain Knowledge

The subject scope of AGROVOC includes comprehensive agricultural sciences and descriptors in related domains. As AGROVOC is used by international organizations, it has a boarder scope of descriptors and non-descriptors. There are about 20 domains in AGROVOC but we are focusing on agriculture domain.

There are two ways to do this conversion. First, translators having background in comprehensive agriculture can convert descriptors and non-descriptors concept, but this process is time consuming and require lots of domain specific and technical expertise to meet standard of International Standardization Organization (ISO). Another way is based on existing ISO certified thesaurus like AGROVOC. In this way, we need only word to word conversion.

However, the translators should have the background of foreign language (English). For example, the descriptor ‘stock’ has different meanings. It was used in economics, horticulture, storage, but the professional people know the correct meanings in their corresponding domains. For example, the ‘stock’ has the meaning of stock-share in economics, the meaning of tree trunk in horticulture and the meaning of stock material in storage.

As thesauri are used in documentation indexing and retrieving in different domains, we recommend, the translators should have capability to translate descriptors and non-descriptors based on their specialty.

2. Our Aim

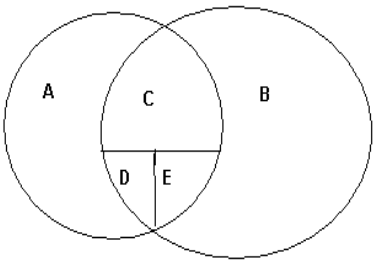


Figure.1.

Suppose A is agrovoc thesaurus and B which we want to build. The thumb rules are:

(a) Region C: common terms which are in A as well as in B i.e. English term equivalent to Hindi Term.
(b) Region A: Remove those terms from A which are not required for B i.e. Hindi term of an English term is not available.
(c) Region B: Add new terms in B which are not in A i.e. English term for a Hindi term is not available.
(d) Region D: Two English terms have same Hindi term
(e) Region E: Two Hindi terms for an English term.

Region A is mechanical work and usually word to word translation. Issues of region A, B, D and E should be checked, solve and approved by subject specialist.

3. Indian Language Issues

ISO 5964, an international standard on multilingual thesaurus, specified that all languages are at an equal position, one language should not be in a position exceeding another language. When we translated the thesaurus, we met many kinds of relations among terms. In AGROVOC, we often meet the situation that one descriptor used for several non-descriptors, sometimes we can find more Indian non-descriptors to a corresponding English non-descriptors, but we also have the situation in which there is not enough Indian non-descriptors for a corresponding English non-descriptor. The best translation is the corresponding Indian descriptor.

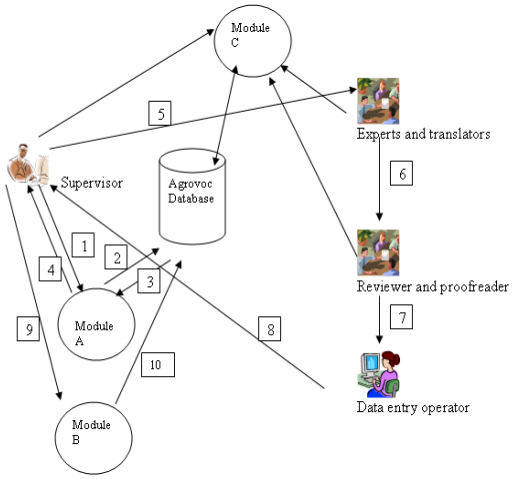
3.1.1. Indian Languages in Unicode

The Unicode Standard has incorporated Indian scripts under the group named Asian Scripts (Chapter 9, Unicode Standard 3.0). The Indian scripts included are Devanagari, Bengali, Gurumukhi, Gujarati, Oriya, Tamil, Telugu, Kannada and Malayalam. The Indian language block of Unicode Standard is based on ISCII-88.

The Unicode standard encodes Indian language characters in the same relative positions A0-F4 in ISCII-88 standard. This parallel code layout emphasizes the structural similarities of the Brahmi scripts and follows the intention of the standard to enable one to one mappings between analogous coding positions in different scripts in the family.

When Unicode Standard Version 1.0 was published, The Bureau of Indian Standards (BIS) published a new version of ISCII in Indian Standard (IS) 13194:1991. This new version partially modified the layout and repertoire of ISCII-1988 standard. Because of these events the Unicode standard does not precisely follow the layout of current version of ISCII. Nevertheless the Unicode standard remains a superset of the ISCII-1991 repertoire except for a number of new Vedic extension characters defined in IS 13194:1991 Annex G-Extended Character Set for Vedic. Modern, non-Vedic texts encoded with IS-1991 may be automatically be converted to Unicode code values and back to their original encoding without loss of information.

4. Workflow



Module A : Program to retrieve data from database.

Module B : Program to check redundancy and insert translated data into database.

Module C : Kheti browsing interface.

Explanation

1 Supervisor request for terms from Module A.

2, 3, 4 Module A retrieve the requested data from Agrovoc database and return it to the supervisor.

5 Supervisor pass this data to experts to convert the data.

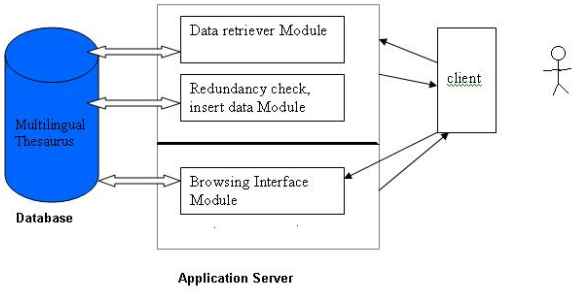
6 Proofreader review the converted data and made the necessary corrections and pass it to the data entry operators.

7, 8 data entry people type and pass this to supervisor.

9 Supervisor pass the converted data to Module B. Module B checks the accuracy and insert only correct information into database.

Now Supervisor, Linguistic, expert, translator and proofreader can check every aspects of translation from Module C (Browsing Interface)

5. Architecture



Our thesaurus building application is built on the LAMP open source software stack (Linux, Apache, MySQL, PHP / Python / Perl) which provides the main infrastructure for cost-effective application development and deployment.

