APPENDIX I

REPORT OF THE WORLD METEOROLOGICAL ORGANIZATION RA I EXPERT GROUP MEETING ON THE IMPLEMENTATION OF CLIMATE FORECASTS FOR AGRICULTURE

(9 to 13 December 2002, Banjul, The Gambia)

1. The World Meteorological Organization (WMO) Expert Group Meeting was opened at the Jaama Hall of the Kairaba Beach Hotel at 10:15 a.m. on Monday, 9 December 2002 by the Honorable Susan Waffa-Ogoo, Secretary of State for Fisheries, Natural Resources and the Environment. Fifty-one participants from Africa and outside attended the meeting. The list of participants is provided in Annex I.

2. On behalf of His Excellency, the President, Alhagie Dr. Yahya A.J.J. Jammeh, the Government and people of The Gambia, the Secretary of State extended a warm welcome to the participants and expressed The Gambia Government's sincere appreciation to Prof. Obasi, the Secretary-General of WMO for allowing The Gambia to host this important meeting. In addressing the participants, Honorable Waffa-Ogoo noted that "at the beginning of the rainy season, the rains failed and crop productivity was reduced. At the end of the rainy season, unseasonal rains destroyed the little amount of crop that was harvested. Productivity was again reduced. That tells you the plight of the Gambian farmers and the economy, which are completely dependent on rain-fed agriculture".

3. She expressed the shortcomings of the Gambian forecasters in making seasonal weather forecasts but noted that a seasonal forecast model, which provides forecasts of average seasonal rainfall quantities and anomalies thereof, is presently being experimented. Through the WMO Voluntary Cooperation Programme, the Government of the United Kingdom and the Meteorological Office provided the Gambian Meteorological Services with a Media Weather Presentation System. A technician from the UK Meteorological Office was in The Gambia to upgrade the Media System with state-of-the-art equipment and software. The Government of The Gambia also constructed a building for the Media Weather Studio. In this connection, she emphasized the need to have accurate predictions of beginning and end of the rainy season; start, duration and end of dry spells and magnitude and duration of floods in The Gambia and the Sahel, and highlighted the lack of technical and technological capacities.

4. The Secretary of State ended her remarks by saying, "We in The Gambia look forward to your state-of-the-art presentations and discussion papers that, we hope, will contribute to addressing and alleviating our climate-related agricultural problems and those of the African Region in general. We also look forward to future collaboration and cooperation with your parent institutions in advancing climate forecasting in The Gambia and the African Region as a whole. I hope the brainstorming sessions of the Meeting will take into consideration all the needs of the Region to come up with tangible and practical recommendations for future actions by the scientific community, WMO and Member States of the African Region".

5. On behalf of the Secretary-General of WMO, Dr Buruhani Nyenzi, Chief, World Climate Applications and Climate Prediction and Application Services (CLIPS) Division addressed the meeting, during the opening session. He informed the meeting that the RA I Expert Group Meeting was jointly organized by the Agricultural Meteorological Division and the Climate Applications and CLIPS Division of WMO. He reiterated that

the meeting was timely as many countries in Africa including The Gambia are currently engaged in combating the impacts of climate variability, droughts and famine that pose many challenges to the agricultural sector, which is one of the largest contributors to gross domestic product (GDP).

6. Dr Nyenzi highlighted the purpose of the meeting and the expected outcome. He assured the meeting that WMO is working very hard to see how it can help the Meteorological Services within the Region in improving the provision of early warning for climate-related events within the Region. In order to enhance this effort, he urged governments in the Region to provide adequate support to National Meteorological and Hydrological Services (NMHSs), as well as other related national and regional institutions and programmes, so as to ensure that these institutions and programmes continue to utilize new developments and skills in climate prediction in support of sustainable development.

7. Finally, he assured the participants that on its part, WMO will continue to support the activities of the NMHSs and those of the African Centre for Meteorological Applications and Development (ACMAD), Agrhymet Centre and the Drought Monitoring Centres (DMCs) in their effort to further contribute effectively to a sustainable national and regional agricultural development. WMO will also continue to work with its partners in the international community as well as Governments in order to ensure the sustainability of these institutions.

8. Following the opening session, and the adoption of the programme of the meeting (see Annex II), papers were presented under the different themes. The presentations and discussions that followed are summarized here below.

THEME I: CURRENT ADVANCES IN THE SCIENCE OF CLIMATE PREDICTION: CAPACITY FOR AGRICULTURAL APPLICATIONS IN AFRICA.

9. The meeting noted that most of the models used in Africa are largely statistical. Apart from South Africa and few other African countries, many African countries rely largely on the General Circulation Model (GCM) outputs produced from Advanced Centers without adequate capacity to interpret and verify the skill of such models in the Region. This is a serious challenge to ACMAD and the DMCs that have recently undertaken the responsibility to ensure that the NMHSs use of similar statistical models is discussed and experimented within the auspices of the regional climate forums. DMC-Nairobi is currently running some trial dynamical models in conjunction with International Research Institute (IRI) through support by United States AID (USAID).

