Applications of Meteorological Information to Agriculture in West Africa

Giampiero Maracchi[1] and Simone Orlandini[2]

Abstract

The application of agricultural meteorology can be considered particularly important in developing countries, providing information in order to support decision making. Early warning systems, technical assistance during the agricultural season and improving production systems can be considered as the main goals of agrometeorology. In this paper several examples of agrometeorological applications are described. They have been realised by several research institutions in Florence, to support the activity of agricultural producers, particularly for the forecast of rainy season and the monitoring of crop production.

Introduction

In developing countries (DCs), the availability of processed information can represent the basis for the survival of the population. These are two main obtainable goals: food commodities and system sustainability (Hollinger, 1994). In this context, weather/climate application to agriculture can play a fundamental role, providing information to support the decision activities of agricultural producers and politicians (Bacci, 1994). Agrometeorology can propose a wide range of agricultural strategies, among those the farmer can choose the most suitable strategy depending on the characteristics of the environment, to reduce the negative effect of weather variables and the interannual variability of crop production. Important information can be provided with a short time horizon for tactical applications concerning early warning (short cycle varieties, choice of alternative cultural systems, real time seed distribution, irrigation management), and with a long time horizon for:

[1] Institute of Biometeorology - National Research Council, Piazzale delle Cascine 18, 50144 Firenze, Italy.
Tel : +39 055354895, Fax +39 055350833, E-mail: maracchi@iata.fi.cnr.it

[2] Department of Agronomy and Land Management – University of Florence, Piazzale delle Cascine 18, 50144 Firenze, Italy.
Tel : +39 055354895, Fax +39 055350833, E-mail: orlandini@iata.fi.chr.it

1. agro-economic planning with benefits at national scale (stock, production, import/export);
2. agro-industry production with benefits at international level (yield forecast in main production zones and in different countries).

The main goals of agrometeorology in DCs are directed at improving the stability of production from one year to another and increasing national agricultural production. The main characteristic of agriculture in DCs being the provision of food for farmers themselves, even if the growth of towns in the last decades demands provision of food also for non agricultural activity, all efforts should be made in this direction. The principal aims of agrometeorology can be summarized as the following (Maracchi et al., 2000):

1. Early Warning Systems, the possibility to forecast on an administrative basis lack of production, and therefore the food available to governments, and international cooperation through humanitarian aid to reduce the impact of unfavourable years;
2. technical assistance during the agricultural season, monitoring of the meteorological parameters and comparison with the previous years and with modelled conditions. This enables farmers to be advised on how best to take advantage of favourable conditions or fight unfavourable conditions by choosing the best time to seed, ways to save water through weeding at the right time or to defend themselves from pest and diseas attacks;
3. improving production systems, assuming that in many cases in the poorest countries the traditional ways of improving production through the application of technological inputs such as fertilizers and machines is very difficult for financial reasons. Simple techniques to take the greatest advantage from natural and human resources is the only way to improve production and to sustain the same. As climate is one of the main natural driving forces, agroclimatic analysis and advice become crucial to improve the situation.

At present many tools are available to increase the performance of the agrometeorological applications. They allow the monitoring of analysed region, the complete data elaboration to provide information and finally the real time dissemination of information to the end-users. We can indicate the earth observation from the space, the computer science progress, internet technologies, electronic devices development, numerical meteorological model improvement, crop model set up and seasonal climatic models for climate prediction (Maracchi, 2002).

To provide a picture of the present situation, several applications of agrometeorology in West Africa are described in this paper. They are realised following international projects, by several research institutions from Florence (Italy), belonging to the National Research Council and the Accademia dei Georgofili.

Utilisation of Rainfall Forecast Data Available on the World Wide Web

This activity has been realised during the agricultural season 2001 in Mali, by the Institute for Agrometeorology and Environmental Analysis Applied to the Agriculture of the National Research Council. The main goal is to advise farmers for the best sowing period some days before the rain in order to help them in taking the right decision. The system is structured in three main sections:

- Rainfall Forecasting section
- Rainfall Estimation section
- Field data section

In the first, through the daily images on WWW it's possible to forecast the amount of rainfall expected into the decade and give the advise on sowing to farmers (Fig. 1). The second section is involved in rainfall estimate based on GPI, SSM/I, AMSU and GTS. The output of this section is used to validate the information prepared by the forecasting information (Fig. 2). Finally the third section provide field data collected by local institutions in observation areas (Fig. 3). The results obtained in the sections have been compared in order to evaluate the process (Fig. 4).

