

Leveraging novel opportunities for operationalizing annual cropland mapping in smallholder systems of Sub-Saharan Africa: Analyzing NICFI PlanetScope mosaic time series in Google Earth Engine

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Current advances in Earth observation facilitate operational mapping of cropland extent, crop types, field sizes, and other land management parameters in consolidated agricultural systems of many world regions. Contrastingly, such mapping approaches in smallholder agricultural systems are still challenged by three key system characteristics. First, the spatially fragmented nature of smallholder systems, often featuring field sizes below one hectare, irregular shapes, and lack of clear field boundaries, require very high spatial detail. Second, a diverse set of cultivation practices and a large gradient of land management opportunities create a heterogeneous picture in terms of cropland and land use intensity. These range from extensive shifting cultivation practices in agricultural frontiers, to labor-intensive household farming on constrained land extents and no access to inputs, or medium-size farmers with potential access to mechanization, inputs, or irrigation infrastructure. Third, the swift dynamics of croplands in smallholder systems, where cultivated lands can be left fallow after only a few years of cultivation and regrowth of herbaceous and woody vegetation occurs rapidly, require timely mapping approaches.

Recent developments in the Earth observation domain open novel opportunities to overcome these challenges and thus to provide spatially precise, thematically detailed, and timely information on smallholder agricultural systems, which can facilitate decision-making across the globe. First, Norway's International Climate And Forests Initiative (NICFI) Imagery Program recently granted public access to bi-annual (December 2015 – August 2020) and monthly (September 2020 and onwards) mosaics of PlanetScope surface reflectance data at ~5m spatial resolution covering the world's tropical belt. This unprecedented initiative provides a dataset with the potential to overcome the key challenges in mapping smallholder agricultural systems. Second, cloud-computing platforms such as Google Earth Engine offer the processing infrastructure to analyze such large datasets at no cost for research applications. The provision of the NICFI PlanetScope data in Google Earth Engine opens huge opportunities for generating timely and spatially detailed maps of agricultural systems across large areas at a low cost.

This work explores these emerging opportunities by investigating the use of a NICFI PlanetScope mosaic time series for mapping agricultural systems across four provinces in Northern Mozambique (Niassa, Zambezia, Nampula, and Cabo Delgado). The key objectives are 1) to accurately map active cropland extent for the growing season 2020/2021 across the entire study region (~400,000km²), 2) to compare the resulting cropland extent map with a set of currently available land cover products for the region, 3) to discuss opportunities, strengths, and caveats of the available NICFI mosaics for large area cropland mapping in smallholder systems, and 4) to locally assess a set of land use intensity proxies for mechanization and irrigation, by integrating field-based reference data to further disentangle the complex characteristics of smallholder agricultural systems in Sub-Saharan Africa.