Drones for Precision Agriculture

Drone Technology Development Program for Precision Agriculture Aims to Help Farmers Reduce Environmental Impact and Increase Crop Yields

In Brazil, a global agricultural superpower, family farms account for approximately 85 percent of all rural properties and produce more than 70 percent of food consumed domestically. In collaboration with the Brazilian Agricultural Research Corporation (Embrapa) and the Institute of Solidarity Socioeconomics (ISES) on the Drone Technology Development Program for Precision Agriculture this program innovates drone technologies that will provide accurate, real-time agricultural intelligence to farmers, enabling them to reduce environmental impact and increase crop yields. Ultimately, the program aims to demonstrate how drones for precision agriculture may reduce the negative impact of climate change by providing timely and accurate information to farmers, allowing them to take immediate actions in favor of the environment and their business.

BRAZIL
2018 Statistics*

Population (2017 est.) **207.3 million**

Life Expectancy **74 years**

GDP Per Capita (2016 est.) **$ US$15,500**

Mobile Penetration **112.54%**

*Sources: CIA World Factbook (https://www.cia.gov/library/publications/the-world-factbook); Mobile penetration data provided by Ovum World Cellular Information Service and based on market intelligence.

Challenge

- Brazilian farmers would benefit greatly from access to real-time reports of the environmental condition of their fields, processed by drones for precision agriculture. But today, high costs, the need for specialized operators and technicians, and access to powerful computers make the use of drones in agriculture inaccessible to most of the nation's farmers.

- For farmers who are able to use drone technology, intelligence data gathering and reporting is a four-step process that can take hours, or even days, to run a complete cycle:

  ° Fly the drone over the land to capture a set of images;
  ° Extract the memory card with captured images from the camera on the drone; transfer it to a web-connected device and upload the images to a processing server;
  ° Wait for the server to complete the data analysis;
  ° Read the analysis and take necessary actions, such as irrigating areas that appear dry, fertilizing areas that are producing little crop and spraying pesticides in bug-contaminated areas.

- Agrochemicals are widely used in Brazil to protect crops from pests, disease and invading species. Indiscriminate use causes unnecessary accumulation of those substances in the soil, water and air.

Solution

- For this program, a research laboratory will be installed within Embrapa's National Precision Agriculture Laboratory (LANAPRE) in São Carlos to enable the development of on-board systems that will be embedded in commercially available lightweight drones.

- The on-board systems will combine Embrapa's expertise in agriculture and image processing algorithms with Qualcomm's® Snapdragon Flight™ drone platform and advanced wireless technologies to collect, process, analyze, and transmit real-time crop intelligence data to farmers while flying over their fields. The on-board systems will serve as proof-of-concept for a flying drone that will provide image-based agriculture intelligence.

- Farmers will have access to precise crop intelligence metrics and recommendations for taking specific actions corresponding to this intelligence, such as irrigate, fertilize or spray pesticides, in order to produce higher crop yields. The ability to pinpoint areas needing action allows for spot application rather than whole-field treatment, which reduces negative impacts to the environment.

- Farmers will access the information via a user-friendly web interface, accessible by a 4G, WiFi or LAN capable device, such as a smartphone, tablet or PC.

Technology

- Qualcomm® Snapdragon Flight™ drone platform
- Embrapa's image processing algorithms
- On-board system with a user-friendly web interface accessible by a 4G, WiFi or LAN capable device
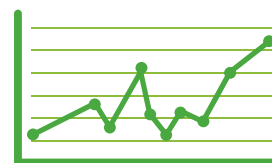
Impact

Accelerating Adoption
By developing robust on-board systems for drones and providing a proof-of-concept, this program can accelerate the widespread adoption of drone technology in the farming industry.

Demonstrating a Wide Range of Benefits
Ultimately, the program aims to demonstrate to Brazilian regulators, researchers, environmentalists, farmers, agriculture service providers and drone manufacturers the innovative use of drones to improve agricultural yields as well as to monitor and reduce environmental impacts.

Economic and Social Impact
Future phases of this program will include field testing and an evaluation that measures economic and social impact.

Program Stakeholders

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StoveTrace
A Mobile Application to Monitor Use and Promote Adoption of Clean Cooking Technologies

The StoveTrace program demonstrates how mobile networks can aid in advancing the economic, health and environmental objectives of individuals and communities. StoveTrace provides an affordable, reliable, mobile-phone-based monitoring device to enable widespread participation in a voluntary carbon market when individuals use clean cookstoves instead of traditional biomass burning cookstoves.

