

Information and Communication Technologies for Agriculture Knowledge Management in India

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Abstract: The National Agricultural Innovation Project (NAIP) of The Indian Council of Agricultural Research (ICAR), New Delhi supported a Consortium project on the use of ICTs in developing a multimedia data base of Best Management Practices (BMPs) for few important crops and provide solutions to production problems faced by farmers across the country. Through the activities of the Consortium, leading professionals in agriculture and ICT sectors have developed key new products and platforms that form the nucleus of a possible global collaborative effort. Salient findings from the work carried out in the consortium mode by The Universities of Agricultural Sciences, located in Dharwad and Raichur are briefly presented here. Useful and relevant bilingual multimedia content on important crops such as paddy, cotton, pigeon pea and chick pea was developed in collaboration with Indian Institute of Technology (IIT), Kanpur and Indian Institute of Technology and Management (IITM), Kerala by using their web platforms namely Agropedia indica and AKMIndia, respectively. A very popular aAQUA portal developed by IIT, Mumbai was used to transfer agriculture technologies from National Agriculture Research System (NARS) to the farmers. Nearly 18,000 members and 13,000 threads were created in aAQUA besides posting 250 audio clips on 25 crops. Multimedia content in bilingual language on cotton, paddy, chickpea and pigeon pea has been uploaded to Agropedia indica portal. Around 1200 online fertilizer recommendation for 26 crops has been generated through GIS web based application in AKMIndia portal.

Key words: Information and Communication Technologies (ICTs) • Agriculture Knowledge Management (AKM) • Web portals • Multimedia content • aAqua and Agropedia indica

INTRODUCTION

India is one of the biggest and strongest agro-based nations in the world. In spite of an alarming increase in the population, it has managed to attain self sufficiency in agriculture, thanks to green revolution and sustainable agriculture. However, looking into the total area under cultivation, achievements made in agricultural productivity are far below the desired levels. One of the major constraints facing Indian agriculture is the deficiency in transfer of relevant knowledge from National Agriculture Research System (NARS) and State Government Agriculture Departments to the small and

marginal farmers who form bulk of the nation's agricultural population. Hence, farmers are deprived of timely availability of latest technology and support leading to considerable economic loss, distress and suicides in extreme cases. Further, there exists a huge gap between farmers and agricultural scientists and extension agencies involved in technology development and transfer activities. Under such circumstances, innovative Information Communication Technologies (ICTs), can play a major role in bridging this gap.

Agriculture Knowledge Management (AKM) helps in creating knowledge repositories, improving knowledge access, sharing and transfer and enhancing the

knowledge environment in the rural communities. ICTs can make AKM more effective by providing agro-information services that are affordable, relevant (timely and customized), searchable and up-to-date. ICTs is an umbrella term that includes computer hardware and software, digital broadcasting and communication technologies, digital information repositories [1] and internet, television, radio, mobile phones and the policies and laws that govern the use of these devices and media. The intrinsic and instrumental importance of ICTs in AKM is such as to make it a significant factor in the future competitiveness of agriculture in the global economy [2]. The experience of rural tele-centers in the developing world shows that ICTs can help intermediaries to gather, store, retrieve, adapt, localize and disseminate a broad range of information needed by rural communities [3]. Though tele-centers are beginning to dot the Indian rural landscape [4, 5], they lack agro-content in local language and quick delivery of the information that is of immediate use to them. The role of ICT to enhance food security and agricultural livelihoods are widely recognized and discussed world over [6]. Klerkx and Leeuwis [7] presented an overview of the innovation intermediaries that have emerged in AKM in The Netherlands and argued that the state should play a role as a 'market facilitator' by funding such innovation intermediaries. Lemma [8], assessed the role of ICT in World Knowledge Centers (WKC) projects in Ethiopia and observed that the role of ICT in the WKC was moderate due to the inefficiency of Ethiopian Telecommunication system.

