CORBANA-BANACLIMA: A weather monitoring system to support the banana production in Costa Rica

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ABSTRACT

The Costa Rican banana industry is mainly located in the Caribbean basin, which gives good weather and soil conditions for intensive production for export purposes. However, as is characteristic of tropical zones during the year, occur considerable variation in climate that may cause a significant impact on production.

A detailed knowledge of the behavior of the weather in real-time could help to optimize the weather forecasting, production control (best times for planting and harvesting), the development of forecast systems for diseases and pests, recommendations for pesticides application, provide information for scientific research and in the prevention of emergencies and natural disasters.

The BANACLIMA Program specializes in the storage and management of 12 automatic meteorological station installed at banana plantations distributed along the Caribbean basin. The network makes use of a Mikrotic WiFi system for data transmission and internet. BANACLIMA will be able to relate environmental parameters like rain, wind, temperature and relative humidity, solar radiation, and leaf wetness to aspects of crop management like planting, irrigation, fertilization, disease, and banana production.

The main objective of the BANACLIMA Program make this information available to banana producers and crop managers; in real-time, allowing a continuous monitoring of weather conditions in the major banana producing areas in the country. The real-time information is put on the website of CORBANA (www.corbana.co.cr), facilitating the use of the information for the producer and farms managers farms to optimize the input, such as, fertilizers, nematicides and fungicides to obtain greater economic and environmental benefits. Another tool of the BANACLIMA is the e-mail and SMS with weather forecast, alerts and warning of extreme weather events and GIS maps.

The information available in BANACLIMA contributes with the national banana industry to optimize the cultural plantation management, reducing costs and increasing production by the use of the precision agriculture.

Keywords: Agrometeorological data, Bananas, Costa Rica, meteorological stations, pest forecasting, weather.

1. INTRODUCTION

Weather is the state of the air and atmosphere at a particular time and place is expressed by meteorological elements such as temperature, humidity, wind, rain, etc. The weather is the combination effect of all meteorological elements and their causes is determined by factors as latitude, longitude, continental and oceanic distribution of masses, ocean currents, pressures center and orographic barriers (Heuveldop et al, 1986).

Costa Rica is located in the tropical zone of the Americas, with a land cover of 51.100 km2 influenced by two oceans on the West by Pacific Ocean and East with by the Caribbean Sea. A central mountain system with orientation NW-SE divide the country into two parts: the Caribbean basin and the Pacific basin, also the high diversity in topography, exposure, distance coast and atmospheric circulation patterns provides a large variability of microclimates. Among the macro factors that can influence the weather in the Caribbean basin are: El Niño-Southern Oscillation (ENSO), Intertropical Convergence Zone (ITCZ), Cold fronts, Tropical Storms and Hurricanes (Amador et al, 2013; Herrera, 1985).

The Caribbean basin is characterized by heavy rainfall without dry months, the lowest precipitation by month are in the range of 50 – 100 mm and the cumulative annual rainfall in the range from 1700 mm to 5500 mm with a high special variability. Regarding to the average temperature shows little thermal variation along the coastal area, with high values of between 25° C and 26° C (Amador et al, 2013).

The banana activity is mainly in the Caribbean basin, which is an area with good weather and soil conditions for intensive production with export purposes (Lara, 1970; Soto, 1992). However, as is characteristic of the tropics zones during the year there are considerable variations in climate that may cause a significant impact on production (Sastry, 1988; Robinson, 1996; Stover, 1962), due to the high influence of weather on the growth, crop production and on the incidence and severity of pest attack. Disease such as black Sigatoka, caused by the fungus *Mychosphaerella fijiensis* Morelet and the nematode *Radopholus similis* Cobb, continue to be a serious threat to the sustainable production of bananas in the Caribbean basin. In Addition, it may affect the use of input such as fertilizers and reduce the impact of applications of herbicides, fungicides and nematicides.