Utilisation of Agrometeorological Data "S.I.S.P. - Système Intégré de Suivi et Prévision"

SISP has been developed by the Institute for Agrometeorology and Environmental Analysis Applied to the Agriculture of the National Research Council and can be considered as an integrated information system for monitoring cropping season by meteorological and satellite data (Di Chiara et al., 1994). The aims of the project are:

- to use and integrate different information sources and analysis procedures;
- to allow the meteorological services a decadal growing monitoring;
- to provide national early warning system with useful information about the evolution of the season.

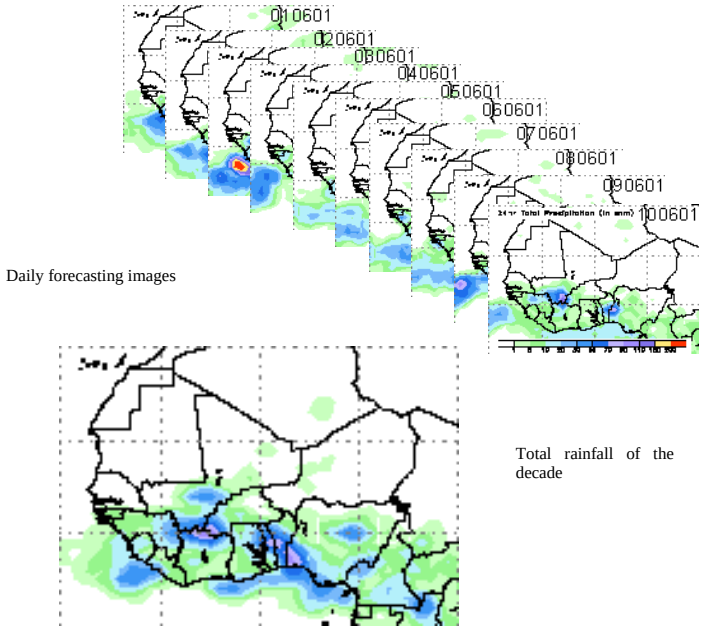


Figure 1. Forecasting Section.

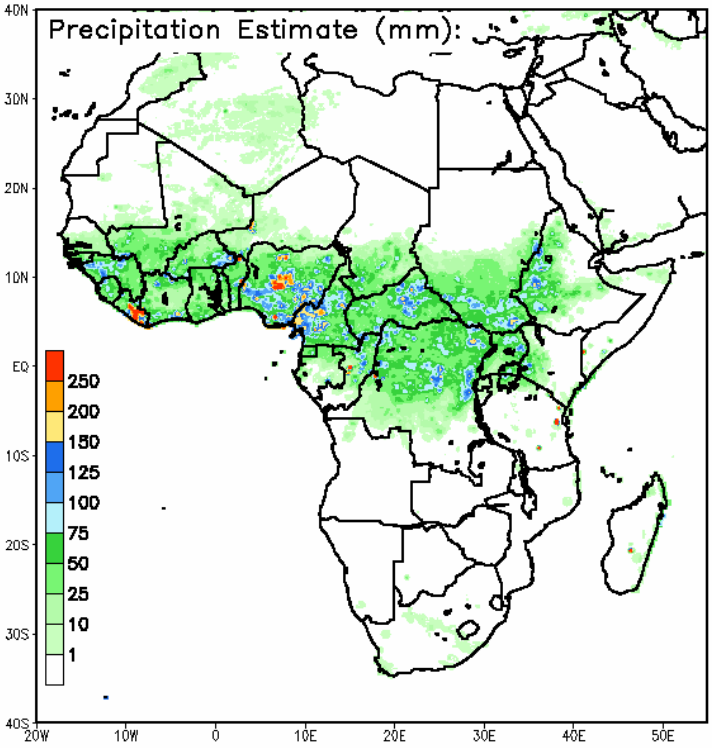


Figure 2. Estimation Section.

