Agrometeorological Bulletins: How Can We Improve Them?***

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Weather information is extremely important for many tactical (day-to-day) and strategical (long-term) agricultural decisions. Tactical decisions include such farm management activities as sowing, cultivating, spraying, and irrigating. Strategical decisions include cropping intentions, management practice, and marketing. While daily rainfall and temperature patterns have a direct influence on tactical decisions, favorable or unfavorable seasonal weather patterns (including long-term trends and variability) may force alterations in cropping patterns and marketing decisions. There are growing demands for timely and effective agricultural weather information for a wide variety of agricultural management decisions, ranging from crop's response to daily weather to the crop's adaptation to changing climate.

Agrometeorological bulletins can serve a vital role by providing to the agricultural community relevant decision-making information. The key to a bulletin's success is to deliver the right information to the right user at the right time. One of the first criteria that must be identified is to determine who the users are. In other words, who needs the information that can be effectively delivered. Then, the user requirements must be established so products that are delivered will serve the necessary purpose.

Before discussing the agrometeorological bulletin in more detail, allow me to start with some philosophical quotes that I found which I will call "food-for-thought" for this presentation.

"An expert is one who knows more and more about less and less until he knows absolutely everything about nothing."

Agricultural meteorology is a highly specialized field that is composed of diverse disciplines. Meteorological and climatological principles are related to agriculture in an array of applications ranging from crop growth and productivity to land resource management. Knowledge of agronomy, crop physiology, hydrology, and ecology are complementary interdisciplinary fields that influence the skills of an agricultural meteorologist. Moreover, the ability to migrate this knowledge into a comprehensive resource base for applications, often employing computer and GIS technology tools, illustrates the complex nature of this expertise.

Depending on the specific application, these resources must be utilized appropriately to process the information needed by the user. The expertise from different disciplines must be drawn together to compile the data, analyze the results, and produce meaningful information for the decision-maker. An open channel of communication between experts in different fields of expertise is essential for a successful bulletin.

A cooperative effort between experts in the various fields, along with proper recognition for their contribution, can be a very effective means for the collaboration, preparation, and dissemination of a quality bulletin.

*** This paper was published from the publication entitled "Improving Agrometeorological Bulletins", Proceedings of the Inter-regional Workshop, 15-19 October 2001, Bridgetown, Bardados. p. 13-24.

"It's a simple task to make things complex, but a complex task to make them simple."

The objectives of a bulletin must be clearly defined. The first, and perhaps, most important objective is to know who the users of the bulletin are. There are a wide variety of potential users with a varying range of information needs. Farmers would like daily information during the growing season to assist their daily activities in the field, such as planting or spraying. They also need information that may be more meaningful on a weekly basis to monitor and manage farm operations like irrigation scheduling. Water budgeting techniques often need cumulative data to best calculate these data. Agribusiness concerns, such as seed and fertilizer companies, may need longer term data to evaluate trends in cropping practices to plan for the needs of the next growing season. Marketing decisions may also depend on the magnitude and severity of weather extremes in other crop areas.

In order to satisfy many of these user requirements, accessibility to appropriate input data is absolutely necessary. Further, this input data must be available on a routine basis to ensure systematic reporting of the informational requirements. Knowing the input requirements, techniques can be established utilizing computer and human resources to prepare the appropriate products for dissemination during the growing season. Pooling of resources can certainly ease the demands imposed to meet deadlines for publication, but this requires explicit coordination among the contributors. While it may initially be a complex task to coordinate resources for the bulletin, the end result will be an efficient process to satisfy user requirements in a timely fashion.

"Complex problems have simple, easy-to-understand wrong answers."

In many meteorological applications, comparisons of observed data with respect to a standard normal value provide very useful information. For example, rainfall represented as a percentage of the standard 30-year (or 10-year, etc.) normal rainfall is a widely used and meaningful computation. In the application of meteorology to agriculture, there are well-known relationships between rainfall, temperature, and crop yields. The comparisons of each parameter with their respective normal values may be valid as initial qualitative estimates of potential yields. However, more complex analytical computations may be required to quantify the impact of weather on crop yields.