We have used 3-tier web architecture, multilingual data repositories have been stored in MySql database, and application server includes business logic, written in PHP and Apache web server. Only supervisor can use data retriever, authentication and insertion module to retrieve, check and insert translated data into database. Any other user can view our translated work from thesaurus browsing interface (http://www.kheti.org.in).

6. Visual representation of the thesaurus.

As we discussed above that Agrovoc has a total number of 16 700 descriptors, and 10 758 non-descriptors. Technical person can understand the concept, complexity and relationship of the Agrovoc terms but non-technical person could not. To overcome above problem we have developed knowledge (Database) visualization tool to provide a rich, ecological representation of a knowledge domain. Domain experts can use these visualization tool to view relations and cross references between the concepts.

We found 1560 Broader Terms (BT) in Agrovoc database. The crucial question is that how we draw the hierarchy of each BT. We have used simple and straight forward iterative technique. First we've created temporary tables in layered fashion, second we kept all BTs in first layer and their first level NTs (Narrower Terms) in second layer, third level NTs in third layer respectively. Now the subject specialist can follow these hierarchies to translate the term.

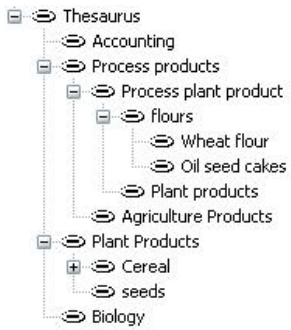


Fig.2 Thesaurus: View1

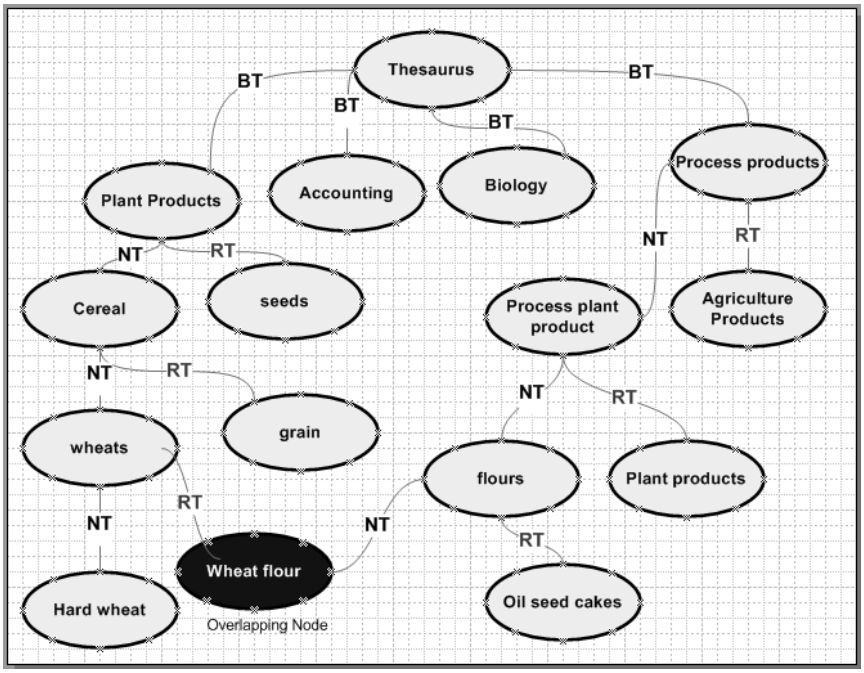


Fig.3 Thesaurus: View2

9. Tools to Help Conversion Process

Interface to provide data to the translators.[Fig.4]
Format for data entry operator to insert the translated terms into database.[Fig.5]

Agrovoc Data Entry Form For Hindi Terms

Agrovoc Terms

Term Code	English Name	Hindi Name
35335	T-2 toxin	
32792	T-cells	
16612	T-lymphocytes	
7582	Tabanidae	
14767	Tabanus	
30607	Tabanus nigrovittatus	
7583	Tabasco	
16294	Tabebuia	
37847	Tabebuia heterophylla	
14768	Tabernaemontana	
14057	Table salt	
14769	Tableting	
7584	Tacca	
7585	Tacca leontopetaloides	
14771	Tacca pinnatifida	
7586	Taccaceae	
14772	Tachardia lacca	
30608	Tachinidae	
7587	Tachira	
7588	Tadzhik SSR	

Fig.4

Data Entry Format to insert converted terms into database.

Termspell(Hindi)	Termcode	Termspell(English)
एकटीनोमाइसीटेलस	111	Actinomyces
एकटीनोमाइसीटेलस	112	Actinomycetales
ऐडीनोसिन डाई फॉस्फेट	123	Adp
कृषि रसायन	198	Agricultural chemicals
कृषि नीतियाँ	201	Agricultural policies
कृषि	203	Agriculture

Fig.5

10. *Kheti* Bowsing Interface

Our translation work of Hindi AGROVOC is available on website http://www.kheti.org.in. This web interface provides the following functionalities:

(a) Search

(b) Alphabetical List

(c) Word Tree

(d) Scope notes and Descriptions

(e) Categories

This interface has been developed to cross check the overall translation work. This mainly helps us to check the hierarchy, scope notes and description, cross relationship and categories of any agriculture concept.

For example from the interface shown in Fig.6 & Fig.7, you can cross check following:

(a) Total number of terms in the selected category?

(b) Any missing term?

(c) Any misplaced term?

(d) Any mistyped term?