10. The process for the development and dissemination of seasonal forecasts in Africa starts with a pre-forum (typically a few weeks) at which key points and national statistics for the next rainy season are prepared and presented. This is followed by the Forum (typically a few days) which involves the presentation of the latest information on the climate system and its evaluation, elaboration of regional forecasts for the next rainy season and the presentation and discussions of the application of the forecasts on various sectors such as agriculture, hydrology, health and transport. Users from these various sectors are usually invited to participate in these Forums. Forecasters from NMHSs are directly involved in the preparation and elaboration of the forecasts. When the forecasters go back to their countries, they downscale it and disseminate the products to the users at national level. Dissemination involves appropriate interpretation to the benefit of users including national adaptation of regional products.

11. The second phase of the process involves the update of the forecasts on monthly basis and the continuous adaptation of the forecasts to the latest available information, e.g., Sea Surface Temperature (SST) on the climate system. This is followed by the evolution of the forecasts in terms of the quality of rainfall forecasts (technical evaluation) and utilization of the forecasts from the point of view of the users.

12. The forecasting methodology used in these regions involves the division of the oceans into key ocean zones Central/East Pacific (Niño 3 & 3,4 boxes), Atlantic (including the Atlantic dipole), Gulf of Guinea and Indian Ocean. The countries of Africa are also divided into subregions, namely: PRESAO for West Africa, PRESAC for Central Africa, GHACOF East and the Horn of Africa, SARCOF for Southern Africa; and PRESANOR for North Africa and this partition into subregions is based on the features of the rainy season in Africa. One model is used in each subregion and multiple regression models and stepwise predictors are selected. Quantitative forecasts are transformed into qualitative forecasts [building 3 categories (below normal, normal, above normal) using the terciles of the anomalies' distribution] and the quality of each model is evaluated using cross validation and contingency tables (observed categories versus forecast categories).

13. To arrive at a forecast agreed by the Forum (Consensus Forecast), forecasts coming from the countries are integrated, taking into account the complementary information coming from Numerical Models (coupled and forced). The forecasts are also adapted to the expected evolution of the climate system using expertise of well-known experts present at the Forum or through consultation. The outcome is a regional forecast (PRESAO, PRESAC, GHACOF, SARCOF, and PRESANOR) expressed as a probabilistic forecast for the three categories previously presented (dry, normal and wet).

14. A typical example of a seasonal rainfall prediction methodology and models used by the National Meteorological Services Agency (NMSA) of Ethiopia was presented. These are mainly based on the results of ENSO analogue methodologies. The Agency uses the Markov Chain approach to summarize large data records into equations of few curves and few shape parameters. It also uses this approach to study the effects of ENSO on Ethiopian rainfall.

15. Another methodology used in NMSA was related to the investigation of the effects of El Niño – Southern Oscillation (ENSO) episodic events on the amount and distribution of rainfall as well as dry spell lengths within the rainy seasons of Ethiopia. This information and its implications are found useful for agriculture.

16. To proceed with this study it was necessary to classify the historical rainfall data into years of La Niña (cold episode with cold/negative Sea Surface Temperature Anomaly (SSTA)), normal episode (Mean SSTA) and EL Niño (warm episode with positive SSTA) as follows:

    - Cold (La Niña): 1964,1971,1973,1974, 1975, 1988, 1998, and 1999.
    - Normal episodes: 1967, 1968, 1970, 1976, 1977, 1978, 1979, 1980, 1981, 1983, 1984, 1985, 1989, 1995, and 1996.
    - Warm (El Niño): 1965,1966,1969,1972, 1982, 1986, 1987, 1990, 1991, 1992, 1993, 1994, and 1997.

    Markov Chain was fitted into the classified years and the characteristics of the rainfall in each episode were studied. The link found between the ENSO phenomena and rainfall variability in Ethiopia was strong and not a simple statistical chance and agricultural planners should be advised to incorporate the possible effects of ENSO episodic events in their decision-makings when ENSO signal is evident.

17. Some of the existing key climate prediction models and methodologies include the following:

The International Research Institute for Climate Prediction Group provides a net assessment (or distillation) of information from a variety of climate prediction tools to arrive at an integrated forecast. These tools, include:

a) Coupled ocean-atmosphere model predictions of tropical Pacific SST covering the forecast period;
b) Statistical forecasts of Indian Ocean and Atlantic Ocean sea surface temperature developed by the IRI;
c) The response of atmospheric global circulation model (GCM) predictions to the present and predicted SST patterns;
d) Statistical analyses; and
e) Appropriate Regional Climate Outlook Forum consensus guidance.

The output of the IRI integrated forecast model consists of maps that show expected precipitation probabilities in tercile classes. The maps indicate probabilities that seasonal precipitation will fall into the wettest third of the years (top number), the middle third of years (middle number) or the driest third of the years (bottom). The output has a resolution of 2.8° and is issued twice a year.

IBIMET Group provides a short-term prediction of the onset of the growing season. The development of this methodology has followed three different steps in order to assess the onset and the development of the growing season in Mali, with a particular attention to the determination of the sowing date.

a) Step I - Utilization of the AGRHYMET Data Bank to determine the average decade for the onset of the growing season;
b) Step II - Determination of the planting date and evaluation of the crop installation using the SISP system; and
c) Step III - Operational application of the climate predictions.

