CARIBBEAN AGROMETEOROLOGICAL INITIATIVE (CAMI)

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Applicant: Caribbean Institute for Meteorology and Hydrology (CIMH)

Partners: Caribbean Agricultural Research and Development Institute (CARDI)
World Meteorological Organization (WMO)
National Meteorological/Hydrometeorological Services of – Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St. Lucia, St. Vincent, Trinidad and Tobago.

Objective(s)

The overarching objective of the Action is to increase and sustain agricultural productivity at the farm level in the Caribbean region through improved applications of weather and climate information using an integrated and coordinated approach.

The issue of food security is a very important issue for all the governments in the Caribbean region, especially during the current times witnessing several challenges to agricultural production. Agricultural growth contributes directly to food security, but it also supports poverty reduction and acts as an engine of overall economic growth in the Caribbean region. Agricultural sector in the Caribbean region is declining in relative importance, both in terms of its contribution to GDP and its share of the labour force and this is inevitable in the region which experiences economic growth. Nevertheless, a good proportion of the economically active population is still involved in agriculture in the Region and agricultural employment is especially important for the livelihoods of the poor.

The Caribbean region is vulnerable to a wide range of natural hazards, ranging from catastrophic events such as floods, droughts, and tropical cyclones to pests and diseases in plants, animals and humans. Especially in poor rural areas, these disasters cause much suffering, infrastructure and environmental damage, aggravate food insecurity and slow down or even reverse development gains. Land degradation is a threat to natural resources with direct consequences on food security, poverty, and environmental and political stability. Climate variability, climate change and land degradation are intimately linked and are generating unexpected effects eg., an increased occurrence of extreme weather conditions in the Caribbean region.

Weather and climate information is of critical importance in the decision making process for agriculture, water resources management, and environmental conservation in the Caribbean region. The specific objective of this Action is to assist the farming community in the Caribbean region through provision of information on predictors of the rainy season potential and development of effective pest and disease forecasting systems for improved on-farm management decisions; preparation and wide diffusion of a user-friendly weather and climate information newsletter and organization of regular forums with the farming community and agricultural extension agencies to promote a better understanding of the applications of weather and climate information and to obtain feedback to provide better products from the meteorological services for use by the farming community.

Relevance of the Action

The Caribbean islands vary in population, size, income and ethnic composition, but they all share a common heritage in agriculture. In the past, the economies of the Caribbean islands were based on cultivation of tobacco and cotton, but were later transformed to sugarcane-based economies. Although the importance of tourism increased over the years as the main economic activity in most of the islands, agriculture continues to make an important contribution to the GDP of the islands.

Statistics on land use, contribution of agriculture to GDP and the percentage of population employed in agriculture in the Caribbean region show that percentage of arable land varies from as low as 2.4% in Guyana to a high of 37.2% in Barbados. Agriculture is an important sector of economy in countries like Guyana where it contributes to 35% of the GDP. In Belize and Dominica, agriculture contributes to 18% of the GDP. In Grenada, agriculture has been the largest revenue producer. The percentage of population employed in agriculture ranges from 40% in Dominica while in Belize, Grenada, Jamaica, St. Lucia and St. Vincent it varies from 21 to 27%.

A range of crops are grown in the Caribbean islands, the most important of which are sugarcane, bananas, vegetables, cocoa, cotton and citrus. Most of the farms are small with about 4 ha or less. One consequence of the small farm size is that production tended away from plantation crops of sugar and cotton towards a varied system of fruits and vegetables to reduce food imports for the local market and tourist industry.

The agricultural sector in the Caribbean faces a number of serious problems and is generally on the decline in most of the Caribbean islands. Agriculture's inability to keep pace with other sectors of economy or population growth has forced an increase in food imports. The problems facing the agriculture sector include: inefficient production and falling yields of sugarcane; slow traditional farming methods, including slash-and-burn methods which still dominate most of the farms; serious soil erosion in the mountainous islands; slow technological advances, diseases and shortage of inputs for banana cultivation; and lack of appropriate and timely dissemination of weather and climate information to promote sustainable agriculture.

