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USAID CONSERVATION OF CENTRAL AMERICAN WATERSHEDS PROGRAM (CCAW)

Grant No. 404FO-APS01-FHIA

ENHANCEMENT AND EXTENSION OF THE MESOAMERICAN AGRO-CLIMATOLOGICAL SYSTEM

FINAL REPORT

FHIA

The Author's views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government

RESUMEN EJECUTIVO

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Four weather stations were purchased from ADCON Telemetry Inc in December 2007 through the USAID Grant No, 404FO-APS01-FHIA. Each station was equipped with the following sensors: precipitation, air temperature, relative humidity, wind velocity, wind direction, solar radiation and leaf wetness, in addition to a RTU Addwave 733 GSM/GPRS for communications. Three of these four stations were configured and installed in Honduras, at Dole's pineapple (2) and AZUNOSA's sugarcane (1) fields. The fourth station was configured, and installed in Guatemala, at INDESA oil palm plantations (Pataxte). The latter will start sending data by the end of August, when COMCEL provides the GSM/GPRS service at this location. For this purpose a 60-m tall antenna was built on site. INDESA also acquired three additional stations which are linked to the Mesoamerican Weather Monitoring System, making a total of 12 stations deployed in the MAR area. Finally, the Seminar-Workshop "Understanding the Agro-climate in the Mesoamerican Reef Region" held at FHIA during April 2008 and sponsored by this USAID Grant, brought up the attention of 32 participants from more than 8 organizations and 5 countries. These new tools were described and made available to farm operators to make better decisions in agriculture and the environment. A video clip was shot and uploaded in the WWFMAR YouTube channel, as part of the Panda Agriculture and the Environment BMP Video Series. It was concluded that this project was successfully carried out, and future advanced training is needed as requested by the participants in the workshop, as well as increasing in the network coverage to increase the forecasting precision.

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LIST OF ABREVIATIONS

AGROTOR	AGROPECUARIA TORNABE
AGROPOR	AGROPECUARIA PORVENIR
AZUNOSA	AZUCARERA DEL NORTE, S. A.
CAHSA	COMPANIA AZUCARERA, S. A.
FHIA	FUNDACION HONDURENA DE INVESTIGACION AGRICOLA
INDESA	INDUSTRIAS DE DESARROLLO
MAR	MESOAMERICAN REEF
MAWMS	MESOAMERICAN WEATHER MONITORING SYSTEM
WAP	WIRELESS APPLICATION PROTOCOL
WWF	WORLD WILDLIFE FUND, INC.

INTRODUCCION

Farm operators in the Gulf of Honduras watershed requiere to have access to precise and timely agro-climatological information in order to determine the need for and the amount of agrochemical applications on their agricultural land. Improved agro-climatological information will help farmers make better decisions as to the "when, where and how" to apply agrochemicals or to use biological control methods; thereby controlling the use of pesticides, while simultaneously reducing the environmental impact of these chemicals. Additionally, agricultural water use efficiency in the Gulf of Honduras watersheds can be significantly improved by relying on timely estimates of ETo (evapotranspiration) provided by algorithms based on quasi-real time readings from precipitation, temperature and radiation sensors.

To optimize agricultural production and quality, while reducing the impact in the environment, agronomists and environmentalists must get acquainted with agro-climatological determinants and even more, have a system that provide reliable data with precision and accuracy. Nowadays, adoption of any agricultural practice to improve yield and quality, must consider the impact on the environment, so as to be called a Better Management Practice (BMP).

A **Better Management Practice** (BMP) in agriculture is defined as one of the most efficient ways (less effort), more effective (better results) to accomplish a particular agricultural and environmental friendly activity, based on replicable and repetable procedures that can be tested over time, over diverse agroenvironments and agricultural operations. Weather monitoring is perhaps one of the most important tools that can enhance the adoption of specific BMP related to reduction of total pesticide toxicity, erosion control practices and water saving.