The scope of the exercise is to predict the planting period for the different zones in order to provide lead-time advisories to the peasants concerning the most opportune moment to plant their crops.

Omotosho's Prediction of the onset of growing season (two Empirical/Dynamical methods used for a few years now in West Africa) is a model that uses the U-component of the wind at the surface and upper levels. It requires that the difference between the U-component of the wind at 3000m (700 mb) and that at the surface must be between 20 m/s and 5 m/s. Also the difference between the U-components of the wind at 7500 m (400 mb) and that at 3000m (700mb) must be between 0 and 10 m/s. The method gives the date of the onset of the rainy season two to three weeks ahead after the above conditions have been satisfied for three consecutive weeks. The scale of the analysis is over the Sahelian region, from the Senegal to Chad.

18. As a way forward, the meeting discussed and agreed that the use and value of the forecasts should be evaluated and new user-oriented products elaborated and adapted particularly in terms of downscaling models and model products. Existing material (statistical models, new predictors, etc.) should be consolidated and improved. The communication system with users should be strengthened and co-ordinated.

THEME II: REGULAR MECHANISMS FOR THE IMPROVEMENT AND CONSOLIDATION OF METHODS OF CLIMATE FORECASTS.

19. It was noted that seasonal climate forecasting procedures normally start with appropriate historical climate records, or a climatological database. This database (temperature or precipitation) should be 'clean' (quality controlled), complete and as long as is possible. A standard 30-year period, such as 1961-90 or longer is applied for most databases.

20. Another mechanism for the improvement of seasonal forecasts is verification of forecast skills using verification measures such as accuracy, skill, reliability or bias, resolution and sharpness. Various quantitative measures for verifying forecast skills were also presented. These include the use of contingency tables and associate scores, Critical Success Index (CSI), Heidke skill score, and Linear Error in Probability Space (LEPS).

21. Predictability depends on scale of the forecast phenomenon and the range of the forecast. It is also a function of the deterministic (error or lost of information is inherent) and probabilistic (interpretation problems likely to arise) formulation. All these lead to uncertainty in the forecast and this situation must be addressed to improve the methods and models for forecasting. Uncertainty also arises from measurements, assimilation and inadequate data representation of regions.

22. The meeting highlighted the following points regarding the issue of uncertainty and verification of the seasonal forecast:

- the verification process is an important part of the prediction process;
- the verification of the utilization and impact of the seasonal prediction should carried out;
- the feedback of user experience to the climate forecasters should be improved;
- pertinent and reliable databases at the end of verification should be established and made accessible;
- a formulation of the forecast, basically probabilistic should be considered;
- the promotion of the transformation of the probabilistic forecasts in more accessible and comprehensive terms should be encouraged (transformation in terms of scenarios or the risk incurred by the user and some associated probabilities etc).

23. For the effectiveness of all the forecast systems existing in Africa, monitoring activities represent an added value to the system analysis both because they allow evaluation of the conditions of the wet season on the agricultural and food situation as well as the conditions and the effectiveness of the early warning systems and of the mechanisms of crisis management. Several monitoring tools exist, dealing with food security and primary production in the Sahelian region. Most of them are based on the meteorological stations and the field surveys. Recently, a portion of the monitoring activities are carried out using remotely-sensed information, supposed to be more objective, near real time and validated data sets.

24. Apart from the methods mentioned earlier, the meeting recognized other season prediction products that are being utilized in and outside Africa. These include:

- ❑ numerical products from big world prediction centres such as IRI, European Centre for Medium-range Weather Forecast (ECMWF), United Kingdom Meteorological Office (UKMO); Meteo France (MF), Japanese Meteorological Agency (JMA), and National Centres for Environmental prediction (NCEP);

- statistical products, generally prepared outside Africa for example the African Desk in the USA;
- complementary products from methods including that of Cèron and Gueremy on intraseasional evolution in West Africa, and Mainguy, Cèron and Gueremy on the long rainy season in Kenya;
- monthly and decadal bulletins and products from ACMAD, DMCs and the Agrhymet Centre.

THEME III: THE APPLICATION OF CLIMATE FORECASTS AND AGROMETEOROLOGICAL INFORMATION FOR AGRICULTURE, FOOD SECURITY, FORESTRY, LIVESTOCK AND FISHERIES.

25. The meeting considered the different areas of application of climate forecasts and agrometeorological information and noted the following:

In the short-term, agrometeorological information is useful for:

a) provision of planting schedules;
b) utilization of inputs or other factors of production;
c) identification of varieties adapted to seasons; and
d) identification of dates suitable for farming under optimum conditions based on short-term meteorological predictions.

In the medium- and longer-term and for planning purposes, agrometeorological information is utilized for:

a) prevention of damage due to weather conditions and pests on harvest;
b) building a national safety stock;
c) market regulation (transfer from surplus to deficit areas);
d) food aid projections;
e) mitigation of food crises (off-season cropping); and
f) plan fodder harvest.