Weather and climate affect agricultural production in the Caribbean significantly. The rainy season coincides with the disastrous summer hurricane season and these hurricanes cause much damage. For example, in 2004 Grenada's agricultural sector suffered almost US $ 40 million in losses with damage to the nutmeg sub-sector affecting the approximately 30,720 persons it directly and indirectly employed, about 30 % of its population. Rainfall variability results in droughts and floods with significant impacts on agricultural production. Drought in 1999 to 2000 in Jamaica resulted in crop losses of approximately US$6 million, whereas flooding in Guyana in 2005 caused 59.5 % GDP in total losses with US $55 million from agriculture alone.

Climate change is likely to exacerbate the impacts of natural variability and its extremes. IPCC AR4 has suggested reduced rainfall and more frequent droughts in the future, accompanied by more frequent episodes of high intensity rainfall which can lead to flooding. Recent research has also suggested that there is likely to be more major hurricanes (particularly categories 4 and 5) in the Atlantic. Hence it is important to raise the awareness of the farming community in the Caribbean region through provision of information on climate change impacts to their production systems.

Application of the outputs of technological developments in the monitoring and applications of weather and climate have allowed a noticeable increase in agricultural productivity in several regions around the world and have become a key element for mitigation and prevention of natural disasters. Despite the great impact of climate variability on agricultural productivity in the Caribbean countries, agrometeorological applications in this region have progressed at a relatively slower pace compared with other parts in the world. Agrometeorological services, especially the bulletins and advisories based on the production and use of weather and climate information, are needed by farmers in the Caribbean countries to make operational decisions related to crop and soil management. These would include predictors of the rainy season potential in different Caribbean countries; interpreting the

climate predictor and near-real time weather information for improved management decisions, especially irrigation scheduling, for the important crops in the different Caribbean countries; and developing an effective pest and disease forecasting system in the Caribbean region through improved crop monitoring and use of modelling approaches. Agrometeorological applications could be improved in the Caribbean region and this Action addresses the provision of agrometeorological services needed in different countries through an integrated approach.

Given the small size of the countries in the Caribbean, there is a lack of trained manpower to provide agrometeorological services and applications on an individual country basis, but through a concerted regional approach, such services could be made available to the farming community. Hence this action emphasizes the promotion of an integrated approach to sustainable development in the Caribbean region through coordination and networking of the limited meteorological services available in the region (Axis 1). The Caribbean Agrometeorological Initiative would establish close contacts with the Agrometeorology Division of the World Meteorological Organization (WMO) and with Global Producing Centres of Long-range Forecasts. The Caribbean Institute for Meteorology and Hydrology (CIMH) will coordinate these networking efforts on behalf of all the Caribbean countries. The action also emphasizes training of personnel of the Meteorological and Agricultural services in relevant aspects of agrometeorology. Capacity will also be built in the research institutes (CIMH, CARDI) through working with international scientists and attachments at cutting-edge international institutes. The regional research institutes will expand the experience and knowledge gained in the region.

The target groups of this action are the farming community and agricultural extension agencies in the Caribbean region. The final beneficiary is the whole farming Community in the Caribbean Region estimated at about 1.4 million.

The specific problem addressed by the Action is the timely and adequate provision of weather and climate information to facilitate operational decisions by the farming community in the Caribbean region. One of the major constraints faced by the farming community in the small islands is the lack of even simple newsletters on weather and climate information due to inadequate personnel and services at the individual country level. Hence there is a critical need to provide this information on a regular and timely basis.

This Action addresses this critical need through coordination and networking at the level of the Caribbean Region (Axis 1) with linkages to international networks providing climate services and management of research activities (Axis 3).

This emphasis on a combination of axes in this Action is quite relevant for the Caribbean region with small island countries with limited human and technical resources at the national level, but through adequate networking and pooling of the resources and through effective coordination of research activities amongst the national and regional entities, the needs of the entire farming community in the Caribbean region could be addressed. This can be accompolished by bringing the NMHSs together under the auspices of the CIMH and by accessing the climate services provided by the international networks under WMO.

