Information and communication technologies in weed management

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SUMMARY

India has made a tremendous progress in the field of agriculture over last few decades. The technological developments in agricultural sciences have changed the agriculture sector to a great extent. Information and Communication Technology (ICT) technologies have been introduced in the agri-food sectors. Important milestones like introduction of televisions, computers, internet, email and smart phones, and Global Navigation Satellite Systems (GNSS), social media platforms etc., have revolutionized the information sharing. The ICT tools are in use for many agricultural sectors like weather forecasting, input management, irrigation management, market related information sharing etc. Weed management is one of the important crop management practices wherein the use of ICT tools will help the farmers and other stakeholders to achieve the task with ease besides saving time and expenditure. In this chapter the relevance of various ICT tools to weed management are discussed in detail.

Keywords: Expert systems, ICT, Internet, Weed identification, Weed management

INTRODUCTION

Information and Communication Technology (ICT) consists of three main technologies, viz. computer technology, communication technology and information management technology. These technologies are applied for processing, exchanging and managing data, information and knowledge. Unique features of ICT are: (i) access to the astounding store-house of information is free, (ii) information is available instantaneously round the year and twenty four hours a day, (iii) communication can also be interactive, (iv) information is available from any point on the globe, and (v) communication is dynamic and ever-growing.

Any system applied for getting information and knowledge for making decisions in any industry should deliver accurate, complete, concise information in time or on time. The information provided by the system must be in user-friendly form, easy to access, cost effective and well protected from unauthorized accesses. The ICT can play a significant role in maintaining the above mentioned properties of information as it consists of three main technologies. It is an integration of the technologies and the processes to distribute and communicate the desired information to the target stakeholders and making them more participative in nature.

ICT IN AGRICULTURE

In present day agriculture, soft resources like knowledge and skills are as important as hard resources like inputs, and sometimes even more important (Saravanan and Bhattacharjee 2014). Further, land and water resources are almost reaching their limits; hence, achieving food security heavily relies on 'Knowledge Resource' (Saravanan 2011). Estimates indicated that 60% of farmers do not access any source of information for advanced agricultural technologies resulting in huge adoption gap (NSSO, 2005). The ICT in agriculture is an emerging field focusing on the enhancement of agricultural and rural development in India. It involves application of innovative ways to use ICTs in the rural domain. The advancements in ICT can be utilised for providing accurate, timely, relevant information and services to the farmers, thereby facilitating an environment for more remunerative agriculture. Given the development scenario in Indian Agriculture, ICT movement is still evolving. However, all the ICT initiatives are not uniform with disparities between regions in the level and quality of tele communications, information and the effort of individuals, public and private organizations, and differentiated nature of demand of the farmers in different areas. As a result, there have been many successes, failures, lessons learned and experience gained, so far. While these initiatives are intended to address the needs of the farmers through ICT, their actual usage and their ability to bring significant impact on the farm productivity and socio-economic development of the intended beneficiaries is to be understood. It is relatively unknown as to whether the ultimate beneficiaries actually use the facilities provided for them

meaningfully to meet their needs. The common problems in adoption of ICT in rural segments are ICT illiteracy, availability of relevant and localized contents in their own languages, easy and affordable accessibility and other issues such as awareness and willingness for adoption of new technologies among the rural people etc. One critical aspect in the usage of ICTs for farmers and their groups, as seen in some of the ICT driven initiatives, is the involvement of human interface at the last mile indicating that there is a human dependency in transmission of information / knowledge to farmers. Thus, there is a need to understand as to how far the ICT initiatives are able to address the farmers need so that better solutions can be developed to address those unmet needs.

The ICT enables vital information flows by linking rural agricultural communities to the Internet, both in terms of accessing information and providing local content. New information and communication technologies are generating possibilities to solve problems of rural poverty, inequality and giving an opportunity to bridge the gap between information rich and information poor and support sustainable development in rural and agricultural communities.

As farming is becoming highly knowledge intensive, commercialised, competitive and globalised against traditional resource based approach, the need to adopt right means to bring in all players of agribusiness, cannot be over emphasised. Innovations in ICT are of great help in offering a communication platform circumventing all traditional physical barriers and backwardness with its wider reach out and neutrality to social and gender bias; and its inclusive nature of public and private sectors and its innate strength of offering a reliable, good and cost effective communication platform to various management agencies involved in the extension to and from to the farmers. With these features, ICT will definitely strengthen the current ongoing extension reforms in bridging gaps in access and in bridging rural economy with globalised markets.