On the contrary, the strong ICT sector in India, with rural broad band connectivity in the offing provide a great opportunity for developing effective AKM systems. However, at present, the conventional agricultural extension and farmer-outreach programs in India face major challenges such as quick and timely outreach, solutions tailored to needs of individual farmers and cost effective outreach. Keeping these factors and the needs of Indian farmers in mind, a project 'Re-designing the farmer-extension-agricultural research/education continuum in India with ICT mediated Knowledge Management' was implemented under the aegis of the World Bank funded National Agricultural Innovation Project (NAIP) (Component-I) of the Indian Council of Agricultural Research (ICAR), New Delhi. The intent was to develop highly integrated knowledge management approaches between agricultural research, education and extension services.

The NAIP's approach to knowledge management involved the development of highly integrated

approaches between agricultural research and education sectors and ICT sector. Indian Institute of Technology, Kanpur (IIT-K), Uttar Pradesh., Indian Institute of Technology, Mumbai (IIT-M), Maharashtra, Indian Institute of Information Technology and Management (IIITM-K), Thiruvanthapuram, Kerala, National Academy of Agricultural Research Management (NAARM), Hyderabad andhra Pradesh, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttaranchal and Universities of Agricultural Sciences (UAS), Dharwad and Raichur were consortium partners in the national pilot project. The main project was divided into 6 sub-projects and The Universities of Agricultural Sciences (UAS), Dharwad and Raichur, Karnataka executed one of the sub-projects entitled "Digitization of Agricultural Information for Knowledge Management System, its delivery and Impact Assessment". The role included the following: providing agricultural information / content to the knowledge organization systems developed by three IITs and NAARM, providing logistic support in developing information structure for semantic / ontological search engines, to develop knowledge interface between farmers and information resources at SAUs by strengthening and modernization of the selected KVKs / ARS, delivery of the developed knowledge resources / tools through KVKs / ARS and assessment of the impact of the KM Resources / Tools on the functioning and effectiveness of the KVKs /ARS.

MATERIAL AND METHODS

In this consortium project, IIT-B, IIT-K and IIITM-K individually developed knowledge organization systems such as aAQUA, Agropedia and AKMIndia respectively. The role of UAS Dharwad and Raichur was to provide agricultural information content and its incorporation into the knowledge organization systems and Krishi Vigyan Kendras (KVKs) / Extension Education Units (EEUs) for the delivery of developed knowledge resources/tools.

aAQUA: aAQUA (almost All QUestions Answered) is an online multilingual, multimedia portal for disseminating agricultural information to the Indian farming community [5]. They made use of novel database systems and information retrieval techniques like intelligent caching, offline access with intermittent synchronization, semantic-based search, etc., for demonstrating the utility of various component DB/IR technologies built into aAQUA to enhance the Q&S delivered to rural populations. In a typical aAQUA thread, a farmer submits a problem based query and an agricultural expert provides an answer with

solutions. Users can post a question on aAQUA site through the web site (www.aaqua.org) or via mobile texting by registering free of cost. This portal is in public domain with free access to all the registered users. The individuals interested in registration should include details such as name, address, contact details, crops grown etc. After registration and login, questions can be asked in a separate editor in any of the five languages such as English, Hindi, Marathi, Kannada and Telugu. Assuming the question is clear and complete, agri-experts provide a detailed answer and attach relevant images or documents, if necessary. If the question is incomplete, the agri-expert asks the user to clarify the problem. To answer farmers' queries, 24 scientists (11 from UAS, Dharwad and 13 from UAS, Raichur) from various disciplines of agricultural sciences (Crop production, Crop Protection, Agricultural Economics and Marketing) were involved as experts. More than 10,000 farmers' contact numbers were collected and categorized based on region and crops cultivated in order to send region and crop specific agro-information tips. Relevant tips on various aspects of agriculture and allied activities were sent through short message service (SMS) to mobile phones of the registered members. Apart from this, recommendations on Best Management Practices (BMPs) for various crops, images that help in pest and disease diagnosis, audio clips and video clips, etc. were uploaded on to the digital library of aAQUA.