The promotion and strengthening of the network of agrometeorological services and research in the Caribbean region by interlinking the NMHSs; the “Centres of Excellence” such as the CIMH and CARDI (which is the Caribbean branch office of the Technical Centre for Agricultural and Rural Cooperation, CTA); and the national agricultural research and extension services; and the civil society, this Action addresses the issue of Support to Coordination and networking in applied research (Axis 1). By collecting, sharing and analyzing weather and climate information and by using the latest models and tools to develop applications for improved management decisions, especially irrigation scheduling and pest and disease management for the farming sector, this Action addresses the issue of Support to Instruments for collaborative research (Axis 2).

Description of the Action and its effectiveness

Background Information

At the WMO/FAO Seminar on the Application of Climate Data for Desertification Control, Drought Preparedness and Management of Sustainable Agriculture in the Caribbean Region held at the Antigua and Barbuda International Institute of Technology in 2004, several brainstorming sessions were organized with meteorologists and agriculturists from the ten Caribbean countries including Antigua and Barbuda, Barbados, Belize, Dominica, Grenada, Guyana, Jamaica, St Lucia, St Vincent and the Grenadines and Trinidad (Table 1) to discuss the important services needed by farmers in their countries and the critical issues related to the production and use of weather and climate information in the Caribbean region. Discussions centered on how agrometeorological applications could be improved in the region. Agrometeorological services needed in different countries were identified and prioritized (Table 1) by the participants (Appendix 1). This information is still current as these issues have not been addressed.

Table 2. Agrometeorological Services needed and their priority ranking for different Caribbean countries

Country	Type of service needed*					
	1	2	3	4	5	6
Trinidad	3	5	6	2	1	4
Belize	4	5	6	3	1	2
St Vincent	5	1	6	2	4	3
St Lucia	3	6	5	2	4	1
Dominica	2	5	6	1	4	3
Grenada	6	5	4	2	3	1
Jamaica	4	2	6	5	3	1
Guyana	1	4	6	3	2	5
Antigua	5	6	4	2	3	1
Average	3.6	4.3	5.4	2.4	3.0	2.4

* 1) Seasonal to inter-annual climate forecasts; 2) When and how much water to apply;
3) Forecasting crop pest and disease incidence; 4) User-friendly weather and climate information;
5) Research studies; 6) Improved awareness of the economic value of agrometeorological information

Overarching Objective and the Purpose of the Action

The overarching objective of the Action is to increase and sustain agricultural productivity at the farm level in the Caribbean region through improved applications of weather and climate information using an integrated and coordinated approach.

Human-induced climate change, and increasing climate variability, as well as other environmental issues such as land degradation threaten the ability of the Caribbean nations to meet the needs of its populations for food. To address these challenges, it is important to integrate the issues of climate variability and climate change into resource use and development decisions. Decreasing the vulnerability of agriculture to natural climate variability through a more informed choice of policies, practices and technologies will, in many cases, reduce its long-term vulnerability to climate change. For example, the introduction of seasonal climate forecasts into management decisions can reduce the vulnerability of agriculture to floods and droughts.

Catastrophic events like droughts, floods and cyclones, spatial and temporal changes in important weather parameters like rainfall, temperature, wind, cloud cover, humidity, etc. effect crop yields by influencing farmers' decisions about selection of cultivar, use of inputs, crop management practices, etc. Short-range forecasts are normally available one day in advance, but modern agricultural practices such as sowing of weather-sensitive high yielding varieties, need-based application of fertilizer, pesticides, insecticides, efficient irrigation and planning for harvest require weather forecasts with higher lead time which enable the farmers to take ameliorative measures. Thus, for the agricultural sector, location-specific weather forecast in the medium range (3 to 10 days in advance) is very important. These forecasts and advisories should be made available in a language that farmers can understand.

The purpose of this Action is to assist the farming community in the Caribbean region through provision of information on predictors of the rainy season potential and development of effective pest and disease forecasting systems for improved on-farm management decisions; preparation and wide diffusion of a user-friendly weather and climate information newsletter and organization of regular forums with the farming community and agricultural extension agencies to promote a better understanding of the applications of weather and climate information and to obtain feedback to provide better products from the meteorological services for use by the farming community.

