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### e-Agriculture Prototype for Knowledge Facilitation among Tribal Farmers of North-East India: Innovations, Impact and Lessons

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# e-Agriculture Prototype for Knowledge Facilitation among Tribal Farmers of North-East India: Innovations, Impact and Lessons

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**ABSTRACT Purpose:** *This case study deals with the implementation methodology, innovations and lessons of the ICT initiative in providing agricultural extension services to the rural tribal farming community of North-East India.*

**Methodology:** *This study documents the ICT project implementation challenges, impact among farmers and briefly indicates lessons of the e-agriculture project.*

**Findings:** *The e-agriculture prototype demonstrated that the Rs. 2,400 (USD 53) cost of the extension services to provide farm advisory services was saved per farmer per year, expenditure was reduced 3.6 times in comparison with the conventional extension system. Sixteenfold less time was required by the farmers for availing the services and threefold less time was required to deliver the services to the farmers compared with the conventional extension system. However, this article argues that in less developed areas, information through ICTs alone may not create expected development. Along with appropriate agricultural information and knowledge, field demonstrations and forward (farm machinery, manure, seeds) and backward linkages (post-harvest technology and market) need to be facilitated with appropriate public–private partnership between knowledge and other rural advisory service providers for agricultural development.*

**Practical implications:** *This article lists a number of practical lessons which will be useful for the successful planning and implementation of e-agriculture projects in developing countries.*

**Original value:** *This article is a first case study on ICTs for agricultural extension initiatives among the tribal farmers who dominate the less developed North-East India.*

**KEY WORDS:** e-Arik, e-Agriculture, Extension, ICT, Innovations, India, Farmers, Impact, Lessons

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## 1. Introduction

Agricultural extension continues to be a key facilitator for achieving food security and also for reducing poverty in the majority of the rural population in most developing countries, including India. Research evidence indicates that rural livelihoods are considerably enhanced by access to information on improved agricultural practices, market, weather, etc. Further, land and water resources are almost reaching their limits and, hence, knowledge resources play a crucial role in achieving food security. Agricultural extension, as an enabler of knowledge resources, is receiving renewed attention across the globe. Most national governments and agricultural stakeholders are trying to revitalise their extension systems. However, estimates in India indicate that to disseminate advanced agricultural technological information to its 120 million farm holdings requires at least 1.3–1.5 million extension personnel against which present availability is only 0.1 million (Planning Commission, GoI, 2007). In India, during 2004, public extension (including the Krishi Vigyan Kendra centres) reached only 6.4% of the farmers, who instead mostly got their information from other progressive farmers and input dealers (17 and 13%, respectively) and mass media (Binswanger-Mkhize and Zhou, 2012). Further, even after continuous efforts of extension organisations, 60% of the farmers do not access any source of information for advanced agricultural technological information, resulting in a huge adoption gap (NASSO, 2005). Hence, extension reforms are underway and integration of new Information and Communication Technologies (ICTs) are rapidly transforming agricultural extension. The ICT-enabled extension systems are acting as a key agent for changing the agrarian situation and farmers' lives by improving access to information and sharing knowledge. It is believed that ICT-based agricultural extension brings opportunities and has the potential for enabling the empowerment of farming communities. And hence, extension practitioners are interested in experimenting with innovative e-agriculture initiatives in India (Saravanan, 2010a).

### *1.1 Theoretical Framework*

The first known example of using a Mesopotamian clay tablet as a communication aid to disseminate agricultural advice was used around 1800 BC (Jones and Garforth, 1997). Since then, along with face-to-face communication, a variety of communication devices from print media to electronic media and a variety of ICT tools have been used for the facilitation of farm information to farmers and other stakeholders around the world.

In India, since the beginning of the twentieth century, a number of individuals (mostly philanthropists), the government and non-governmental organisations (NGOs) have undertaken isolated agricultural extension efforts in which face-to-face communication and demonstrations have played a significant role in the dissemination of agricultural information and knowledge to farmers. Since the 1950s, organised extension efforts in the public sector have mostly used interpersonal communication and demonstrations continuing up to the training and visit system era of the 1970s. At the same time, some informal information sources, such as friends, relatives, neighbours, progressive farmers and input dealers, have played a significant role in agricultural information dissemination among rural farmers. Along with interpersonal communication sources, in the 1960s to the 1970s, mass media was

given more emphasis for agricultural extension, and, in 1975, the Satellite Instructional Television Experiment (SITE) project was started to reach 2,400 villages in 20 districts with satellite television broadcasts (Agrawal, 1985). The basic idea was to broadcast synchronised agricultural, health, nutrition and family planning messages to the rural poor (Lie, 2012). Similarly, from the beginning of the twenty-first century, extension practitioners and other agricultural stakeholders have given a lot of emphasis to using new ICTs (mainly internet, tele-centres/village knowledge centres and mobile phones) for the communication of agricultural information, knowledge and innovations among farmers and others.

