Applied Research Partnerships with Developing and Transition Countries
Swiss Universities of Applied Sciences and Universities of Teacher Education

Foto: Daniel Pittet

Project title

Revealing New Opportunities for Fruit growers in Colombia in a Collaborative Site-specific Agricultural Setup

Thematic focus

Site-specific agriculture, bio-inspired systems, crop modeling

Year

2012

Project location

Cali and south-west of Colombia

Swiss Institution

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Description

Tropical fruit growers have little reliable information on the factors that affect the development and yield of their crops and there is a dearth of information on the proper conditions to grow and manage them (so far, this criterion resides in the mind of a handful of experts and practitioners), yet native tropical fruit could be an affordable alternative for developing countries, as they have high regional demand and are potentially exportable to developed countries at interesting prices. One way for farmers to improve the management of their fields is for them to learn from their multiple experiences over a wide range of conditions and management. This approach is being implemented in a collaborative program,"Site-specific Agriculture based on Farmers Experiences" (SSAFE) [www.frutisitio.org] in Colombia (2010-2013), in which potentially thousands of farmers are being encouraged to share their experiences, with the objective of modeling their crops by means of machine learning and statistical techniques, in order to produce specific recommendations about what to plant, as well as techniques for boosting both yields, quality and sustainability. This project has the objective of revealing new opportunities for small-scale farmers by further exploiting the data they are providing. In particular, by introducing a Fuzzy Logic approach and by integrating the temporal context of the crops.

Development relevance

Just as biotechnology has opened up immense new opportunities for genetic improvement of crops, advances in modern information technology makes it possible to revolutionise the incorporation of improved management practices in agriculture, which contributes to 10.3% of the GDP of Colombia, contributes to 21% of national employment, and rural areas have the highest levels of poverty in the country. National analyses of the fruit industry in Colombia have identified enormous unrealized potential for income generation and poverty alleviation through the increase of land devoted to fruit production, and through productivity enhancements in existing fruit production systems. Cultivating fruit trees is a viable pathway to cover not only the food missing in the diet of rural people, but also to increase farmer's incomes.

Avocado (Copturus aguacatae)

SSAFE program fieldwork data collection

KFH
Rektorenkonferenz der Fachhochschulen der Schweiz
Conférence des Recteurs des Hautes Ecoles Spécialisées Suisses
Conferenza dei Rettori delle Scuole Universitarie Professionali Svizzere
Rectors' Conference of the Swiss Universities of Applied Sciences

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Main features of the project

Agricultural site specificity refers to precise information from a given cultivation instance or cropping event that accurately relates crop behaviour to the variation in such factors as the weather, soils, crop management, and social and economic conditions. This information can be used to predict crop performance under various management scenarios and hence can be used to more efficiently manage the production. In simple terms it allows the farmer to answer the question “What happens if I manage my crop in a certain way under my specific conditions?”. Due to the nature of information collected from farmers’ experiences, it may often be imprecise and/or incomplete and hence, the techniques employed when processing it have to tolerate imprecision, uncertainty, partial truth, and approximation. So far we have explored the use of Artificial Neural Networks (ANNs) as modelling tool because of their inherent plasticity, meaning their ability to adapt (learn) their parameters hence to attain a required behaviour. However, ANNs are black-box models demanding additional processing in order to understand the underlying relationships they represent (Satizabal and Perez-Uribe, 2007). Another bio-inspired approach having similar characteristics in terms of robustness is fuzzy logic (Peña-Reyes, 2004). The power of fuzzy systems lies in their representation of knowledge, expressed in terms of linguistic rules containing human-like concepts as “Low” or “Fast”, thanks to which, humans can interact with them by extracting, injecting, and modifying the knowledge they contain. Additionally, being rule-based, they appear to be a feasible approach when working with the combination of various factors that are known, both to vary from site to site and over time and also to impact production in site-specific agriculture.