Outputs and expected results

Improved ability of policy makers and extension agencies in exploiting the rainy season potential fully through strategic decisions and better preparedness strategies in case of a high probability of occurrence of extreme events.

Improvements in the ability to forecast climate variability based on the advances in our understanding of ocean-atmosphere interactions over the past two decades offer opportunities to develop applications of the seasonal-to-interannual climate predictions in the agricultural sector to deal more effectively with the effects of climate variability than ever before. The Action aims at taking advantage of current climate data bases, increasing climate knowledge and improved prediction capabilities to facilitate the development of relevant climate information and prediction products for applications in Caribbean agriculture to reduce the negative impacts due to climate variations and to enhance planning activities based on the developing capacity of climate science. Better knowledge of rainy season potential ahead of the rainy season could help policy makers and extension agents to prepare strategic decisions and appropriate preparedness strategies. CIMH has the necessary expertise and tools available to predict the rainy season potential. A publication on the climate prediction products for applications in Caribbean agriculture based on the research carried out on exploiting the rainy season potential is envisaged.

Better informed farming community regarding the climate situation before and during the crop growing season

Agricultural production is highly dependent on weather, climate and water availability, and is adversely affected by weather- and climate-related disasters. Farmers in the Caribbean region are increasingly demanding information on specific events such as the start of the rainy season and the occurrence of dry spells. When farmers receive the climate information in time and are equipped to correctly interpret the information they can apply the information in making on-farm operational decisions. This Action aims at supplying the weather and climate information to the farming community in near-real time to help them make such decisions. CIMH will work closely with the NMHSs in ensuring timely dissemination of such information to the farming community. The successful experiences of farmers in receiving and using the climate information for operational applications will be documented in the form of simple brochures and newsletters to promote greater participation of farmers in the Caribbean region in exploiting the weather and climate information.

Improved capabilities for the farming community to make strategic and tactical decisions for soil and crop management and enhanced incomes.

Year-to-year variability of climate significantly affects the agricultural fortunes of most Caribbean farmers. Farmers have to take a number of crucial land and water management decisions during the growing season, based on climatic conditions, and sometimes these decisions have to be taken several weeks in advance. Climate variability, with its resulting risk of financial loss in poor years, is one of the key reasons for underinvestment in fertilizer inputs. To address such challenges, it is important to integrate the issues of climate variability into resource use and development decisions. The introduction of seasonal climate forecasts into management decisions can help the farming community in making appropriate strategic decisions for soil and crop management and enhance farm incomes. Information on seasonal climate forecasts and medium and short-range weather forecasts and their applications will be provided to the Caribbean farmers in the Farmers Forums that will be organized throughout the region, in collaboration with the agricultural extension agencies. Experiences in generating and disseminating climate forecasts in the Caribbean region will be documented in appropriate publications for journals and will be diffused online through the CIMH website.

More efficient irrigation scheduling and quantifying, especially for domestic food crops and important export crops.

Seasonal to inter-annual climate predictions could improve water management for agriculture and could help water managers in their critical decisions concerning water allocation to agriculture, industry and domestic uses. Near-real time weather information could be used in simple water balance models to assist more efficient irrigation scheduling, especially for sugarcane, cotton, bananas, vegetables in the Caribbean region, in collaboration with CARDI.

Conservation-effective soil and crop management practices to reduce land degradation and improve long-term crop productivity

Human and climatic factors can contribute to land degradation in a number of complex, interactive ways. Emphasis will be placed on identification and assessment of physical and biological factors contributing to land degradation (eg., climate; physical, chemical and biotic factors of soils; vegetation characteristics; and livestock). These include the long-term effects of different forms of land management on soil fertility and plant growth and the interactions of different climates with the degree and duration of anthropogenic pressures. In collaboration with CARDI, studies will be conducted on the development and evaluation of appropriate technologies for soil and water conservation eg., surface tillage, animal traction, mulching, contour hedgerows, grass strips etc.,

Greater farm incomes, improved crop quality and enhanced environmental benefits for small farmers through more effective pest and disease management