### *1.2 Status of e-Agriculture Initiatives in India*

A research report presented in the global ICT summit of 2004 indicated that 45% of the world's ICT projects were implemented in India (Manzar, 2004). Also Asia's highest number of information kiosks were implemented across rural India. However, most of the rural ICT projects were implemented in the socio-economically developed states of south and north India (Paul et al., 2004). Numbers of ICT initiatives were documented in the literature (Saravanan, 2010a; Saravanan et al., 2011) and are also available online (<http://www.ekrishinaip.in>). There are four major types of e-agriculture initiatives in India. They are:

- (1) Web portals: aAQUA, KISSAN Kerala, TNAU AGRITECH Portal, AGRISNET, DACNET, e-Krishi, ASHA, India Development Gateway (InDG) portal, Rice Knowledge Management Portal (RKMP), Agropedia, AGMARKNET, ITC-e-Choupal, EID Parry-Indiagriline, Indiancommodities.com, Mahindra Kisan Mitra, IFFCO Agri-Portal, Agrowatch Portal, iKissan, etc.
- (2) Knowledge centres/tele-centres: Village Knowledge Centres (VKCs) of M.S. Swaminathan Research Foundation (MSSRF) (Senthilkumaran, 2011) & others, Village Resource Centres (VRCs) of the Indian Space Research Organisation (ISRO), Community Information Centres (CICs), Common Service Centres (CSCs), etc.
- (3) Telephony/mobile telephony (m-agriculture initiatives): Farmers Call Centre (Kissan Call Centre), Lifelines India, IFFCO Kisan Sanchar Limited (IKSL), Fisher Friend, Reuters Market Light (RML) (Mittal et al., 2010), Mobile Advisory Services by Krishi Vigyan Kendras (KVKs) of Indian Council of Agricultural Research (ICAR), etc.
- (4) Hybrid projects (ICTs with traditional extension elements): e-Sagu, Digital Green, e-AgriKiosk, e-Villages, Knowledge Share Centres, etc.

### *1.3 Advantages of e-Agriculture Initiatives in India*

Available literature on the advantages of using ICTs for agricultural extension contained only anecdotal evidence (Saravanan, 2010a). However, Gandhi et al., (2008) indicated that the Digital Green project (participatory digital video for agricultural extension) increased the adoption of certain agriculture practices sevenfold over classic extension approaches. The Digital Green project was shown to be 10 times more effective per dollar spent. Further, it resulted in 85% adoption of

improved technologies compared to 11% adoption by traditional extension methods. Similarly, Krishnareddy and Ankaiah (2005) reported that deploying the e-Sagu prototype increased the income of farmers by up to Rs. 9,491 (USD 240) per ha and also reduced pesticide usage. Further, their rudimentary estimate of economic advantage indicated that if the e-Sagu prototype was used by 1,000 farmers, the overall net benefit of the proposed ICT-based system would be Rs. 100 million (USD 204,800). Interestingly, Gandhi et al. (2009) reported positive social side effects and other qualitative results of the Digital Green project on participatory video for agricultural extension. Further, new devices like tablets and new services like cloud computing have great potential in agriculture (Szilagy, 2012).

#### *1.4 Limitations of e-Agriculture Initiatives in India*

In India, most of the ICT-based agricultural extension projects were implemented as 'pilot projects'; and after the pilot period, most of the projects were never implemented on a larger scale. Efforts for the continuance of pilot projects were not taken seriously by the implementing, and also funding (donor), agencies. Similar to farmers in other developing countries, in India most farmers also feel that the agricultural advisory services are a welfare activity of the state and national governments (Saravanan, 2011). And hence, they are unwilling to pay for agricultural extension services. The ICTs for agricultural extension projects were implemented in a very limited geographical area (except IKSL) and covered a few hundred, or at a maximum a few thousand, farmers (Saravanan, 2010a). Nevertheless, agricultural and farming communities, as a whole, do not adopt new ICT tools and systems to the degree required for substantial agricultural development (Sideridis et al., 2010). Exceptionally, a few projects like farmers' call centres (Kissan Call Centres—KCCs) and the e-Soil health card programme cover the entire country and Gujarat state, respectively. Few web portals are developed for larger farm stakeholders (AGMARKNET, InDG, e-Krishi, TNAGRITTECH Portal, Rice Knowledge Management Portal (RKMP), Agropedia and AGRISNET portals of the state government of India). However, continuous updating and maintaining of web portals requires sufficient resources, which were not ensured continuously in most of the cases. In almost all the projects, the participation of agricultural education and research institutions appeared to be marginal (Balaji et al., 2007). Most of the projects do not have collaboration with other farm research and extension stakeholders. Practical challenges or constraints in implementing the ICT projects were seldom disclosed and shared with others. Learning experiences were seldom shared from one project to another. Most of the projects never revealed their actual evaluation results, generally they reported 'positive' results, and most common constraints such as inadequate rural ICT infrastructure (especially frequent power cuts) and difficulty in content localisation and customisation were indicated. Systematic and objective evaluation of the impact of the projects was seldom carried out. Similar types of projects, with little modification, were implemented in an isolated manner. Except for a few projects, evaluation results were not published or communicated. Even after experimenting with hundreds of ICT projects for rural development over the last two decades, there was no noteworthy comprehensive comparative evaluation of e-agriculture projects in India (Keniston, 2002; Saravanan, 2010a). Along with ICT-based advisory services, input supply and testing need to be

integrated for greater impact (Balaji et al., 2007). Content needs to be aggregated from different sources but it needs to be sorted in granular format for rapid adaptation for local use. Localisation and customisability of content was not practiced on a significant scale (Balaji et al., 2007). The direct involvement of users in content production can improve the content localisation (Glendenning and Ficarelli, 2011). If sufficient scientific information is not available, content needs to be generated, tested, refined and used for further advisory services through ICTs. Most of the web portals lack relevant content in the local language. In the absence of collective and coordinated efforts by the public–private agricultural research and extension institutions, ICTs have not penetrated satisfactorily into rural India, despite the time, money and efforts invested so far (Patil et al., 2009). An article by Sulaiman et al. (2012) documented major features of ICT initiatives in India and other South Asian countries.