11. Technical details about *Kheti* Database

Total terms translated so far: 19466

Total duplicate terms(two English terms have same Hindi term): 544

Total English term without Hindi term: 721

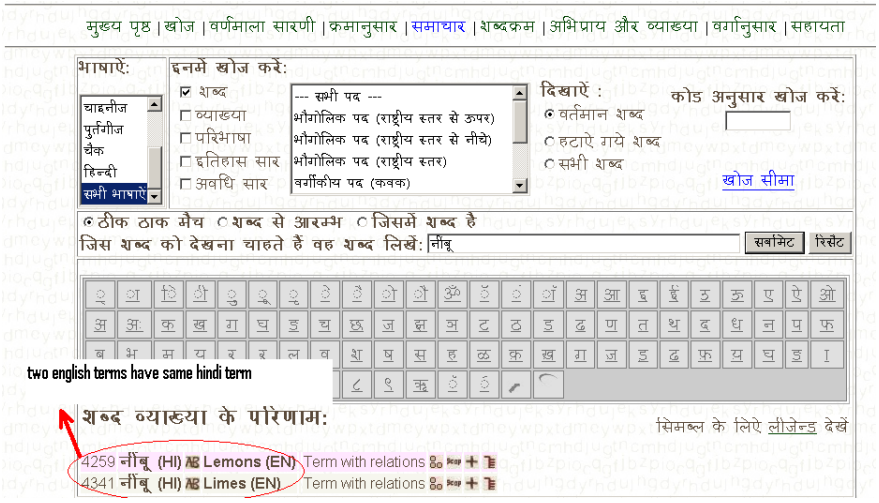


Fig.6 *Kheti* Browsing Interface

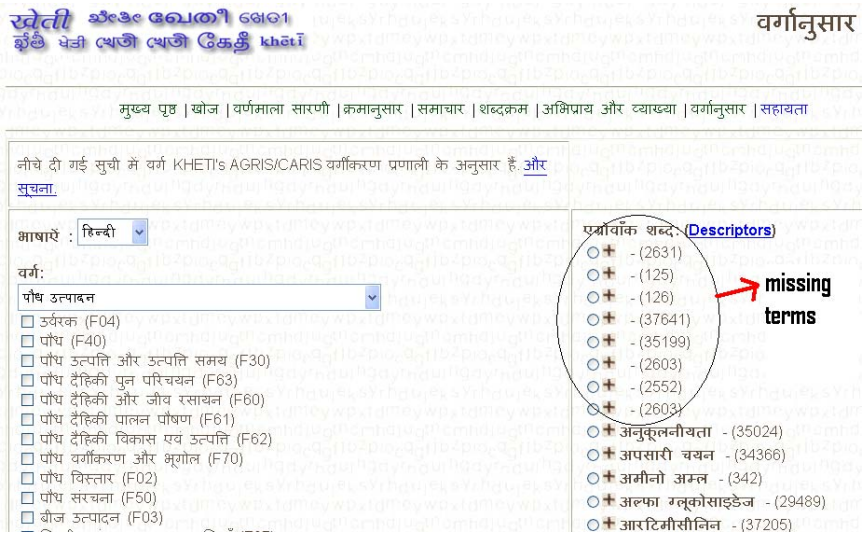


Fig. 7 Kheti Browsing Interface

12. Conclusion

To build thesaurus for particular domain, follow the international standard. Plan your translation work according to the complexity of your domain. Split the overall process into manual and computational part. Manual part should be handled by domain experts and computation part by efficient programmer.

Building thesaurus in Indian languages is an iterative process and it needs proper coordination among all the stakeholders.

Reference

Agronomic terminology, Forth Edition, New Delhi: Indian Agricultural Research Institute.

Comprehensive glossary of technical terms agricultural science, 1991, Edition 1978, New Delhi.

Chun, Chang and Scientech, Lu Wenlin. Documentation and Information Center, Chinese Academy of Agricultural Sciences. Beijing, P.R. China 100081.

FAO. Multilingual Agricultural Thesaurus (AGROVOC). Food and Agricultural Organization of the United Nations. http:// www.fao.org/agrovoc1.

International Standard Organization. Documentation — Guidelines for the establishment and development of muitilingual thesauri.' First edition,' 1985-02-15.

Radulaski, Tatjana Filipovic. (n.d.) Problems of thesaurus creating for theory of literature. Beograd, Yugoslavia: Serbian Academy of Sciences and Arts.

Web Sites

Centre for Development of Advance Computing. http://www.cdac.in.

http://www.unicode.org.

The charts of Indian language character sets in Unicode. http://charts.unicode.org.

Compiled Bibliography

Adler, Paul. S., and Heckscher, Charles (2007). Towrds collaborative community. In Charles Heckscher and Paul S. Adler (Eds.), *The firm as a collaborative community: Reconstructing the trust in a knowledge economy*. London: Oxford University Press.

Anand, S., and Parashar, V. (2006). Integrating local and global knowledge through ICT: Implications for rural business and develeopment, *IIMB Management Review* 18, (1): 85-93.

Antweiler, C. (1998). Local knowledge and local knowing: An anthropological analysis of cultural products' in the context of development. *Anthropos* 93: 469-494.

Ashby, W. R. (1964). *An introduction to cybernetics*. London: Methnen.

Banarjee, P., and Richter F. J. (Eds.), The information economy in India (pp.24-57). London: Palgrave/Macmillan.

Bannister, Kelly and Barrett, Katherine. (2001). Challenging the status quo in ethnobotany. *Cultural Survival Quarterly* 24, no.4: 10-13.

Baumgartner, Tom, Buckly, W., Burns, T. R. and Schuster, P. (1976). Meta power and the structuring of social hierarchies. In T. R. Burns and W. Buckley (Eds.), *Power and control*. Beverly Hills: Sage.

Beck, Ulrich. (1996). *Risk society*. London: Sage Publications.

Bell, T. (2006). Village computing: A state of the field reflections on the village computing consultation. Grameen Foundation. Last accessed July 14, 2008, Available from INTERNET: http://www.villagecomputing.org/docs/A_State_of_the_Field.pdf.

Ben-Porath, Y. (1980). The F-connection: Families, friends, and firms and the organization of exchange. *Population and Development Review* 6, no.1: 1-30.

Berners-Lee, T., (1999). *Weaving the Web: the original design and the ultimate destiny of the World Wide Web* by its inventor. San Francisco: Harper.

Bhatnagar, S. (2004). E-Government: From vision to implementation. New Delhi: Sage Publications.

Bhatnagar, S., and Chawla, R. (2005). Bhoomi: Online delivery of record of Rights, Tenancy and Cultivation to farmers in Karnataka. In W. Habibullah and M. Ahuja (Eds.), *Land Reforms in India - Computerization of Land Records* (pp. 47-77). New Delhi: Sage Publications.