Agropedia Indica: IIT-Kanpur developed a portal called Agropedia (www.agropedia.in) with an objective to create a repository of Agriculture Knowledge containing universal knowledge models and multilingual crop content with appropriate interfaces. These universal knowledge models help in mapping the knowledge and tagging content of this site so that the information is semantically searchable. Initially, both text and multimedia contents on crops such as paddy, wheat, chickpea, green peas, pigeon pea, sorghum, groundnut, litchi and sugarcane were added to the portal with the help of consortium partners from UAS Dharwad / Raichur and GBPUAT, Pantnagar and ICRISAT, Hyderabad. As per the mandate of UAS, Dharwad/Raichur, region specific bilingual (Kannada and English) multimedia (text, images, graphic, audio and video) content on rice, cotton, pigeon pea and chickpea was developed and added to the portal. The portal also includes 'Crop Calendar' and 'Do's and Don'ts' on selected crops. Experts from UAS, Dharwad/Raichur utilized the interaction space such as agrowiki and agroblog available in agropedia for adding content and also for commenting on the existing content.

AKM India: AKMIndia (www.akmindia.net) portal developed by IIIM-K mainly focuses on web based Decision Support Systems (DSS) such as Online Fertilizer Recommendation System (OFRS), weather information and forecasting and soil nutrient information. OFRS included fertilizer recommendations for 26 agricultural and horticultural crops covering 10 agro-climatic zones of Karnataka state. The web enabled GIS map has a weather location layer represented as points showing various talukas of all the 33 districts of Karnataka State. By clicking on these points, the weather conditions of the respective talukas are pulled dynamically from fallingrain genomics service. Currently, the weather information includes three parameters, such as temperature, cloud cover and precipitation (rainfall). The physical and chemical properties of soils of Dharwad district of Karnataka, are represented as individual GIS layers and classified as low, medium and high availability levels. The data on soil micronutrient status of soils was provided by ICRISAT.

For the impact assessment, 10% of the total farmers registered for SMS service were selected randomly (using computer generated randomization). Chosen farmers were contacted individually to their mobiles to record their feed back in the form of relevancy of crop tips, adoption of the disseminated technology and the benefit realized from the adopted technology.

RESULTS AND DISCUSSION

aAQUA: At present there are 17901 members (Fig. 1) 13673 threads (Fig. 2) and 34580 posts. Majority of the registered members from Karnataka State were from northern districts. Most of the questions (both in English and Kannada) from farmers were related to plant protection in agricultural and horticultural crops. Apart from farmers, representatives of farmers organizations, small and medium-sized agri-businesses and larger agro-based companies also posted their queries in crop, animal and other forums. The average response time for answering a query was from 5 minutes to 24 hours. Since it is an open access portal, domain experts including scientists, Officers of the department, Progressive farmers and agri-business executives can provide the needed information on real time basis to farmers.

The major contribution of UAS, Dharwad / Raichur to aAQUA portal was in the form of providing crop recommendations. Around 250 audio clips on 27 crops each of 15 to 45 seconds duration focusing on pest and disease management were posted. There were 345 posts and 329 threads in UAS Dharwad/Raichur forum (Table 1).

State Name and Number of users

| | |
|--------------------|--------------------------|
| Maharashtra :6907 | Karnataka :2500 |
| Tamil Nadu :838 | Andhra Pradesh :779 |
| Gujarat :386 | State Not Specified :348 |
| Uttar Pradesh :294 | Madhya Pradesh :272 |
| Kerala :207 | Delhi :166 |
| Rajasthan :140 | Others States |

[List of users >>](#)

Fig. 1: Pie chart showing the number of online registered members from different states in aAQUA portal.

State Name and Number of questions

| | |
|---------------------------|---------------------|
| Maharashtra :7038 | Karnataka :1418 |
| Andhra Pradesh :664 | Tamil Nadu :614 |
| Uttar Pradesh :578 | Uttarakhand :249 |
| Gujarat :191 | Madhya Pradesh :174 |
| Not specified states :127 | Kerala :124 |
| Others States | |

[List of questions >>](#)

Fig. 2: Pie chart showing the number of questions from different states in aAQUA portal.