### *1.5 Status of e-Agriculture Initiatives in North-East India*

In contrast to the national e-agriculture scenario, there was no village level e-agriculture initiative in the poorest tribal population-dominated eight states of the north-east hill region of India. Considering the geographical remoteness of the region, the Ministry of Communications & Information Technology (MoC&IT) of the Government of India implemented Community Information Centres (CICs) in all the headquarters of the 487 blocks of the 79 districts of North-East India. But, the functioning of the centres was not up to expectation because the basic purpose of community information centres, to provide e-education, e-governance, e-health and e-business information services to the common people, was not realised and centres merely acted as an internet browsing centre to the elite and educated urban population. For effective functioning of CICs, locale specific content needs to be generated. The Government of India's e-readiness assessment reports from 2004 and 2008 (MoIT-GoI, 2004; MoIT-GoI, 2008) indicated that Arunachal Pradesh state was categorised under the least achievers category. The report also recommended increasing the awareness of the potential benefits of ICTs for rural development. Further, unique geographical (hilly and remote area, frequent natural disasters, population settlements are very scattered and thinly populated) and socio-economic and linguistic conditions (disadvantaged tribal population with a large number of tribal dialects) posed challenges and also prevented adopting successful ICT projects from other parts of the country.

### *1.6 Statement of Problem and Objective of the Study*

The North-East region of India has exhibited the highest level of backwardness in the important indicators of human development, such as income and health (MoRD-GoI, 2005). Further, agricultural productivity was lowest among the states of India. For example, paddy (*Oryza sativa*) productivity was 1.76 t/ha in the Arunachal Pradesh state (district crop data 2006–2007). Endemic malaria, drug addiction and AIDS add to the problems of North-East India. Limited access and inadequate information on advanced farm technologies, market intelligence and rural development schemes produced the income poverty in the region (40% of the population lives below the poverty line (MoRD-GoI, 2005)). Limited technical manpower as per the

agricultural census of Arunachal Pradesh state, there were only 262 extension personnel working in the department of agriculture serving the 237,900 cultivators in the state (Bhattacharjee and Singh, 2002). Similarly, in 2008, there were only 16 extension personnel for horticultural information and knowledge facilitation among the 65,432 rural farmers spread over the 142 villages of East Siang district of Arunachal Pradesh state (DoH, 2008), lack of transport and communication facilities, limited financial support to the technology transfer and less infrastructure facility creates a huge technological gap among the rural tribal farming community. Further, difficult terrain, a mountainous periphery and frequent natural disasters hinder the development of the region. Due to non-availability of improved technological information to the tribal farmers, agriculture exhibited low and unstable productivity, which in turn created a food insecurity problem and also posed a serious developmental question to the policy-makers.

Considering the disappointing development scenario in the region, a research project entitled 'e-Arik' ('Arik' means 'agriculture' in the Adi tribal dialect of Arunachal Pradesh state). e-Arik means e-agriculture. e-agriculture refers to the use of ICTs by the farmers, other rural people and farm stakeholders for information exchange, communication and learning processes, which is useful for the better management of their agricultural systems and livelihoods (<http://www.e-agriculture.org>) and has been implemented by the College of Horticulture and Forestry, Central Agricultural University (CAU), since 2007. The e-Arik research project, sponsored by the Technology Information Facilitation Programme (TIFP), Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology, Government of India, examined the application of ICTs in providing agricultural extension services and also in assessing its impact among the rural tribal farming community in the 'Yagrung' and nearby villages of East Siang district of Arunachal Pradesh state.

### *1.7 Incorporating e-Agriculture Project Lessons and e-Arik Project Implementation Design*

A comprehensive review of e-agriculture initiatives in India during 2007 indicated that ICT infrastructure, relevant content, language compatibility, local ownership and community participation were crucial for the success of the ICT initiatives. Further, stand-alone initiatives had difficulty in sustaining project implementation after the project period or donor withdrawal. Considering the above lessons, the e-Arik project was designed to create ICT infrastructure at village level to provide agricultural extension services to farmers with the help of agricultural experts and project staff (from the Central Agricultural University), those who can provide locally relevant content based on farmers' demand and can also sustain services after the project period through their regular field extension job responsibilities. To overcome the language barrier, a farmer-to-farmer communication approach was introduced. Along with ICTs, traditional extension methodologies (interpersonal communication, demonstrations, etc.) were also used by the project staff and also by establishing a partnership with the farm science centre (Krishi Vigyan Kendra) of the project area. A project advisory committee was constituted in partnership with the village tribal council to ensure community participation and ownership in the project.

## **2. Research Methodology**

### *2.1 Selection of the Study Area*

The project implementation area (locale of the study area) was selected based on the following criteria: farmers' willingness to host the e-Arik centre (village knowledge centre) and villagers' need to provide a common village building (free of cost) to host the centre, free electricity and a village tribal council willing to have a partnership with the project advisory and management council. Further, selected villages need to have a cluster of villages in their surroundings and there should be scope for having a control group with a reasonable isolation distance (20 km) from the e-Arik centre, but both groups (project implementation villages and control villages) need to have a similar socio-economic background, cropping pattern, market and weather conditions. To select project areas based on the above criteria, a series of Focused Group Discussions (FGDs), Participatory Rural Appraisal (PRA) and also discussions with key informants were conducted, and, based on the indicated criteria, a project area (Yagrung and 12 villages nearby) was selected to implement the project.