ICT IN WEED MANAGEMENT

Weeds can be successfully managed through integration of different management practices. The success of integration depends on the proper choice of measures (cultural, mechanical, biological and chemical) so that the components are compatible and complement each other to keep the weed population at manageable levels. However, absence of a structured information system with the latest research outputs, coupled with a lack of awareness, timely information and knowledge of the weeds, is limiting the practical implementation of integrated weed management practices. ICT tools address effective weed management practices empowering research, extension and farming communities. They contribute to building and strengthening science and technology capacities through the interdisciplinary and participatory building of an ICT knowledge base on major weeds affecting cropping and non cropping systems. It also helps in establishing collaboration among research and extension personnel, students and farmers in order to get updated technical knowledge and adopt appropriate technologies to propagate best weed management practices.

POPULAR ICT PLATFORMS

Community radio

Radio is a powerful communication tool. India's post-independence experiments with ICT use in agricultural development started with radio. In India, where literacy remains a substantial barrier to development, radio especially community radio, can reach a large number of poor people because it is affordable and uses little electricity. Community radio gives a voice to the community they serve with programmes in local languages. Community radio stations fill the gap left by national and commercial media, and reach local audiences the national media ignore. Community radio stations are often the only media available, where they are listened to by large parts of the population. Community radio can thus play an immense role as an information and communication technology for development especially in rural India where other ICTs have limitations. Agriculture is one area in which community radio can be very useful. Some KVKs and agricultural universities across the country have started the community radios.

Example: Krishi Vigyan Kendra, Babhaleshwar, Taluka-Rahata, District Ahmednagar (Maharashtra) has established the KVK-Pravara Community Radio Station in service of local community on 01 October 2009. The broadcast coverage area of the radio station is 25-30 km area serving a population of 8.56 lakhs

in 242 villages in and around the KVK campus. The radio station is dedicated to the local community comprising farmers, rural youth and farm women providing customized information in an innovative format with daily broadcast of 4 hours with half of the broadcast time for rural community and development while the remaining is devoted to agriculture and farming community. The KVK has successfully demonstrated and disseminated through community radio the use of oxyfluorfen and quizalofop-ethyl for control of grassy and broad-leaved weeds in onion. There is a large scale adoption of these technologies following this intervention.

Television programmes

Television is one of the potent development communication tools in the present era. Due to audio visual features, television is very effective medium to impart the knowledge and information to the rural area. Doordarshan started a project named "Krishi Darshan" on 26 January, 1966 for communicating agricultural information to the farmers on experimental basis. Initially 80 villages of Union Territory of Delhi were selected. This experiment was successful and there was substantial improvement in the utilization of knowledge and information in adopting better agricultural practices. The programme delivered documentaries, some success stories of farmers, crop seminars, research inputs, quiz and live calling programme to talk to experts. On 26 May, 2015 the Government of India launched a 24-hour television channel 'DD Kisan', which is owned by Doordarshan. The channel has been dedicated to agriculture and related sectors, which disseminates real-time inputs to farmers on new farming techniques, water conservation and organic farming among other information. Almost all the states in India have regional television channels telecasting programmes on agriculture. Location-specific weed management technologies can be disseminated through TV programmes.

Audio and video conferencing

Many experiences can be quoted from the length and breadth of India wherein the direct and indirect use of audio and video conferencing, satellite communication and multi-media are currently being implemented to reach out to farmers. Falconer and Lignugaris-Kraft (2002) stated that video-conferencing technology typically has been found to be less conspicuous, less disruptive, and less obtrusive, as well as more pedagogically sound, than are the more traditional in person classroom observations. Interactive video conferencing had helped farmers to increase their knowledge on various agricultural technologies and made adoption of technologies easier (Shamna et al. 2013). Reliance Foundation Information Service (RFIS) programme started in 2013 has been providing critical information and linkages using various communication media including audio and video conferencing to poor households including farmers.

Example: Under Rashtriya Krishi Vikas Yojana (RKVY) project the Tamil Nadu Agricultural University (TNAU) has the component of linking all the centers of TNAU (36 Agricultural Research Stations + 14 KVKs + 8 Academic Campus + 4 PCCs) through Video Conferencing Facility to build an interface mechanism with Research Institutions and Farmers. The TNAU HUB centre would be uplinking the conference connectivity to 385 Agricultural Extension Centres (AECs) across Tamil Nadu through Tamil Nadu State Area Wide Network (TNSWAN). The AECs, district headquarters and state level head offices can access and share the information related to agriculture and allied sectors through TNSWAN connectivity. Such facilities can be utilized for sharing the weed science and weed management related information.

Kisan mobile advisory

Kisan Mobile Advisory (KMA) services through messages are being used to deliver the needful agricultural information and specially to improve farmers' agricultural technical knowledge with decision making ability, so that they may enable to increase their production and productivity to fulfil market demands with securing better quality life and income in present competitive agrarian economy. The advisory was sent to targeted farmers covering the broad category of information like, crop production, livestock management, weather forecast, marketing, general awareness and other enterprises etc. the KMA was found the novel step to transform the present agricultural information communication system at grass root level very quick and worth (Kumar et al. 2014).

