COMMUNICATING AGROMETEOROLOGICAL INFORMATION*

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Introduction

Either directly or indirectly, new information and communications technologies (ICTs) will have a dramatic impact on our lives. The lnternet, satellite technology and geographical information systems are prime examples of ICTs that have changed the way we carry out our daily activities. Data and information on an almost infinite amount of topics are available in a timely fashion on the Internet at the click of a mouse. Our goal in this article is to address methods of communicating agrometeorological information, which consists of disseminating and evaluating information, and to provide examples of these processes. Given the dynamic nature of ICTS, some of the examples given here may be outdated in a short time, while new applications, that are currently beyond our imagination, will be developed and accepted. We conclude by raising and responding to some critical questions about communicating agrometeorological information in the future. A representative list of Websites dealing with agrometeorology not discussed in this article is given as an annex to this article.

Agrometeorological information is part of a continuum that begins with scientific knowledge and understanding and ends with the evaluation of the information. Intermediate processes are the collection of data, changing data into useful information and dissemination of information. While scientific knowledge and understanding transcend national borders, the remaining components of the continuum may differ between developed and developing countries. The reasons for these differences are mainly a function of human, financial, and natural resources.

In order for this information to be useful, it must be accurate, timely, and cost-effective, i.e. the benefit to be gained from implementing the information is more than the cost to obtain the information.

Communicating agrometeorological information

While it is conventional wisdom that "we live in the information age", in an era characterized by information "superhighways" that span the globe, it is evident that there is a large gap between the "information rich" and the "information poor". Rural communities represent the "last mile of connectivity".

Some observers see the lack of telecommunication infrastructure in developing nations as a possible advantage in the long run. The low level of infrastructure may mean that, when a new

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telecommunication infrastructure is installed, it will be digital and possibly wireless, from the beginning. Since lnternet services rely heavily on the extent of network digitization, developing countries just starting lnternet services may be able to quickly develop digital networks. This has been the case in countries such as Botswana, Gambia, Mauritius and Rwanda, where a large percentage of the lines are digital.

"Telecentres" are increasingly being seen as a means to provide a wide range of telecommunication services to rural residents through a single access point. Multi-purpose community telecentres (MCTS) are being established in various countries in Africa, Asia and Latin America by the International Telecommunication Union with various national and international partners. Located in a shared rural community facility, MCTs can offer telecommunication services such as telephone, fax, e-mail and lnternet access, together with training and support in their use. In the design of MCTS, attention is given to specific applications and content for several sectors, for example; health, education, environmental protection, and agriculture.

In many cases, the effectiveness of ICTs for agrometeorological information dissemination can be enhanced by linking them to other communication media, especially media which are more accessible to farmers—such as rural radio. In this way, a "multiplier effect" can be achieved.
Changes in radio technology will have an important impact on the dissemination of information. Low-powered radio stations that can broadcast a signal within a radius of 2O km are available at the cost of a moderately priced PC. Radios that do not depend on batteries or line voltage are ideally suited for use in remote locations. These radios have a built-in generator that is operated by a crank mechanism, one revolution is equivalent to approximately 45 minutes of playing time. A major limitation of this radio is the cost, currently about US$ 100.

The following examples from a variety of sources illustrate the different approaches that can be used to communicate agrometeorological information. It is not an exhaustive list. As noted earlier, this is an area of rapid change.
The California PestCast system (http:// www.ipm.ucdavis.edu/DISEASE/california_
pestcast.htmi) is a joint effort of the UC-IPM Project, the US Environmental Protection Agency and the California Department of Pesticide Regulation. The overall goal of this effort is to expand the application of computer-based crop-disease forecasting in order to reduce unnecessary pesticide usage. There are currently 15 disease models available for use with fruits, vegetables and turf.