Mesoamerica is located in the tropical region of the Earth (23° N & 23° S) and presents a significant variety of agro-climates that are exploited by agriculturalists all the way from the sea-level up to the hillsides of the mountains (4,000 masl). Precise knowledge on the variation of these determinants is fundamental to optimize production and reduce environmental impacts. The concepts in the lef-botton box are extremelly important to manage for the decision-making process to develop, implement and adopt a BMP targeted to reduce the impact of agriculture in the environment.

Weather. It is the state of the atmosphere with regard to temperature, cloudiness, rainfall, wind, radiation and other meteorological conditions. Weather is what nature is doing now with respect to these determinants.

Climate. It is how weather acts over many years. This can be described with words, or by using tables and charts to represent the conditions. There are several different ways to group areas with similar climatic elements. One method uses the factors that, in addition to the sun, shape the climate of a region. This method describes climate regions such as polar, temperate, tropical, marine, and mountain, among others.

Microclimate. It is the climate in which plants and animals live. It differs from the **Macroclimate**, which prevails above the first two meters over the ground, primarily in the intensity of the change in elevation and the changes with time that occurs there. The weather-microclimate-macro-climate determinants affect the agricultural production and its impact in the agro-ecosystems. Almost all the energy received by the earth surface originates from the sun. Some of this solar radiation is reflected back to space. The earth reradiates some of this energy received from the sun. The quantity of radiant energy remaining at the earth's surface is the net radiation, which is the energy available to drive certain important process in plants, animals and atmosphere.

The purpose of this report is to describe the events of enhancing the Mesoamerican Weather Monitoring System (MWMS) by purchasing four weather stations and introduce farm operators to the goodness of this system. In addition, it provides insights on these new tools to monitor agricultural weather and micro-macro-climate, and generate knowledge to make better decisions based on quasi-real-time reliable data. This knowledge, in the long run, will also help to understand and develop BMPs to ameliorate the global effect that

agriculture has on "Climate Change".

OBJECTIVES

This project was aimed to acquire four weather stations to enhance coverage along agricultural areas within the Gulf of Honduras watersheds. This project is capitalizing on the successful results from the on-going WWF-CA/SUMMIT initiative targeted to develop and deploy Better Agricultural Management Practices within these critical watersheds, using real-time and readily available weather data, and other agro-climate indicators; complemented with a seminar-workshop held in April 2008, with participants from Mexico, Belize, and Honduras, to acquaint farm operators with these new tools.

The grant was assigned to FHIA (Fundación Hondureña de Investigación Agrícola) that is actively engaged with the Agricultural Program of WWF-CA and is focused on fostering the development and adoption of BMPs in agricultural operations along several watersheds.

The Project accomplished the following objectives/activities:

1. Increase the Mesoamerican Agricultural Weather Monitoring System coverage in agricultural areas within the Gulf of Honduras selected watersheds by purchasing four telemetric weather stations.
2. Install and configure the new weather stations and route them to the active Mesoamerican Agricultural Weather Monitoring System using the already available networking service provided by the WWFCA from La Lima, Honduras.
3. Promote the use of agriculture Better Management Practices for pesticide reduction and water use efficiency within the Gulf of Honduras, through exposure to these new technological tools.

RESULTS AND DISCUSSION

The Project successfully accomplished all the three objectives proposed as described in Tables 1 and Figures 1-7. These additional stations provide enhanced variety and predictive capabilities for biological modeling, due to increased coverage of crop areas and an associated increase in precision of the forecasted values for disease and pest indexes, as well as water use needs by crops. In the short run, this project shall increase the dissemination and adoption of Better Management Practices for pesticide reduction and water use efficiency in the Gulf of Honduras agricultural sites. In addition, it brought up several opportunities that are being pursued and achieved accordingly.

