

# AI for Earth Grantee Profile

## Farming Online

### Optimizing coffee harvesting with AI

## Summary

Coffee farming is a financially risky effort because the coffee berries ripen at varying rates even on the same tree branch, making it challenging to avoid a wasteful amount of underripe or overripe fruit. Climate change is increasing that risk by reducing yields and quality, increasing pests and diseases, and even making farmlands untenable. These changes are not merely an inconvenience for coffee drinkers around the world, but represent a serious threat to the livelihood of tens of millions of small-scale farmers in developing nations. Farming Online is working to mitigate that risk by enabling farmers to harvest a higher proportion of fully ripe coffee. Through a Microsoft AI for Earth grant, the Farming Online team is developing a machine learning model and smartphone app that will let farm workers in the field use photos of the coffee berries and current weather data to predict the best time to harvest.

## Optimizing coffee harvesting with AI

Coffee is one of the most-consumed beverages in the world, with [over 2.25 billion cups drunk a day](#). Meeting this demand is the work of 25 million coffee farmers, most of whom are smallholders—individual families running small-scale farms. And over 125 million people make a living from the global coffee trade, which is worth US \$19 billion.

**With current coffee picking methods, anywhere from 25 to 80 percent of the fruit may end up being unsuitable for use, at a loss to farmers and producers.**

But in recent years, these livelihoods have become threatened as [climate change makes coffee farming more difficult](#). Coffee trees require cool to warm tropical climates with moist, rich soil for optimal fruit growth, and as global average temperatures rise and rainfall patterns change, the yield and quality of the fruit will decline. The warming climates already are increasing the spread of pests and diseases such as the coffee berry borer and leaf rust fungus. Sustained warming will also shift the suitable farmlands to higher elevations, reducing the overall available area.

Even without the effects of climate change, coffee farming is already a laborious and sometimes financially risky effort. Coffee berries (coffee “beans” are actually the seeds of this fruit) ripen at different rates even on the same branch of a single tree, presenting a challenge for harvesting. One variety, Robusta, which is used mainly for lower-quality instant coffee, may be strip-picked all at once, which can be done by machine, but this risks a low ratio of ripe to unripe or overripe berries, affecting the quality of the final product.

The other and higher-quality variety, Arabica, which makes up 70 percent of the supply, must be hand-picked individually as the berries become ripe, which is labor-intensive and time-consuming. This selective picking is done on an eight to ten-day rotation, but even in that time period some berries will transition from nearly ripe to overripe.

With either method, anywhere from 25 percent to 80 percent of the fruit may end up being unsuitable for coffee production, resulting in a loss to both the grower and the producer. Improving this ratio of suitable fruits harvested would help farmers increase their revenue and maintain their livelihood, especially in the face of climate change.

### **Predicting the best time to pick coffee**

A team with [Farming Online](#), led by Peter Griffith, hopes to meet that challenge. After meeting some smallholder coffee growers in Nepal during work on another project, Griffith’s team became interested in this problem and how modern technology, including neural network machine learning and smartphones, could help. Whether harvesting by hand or machine, farmers judge the ripeness of the coffee berries by sight.

**With a smartphone app predicting when the most berries will be ripe for picking, farmers can harvest a more uniform crop, increasing their revenue.**

Berries change from green through orange toward red as they ripen. Red berries are fully ripe and provide the best flavor, and then the berries darken toward black when they are overripe. That means a machine learning model can be developed to identify the percentage of ripe berries through image recognition. Furthermore, by taking into account the current conditions such as daily temperatures, soil moisture content, and rainfall, the model can further predict the optimum date for picking the berries. When this model is combined with a smartphone app that can take photos and process the images in real time, the farmers would be able to assess their crops right in the field and decide when to harvest for a more uniformly ripe crop.

Farming Online received a Microsoft AI for Earth grant to pursue this project. With access to Microsoft Azure cloud platform components, including the Custom Vision Service, App Service, virtual machines, Azure SQL

Database, and storage, Farming Online has all the tools they need on a widely supported platform. Rather than developing everything from scratch, the team can focus on training and refining the image recognition and prediction models, and building a custom app that will be simple and intuitive even for workers with low literacy skills. The team will draw upon their own experience with machine learning, database structuring, smartphone app development, and the needs of low-literacy users to bring the project to life.

## Going forward

Currently, the team is using photos from coffee farms in Brazil and Vietnam to train the image recognition model. Initial results have been encouraging and also helpful in identifying the photo conditions that give poor results and what kinds of image cleanup can help increase correct assessments. In addition to further developing the model to improve its accuracy, the team is acquiring more test images from its partners in Brazil and Vietnam, and is working with Microsoft to explore other training models and machine learning techniques. Meanwhile, the smartphone app development has proceeded with work on accepting and processing images from the field, with plans for releasing a beta test version in the (northern hemisphere) summer.

Beyond this coffee-focused project, Griffith and his team anticipate that their work will benefit other efforts to improve agricultural production in the developing world. The general concept of applying machine learning solutions to smartphone-camera images for better farming management can be adapted to other crops, such as pepper or tomatoes which are key cash crops for smallholders. The Farming Online team will disseminate their results to explore with others how to build more tools that bring scientific advancements into the fields where farmers need them to face the challenges of climate change.

## About Farming Online

Farming Online provides free and premium farming news, weather forecasts, up-to-the-minute prices, smartphone applications, and advertising solutions for the United Kingdom, Europe, and Australia. Farming Online was established in 1995 as an ISP and information provider exclusively for UK agriculture, and expanded into smartphone app development and unique tailored regional content for growers and producers. The team at Farming Online have brought to market decision-support systems for actors in the food supply chain. They have delivered for some key international companies and worked alongside several research stations in the UK. Project manager Peter Griffith, BSc. MS., is an agronomist with extensive research and advisory service experience working in Southeast Asia, North America, and Western Europe. He led the Farming Online team that were finalists for a USAID Data-Driven Farming prize in September 2017. This involved trips to Nepal, which brought the team into direct contact with smallholder coffee growers.

# Resources

## Websites

[Farming Online](#) site  
[AI for Earth](#)

## Documentation

Michon Scott. "Climate & Coffee." NOAA. June 19, 2015. <https://www.climate.gov/news-features/climate-and/climate-coffee>

"Here's How Climate Change Hurts Coffee." Climate Central. January 16, 2019.  
<https://www.climatecentral.org/gallery/graphics/heres-how-climate-change-hurts-coffee>