Table 1: Number of threads and posts under UAS Dharwad/Raichur recommendations forum in aAQUA portal

| कृषि प्रश्नोत्तर - के. वी. के (Agriculture Q&A from Krishi Vigyan Kendras) | Threads | Posts | Last Post |
|--|---------|-------|---|
| ✓ <u>फसल / Crops</u> | 5157 | 13089 | May 28, 1:22 AM by farmboy |
| ✓ <u>पशु / Animals</u> | 2440 | 7366 | May 28, 8:25 AM by drshibi |
| ✓ <u>अन्य / Others</u> | 1021 | 2737 | May 27, 5:47 PM by RURALINDIA |
| ✓ <u>के.वी.के. सुझाव / KYK Recommendations</u> | 221 | 476 | May 13, 7:47 PM by dharwad |
| SMS | Threads | Posts | Last Post |
| ✓ <u>SMS</u> | 0 | 0 | No Posts |
| ✓ <u>Bulletin Board</u> | 60 | 64 | May 26, 3:36 PM by dharwad |
| NAIP Farmer Queries | Threads | Posts | Last Post |
| ✓ <u>GBPUAT Pantnagar Recommendations</u> | 108 | 113 | Mar 23, 12:18 PM by pantnagar |
| ✓ <u>UAS Dharwad / UAS Raichur Recommendations</u> | 329 | 345 | May 17, 1:07 PM by dharwad |
| ✓ <u>Agri Videos</u> | 23 | 25 | Apr 27, 10:56 AM by dharwad |
| ✓ <u>Audio Clip Forum</u> | 56 | 58 | Feb 22, 8:21 PM by dharwad |
| E Mail | Threads | Posts | Last Post |
| ✓ <u>E Mail Forum</u> | 0 | 0 | No Posts |

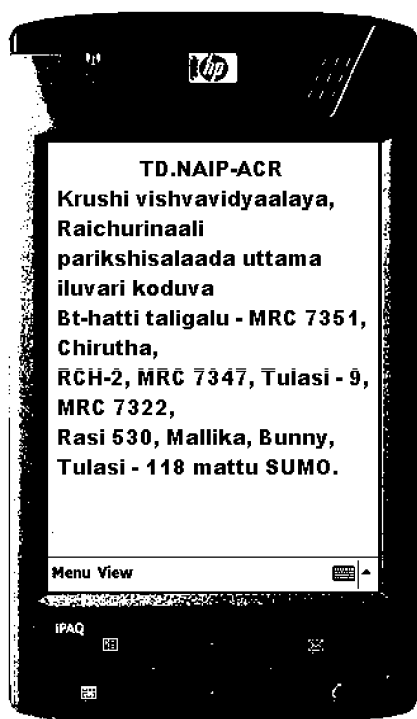


Fig. 3: Sample crop tip in mobile phone

aAQUA simultaneously addresses two major challenges in farmer outreach programs – geographic reach and customized delivery [5]. Mobile phone technology helped to reach large number of farmers. A database (name, address, mobile number and crops grown) of 10,000 farmers was developed and 250 tips on agriculture and allied enterprises such as animal husbandry and pisciculture were sent to all of them (Fig. 3). Apart from this, the registered farmers were also provided with contact numbers of the scientists for contacting them to seek solutions to their problems. On an average each scientist gets around 5-6 phone calls from farmers seeking solutions to their problems. There was positive feedback from few of the farmers. Some of the farmers made a suggestion to incorporate weather forecasting.

The library of aAQUA contained 'Crop Doctor' which is a collection of textual information and images that help farmers in diagnosis and management of pests and diseases of crop plants. The Crop Doctor contained 250 images of pests and disease of 19 crops covering cereals, pulses, oil seeds and commercial crops, along with detailed information on their symptoms, causal organism, preventive and curative measures. An Expert Bulletin Board is also added in the aAQUA for continuously displaying agricultural information.

Table 2: Number of posts from UAS Dharwad / Raichur to Agropedia portal

| User Id | No. of Posts |
|-------------------|--------------|
| Naipictuasdharwad | 688 |
| Kiran yadav | 230 |
| Fatima Abedi | 211 |
| Bharati | 187 |
| Sandhyagir | 185 |
| Akanksha | 144 |
| Kanchannainwal | 120 |
| Deepalitewari | 109 |
| Yogesh | 96 |
| Awaneesh | 83 |
| Vimlesh | 74 |
| Shelly | 73 |
| Sugatha | 68 |

The impact assessment on level of adoption of text SMS (free agri tips) messages sent in a particular season to farmers was done in next season. The study revealed that, 38.46% of the farmers opined messages as highly relevant. Around 59% of the farmers considered the messages as moderately relevant, whereas, only 2.56% of farmers considered messages were of no relevance. More than 66% of farmers adopted the technology sent through text messages.