The following Table 1 indicates that the Mesoamerican Weather Monitoring System (MAWMS) with the addition of the four complete stations purchased through this project (in red), reached a 12-full-unit network system, distributed in three countries and five crops. Of great importance, is the purchase of three additional stations by INDESA, which are linked to the MAWMS and the Panda Server at La Lima, Honduras. The station at Pataxte was purchased by this

USAID/CCAW, and INDESA in turn decided to buy three more stations for its oil palm plantations near Izabal Lake, to support its recently created Research and Development Department. Examples like this are being pursued with other farm operators in the area. It is worthwhile noticing that at INDESA oil palm area around Lake Izabal shores, the GSM/GPRS connection was inexistent. The project undertook the task together with INDESA and COMSEL, to procure the installation of a 60 meters cellular antenna, which was installed by August the 8th. This structure provides excellent coverage of that area, and will be used to send-receive data, as soon as the cellular numbers are assigned by COMSEL and purchased by WWF.

Table 1. Mesoamerican Weather Monitoring System (MAWMS). Distribution of 12 weathers stations comprising the MAWMS, according to the country, location, sensors, year of purchase, crop, farm operator and donor/buy-in, as August 2008. Red font specifications correspond to the four stations purchased by this project.

	Country	Location	Sensor	Year	Crop	Farm Operator	Donor/Buy-in	State
1	Honduras	Tornabe	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2006-2007 2007-2008	Oil Palm	AGROTOR	WWF/SUMMIT	Active[1]
2	Honduras	Sonaguera	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2006-2007 2007-2008	Citrus	COFRUCTO	WWF/SUMMIT	Active
3	Belize	Corozal	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2006-2007 2007-2008	Sugar cane	Sugarcane Grower Associations	WWF/SUMMIT	Active
4	Belize	Stann Creek	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2006-2007 2007-2008	Citrus	Belize Citrus Grower Association	WWF/SUMMIT	Active
5	Honduras	El Porvenir East 305	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2007-2008	Pineapple	Dole	USAID/CCAW	Active
6	Honduras	El Porvenir West	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2007-2008	Pineapple	Dole	USAID/CCAW	Active
7	Honduras	Bemilia	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2007-2008	Sugarcane	AZUNOSA	USAID/CCAW	Active
8	Guatemala	Pataxte	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2007-2008	Oil Palm	INDESA	USAID/CCAW	Active
9	Guatemala	Chabiland	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2007-2008	Oil Palm	INDESA	INDESA	Inactive[2]
10	Guatemala	Chahal	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2007-2008	Oil Palm	INDESA	INDESA	Inactive
11	Guatemala	Fray Bartolomé de Las Casa	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness	2007-2008	Oil Palm	INDESA	INDESA	Inactive
12	Guatemala	Iñite	Precipitation, Temperature, Relative Humidity, Solar radiation, Wind Velocity and Speed, Leaf Wetness.	2007-2008	Sugar Cane	Ingenio Guadalupe	WWF/SUMMIT	Inactive

[1] Active means that is actually sending data through the GSM/GPRS system.
[2] Inactive means that is not actually sending data through the GSM/GPRS system du to a local service problem

The Panda Server System (Figure 1) at La Lima, Honduras is linked to an Adcon A840 Telemetry Gateway that receives the data via GSM/GPRS from every station from Corozal, Belize to Sonaguera, Honduras, every two-hours or as requested by the users. Each sensor takes reading every minute and averages or accumulates them every 15 minutes. These packets of data are sent via GSM/GPRS at a very low cost, and uploaded in the www.wwf-mar.org/services. Every user can access the data using a generic user name (GUEST) and password (GUEST) from everywhere in planet Earth. In addition, the WAP communication alternative is

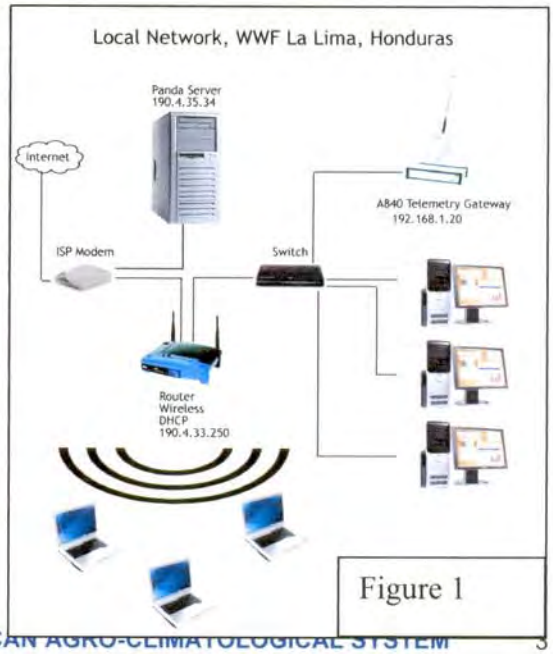

Figure 1

becoming available for those users that have GSM/GPRS service from their cellular providers.