26. The applications of climate forecasts and agrometeorological information for agriculture, food security, forestry, livestock and fisheries are common in food security systems. These include:

i) The AGRHYMET SISP, which aims to use and integrate different information sources and different analysis procedures to allow the meteorological services to monitor the growing season on a decadal time scale and provide national early warning systems with useful information about the evolution of crop conditions. The modular structure used allows the meteorological services to provide agroclimatic characterizations, season monitoring, crop growth assessment and yield forecasting based on the most common and easily obtainable agrometeorological parameters.

ii) Diagnostic Hydrique des Cultures- Champs pluviometric system uses remote sensing data and information (cold cloud duration, maximum and minimum temperatures) to develop and correlate the seasonal forecast on the 1st of August with the estimation of various crop yields.

iii) WFP-Vulnerability Analysis and Mapping is typically undertaken in the following three stages:

a) Identifying the important income sources for each population group;
b) Analyzing the casual structure of vulnerability to understand why particular population groups are vulnerable;
c) Reconciling the analysis of risk and coping capacity across income sources into an overall analysis of current or chronic vulnerability conditions.

iv) FAO- Global Information and Early Warning System is designed with the goal to provide policymakers and policy-analysts with the most up-to-date and accurate information available on all aspects of food supply and demand. In doing so, it provides regular bulletins on food crop production and markets at the global level and situation reports on a regional and country-by-country basis.

v) USAID FEWS-net uses a survey system whereby the mode of acquisition of food and cash income and how these are spent in most years is assessed to determine the survival of the communities and their vulnerability in the years. Hazard data and information (wars, droughts/floods, change is policies, fluctuations in production levels and markets, etc.) are also collected. The vulnerability and hazard information are then put together to determine impacts of a hazard on the communities.

27. The Malian Pilot Project was presented as a typical case study. Mali utilizes agrometeorological information and warnings to improve agricultural production by about 20 to 25%. The Multi-disciplinary Working Group (MWG) of Mali is mandated to collect, analyze, elaborate and disseminate agrometeorological information and warnings to users. The information and warnings are directed to decision–makers, national and international organizations in-charge of early warning and food security. For improvement of agricultural production, the information provided goes to farmers for the planning of their daily agricultural activities. The purpose and type of agrometeorological information and warnings issued are as follows:

i) For Food Security:

a) Decadal agro-hydro-meteorological bulletins that give the evaluation of the cropping season;
b) Rainy season characteristics to determine risk zones;
c) The vegetation development front to monitor the evolution of pasture and water points.

ii) For agricultural production:

a) Evolution of agroclimatic resources (rainfall, start, end and length of the season etc.); and

iii) Operational applications:

a) Provisional sowing calendar that allows farmers to sow on the basis of a rainfall threshold, and a given crop variety;
b) Daily weather forecast that allows farmers to plan their daily activities;
c) Seasonal forecasts that help meteorologists prepare a provisional calendar in relation to the start of the rainy season.

The socio-economic advantages of the application of agrometeorological information and warnings depend largely on the quality of the information provided, its dissemination in real time and correct use by farmers.

THEME IV: THE ESTABLISHMENT OF NEEDS FOR CLIMATE FORECASTS AND OTHER AGROMET INFORMATION FOR AGRICULTURE BY LOCAL, NATIONAL AND REGIONAL DECISION-MAKERS AND USER COMMUNITIES

28. An "end to end" scheme was proposed as a good guideline for understanding the value of activities in the fields of data, research, education, training and extension and policies, for the design of agrometeorological services for end-users. The main bottlenecks appear to be:

    (i) insufficient considerations of the actual conditions of the livelihood of farmers;
    (ii) developments of inappropriate support systems.

29. The scheme has the support systems: data, research, education/training/extension (e, t & e) and policies, of purely supportive nature. This support, in turn, should be carried out by the right mixture of knowledge pools through appropriate activities. As a consequence of the inadequate knowledge of the conditions that actually shape the livelihood of farmers, we have too often:

    (i) insufficiently taken into account local adaptive strategies,
    (ii) not made the right choices in the use of contemporary science, and
    (iii) indeed not understood the overwhelming effect of inappropriate policy environments.

30. The social concerns and the environmental considerations (user needs) that are at stake need the scientific support, as well as the understanding of what is actually possible and of the very conditions in the livelihood of farmers. All agroclimatological information that can be directly applied to try to improve and/or protect agricultural production, such as yield quantity and quality, while protecting the agricultural resource base from degradation, are considered to belong to such services.

31. General weather forecasts for agriculture provide information to the farmer so that he could make his own operational decisions. This special type of advice is given in advisories issued by agrometeorologists in cooperation with agricultural extension workers and these advisories may recommend implementation of certain practices or the use of special materials to help effectively halt or minimize possible weather-related crop damage or loss.

32. The agrometeorological services or a multi-disciplinary group of experts carries out the quantitative and qualitative evaluation and forecasting of the condition, growth, development and yield of pastures as well as provision of advisories on the state and productivity of stockbreeding. The functioning of the whole system obviously depends on the establishment of close interaction between agrometeorological observers, telecommunication experts, programmers, agrometeorologists and other experts.

