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Application note

AgriMaps: Improving site-specific land management through mobile maps

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ABSTRACT

Population pressures have led to crop cultivation taking place on steep slopes and other marginal lands in the small island developing states of the Caribbean. This threatens regional food security and can result in environmental degradation if site-specific land management practices are not adopted. AgriMaps is a mobile application developed to support decision making in the agricultural sector of Trinidad and Tobago. This application uses an evidence-based approach to making crop and mitigative land management recommendations. The app is a platform for spatial data visualization and provides a greater range of geo-spatial information than is currently available to stakeholders in the farming community. It is envisioned that this application will improve land use planning decisions and the adoption of sustainable agricultural management techniques. We provide the theoretical and technical frameworks needed to develop similar ICT tools in other territories.

1. Introduction

Food insecurity in the Caribbean region is partly due to the limited availability of arable land resulting in most crop production taking place on lands with limited agricultural capability. Farmers in the Caribbean typically rely on agro shop owners and other informal channels for guidance on land management due to limitations in the agricultural extension system (Raymond et al., 2013). This reduces the likelihood of best agricultural practices being adopted, resulting in reduced soil productivity and increased risk of environmental degradation. Increasing soil productivity is essential to improving food security in the Caribbean. Better methods of planning land use and identifying optimal growth conditions for crops are therefore needed.

The implementation of Precision Agriculture (PA) practices has helped to foster effective land use in developed countries. Often associated with high degrees of mechanization, PA provides a methodology for in-depth detailing of land use plans and accurate farm management (Olson, 1998). PA relies heavily on gathering accurate data at the right time to inform and manage decisions. In this way, food security can be monitored more effectively. These characteristic features of PA pose a challenge for small holder farms synonymous with small island developing states (SIDS) due to limited resources. A new methodology is needed to mitigate these challenges, SIDS need better ways to determine land use and identify optimal conditions for crop cultivation in order to manage limited land resources to their advantage.

An ICT tool which can provide agricultural stakeholders with information on land use planning and farm management can improve decision making and achieve some level of PA, mitigating the challenges often experienced across SIDS. More specifically, a mobile ICT tool which can identify spatial features as well as provide recommendations on the most suitable crops to cultivate can optimize land use, improve crop yields and readily provide soil suitability details to educate stakeholders on the versatility and limitations of the agricultural land in their current location.

Such a tool complements goals related to development policies in the agricultural sector of Trinidad and Tobago. For example, policy initiatives such as the National Food Action Plan 2012–2015 promote sustainable agriculture for the purpose of medium to long-term food security (Ministry of Food Production, 2012). Other policies like the Agricultural Policy Framework and Vision2020 were created to stimulate improvement in agricultural production and increase the use of technology in the sector as a way to increase foreign exchange through exports (Ministry of Agriculture, Land and Marine Resources, 2006). With 122 distinct soil series in Trinidad, there is significant spatial variability that warrants the need for technology applications catered to

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predominantly small holder farms. Understanding how the characteristics of land can optimize use and earmarking specific areas and crops for agricultural investment can be improved. This will empower those in the public service entrusted with this responsibility as well as all other land users.

AgriMaps is one such solution. This application (app) can be downloaded from the Google Play Store using the search keyword 'agrimaps'. At the time of writing, data was available for Trinidad and Tobago only.

2. Background

AgriMaps is a personalized e-extension tool which allows for the visualization and analysis of spatial features. The app first identifies a user's current location and provides details on the surrounding spatial features. The app is free of cost, built on an open data platform and has a core recommendation feature that provides suggestions on the best crops to plant and supporting land management practices. AgriMaps can be applied to any country with georeferenced edaphic and climate data.

Where comparable apps have been found, much of the extant literature details applications which act as web portals, online discussion boards and blogs, short message services (SMS), mobile apps for collecting sample data and tailored to specific needs. For example, e-extension (Phillipines), Agropedia, aAqua (India) and Pakissa (Pakistan) were developed for use across specific developing countries (Brugger, 2011). These applications provide web-portal services and act as discussion boards and blogs.

