ICRISAT INTERNATIONAL CROPS RESEARCH INSTITUTE FOR THE SEMI-ARID TROPICS

Berkeley UNIVERSITY OF CALIFORNIA

NCFC

Forecasting yields from outer space, months in advance

Our idea

How can we know the most basic impact of agricultural programs - increased yields - at various stages of a program without costly crop-cuts or unreliable self reports? How can smallholder farmers better plan for harvest knowing the expected prices and yields in their region? How can the Indian government offer index insurance to farmers on a large scale? All of these possibilities would be unlocked by a cheap way of forecasting and measuring crop yields before harvest. This measurement challenge is the one we aim to take on.

We would use Machine Learning methods and newly available extremely high-cadence and high-resolution satellite images (e.g. Planet, Digital Globe) to forecast and measure crop yields throughout India. This can be both a very cheap way to assess the impact of any policy that affects yields, as well as a tool for government to respond to emergencies before they materialize. The existing program used by NCFC, "Forecasting Agricultural output using Space, Agro-meteorology and Land based observations (FASAL)", uses crop-cuts, meteorological data and agricultural modeling as well as more traditional methods of remote sensing to predict these yields. We would integrate all of those datasets. Our approach can be far cheaper in marginal costs, and yield more accurate predictions at a finer regional level.

So far, remote sensing Machine Learning methods were moderately successful at measuring yields for smallholder farmers (Burke & Lobell, 2017) but also required GPS demarcation of the fields, which is costly. Fortunately, for most government policies and assessments, only prediction at a larger regional level (such as the village or block) is required. At this scale the predictions would be far more accurate, and no demarcation of fields is required, so the solution is very cheaply scaled. Since these predictions are already used by the National Crop Forecast Centre (NCFC), better predictions are highly likely to be taken up, scaled and used immediately rather than sit on a shelf.

Piloting the solution

- **Needs.** The first step in devising a solution is understanding the problem. Our partners from NCFC, who implement these predictions today, will map out all the uses for these forecasts and make sure our solution addresses them and fits into current workflows, so that the transition is seamless.
- **Data.** Next, we will leverage our relationship with providers of cutting edge satellite imagery to obtain the data to create forecasts. NCFC will contribute the currently used data - meteorological data, crop cuts experiments undertaken over multiple states in India, agricultural models. We would draw on all these data sources to achieve the best results possible.

- **Prediction**. Our ICRISAT team is an expert at crop yield estimation using remote sensing. This enables us to execute this complicated project in a short timeframe. The data generated is crop yield forecasts a few months before harvest, getting increasingly precise as harvest draws near. High cadence satellite imagery can also monitor progress during a program, to measure various kinds of behavior change (planting practices, fertilizer application, pest control) since they affect different stages of plant growth.
- **Productization**. A tool would be created to use these predictions on a regular basis without the full expertise. The code, building on open source ML libraries such as keras and tensorflow, will also be completely open source and freely available for anyone who wants to take advantage of these methods in other contexts. It also makes the code easy to maintain.

Our Data Sources:

Remote sensing | Agro-meteorology | Crop cuts



Scaling up

If the pilot is successful, we would move to the next phase of implementation.

- **Integration**. Within our team of remote sensing scientists and development economists, we have the knowledge and experience to recommend uses of these predictions in a way that maximizes gains for farmers, either through government policies or through recommendations to farmers.
- **Evaluation**. We want to check both that our performance is better than current estimates, and that using these better predictions results in real gains for farmers. That is also within the realm of expertise of the economists on the team.
- **Sustainability**. Both NCFC, a branch of the government, and ICRISAT, a research institute based in India, are well placed to sustain the project and support any future requirements. NCFC already employs people working on this problem, facilitating sustainability.