Dissemination of Agrometeorological Information

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Abstract

Much climate data are available that can only be utilized if there is a flow of information to agri-business and farmers. As dissemination is the distribution of information, two-way communication channels are a necessity. The content of the message must be relevant to the decisions of the client. The process should involve the identification of climate sensitive decisions and interactions between the climatologists and the role players to develop technological products that should be evaluated prior to introduction at an operational level. Various modes of delivery can be used including mass and electronic media, as well as group and individual relationships. Dissemination of agrometeorological information is illustrated with examples from the Florida Consortium, FARMSCAPES in Australia, seasonal forecasts in Burkina Faso, and irrigation scheduling in Mexico. Critical factors for successful dissemination include good communication channels, preferably based on a relationship between the agrometeorologists and the role-players in the agricultural industry; and the collaborative development of products that can bridge the gaps and be relevant to climate-sensitive decision making in agriculture.

Introduction

The National Meteorological Services (NMSs) around the world are collecting daily weather data that are archived into state-of-the-art electronic databases (e.g., World Weather Watch, 2004) or at least as written copies. However, for these data to become useful to the many users, they must be processed or transformed into relevant information and also be communicated to specific users or the general public. This paper will address some aspects of the process involved in the flow of information from the NMSs to the users and give some examples of successful utilization of available climate data by the agricultural sector. Linkages and information flow between the users and the NMSs are vital for the successful application of all types of weather and climate information. These linkages should provide opportunity for the flow of information in two directions, from the NMS to the client as well as from the user to the NMS. When the users are in the agricultural sector, these tasks can largely be fulfilled by the agrometeorologists who have training and expertise in both meteorology and in agricultural production. This enables them to understand and communicate with the NMS climatologists and forecasters as well as with the extension personnel and the farmers themselves.

The needs of farmers and agri-business should be identified. Often the farmers are acutely aware of the effects of the weather and climate on both the day-to-day and planning activities in crop and livestock production. However, many times these relationships are not clearly defined or described in a scientific fashion, or able to be applied to the specific farming system or transferred from one system to another due to lack of environment characterization (White, et al., 2002). Therefore, a detailed analysis of the influence of weather parameters on production must form part of the needs assessment.

From the meteorological services point of view, these needs should be linked to the available climate data by using various types of analysis or application tools. Often a new approach may be needed to address the specific queries and requirements of the farmers in a particular region. This then becomes an ongoing challenge for the climatologists, meteorologists, and forecasters to work together with the agrometeorologists and extension personnel and clients to answer a particular need or requirement by developing a new application. In this way, the science will be advanced and become more and more applicable as well as user-friendly. This is also where the international connections, enabled by organizations such as the World Meteorological Organization (WMO) and particularly the Commission for Agricultural Meteorology (CAgM), can be most useful as they enable scientific exchange between regions and also exchange of applications and experiences between colleagues across the world.

To consider dissemination of agrometeorological information, first define what is meant by "dissemination" and "communication." Then, a model can be constructed for this process to achieve successfully the dissemination of agrometeorological information.

What is Dissemination?

Technology transfer can be defined as the transmission of goods, data and information, and knowledge, know-how, and skills (Day, et al., 1995). The extension task is to provide access to information and skills to help farmers make the best possible use of resources and services available to them (Mosher, 1978). However, the downfall here is that two assumptions are made: 1) that there is a lack of relevant knowledge and skills; and, 2) a one-way flow of communication (Day, et al., 1995). Many times, the lack of adoption or use of the products can be due to this one-way communication channel and little or insufficient time being spent listening to the farmers themselves. Dissemination can be defined as the scattering or spreading abroad or distribution or dispersion of certain information (Reader's Digest, 1998). The diffusion of innovations is considered to be the process by which a new product is spread among users, in contrast with adoption which is when it is absorbed and utilized in the decision making process (Fisher, et al., 2000). However, if the agrometeorologists do not want their efforts to be wasted, it would be most advisable to have good communication and working relationships with the agricultural extension, cooperatives, and agricultural suppliers' staff and to promote participatory methods for interactions with farmers (Martin & Sherington, 1997). In this way, it can become a focused effort and collaborative learning process that is more likely to achieve its aim.