Bhatnagar, S., and Vyas, N. (2001). Gyandoot: Community-owned rural intranet kiosks, E-Government Case Studies. Last Acessed July 14, 2008, from INTERNET: http://web.worldbank.org/WBSITE/EXTERNAL/TOPICS/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIES/EXTEGOVERNMENT/0,,contentMDK:20486032~menuPK:1767268~pagePK:210058~piPK:210062~theSitePK:702586,00.html.

Bhatnagar, S. and R. Schware (Eds.) (2000) Information *and communication technology in development*.New Delhi: Sage.

Bhatnagar, S., and Patel, N (1988). Decentralized computer for rural development. *Omega* 16, no.1:165-170.

Borgatti, S. P., Everett, M. G. and Freeman, L. C. (2002). *Ucinet for Windows: Software for social network analysis*. Harvard, MA: Analytic Technologies.

Buskens, V. (1998). The social structure of trust. *Social Networks* 20: 265-289.

Butcher, S. (2003). Social capital in economics: Why social capital does not mean the end of ideology. *The Drawing Board: An australian Review of Public Affairs* 3, no.3: 181-203.

Canclini, Nestor Garcia. (1995). Hybrid cultures: Strategies for entering and leaving modernità. Minnesota: University of Minnesota Press.

Capra, F. (2003). *The hidden connection*. London: Flamingo

Card, S. K., Robertson, G. G., and Mackinlay, J. D. (1991). The information visualizer: An information workspace. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Reaching through Technology*, (pp.181-186). New York: ACM.

Cavallo, D. (2000). Emergent design and learning environments: Building on indigenous knowledge. *IBM Systems Journal* 39, no.3-4: 768-781.

Castells, Mannuel. (1999). *Information Technology, Globalization and Social Development*, Discussion Paper no.114. Geneva: UNRISD. Last accessed July 12, 2008, from INTERNET: www.unrisd.org/80256B3C005BCCF9/(httpAuxPages)/F270E0C066F3DE7780256B67005B728C/$file/dp114.pdf.

Cecchini, S., and Raina, M. (2004). Electronic government and the rural poor: The case of Gyandoot. *Information Technologies and International Development* 2(2): 65–75.Last Acessed July14, 2008, from INTERNET: http://www.mitpressjournals.org/doi/abs/10.1162/1544752044193434.

Cecchini, S. and Prennushi, G. (2002). Using information and communications technology to reduce poverty in Rural India. *World Bank PREM Notes*.1-4.

Centre for Electronic Governance, Indian Institute of Management, Ahmedabad (CEG-IIMA). (2002). Gyandoot: Rural cybercafes on Intranet. Dhar, Madhya Pradesh, India. A Cost-benefit evaluation study. Last Acessed July 14, 2008, from INTERNET: http://www.iimahd.ernet.in/egov/documents/gyandoot-evaluation.pdf.

Chan, C. M. L., Bhandar, M., Oh, L.-B., and Chan, H.-C. (2004). Recognition and participation in a virtual community. Paper presented at HICSS'04: 37th Annual Hawaii International Conference on System Sciences.

Chan, Y. E. (2000). IT value: The great divide between qualitative and quantitative and individual and organizational measures. *Journal of Management Information Systems* 16, no.4: 225-261.

Chapin, Mac. (1991). Losing the way of the great father. *New Scientist*, 131, no.1781: 40-44.

Chatterjee, J. and Prabhakar, T. V. (2005). On to action - Building a digital ecosystem for knowledge diffusion in rural India. Proceedings of the 2005 International Conference on Knowledge Management, North Carolina, USA. Last acessed July 14, 2008, from INTERNET: www.cse.iitk.ac.in/users/tvp/papers/vof_pasadena.pdf.

Chatterjee, J. (2004). Information communication and e-Marketing in rural India - Learnings from the Digital Mandi project. In A. Haleem (Ed.) *Innovation, flexibility and technology transfer*. India: Tata Mc-Graw Hill.

Chatterjee, J., Runa Sarkar and T. V. Prabhakar (2006). 'From the Policy Framework for Competitive Agriculture to a Knowledge Ecosystem Development Process-Some Empirical Findings,' n.d. (Digital Document).

Chengappa, R., and Vinayak, R. (2007, June 11). Grain drain, *India Today*, 39-54.

Chow, Rey. (1994). Where have all the natives gone? In A. Bammer (Ed.) Displacements: Cultural identities in question. Bloomington: Indiana University Press.

Chun, Chang and Scientech, Lu Wenlin. Documentation and Information Center, Chinese Academy of Agricultural Sciences. Beijing, P.R. China 100081.

Cibora, Claudio. (2004). Encountering information systems as a phenomenon. In Chrisanthi Avegerou, Claudio Cibora and Frank Land (Eds.), *The social study of Information and Communication Technology: Innovation, actors and context.* Oxford: Oxford University Press.

Claudia, D. (2001). Corporate portals: A literature review of a new concept in Information Management. *International Journal of Information Management* 21, no.4: 269–287.

Clifford, James. (2002). *The predicament of culture: Twentieth century ethnography, literature, and art.* Harvard: Harvard University Press.

Clifford, James. (2001). Indigenous Articulations. *The Contemporary Pacific* 13, no.2: 468-490.

Clifford, James. (1997). *Routes: Travel and translation in the late 20th century*.Harvard: Harvard University Press.

Cohen, Ira J. (1989). *Structuration theory: Anthony Giddens and the constitution of social life*. Newyork: St. Martin Press.

Coleman, J.S. (1988). Social Capital in the creation of human capital. *The American Journal of Sociology* (Supplement 1): 95-120.

Coleman, J. S. (1990). *Foundations of social theory.* Cambridge: Harvard Press.

Constant, G., Jean-Pierre, H., Giovanni, P., and Asser, N. T. (1998). An architecture for the integration of internet and telecommunication services. Technical Report SSC/1998/025. Last acessed July 14, 2008, from INTERNET: infoscience.epfl.ch/record/52285/files/IC_TECH_**REPORT**_199825.pdf.

Contractor, N. S. (1994). Self organizing systems perspective in the study of organizational communication. In B. Kovacic (Ed.), *New approaches to organizational communication* (pp. 39-99). Albany: SUNY Press.