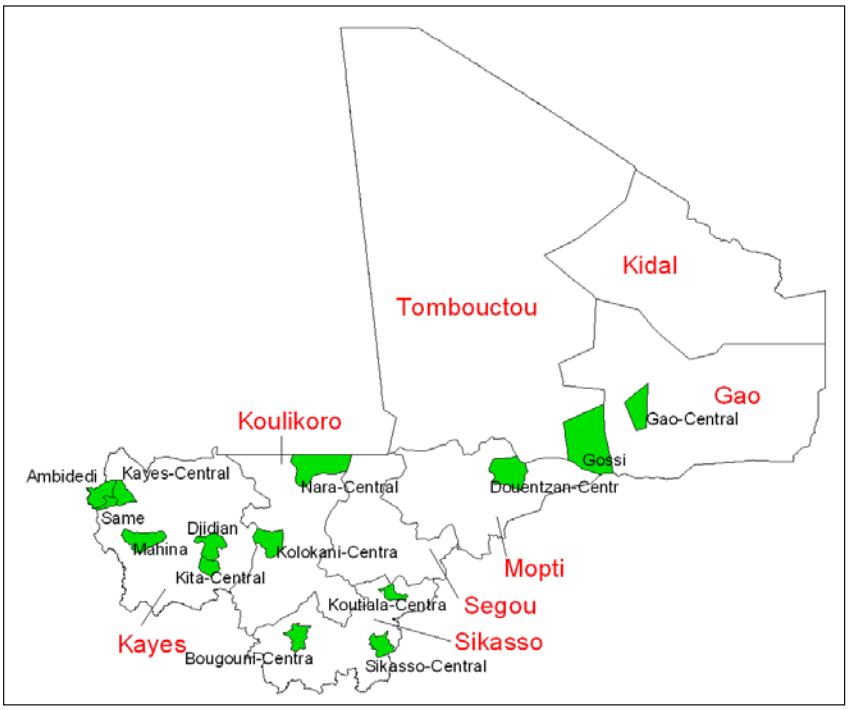
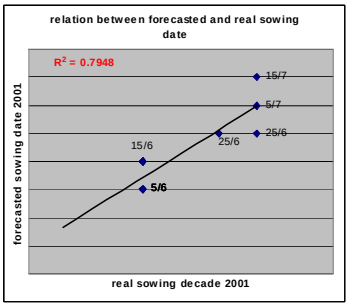


Figure 3. Field Observation and Data Section.

DEPARTMENT	REAL SOWING DATE 2001	FORECASTED SOWING DATE	ESTIMATED DATE SOWING DATE
Gao-Central	5/7	15/7	25/6
Gossi	5/7	5/7	25/6
Nara-Central	25/6	25/6	25/6
Douentzan-Centr	5/7	25/6	15/6
Kayes-Central	5/6	15/6	5/6
Ambidedi	5/6	15/6	5/6
Same	5/6	15/6	5/6
Kolokani-Centr	5/6	5/6	5/6
Mahina	5/6	5/6	5/6
Djidian	5/6	5/6	5/6
Kita-Central	5/6	5/6	5/6
Koutiala-Centr	15/5		15/5
Bougouni-Centr	15/5		15/5
Sikasso-Central	15/5		15/5



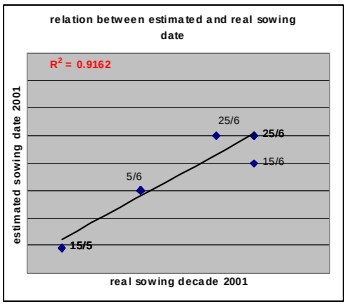


Figure 4. Comparison among Results obtained in the Three Sections and Evaluation Results.

The system is based on several tools:

- statistical analysis on historical series of rainfall data to produce agroclimatic characterizations;
- a millet (*Pennisetum americanum*) simulation model estimating the effect of rainfall distribution on millet crop growth and yield;
- NOAA-NDVI images analysis monitoring vegetation development;
- decadal reporting produced by national meteorological services and national early warning units.

The final result is characterised by many operation production, giving important advises to the decisions makers, extension services, farmers, businessmen (Fig. 5). Several final considerations can be presented:

- the system has a modular structure and an user-friendly interface;
- data and parameters used are common and easy obtainable;
- the system is oriented to provide national meteorological services with a simple methodology for agroclimatic characterization, seasonal monitoring and yield forecasting;
- METEOSAT images of estimated rainfall could be integrated in the system and used instead of station rainfall data;
- integration of a module for the forecasting of sowing date;
- strengthening and improving of the data collection and dissemination systems.