Communication Model

Communication is vital for the dissemination of information. Most definitions of communication include five fundamental factors: an initiator, a recipient, a mode or vehicle, a message, and an effect (Bembridge, 1991, Mukhala, 2000). So, the message is first conceived by the sender and then encoded into a format that can be sent by a specific medium. This must further then be decoded by the recipient before it can be acted upon and a return message is sent regarding the successful understanding or not of the message (Mukhala, 2000). So communication must include a sharing of meaning or understanding for it to be successful (Mukhala, 2000). It must also be a two-way process to be considered successful.

The dissemination of agrometeorological information illustrates the vital parts of communication. Communication begins with the farmer who formulates a request to the

NMS via the extension officer. For example, a useful forecast is needed for the onset and amount of rainfall for the upcoming growing season. In this case, the farmer, as sender, must formulate (or encode) the request in such a manner that it is specific with sufficient detail. The message or request is then sent to the NMS via some medium (e.g., postal service or telephone). When the NMS receives the request, they must be able to interpret (decode) it into a scientific formulation to perform the data analysis. For communication to be completed, the NMSs must reply to the farmer indicating that they received the request and have understood it. Again, the message must be encoded in a format and language that the farmer can understand. The agrometeorologists, acting as a part of the channel, must first interpret the statistics and the scientific analysis and translate it into layman's terms so that the farmers can understand it. Thus, the agrometeorologists play a vital role in the encoding and decoding of the messages from the climatologists to the agricultural sector. The institutional dissemination channels are a vital part of the chain including the farmer association, non-governmental organizations (NGOs), input suppliers, village leaders, and influential or lead farmers (Hansen, 2002).

The content of the message is also important to its value. It must be relevant to the decision making processes of the clients (Hansen, 2002) and must also alter actions in a way that improves outcomes (Mjelde, et al., 1997). The desired information can be obtained from users by exploratory surveys or participatory methods of personal interactions with users. The critical issues consistently highlighted from such studies have been categorized and summarized by Hansen (2002) as follows: a) site specificity – that farmers are aware of spatial variability and can recognize scale mismatches between the forecasts and their on-farm decisions; b) temporal specificity – including timing relative to decisions and impacts, highlighting factors such as onset of rainfall, dry spell distribution, and weather conditions during harvest; and, c) skill of the forecast – often in different terms from the forecasters but relative to the other risks within their farming operations.

In general, much of the dissemination of agrometeorological information may have to be considered unsuccessful as there is often a breakdown somewhere in the communication process. So, it is necessary to go to the various parts of the communication model and identify gaps in transferring or encoding the content of the message. Bridging these gaps is an ongoing challenge (Hansen, 2002) and additional action needs to be included into the process to avoid these points of breakdown in communication. A good model of the process that considers all the aspects pertinent to the flow and content should be used; thus, enabling a good strategy to be developed for dissemination of agrometeorological information (Hansen, 2002).

Process of Dissemination

The influence of climate on agriculture is considered to be complicated, including uncertainty, and large temporal and special differences exist as well as irreversible consequences (Joyce, 2003). There may be several different approaches to the development of climatological technology that the agricultural sector can use and the means to communicate it to the relevant persons. The nature of meteorological information is that it is always changing and so repetitive actions of communication are usually necessary. Therefore, it is easy to adopt a reiterative process. This should include an awareness and description of real-life experiences, a systematic reflection on these, and diagnosis of gaps in the system (van Veldhuizen, et al., 1997). This can lead to a conceptualization and formulation of aspects that require further analysis and development and gathering of more information (van Veldhuizen, et al., 1997). Following these analyses and experimentation (including field work, critical reviews, analysis of case studies, experiments, etc.) the main findings can be integrated and translated into the work activities (van Veldhuizen, et al., 1997). If both the meteorologists and the members of the agricultural sector (e.g., farmers, extension staff, and agricultural suppliers) are involved, then it is possible for this participatory technology development to be user-friendly, meet the needs of the user, and have stretched the limits of the climate-science expertise.