Challenge

- Nearly three billion people, about 40 percent of the world's population, depend on traditional cookstoves that use fuels like firewood, cow dung and crop residues for their cooking needs.[1]

- The Global Burden of Disease Study 2010 estimates that four million people die each year as a result of inhaling the smoke and soot produced by cooking over traditional cookstoves.[2]

- Switching to clean cookstoves can reduce the amount of firewood used for cooking, as well as the amount of smoke produced indoors and outdoors, reducing pollution and improving health for the women and children who are most exposed to the smoke.

- Unfortunately not all clean cookstoves perform well in the field. Advanced clean biomass-burning cookstoves still burn locally available biomass, but dramatically and measurably reduce harmful emissions.

- At a cost of approximately 2700-6500 Indian rupees (US $42-$100) each, advanced clean cookstoves are currently unaffordable for the estimated two billion people worldwide living on less than US $3 per day.

- Registered carbon credit programs are beginning to provide financial incentives for reducing carbon emissions through the use of clean cookstoves. However, it is difficult and expensive to verify that these stoves are being used and measure the reduction in carbon emissions that results from use of clean cookstoves, making it a challenge to apply carbon credits for improved cooking technologies.

INDIA
2018 Statistics*

Population (2016 est.)		**1.28** billion
Life Expectancy		**68.8** years
GDP Per Capita (2016 est.)	$	**US$7,200**
Mobile Penetration		**86.14%**

## Solution

- To address this challenge of accurately and affordably verifying the use of a clean cookstove, StoveTrace, a state-of-the-art mobile-phone-based temperature sensing application, has been developed.

- StoveTrace was created to support Project Surya, an international collaboration between the University of California, The Energy and Resources Institute (TERI) and Nexleaf Analytics. Project Surya is an initiative focused on mitigating climate change by integrating clean cooking technologies with innovative sensing and climate financing for reduction of carbon dioxide and black carbon.

- The StoveTrace system includes a mobile-phone-based temperature sensing application, a thermal sensor that connects to the mobile device and a web-based analytics dashboard. Each time the clean cookstove is fired up, the StoveTrace senses the cooking event via the temperature probe and stores and uploads cooking event data.

- The temperature data is wirelessly uploaded from the mobile phone to a central server via a wireless broadband network.

- The data collected includes the number of times a stove is used and the duration of each use, enabling remote verification of stove usage. This data can be used by carbon market investors as verification of reduction in carbon emissions.

- A web-based dashboard has been developed which shows the number of times the stove has been lit and duration of cooking.

- Vodafone mPesa enables remittance of the carbon market payments directly to the clean cookstove users.

*Sources: CIA World Factbook (https://www.cia.gov/library/publications/the-world-factbook); Mobile penetration data provided by Ovum World Cellular Information Service and based on market intelligence.
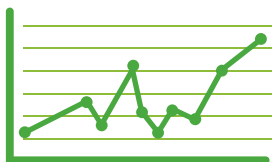
Accurate Tracking
StoveTrace sensors have been determined to be the most accurate in tracking cookstove usage and more reliable than other methods like self-reporting and data loggers.

>140,000

Over 140,000 Hours Logged
StoveTrace has been tested and validated in field settings involving more than 700 households in rural villages in Uttar Pradesh and Orissa, India. Participating families have logged over 140,000 cooking hours on clean cookstoves, saving 530 combined tons of carbon dioxide and black carbon.

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Insightful Data
Continuous monitoring of clean cookstoves through StoveTrace improves understanding of cookstove usage and reveals insights to drive behavior change for increased adoption of clean cooking technology without using tedious and unreliable surveys.

Less Downtime
StoveTrace data has also enabled clean cookstove implementers (including NGOs, manufacturers and entrepreneurs) to detect mechanical breakdowns, allowing implementation teams to quickly repair the stoves resulting in resumed usage by the families.

Micro-payments
Stove users have been rewarded thus far with a combined total of nearly US $1500 in micro-payments, commensurate with hours of usage, paid directly to their bank accounts. Additionally, remittance of carbon credits to families based on clean cookstove usage has led to increased clean cookstove usage among families.

Successful Collaboration
The Gold Standard Foundation, Nexleaf Analytics, and the University of California San Diego among other experts in climate and development, have collaborated in launching a pioneering methodology for quantifying and monitoring emissions from black carbon and other short-lived climate pollutants which will drive finance into projects that provide an immediate and measurable impact on mitigating climate change at a local level.

Program Stakeholders

NEXLEAF ANALYTICS

project surya
Fighting Climate Change Now

teri

Qualcomm
wireless reach

[1] http://cleancookstoves.org/resources/reports/fiveyears.html
[2] Lim S.S. et al., 2012, A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010, Lancet, 380: 2224-60.

