October 10, 2023

**TERMS OF REFERENCE**

**A SIMPLIFIED MODEL FOR ANNUAL CROP YEILD FORECASTING**

**USING REMOTE SENSING**

1. **OBJECTIVES**

The objective of the work described in this TOR is to develop a simplified, automated forecasting tool to assist IFPRI and the Ethiopian Ministry of Agriculture with agricultural policy planning. The model would aim to provide reasonable estimates of annual total production for groups of crops (or possibly individual crops) at the district and regional. In order to facilitate its local adoption, it will aim to provide a fully automated open-source system that downloads, processes, and analyzes the necessary data with minimal inputs from the user.

1. **SCOPE OF WORK**

The scope of work to be undertaken includes:

* Development of a methodology for a simplified and automatable crop forecasting tool in R.
* Initial implementation and testing of the tool using available historic data.
* Delivery of a report that summarizes the findings of the project, clearly details the systems effectiveness, and which identifies areas for future work.
* To assist local capacity, the PI will conduct 5 hours of training sessions on open-source geospatial tools open to the staff of IFPRI, and Federal Bureaus.

1. **OUTPUTS AND PRODUCTS**

The following products are to be delivered under this TOR:

* A final report (10-12 pages) which, at minimum, meets the requirements outlined in section 2.

1. **METHODOLOGY**

Although the variation in crop yield are determined by a complex mix of biotic, edaphic and management factors, remote sensing (RS) may hold the key to the development of cheap, reliable, and localize estimates of total output. Freely available medium resolution RS products, available ever 8 to 16 days, can provide a snap-shot of growing conditions. Variation in the reflectance of green, blue, and near-infrared components of the electromagnetic spectrum can be exploited to provide indications of plant productivity, leaf size, water availability, phenology as well as health. These nearly real-time indicators have been used successfully to independently estimate agricultural crop yields and total production at regional and national levels ([*1*](#_ENREF_1)*,* [*2*](#_ENREF_2)).

The model could be applied to groups of long and short-cycle crops, or attempted for individual crops of interest for the Meher crop season:

(1) 

where is the total annual production at year *t* for region *i*. is a vector of temporally lagged remotely sensed indicator variables including: normalize difference vegetation index (NDVI), cumulative NDVI (), normalized water index (NDWI), the enhance vegetation index (EVI), surface temperatures and their non-linear interactions with the day of the year as well as estimates of total planted area. is a temporally lagged vector of edaphic, topographic, and economic determinants of productivity including: regional soil-type dummy variables, average fertilizer prices, and regional fixed effects. is the non-spatial component of the error term, while is the spatial component defined by the row-standardized weights matrix for a region *i* and its neighbor *j*. Sampling locations could be determined from annual crop masks produced by the Global Agricultural Monitoring (GLAM) project. As such, formula one should provide out-of-sample forecasts of total production of individual crops or short- or long-cycle crops.

1. **TIMEFRAME**

The work outlined in this TOR will commence upon issuance of a formal contract with travel to Ethiopia beginning in June 2014 and must be completed within 3 months of the start date.

The project is expected to take two and half summer months, one of which will be carried out at IFPRI’s home offices in Ethiopia. The remainder will take place at the PI’s home institution The George Washington University.

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| Activity | Week  1  June  13th | Week  2  June 20th | Week  3  June 27th | Week  4  July  4th | Week  5  July  11th | Week  6  July  18th | | Week  7  July  25th | Week  8  Aug.  1st | | Week  9  Aug.  8th | Week  10  Aug.  13th |
| Review Literature | **John & Sally** | |  |  |  |  | |  |  | |  |  |
| Initial Data Collection | **Jose & John** | |  |  |  |  | |  |  | |  |  |
| Develop Database and Analysis |  |  | Sally | | |  | |  |  | |  |  |
| Open multiband imagery / raster math |  |  |  |  | Johanna | | | | | | | |
| Raster classification |  |  |  |  | Sally | | | | | | | |
| Finalize and comment code |  |  |  |  |  | | Jose and John | | |  | | |
| Presentation |  |  |  |  |  |  | |  |  | | Jose | |

1. H. Zhang, H. Chen, G. Zhou, THE MODEL OF WHEAT YIELD FORECAST BASED ON MODIS-NDVI A CASE STUDY OF XINXIANG. *ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences* **l-7**, 25 (2012).

2. GOEO, “Best practices for crop area estimation with Remote Sensing” (Group on Earth Observations, 2011).