



December 3, 2020

## Background

As per the Service Agreement between the University of British Columbia (UBC) and the International Centre for Tropical Agriculture (CIAT), the Land Use and Global Environment (LUGE) research group at UBC provided services to CIAT aimed at fulfilling the objectives of the “*Digital Atlas for Agricultural Adaptation*”, a project supported by the Bill & Melinda Gates Foundation.

The *Digital Atlas for Agricultural Adaptation* project aims to generate strategic, spatially explicit information on the nature and scale of climate-induced risks and smallholder vulnerabilities in sub-Saharan Africa and South Asia, and to map the potential efficacy of prioritized adaptation options.

A smallholder layer, i.e. a map layer showing where small-scale producers are located, is a fundamental base layer for the *Digital Atlas for Agricultural Adaptation*. To date, there are no spatially explicit farm-size distribution data for the globe which would enable the creation of a such smallholder layer. The LUGE lab’s objective was to develop such a layer by pooling datasets & modelling relationships between national statistics and subnational farm size.

## Summary

LUGE aggregated and harmonized subnational data across 35 countries in Africa to create a map of the distribution of farm sizes on the continent. This product will be used as a base layer for analyses of smallholder exposure and vulnerability, to help high-level decision makers better understand climate adaptation challenges and solutions.

## Data

The raw data used to create the smallholder layer consist mainly of household surveys. These range from nationally administered surveys to those administered as part of international efforts such as the World Bank’s Living Standards Measurement Study (LSMS) and Core Welfare Indicator Questionnaire (CWIQ). We also explored additional sources including Rural Livelihoods Information System (RuLIS) and Rural Household Multi-Indicator Survey (RHoMIS; van Wijk et al. 2020) but did not use these in the final product. The table below details the data used in this project.

Source	# Countries	Countries
Azzarri & Signorelli 2020	15	Burkina Faso, Burundi, Cameroon, Côte d’Ivoire, Ghana, Kenya, Lesotho, Madagascar, Mauritania, Mozambique, Rwanda, Senegal, South Sudan, United Republic of Tanzania, Zambia
Ricciardi et al. 2018	7	Ethiopia, Malawi, Mali, Niger, Nigeria, South Africa, Uganda
Evans School Policy Analysis & Research group (EPAR)	5	Benin, Gambia, Namibia, Sierra Leone, Togo
LUGE	2	Algeria, Guinea Bissau
Lowder et al. 2016	6	Democratic Republic of Congo, Djibouti, Egypt, Guinea, Libya, Morocco

For many countries, there were multiple available datasets. We selected one based on the following criteria:

- Data are known to be representative at the given administrative unit
- Farm size *distribution* (and not just summary statistics) was available
- Lowest administrative unit (finest spatial resolution) available
- Data covered the full farm size distribution (lowest class was 0-1 ha, highest class was 20+ ha)
- Year closest to 2010



## Methods

Two approaches were proposed to create the smallholder layer:

1. Bottom-up: obtain national-level statistics of farm size distribution and subnational-level proxies that are spatially explicit (i.e. field size distribution maps); establish statistical models relating farm size distribution and field size distribution; use map of field size distribution to predict farm size distribution across the continent.
2. Top-down: pull together best possible subnational resolution data for as many countries as possible.

The bottom-up approach was first tested on a subset of countries with subnational-level farm size data and it was found that there was no reliable relationship between farm size and field size. Thus, the bottom-up approach was abandoned in favour of the top-down approach.

The highest resolution microdata available for each country was compiled from the sources described in the Data section. Variables pertaining to geographic location, sample weight and land holding were retained and harmonized. Farm size was calculated according to available variables -- for some countries, this meant summing plot areas across all crops; for others, land owned was used as a proxy. A farm-size class was assigned to each household according to the modified World Census of Agriculture (WCA) classes: 0-1, 1-2, 2-5, 5-10, 10-20, 20+ hectares (farms larger than 20 ha are not of interest in this project). An additional “landless” category was added to account for households with farm size equal to 0.

For each administrative unit, the *total agricultural area*, *total number of farms*, *proportion of agricultural area* and *proportion of farms* in each farm size class were calculated (using household sampling weights where applicable). Proportions of agricultural area and households were also calculated for cumulative farm size classes (0-1, 0-2, 0-5, 0-10, 0-20 ha).

Values for each administrative unit for each country were joined with a shapefile via administrative unit names. A merged shapefile for all of Africa was created.

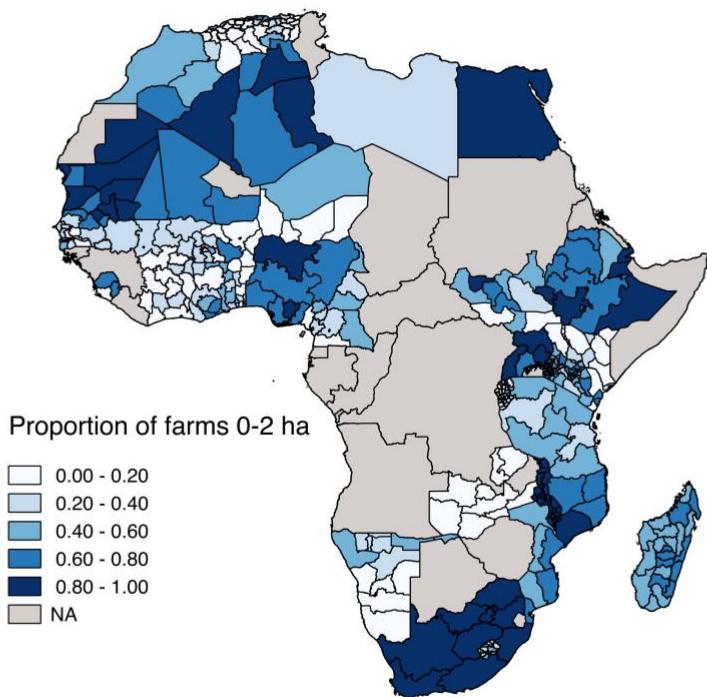
## Product

The outputs of this analysis are:

- A shapefile consisting of the smallest administrative units for which we have representative data, for all countries in Africa (Figure 1)
- A csv file that is equivalent to the attribute table of the shapefile
- A metadata spreadsheet describing which datasets were used to create the shapefile

Figure 1

## Distribution of smallholders



### Bibliography

- Azzarri, C. and Signorelli, S., 2020. Climate and poverty in Africa South of the Sahara. *World development*, 125, p.104691.
- Lowder, S.K., Skoet, J. and Raney, T., 2016. The number, size, and distribution of farms, smallholder farms, and family farms worldwide. *World Development*, 87, pp.16-29.
- Ricciardi, V., Ramankutty, N., Mehrabi, Z., Jarvis, L. and Chookolingo, B., 2018. An open-access dataset of crop production by farm size from agricultural censuses and surveys. *Data in brief*, 19, pp.1970-1988.
- van Wijk, M., Hammond, J., Gorman, L., Adams, S., Ayantunde, A., Baines, D., Bolliger, A., Bosire, C., Carpene, P., Chesterman, S. and Chinyophiro, A., 2020. the Rural Household Multiple Indicator Survey, data from 13,310 farm households in 21 countries. *Scientific Data*, 7(1), pp.1-9.