Another important consideration in yield analysis is the influence of technology. Changes in trends of crop yields due to the introduction of technology over a period of time must be evaluated to determine the most representative deviations for trends. Technological changes, introduced by fertilizers, hybrids and varieties of seeds, and farm management practices, often cause step-like changes in the trend values. Crop yields, expressed in terms of departures from trend, are much more representative than departures from a long-term normal, which do not account for trend changes. Thus, while it would be simpler to evaluate weather's impact on yields with respect to long-term averages for all parameters, the results would not provide a true representation of the actual yield potential.

Whether it is a computation of a derived relationship or a process for the preparation and distribution of a bulletin, a well-prepared plan of action must be carefully developed and implemented to ensure that meaningful and pertinent information is available to the user.

"One thing that is good about procrastination is that you always have something planned for tomorrow."

Whether it is a new data source, a new technological tool for analysis, or, a new desktop publishing capability, it is virtually impossible to reach a steady-state condition in which no additional improvements are necessary. Each new task must be well thought out with respect to the final product. Procedures need to be tested before operational implementation. Feedback from the users is an absolute necessity to ensure the desired outcome. Some of these tasks may be completed in a short period of time. Others may require a lengthy trial and error process. Inquiries should be encouraged from the user community to offer suggestions for improvement. This important aspect of a successful bulletin not only promotes enhancements of the bulletin but also opens an important channel of communication between the information providers and information users. This is a proactive approach to continually improve the quality, content, and timeliness of the bulletin.

"Short-term gain can be long-term pain."

Hasty solutions that seem to remedy a situation may cause more complicated problems to be resolved later. One of the most notorious dilemmas facing computer technology was the Y2K problem. While it may have seemed to be an eternity before the year 2000 was reached by the initial computer programmers in the early high-tech age of the mid-1900's, a simple flaw in design 'thinking' to conserve space in programming languages created a costly and laborious effort to overcome a potential computer-age nightmare on January 1, 2000. While a focused worldwide effort to correct this flaw succeeded in avoiding major disruptions in service, the effort required tremendous computer resources. This is a prime example of how a simple design oversight can have unintentional consequences in the future. While it is impossible to anticipate some of these problems, a hasty quick fix is usually not the best solution.

"Anything you try to fix will take longer and cost more than you thought."

Some problems may be solved by readily available 'off the shelf' solutions. In fact, there are commercial off the shelf (COTS) software packages that may be directly utilized for specific applications. However, no one solution will satisfy all needs. Further, cost restrictions and human resource limitations may prohibit the use of COTS solutions. If the goal is to improve a product or to introduce new technological innovations, then careful consideration must be given to the development, testing, and implementation phases to ensure success. Often, the approach to problem solving entails a trial and error process. A plan of action needs to have a well-defined end product and a set of time lines to meet the desired outcome.

An important step is to establish guidelines for improving the bulletin. The first and foremost consideration is user requirements. If the information is scientifically and technically sound but not useful to the user in the decision making process, then the product will likely be deemed unsuccessful. The next factor to consider is the basic, or minimum, need that can be satisfied by the product. With this basic but useful information available to the users, a steady-state interest for the product and demand for additional information will be maintained. Finally, as resources expand and cooperation with other sources of information is developed, enhancements to the basic information and more user-friendly products can be achieved.

"If everything seems to be going well, you have obviously overlooked something."

In a newspaper cartoon, an employee meets with his supervisor. The employee notes "I'm pleased to report that I had no problems this week. I only had issues, opportunities, challenges, and valuable learning experiences. To that the supervisor asked "Did you do any work?" The employee responded "It didn't seem necessary." There may be frequent relatively benign intervals when users are satisfied with the products or even have just become accustomed to the expected products. During these times, there may be no proactive effort to alter the process or to make any revisions on the bulletin. However, over the course of time, some products may become less useful, may become outdated, or even may become counterproductive. Let me illustrate this observation by an example. A weather station has been reporting reliable precipitation and temperature data from an agricultural area for 30 years. Useful information related to the impact on traditional field crops grown in the area was helpful to farmers during the first half of the period. However, a trend was occurring over time that was not documented by weather observations nor seemed relevant to the observers. Demographic changes due to increasing population and urban growth resulted in a significant alteration in cropping patterns, shifting from predominant field crops to smaller-scale market crops in the proximity of a more urbanized setting. Without proper documentation of these changes, the information provided in the bulletin may become less important due to shifts in demography, cropping patterns, and user needs. Further, without a mechanism for user feedback, some of these shifts may be difficult to ascertain. While the provider of information may think relevant information continues to be included in the bulletin, the dynamics of change have in reality altered its usefulness. The moral of this story is to keep looking for new ideas and ways and means of improving your product, and know what your clients need. What may be considered "good" today, may only be "satisfactory" next month, and "inadequate" next year.