### *2.2 Description of the Study Area*

The selected villages are located in the East Siang district of Arunachal Pradesh state. The Adi is one of the major tribes living in the eastern Himalayan hills and they are found in the sub-tropical regions within the districts of East Siang, Upper Siang, West Siang and Dibang Valley districts of the Arunachal Pradesh state of North-East India. The literal meaning of Adi is 'hill' or 'mountain top' (Saravanan, 2010b). They have a well organised traditional village council called *Kebang* (*Kebang* administers village affairs, manages the day-to-day problems of the village and also formulate laws and issue ordinances for the well-being of the society). The *Kebang* was formed naturally; the village elders naturally become *Kebang* members. The *Kebang* is a democratic institution and Adi tribals are traditionally republican, democratic and socialist in aspiration. However, the *Kebang* does not rule out capitalistic economy, at the same time, they attach importance to the sociologistic ideology. Equality in the distribution of wealth and opportunities is also on their cards.

The average annual rainfall is 440 cm. Generally, rocky sandy loam soil with a pH range from 5 to 6.5 and a sub-tropical climate condition favours cultivation of a wide range of crops. The major cultivated crops are rice, mustard, maize, mandarin orange, pineapple and vegetables in the foothill and mid hill areas. There is a prevalence of shifting cultivation ('slash and burn' or 'Jhum' agriculture system), also called Jhum cultivation, which involves the slashing and burning of the vegetation on hill slopes and the use of land for cultivation for two or three years. Farmers then move to a new area and carry out the same practice. In recent years, the Jhum cycle interval has been reduced to two to three years (previously it was a seven to eight-year cycle), and the farmers return to the same area for carrying out shifting cultivation (Saravanan, 2010b). The Adi tribe extensively practice irrigated rice cultivation and have a considerable agricultural economy (Saravanan, 2010c). Traditional farming systems, ecological pest and diseases control measures, bio-diversity conservation and traditional homestead agro-forestry systems are unique to the Adi tribal farmers (Danggen, 2003; Misra and Dutta, 2003).



### 3. Project Methodology

In order to provide agricultural extension services through ICTs, it is necessary to assess the information needs of the farmers so as to prepare and deliver specific messages or technologies and also to develop ICT-based training modules as per the farmers' requirements. Hence, a research survey was carried out with the following objectives:

- (1) To assess the tribal farmers information needs.
- (2) To find out the ICT availability, access and usage and ICT preferences among the tribal farmers.

The survey was conducted in the randomly selected three villages (in the project area) namely: Yagrung, Tekang and Kangkong of Pasighat circle in the East Siang district of Arunachal Pradesh state. Sixty tribal farmers were randomly selected from three villages for the individual household survey and also to conduct the Participatory Rural Appraisal (PRA). To find out the tribal farmers' information needs, quantitative and qualitative data were collected using a pre-tested structured interview schedule and PRA methods. To assess the availability, access and usage of ICT indicators, a structured interview schedule was developed based on the International Telecommunication Union (ITU) and United Nations Conference on Trade and Development (UNCTAD), which identified ICT indicators on the 'access to', 'usage indicators' (age, gender, education, frequency and purpose) and ICT infrastructure.

#### 3.1 Farmers' Information Needs Assessment

From the research survey, it was indicated that only 4% of farmers had regular access to the agricultural information sources. An information needs assessment indicated that a majority of tribal farmers, those who were growing paddy (*Oryza sativa*), needed information on pest management (92%), followed by disease management (88%), manures and fertiliser management (78%) and seed treatment (72%). Among the pests, paddy stem borer (*Scirpophaga incertulas*), case worm (*Nymphula depunctalis*) and leaf folder (*Cnaphalocrocis medinalis*) were the common problems among the surveyed farmers. In the paddy crop, sheath blight (*Rhizoctonia solani*) disease was commonly identified by the farmers. Results also indicated that all of the Khasi mandarin orange (*Citrus reticulata*) growing farmers (100%) expressed a need for information on pest management methods to control citrus trunk borer (*Anaplophora versteagi*) and fruit sucking moth (*Othresis fullonica*). Further, a majority of the farmers expressed the desire to learn scientific and technological information on complete crop production and also processing aspects for paddy (*Oryza sativa*) and Khasi mandarin orange (*Citrus reticulata*) crops.

Results also indicated that two-fifths of the farmers (40%) were obtaining agriculture-related information from the radio: the *Farm and Home* programme regularly broadcast by the All India Radio (AIR) station, Pasighat. The radio programme *Farm and Home* was regularly broadcast between 5pm and 6pm. The farm-related programme was considered useful by 28% of listeners. The radio

programmes are broadcast in the Adi tribal dialect, and, hence, an overwhelming majority of the farmers are radio listeners. In contrast to this, only 4% and 14% of the farmers were regular and occasionally viewers of farm-related programmes on TV, respectively, which was due to the fact that the majority of the tribal farmers were not well acquainted with the Hindi language. Few farmers (8%) were getting information from the agriculture and horticulture departments, due to there being inadequate technical manpower in the agricultural developmental departments (For example, in 2008, there were only 16 horticultural extension personnel for the horticultural information and knowledge facilitation of the 65,432 rural farmers spread over 142 villages in the East Siang district of Arunachal Pradesh state (DoH, 2008). Data indicates that each horticultural extension professional needed to concentrate on 4,089 farmers. Similarly, 12 veterinary and animal husbandry extension personnel and 16 fisheries extension personnel were working in their respective subject matter areas concentrating on a rural population of 65,432 spread over the same geographical area (<http://www.earik.in>). Further, tribal farmers' land holdings were scattered and located far away from the villages; hence, for extension personnel it was difficult to visit a number of farms. Further, the developmental departments had constraints such as inadequate technical manpower, lack of standardised, location-specific technologies, lack of training facilities for extension personnel, lack of conveyance facilities, lack of essential teaching and communication equipment (audio visual (AV) aids and ICTs), non-availability of timely inputs and a lack of quality inputs. The Krishi Vigyan Kendra (KVK) Farm Science Centre in East Siang district, started during 2006, had only three Subject Matter Specialists (SMS) and conducted a limited number of extension activities. The involvement of the private sector, such as agri-business firms, input dealers, print media and NGOs, in agriculture technology transfer was negligible (Saravanan, 2010b).