The process should include the following (adapted from van Veldhuizen, et al., 1997):

a) Identification of the clients or target groups;
b) Interaction between the service provider and clients to identify the climate-sensitive decisions that are made during the course of everyday business. This step enables a relationship (Relationships Foundation, 2004) to be built between the NMS, agrometeorologists, and specific clients so that they can identify or diagnose the gaps in weather information available from the NMS;
c) Development of products or technology into useful packages or forecasts by further specific climate-data analysis, the use of modeling techniques to simulate the effect of weather variability on the agricultural production system, and risk and sensitivity analyses for various climate parameters;
d) Further interaction with the clients to evaluate the results from the scientific analyses. This gives an opportunity for clients and climatologists to reflect on the needs expressed in (b) and the products developed in (c). It also provides an opportunity for the client to experiment with the products and to test and evaluate their usefulness and applicability. There needs to be a re-iteration process back to (c) and (d) before proceeding to (e); and,
e) Introduction and integration into the routine operational forecasts and products of the NMS, when the product or technology or forecast is acceptable and usable for the clients. This will be an implementation phase in which it must be publicized and distributed to the clients on a wider scale, so that they can begin to utilize it in their day-to-day operational decisions.

As the interaction between the weather and the agricultural production is so complex (Hoogenboom, 2000), it is not just a case of applying a simple solution and expecting implementation by the farmers. As each year or season will bring a different set of circumstances, the actions required will also be different. That is why the participation approach involving the NMS and the agricultural community and farmer clients is necessary. So first, an awareness of the influence of the weather and climate parameters on sustainable agricultural production is needed (Sivakumar, et al., 2000). In many cases, this awareness is already acutely present and many farmers are looking for intelligent low-risk solutions. This should stimulate an interest among the farmers to be willing to evaluate the forecast products produced by the NMS. If the NMS or agrometeorologists are willing to work together with the farmers, then new technology will be developed during the experimental phase of a project (Bembridge, 1991; Mosher, 1979). Once this type of product has been developed with a small group of farmers, they can be made available to a wider audience to be tested and adapted before widespread adoption. This technology, innovation, or forecast product should have a firm scientific base and meet the requirements and specified needs of the users or clients. In this way, during the initial phases of the development of the technology or forecast product, it will already be tested and improved or adapted. These farmers can then also be used in a farmer-to-farmer technology transfer action to distribute it further afield.

Modes of Dissemination

The practical methods or channels that can be used for the actual dissemination of agrometeorological information depend on the client to be reached and the sender as well as the format of the message or information (Bembridge, 1991). The communication channels can be broadly divided into three groups, namely mass and electronic media, group methods, and individual contacts. In general, the use of more than one channel gives a greater chance of reaching the client or user (Bembridge, 1991). The individual contacts can be time consuming but also build good rapport and help maintain credibility between the role-players. It is a vital part of the participatory technology development (van Veldhuizen, et al., 1997) and the training and visit method of extension (Benor & Baxter, 1984).

In identifying the clients, it is often useful to focus on a specific homogenous target group likely to have sufficiently similar needs and, therefore, can also benefit from similar information (Bembridge, 1991). This target group may not be existing groups, as such, but more a category of clients or farmers who would be able to identify similar weather dependent decisions. Therefore, the same sort of uniform recommendations, advisories, or information can be formulated to address these critical decisions and provide the desired weather information using the same format and language, etc.

The group methods include the use of already existing study groups or other interest groups such as sewing, church, or sports groups (FAO, 1999). This also provides face-to-face contact with people who are the clients and enables the agrometeorologists to obtain more general feedback from more users concerning the information provided. This is a way of making better use of scarce human resources, and groups can meet on a regular basis or be one of the meetings (Bembridge, 1991). Group meetings can be informal or formal, a discussion, or formal farmers' days of information meetings. There are advantages for both the farmers and for the extension staff. The groups allow farmers to be exposed to other farmers' successes as well as realize that they may encounter similar problems or obstacles. This encourages them to preserve and to consider alternatives that may have been used by others. It also helps to share experiences and opinions and identify gaps in the knowledge or information flow (Joyce, 2003). Groups can also commit together to take certain action and then support each other throughout the process (Bembridge, 1991). Groups generally should save the extension staff some time as the message is only explained once to the whole group. The groups can be used in follow-up to both mass media and previous individual contacts.

The use of mass media has the advantage of reaching many more people with each action. The format can be a written article on a specialized printed pamphlet, newspaper, magazine article, or e-mail or Internet posting. Alternatively, it can be distributed via the electronic media including radio, television, tape recording, e-mail, or Internet. The disadvantage of the audio and visual media is that the receiver only has to rely on their memory to recall the information at a latter stage. Therefore, it is often good to have a follow-up with printed matter and diagrams, especially if this can be in the local language. The use of electronic media such as e-mail file transfer protocol (FTP) or the Internet will depend on the availability and access of these methods to the users or clients who make up the target groups (WMO, 2000).