33. In a typical case study in Guinea, the following users' needs on agrometeorological information were established by a survey:

    a) Department of Agricultural Services
        - Agricultural Calendar
        - Seasonal Forecast
        - Study on rainfall and water balance

    b) Department of livestock services
    Pastoral monitoring and environmental degradation

- Modelling on livestock disease in function to climatic elements
- Rainy season monitoring (start, duration/intensity)
- Monitoring the quality and quantity of biomass

c) Forestry Department
- Weather forecast and fire outbreaks
- Reinforcement of rainfall stations and regular dissemination of agrometeorological information

d) Fisheries Department
- Forecast of marine meteorology for the security of fishermen
- State of the sea and forecasting of strong winds

e) Guinean Society of Palm Oil (SOGUIPAH)
- Study of wind
- Study based on NDVI and other elements of the climate

f) Cotton Project
- Rainfall and solar distribution
- Develop modules for yield forecasting
- Determination of the start of the season
- Reinforcement of the rainfall stations

34. The Senegalese case study showed that the Centre for Ecological Monitoring (CSE) developed a model for the determination of risk zones for rain-fed crops. This model uses the images of rainfall estimation and normalized difference vegetation index (NDVI) as input data. The relative areas of monitoring are vegetative production, cropping season and bush fires.

35. During the cropping season, risks zones for rain–fed crops are identified using very advanced technology tools: satellite images, computer models. Geographic Information System (GIS), computerized data banks.

36. The modules are composed of two principal modules. The first module produces maps that can characterize the installation phase of crops using rainfall estimation images. The second module uses NDVI and produces different maps and temporal profiles related to Vegetation Condition Index (VCI), which is a particular index, effective in determining the impact of meteorological factors on vegetative growth.

37. The results allow making warnings in the season (start of August) to the governmental authorities and development partners in providing them with information on the installation of the cropping season. The output data is maps of vegetative index, sowing dates, re-sowed zones, decades of first sowing, duration of the period favorable to crop growth, limited dates for sowing.

38. During the year 2002 / 2003, the application of the module showed an early installation of the rainfall in much part of the country in the month of June. The season started with good hopes, but a long dry spell (more than one month) affected the crop growth.

39. A Pilot Project was implemented in The Gambia in 1988 to define user needs. The long-term objective of the project was to contribute to the enhancement of agricultural production by encouraging the farming community to use agrometeorological and hydrological information in carrying out production-related activities on the farm.

40. Forecasts and warnings on the abnormality of the rainy season and the possible occurrence of dry spells were issued. Information on the probability of the start of rains and on optimum planting dates of various crops and varieties were also issued. Results from the basic analyses revealed a highly significant response of crops to fertilizers and timely agrometeorological practices. Increased percentages of 13 and 23 in actual millet yields were registered at Pirang in plots where agricultural and agrometeorological inputs were applied as compared to the farmer's plots where these were lacking.

41. The trial showed that climate forecasts and agrometeorological warnings can only achieve their full value if conceived, executed and applied in close and continuous cooperation with the ''users''. Thus, successful policies require precise information on the weather and how it affects harvests. Unfortunately, the extension phase did not take off due to lack of continued donor support.

THEME V: OPTIMUM MEANS OF DISSEMINATING CLIMATE FORECASTS AND THE MEDIA FOR TRANSMITTING CLIMATE FORECASTS AND OTHER AGROMETEOROLOGICAL INFORMATION TO USERS

42. The meeting agreed that effective method of communicating forecasts to farmers requires sufficient knowledge about the farmers and users in the agricultural industry. For that matter disseminators of climate information must realize that they are dealing with a highly perishable product. A delay of a few days may mean disaster as farmers fail to plant their crops in time. There is, therefore, need to devise means of getting the products to the consumer-farmers and other end-users as fast as possible.

43. The communities cannot easily assess information about the climate forecasts that is produced by the Meteorological Services because meteorologists are not qualified to communicate at the community level where the information is needed most in Africa. The language that these forecasts are written is in most times the official language (English, French, Arabic, etc.) used in the individual countries. Yet very few of our people speak and understand these languages.

44. In order for communication to be effective, it should be able to influence decision-making by the farmers. The following are considered very crucial in influencing decision-making of the farmers:

- Scientists need to stop writing to themselves and go the extra mile to write products that can be consumed by the ordinary people;
- Forecasts and advisories should be translated into local language to allow participation from the broader community;
- Forecasts and advisories must be localized to make them relevant to cropping calendar of the community;
- Forecasts and advisories need to have an economic value attached. What are the economic benefits that will accrue in planting, weeding, harvesting, storage or moving livestock at a particular time?

45. Achieving the communication goal would require understanding the forecasts by all the people in the communication chain, understanding and downscaling the advisories, and understanding the rural livelihoods and their priorities; understanding the traditional forecast systems, and understanding the local languages that are used to convey the information contained in the forecasts and advisories.

46. A case study on Mali was presented. The quality of all communication networks depends on the capacity of the providers to properly formulate the message, and receivers to understand the message, which is transmitted to them. In this direction, the Meteorological Service of Mali started by training staff in communication terminologies and organizing study tours for them in Mali, France and Morocco. Speakers of the local languages and journalists have undergone several training sessions, generally organized in the form of workshops and completed by Meteo-Media days. Open Days were organized where exchanges between communicators and meteorological staff were carried out. This is to make possible the understanding of the contents of the meteorological bulletin whilst preserving its scientific values.

