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FOOD SECURED: SATELLITE IMAGING MODELS TO IMPROVE SMALLHOLDER FARM EFFICIENCIES

Abstract

This paper examines the use of satellite imaging and historical datasets to train models that predict irrigation needs for small farms. Such recommendations can increase specific crop yields and water use efficiency for farms that do not have access to infrastructure and technology used in commercial farming. This paper outlines how a non-profit organization could aggregate historical data, train a model, and deploy it to small farms across the globe. This work is an expansion of my Food Secured presentation which won the 2023 AIAA SciTech Idea Challenge.

Several key drivers for improving small farm crop yields include planting and harvest times, irrigation patterns, machinery use, and pesticides. Technological advancements in the past 100 years have allowed large, commercial-scale farms to significantly increase their crop yield (U.S. corn yields have risen by more than 600% in that period). These technologies often require substantial infrastructure investments that do not scale well for small farms. Space-based imaging enables government agencies and commercial companies to capture data on all farms, regardless of size, for a fraction of the cost. These datasets have become sufficiently large to train reliable machine-learning models. But to ground this model in truth, we need another dataset to correlate the satellite data to what actually happens on the ground.

Commercial farms have been instrumented with sensors that capture soil moisture for decades and represent an ideal truth dataset for training the model. Correlating soil moisture data to satellite images of the same farm on the same day is the key to training a useful model. Developing a model which can associate satellite imagery with crop moisture allows for pairing irrigation predictions with weather forecasts to generate irrigation recommendations. This allows us to suggest when to water, or not water crops for any farm in the world.

The impacts of such an application are copious. Crops are irrigated only when they need to be, leading to less fresh water usage and decreases in drought/flooding of fields. This leads to greater crop yields, increasing supply and driving down food costs. Developing this model and application as a non-profit entity allows for collaboration with satellite operators and humanitarian organizations invested in promoting food security across the world. This paper delves into all the above topics and more, examining system architecture, concept of operations and impacts on society.