Several meteorological and climatological databases can be easily accessed from the lnternet. An extensive list can be found at the lnternet site of the Usenet newsgroup sci.geo.meteorology (http://www.scd.ucar.edu/dss/faq/). The mission of the High Plains Climate Center (HPCC) is to increase the use and availability of climate data in the High Plains region of the USA. The HPCC's activities include operating the Regional Automated Weather Monitoring System; conducting regionwide soil-moisture and drought studies; developing connections with other climate centres; and developing computer software for the summarization and dissemination of important climate-related information (http://hpccsun.uni.edu). The Register of Ecological Models at the University of Kassel, Germany, is a meta-database for existing mathematical models in ecology: http://dino.wiz.uni-kassel. de/ ecobas.html. In South Africa, daily weather data can be retrieved for a large number of stations from: http://www.sawb.gov.za/www/climate/bull.htmi.

From the FAO lnternet site, the Global Information and Early Warning System on Food and Agriculture (GIEWS) provides extensive agricultural and climatic information for most of the countries in Africa, including crop production areas, crop calendars, and satellite images: http://www.fao.org/WAICENT/faoinfo/economic/ giews/english/giewse.htm.

In Brazil, two systems have been developed by the National Institute of Meteorology for dissemination of meteorological and agrometeorological information. They are VISUAL TEMPO and VISUAL CLIMA. The first system allows the user to have access, through different modalities (BBS or Internet), to real-time meteorological information as weather forecast or satellite imagery. Through the second system, the user can have access to the agrometeorological information as published in the dekadal and monthly bulletin. The software for access can be downloaded free: http://www.inmet.gov.br/frameset.htm.

Also in Brazil, the National Confederation of Agriculture, in collaboration with the Council of the Small and Mid-Size Enterprise Supporting Service, has implemented an lnternet system called SIAGRO, providing useful information about prices, weather, databases on rural legislation and crop and animal protection laws and measures. (http://www.siagro.com.br/siagro/ ClimaTempo.htmi).

The AgroExpert Disease Forecasting System developed by Adcon Telemetry GmbH (http://www.adcon.at/Products/AgroExpert.htmi) is a complex system intended to reduce the amount of chemicals used in the treatment of plant diseases. Basically, the system uses climatic data which are processed according to rules developed by plant protection researchers, to establish the optimum time for chemical treatments. The system has been used in northern Europe for the past five years. It employs a network of solar-powered weather stations to monitor rainfall, humidity, temperature, leaf wetness and other factors. Farmers can be contacted by phone or pager, or can access the system directly via a PC and modem to determine the optimum time for chemical treatment.

Under a FAO technical assistance project, a well-equipped, decentralized system for agrometeorological and remote-sensing data handling, processing and analysis, as well as information product generation, compatible with relevant background databases, is operational in southern Africa. Activities are carried out by trained staff in the Regional Early Warning Unit for Food Security and the National Early Warning Systems for Food Security within South Africa Development Community (SADC) countries. Facilities are being established in Harare, Zimbabwe, for the direct acquisition of Meteosat data to support rainfall monitoring across the region. The use of geographical information systems and the FAO-GIEWS workstation for handling analysis of data from different sources on a common geographical basis exists at the national level within SADC countries.

Evaluating the impact of information and information delivery systems

Evaluation of the impact of information delivery systems can be done by surveys and by the use of focus groups and innovative end-users. The specific survey instrument or the techniques for gathering information may differ from community to community, but the goal is essentially the same: to evaluate the impact of the information and the information delivery system and to have a quantifiable basis to improve the system.

Standard survey procedures, such as purpose and importance, confidentiality, and follow-up, must be carefully explained to the respondents. Survey results must be communicated to the necessary agencies that developed and funded the survey for evaluation of current programmes and for future planning. The results may be published in the appropriate scientific journals. The initial respondents should not be forgotten in this communication process. By providing a summary of the survey results to the respondents, not only are the survey developers giving feedback to those who participated in the survey, they are developing a marketing tool.