Cox, Paul Alan. (2000). Will tribal knowledge survive the millennium? *Science* 287: 44-45. This paper is also avaible from INTERNET: http://www.sciencemag.org/cgi/content/full/287/5450/44.

Dahrendorf, Ralf (1968). Essays in the Theory of Society. Stanford University Press, Stanford.

Davis, F. (1989). Perceived usefulness, perceived ease of use and user acceptance of information technology. *MIS Quarterly* 13, no.3: 319–340.

Debroy, B., and Kaushik, P. D., (Eds.) (2004), *Energizing rural development.* New Delhi: Academic Foundation.

Dei, G. J. (2000a). Rethinking the role of indigenous knowledge in the academy. *International Journal of Inclusive Education* 4, no.2: 111-132.

Dei, G. J. (2000b). African development: The relevance and implications of 'Indigenousness.' In G. J. Dei, B. L. Hall, and D. G. Rosenberg (Eds.), *Indigenous knowledge in global contexts: Multiple readings of our world* (pp. 70-86). Toronto, ON: University of Toronto.

Dijk, J.V. (1999). *The network society.* London: Sage Publications.

Dillon, P. (2004). Trajectories and tensions in the theory of information and communication technology in education. *British Journal of Engineering Education* 52, no.2: 138-150.

Dini, P., and Nachira, F. (2005). The paradigm of structural coupling in digital ecosystems. Last Acessed July 14, 2008, from INTERNET: www.nachira.net/franz/**Structural_Coupling**_s.pdf.

Dini, P., et.al. (2005). The digital ecosystems research vision: 2010 and beyond. Last Acessed July 14, 2008, from INTERNET: www.digital-ecosystems.org/events/2005.05/de_position_paper_vf.pdf.

Doll, W., and Torkzadeh, J. (1988). The measurement of end-user computing satisfaction. *MIS Quarterly* 6, no.2: 259–273.

Dossani, R, Misra, D.C. and Jhaveri, R (2005). *Enabling ICT for rural India*. Asia Pacific Research Center, Stanford University and National Informatics Centre. Last Acessed July 14, 2008, from INTERNET: http://iis-db.stanford.edu/pubs/20972/ICT_full_Oct05.pdf.

Dreze, J., and Sen, A. (2002). *India: Development and participation.* New Delhi: Oxford University Press.

Dreze, Jean, and Sen, Amartya, (Eds). (1997). *Indian development: Selected regional perspectives*. New Delhi: Oxford University Press.

Ees, H.V., and Bachmann, R. (2006). Transition economies and trust building: A network perspective on EU enlargement. *Cambridge Journal of Economics* 30, no.6: 923-939.

European Commission. (2003). European economy 2003 review.Luxemberg: Official Publication of EC. Last Acessed July 14, 2008, from INTERNET: http://ec.europa.eu/economy_finance/publications/publication7694_en.pdf.

FAO. Multilingual Agricultural Thesaurus (AGROVOC). Food and Agricultural Organization of the United Nations. http:// www.fao.org/agrovoc1.

Fahey, L. and Prusak, L. (1998). The eleven deadliest sins of knowledge management. *California Management Review* 40, no.3: 265-76.

Feather, J. (1998). *The information society*. London. Library Association Publishing.

Feder, Gershon, Willett, Anthony and Zijp, Willem. (1999). Agricultural extension: Generic challenges and some ingredients for solutions. World Bank Policy Research Working Paper No. 2129. Last Acessed July 14, 2008, from INTERNET: SSRN: http://ssrn.com/abstract=620481.

Fleischaker, G.R. (Ed) (1992), Autopoiesis in system analysis: A debate. A special forum issue of *International Journal of General Systems* 21, no.2.

Floridi, Luciano, and Sanders, J.W. (2004). On the morality of artificial agents. *Minds and Machines*.14, n0.3: 349-379.

Freund, Julien. (1968). The Sociology of Max Weber. Random House, New York.

Garai, A., and Shadrach, B. (2006). *Taking ICT to every Indian village.* New Delhi: One World South Asia Publications.

Garai, A., and Shadrach, B. (2006). Taking ICT to every Indian village: Opportunites and challenges. Last Acessed July 14, 2008, from INTERNET: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID897910_code509287.pdf?abstract_id=897910 &mirid=1

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *The American Journal of Sociology* 91, no.3.: 481-510.

Granovetter, M. (1983). The strength of weak ties: A network theory revisited. *Sociological Theory* 1: 201-233.

Geertz, Clifford. (1986). The uses of diversity. *Michigan Quarterly Review* 25, no.1: 105-123.

Giddens, Anthony. (1984) The Constitution of Society: Outline of the Theory of Structuration. Polity Press, Cambridge.

Giddens, Anthony. (1981) A Contemporary Critique of Historical Materialism: Vol 1: Power Property and the State. MacMillan London.

Giddens, Anthony. (1979) Central Problems in Social Theory. Macmillan, London.

Goldfarb, Charles F. and Paul Prescod, P. (2001) *XML Handbook*, 4th edition. USA: Prentice Hall.

Grenier, L. (1998). *Working with indigenous knowledge: A guide for researchers*. Ottawa, ON: International Development Research Centre.

Grover, V., and Davenport, T. H. (2001). General perspectives on knowledge management: Fostering a research agenda. *Journal of Management Information Systems* 18, no.1: 5-21.

Gustavo, Esteva and Prakash, M. S. (1998). Beyond development, What? *Development in Practice* 8, no.3.

Hannerz, Ulf. (1992) Cultural complexity: Studies in the social organization of meaning. Columbia: Columbia University Press.

Heeks, R., (2005). ICTs and the MDGs: On the wrong track? In Development Studies Association Conference. University of Manchester, UK.

Herselman, M., and Britton, K. G. (2002). Analysing the role of ICT in bridging the digital divide amongst learners. *South African Journal of Education* 22, no.4: 270-274.

Hongladarom, S. (2004). Making information transparent as a means to close the global digital divide. *Minds and Machines* 14: 85-99.