Example: Knowledge management service through SMS has been launched by the ICAR-Directorate of Weed Research for disseminating weed management technologies to the farming community. The kisan

mobile advisory service delivers real time agricultural information and customized knowledge to improve farmers' decision making ability in developing strategies to manage weeds for enhancing farm productivity. The advisory services on weed management are provided to more than 10,000 of registered farmers/stakeholders. Any farmer may avail the service by getting registered free of cost.

Kisan call centres

Department of Agriculture & Cooperation (DAC), Ministry of Agriculture, Govt. of India launched Kisan Call Centers (KCC) on 21 January, 2004 across the country to deliver extension services to the farming community. The purpose of these call centres is to respond to issues raised by farmers, instantly, in the local language. There are call centers for every state which are expected to handle traffic from any part of the country. Queries related to agriculture and allied sectors are being addressed through these call centres.

A farmer from any part of the state can contact the KCC by dialling the toll free Telephone No. 1551 or 1800-180-1551 and present their problems/queries related to farming. The operator at the KCC will attempt to answer the problems/queries of the farmers immediately. In case the operator at the Call Centre is not able to address the farmer's query immediately, the call will be forwarded to agricultural specialists. The farmers can best utilize the KCCs to get the answers to their queries related to weed management.

mKisan portal

mKisan Portal, an innovative knowledge management tool conceived by Ministry of Agriculture and Farmer's Welfare, Government of India. Started in 2013, the portal was designed from a farmer's perspective and has a number of features like Pull SMS, USSD and value-added services like Interactive Voice Response System (IVRS), Push SMS, buyer seller platform, and a number of customized mobile applications. It has created its own database of farmers or incorporates the data from other reliable sources like Kisan Knowledge Management System (KKMS), which is intended to serve the KCC. All applications and services listed in other sections of m-Kisan Portal are accessible on any kind of mobile phone including basic feature phone.

aAQUA

aAQUA (Almost All Questions Answered) is a multilingual expert advisory service that has been designed jointly by IIT Mumbai and KVK Baramati, providing answers to agriculture related questions asked over the internet. The portal can be viewed on www.aaqua.org. The aAQUAeAgri Service is a problem-solving system dedicated to find solutions to problems posted by Indian farmers - small and large. Answers to agri-related queries are sent in 24x7 hours depending on the difficulty. Almost all of the questions have been answered in the local language (Marathi) with English answers given to people posting from outside the state. Local farmers trust the aAQUA service and are sensitive to the time it takes for the answers to arrive (current average is 1-2 days).

WhatsApp Groups

WhatsApp messenger is a cross-platform instant mobile messaging app which allows you to exchange messages without having to pay for SMS. WhatsApp messenger is available for iPhone, Blackberry, Android and Windows phone because WhatsApp messenger uses the same internet data plan that is used for email and web browsing. So, there is no cost to message sent or received. In addition to basic messaging, WhatsApp user can create groups, send each other unlimited images, video and audio media messages. Various WhatsApp groups are available in internet based on crops. Any information related to particular subject has been forwarded in the form of Message, Photo, audio/video clip etc. Farmers within the groups will send their problems and receiving the information within 24 hrs like identification of pest and disease problem and its recommendation will be sent to the concerned farmer for its final utilization. Now this technology has become a very easy mode of transferring the technology to commodity wise group.

EXPERT SYSTEMS

Effective weed management can be possible with the sound knowledge of weed biology and ecology, which can be understood only with the correct identity of the weeds. Assistance in the form of a

manual or software is very much needed for correct identification of weeds. In order to overcome this type of problem, expert systems have been developed. The expert system technology is a new approach for weed identification.

An expert system is a computer program that contains formally encoded knowledge of experts in a given problem area or domain, and is able to use this knowledge to provide help to a non-specialist in problem solving in that domain. The primary goal of expert systems is to enable decision makers and technicians to do the job more efficiently.

Process of developing expert systems and their utilization

Step-1: Compilation of existing knowledge and collection of new knowledge on weeds of cropped and non-cropped areas

Step-2: Development and management of database on weeds (Identity-Biology-Management)

Step-3: Training and dissemination of these tools to the stakeholders, such as scientists, extension officers, students, public and private industry people to promote their use and to encourage their contribution for further strengthening of the database.

Step-4: Capacity building through workshops and training sessions on ICT knowledge base of important weeds; strengthening of network and collaboration among researchers, extension officers and other users.