A detailed knowledge of the behavior of the weather in real-time could help to optimize the forecasting, production control (best times for planting and harvesting), the development of forecast systems in diseases and pests, improve recommendations for pesticides application, scientific research and in the prevention of emergencies and natural disasters.

For the Costa Rican banana sector is of utmost importance to determine the influence of the climate on banana crop, climate variability and climate change on banana crop, for which the National Banana Corporation (CORBANA) decided in 2005 to create the BANACLIMA Program, whose support is an automated weather station network distributed throughout the Caribbean basin in banana farms. The main objective of BANACLIMA is to generate real-time

information available to user in a web page, and besides to promote and facilitate the generation of weather forecasting, improve production and pest management for the banana crop.

2. METEOROLOGICAL STATION NETWORK

There are currently 12 automatic weather stations (Campbell Scientific, Inc.) distributed in banana plantations, through the Caribbean basin from the Panama border (Sixaola) to Sarapiqui, Heredia (figure 1). For its location was considered the life zones of Holdriedge and the influence of watersheds of the major rivers, along of the Caribbean region. In the farms selected, the station was located at the edges of the plantation, as close as possible to the crop environment, because the main interest is to develop models and studies that directly impact growth and produccion and finally the banana industry of Costa Rica.
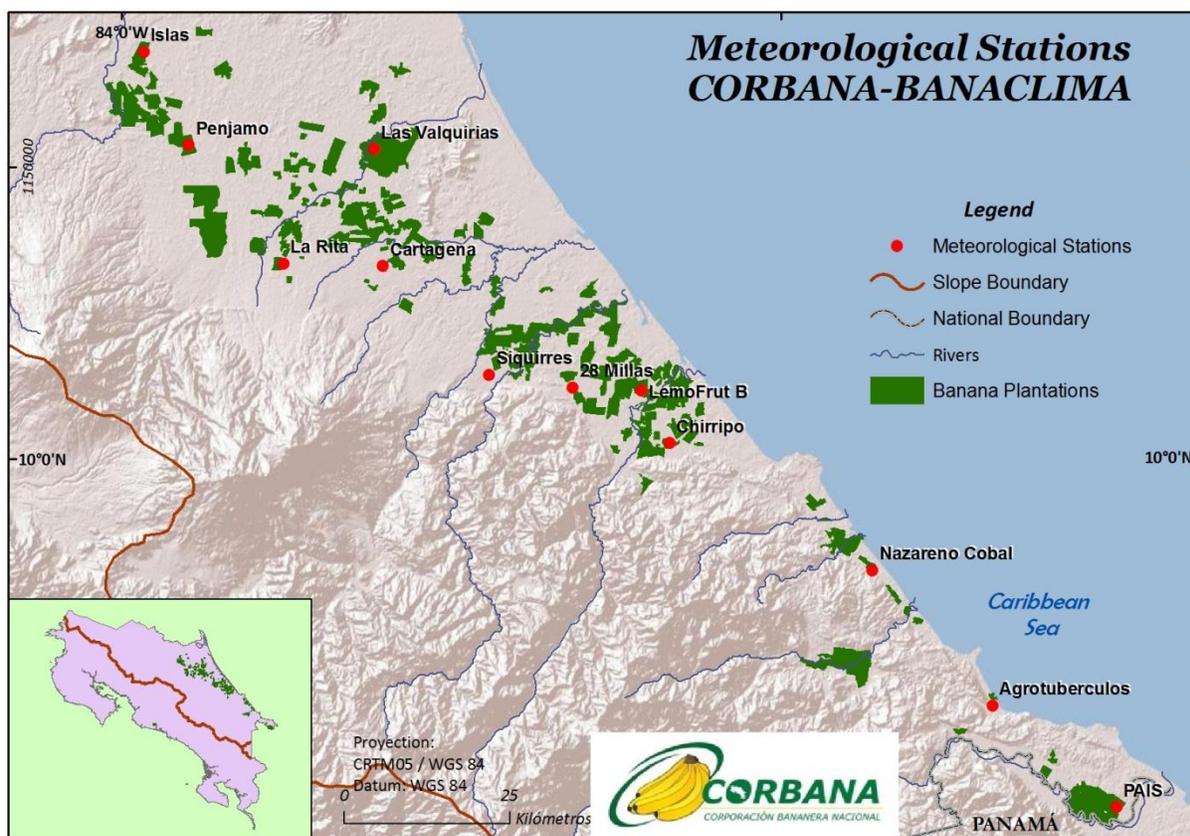

