UNIVERSITY OF SOUTHERN QUEENSLAND

An Integrated Climate-Crop Forecasting System

for Robusta Coffee Yield

General context

Coffee is one of the most important commodities in the international agricultural trade, playing a crucial role in the economy of several African, American and Asian countries. Current coffee bean production is dominated by Arabica coffee, which represents roughly 60% (40% for Robusta coffee; International Coffee Organization 2016). The coffee industry's growth is expected to be fuelled over the next years given an increased activity at both consumer and trade levels from local and international players.

The success of the coffee industry depends heavily on capitalising on the opportunities and minimising the risks associated with climate variability along the supply chain. Given the importance of climate risks and vulnerabilities of the coffee industry in coffee growing regions (tropical and sub-tropical zones), a special attention is required in regard to the use of seasonal climate forecasts throughout the coffee value chain at reliable and relevant spatial and temporal coverage and scales. Indeed, accurate and relevant seasonal climate forecasts are pivotal for the success of any agricultural industry that plans or sells ahead of the annual harvest.

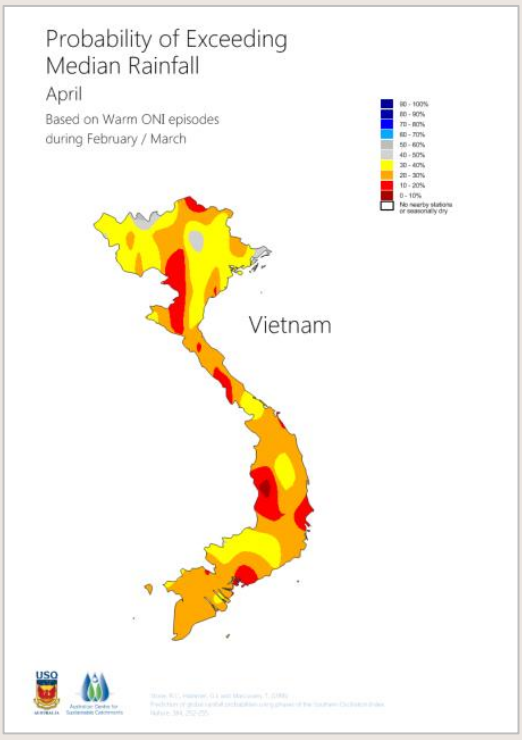
Furthermore, operational process-based model for Robusta coffee bean yield estimates at larger spatial scale (e.g. regional scale) are very limited. So far research efforts have been focusing on the impacts of climate change on coffee productivity (e.g., Bunn *et al.* 2015, Craparo *et al.* 2015) and distribution at a national or global scale (e.g., Davis *et al.* 2012).

The integrated seasonal climate-crop yield forecasting system has been developed for Robusta coffee

ICACS/USQ is well known as a leading climate science research agency, and renowned for its ability to integrate climate risk management into agricultural productivity models and environmental and key business decision making processes. Thus, an integrated seasonal climate-crop yield forecasting system has been developed for Robusta coffee (i.e. ICCFS-Robusta coffee), and tested for the Vietnamese coffee industry (Vietnam is the second largest producer of coffee beans worldwide, the first in Robusta coffee; FAO 2016). Through the ICCFS-Robusta coffee, targeted seasonal climate and coffee potential yield/production forecasts are delivered for all for key coffee producing regions, as required.

Seasonal climate forecasts

Provision of regularly appraised and improved 'targeted' seasonal and longer term forecasts (specific aspects and parameters such as frost, maximum and minimum temperatures, and rainfall) for nominated key coffee producing regions on regular rolling three month basis (or more targeted temporal scale) by means of ICACS/USQ in-house seasonal climate forecasting systems as well as latest advanced general circulation models (GCMs).



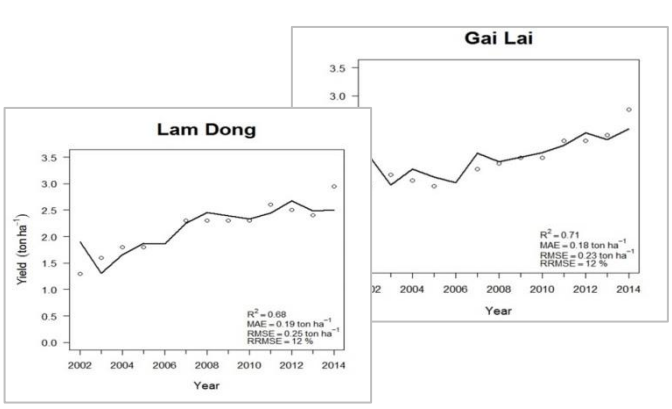
Robusta coffee yield forecasts

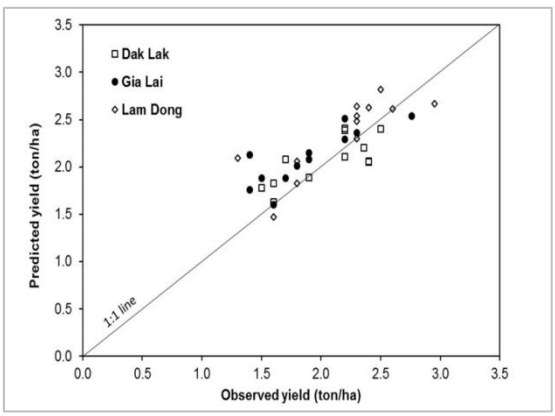
A biophysical model for predicting Robusta coffee bean yield at a regional scale has been developed. The model simulates the growth of different organs and the phenology of coffee plants at daily time step, based on initial information from the previous season (i.e. harvest date and yield) and meteorological data (minimum and maximum temperatures, solar radiation, rainfall). Inter-annual Robusta coffee yield variability can be captured, with prediction errors (root mean square error) ranging from 0.23 to 0.25 ton ha-1 (~12% of error).