Examples

One of the best ways to illustrate what has been explained is to look at some examples of the process that have resulted in successful dissemination and utilization of agrometeorological data. Examples that integrate the whole range of weather and climate data and information transfer to farmers include the following:

- From research to application by Florida Consortium (FC) (Jagtap, et al., 2002). As agriculture is one of the most important sectors of the economy and climate variability is a major source of risk in the southeast USA, the FC was formed to capitalize on the potential predictability of the climate. The FC aims to bridge the gaps by characterizing users' needs, then adapting research tools to support agricultural decision making. This process was also evaluated and mechanisms were developed to deliver useful climate forecast applications.

  The framework that the FC developed had many activities that were integrated into a whole and yet ran parallel, including physical, biological, social, and economic aspects. Basically, the framework consisted of four integrated components of climate information, namely a) generation; b) communication; c) use, and d) implementation; and evaluation of a) to c).

  The generation of climate information was mainly a diagnostic analysis of historical climate and agricultural data in which the influence of El Niño-Southern Oscillation (ENSO) on climate and thus agriculture was characterized using models. The second component of communication of climate information had already been identified as a challenge (Hammer, et al., 2001, Keating & McCown, 2001). This included distribution of information and the maintenance of communication channels by interaction with stakeholders. This enabled learning about the current decision making processes and what influences them, so that gaps could be identified for improvement. Some matters identified were referred back to the first component as areas that needed climatological research and analysis. The methods included the Florida automatic weather network, the Florida cooperative extension service, as well as the stakeholders. Rapid rural surveys were also conducted to gather information on climate-sensitive decisions that farmers and ranchers have to make. Training was conducted on how growers can incorporate weather data into management tools to assist with day-to-day management decisions. The third component was the use of the climate information. Benefits have long been identified in climate-sensitive sectors, but for success it must induce a change in the decision making process and actions of stakeholders (Sonka, et al., 1992). In this case, the use of climate information was applied to irrigation and planting dates of peanut production; winter tomato production using ENSO models to address labor constraints; cow-calf livestock operations with decisions such as when to plant hay, and seeding and fertilizer rates versus purchase of bulk-feed and nutritional supplements for the cattle. Models of these specific farming operations were then used together with the ENSO forecasts to develop advisories. The fourth component of implementation and evaluation actually ran parallel to the others. This part included an analysis of the effect of extension as a means of transferring and disseminating research results together with the infrastructure needed and the process of interactions as bridge builders between extension and stakeholders.

Some of the conclusions include the following:

- That farmers do require climate information;
- End-users trust information from a credible or trusted source;
- A wide range of opinions from no confidence to high level; and
- Active involvement of agencies with good, strong and established relationships was required to improve chances of delivering operational applications.

Therefore, while dissemination of climate-agricultural information is necessary, the agent delivering it needs to have a track record and be a trusted source. They also need active involvement of the agencies with a good relationship with the stakeholders to achieve a wide acceptance of the information.

- Farmers', Advisers', Researchers', Monitoring, Simulation, Communication and Performance Evaluation (FARMSCAPES) approach to decision support in northeastern Australia (Carberry, et al., 2002, McCown, 2002).

  The FARMSCAPE approach to a decision-support system was developed as a program of participatory action research (Martin & Sherington, 1997) with the farming community in northeastern Australia. The initial question that was asked was "who are the clients?" This is to identify the group of society whose needs were to be addressed in the program. The approach taken throughout was that of participatory action research where a cycle is followed together with the selected role-players from planning to action to observations to reflection and then returning to planning again. The Agricultural Production Systems Research Unit (APSRU) was formed to conduct the on-farm research including collaborative experimentation and monitoring production variables and using simulation models to explore other issues and options. The FARMSCAPE project included the development of networks of individuals and groups of farmers and consultants, advisors, extension officers, etc., who were engaged in monitoring on-farm activities. It also included investigation of alternative ways that other farmers and advisors could be incorporated to derive some benefit resulting in training and communication activities. The communication activities included different media, e.g., video, newsletters, field days, printed articles, internet website, on-line sessions, etc. One of the approaches developed was the "WifAD" or "What if? Analysis and Discussion," which is an interactive discussion with collaborating farmers and advisers. This allowed scenarios (Urli & Nadeau, 2004) for alternative management options to be developed which were then run with a simulation model to evaluate strategies and develop tactical plans which used yield forecasting as an evaluation tool (Podesta, et al., 2002). The seasonal forecasts developed using Southern Oscillation Index (SOI) phases was one of the scenarios together with soil as a resource, soil monitoring, and industry acceptance of modeling. Changes in production expectations and consideration of innovative changes in farming decision making and practices were all evaluated.