Some of the questions below may not be relevant to a region, other questions may have to be added, and some questions may have to be deleted. The following questions serve as an example.

- Location: answers to this question give an idea of the demographics of the end user;
- For pest surveys: occurrence of pest in the last several years. Response to this question gives an idea of locations where pest has occurred and if these locations fit into what “experts” have predicted or noted. Ability to identify pest. Provide several descriptors. If the end user can’t identify pest or pest symptoms, then this is an area of further education that fits into the training needs of end users;
- Has the respondent used the information delivery system?;
- Has the information been helpful? At this point in the survey for the remaining relevant questions, there should be several options, such as “strongly agree”, “agree”, “neutral”, “disagree” and “strongly disagree”. If yes, how has the information been helpful? (List several key components of the information delivery system, e.g. timeliness; caused the end user to think differently about the situation; easy to understand the different recommendations and their consequences; easy to implement recommendations). If no, how has the information not been helpful? (List same options as above.) Possibly the end user knew how to deal with the management situation and the information was not needed;
- What feature did the user like most about the information delivery system? List several options; respondent can also fill in the blanks;
- What feature did the user like least about the information delivery system? List several options; respondent can also fill in blanks;
- What improvements would the user like to see in the system? Leave blank spaces to fill in responses. Responses may indicate areas for future research;
- Would the user be willing to pay for this information? If no, what improvements in the system would make users change their minds? Leave blank spaces to fill in responses. Again, responses may indicate areas for future research or changes in dissemination.
- How should the cost of this information delivery system be supported? Rate percentage of cost to be borne by each entity. Choices should include government, university, farmers association, private industry and other sources.

Some critical questions

Continued improvement in communicating agrometeorological information to farming communities requires addressing the following critical questions.

- How can diverse types of agrometeorological data be integrated into useful information that responds to the often-dissimilar application needs of farming communities?

Agrometeorologists change data into information through whatever tools are available, currently through the use of computer-based technologies. In addressing the first question, we must begin by considering the training of agrometeorologists. Training in this area should include an appreciation of the complex interactions of biotic and abiotic factors as plants and animals develop and grow. This addition to the traditional training of agrometeorologists is necessary to provide a larger perspective to the transformation of data into useful information.

- What types of information are needed by diverse groups of end-users and, given their different farming, socio-economic and cultural systems, which are the appropriate communication technologies to reach them?

The information needed for diverse groups of end-users growing crops or raising animals is basically the same. The differences arise from the human and financial resources available to implement this information and the methods of information dissemination. These differences must be considered in designing any information dissemination system.

- Given diminishing public support for agricultural advisory services, what alternatives exist for the communication of agrometeorological information and under which circumstances can it be provided on a fee basis?

First, as much as possible, agricultural advisory services must accurately document the added value and impacts of these services. This should be done as a proactive, rather than a reactive, position. The documentation should include the monetary value of the information, if used properly. Just because accurate information is disseminated doesn't mean that it will be used or used properly. Included in this documentation should be detailed descriptions on changes in positive behaviour (impacts). This documentation may positively influence government funding or funding from other sources.

The information must be prepared by agrometeorologists in a way that the majority of users will easily understand it. Then it can be adapted and sent to key communication outlets such as radio, television, newspapers, bulletins, specialized information networks and Websites for broad-scale, as well as targeted, dissemination. From the perspective of these media outlets, the information must also have a value, a different value than that intended for the end-users. Various types of users may buy the products advertised by the different media outlets or subscribe to information services.

- What are the training needs of end-users and of the various intermediaries that provide them with advisory services?

Before the training needs of end-users and intermediaries can be addressed, the question of motivation for users to access and use the information should be discussed. While altruistic values to use the information can be a source of motivation, e.g. sustainability of the environment, they will probably have minimal success. Farming is a long-term business and, like any business, its practitioners want to be successful—motivation should be based on sustainable profitability. Given this perspective, what information is needed? What information is already available? What information needs to be provided? Of the information that needs to be provided, what information is of primary importance, secondary importance, etc? Addressing these questions requires assessments of the information needs and resources of specific groups within the diverse user community. In order to facilitate the communication of information to the user community, social scientists should interact with agrometeorologists to provide a structure for the information that is suited to the target audience.