Figure 2 shows (left) the distribution of the 12 weather stations comprising the MAWMS, including those acquired by USAID in 2007-2008. The interactive window (center) from AddVantage 5.2 is used to access each individual station, and a screen output (right) shows data from one station and seven weather determinants (raw data) discriminated by colors.

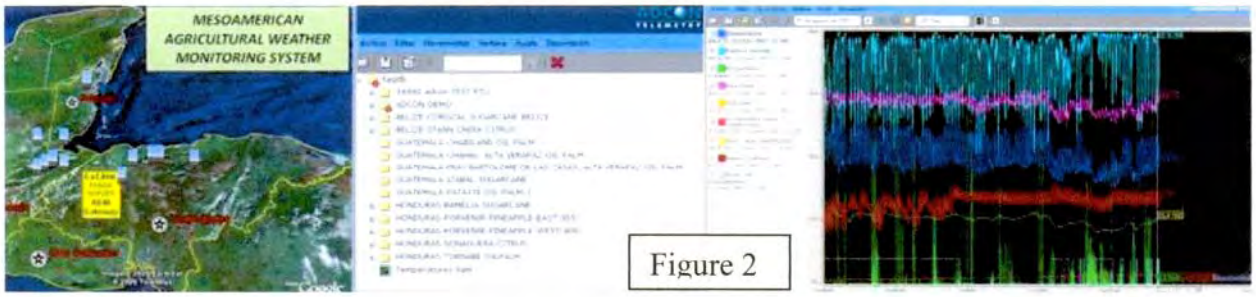

Figure 2

To date, the sensors (Figure 3) attached are capable of estimating ETo (Penman-Monteith Method), Heat Units (5 different procedures) and the raw readings are informative for the farm operators using the classical approach of knowing how hot or cold is, and how much precipitation fell in a particular day. All these activities have certainly enhanced the potential and predictive capabilities of a variety of biological models, due to increased coverage of crop areas and an associated increase in precision of the forecasted values for disease and pest indexes and water use needs. Forecasting models that are initially being developed would be related with phenological stages of pineapple using heat accumulation units, in pursuing the anticipation of the disastrous natural flower differentiation (NDF), which in addition to reduce yields significantly, it induces more insecticides applications to control the pest called Thecla (*Thecla basilides*), and other chemicals to promote growth and keep the pineapple plant in the juvenility stage until the appropriate size is reached to bear a market-quality fruit.

Figure 3

An additional model being developed is the "Froghopper Model". This pest causes significant losses in sugarcane and is an excellent example of a BMP using traditional IPM methodologies enhanced by an accurate forecasting of the phenological stages of the insect, before every sampling cycle. This information will augment the use of biological control with *Metarhizium anisopliae*. The actual model being develop is presented in Figure 4.