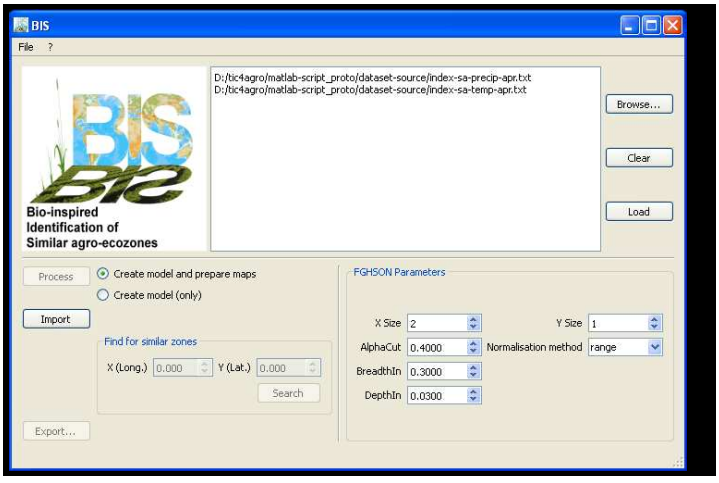
We propose two complementary lines of research:

i) one concerns the derivation of recommendations in the form of simple rules by using a Fuzzy modelling approach (Peña-Reyes, 2004) in conjunction with our machine learning models (Jiménez et al. 2009, Satizábal et al. 2010, Jiménez et al. 2011), and

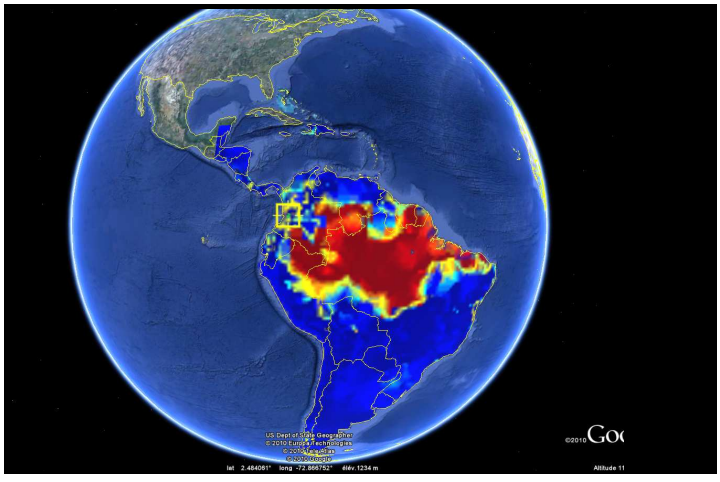
ii) a second line that will consist of explicitly integrating the temporal variation of the farming data in the models (Barreto, 2011), which has often been overlooked in the past.

This project will provide an extension to the BIS software (Bio-inspired Identification of Similar agroecozones) developed in a previous KFH-DC project, which now, based on the experience and data gathered in the SSAFE project, will allow farmers to recognize new opportunities not only by identifying recommendations based on information from high yield regions, but also by uncovering management practices used by growers who obtain exceptionally good results in spite sub-optimal environmental conditions.

New opportunities will be moreover uncovered by "harnessing time", that is, by considering environmental conditions over time, in order to provide new insights about when to plant, when to harvest, and in many perennial crops, how to manage the crop at different times of the year so as to maximize production when market demand is greatest and prices are highest. This is of paramount importance in tropical regions where it is often possible with adequate management either to harvest all the year round, or to concentrate production in those months when prices are high. Last but not least, these models will enable us to estimate the consequences of climate change on crop yield, given that a permanent shift to higher average temperatures, or radical changes in rainfall patterns, might induce farmers to grow different crops (e.g., it has been predicted that the main corn growing region would shift north from the USA into Canada (Smit et al., 1988, Jonnes, 2000).



Bio-inspired Identification of Similar agro-ecozones software tool. The BIS software currently exploits the FGHSOM algorithm to model environmental or crop data.



The BIS software generates both, a hierarchical set of clusters and a map illustrating the belonging of sites to the clusters of the model. This information is then used to recommend fruit growers. We are currently enhancing this software by integrating a Fuzzy Logic approach and the temporal context of crops.