Preparation, modernization and distribution of agrometeorological bulletins – some issues

These discussion points hopefully illustrate the complexity of issues involved in the preparation, modernization, and distribution of an agrometeorological bulletin. Given the current status of a national bulletin, regardless of its content or infrastructure, lets turn to the objective of this workshop; namely, the improvement of agrometeorological bulletins. This is not an easy task. Any standardization of product format must be balanced by the unique informational requirements of the local user community. Any effort to expand or enhance a bulletin must also be accompanied by appropriate training to ensure continuity of service. Training involves all aspects of the bulletin, ranging from those who prepare the products to those who receive the information. The training process must also include an open dialogue, or forum, for an exchange of communication between the providers and users of the products. This helps to ensure an adequate understanding of the intent of the bulletin as well as its limitations with respect to support for the user's decision-making process.

To establish a guide for improving the bulletin, several issues must be evaluated. These include accessibility of data to meet basic user requirements, sources of routine and ancillary data; technical and human resources available for the product; appropriate user surveys of information delivery mechanisms; a strategy to develop and promote institutional collaboration; and mechanisms to establish appropriate user feedback.

While there are many factors to be considered in evaluating the strengths and weaknesses of a national bulletin, most can be grouped with three main categories. These are input requirements, analytical tools, and information delivery. Each of these categories will be discussed; keeping in mind that the emphasis is on weather and climate information needed by agriculture.

Input requirements

Input requirements refer to the quantity, quality, and timeliness of data that are available for the preparation of the bulletin. The number of reporting stations in key agricultural areas, instrumentation standards and maintenance, data collection and processing methods, data standards and quality control procedures, and, human resources are all factors involved with input requirements. Further, are the appropriate data being collected? This is an essential component that requires technical expertise and resources to meet the input requirements, and complete knowledge of the user requirements. Thus, appropriate channels of communication between producers and users of the bulletin are an absolute necessity.

The data issue is of utmost importance for obvious reasons. Metadata, or information about the data, is very important documentation to build the solid foundation. Valuable information is available from the location of stations with respect to crop areas and station history with respect to weather and climate patterns. A search for other sources of data, from different operating networks, must be conducted periodically. While some networks provide data for different operating requirements, the information can still serve to improve the density of observations with proper recognition of the sources and proper documentation of metadata files. Some data may not be timely for routine operational assessments but may be useful as they become available for historical analyses or model outputs that are reported on a more periodic basis.

Different types of data can also enhance the quality of the final product. For example, a satellite image of the areal extent of a tropical storm over a crop area provides useful insight about potential storm damage. A special written text, providing more detail of an unusual agricultural weather event, can highlight the magnitude and severity of nature's impact on agriculture. As an example, as a prolonged dry spell turns into an agricultural drought, reporting this information in terms that the user can identify and may help provide guidance in both daily and seasonal planning. The value of accessible data is measured by how timely the information is translated into a format for the decision-making process.

Another key factor is that the bulletin derives its success from not only weather data input but also agronomic input. Crop type, crop stage, crop condition, and soil information are all necessary input requirements for a comprehensive agrometeorological bulletin. Much of this information is usually available from a variety of sources in different agencies at various national, state or provincial, and local levels. The task at hand then becomes a search for these data sources and perhaps a mutual cooperative agreement, for proper recognition, to ensure access to these data for public dissemination. A very useful model of this arrangement is illustrated by the United States Department of Agriculture (USDA) and Department of Commerce (DOC), who cooperatively operate the Joint Agricultural Weather Facility under a formal memorandum of understanding (MOU). The MOU clearly defines the responsibilities of all participating agencies that contribute to JAWF's operation. JAWF has existed for over 30 years and is responsible for publishing the U.S. Weekly Weather and Crop Bulletin, a publication in existence since

1872. Weather data are provided by DOC's National Weather Service (NWS). Crop data are provided by USDA's National Agricultural Statistics Service (NASS) and World Agricultural Outlook Board (WAOB).