Step-5: Location-specific implementation of ICT tools on important weeds with the active involvement of local partners/stakeholders.

Step-6: Recording the feedback and updating the database.

Step-7: Setting-up of mechanisms for long-term sustainability of the network.

Target groups

Scientists and students: The ICT tools find relevance in professional education in agriculture (B.Sc., M.Sc. and Ph.D.), and it could also be relevant for in service trainings at the level of 'teaching the teachers'.

Extension Officers: In general extension officers are well trained and well versed with the subject matters and therefore it seems to be not a major problem in weed identification for them. In case of difficulty they consult the scientists concerned. The use of software and database is more relevant at this level.

Farmers: Management of weeds but not their identification is priority issue for farmers. However, usage of a visual interface in identification process is a major advantage as it does not need prior botanical knowledge about weed species, literacy and computer skills.

Expert systems on weed identification and management

Several expert systems have been developed for weed identification. Some examples are: expert systems for identification of weeds, weed seeds and weed seedlings in India (Naidu et al. 2013, 2014, 2015); Adventrop for general weeds in the Sudano-sahelian zone of Africa (Grard et al. 2010); AdventOI for weeds in Indian Ocean islands (Le Bourgeois et al. 2008); and OSWALD for major weeds in rice paddies of Cambodia and Lao People's Democratic Republic (Grard et al. 2006). Like Adventrop, AdventOI, and OSWALD, the AFROweeds identification tool is a computer programme (also called identikit), based on IDAO, an open-source plant identification software with an interactive graphical interface and supported by a database. AFROweeds is available online (www.weedsbook.org/idao), as a CD-ROM (Grard et al. 2012) for use offline as a program on a desktop or laptop, or as an application on smartphones or electronic tablets (currently available in the App store, Apple Inc.). All formats, whether online, CD-ROM, or App have a similar interface

Decision making on weed control is challenging. The broad-spectrum of weeds found in many fields, and availability of a number of herbicides in the market make the selection of a particular herbicide for a particular field is a difficult task. A practical expert system can assist in making right decision to manage weeds. Expert system for weed management provides advice on the base of interactions of weeds

and the crop including chemical and mechanical weeds control treatments and selects the best herbicide with optimum dosage and method of application. Economical recommendation can be made by estimating yield loss due to the weeds, expected yield, herbicide cost and price of the produce (Atri et al. 2009).

An Expert System on wheat was developed by ICAR-IASRI, New Delhi. It is an integrated system which addresses all aspects of wheat management in India. The main goal of this system was to provide the users with recommendations and advice concerning wheat production. The system was divided into four modules and weed management was included under plant protection module (http://www.iasri.res.in/wheat/general/about_disease.asp?pest_str=Weed)

SELAOMA is an expert system developed based on field survey data on weed density, crop and weed growth stage and height (Stigliani and Resina 1993). SELOMA evaluates weed competitiveness and provides weed management advice. It suggests whether or not to intervene, chemical and mechanical weed control treatments, and select the best herbicides including commercial formulations, costs and optimal dosages.

An interactive microcomputer program named SEMAGI has been developed for sunflower to evaluate the potential yield reduction from multi-species weed infestations and to determine the appropriate selection of herbicides (Castro-Tendero and Garcia-Torres 1995). It combines databases on herbicides, weeds and their interaction. Originally, 34 weed species and 26 herbicides were introduced specifying each weed/herbicide efficacy combination. For other agricultural situations, SEMAGI permits the introduction of new weeds (up to 80), new herbicides (up to 40) and each herbicide-weed efficacy combination. The user evaluates the weed infestation by field survey or density counting and the program converts it into equivalent weed biomass. Weed species are classified in three groups according to their final size. A relationship between weed density, weed size and equivalent biomass is established for any weed group. In addition, SEMAGI provides an economic study of any herbicide treatment selected or introduced by the user, based on herbicide treatment cost, expected yield increase from the weed control treatment and sunflower selling price. The expert systems or the decision support systems on weeds would be useful for extension functionaries and farmers, if the content is more focussed on weed management.

INTERNET (WORLD WIDE WEB)

Internet plays a vital role in exchanging the information. Farmers can get the improved information services through the creative use of the Information Technology (Suriyanarayanan 2003). Agricultural issues are being covered by national media like Radio, TV and Newspapers only at macro level due to time constraint. But internet can go an extra mile by providing the information round the clock in local language too.

In a developed country like USA, most of the big farmers are using the internet to get information, communicate and for buying inputs or selling outputs. In this case a beginning is important for Indian farmers. So government should focus on Internet, which can provide agricultural information through portals. Thus by providing information through rural portal, farmer can get answers about cropping strategies appropriate to their fields, based on integrated information on soil, weather, fertilizer and management of pests. They can also be informed where to get the proper seeds or nursery plants.