Hooker, N. H., Heilig, J., and Ernst, S.(2001). What is Unique About E-Agribusiness?,' *IAMA World Food and Agribusiness Symposium,* Sydney, NSW, Australia. Last acessed July 14, 2008, from INTERNET: http://ifama.org/tamu/iama/conferences/2001Conference/Papers/Area%20III/Hooker_Neal.PDF.

Huang, W. (2001) 'Using Information Technology to Enhance Communications among Agribusiness Organizations,' *IAMA World Food and Agribusiness Symposium*, Sydney, NSW, Australia. Last acessed July 14, 2008, from INTERNET: http://ifama.org/tamu/iama/conferences/2001Conference/Papers/Area%20III/Huang_Wen-Chi.PDF.

Huizingh, E. K. R. E. (2000). The content and design of Web sites: An empirical study. *Information and Management* 37, no.3: 123–134.

Huener L, von Krogh, G, and Roos J. (1998). Knowledge and concept of trust. In G. von Krogh, J. Roos, and D. Kleine (Eds.), *Knowing in firms, Understanding, Managing and Measuring Knowledge.* London: Sage Publications.

Illich, Ivan. (1973). Tools for Conviviality. Last Acessed July 14, 2008, from INTERNET: http://opencollector.org/history/homebrew/tools.html.

Institute of Information Technology (2005). Information and Communications Technologies for Development: A Comparative Analysis of Impacts and Costs from India. Bangalore: International Institute of Information Technology. Last Acessed July 14, 2008, from INTERNET: http://www.iiitb.ac.in/Complete_report.pdf.

Iske-Barnes, Judy, and Danard, Deborah. (2007). Indigenous knowledges and world view: Representations and the internet. In L. E. Dyson, M. Hendricks, and S. Grant (Eds.), *Information Technology and Indigenous People* (pp. 27-37). London: Information Science Publishing.

Jones, A. (2001).: Developing research in technology education. Theme issue of *Research in Science Education* 31: 3-14.

Kaushik, P. D., and Singh, N. (2004). Information technology and broadbased development: Preliminary lessons from North India. *World Developement* 32, no.4: 591-607.

Keniston, K., and Kumar, D. (Eds.) (2004). IT experience in India: Bridging the digital divide. New Delhi: Sage Publications.

Kinuthia, Wanjira. (2007). Instructional design and technology implications for indigenous knowledge: Africa's perspective. In L. E. Dyson, M. Hendricks, and S. Grant (Eds.), *Information Technology and Indigenous People* (pp. 3-57). London: Information Science Publishing.

Koert, R. V. (2000). 'Providing Content and Facilitating Social Change: Electronic Media in Rural Development Based on Case Material from Peru ' First Monday 5(2).

Kralisch, A., and Mandl, T. (2006). Barriers to information access across languages on the internet: Network and language effects. *Proceedings of the 39th Hawaii International Conference on Systems Science* (HICSS-39): 1-10.

Krippendorff, K. (2006). *The semantic turn.* Boca Raton: CRC Press.

Krishna, A. (2003).Understanding, measuring and utilizing social capital: clarifying concepts and presenting a field application from India. CAPRi Working paper No. 28. Last Acessed July 14, 2008, from INTERNET: http://www.capri.cgiar.org/pdf/CAPRIWP28.pdf.

Krishnan, R., Smith, M. D, and R. Telang, R. (2003). The economics of peer-to-peer networks. *Journal of Information Technology Theory and Application* 5, no.3: 31-44.

Kwok, J. S. H., and Gao, S. (2004). Knowledge sharing community in P2P network: A study of motivational perspective. *Journal of Knowledge Management* 8, no.1: 94-102.

Laroui, Abdallah. (1998). Cultural identity and modernity. *International Social Science Journal* 118: 551-559.

Latouche, Serge. (1997) Paradoxical Growth. In Majid Rahnema and Victoria Bawtree (Eds.), *The Post-Development Reader.* London: Zed Books.

Latouche, Serge. (1996). *The westernisation of the world.* Cambridge, United Kingdom: Polity Press.

Latouche, Serge. (1993). *In the wake of an affluent society: An exploration of post-development.* London: Zed Books.

Latour, Bruno. (2005). *Reassembling the social: An introduction to actor-network-theory*. Oxford: Oxford University Press.

Ledgerwood, Joanna. (2000). Microfinance handbook: An institutional and financial perspective. Washington DC: The World Bank.

Lieberman, A. E. (2003). *Taking ownership: Strengthening indigenous cultures and languages through the use of ICTs*. Retrieved January 2, 2005, from INTERNET: http://learnlink.aed.org/Publications/Concept_Papers/taking_ownership.pdf.

Lobo, Albert, and Balkrishnan, S. (2002). Report card on service of Bhoomi Kiosks: An assessment of benefits by users of the computerized land records system in Karnataka. Bangalore: Public Affairs Centre. Last Acessed July 14, 2008, from INTERNET: http://www1.worldbank.org/publicsector/bnpp/Bhoomi.pdf.

Lucas, Gyrogy. (1971) History and Class Consciousness. MIT Press, Cambridge MA.

Luhmann, N. (1990). *Essays on self reference.* New York: Columbia University Press.

Luhmann, N. (1992). What is Communication? *Communication Theory*, 2: 251-259.

Mammo, T. (1999). *The paradox of Africa's poverty: The role of indigenous knowledge - Traditional practices, and local institutions: The case of Ethiopia*. Lawrenceville, NJ: The Red Sea.

Manek, Mita and Lettington, Robert. (2001). Indigenous knowledge rights: Recognizing alternative world views. *Cultural Survival Quarterly* 24, no.4: 8-9.

Marca, D., and Bock, G. (1992). *Groupware: Software for computer-supported cooperative work.* Washington: IEEE Press.

Markus, M. L. (2001). Toward a theory of knowledge reuse: Types of knowledge reuse situations and factors in reuse success. *Journal of Management Information Systems* 18, no.1: 57-93.

Marx, Karl and Engles F. (1968) Selected Works. Progress Publishers, Muscow.

Matthew O. Jackson, A.W., (1996) A Strategic Model of Social and Economic Networks. Journal of Economic theory 71: 44-74.

Maturana, H., and Varela, F. (1980). *Autopoiesis and cognition: The realization of the living*. Dordrecht, Holland: D. Reidel Publishing Company.