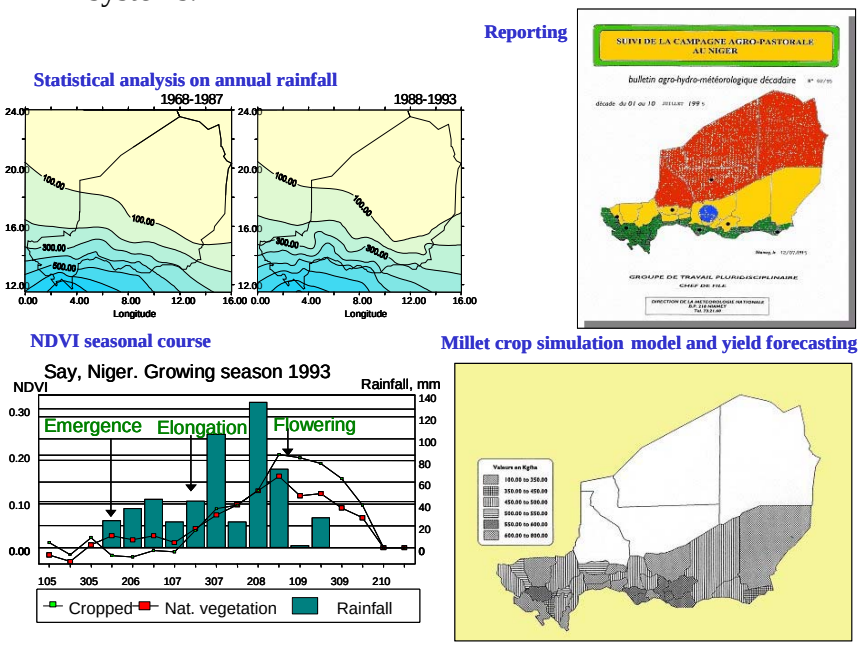


Figure 5. Main Products of SISP.

The ZAR (Zones A Risque) Model

This model, realised in collaboration between the Centre for Computer Science Application to Agriculture of Accademia dei Georgofili and the AGRHYMET Regional Centre, allows to identify the zones at current risk for agricultural production on the basis of the following data: rainfall estimates derived from METEOSAT images and agroclimatic characterisation on the territory based on rainfall time series analysis.

From the 1st decade of May to the 3rd decade of July the ZAR model produces the following layers:

- first successful sowing
- sowing failures
- last decade suitable for sowing
- zones where after the sowing failure it is possible to re-sow
- successful sowing
- average growing season onset
- average growing season end
- average growing season length
- length of the current season
- evaluation of the possibility to sow in zones that are not yet sown
- comparison between the actual onset with the average onset of the agricultural season
- comparison between the actual onset with the onset of the agricultural season of anomalous years.

Conclusions

The described procedures can be operationally applied in DCs, providing important applications for the improvement of crop cultivation. Particularly important are the possibilities for optimising the exploitation of water resources, generally representing the limiting production factor of these areas. The range of elaborated information can be very important for successful agrometeorology applications, as well as the possibility of a real time dissemination of information satisfying the end-user needs. Also in these less developed countries Internet can be a good solution to reach the local services, but it is possible to use local or national broadcasting.

References

Bacci, L. 1994. Modeles agrometeorologiques pour la culture du mil. Quaderno CeSIA, Firenze, Italy.

Di Chiara, C., Montanelli, M. Daouda, M. and Labo, M. 1994. Manuel de suivi de la campagne agricole et alerte précoce au Niger – SISP. Quaderno CeSIA, Firenze, Italy.

Hollinger, S.E. 1994. Future direction and needs in agricultural meteorology climatology and modeling. Agricultural and Forest Meteorology 69: 1-7.

Maracchi, G. 2002. Meteorologia e climatologia applicate. Istituto Geografico Militare, Firenze, Italia (in press).

Maracchi, G., F. Sabatini,. and M.V.K. Sivakumar, 2000. The role of Automated Weather Stations in Developing Countries. In: Proceedings of "Automated Weather Stations for Applications in Agriculture and Water Resources Management: Current Use and Future Perspectives, 6-10 March 2000, Lincoln, NE, U.S.A.