### *3.2 ICT Availability, Access and Usage among the Tribal Farmers*

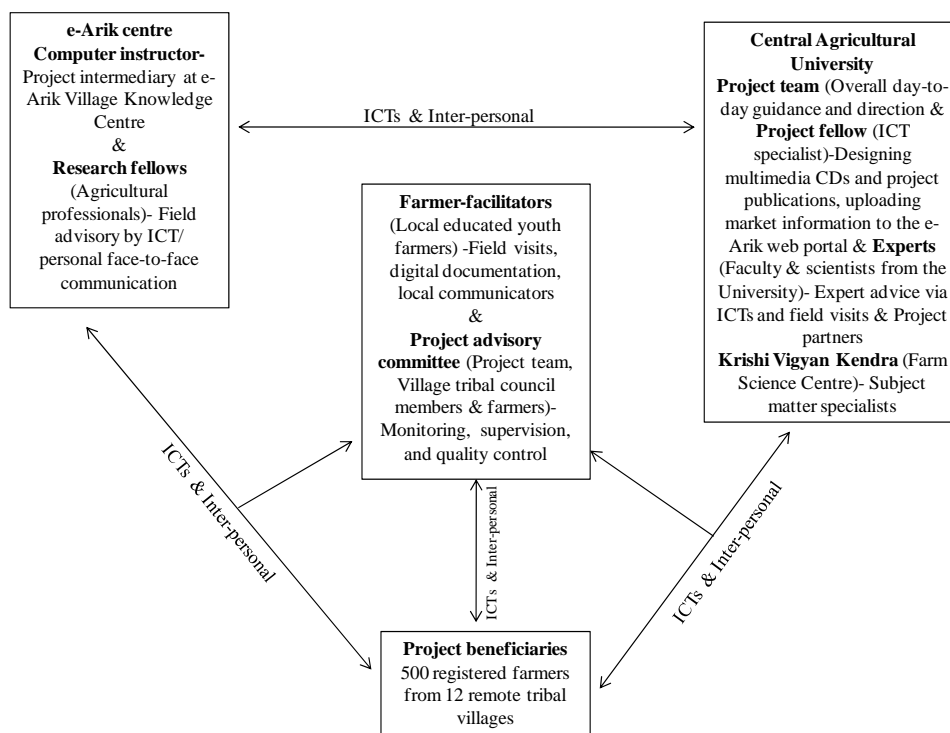
Findings indicated that four-fifths of the rural population possessed a radio, and nearly one-third of farmers had a TV and fixed phone line. However, very few possessed cellular phones (9%), and in three villages no one had a computer or internet facility. More than half of the households (56%) were not connected with electricity. Very few students and degree holders used the internet (3%) at all, or even occasionally. Among ICTs, radio was widely possessed (80%) and used for getting agricultural information (Saravanan, 2010d). Farmers were asked to express their preference of ICT for getting farm information; the majority of the farmers preferred a computer with internet access (88%), radio (84%) and television (76%). In contrast to this, only four farmers (16%) preferred receiving information by telephone (Saravanan, 2010b). During the survey it was found that none of the village households had a computer. However, 88% stated a computer with internet access as their preference for receiving agricultural information. This was mainly due to a high awareness of using computers among the rural tribal population. This was reflected by the village tribal chief (*Guonbura* of the village), Mr Tapang Jamoh (75 years old), who said that 'nowadays, I am hearing lot about computers through radio, they are telling so many things we can do by computer, at least before by death I want to see a computer. You came with good news and project will be good for villagers' (Drishti, 2011).

### *3.3 e-Arik Application Description*

Based on the farmers' need assessment and ICT preference findings, the e-Arik-Village Knowledge Centre was established with a computer, internet facility, printer, scanner, phone, and TV at Yagrung village. Project facilitators (agricultural professionals, a computer instructor and farmer facilitators) were appointed at the centre to assist the farmers in getting access to farm information by the ICTs. A full-time query resolution and expert consultation mechanism was established for the farmers through computer-based internet and email, web camera, website, offline CDs, digital library, TV, radio and face-to-face personal communication methods. The e-Arik project employed a variety of ICT tools, such as a web portal, digital video, internet applications (email, video conference, etc.), multimedia CDs, mobile phones, digital cameras, TV and radio. The e-Arik research project staff regularly undertook field visits to facilitate sustainable agricultural practices, observe crop conditions, diagnose pests, diseases and nutrient deficiency, physiological problems, and then field crop conditions were digitally documented. To solve complex crop pest, diseases, nutrient deficiency and physiological problems, symptoms were digitally documented and communicated to experts at the e-Arik research laboratory at the Central Agricultural University. Problems were analysed by the experts and recommendations were passed on to the e-Arik village knowledge centre by email and then to the concerned farmers by phone/personal face-to-face communication by the farmer facilitators. Further, farm scientists undertook needs-based field visits and provided expert advice to the farmers. The project portal (<http://www.earik.in>) provides information on crop cultivation aspects, agriculture and rural developmental departments (information on objectives, mandate, thrust areas, administrative and technical personnel details, their area of expertise, and contact details for the Departments of Agriculture, Horticulture, Fisheries, Animal Husbandry and Veterinary, Dairy, District Rural Developmental Agency) and their schemes (through these departments central and state governments implement different farmer welfare programmes), day-to-day market information and weather conditions. Innovative approaches such as farmer-to-farmer communication, local leadership and self-help group approaches were employed for agricultural information dissemination.