  A wide range of dissemination modes was used in this project. The innovative methods included direct links by individual relationships between researchers and advisors and farmers, and the use of models as a demonstration tool and also as a practical scenario-building tool to explore outcomes to "what if questions" on a specific farm. However, one mistake was a "failure to deliver" by researchers due to the time-consuming, stressful, confronting, demoralizing participatory mode of working. This can be a learning curve, but one solution was to train accredited users who could take the process to a wider range of stakeholders.

- Use of seasonal precipitation forecasts in Burkina Faso, West Africa (Ingram, et al., 2002).

  This project addressed several aspects of the seasonal rainfall forecasts and the path from producers (NMS or other sources) to the farmers. There was an overwhelming demand and request for the rainfall-forecast information as rain-fed farming is their main livelihood. The specific requests included the quantity, duration, and distribution in space and time at least 1-2 months prior to the onset of the rainy season, so the producers can use this information in the decision-making process to optimize labor, land allocation to various crops, seed choice, etc.

  The consensus about dissemination of the message was that the local language radio would achieve the best widespread and timely distribution of the forecast, as most had access to battery operated radios. However, they requested a follow-up by the extension officers, possibly on market day or at the mosques as these were general meeting places. The most useful forecasts were also those that included information from both the NMS and the agricultural and development and resource management experts. In this way, the message could include some strategies to consider such as crop diversification, land allocation, and suggestions as to resource management.

- Transfer of irrigation scheduling technology in northern Mexico (Quiñones, et al., 1999).

  This real-time irrigation forecasting system integrates crop, soil, weather, and water distribution networks to schedule irrigation water applications on a plot-by-plot basis with easy up-scaling to a district level. The system involves part of the national agrometeorological network of automatic weather stations connected, via radio-repeater stations, to a computer server from which users can download climate data via a direct telephone line. Reference evapotranspiration is calculated for the real-time irrigation forecasting system, available on a 24-hour basis due to 15-minute automatic downloading from the weather stations. The station data is also available in hypertext from the web page that is updated periodically. Maize and wheat field experiments were used to calibrate aspects such as rooting depth, allowable soil water deficit, and calculation of crop factors. During the evaluation part of the project, the users participating in the real-time irrigation forecasting system obtained 12 percent and 26 percent higher crop yields in maize and wheat, respectively. Under the real-time scheduling system, the water productivity of maize improved by 18 percent and wheat by 59 percent, relative to the traditional irrigation scheduling methods despite applying more water than the model predictions. Following the success in the prototype system in the Carrizo Valley, the system was transferred to the Del Fuerte Valley with adaptations including additional weather stations due to the variable microclimate and the use of growing degree days to adapt the length of the phenological phases of the crops. Further expansion of this program, by transferring the technology to other important irrigation districts in northern Mexico, is planned. The principle mode of information distribution in this irrigation scheduling system is the farmers' access to weather data and other water use information directly from the database via computer links, either on a dial-up system or via the web page. This information is available on a routine basis to the users, 24 hours per day.

Conclusions

Dissemination is vital if agriculture is to benefit from the available agrometeorological data and products. It is necessary to have two-way communication between the climatologist or forecaster and the potential clients, whether farmer or agribusiness advisor or extension staff. This can be best achieved when there is a personal relationship between the parties with continuity being maintained by regular contact and interactions with open communication channels (Relationships Foundation, 2004). It is critical to identify the climate-sensitive decisions that are used in planning or on a daily operational basis and to identify gaps in information needed so that technology can be developed to bridge these gaps. The products must then be evaluated before being integrated into the operational forecasts for dissemination to a wide range of decision makers. Since the relationship between the NMSs and agricultural role players is so critical, it would be good to assess whether they have shared values and aims, have respect for each other, and are aware of each other's circumstances and roles (Relationships Foundation, 2004). The way forward is to form good relationships so that new agrometeorological applications can be developed as a cooperative and collaborative learning process to bridge the identified gaps in the knowledge chain, and thus, enable meteorological science to contribute to the economic benefit of the agricultural industry.

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