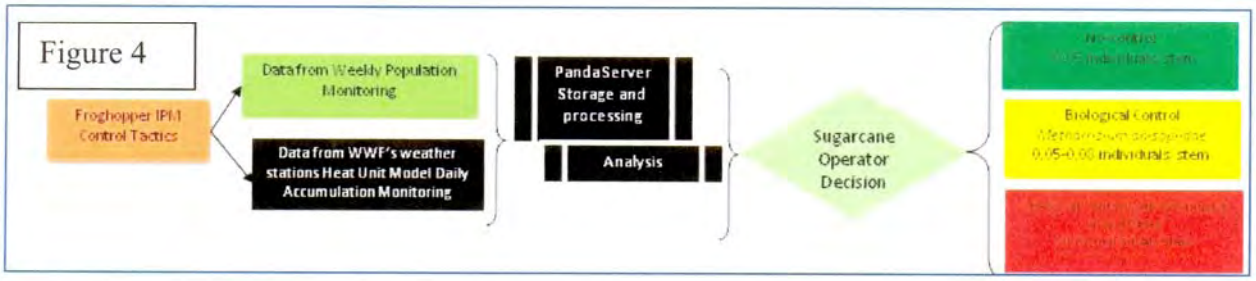

Figure 4

Moreover, the data warehousing and mining facilities at WWF in Honduras provides a fidelity and ample storage space to monitor mid-term behavior of the climate changes and associated agricultural and the environmental variables. Finally, the backup capability of the WWF network system is outstanding and backups are performed automatically every single day with redundancy. One copy is kept at the WWF at la Lima, Honduras and the other one in Boston, Massachusetts, USA.

Further improvement through training will definitely enhance the adoption of Better Management Practices involved with monitoring of the weather. This was evident during a Seminar-Workshop "Understanding the Agro-climate in the Mesoamerican Reef" that was held at la FHIA, La Lima Honduras, sponsored by this USAID Grant. Thirty-two participants/expositors from five countries and 8 organizations attended a two-day event in these premises.

This workshop brought about the immense necessity for this type of information, as well as the frequency and availability of them, as well as a proper scientific and technical on-site support. Expositors from FHIA, DOLE, and CHIQUITA highlighted the need for employing local weather information in the day-to-day decisions, using data in the traditional way and some new novel ideas to explain crop production variability and related them to weather conditions. For sure, the lecturers from WWF and ADCON outlined new ways of using the weather data for making precise decision in agriculture and implement Better Management Practices, such as disease and pest control and irrigation.

Figure 5-7. Some of the participants attending the Seminar-Workshop "Understanding the Agro-climate in the MAR Region, held at FHIA, Honduras, on April 23-24 2008, and sponsored by USAID.

A video clip from "The Panda Agriculture and the Environment BMP Video Series" was developed to describe the Mesoamerican Agriculture Weather Monitoring System and the insights of the workshop-seminar "Understanding the Agroclimate in the MAR Area. This video can be accessed in the WWFMAR YouTube Channel through:

http://www.youtube.com/results?search_query=WWFMAR&search_type=search_users&aq=f

CONCLUSIONS

1. Purchasing, configuring, and installing the weather stations were perfectly done at all sites.. Three of them (Dole 2 and Azunosa 1) are sending data from the very same date of installation on the field. One station installed at Pataxte Guatemala will start sending data by the end of August 2008 because COMCEL just activated the GSM/GPRS system on August the 8th.
2. The Seminar-Workshop held at FHIA, La Lima, Honduras, was a key event to incipiently demonstrate the new tools to the farm operators, who showed a great deal of satisfaction and advanced training was requested.

AKNOWLEDGEMENTS

FHIA WOULD LIKE TO AKNOWLEDGE THE PEOPLE OF THE UINITED STATES OF AMERICA THROUGH THE REGIONAL USAID OFFICE TO MAKE THIS PROJECT AN OUTSTANDING COLLABORATIVE EFFORT THAT WILL ENHANCE THE CAPABILITIES OF THE FARM OPERATORS IN THE GULF OF HONDURAS WATERSHEDS AND INCREASE PRODUCTION WHILE REDUCING THE IMPACT IN THE NATURAL RESOURCE BASE OF MAR.

FHIA WOULD ALSO LIKE TO COMMEND THE SUPPORT AND DEDICATION OF THE CCAW/CHEMONICS FOR REVISING AND APPROVING THE GRANT 404FO-APS01-FHIA. OUR AKNOWLEDGMENT GOES TO ROBERT WALLE, SONIA URIBE, EVELYN ESCOBAR AND CLAUDIO SAITO.

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FINALLY, FHIA ALSO RECOGNIZES THE QUALITY WORK PERFORMED BY CLAUDIA SOLORZANO FROM MEDIA CONSULTANT TO REGISTER THE EVENTS OF THE WORKSHOP IN AN OUTSTANDING VIDEO CLIP.