Figure 1. Meteorological Station Network CORBANA- BANACLIMA.

Each station is equipped with for the measurement of different climatic variables: temperature and humidity, solar radiation, wind speed and direction, soil moisture, soil temperature, leaf wetness and rain, as is shown in the figure 2. The Weather stations generate readings every 5 minutes of different climate variables, this information generated by the network stations is transmitted to a data reception center locate in the La Rita Research Center using a Mikrotic WiFi system for data transmission and internet. The communication system is composed by

tower located in the farms fitted with special equipment and repeaters located at strategic points along the Caribbean basin.

The text files are stored on the server in La Rita Research Center and from La Rita the files are replicated to another server located in CORBANA headquarters in San José. Finally the date is stored in ORACLE database that displays information online of the different stations in BANACLIMA Web page (https://www.corbana.co.cr/categories/banaclima).
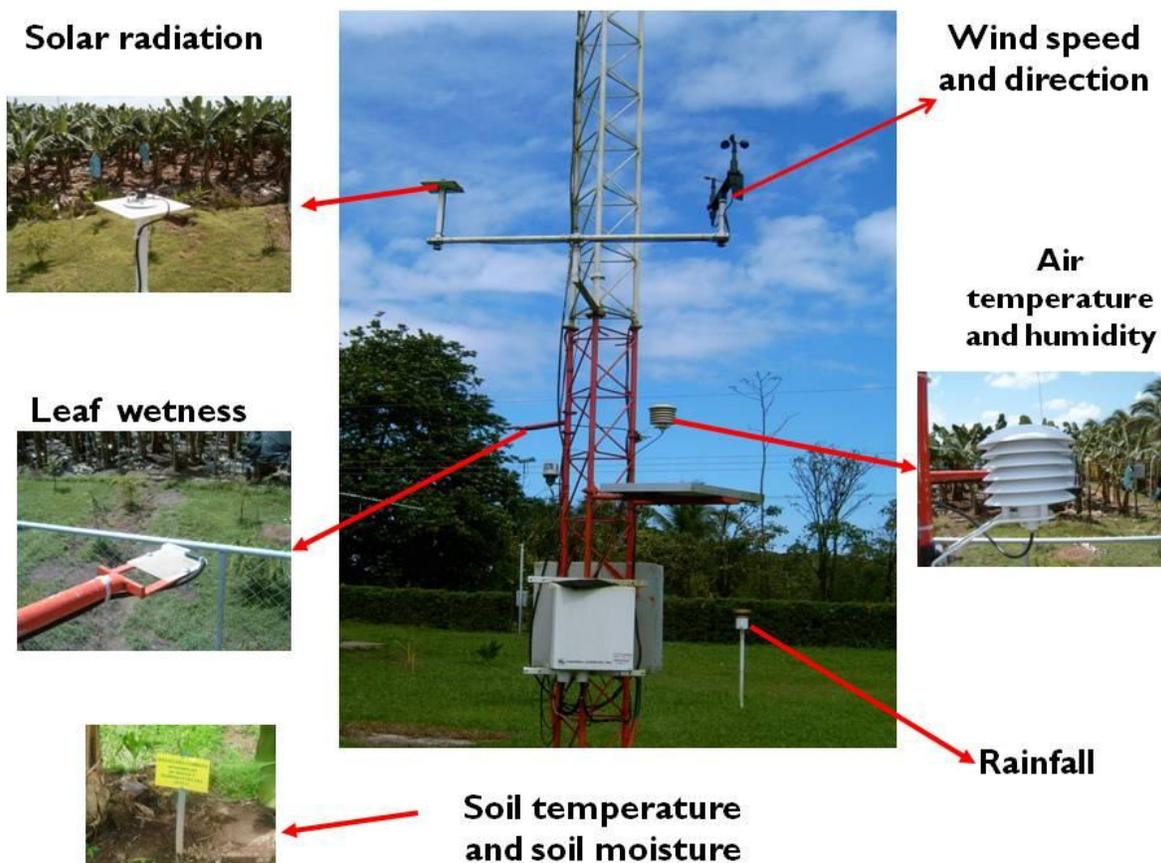