### *3.4 e-Arik Service Provision Mechanism*

Registered farmers obtained information directly (for example, from the project staff, project portal and other related websites, or from offline CDs) at the e-Arik centre, but more often worked via the facilitator intermediaries to access ICT-based information or to engage in remote consultation with other agricultural experts (see Figure 1). Five hundred registered farmers from 12 remote tribal villages were the beneficiaries of the e-Arik system. Each farmer had at least two advisory visits per month by the e-Arik project staff. Interested farmers and others visited the e-Arik centre to avail themselves of the services. The e-Arik project staff regularly undertook field visits to observe crop conditions and to diagnosis pests, diseases, nutrient deficiencies and physiological problems. They digitally documented these issues using ICTs in the field and via email and webcam, and communicated them to staff at the e-Arik Research Laboratory at the Central Agricultural University. Problems were analysed by the experts (who themselves sometimes also undertook field/advisory



**Figure 1.** e-Arik project working mechanism.

visits) and recommendations were passed on to the e-Arik village knowledge centre by email and then to the concerned farmers by phone or personal face-to-face communication by the farmer-facilitators. Dissemination of information and good practice was also addressed by innovative approaches such as farmer-to-farmer communication and local self-help groups (Saravanan, 2011).

The following services/activities were carried out by the e-Arik project for the benefit of farmers: agriculture and allied sector information was disseminated through ICTs, followed by farm advisory services for major crops (rice and Khasi mandarin). The digital documentation of pests and diseases was undertaken for the benefit of farmers and other farm stakeholders. The project team also documented crop history for the ready reference of the project staff, experts and also for other extension personnel working in the project area. Farm market and weather information was disseminated through the project portal and also displayed on the notice board at the e-Arik centre. Announcements on farm training programmes were made through the project portal and notice board at the e-Arik centre and also through personal communication to the farmers by the e-Arik project staff. Information on the governance, health and education sectors, results of survey reports, newsletters and farmers training reports were published through the project web portal. Further, computer education and general developmental and environmental awareness information was provided to the farmers and school children at the e-Arik centre. Farm multimedia shows, on-farm training and demonstrations were

regularly organised by the e-Arik project staff. Scientists visits to the farmers' fields were facilitated as also was multi-agency extension through the e-Arik village knowledge centre.

#### **4. Innovations**

##### *4.1 Farmer-to-Farmer Communication*

Arunachal Pradesh state's inhabitants used to speak a large number of tribal dialects (20 major tribal dialects and more than 25 minor dialects). In the project area, farmers speak the Adi tribal dialect. Hence, to overcome language barrier, four educated farm youths were selected and trained to communicate among the farmers in their local dialect to facilitate a 'farmer-to-farmer communication approach', and they were designated 'farmer facilitators'. The trained farm youth also acted as 'local knowledge managers'/'para extension professionals' in facilitating climate smart agriculture practices (agriculture that sustainably increases productivity, resilience (adaptation), reduces/removes greenhouse gases (mitigation), and enhances achievement of national food security and development goals (FAO, 2010)) among tribal farmers. The local educated farm youth had more communication credibility and trust worthiness among local tribal farmers. Farm youth used digital cameras and camera-enabled mobile phones for the digital documentation of field condition, diseases and pest problems and passed these to the e-Arik village knowledge centre for recommendation or further transmission to the experts (the farmer facilitators were paid a nominal amount of Rs. 3,000 (USD 60) per month for undertaking the project work).

##### *4.2 Message and its Treatment*

The selection of the appropriate technical message and its treatment by using a variety of ICT tools combined with conventional extension methods facilitated effective communication among the tribal farmers. For example, to create awareness on farm technologies, videos were screened and were also demonstrated at the farmers' fields (for example, vermi-compost preparation, mushroom cultivation). For awareness creation, radio and farmer facilitators were used as communication sources. For introducing new technology, experts from the Central Agricultural University visited the villages, followed by demonstrations in farmers' fields and then a video showing case studies of farmers who had adopted the practices and their experiences were used for further dissemination through digital media.

##### *4.3 Farmer Specific Information*

Compared to the blanket recommendations of conventional extension systems, the e-Arik project provided farmer-specific information which enhanced the adoption rate of disseminated farm practices, and client satisfaction was also considerably high. For example, among the farmers who availed themselves of the e-Arik project service, 44% and 92% of farmers implemented the information on climate smart farm practices on paddy (*Oryza sativa*) and Khasi mandarin (*Citrus reticulata*) crops, respectively.

#### 4.4 Partnership

Along with the project team, the convergence of other agricultural advisory service providers, such as the farm science centre and developmental departments, gave the efforts of the project team synergy. For example, indigenous pest and disease management measures were documented by the farmer facilitators and popularised by the SMSs of farm science centers by using ICT facilities at the e-Arik village knowledge centre. Similarly, the project's farmer facilitators helped the farm science centre (KVK) by facilitating the farmers' meetings, training programmes and they also collected feedback from the farmers.

#### 4.5 Media Mix and Reinforcement

The e-Arik project design integrated the village knowledge centre (tele-centre) concept with all possible ICTs, for example, computer with internet, telephone, mobile, radio, TV, multimedia CDs and traditional extension approaches. Having considered the high potential for frequent outages of power and therefore the internet, in order to minimise farmers' disappointment and also to add value to their waiting time, the e-Arik centre contained a 'village library' with the publications containing information on climate-smart farm practices and other scientific cultivation methods. For general education and awareness, TV was also used. The 'farmer participatory video' at the e-Arik centre regularly reinforced farmers' learning. A display of 'organic farm inputs' at the e-Arik centre created a lot of interest and awareness among the tribal farmers on organic agriculture, because the visitors' record at the e-Arik village knowledge centre indicated that 90% of the farmers who visited the centre had a glance and raised an enquiry about the availability of the products. Farmers also suggested establishing an outlet for organic inputs at the e-Arik village knowledge centre.