Farmers use web stores to search for and purchase farming equipment, and they use government web sites to get informed about actual commodity prices. Small farms are creating shiny web sites, presenting products online and spreading the word on how they produce food. One of the latest examples of farmers leveraging the power of internet is the growing establishment of online government tools built for farmers to easily report their production data to relevant parties, very fast and almost in real time.

The International Rice Research Institute (IRRI) developed the Rice Knowledge Bank (RKB) - a digital extension service that provides practical knowledge solutions, specialized for small-scale farmers in developing countries. The RKB serves to address the biggest challenge to agricultural development by supporting fast and effective transfer of technologies from the research laboratory to the farmer's field. RKB showcases rice production techniques, agricultural technologies, and best farming practices based on IRRI's pool of knowledge from research findings, learning and media resources, and in-country projects. To facilitate easy access to information, RKB highlights the Step-by-step Production Stages from pre-planting to post-production management, Decision Tools, and Agronomy Guides to help people make

informed farming decisions. Weed identification information is available under Decision Tools (http://www.knowledgebank.irri.org/decision-tools/weed-identification).

Open Source Simple Computer for Agriculture in Rural Areas (OSCAR) project is an initiative from European and South Asian Institutions to assist decision making in agriculture. OSCAR developed a weed identification system for the major weed species in rice-wheat cropping systems of the Indo-Gangetic Plains (IGPs) covering Pakistan, India, Nepal and Bangladesh. More specifically the project aimed to develop a decision making tool for weed identification and control that addressed the issue of declining agricultural productivity in the Indo-Gangetic Plains.

An interactive weed identification tool was developed under a project on "African Weeds of Rice" (AFRO weeds) for identifying nearly 200 different weed species of lowland rice in East and West Africa. AFRO weeds project was carried out with the aim of consolidating existing knowledge on selected weed species using information and communication technologies (ICT) and enhance the use and dissemination of best weed management practices. The target users are weed scientists and agronomists, students and professors of universities, farmers' associations and extension functionaries.

The ICT tool for weed identification was built on a comprehensive knowledge base that can be accessed online (http://www.afroweeds.org/idao/) and offline on laptops and CD-ROMs or as an app on smart phones and tablet computers. Other important products of the AFRO weeds project are:

- A collaborative platform – called Weeds book – that enables access to a professional social network and facilitates the sharing of information between professionals and students interested in applied botany, weed science and weed management in rice in Africa.
- An online database on selected weed species, including images, articles, reports and recommendations on weed management.

The aim of the AFROWeeds project was to develop an identification and information retrieval system, which allows every end user (specialist or not specialist) to identify weeds of Rice in Africa, and to get information on these species throughout a specialised network system. Moreover it will be an opportunity for updating data and sharing information on rice weeds. The AFROweeds database has been expanded to the RiceWeeds project for weeds of rice over the world. It addresses more than 400 major weed species of irrigated and lowland rice cropping systems all over the world. It is regularly updated by partners.

Other important weed science portals

i. Noxious weed species: https://www.colorado.gov/pacific/agconservation/noxious-weed-species
ii. Introduced, invasive, and noxious plants: https://plants.usda.gov/java/noxious?rptType=State&statefips=08
iii. Weed science: http://weeds.cropsci.illinois.edu/index.htm
iv. Weed ID guide: http://weedid.missouri.edu/
v. Weeds in Australia - Identifying weeds: http://environment.gov.au/biodiversity/invasive/weeds/identification/index.html
vi. http://www.weedinfo.ca
vii. Weed information – UW Madison: http://www.weedid.wisc.edu/index.php
viii. Global status of herbicide resistant weeds and many more useful information related to weed science - http://www.weedscience.org/
ix. Weed science activities in India - http://is ws.org.in/

Social media

Social media has become an important and powerful component of information sharing with its potential to reach a wider user base and more consumer friendly mechanism. Individuals, public and

private organizations using social media in agriculture include: producers, researchers, consumers, agrichemical industries, government departments, weather organisations, grower groups, seed/chemical/marketing companies and the media (who often monitor social media to find stories as news often breaks in social media before it hits the mainstream). This is on both a local, national and international scale. In the agricultural world, information from social media can be used to identify weed problems, give clues about crop yields and local conditions, and give you fast access to market information, especially at an international level.

Facebook

With over one billion profiles globally, Facebook enables its exceptionally active users' base to freely share information about their lives particularly through pictures and videos. Users access a wide array of functions, including phone, chat, payment, and login to meaningfully connect both through Facebook's website and across the internet via plug inns on other websites.