Agropedia Indica: There are more than 60 agricultural websites developed by public, private and cooperative sectors in India. Agropedia is a portal developed by IIT, Kanpur. It is an open access portal where in scientists, students, extension workers, farmers, traders and businessmen can interact with each other. Using state of the art practices and techniques of the semantic web, domain experts can make lasting contributions to the vast knowledge base of agropedia [9]. UAS, Dharwad / Raichur were involved in contributing content to the *gyan dhara* (certified content) and *janagyan* (emergent knowledge) components of Agropedia. The bilingual (English and Kannada) crop content in the form of text, graphs, images and videos on paddy, cotton, pigeon pea and chick pea were added to *gyan dhara* (Table 2).

The semantic technology in agropedia was implemented using 'Knowledge Models' which formed the basis of cataloging. Knowledge models formulated by domain experts, helped in developing links among different concepts in agriculture through simple relationships. These models enabled agropedia to produce better search results set as all the documents, images and videos come with appropriate live tags attached which make them visible and searchable [9].

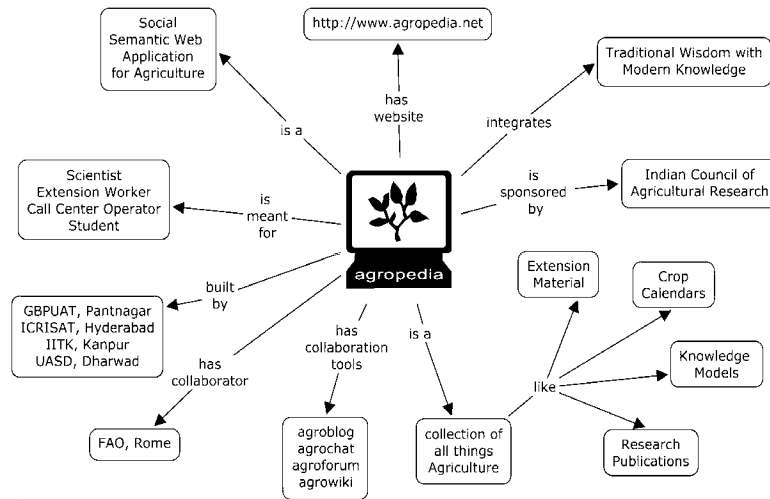


Fig. 4: Agropedia portal

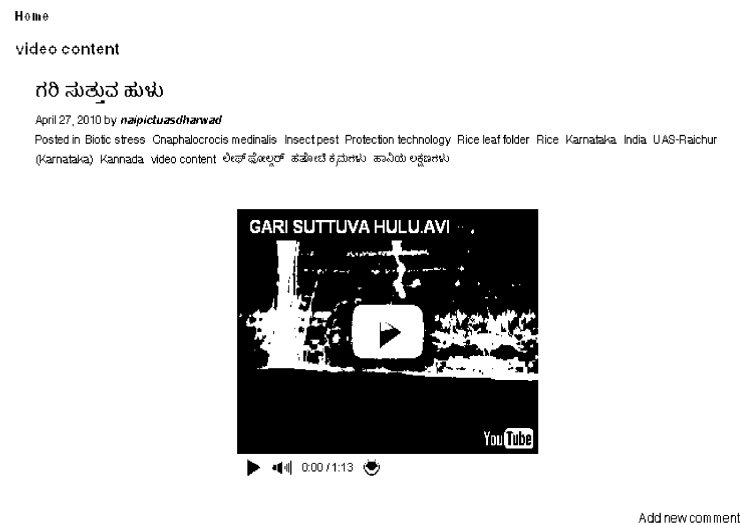


Fig. 5a: Online video clip on pest management in Agropedia portal (Kannada)