Conclusions

The lnternet will play a major role in agrometeorological information either through direct or indirect access. In developing countries, multi-purpose community telecentres will be the focal point for many types of information, some of which will come from the lnternet. These MCTs can be the source of agrometeorological information that can be disseminated through rural radio stations in local languages. Remote-sensing data and geographical information systems are being used in southern Africa to provide information on agricultural production conditions and food security.

While information can be disseminated, is it being used? A methodology was presented to evaluate the impact of information. This methodology can be applied as a written survey or through interviews. Evidence is presented that people would be willing to pay a fee for agrometeorological information if it has value, in both the developed and developing world.

Critical questions have been raised but clear responses are linked mainly to the scientific, technological, and social developments that will take place in the 21st century. There is no doubt that information and communication technologies will improve in the future, as will accessibility. What will limit the generation and dissemination of agrometeorological information in the future is the same that limits it today: the interaction of people, from scientist to extension worker, in the continuum from basic understanding to practical applications. Thus, to prepare for the future now, we have to better integrate the human capital available at all levels of organization. Specifically, we recommend that information and communication technologies be a component of the training of agrometeorologists in order to provide the best possible advice to farmers.

Annex

A representative list of Websites related to agrometeorology not discussed in the article (Some links may not be current)

Austria
• University of Agricultural Sciences
http://www.boku.ac.at/imp/agromet/agrarl e.htm

Australia
• SILO
http://www.bom.gov.au/silo/
• Agriculture Western Australia Service Unit
http://www.agric.wa.-qov.au/climate/
• Agricultural Production Systems Research Unit
http://www.apsru.qov.au
• The Long Paddock
http://www.dnr.gid.gov.au/lonqpdk/

Belgium
• UCL-FAO AGROMET Project (spatial interpolation for agrometeorological variables)
http://www.agro.uci.ac.be/biom/recherche/pro6ets/
agromet/a-qromet.htm

Brazil
• CEPAGRI/UNICAMP
http://orion.cpa.unicamp.br/

Canada
• Drought Watch
http://www.a-qr.ca/pfra/drought.htm
• Government of Newfoundland and Labrador
http://www.gov.nf.ca/agric/soils/agromet.htm
• Winnipeg Climate Centre
http:/lwww.mb.ec.gc.ca/ENGLISH/AIR/WCC/agrom.htmi
• Canadian Society of Agrometeorology
http://www.oac.uoquelph.ca/-csam/

China
• Agrometeorological Center of Jiangsu Province
http://www.angelfire.com/ni/OgWU/

England
• University of Reading INSTAT+ software

http://www.rdg.ac.uk/ssc/software/instat/instatinfo.html

European Union

• Joint Research Centre-Monitoring Agriculture with Remote Sensing (MARS Bulletin)
http://mars.jrc.it/stats/bulletin/

Hungary

• Meteorological services
http://www.met.hu/eao/eao-e.htm

India

• National Centre for Medium Range Weather Forecasting and Development of Agrometeorological Services
http://www.nic.in/snt/ncmrwf.htm