Figure 2. Meteorological Station sensor of CORBANA BANACLIMA Network.

The Web site offers different products and the users can see the current weather conditions, the regional forecast over the Caribbean basin, create graphics, reports, summary tables and historical data reports. Furthermore, alerts for weather events as: Tropical waves, systems of high and low pressure, cold fronts and the presence of hurricanes (figure 3). Three times a week are forecasts available for the weather conditions in all the subregions of the Caribbean basin, which gives a fairly realistic scenario of the time. As previously indicated, for CORBANA is very important that access to this information is quickly and efficient, to facilitate the alerts and forecast are sending via email and SMS. In addition there are links to satellite images for people who have more knowledge on the dynamics of the atmosphere.

Another sub product of the BANACLIMA program is the monthly agro climatic bulletin. It is sending the first week of every month, shown the in maps the distribution of precipitation and temperatures of the last month, also include a graphics of precipitation, degree-days of the month in comparison with the last 4 years. In addition in some bulletins has information about the ENOS forecast, hurricane season and information relevant for the banana industry relate with weather condition (figure 4).
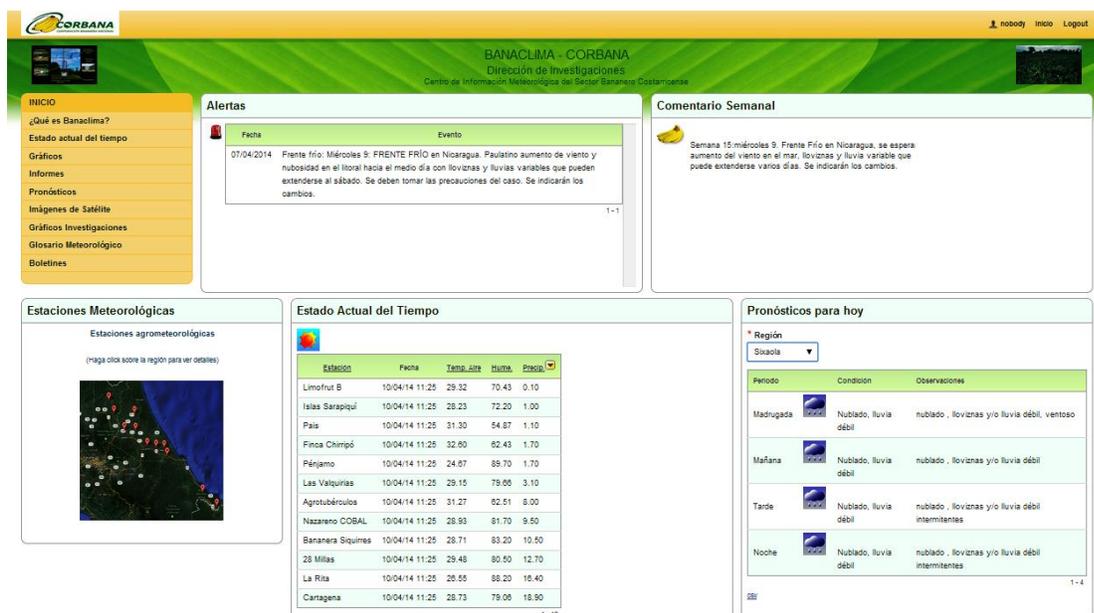
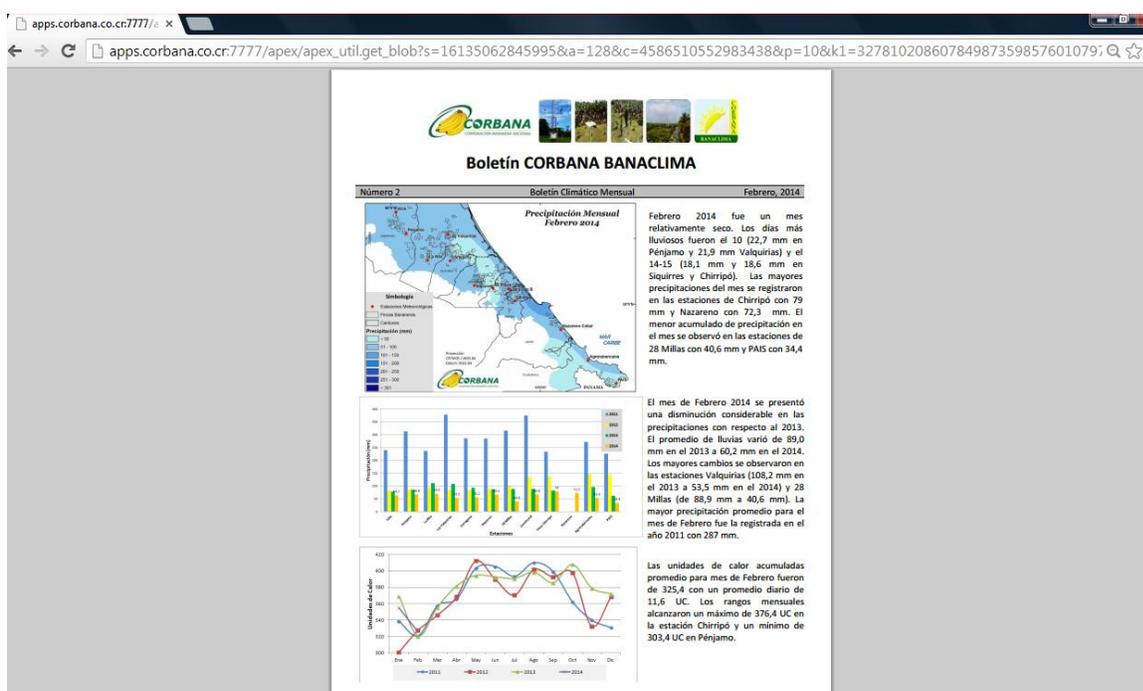

Figure 3. Web page CORBANA- BANACLIMA.

Figure 4. Agroclimatic Bulletin CORBANA- BANACLIMA

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3. RESEARCH PROJECTS

Through the year CORBANA research staff conducts several investigations to determine the influence of the weather condition on banana crop such as: "The study of the relationship of temperature with the production and yield using the climatic variables as accumulate growing degree-day (GDD)" (Mora and Guzmán, 2007).

Also in 2007 was exposed the work about of the phenological behavior of banana plants established in the Atlantic zone of Costa Rica (González et al, 2009), that was the beginning for the final work in the study of the effect of climate on crop phenology of banana (González et al, 2014) using phenological variables as: leaf emission, flowering, height and pseudostem height can be estimate the plant flowering day and help to get a more accurate estimate of the return on production units by season of the year and weather conditions as shown in the figure 5.