In the Caribbean, the Jamaica Agriculture Market Information System (JAMIS) and the National Agriculture Market Information System (NAMIS) exist. Both provide weekly pricing information on commodities across local markets in SMS format (Goundar, 2010; Ganpat and De Freitas, 2010). The latter application, NAMIS, is available in Trinidad and Tobago. Although not mobile, there are digital open access spatial soil and land resources for Jamaica and other Caribbean islands (Food and Agriculture Organization of the United Nations, 2000). Available data includes soil fertility maps detailing pH, phosphorus and potassium, for example.

The Africa Soil Information Service (AfSIS) is specific to soil mapping and developed for the African continent. The application, which has geospatial and mobile capabilities, provides a mechanism for soil sampling and mapping ecosystem change (ISRIC/WDC-Soils, 2013). It is one which offers recommendations for soil improvement and land management though, unlike AgriMaps, the recommendations are not explicitly detailed (Sachs et al., 2010).

Other geospatial apps exist. Optimizer 2.0 is a web portal with SMS features. This web app uses data on soil type, weather and other growing conditions to determine information on estimated yields (Advance Ag Solutions Technology, 2013). YieldCheck is specific to iOS and estimates corn yields. Like Optimizer 2.0, users are able to visualize yield data directly related to an area of interest (Precision Planting LLC, 2015). iCropTrak is a farm management iOS app which is used to track all resources and outputs that make up the farming cycle (Cogent3D Inc, 2015). The app uses spatial data for visualization. PrecisionEarth gives users the opportunity to upload and download soil sampling details using spatial data as the backdrop for visualization (Cogent3D Inc, 2015). It is an iOS app, based on the open standards concept such that data can be transferred between mobile and desktop devices seamlessly.

Table 1 provides a synopsis of these applications. Though each of the applications support PA in some way, AgriMaps offers a specific combination of advantages. It is free to users, provides soil and land data in an accessible format and educates agricultural stakeholders by providing recommendations on crops to cultivate as well as site-specific management practices for improved land management.

Though traces of these features can be found in the applications presented in Table 1, all of these features are encapsulated into this free to use AgriMaps application. For farmers, the app provides descriptive details specific to their area of interest and illustrates how best the land resource can be utilized in terms of cultivation. This is beneficial as this method of matching soil and spatial features to crops based on suitability optimizes the use of the land and has the potential to create greater yields at harvest time (Beaton and Nelson, 2005). For extension services, AgriMaps translates material previously held in physical books such that land information becomes more readily available. For planners and other stakeholders who view the agricultural sector at the macro level, issues of zoning and land use can be addressed to the extent that development policy can be better informed.

The app is not merely a web-portal which may present users with more information than needed or a discussion-based tool whose accuracy must be closely monitored. It is not specific to one crop or focused on data storage only, rather, it is a personalized, geospatial crop recommendation tool which provides in-depth details in an accessible way.

3. AgriMaps technical development (methodology)

The Android-based app is facilitated by a standard mapping interface with Open Street Maps as the underlying map source. The app offers two distinct modes; Land Profiles and Crop Recommender. The Land Profiles mode allows for the visualization of specific spatial features while the Crop Recommender mode provides recommendations on suitable crops for cultivation in a pre-specified location. Landmarks of interest are also detailed in this mode, i.e. nearest river and major road. Fig. 1 highlights each mode.

In Fig. 1 (left), the GPS locator identifies the user's position; shown in the center of the map. Here soil series data is detailed within a 500 m radius of the user's position. Each soil series is color coded and users can access specific lithological and analytical

Table 1
Synopsis of Comparable Agricultural Applications.

Application Name	Region of applicability	Spatial data visualization	Crop Recommendations	Distinguishing feature
e-Extension	Philippines	Static pictures available	Not explicit	Online training
Agropedia	India			Online encyclopedia
aAqua	India			Online discussion board
Pakissa	Pakistan			Web-portal
JAMIS	Jamaica	No	No	Weekly pricing details for local produce
NAMIS	Trinidad and Tobago	No	No	Weekly pricing details for local produce
AfSIS	Africa	Yes	Not explicit	Soil data repository, soil sample collection and management
Optimizer 2.0	USA	Yes	No	Soil data, estimated yields
YieldCheck	USA	Yes	No	Estimated corn yields
iCropTrak	USA	Yes	No	Farm management
PrecisionEarth	USA	Yes	No	Soil sample collection and management