Maturana, H., and Varela, F. (1987). *The tree of knowledge.* Boston: Shambhala.

Maula, M. (2006). *Organizations as learning systems.* Oxford: Elsevier.

Maybury-Lewis, D. (2002). *Indigenous peoples, ethnic groups, and the state* (2nd Ed.). Boston: Allyn and Bacon.

McGovern, S. (1999). *Education, modern development, and indigenous knowledge*. New York: Garland.

McIntosh, Ian S. (2000). Are there indigenous people. *Cultural Survival Quarterly* 24, no.3: 4-7.

McIntosh. Ian S. (2001). Intellectual property responsibilities. *Cultural Survival Quarterly* 24, no.4: 4-5.

McMillan, S. J., and Hwang, J. (2002). Measures of perceived interactivity: An exploration of the role of direction of communication, user control, and time in shaping perceptions of interactivity. *Journal of Advertising* 3: 29-42.

Mekelvey, B. (1999). Self organization, complexity catastrophe and microstate models at the edge of chaos. In J.A.C. Baumn and B. Mekelvey (Eds.), *Variations in organization science.* Thousand Oaks: Sage Publications.

Merton, Robert K. (1968) Social Theory and Social Structure, New York, Free Press.

Michael, Katina, and Dunn, Leone. (2007). The use of information and communication technology for the preservation of aboriginal culture: The Badimaya people of Western Australia. In L. E. Dyson, M. Hendricks, and S. Grant (Eds.), *Information technology and indigenous people* (pp. 170-174). London: Information Science Publishing.

Miller, B. G. (2003). *Invisible indigenous: The politics of nonrecognition*. Lincoln, NE: University of Nebraska.

Mingers, J. (1995). *Self-producing systems*. New York: *Plenums.*

Monge, P.R., and Contractor, N.S. (2003). *Theories of communication networks.* New York: Oxford University Press.

Mosha, R. S. (1999). *The heartbeat of indigenous Africa: A study of Chagga educational system*. New York: Garland.

Mueller, R. A. E. (2001). Impacts of E-Commerce and information technology on global agricultural markets. Paper presented at *Symposium sponsored by the Economic Research Service, Farm Foundation and the University of Minnesota*, Washington, DC.

Mundy, P., and Compton, J. L. (1995). Indigenous communication and indigenous knowledge. In D.M. Warren, D. Brokensha, and L. Jan Slikkerveer (Eds.), *The cultural dimension of development: Indigenous knowledge systems* (pp. 112-123). London: Intermediate Technology.

Nachira, Francesco, et al. (2002). Towards a network of digital business ecosystems fostering the local development (Discussion paper). Last Acessed July 14, 2008, Available from INTERNET: http://www.digital-ecosystems.org/doc/discussionpaper.pdf.

Nonaka, I., and Takeuchi, H. (1995). *True knowledge creating company.* Oxford: Oxford University Press.

Norris, P., and Zinnbauer, D. (2002). *Giving Voice to the Voiceless: Good Governance, Human Development and Mass Communication,* Background paper for HRD.New York: UNDP online.

Nuffic. (2000). About indigenous knowledge. Last Acessed July 14, 2008, from INTERNET: http://www.nuffic.nl/ik-pages/about-ik.html.

OPAALS Project. (2008). *Del 7.1 – Policy and business models for the regional developement of community networks*, Project funded by the European Community under "Information Society Technology Programme. Licensed under Creative Commons.

O' Neil, Jim. (2000). Scientific Method vs. 'Knowledge'. Last Acessed July 14, 2008, from INTERNET: http://www.sciencemag.org/cgi/eletters/287/5450/44.

Owen, A. L. and J. Videras, J. (2007). Trust, cooperation, and implementation of sustainability programs: The case of local agenda 21.Last Acessed July 14, 2008, from INTERNET: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID976074-code1908.pdf?abstract_id=976074&mirid=1.

Park, Jack, Hunting, Sam, and Engelbart, Douglas C.(2003). XML topic maps: Creating and using topic maps for the Web.USA: Prentice Hall.

Palmer J.W. (2002). Web site usability, design, and performance metrics. *Information Systems Research* 13, no.2: 151-167.

Palmer, J.W., and Griffith, D. A. (1998). An emerging model of website design for marketing. *Communications of the ACM* 41, no.3: 44–51.

Palmer, J. W., and Griffith, D. A. (1998). Information intensity: A paradigm for understanding web site design. *Journal of Marketing Theory and Practice* 6, no.1: 38-42.

Pandey, Deep Narayan. (2000). Equity of knowledge. Last Acessed July 14, 2008, from INTERNET: http://www.sciencemag.org/cg1/elleters/28//5450/44.

Parameswaran, M., Susarla, A., and Whinston, A. B. (2001). P2P networking : An information sharing alternative. *Compute* 34, no.7: 31-38.

Parthasarathy, D., and Chopde V. K. (n.d.) Building social capital: Collective action, adoption of agricultural innovations, and poverty reduction in the Indian Semi-Arid Tropics.Paper for the research theme 'Escaping Poverty'. Last Acessed July 14, 2008, from INTERNET: http://www.gdnet.org/pdf/776_D.pdf.

Pattanaik, Debashis and Jha, Munmun. (2007). 'Knowledge and identity among indegeneous people. *The Oriental Anthropologist* 7, no.2: 199-212.

Pepper, Steve. (n.d.) *The TAO of Topic Maps-finding the way in the age of info glut.* Last Acesed July 14, 2008, from INTERNET: http://www.ontopia.net/topicmaps/materials/tao.html.

Pepper, Steve and Moore, Graham (n.d.) XML Topic Maps (XTM) 1.0. TopicMaps.org specification, Last Acessed Last Acesed July 14, 2008, from INTERNET: http://www.topicmaps.org/xtm/1.0.

Pirolli, P., Card, S. K. and Van der Wege, M. (2001). Visual information Foraging in a Focus+Context Visualization,' *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,* (pp.506-513). New York: ACM.