Due to the importance of climate change and its effect on the agricultural sector and particularly in the production of banana an agreement between CORBANA and Geophysical Research Center of the Universidad de Costa Rica" was carried out to develop a project called Weather, Climate Variability and Climate change in the Caribbean basin of Costa Rica. The objective of this study was to identify the characteristics of climate, climate variability and aspects related to regional climate change that have been affect affected banana production in Costa Rica (Amador et al, 2013).
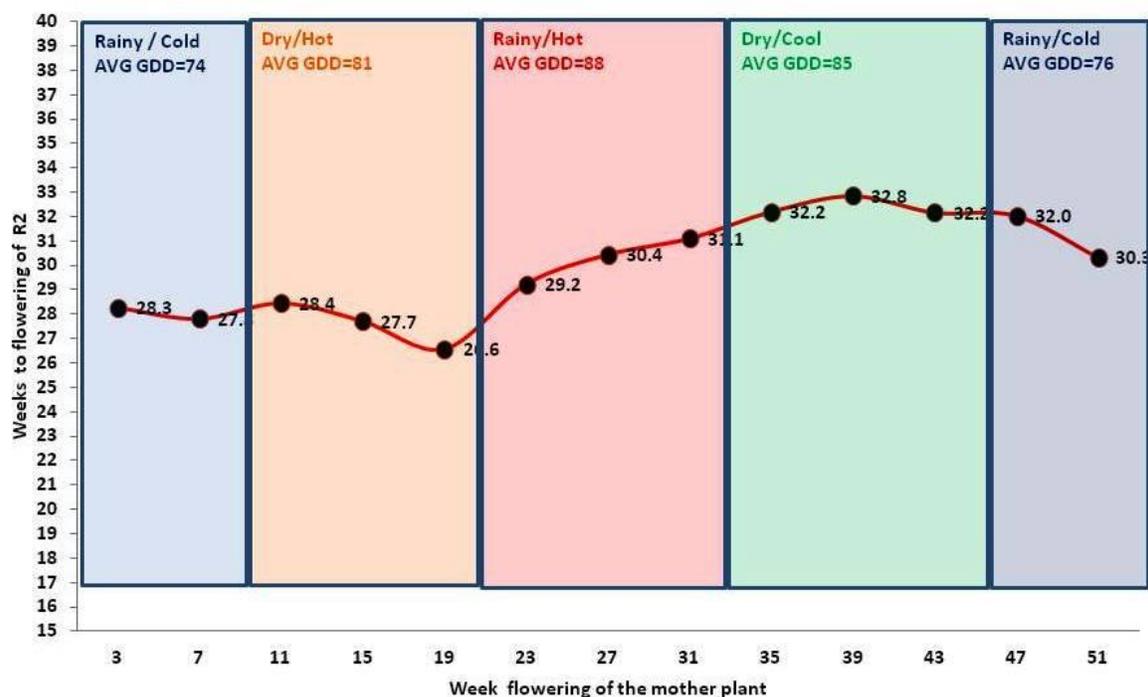

Figure 5. Intervals between blooms according to the season of the year (González, et al, 2013)

The first step for understand the behaviour of the climate was to develop a climatic classification map for the Caribbean basin, which described the zone as humid region with high rainfall and temperature caused a high evapotranspiration. Despite this was possible to obtain more details with 10 climatic groups: The group B is less humid with low rainfall and high temperatures, the group B is located in the north part; the northern coastal area belongs to group G, very humid with high evapotranspiration; the southern Caribbean coast is less humid with high temperature and moderate rainfall; the groups E and F both are wet; in the mountainous parts the humidity is higher and therefore there are the more humid like climatic groups G14 and H6, very wet and very humid.(figure 6).

Among the most notable achievements of this project was to get a depurated and corrected data base for a better quality data, annual and diurnal cycle analysis that shows the annual average of the climatic variables during the 24 hours by day in each month for each meteorological station. This information can have a great impact on crop activities and in the subsequent analysis, and the correlation of the variables of the growth, pest and disease, also as tool for decision-making.