47. The Malian media disseminates two types of meteorological information, the daily forecast and the decadal advice to farmers. The daily weather forecast by the press remains timely, and is published from Monday to Friday.

48. The Decadal Agro–hydro-Meteorological Bulletin is established by a Multi-disciplinary Working Group and is disseminated in two ways:
    I. By post addressed to technical services, administration and development partners;
    II. By the press (Radio, Television, New papers).

49. The summary of the bulletin is broadcast in all national languages and in French on its first day of publication and the whole content is broadcast on the Friday of the same week. The bulletin is transmitted from the meteorological centre to the national and the private radios and the television by facsimile, and copies are sent to communicators in national languages. Telephones are also used to ask for forecasts when they are late. Letters from listeners and viewers, particularly farmers, are read during the programme called “A Ni Cié” (Greetings to workers). It consists of the rainfall and the state of crops some times a farmer will indicate the presenting qualities of a presenter on TV.

50. The success of any development project depends on the mobilization capacity of its actors or partners based on information not only for its quality, but also through a viable circulation network of this information. There must be a horizontal communication between the meteorological service and the technical structures (radio, television, press) and the Directorate of Agriculture) and also a descending and ascending communication between farmers and these structures served by the media and other adapted supports.

THEME VI: MEANS OF ACHIEVING BETTER RECOGNITION OF THE VALUE AND BENEFITS OF CLIMATE FORECASTS AND AGROMETEOROLOGICAL INFORMATION DISSEMINATED TO USERS

51. The meeting recognized that for a user of climate forecasts and agrometeorological information to be satisfied with the products received, he or she must realize some economic value. The product must be based on routine operations and be responsive to the specific requirement of the user. With time, the user builds confidence in the products if they serve the purpose and are received on a timely basis. The products should be available for risk analysis and in good time to satisfy planning purposes. It is only when these conditions (availability, confidence, user-needs) are met will the services be of value to the user. The user then recognizes the value of the services and will always look towards new products. Also, the products are more recognized if they are simple, user-friendly and customized to user-requirements.

52. An example of a product that has a high degree of user satisfaction is the monthly service provided by Envirovision in the “Maize Vision” programme in the Republic of South Africa (RSA). Maize vision provides an integrated analysis of the current status of the global climate situation and its effect on maize production in RSA. The current SOI is applied locally to a typical maize production system in South Africa via a crop growth simulation model using climate scenarios. These predicted yields are used together with the current trends of economic indicators (e.g. maize price/exchange rate (Rand to US $) etc) to allow the producers to make informed / educated decisions regarding the on-farm operations such as planning for the new season and planning for the following month.

53. It was noted that the value of the services provided would depend on the frequency, the convenience of its use, and the availability of the forecast. The availability would depend on the means by which it is communicated either through radio, television, print media, telephone or telefax or other means. The value of the services also depends on the confidence the user has in the supplier of the forecast and whether it is tailored to meet the specific needs of that user. An example of a valuable service provided by the agrometeorologists in South Africa is that of the estimation of the maize crop during the growing season. At present there is a project running which aims at improving the estimate using advanced stratification modelling and new Landsat imagery. This is an example of tailor-made produce, which has been developed together with the user over many years and evolved into something of very high value to the maize industry in RSA.

54 It was further noted that recognition, value and confidence could be achieved or influenced by:

a) Track record/credibility (success/disaster stories);
b) Strategy to develop new products (tailor-made forecast for specific users);
c) Response to user needs/demands (market requirements, formats of forecasts, and response time to requests);
d) Forecast services not limited to National Meteorological Services but in partnership with industry); and
e) Use of media (according to public demand, various formats (prints/radio/TV), local language, etc.).

55. Improvement of user perception on the services provided is possible and must be made through targeting and involvement of the users. Economic value is one way to persuade the users when impact assessment is possible. Skill assessment of the forecast is one fundamental way to demonstrate the usefulness of the forecast and this should be encouraged.

56. In considering ways of achieving better use of climate forecasts and agrometeorological information by users, the meeting also noted the following:

- Users vary in their capacities to understand information that is potentially useful to them. They differ in the levels of basic literacy and information is most effective if it meets the users at their own level. They also differ in the kinds of information that is most useful given their particular situations, and in some situations, the effectiveness of the information depends greatly on other conditions.

- When information reaches the users is of great importance for decision-making. Lead-time is a very important factor. The usefulness of a climate forecast may also depend on how frequently it is updated and how well users understand the implications of updating. In this regard, climate scientists or agrometeorologists should work closely with agricultural extension officers, who will downscale and interpret the information and then pass it onto farmers.

- Participatory approaches to delivering climate forecasts might include structured dialogues between climate scientists and forecast users to identify climate parameters of particular importance to users and the organizations that the users might rely on for climate forecast information. Such dialogues might assist in establishing communication channels and improve mutual understanding.

- Information on the behaviour of the weather or weather related parameters is more acceptable when combined with mitigation or preventive strategies. For example a frost forecast can be combined with frost prevention mechanism and a forecast of drought with ways of conserving soil moisture.