YouTube

You Tube is a video sharing website. This service was created by three former PayPal employees in February 2005. In November 2006, it was bought by Google. YouTube now operates as one of the Google subsidiaries.

Weed management innovations by farmers uploaded on youtube

- Weed control equipment manufactured by East Godavari farmer (https://www.youtube.com/watch?v=e2iP03CUO3g)

  Published on Sep 15, 2014: Palacharla Vishwanatham, a farmer from East Godavari, Andhra Pradesh manufactured a weed control equipment with a very low maintenance cost.

- Removing unwanted weeds in the sugarcane field (Weed Control by P.K. Jayakrishnan) (https://www.youtube.com/watch?v=QdJQ5nUyNs0)

Published on Jan 2, 2016: Mr. Jayakrishnan is a farmer in Anthiyur village of Erode district of Tamil Nadu has designed a standalone machine to remove unwanted weeds in the sugarcane field. It is very expensive if done by man power. This machine reduces the cost of labour by 70% .

Mobile Apps

Even today, feature phones (as against smart phones) constitute maximum share of mobile phone in India. However, with increasing penetration of smart phones in India and affordable prices (likely to go down further with the introduction of Android One by Google), it has been considered necessary to create mobile Apps. Android Operating System has the largest share among the smart phones in India. Therefore, initially Apps are being developed for Android and gradually other operating system such as Windows and iOS will also be worked upon. The Apps are not only useful for remote location data entry where desktop PCs are not available, but would also be available to farmers and all other stakeholders for extracting information from the web.

Mobile Apps related to agriculture

Kisan Suvidha: Kisan Suvidha is an omnibus mobile app developed to help farmers by providing relevant information to them quickly. With click of a button, they can get the information on weather of current day and next 5 days, dealers, market prices, agro advisories, plant protection, IPM Practices etc. Unique features like extreme weather alerts and market prices of commodity in nearest area and the maximum price in state as well as India have been added to empower farmers in the best possible manner.

Download App: http://mkisan.gov.in/downloadmobileapps.aspx

mKisan Application: This app has been designed and developed by in house IT team of DAC with the help of C-DAC, Pune. It enables farmers and all other stakeholders to obtain advisories and information being sent by experts and government officials at different levels through mkisan portal without registering on the portal.

Download App: http://mkisan.gov.in/downloadmobileapps.aspx

Shetkari Masik Android App: "Shetkari Masik" is one of the most popular monthly magazines in the Agriculture sector, under publication since 1965. It is published by Department of Agriculture, Maharashtra. The Android app for Shetkari magazine has a very simple interface and requires mobile internet or Wi-Fi connectivity to register and download the issues. Once downloaded, the magazine can be read without internet connectivity.

Download App: https://play.google.com/store/apps/details?id=com.shetkari.shetkarimasik

Download User manual: http://mkisan.gov.in/mApp/Shetkari%20Magazine.pdf

IFFCO Kisan-Agriculture App

IFFCO Kisan is an Indian agriculture farmer suvidha App, which helps farmers to take informed decisions by accessing customized agricultural information related to their need.

Download App: https://play.google.com/store/apps/details?id=com.IFFCOKisan

Farm-o-pedia: It was developed by CDAC, Mumbai. The application is a multilingual Android application targeted for rural Gujarat. The app is useful for farmers or anyone related to agriculture. It is available in English and Gujarati languages. The main functionalities of the app are: (i) get suitable crops as per soil and season, (ii) get crop wise information, (iii) check weather in your area, and (iv) manage your cattle

Download App: https://apps.mgov.gov.in/descp.do?appid=587

Mobile Apps related to weed science

Weed ID App: Based on the acclaimed Encyclopaedia of Arable Weeds and developed in association with ADAS, the BASF Weed ID app aims to provide an easy to use reference guide to the major broad-leaved weeds and grass-weeds in the UK supporting weed identification of 140 species. This App has been designed to be an easy to use in-field practical aid to Crop Advisors, Growers, Trainee Agronomists and Agricultural Students.

Main features of Weed ID App are:

- Quick and easy access to extensive weed library; >140 species, >1000 images
- Full descriptions of each weed species at cotyledon, young plant and mature plant growth stages supported by accompanying pictures aiding identification.
- Detailed grass-weed line drawings to highlight distinguishing features often too difficult to see from a photograph
- Interactive search of weed library via Weed ID Filter, Common Name List, Scientific Name List, or Free Text Search
- Map-my-Weed tool to help pinpoint location of weeds on a google map; assign name, size of patch and year*
- Option to photograph the weed in your field and use to directly compare with images in the app library
- Export your weed photo and it's GPS location by email to customers / colleagues at the touch of a button
- Simple and fast interface.