Italy

• Regional Agrometeorological Services of Sardinia
http://www.sar.sardegna.it/Ewelcome.htmi
• Provincial Agrometeorological Centre of San Michele all'Adige
http://www.ismaa.it/htmi/ita/meteo/agri.htmi
• Regional Meteorological Services of Emilia-Romagna
http://www.smr.arpa.emr.it/
• Centro di Studio per I'Applicazione dell'informatica in Agricoltura (CESIA)
http://www.iata.fi.cnr.it/public htm/cesia/web/english/cesiapre.htm
• Central Office of Agricultural Ecology
http://www.inea.it/ucea/uceaind.htm
• Regional Agrometeorological Services of Friuli-Venezia Giulia
http://www.agromet.ersa.fvq.it/ita/informazioni.htm
• Regional Agrometeorological Services of Treviso
http://www.stelnet.com/coditv/agro 1.htm
• Regional Agrometeorological Services of Toscana
http://meteo.arsia.toscana.it/meteo/hpmeteol.htm
• Regional Agrometeorological Services of Veneto
http://www.campiello.it/csim teolo/finale ing/first.htmi
• Italian Agrometeorological Association
http://www.fisbat.bo.cnr.it/AIAM/

Kenya

• Agrometeorological Services
http://www.meteo.go.ke/obsv/agro.htmi
• Drought Monitoring Centre
http://iion.meteo.go.ke:80/dmc/

Malaysia

• Agrometeorological Services
http://www.kmc.qov.my/people/aqromet/agromet.htm

Namibia

• Meteorological services
http://weather.iafrica.com.na/

Niger

• Regional AGRHYMET Centre
http://www.aqrhymet.ne/
• African Centre of meteorological applications for development
http://www.acmad.ne/

Pakistan

• Agrometeorological services
http://met.gov.pk/Subpaqe3/agromet page.htmi

South Africa

• South African Sugar Association
http://www.sasa.org.za/sasex/irricane/index.htm

Spain

• Agrometeorological Network of Catalunia
http://www.gencat.es/servmet

USA

• USAID Famine Early Warning System
http://www. info. usaid.gov/fews/fews.htm1
• The California Weather database
http://www.ipm.ucdavis/WEATHER/weatherl.htmi
• Georgia Automated Environmental Monitoring Network
http://www.griffin.peachnet.edu/bae/
• ICASA
http://aqrss.sherman.hawaii.edu/icasa
• AWIS Weather Services, Inc.
http://www.awis.com
• National Drought Mitigation Center
http://enso.uni.edu/ndmc
• Washington State University (Public Agricultural Weather System)
http://frost.prosser.wsu.edu
• Response Farming

http://www.davis.com/-wharf
• Global Soil Moisture Data Bank
http://climate.envsci.rutgers.edu/soil moisture/
• USDA-World Agriculture Outlook Board
http://www.usda.gov/oce/waob/gawf/profiles/mwcacp2.htm
• University of Nebraska
http://enso.uni.edu/agmet/
• New York State Agricultural Experiment Station
http://www.nysaes.cornell.edu/pp/faculty/seem/ma/
• Pacific Northwest Cooperative Agricultural Weather Network
http://mael.pn.usbr.gov/agrimet/
• Centre for Precision Farming
http://www.silsoe.cranfield.ac.uk/cpf/
• Oklahoma State University
http://radar.metr.ou.edu/agwx/aqwx.htmi

Zambia
• Meteorological Services
http://www.zamnet.zm/zamnet/zmd.htm

Zimbabwe
• Meteorological Services
http://weather.utande.co.zw/Meteorology/
agricultural.htm
• SADC Regional Remote Sensing Unit
http://www.zimbabwe.net/sadc-fanr/rrsp/qss/qsslist.htm
• SADC Regional Early Warning Unit
http://www.zimbabwe.net/sadc-fanr/rewu/agromet/agu.htm

FAO
• Remote sensing imagery and agrometeorological data
http://1 93.43.36.40
• Agrometeorological Crop Forecasting
http://www.fao.org/sd/Eldirect/AGROMET/FORECAST.HTM

Discussion lists
• FAO-WMO Agrometeorology lnternet Conference (Agromet-L)
http://www.fao.org/Mailnews/agromet.htm
• AGMODELS-L Discussion Group
http://MetaLab.unc.edu/pub/academic/agriculture/
agronomv/AGMODELS-Uindex.htmi

INSAM

• International Society for Agricultural Meteorology
http://www.agrometeorology.org/