### 5. Impact

#### 5.1 Adoption of Sustainable Farm Practices

Through the efforts of the e-Arik project, 44% and 92% of farmers implemented the information on sustainable farm practices (vermi-compost, using leguminous crops for nitrogen fixation, bunds and ridges for water retention, stone contour bunds, agro-forestry, indigenous pest and disease control measures, crop rotation, indigenous pest and disease management, introducing water conserving technologies (system of rice intensification), creating awareness to change Jhum to settled cultivation by rubber plantations and establishment of Khasi mandarin orchards) on paddy (*Oryza sativa*) and Khasi mandarin (*Citrus reticulata*) crops, respectively (Drishti, 2011). After two years of project initiation, 55% of farmers developed new Khasi mandarin orchards in their Jhum fields, which means they permanently moved from old slash and burn agriculture (shifting cultivation) methods to settled cultivation. Low methane emitting and water conserving technology such as the system of rice intensification (SRI) was introduced, and among 40 SRI trained farmers only two farmers adopted it in 2010. It may take a few more years to convince more farmers to adopt because it follows an entirely different farm practice compared to their usual cultivation methods, which have been followed for generations. Forty-two percent

and 29% of e-Arik beneficiaries reported increased production of rice and Khasi mandarin crops, respectively.

### *5.2 Farmers' Income Increase*

A comparison was made with the 120 control group farmers (those who were not availing themselves of the services offered by the e-Arik project but were residing near by the project area (20 km away from the project villages) and cultivated crops in a similar agro-ecological climatic, socio-economic and situational conditions). Further, the control group farmers were selected in such a way that weather and market forces were similar to the e-Arik project service farmers. Control group farmers also operated in a similar agricultural knowledge and information systems environment but without the e-Arik service facility. Further, the control group farmers had very limited social contact with the e-Arik farmers because of the geographical location of the villages and also they (e-Arik farmers and control group farmers) belonged to different sub-tribes. Hence, the influence of e-Arik farmers on the control group farmers was negligible. For calculating yield and income in the two major crops (rice and Khasi mandarin), before the project initiation yield data for one crop season (for the year 2006) was collected from the registered farmers of the e-Arik project and also control group farmers as baseline data. After the project initiation, crop yield data was recorded for three consequent seasons. To mitigate the yield and income difference due to weather and market price fluctuations, comparison was made with the control group, and average yield and income was calculated by considering three-year average yield and income data. The average yield data was subjected to two-way comparison with baseline yield data (first, before and after design—by which average yield increase was calculated among the beneficiaries, second, control group farmers and e-Arik farmers—by which comparison was made between non-beneficiaries and beneficiaries and average yield data was obtained). Based on the above two-way comparison, it was estimated that an average Rs. 1,689 (USD 37.50) and Rs. 5,251 (USD 117) per farmer per season increased income was reported in rice and Khasi mandarin crops among 500 e-Arik beneficiaries.

### *5.3 Cost and Time Savings*

Cost and time savings in delivering (by the public agricultural extension department and e-Arik system) and availing extension services (by farmers) were calculated by comparing actual expenditure statements, number of advisory services and farmers' contact by the Department of Agriculture with the e-Arik project for the corresponding period. Due to a very limited public transport system in the rural area, farmers need to travel by their own vehicle or need to hire a private taxi to visit the public extension department to receive agricultural information or advisory services. But, through the e-Arik system, farmers had the need-based information and advisory services on their doorstep as a result of the e-Arik village knowledge centre and also the project staff. Hence, their fuel costs or vehicle hire charges were saved. Travel costs to avail extension services were calculated by comparing the number of advisory services received from the e-Arik system and the hypothetical transport costs involved in receiving a similar number of advisory services from the public extension organisation. Results indicated that the transport charge of

Rs. 2,400 (USD 53) was saved per farmer per year (an energy saving of 48 litres of petrol (fuel for their vehicles to reach the agricultural department to get advice/information) was saved by each farmer), and 3.6 times reduced expenditure was incurred for providing farm advisory services, in comparison with the conventional extension system (Saravanan, 2008a). The number of e-Arik advisory services delivered to the 500 farmers was compared with the traditional extension system using time and cost indicators. Estimates indicate that sixteenfold less time was required for availing the services by the farmers and threefold less time was required to deliver the services to the farmers compared to the conventional extension system.

#### *5.4 Facilitating for Sustainable Farm Practices and Settled Cultivation*

The project facilitated adoption of sustainable farm technologies such as vermicompost, using legumes for nitrogen fixation, bunds and ridges for water retention, stone contour bunds, agro-forestry, indigenous pest and disease control measures, crop rotation, indigenous pest and disease management, introducing water conserving technologies (SRI), creating awareness to change Jhum to settled cultivation by rubber plantations and establishment of Khasi mandarin orchards by the tribal farmers. Three years after the project's initiation, 55% of farmers had developed new Khasi mandarin orchards in their Jhum fields (continuance of age-old Jhum cultivation or slash and burn agriculture with a reduced Jhum cycle creates large-scale deforestation and results in an unfavourable environmental impact), which means the farmers had permanently moved from the age-old slash and burn agriculture to settled cultivation.