- It is very important to educate the climate scientists and the agrometeorologists on how to package, disseminate and market the information to the users. The users must be educated on the value and cost benefits of applying the information disseminated to them in their operations. The users must also be trained on how to analyze, summarize and interpret the information they receive so that they can derive maximum benefit.

- The typical information disseminating systems such as the distribution of written material, television broadcasts, Internet and so on, are oriented primarily for the educated and the rich farmers. The information distributed through these channels does not normally reach the less-educated, elderly, people with low incomes and those without power. These constraints can be overcome by disseminating the climate forecasts and agrometeorological information through the people who are known and trusted by the marginalized groups, including their social networks.

Conclusions

1. The meeting concluded that climate information required for agricultural activities vary from one application to another and sometimes from one region to another. The required information at the farm level include: the onset and cessation of rains, amount of rainfall, duration and distribution of wet, dry, cold/warm spells, mean, maximum and minimum temperatures and other extreme weather/climate events. It was noted that farmers are very conscious of their needs and that they always take advice to their advantages. However, they do not take advice or messages when the risks involved are high or the messages are in a form not acceptable to them.

2. The meeting agreed that seasonal forecasting is in high demand. However, so far, it is not widely used by farmers because such forecasting is at an experimental stage and there is no appropriate link with early warning systems and farmers. It is used only by decision-makers in some countries. Most of the methods for rainfall prediction in Africa have not addressed the important issue of the onset rainfall and do not give consideration to the first few weeks after sowing or planting, which are extremely critical for crop growth and establishment. The capability to predict the cessation and, hence, length of the rainy season, the expected annual or seasonal and monthly rainfall amount as well as the dry spells between rainfall episodes is currently very limited. The meeting noted that most of the models used in Africa are largely statistical and efforts to develop the capacity of National Meteorological and Hydrological Services (NMHSs) to use these statistical models in the subregions of Africa have been undertaken by ACMAD and the DMCs within the framework of the regional climate forums.

3. It was recognized that dynamical models are often very complex and require very high computing power. These models, including regional models, are available at few climate centres of the advanced countries. Apart from South Africa and few others, many countries in Africa rely largely on the advanced centres regarding GCM products. There is inadequate capacity to interpret and verify the skill of such models in the Region. This is a serious challenge to ACMAD and the DMCs, and other regional centres. The meeting was informed that DMC-Nairobi is currently running some trial dynamical models in conjunction with IRI through support by USAID.

4. The meeting noted the difficulty to come up with user-tailored or specific forecast due to different needs of farmers and encouraged efforts to develop new products. It agreed that for Africa, one should make use of the farming systems database on the techniques used by farmers. Existing projects such as the CLIMAG being implemented in West Africa should also be exploited.

5. The meeting expressed its satisfaction with the implementation of the Mali pilot project and noted that it was a success story because all stakeholders of the process deriving and using the agrometeorological information/services were involved at all stages of the project. It also enjoyed continued donor support. The rural population was very organized and the coordination of the process was not interrupted.

6. Climate forecasts and agrometeorological information are only useful if the recipients of the information use it to improve their production and operations. The information should be disseminated using all means possible so that it reaches all the users and with enough lead-time to influence decision-making.

7. The meeting discussed the Ranet project, designed specifically to address information access and support for rural communities. It is intended to improve technical capacities and networks of national hydro-meteo service and extension agencies so as to provide vital information to farmers in local languages. The Ranet system disseminates information and products in audio, graphics, text and video form (i.e. multi-media). It is a new information and communication technology for the rural areas, which is now being tested in pilot projects in Senegal, Niger, Chad, Uganda, Zambia and Kenya. The meeting took note of the positive results so far obtained in these projects and felt that continued efforts should be made to introduce Ranet to the other countries in Africa.

Recommendations

The meeting took note of the advances made in the science of climate prediction and agrometeorological science and discussed the challenges facing Africa to translate these opportunities into real benefits for the farming and local communities. In order to meet the challenges and pave the way forward, the meeting made the following recommendations, directed mainly to WMO, NMHSs, Specialized Climate Centres (SCCs), Scientists, Universities/Research Institutions (U/RIs) and donors:

(i) Build regional capacity for climate modelling and prediction, especially the downscaling of information for agricultural uses and addressing issues related to dynamical and probabilistic products, especially with respect to the specific requirements of users such as amount of rainfall, onset date, wet/dry spells etc. that are required by many users. Promote the development of climate/weather-agro models and new products of climate forecast, bearing in mind the needs expressed by farmers; (Action: WMO, SCCs, NMHSs, U/RIs)

(ii) Encourage the merging of various methodologies such as those presented by Maracchi, Omotosho and Baddour to advise the farmers on the onset of growing season, the sowing date, the rainfall distribution and amount and the length of growing season through the combination of various tools, crop models, seasonal predictions, climatic analyses, ITCZ position, etc.; (Action: SCCs, U/RIs, WMO, NMHSs)

(iii) Promote the use of these methodologies through the utilization of the data and products available on the Internet and also through the Website of CAgM for the Agrometeorological Bulletin. Validate the methodologies within the context of activities of CCl and CAgM and particularly in the OPAGs on agrometeorological and climatic information applications; (Action: WMO, SCCs, NMHSs, U/RIs)