Farmers now recognize that a sensible form of crop protection is to base application of the pesticides on weather conditions and know the relationship between the development of the pests, diseases and other environmental factors. Progress made in the understanding of pest and disease epidemiology through a systematic approach consisting of a stepwise analysis of the events determining an epidemic has revealed the need for a more precise knowledge of the relationship between climate, pests and pathogens, host and the resultant impacts. Climate influences all stages of host and pathogen life cycles as well as development of disease. Meteorological observations, forecasts and outlooks, coupled with plant and pest observations, can help to predict the development of key pests and can be used to schedule control actions for preventing pest and disease development or protecting an infested crop. Improvements in weather forecasts, together with more accurate estimations of micro environmental variables useful for pest and disease models, such as precipitation and leaf wetness duration, make it possible to provide seasonal estimations of the likelihood of pests and diseases and forecast outbreaks. In this context, crop system models provide useful frameworks in which to examine the interrelationships among crops, the pest and disease complex, and the environment to determine the most appropriate pest and disease management strategies. The experience of CARDI in

Integrated Pest Management (IPM) will be employed to assist farmers in implementing effective management strategies to control pests and diseases and enhance farm incomes. The combination of techniques employed in IPM such as biological control, use of resistant varieties, habitat manipulation, and modification of cultural practices could help reduce the use of pesticides and minimize the risk to human health, beneficial and non-target organisms, and the environment.

Increased interactions between the meteorological services, agricultural research and extension agencies and the farming community resulting in the provision of better services to farmers.

Recent weather and climate research efforts have demonstrated the importance of targeted forecasting and scenario analyses in increasing overall preparedness of farmers and farm business managers, leading to substantially better outcomes overall. However, weather and climate forecasting is just one of many risk management tools that play an important role in on-farm decision-making. More effective approaches to the delivery of climate and weather information to farmers may need the incorporation of a more participatory, cross-disciplinary approach that brings together research and development institutions, relevant disciplines, and farmers as equal partners to reap the benefits from weather and climate knowledge. The experience of WMO in the organization of a series of one-day Roving Seminars on Weather, Climate and Farmers in different regions of the world to sensitize them about the weather and climate information and it's applications in operational farm management will be used in organizing the Farmers Forums in the Caribbean region. The three way interaction between the NMHSs, agricultural research and extension agencies and the farming community would help enhance the synergies and bring the maximum benefit to the farmers. Newsletters and brochures, produced based on this activity, would be widely disseminated to raise the awareness of the farming community in the Caribbean region.

Availability of regular feedback to the meteorological services on the nature of services and products needed by the farmers resulting in the preparation of user-friendly products from the meteorological services.

In the farmer forums that will be organized in the Caribbean region, primary emphasis will be placed on free and frank exchange of ideas and information. This part of the forums will be designed in such a way as to engage all the participants in discussions and obtain full information from the farmers on their needs for weather and climate information and the ways and means to improve future communication of weather and climate information to them to facilitate effective operational decision making. This feeback will help enhance the understanding of the meteorological services on the nature of services and products needed by the farmers and contribute towards the preparation of user-friendly products from the meteorological services.

Enhanced capacity of Meteorological and Agricultural Services, CARDI and CIMH to perform the tasks relevant to the goals of this action.

The goals of this action will be achieved through adequate training of the personnel of Meteorological and Agricultural Services to satisfy the activities required in this action. Meteorological and Agricultural Service personnel will be trained in relevant areas of agrometeorology, whilst personnel from research Institutes (e.g., CARDI and CIMH) will enhance their knowledge from working with international scientists and exposure through attachment at cutting-edge international research institutes.

Proposed activities and their effectiveness

Development of predictors of the rainy season potential in different Caribbean countries through analysis of long-term climatic data and use of seasonal to inter-annual climate prediction models.