Yield forecasts are performed on basis on analogies analysis, i.e. (i) simulation of Robusta coffee yield for the next season using projected seasonal climate data, (ii) similarity analysis of climate conditions based on a 30-year period and long-term coffee yield data, and (iii) probabilistic forecast of the coffee yield at the regional scale.

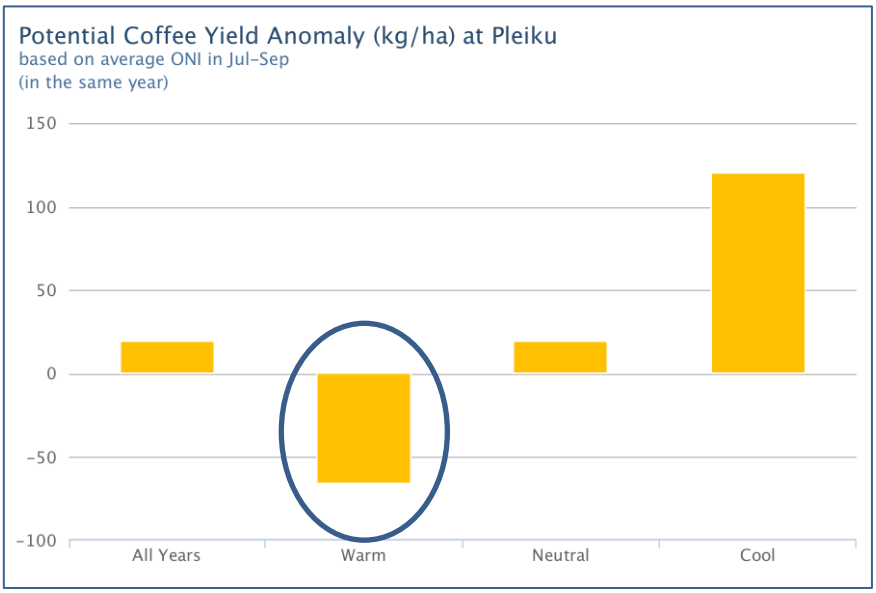
Example of the application of the ICCFS-Robusta coffee for selected coffee growing provinces in Vietnam

Rainfall over the Central Highlands in Vietnam is mainly governed by monsoon. Inter-annual variations tend to be associated with the El Niño-Southern Oscillation, which is believed to influence monsoon behaviour, resulting in drier and warmer than average conditions in Southeast Asia during El Niño years. Through our forecasting system, monthly forecasts of temperatures and rainfall for the Central Highlands provinces are delivered. Additionally, actual/received rainfall maps for the preceding month are provided. An example of forecast rainfall probability value is depicted in figures below.

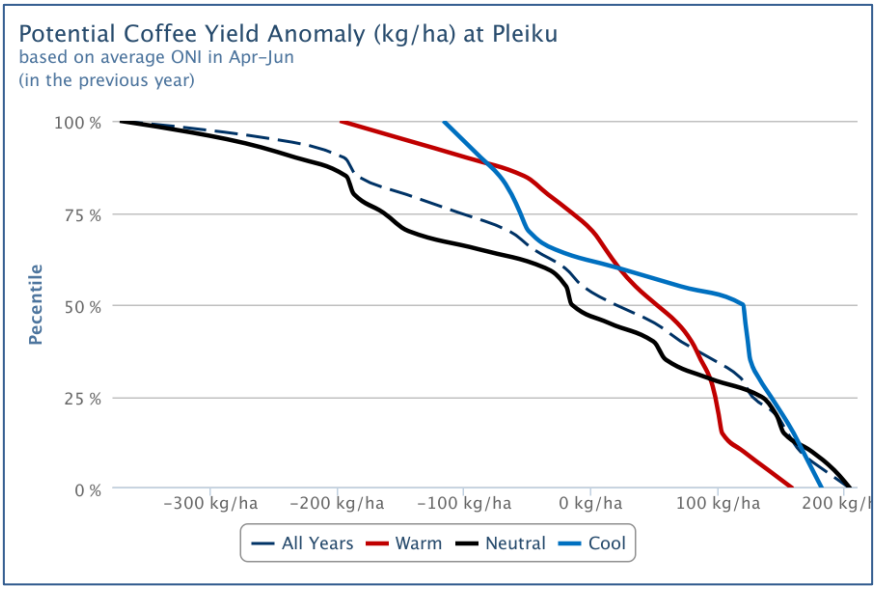




Using the seasonal climate forecasts into the Robusta coffee biophysical model, and on the basis of analogies, the potential coffee yield anomaly for the next growth season is provided:



Forecast of shift in yield for Pleiku district, Gia Lai province that would have been issued this July to September period for harvest of 2015. The pattern this year is shown circled.



Forecast of Robusta coffee yield shift 1.5 years before harvest: example for Pleiku, Gia Lai province, as would have been issued over a year ago. The forecast of shift in yield that would have been forecast in 2014 for the 2015/16 season is the red line (Warm period). This demonstrates that through the ICCFS-Robusta coffee, it is possible to commence forecasts of likely yield shifts 1.5 years before harvest.

USQ Research

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