(iv) Provide the results from models or researchers to users and involve them in the validation, verification and evaluation processes. Adaptation strategies should be developed for the provision and practical use of seasonal forecasts, and meetings should be organized to encourage the exchange of experiences on these issues; (Action: SCCs, NMHSs, U/RIs)

(v) Test the accuracy of the seasonal forecasts for agriculture and analyse the positive and negative effects. Give technical support to ACMAD Centre, DMCs and other centres to test methods of climate forecasting (dynamic and hybrid) before adapting them to particular conditions of the African climate; (Action: SCCs, NMHSs, U/RIs, WMO)

(vi) Reduce uncertainty by performing several forecasts starting from the same initial time but using slightly modified values of the parameters of the simulation; looking at the dispersion of the parameters as a function of the time integration and describe the encountered value distribution rather than the values themselves; using confidence indices with a more or less high value; and including the uncertainty inside the statistical tools; (Action: SCCs, NMHSs, U/RIs)

(vii) Conduct surveys to identify specific products tailored to users. Only very specific forecasts geared to the actual conditions and the most serious problems of farmers, and delivered in plain and simple language, have a chance to be accepted and used by farmers; (Action: SCCs, NMHSs)

(viii) Encourage a regional approach for the development of effective agrometeorological services and ensure that adequate consideration of policies in favour of local communities is given. It is crucial to take into account the conditions that actually shape the livelihood of farmers and the local adaptive strategies; to make the right choices in the use of contemporary science and to understand the overwhelming effect of inappropriate policy environments; (Action: WMO, SCCs, NMHSs)

(ix) Promote the merging of the best practices and methodologies of the current Early Warning Systems (AP3A, FEWS, GIEWS, WFP, SISP, ZAR), taking into account the needs of decision-makers and the operational limitations such as data, personnel, financial resources; (Action: SCCs, NMHSs, U/RIs)

(x) Improve the algorithms of rainfall estimation by satellite and put them at the disposition of National Meteorological Services to complete the data gaps to run the models and for the monitoring of the cropping season; (Action: SCCs, NMHSs, U/RIs)

(xi) Promote the use of geographical information system (GIS) and the development of new remote sensing products, taking into consideration the needs of end users. Ways and means should be studied on how to adopt in other countries risk zone determination models and vegetation monitoring developed in Senegal by the Ecological Monitoring Centre (CSE); (Action: SCCs, NMHSs, WMO)

(xii) Introduce training on seasonal forecasting in the programmes of meteorological and hydrological schools (IMTR, AGRHYMET, EAMAC, etc.) to develop and sustain the competence in the meteorological services and improve the training activities also under the RMTC on the best utilization of the data and related methodologies on Internet; (Action: SCCs, U/RI, NMHSs, WMO)

(xiii) Create a Multi-disciplinary Working Group in each country to analyze the meteorological information before its distribution to end-users. Invite intermediaries such as rural journalists, extension workers and representatives of farmers associations to expert meetings on the applications of climate forecasts. Appropriate feedback mechanisms should be designed regarding the implementation of the advisories given; (Action: NMHSs, WMO)

(xiv) Develop partnerships with users and identify or form a network of stakeholders in the agricultural production chain as a way of adding value to the advisories. Crop, animals, fisheries, construction, health, water, transport, marketing and other sectors that identify with the products need to be linked; (Action: NMHSs, WMO)

(xv) Carry out a massive awareness campaign targeted at the public, policy makers, politicians and, above all, the front line agricultural worker and the peasant farmer. Carry out self-evaluation/assessment and try to achieve excellence by improving and introducing better products and encouraging continuous change; (Action: NMHSs, WMO)

(xvi) Develop a strategy of targeting students from an early age; primary schools are an ideal entry point. The pupils are the farmers of tomorrow but they also speak daily with their farming parents; (Action: NMHSs, WMO)

(xvii) Consider the possibility of launching a pilot applications project, funded by international/national institutions dealing with the application of climate forecast to agriculture in order to address the challenges regarding the effective use of all the methodologies already existing; (Action: WMO, Donors, SCCs, NMHSs)

(xviii) Since Mali was a success story, the group strongly recommended that a post-evaluation of the Mali experience be made to:

- Identify key areas of success in terms of scientific, structural, organizational, economical and societal aspects;
- Identify difficulties encountered during different stages of the project;
- Build a database designed for capitalizing on the experience.

The outcome of the post-evaluation will serve as inputs for the development of scenarios for projects similar to that of Mali to be implemented in other African countries. The post evaluation will not re-evaluate the direct outcome but rather the lessons derived and capitalize on the experience; (Action: WMO, Donors, SCCs, and NMHSs)

(xix) Encourage the active participation of the intermediaries in the implementation of pilot projects on the applications of climate forecasts and agrometeorological information to agriculture; (Action: NMHSs)

(xx) Develop an African training programme on communications to get the best products to the end users. The target communicators (intermediaries) include journalists, meteorologists, and agriculturists, extension agents and NGOs; promote the most feasible means of disseminating information and products including radio, television, and news paper to the rural communities giving special emphasis to new and affordable technologies such as Ranet (Action: WMO, Donors, SCCs, NMHSs).