PriceWaterhouseCoopers. (2004). Rethinking the European ICT agenda: Ten ICT-breakthroughs for reaching Lisbon goals. Ministry of Economic Affairs, The Netherlands: The Hague.Last Acessed July 14, 2008, from INTERNET: http://ec.europa.eu/information_society/eeurope/i2010/docs/events/rethinking_the_european_ict_agenda.pdf

Prigogine, I., and Stengers, I. (1984). *Order out of chaos: Man's new dialogue with nature,* New York: Bantam.

Puri, Kamal. (2000). Is traditional or cultural knowledge a form of intellectual property? O*xford Electronic Journal of Intellectual Property Rights.* Last Acessed July 14, 2008, from INTERNET: http://www.oiprc.ox.ac.uk/EJWPO100.pdf.

Radulaski, Tatjana Filipovic. (n.d.) Problems of thesaurus creating for theory of literature. Beograd, Yugoslavia: Serbian Academy of Sciences and Arts.

Rajora, R. (2002). *Bridging the digital divide*. New Delhi: Tata- McGraw Hill.

Reiser, R. (2001). A history of instructional design and technology: Part II: A history of instructional design. *Educational Technology Research and Development* 49, no.2: 57-67.

Robyn, L. (2002). Indigeneous knowledge and technology. *American Indian Quarterly* 2, no.6: 198-220.

Rothschild, M. (1990). *Bionomics: Economy as ecosystem.* Salt Lake City, UT: Henry Holt and Company.

Sabatini, F. (2005). The role of social capital in economic Development: Investigating the causal nexus through structural equations models. 2005. Last Acessed July 14, 2008, from INTERNET: http://papers.ssrn.com/sol3/Delivery.cfm/SSRN_ID901361-code492973.pdf?abstract_id=901361&mirid=1.

Schiefer G. (2003) 'New Technologies and their Impact on Agriculture, Environment and the Food Industry. *EFITA 2003 Conference* (pp.3-11), Debrecen, Hungary.Last Acessed July 14, 2008, from INTERNET: http://www.date.hu/efita2003/centre/pdf/0001.pdf.

Schollmeier, R. A. (2001). Definition of Peer-to-Peer networking for the classification of Peer-to-Peer architectures and applications. *Proceedings of the First International Conference on Peer-to-Peer Computing (P2P'01).* Washington, DC: IEEE Computer Society.

Semali, L. M., and Kincheloe, J. L. (1999). Introduction: What is indigenous knowledge and why should we study it? In L. M. Semali and J. L. Kincheloe (Eds.), *What is Indegenous Knowledge: Voices from the Academy* (pp. 3-57). New York: Falmer.

Sen, A. (1999). *Development as freedom*. New Delhi: Oxford University Press.

Sen, A. (1997). Maximization and the act of choice. *Econometrica* 65, no.4: 745-779.

Servaes, J. (2008). *Communication for development and social change*. Los Angles: Sage Publications.

Sharma, Shailendra. (2001). Should the local knowledge survive? For whom? Last Acessed July 14, 2008, from INTERNET: http://www.sciencemag.org/cgi/content/full/287/5450/44.

Sillitoe, P. (2002). Globalizing indigenous knowledge. In P. Sillitoe, A. Bicker, and J. Potteir (Eds.), *Participating in development: Approaches to indigenous knowledge* (pp. 108-138). London: Routledge.

Simon, H. (1957). *Models of man*. New York: Wiley.

Singh, N (2002). Information technology as an engine of broad based growth in India. In Parthasarthi Banarjee, and F. J. Richter (Eds.), *The information economy in India* (pp.24-57). London: Palgrave/ Macmillan.

Smith, M., and Kollock, P. (Eds.) (1999) *Communities in cyberspace*. London: Routledge.

Sood, A. D. How to wire rural India? A survey of the problems and possibilities of digital development. *Economic and Political Weekly*, 35, no.43.

Stzompka, Pitor (1993) The Sociology of Social Change. Blackwell, UK.

Sukumar, S., and Murthy, N. R. N. (2003). Influence of ICT on the development of India's competitiveness. In Soumitra Dutta, Bruno Lanvin, and Fiona Paua (Eds.), *The Global Information Technology Report 2002-03: Readiness for the Networked World* (pp.178-190). New York: Oxford University Press.

Todd, L. (1996). Aboriginal narratives in cyberspace. In M. A. Moser and D. Macleod (Eds), *Immersed in technology: Art and virtual environments* (pp. 179-194). Cambridge, MA: MIT Press.

United Nations. (1996). Standard Setting Activities: Evolution of Standards Concerning The Rights of Indigenous People. Economic and Social Council, E/CN.4/Sub.2/AC.4/1996/2., Last Acessed July 14, 2008, from INTERNET: http://www.unhchr.ch/Huridocda/Huridoca.nsf/e06a5300f90fa0238025668700518ca4/2b6e0fb1e9d7db0fc1256b3a003eb999/$FILE/G9612980.pdf.

United Nations. (1992). Declaration on environment and development. General Assembly, A/CONF.151/26 (Vol. I). Last Acessed July 14, 2008, from INTERNET: http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm.

UNDP. (2001*). Making new technologies work for human development*, Human Development Report. New York: Oxford University Press.

Vierger, M. (1999). Indigenous knowledge: An interpretation of views of indigenous people. In L.M. Semali and J. L. Kincheloe (Eds.), *What is indigenous knowledge: Voices from the academy* (pp. 333-343). New York: Falmer Press.

Wangoola, P. (2000). Mpambo, the African multiversity: A philosophy to rekindle the African spirit. In G. J. Dei, B. L. Hall, and D. G. Rosenburg (Eds.), *Indigenous knowledge in global contexts multiple readings of our world* (pp. 265-277). Toronto, ON: University of Toronto Press.

Weber, Max. (1968) On Charisma and Institution Building. The University Press Chicago, Chicago.

Woolcock, M. (1998). Social capital and economic development: Toward a theoretical synthesis and policy framework. *Theory and Society* 27: 151-208.

World Bank. (1997). Rural development: From vision to action. Environmentally and socially sustainable development studies and Monographs series No. 12. Washington D.C: The Internatioan Bank for Reconstruction and Development.

World Bank. (1997). What is indigenous knowledge? Last Acessed July 14, 2008, from INTERNET: http://www.worldbank.org/afr/ik/basic.htm.