*Source: http://www.agricentre.basf.co.uk/agroportal/uk/en/tools/mobile_tools/weed_id_app_3/weed_id_app.html
Download App: http://download.cnet.com/Weed-ID/3000-2094_4-75680544.html
weedinfo.ca-Mobile App

Given the high demand and interest for the database from smart phone users, a preliminary mobile version was created in 2010 at m.weedinfo.com, which allowed users to view content on their handheld devices during critical decision-making periods of weed management needs in the field. The information contained in the weedinfo.ca database was re-structured for improved delivery and access to output for smart phone users, and to expand search capabilities. The French content of the online database was updated with new weed species. A more compact mobile version of the online interface of the weed

For remote sensing to be successful, the target weeds must have distinct reflectance differences from background vegetation, soil and stubble. For detection by current multispectral sensors, these differences must be great enough to compensate for the broad spectral bands and the pixel size of the sensor. Detection may also be limited by the density of the weed infestation.

Differences in plant size, growth rate, maturity, structure and colour at certain times of the year may aid discrimination. For example, major spectral differences often occur when target plants flower (Lass et al. 1996). The growth characteristics of many weeds can assist in their identification by remote sensing. Woody weeds, due to their growth pattern, size and canopy characteristics, can often be readily discriminated (Everitt et al. 1992; Gardiner et al. 1998). The tendency of many pastures and crop weeds to grow in distinct patches, with few individual plants between, will aid their discrimination (Cardina et al. 1997). Some invasive weeds have biological traits that distinguish them from their surroundings, making them good candidates for mapping using remote sensing. In some cases, these traits will allow them to be detected in nearly any environment.

- Some highly pubescent (hairy) plants reflect incoming light much differently than the surrounding vegetation, allowing these plants to be detected using remotely sensed imagery.
- With the change of the season the foliage of some weeds change to a colour that is distinct from the surrounding vegetation, allowing mapping of these species using remote sensing.
- Some dicot weeds can be detected in grasslands using remote sensing because of higher reflectance in the near infrared. The erect canopy structure of grasses results in lower near-infrared reflectance, thus creating a detectable contrast between the weeds and the grasses.
- Root exudates from some weed species inhibit the growth of other vegetation, thus increasing the amount of visible bare soil. In some cases, the bright reflectance from the bare soil allows this weed to be mapped with remote sensing.
- Some weeds are much taller than the surrounding vegetation and will cast distinct shadows when the sun is low in the sky. If imagery is collected when the sun is low in the sky, shadows can be identified to determine the locations of infestations.
- During peak flowering, weeds that would otherwise be indistinguishable from the surrounding vegetation may be easily identified. Timing imagery acquisition to coincide with peak flowering is critical to success. To succeed in mapping these types of weeds, imagery acquisition must be timed at critical stage (Hunt et al. 2007).
- Some weed species can be distinguished because of their canopy architecture.
- Studies have shown that there is some threshold level of cover below which a weed species cannot be detected by remote sensing.
- The ability to detect the weeds will depend on the composition of the surrounding community. As you decide whether your weed is a good candidate for mapping using remote sensing, be sure to consider the likely density of the weed across the survey area.

Despite certain limitations, remote sensing has been successful at identifying and mapping a range of weeds. Aerial photography has been used in a number of studies, particularly for weeds with distinct, showy flowers (Arnold et al. 1985). Airborne multispectral imagery has been used to map a range of weeds in field crops (Lamb et al. 1999) and woody or herbaceous pasture and rangeland weeds (Everitt et al. 1995; Lass et al. 1996). Such imagery can be rapidly processed and used for precision spraying to reduce chemical application costs.

ADVANCED TECHNOLOGIES

Drone - An eye in the sky

Dr José M. Peña (Institute for Sustainable Agriculture, Spain) and his team used drones and image analysis technology, which detects slight differences in field colour, to discover vegetation and competitive weeds. The solution involves examining crop patterns alongside images. According to them

the crop follows a pattern, and the vegetation that is out of this pattern is classified as weeds. The spectral information and also the position and the shape of the plants is integrated in the software to detect those ones that are weeds. Farmers can then apply herbicides to specific areas, monitor the evolution of their crops over time, and create a photorealistic 3D map of their field by taking aerial pictures from multiple views by using the drone. The accuracy was very high that they could detect more than 95% of the weeds in the fields. One important thing is that the parts of the crop field where it's free of infestation could also be detected. This place is the part where the farmer does not have to apply the herbicide.

Cloud computing

Cloud computing is a network based computing model for a shared pool of configurable computing resources (e.g. networks, servers, storage, applications, and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction. It also enables people of rural areas to access the web based application of cloud computing with the help of tablets and mobile phones (Patel and Patel 2013).