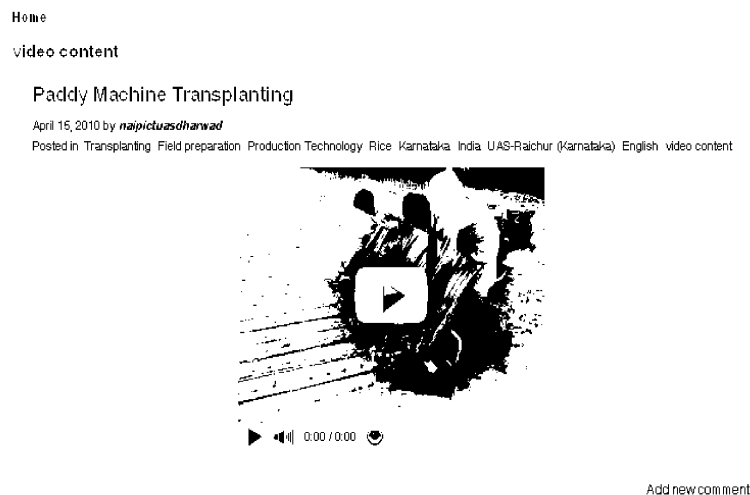


Fig. 5b: Online video clip on machine transplanting in paddy in Agropedia portal (English)

| Fertiliser Recommendation Report | |
|---|--|
| Tamil Nadu | |
| Preference | |
| Fertiliser Recommendation | |
| <p>326.09 kg of Urea</p> <p>428.57 kg of Super Phosphate (double)</p> <p>200.00 kg of Muriate of potash</p> | |

Fig. 6: A sample OFRS report generated in AKMIndia portal

The multimedia content developed for mandate crops in bilingual language was uploaded in to Agropedia portal which can be accessed by following link <http://agropedia.iitk.ac.in/> (Fig.4). The sample pages can be seen in Fig. 5a and 5b.

AKM India: The portal contains sub windows such as Online Fertilizer Recommendation Systems (OFRS), Web GIS based weather information, Web GIS based soil nutrient advisory system and online video channels. So far, 1243 farmers from 38 talukas of 17 districts in Karnataka have registered and around 1160 fertilizer recommendation reports on 26 crops were generated. This indicates that OFRS is becoming more popular among farming community. A sample fertilizer recommendation report can be seen in Fig. 6. Another important feature of this OFRS is that it also provides cost of fertilizers (Fig. 7a) and method of application (Fig. 7b). Availability of dynamic weather information is crucial for efficient planning and decision-making in agriculture. The web GIS technology on online weather forecasting system was used in Karnataka state to disseminate weekly weather forecasts at Taluka level (Fig. 8). It was achieved through virtual integration of dynamic information from multiple

Fertiliser Recommendation Report

| Name of fertiliser | Approximate cost of fertiliser |
|--------------------------|--------------------------------|
| Urea | Rs.1956.52 |
| Super Phosphate (double) | Rs.2571.43 |
| Muriate of potash | Rs.1200.0 |

Fig. 7a: Cost of fertilizers

Chemical Fertilizers : Apply the following **Straight Fertilizers**

: **326.09 kg of Urea**

: **428.57 kg of Super Phosphate (double)**

: **200.00 kg of Muriate of potash**

See cost

| Split Dosage | |
|--------------------------------------|--------------|
| Basal | Top Dressing |
| 326.09kg of Urea | -- |
| 428.57kg of Super Phosphate (double) | -- |
| 200.00kg of Muriate of potash | -- |