Pooling of resources from different agencies provides an effective means of acquiring a comprehensive database for the agrometeorological bulletin. It is not uncommon for multiple sets of data needed for this analysis to be scattered across more than one agency. Every effort should be made to coordinate these resources to ensure an efficient process of acquiring the necessary input requirements.

Analytical tools

The next category, analytical tools, involves converting the input data into information that can be packaged for delivery in a form that adds value to an existing knowledge base. For example, the simple calculation of growing degree-days, based on daily maximum and minimum temperature observations, can be a very useful indicator of crop phenology. More complex computations of soil moisture and evapotranspiration estimates are crucial in an agrometeorological analysis. Temporal and spatial analyses of data provide more information on historical analogue comparisons and the severity, extent, and deviation of extreme weather events. Additional tools, such as geographic information systems (GIS) technology, mathematical models, and to remotely-sensed observations, provide additional resource enhancements that can convey value-added information for the decision making process. While a great deal of information can be developed given access to technology and resources, a fundamental prerequisite must always be kept in mind in this process of information generation. The right information must be delivered to the right user at the right time.

Another major consideration is what technological tools are available to convert these databases into meaningful, user-friendly information. This may be a relatively easy task if all users require the same information or if there are unlimited resources to satisfy all diverse user needs. However, in reality, neither of the above options is usually feasible. Further complicating the process is the fact that weather's influence on crops varies over a growing season. In temperate zones, soil temperature is a critical parameter during the planting season, since seeds will not germinate if the soil temperature is too low. In subtropical zones, infrequent freezing air temperatures during critical flowering stages of citrus trees can be devastating. Other information is crucial throughout the growing season.

Data base management techniques allow efficient processing, analyzing, and graphical display of informational products. Automated software routines can expedite end to end information management. Resource constraints may limit the range of software tools available; however, a number of shareware/freeware programs are available to aid analysis. Another very effective approach to enhance the product is to obtain feedback from other technical experts as a product is being drafted. For example, the United States Drought Monitor is produced on a weekly basis and is published in the Weekly Weather and Crop Bulletin. This product is jointly prepared by DOC, USDA, and the National Drought Mitigation Center (NDMC). The draft of both the national map and text is sent out via email early in the week to all 50 state climatologists and other local specialists for their comments and suggested revisions. A rapid response is essential, and a second draft is sent after incorporation the revisions. Finally, after 3 days of iteration, the final product is released electronically on Thursday mornings. The email communication process has proven to be even more successful than anticipated, allowing local

experts to assist by email with comments and revisions.

Another powerful technological innovation that can greatly improve the quality of a bulletin is geographical information systems (GIS) technology. GIS allows data sets to be overlaid onto one another. A crop area map can be overlaid over a geographic region. Topographical features, such as river basins, mountains, and deserts can be defined to better define the limits of the crop area. Information on specific crop stages can be next graphically identified. Finally, relevant weather information can be displayed on this map. This graphic depiction can be used to identify how weather anomalies are affecting crops, in terms of both aerial extent and severity.

Information delivery

How information is delivered to the users of the product is, finally, of extreme importance. This leads to the third category, information delivery. There are a number of issues that fall into this group. These include clearly defined users, user-friendly information, cooperation and coordination between producers and users of the product, proper training, and, timeliness of information delivery. The form of dissemination is also an important topic within this category. Hard copy publication sent via mail allows detailed text and graphics, but its effectiveness may be hampered by the timeliness of receipt. Delivery by radio allows rapid dissemination but limits the amount of information that may be provided. Internet technology combines the strengths of detailed information and rapid delivery but is definitely constrained by lack of Internet access in many developing countries.