#### *5.5 Farmers' Willingness to Pay*

The e-Arik project farm information and knowledge services were given free of charge, and after demonstrating the potential and value of ICT-based information facilitation among farmers a survey was conducted to discover the willingness to pay for the e-Arik services. A survey was conducted among the randomly selected 120 farmers who were availed of the services from the e-Arik project. Survey results indicated that the majority of the farmers (66%) were willing to pay only a nominal fee ranging from 1–3 USD per crop season. Among the farmers who were willing to pay (66% of farmers surveyed), 100% would pay for pest and disease management, followed by information about new varieties (89%), organic fertiliser and manure (84%), seed treatment (83%) and mushroom cultivation (80%). However, 34% of the farmers were not willing to pay for the services received through e-Arik, because they opined that agricultural advisory services are the responsibility of the public sector and services are 'public goods'; hence, they were not willing to pay, but 100% still desired to use the e-Arik services in coming years as a free service (Saravanan, 2008b). At the same time, farmers also suggested having an organic farm input unit at the e-Arik village knowledge centre as a sustainable business model and also as a revenue source to run the project.



### 5.6 Developing Local Knowledge Managers

Due to the prevalence of tribal dialects, the communication process is a difficult task for developmental professionals who are not familiar with those tribal dialects. Hence, to overcome communication difficulties and also to motivate rural farm youth and others to take up profitable farming activities, four educated tribal farm youths were employed as ‘farmer facilitators’ along with the ICTs. They were given advanced farm technological training at the constituent college of the Central Agricultural University and Farm Science Centre (KVK). The farm youth helped to create general agricultural and rural development awareness among the tribal farmers, facilitated eco-friendly and sustainable farm technology dissemination, developed vocational efficiency among farmers, formed farmers’ groups for self-help, facilitated use of local resources, helped to make timely decisions by the farmers themselves and suggested alternative ways to solve farming and other rural problems in 12 selected villages. Even after the completion of the project, trained farm youth acted as a link between agricultural development departments and tribal farmers for facilitating advanced farm training and advisory services and they became ‘local knowledge managers’ to foster agricultural development in the remote tribal villages.

## 6. Lessons

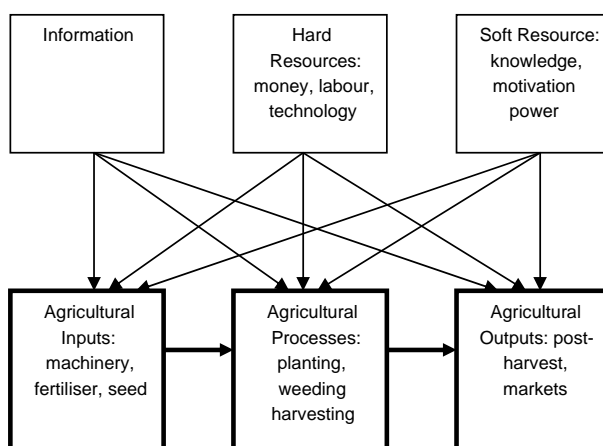
Based on the inputs from the regular village advisory committee meetings, project review meetings with the stakeholders, the experiences and observations of the project team were synthesised as lessons and these are indicated below:

### 6.1 Insufficient Need-based Content and Need for Emphasis on IT, Local Innovation and Refinement

There was lack of availability of need-based content from the developmental departments. However, local innovations and ITKs (Indigenous Technical Knowledge) for mitigating the adverse effects of climate change are abundant, which needs to be slightly refined and then disseminated by the ICTs. For example, climate smart best practices need to be documented digitally and made available to other farmers who are not practicing them. Adi tribal farmers used to control citrus trunk borer (*Anaplophora versteagi*) by inserting pointed bamboo sticks. Indigenous rat control techniques at paddy fields, and legume tree-based agro-forestry systems are some more examples for dissemination among other farmers using ICTs.

### 6.2 Information Alone Not for Development

As indicated by Heeks (2005) e-development projects must be designed around the information chain. They must either provide or draw together an entire ‘information chain package’ of all resources necessary to turn data into effective action. Until this happens, ICTs will not deliver on their developmental potential. Similarly, experience from the e-Arik project indicates that facilitating information exchange by the ICTs alone will not bring desirable changes to the adoption of sustainable farm practices. And hence, appropriate technologies need to be demonstrated and appropriate resources made available at farmers’ field level for the better understanding of the tribal farmers. For example, to disseminate a bio-fertiliser based seed treatment



**Figure 2.** Holistic provision on e-agricultural adaptation projects.  
Source: Saravanan (2011).

(a practice not known to the farmers in the project area), at least for the first time, the practice should be demonstrated at the field among interested farmers and after its adoption by a few farmers the same practice can be disseminated by ICTs.

### 6.3 Knowledge Plus

Information and knowledge on farm practices along with other forward (farm machinery, manure, seeds) and backward linkages (post-harvest technology and market) were essential in adopting farm practices. Rural service provision needs to be more holistic in two ways (see Figure 2). First, the project must find a way to deliver all the resources necessary to turn information into agricultural action (Saravanan, 2011).

### 6.4 Integration of Efforts of Knowledge Providers

For successful implementation of the ICT project and also for its sustainability, integration of the other public (Department of Agriculture, Horticulture, Fisheries, KVK (Farm Science Centres)) and private knowledge providers (agriculture-based NGOs, farm input dealers, agribusiness firms) in the agriculture sector creates synergy and complementarity in disseminating sustainable farm practices. For example, the e-Arik project had collaboration with the Farm Science Centre (KVK) for the dissemination of composite fish culture technology, which proved successful in establishing model fish farmers in the 10 villages of the project area. The Farm Science Centre also used the ICT facilities of the e-Arik village knowledge centre for conducting farmers' training and other extension programmes.

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