Cloud computing in agriculture: People from rural areas are unable to sell their own production (especially in the agriculture and the handicraft industry) in the market directly (Kalghatgi et al. 2015). Many brokers/agents exploit the farmers. Farmers can participate in e-commerce and sell their produced items directly to the end users/retailers using cloud computing. A web-based agriculture management information system can be useful in agriculture field as it brings latest bulletins regarding weather reports, prices, fertilizer, sowing of crops and its pricing etc. to farmers at rural areas.

- Management of all data related to land, including location, area; soil and land characteristics can be integrated.
- Cloud based agriculture system can benefit government officials/private organizations by obtaining/ inserting information regarding pricing of crops, supply of seeds, farming of lands at various places.

Advantages of cloud computing

As the cloud computing are web-based and are run in the cloud desktop PC, laptops, tablets do not need the processing power or hard disk space. Reduced software costs, instead of purchasing licensed software applications; it can be accessed for free. Device independence is by changes to computers, applications and documents follow you through the cloud.

CONCLUSION

The potential of ICT to support the access to and exchange of information for smallholder farmers is clear. In the agricultural systems the end-user is the farmer and his problem is not that of weed identification but management. Many of the existing ICT tools are much useful in the area of identification, which is not so relevant to the end user. However, the technological innovations support the end users indirectly through the other users in the hierarchy – the extension officers and scientists. Interventions based on ICT tools in weed management have relevance but with limitations as it is useful to a limited group of users – scientists and extension officers, who are not necessarily constrained in terms of access and skills. There are certain disadvantages with the ICT tools especially the web-based expert systems. Though it produces instant results than conventional text manuals, there is a very possibility that automated systems could take away instinct power of self-learning and cognition. Therefore, expert systems or decision support systems may be of use as an aid to decision-making, rather than as a complete replacement for self-efforts. On field usage is easier with the text manuals compared expert systems which are to be used back at the office. However, recent technological advancements like Personal Digital Assistants linked remotely to the Internet indicate that expert systems may soon be readily accessible in the field.

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QUESTIONS

I. Subjective type questions (answer in not more than 300 words)

1. Define ICT and list its unique features.
2. What is the role of ICT in Indian Agriculture ?
3. What is the role of ICT tools in dissemination of information on weeds and weed management ?
4. Explain the features of Kisan Mobile Advisory and Kisan Call Centre with examples.
5. What are the various on-line databases in weed management ? Explain any one in brief.
6. What is a social media? How it is useful for weed management?
7. Define an APP. Explain any two mobile apps related to agriculture.
8. What is an expert system? What are the steps involved in development of an expert system?
9. What is the role of expert systems in weed identification / management ? Explain with examples.
10. What is a web portal? List the portals developed for weed management.
11. Explain some of the mobile apps related to weed management.
12. List the main features of weed ID App.
13. Describe advanced technologies in ICT to be used in weed science / management.
14. List the prospects and problems in the use of ICT by farmers in agriculture.
15. What is cloud computing and how it is useful in agriculture ?
16. Describe the role of remote sensing in weed management.

II. Objective type questions

(a) Fill in the blanks

1. ICT stands for _____. **(Information and Communication Technology)**
2. Connection between two or more networks is known as _____. **(internet)**
3. Physical component of computers are known as _____. **(hardware)**
4. _____ is a computer program that contains formally encoded knowledge of experts in a given problem area or domain. **(Expert system)**
5. OSCAR stands for _____. **(Open Source Simple Computer for Agriculture in Rural Areas)**
6. _____ is a network based computing model for sharing of resources with minimal management effort or service provider interaction. **(Cloud computing)**
7. _____ is an omnibus mobile app developed to help farmers by providing relevant information to them quickly. **(Kisan Suvidha)**
8. _____technologies are increasingly important tools used to assess the _____ distributions and predict the spread of _____. **(Geospatial, spatial, weed species)**
9. _____ messenger is a cross-platform instant mobile messaging app which allows you to exchange messages without having to pay for SMS. **(Whats App)**
10. _____ is a social network using for sharing of information in agriculture. **(Facebook)**

(b) Mention whether the following statements are True / False

1. Internet provides global accessing of the information. **(True)**
2. ICT tools creating problems to the farming community. **(False)**
3. Expert systems are in use for weed management for decision making. **(True)**
4. SEMAGI, an interactive computer program has been developed for weed control. **(False)**
5. IRRI has been developed the Wheat Knowledge Bank for online accessing of information. **(False)**
6. Remote sensing offers mapping and monitoring of weed infestations over large areas. **(True)**
7. You tube is a video sharing website popularly in use for agriculture. **(True)**
8. KMA services are used by the farmers to develop the Mobile Apps for agriculture. **(False)**