To be effective in delivering effective information, irregardless of the form of dissemination, the content of the bulletin must be value-added information that is useful to the decision-maker. The product must be delivered or made accessible in sufficient time for the user to make professional sense from the information and use it appropriately in the management process. Key considerations for a successful bulletin are what information does the user need and when does the user need this information? To answer these questions, there must be an established mechanism to allow routine communication between the technical experts who prepare the bulletin and the users of information. Formal lines of communication can be developed through user surveys and open forums. Informal mechanisms, such as telephone, facsimile, or email exchange should also be encouraged. Once established, such mechanisms for communication should become a routine occurrence to accommodate changing user needs, new technological innovations, and more efficient distribution procedures. Constructive feedback mechanisms promote an active dialogue to encourage improvements that not only technically enhance the bulletin but also increase its usefulness. Building upon the minimum requirements, the bulletin can be strengthened and expanded with increasing support and resources to respond to user requests for additional information needs.

Information delivery by Internet communication offers great opportunity to move quality products to the decision-maker rapidly. The computer age technology also allows efficient feedback mechanisms, which in turn may increase the demand for additional information. While these computer resources are limited in many developing countries, Internet technology is rapidly expanding and the cost of computer technology is declining. This offers exciting opportunities for the global community to exchange data and information for the entire user community.

There are numerous and increasing demands for timely and effective agricultural weather information for many agricultural decisions. These decisions range from day-to-day farm management activities, such as planting, spraying, fertilizing, etc. to seasonal and annual agricultural business decisions, such as seed varieties, land-use planning, etc. Daily weather conditions have a major impact on the farm economy, directly affecting crop yield outcome. Long-term weather anomalies and climate variability may also alter cropping patterns and practices, crop adaptation strategies, and natural resource conservation measures.

An agrometeorological bulletin can assist farmers, agricultural business managers, and, government officials in their decision-making processes by providing relevant information in user-friendly terms in time for analysis of the situation. The technical experts who prepare the bulletin must absolutely know who their users are and what are the user requirements. By establishing and maintaining open lines of communication between the providers and users of information, a systematic plan for action can be developed and implemented to achieve the desired objectives.

Some basic recommendations for improving agrometeorological bulletins

Some basic recommendations are now presented to guide planners in their goal of improving the agrometeorological bulletin.

- *Don't promise too much to quickly.* Start with basic, easily accessible weather data and simple derived products. For example, growing degree-days provide a useful indicator of general crop phenology.

- *Relate the weather data to meaningful agricultural information.* While reported weather information may, at times, be useful without further elaboration, its impact on agriculture is the ultimate goal. How does the reported information affect crop growth and yield potential, range and pasture vigor, phenological status, cropping patterns and trends, and land-use changes? How does current weather situation compare to a past known event, which had an impact on agriculture?

- *Don't oversell the information.* Weather has a direct impact on crop yield potential. However, other factors such as farm management practices (cultivation, fertilization, and migration) and technology changes (seed hybrids, conservation practices) may also influence yield potential. Further, crop production is also influence by acreage which will be driven largely by economic conditions.

- *Establish credibility slowly but surely.* There is an essential need to establish consistency and reliability in reporting. While responsive to changing user requirements and increasing demands for information, there is an absolute mandate to strive toward standards of reporting and effective quality control mechanisms.

- *Implement new products with proper introduction*. Announce to the user groups the intention of new product implementation into the bulletin and fully explain why it will be made available. Encourage user feedback to promote response, and modify the product as needed to account for significant user recommendations.

- *Be proactive in demonstrating the usefulness of your products*. Always strive to improve the quality of the bulletin with new products and better representation of existing products. Periodic user forums or surveys should be encouraged to maintain the necessary contact with the client of your bulletin.

- *Training and education is an essential component*. This must involve both the providers and users of data and information. Both parties involved in the agrometeorological bulletin must be able to 'speak' and 'understand' the same technical language.

- *Don't hesitate to pool resources*. Human and financial resources are very often limited. Ways to achieve maximum efficiency by coordinating and combining resources are to share ideas, exchange experiences, establish standard guidelines, and formulate recommendations for bulletin improvements. With proper recognition for contributions and mutual access to the products, great strides can be achieved more rapidly by a concerted and coordinated effort.

In closing, let me summarize by saying that successful improvements in agrometeorological bulletins can usually be derived from the quality of input plus a variety of technological tools which yield simplicity of meaningful output.

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