Fig. 7b: Method of application of fertilizers

Fig.7a and 7b: Cost of fertilizers and method of application

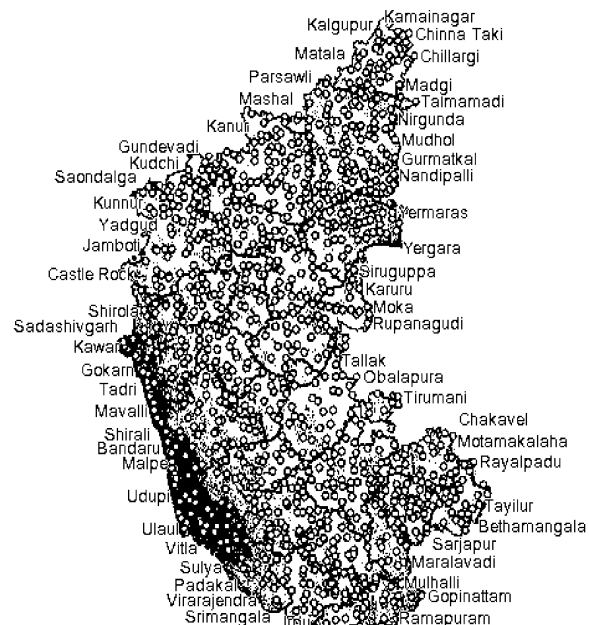


Fig. 8: Web GIS based weather information for Karnataka state

sources. This has helped in providing real time decision support systems for integrated crop management. Through the Web GIS based soil nutrient advisory

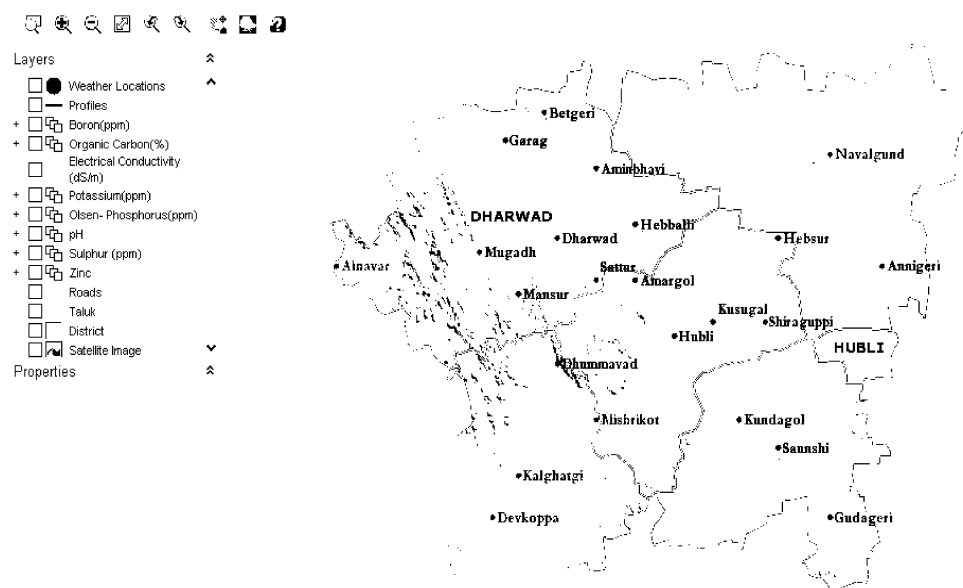


Fig. 9: Web GIS based soil nutrient information of Dharwad district

system, the farmers and extension officers can obtain detailed information on soil properties of Dharwad district (Fig. 9) based on which location specific fertilizer recommendation can be generated.

Social Networking: The efficiency of the portals developed such as aAQUA, Agropedia and AKMIndia can be improved through creating awareness in the Scientists, Officers of the government development departments and farming community with the help of extension agencies such as KVKs, EEUs, RSKs, NGOs and progressive farmers through social networking. Training/workshop is one essential area, without which these agencies could be really ineffective. Keeping this in mind, UAS, Dharwad / Raichur provided training to progressive farmers, NGOs, Department officers on the use of ICTs through a not for profit professional society named Indian Society of Agricultural Information Technology (INSAIT), Dharwad. INSAIT in association with UAS Dharwad / Raichur and IITs conducted 44 workshops and hands-on training programmes on the use of above portals. The feedback obtained from the trainees can be accessed in <http://aaqua.persistent.co.in/aaqua/forum/listthreads?forum=362>. The Indian Council of Agricultural Research (ICAR), New Delhi has recently invited scientists of all the State Agricultural Universities and ICAR institutes to contribute to these platforms to make them much more useful and effective.

CONCLUSION

ICT platforms such as aAQUA, Agropedia and AKMIndia, have proved to be very useful tools for effective transfer of agricultural technology in Agricultural Knowledge Management in India.

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