As a future project of the use of BANACLIMA data base is the studies related to climate variables with pests and production: This study well be conducting as collaboration with the Computation Research Center Technology of Costa Rica for a research on the field of learning machine in the prediction of the evolution state of the black Sigatoka using climatic variables.
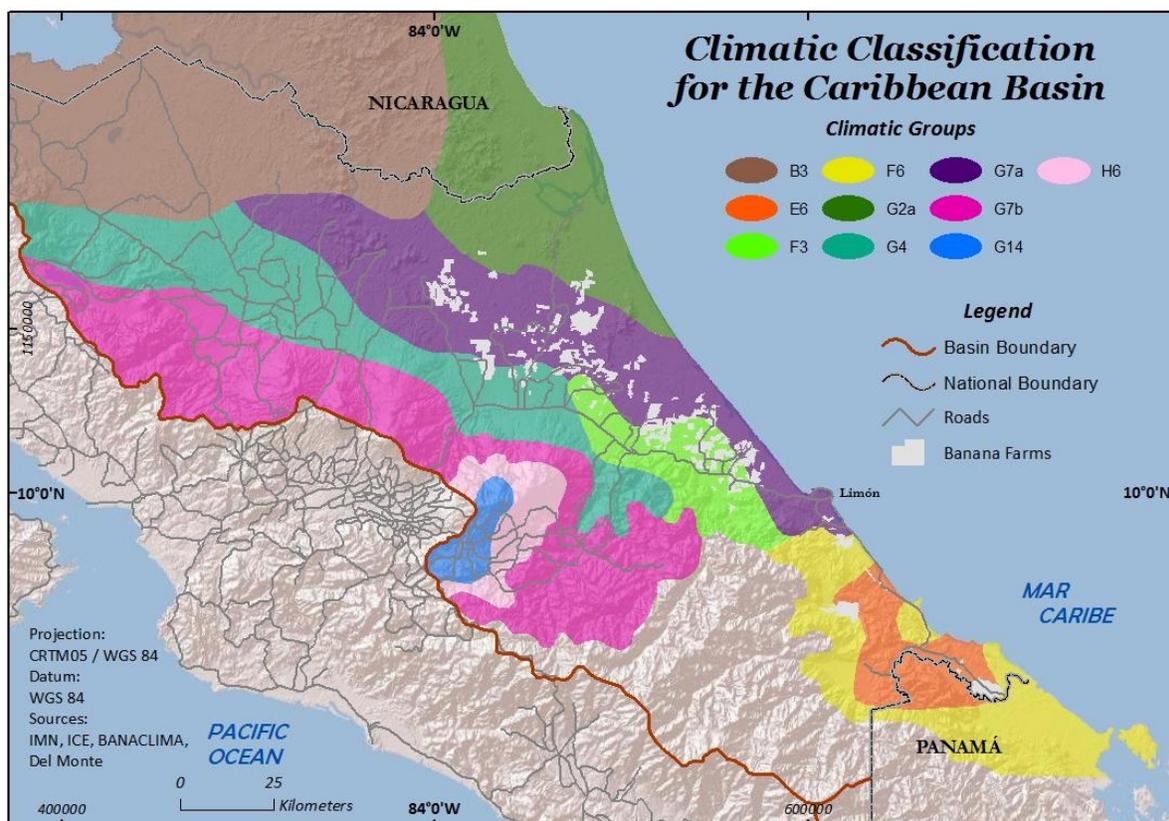

Figure 6. Climatic Classification for the Caribbean Basin of Costa Rica.

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4. IMPACT OF THE PROGRAM CORBANA-BANACLIMA

The agrometeorological data optimizes the weather forecast in the banana region and therefore help the use of the information for producer and farms managers for optimize the inputs, such as, fertilizers, nematicides and fungicides to obtain greater economic and environmental benefits, due to the high cost of this and climate efficacy dependent, during and after application. The availability of this information will also help the banana industry to better prepare for natural disasters related with climate variability and climate change such as floods or droughts and reduce the environmental impact of the use of agrochemicals.

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