The atmospheric circulation over the Caribbean-Central American region is shaped by the competition between the North Atlantic subtropical high sea level pressure system and the eastern Pacific Inter Tropical Convergence Zone (ITCZ), which influence the convergence patterns on seasonal and interannual timescales. Methodologies such as the canonical correlation analysis will be employed to determine the leading modes of interannual sea level pressure (SLP) and SST variability associated with Caribbean rainfall. North Atlantic SLP affects Caribbean rainfall directly, by changing the patterns of surface flow over the region, and indirectly, through SST anomalies. Anomalously high SLP in the region of the North Atlantic high translates into stronger trade winds, hence cooler SSTs, and less Caribbean rainfall. A wide range of forecast methods, both empirical-statistical techniques and dynamic methods, will be employed in climate forecating for the Caribbean region. CIMH, in collaboration with the WMO Global Producing Centres (GPCs) of Long Range Forecasts, will assist the NMHSs of the ten Caribbean countries involved in this Action to develop predictors of the rainy season potential in different countries.

Interpretation of the climate predictor and near-real time weather information for improved management decisions, especially irrigation scheduling, for the important crops in the different Caribbean countries i.e., sugarcane, bananas and vegetables.

Two mesoscale numerical models are run daily for the Caribbean Region at CIMH. The two models are: the PSU/NCAR Mesoscale model (MM5) and the Advance Weather Research Weather Forecasting Model (WRF). The domains covered by either model vary, but both are forced by the same initial dataset. These tools are being used increasingly to support weather forecasts over multiple days. CIMH is providing outputs from its implementations of MM5V3 and WRF to National Meteorological Services in the Caribbean to support their extended forecasts. Predictors of rainy season potential and the weather forecasts will be interpreted, in collaboration with the scientists from CARDI, to provide information to facilitate management decisions, especially for irrigation scheduling, for the important crops in the Caribbean region. A methodological framework, that combines stochastic modeling of meteorological variables, a simple soil-crop algorithm, and a mathematical programming model, will be employed to assess the value of climate information in irrigation scheduling.

Working along side the agricultural research and extension agencies in developing an effective pest and disease forecasting system in the Caribbean region through improved crop monitoring and use of modelling approaches.

Farmers in the Caribbean region use labor-intensive methods to spray their crops for pest and disease control, while large producers use crop-dusting air craft in their operations. Sudden change in weather conditions often completely nullify the crop-spraying operations. To account for the impact of weather and climate variability on disease and pest incidence, information on agrometeorological variables such as relative humidity, maximum and minimum air temperature, soil temperature, total solar radiation, total rainfall and wind direction and wind speed is vital. Microclimate, a mixture of climatic factors (e.g. temperature, humidity, wind, and quantity of energy, etc.) near the ground, is the climate where plants and animals live and affects considerably the pest and disease severity. The climatic factors affect the distribution, development, survival, behaviour, migration, reproduction, population dynamics and outbreaks of insect pests and diseases and their severity over a period can fluctuate according to climatic variation since climatic factors control the population growth rate of pathogens and insects. If climatic factors are not adverse enough to cause extinction, their populations

can rise exponentially. For example, aphids and plant hoppers are the principal vectors of plant viruses. The seasonal life cycle of insects vary with climate and also from year to year. In the Caribbean region, temperature is the most important regulating factor, followed by rainfall. Viruses spread fastest under conditions optimal for insect multiplication and activity.

Experience over the past few decades has shown that the high performance of plant production in most of the developed countries would not have been possible without a well organized plant protection service securing the identification of pests and diseases and supported by scientists with a good understanding of population dynamics and epidemiology and capable of running a forecasting service based on surveillance network and agrometeorology. This represents the minimal structure to assist the growers and advise them on pesticide usage.

Agrometeorology can be applied to the analysis and modelling of plant disease development and creating a Decision Support System (DSS) for the operational management of crop protection. Mathematical models have been developed to understand and forecast the cycle of pests based on climate data. For example, Leaf wetness duration (LWD) is a key parameter related to epidemiology of many important crops, controlling pathogen infection and development rates. Predicting consecutive multiple day periods of LWD above a threshold value is important for forecasting diseases. Because LWD is not widely measured, several methods have been developed to estimate it from weather data. Among the models used to estimate LWD, those that use physical principles of dew formation and dew and/or rain evaporation have shown good portability and sufficiently accurate results. These models were used to compute the probability of particular episodes occurring in any month, the return period of extreme episodes and the average temperature associated with different lengths of leaf wetness duration, but their complexity is a disadvantage for operational use. Alternatively, empirical models have been used despite their limitations. The simplest empirical models use only relative humidity (RH) data e.g., constant and extended RH thresholds and dew point depression.