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MEXICO

2018 Statistics*

Population (2018 est.) — **125 million**

Life Expectancy (2018 est.) — **76.3 years**

GDP Per Capita (2017 est.) — **US$19,900**

Mobile Penetration (2018 est.) — **85%**

*Sources: CIA World Factbook (https://www.cia.gov/library/publications/the-world-factbook); Mobile penetration data provided by Ovum World Cellular Information Service and based on market intelligence.

Smart Water

## Increasing water quality through IoT solutions and community engagement

The only source of drinking water in the Yucatan Peninsula in southeast Mexico comes from a karst aquifer system that is highly susceptible to pollution from human activities. In collaboration with s::can, Junta de Agua Potable y Alcantarillado de Yucatán (JAPAY) – the Yucatan public water authority – the Social Intelligence Unit, Grupo LAN, and Colectividad Razonatura, the Smart Water project provides accurate and real-time data to increase awareness and understanding of water quality in the local community through Internet of Things (IoT) solutions and community engagement activities. Smart Water features smart sensors powered by Qualcomm® wireless technologies to measure key parameters of water quality, providing access to information to government administrators from JAPAY through the use of the Dime H_2O mobile application. Local citizens are encouraged to participate in an educational campaign designed to learn about preventing water contamination, reporting problems, and improving water stewardship.

Challenge

- The absence of robust sanitary drainage networks in the Yucatan Peninsula makes the karst aquifer highly vulnerable to contamination.
- There is limited public understanding about the uniqueness of the karst aquifer geology and its highly permeable limestone composition and deposits.
- Water authorities rely on labor-intensive and expensive water quality measurements, which are prone to human error.
- Groundwater resource management is inadequate and available water quality data is limited.
- Water quality test results are not readily available to the public.
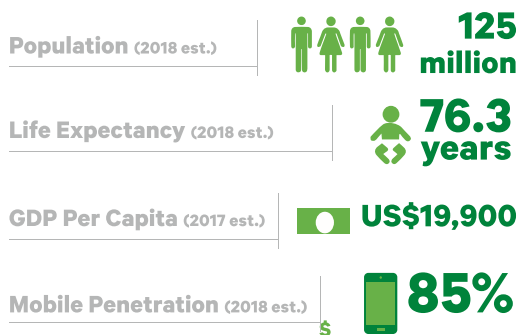
Solution

- Smart IoT sensors, powered by Qualcomm® wireless technologies, are installed in two strategic locations in Merida City. The first is located at the largest water distribution plant in the City and the second is found at the Water Distribution Center, which is responsible for servicing the Dolores Otero neighborhood.
- Connected to a 4G Wireless Network, the smart IoT sensors measure turbidity, free chlorine, dissolved organic carbon (DOC), total organic carbon (TOC), water conductivity, temperature, nitrates, and pH. This information is uploaded to the Dime H_2O system for analysis and the generation of a Water Quality Index.
- The Dime H_2O mobile application provides both the community and JAPAY:
  - Access to the scientifically designed Water Quality Index for the Yucatan Peninsula karst aquifer system
  - Instant access to critical water quality parameters from the s::can's sensors, making it possible for team members to take immediate actions, if necessary
  - To the community only:
    - Access to multimedia educational content
    - An interactive feature for reporting problems such as water leaks
    - Members of 100 households in Dolores Otero were provided with Qualcomm-enabled smartphones and participated in an education campaign designed to increase local awareness on how to preserve water resources and prevent water contamination from human activities
  - To JAPAY administrators only:
    - Delivery of alerts when water quality parameters are out of range, requiring follow up action from JAPAY
    - Graphic visualization of water quality parameters
    - Immediate access to JAPAY's laboratory test results

Impact

Operational efficiencies in administering water quality tests

80% less time spent by JAPAY personnel collecting measurements. Over 2,000 more DOC, TOC, and nitrates measurements collected during a three-day data collection period.

More effective management of pollutants that are found in water once extracted from the karst aquifer system

88% of water quality index measurements were within Mexican water quality standards due to the improved water quality monitoring process in JAPAY.

Increase confidence in water quality understanding

Nearly 100% of household representatives reported an increase in confidence in water quality knowledge after participating in the water education campaign activities.

Program Stakeholders

[1] Herrington, P., Newborne, P., & Saade-Hazin, L. (2003). Social issues in the provision and pricing of water services. Paris: OECD.
[2] CONAGUA (2015). Programa Hídrico Regional 2014-2018 de la Región Hidrológico-Administrativa XII Península de Yucatán.
[3] CONAGUA. Programa Hídrico por Organismo de Cuenca, Visión 2030, Región Hidrológico-Administrativa XII, Península de Yucatán.

November 22, 2019

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