Decision Support Systems (DSS) such as WISDOM for potatoes (University of Wisconsin), RADAR for apples (University of Maine), PAWS for several crops (Washington State University) etc., will be employed to assist extension agents, consultants, growers, and other agricultural clientele in the management of plant diseases. Solutions to pest and disease problems in the Caribbean region must be location, crop and pest and disease specific. Meteorological observations, forecasts and outlooks, coupled with plant, pest and disease observations, can help to predict the development of key diseases and can be used to schedule control actions for preventing pest and disease development or protecting an infested crop. In this Action, NMHSs will work along side the agricultural research (CARDI) and extension agencies in developing an effective pest and disease forecasting system in the Caribbean region through improved crop monitoring and use of modeling approaches described above.

Preparation and wide diffusion of a user-friendly weather and climate information newsletter for the farming community in the Caribbean in close collaboration with the agricultural research and extension agencies.

The activities outlined above are expected to produce a number of important products and information for the farming community in the Caribbean region. It is important that this information is compiled and disseminated widely in a format that is user-friendly and easy to understand and apply. Given the small size of most of the Caribbean countries, this activity is best carried out at CIMH, in close collaboration with the NMHSs and the agricultural research and extension agencies in different countries.

In preparing this newsletter, several issues will be evaluated. These include the accessibility of data to meet basic user requirements, sources of routine and ancillary climate, crop and soil data, technical and human resources available for producing the newsletter, appropriate user surveys of information delivery mechanisms, and a strategy to develop and promote institutional collaboration in the Caribbean region. Pooling of resources from different agencies such as CARDI provides an effective

means of acquiring a comprehensive database for the newsletter. The newsletter can also benefit from CARDI's link with the CTA as its Caribbean branch office. Every effort will be made to coordinate these resources to ensure an efficient process of acquiring the necessary inputs for the newsletter.

The input data will be converted into information that can be packaged for delivery in a form that adds value to the existing knowledge base. For example, 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 agrometeorological analyses. Additional tools such as geographic information systems (GIS) technology, mathematical models, and remotely sensed observations will be used to provide additional resource enhancements that convey value-added information in the newsletter for the decision making process.

Organization of regular forums with the farming community and agricultural extension agencies to promote a better understanding of the applications of weather and climate information and to obtain feedback to provide better products from the meteorological services for use by the farming community.

Farmer Forums will be organized in cooperation with the agricultural research and extension agencies, will help farmers become more self-reliant in dealing with weather and climate issues that affect agricultural production on their farms. The overall goal of the farmer forums is to secure farmer self reliance, through helping them to be better informed about effective weather and climate risk management by sustainable use of natural resources for agricultural production. Typically the farmer forums will be of one-day duration and bring together farmers from a group of villages to a centralized location in any given region.

The programme for the forums will consists of two parts: The first is devoted to providing information in local language on different aspects of weather and climate in the Caribbean region. Weather aspects cover short term weather forecasts, clouds, weather maps and weather forecasting terms. Climate aspects cover seasonal climate patterns, forecasting, drought alerts and use of rainfall records; future climate change in the Caribbean region and implications; climatic risk in production of different crops in the region; and better risk management. Presentations on these topics will be interactive and promote a good dialogue with farmers.

The second is devoted to obtaining feedback from the farmers on weather and climate issues in their farming operations and the nature of assistance they need. Primary emphasis here is placed on free and frank exchange of ideas and information. This part of the farmer forum will be designed in such a way as to engage all the participants in discussions and obtain full information from the farmers on their needs for weather and climate information and the ways and means to improve future communication of weather and climate information to them to facilitate effective operational decision making.

The Farmer Forums will be organized in full cooperation with the NMHSs, local agricultural extension services, and with the active involvement of the agricultural research personnel from CARDI, and/or a relevant university from the region.