Cropland is expanding yet productivity is decreasing in Malawi

The results of a long-term satellite image analysis

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Background and objectives

With rising demand for food in Sub-Saharan Africa (SSA), conversion of forests, grasslands, wetlands and shrublands into cultivated land has become a common strategy for boosting agricultural production[1-2]. However, the expansion of croplands is not a sustainable form of agricultural development due to the limited arable land[3]. Monitoring of cropland expansion and understanding relevant drivers are therefore vital in focusing appropriate interventions to ensure sustainable food production and environmental conservation[3].

We aim to answer research questions:
1. When and where cropland expansion has happened in Malawi?
2. What are drivers of cropland expansion?

Data and methods

- Monitor cropland expansion
  - Satellite images (Sentinel-2, Landsat-8): classify land cover type
  - Forest loss dataset (2001-2018): monitor cropland expansion in relation to forest loss; detect cropland age
  - Satellite vegetation index product (MODIS NDVI): monitor changes in cropland productivity (proxy)
- Explore factors that could explain cropland expansion
  - Integrated Household Survey in Malawi (i.e. agriculture land in estate, irrigation level, population, soil erosion, etc)

Results

1. 3.8 % of cropland expansion are contributed by forest loss (Fig. 1)
2. Declined productivity is more common in older cropland (Fig.2)
3. Expansion is positively correlated with estate agricultural land (Fig. 3), but negatively related to the level of irrigation (Table. 1)

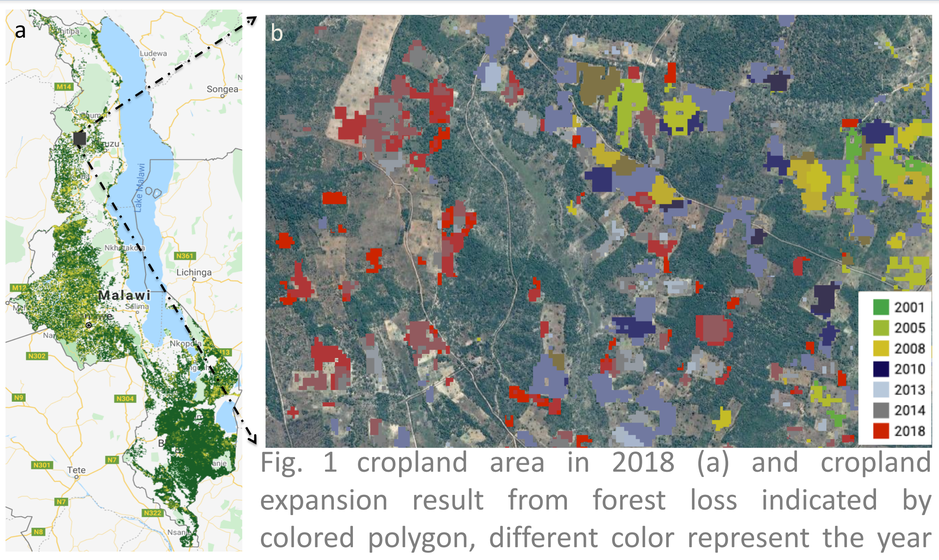

Fig. 1 cropland area in 2018 (a) and cropland expansion result from forest loss indicated by colored polygon, different color represent the year of forest loss (b).

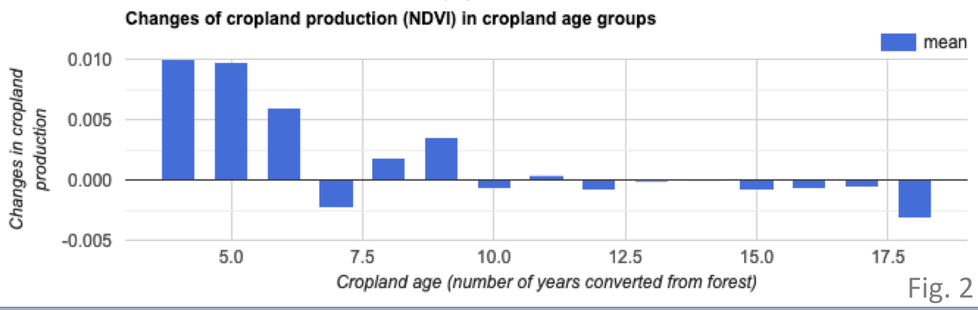

Fig. 2 Changes of cropland productivity (NDVI) (y-axis) in different cropland ages (x-axis)

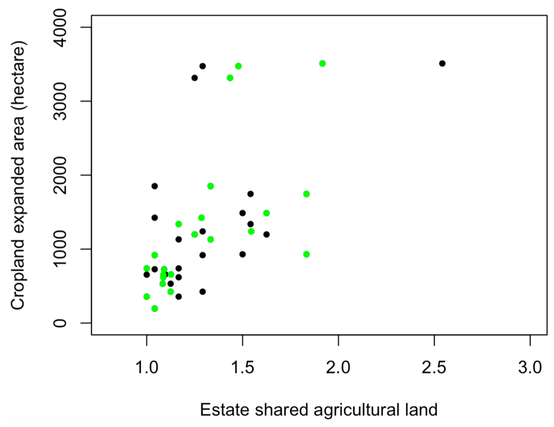

Fig. 3 Correlation between the level of share of the agriculture land is in estates (x-axis) and expanded area (y-axis) at district level. Green color indicate district with

Variables	R^2	P	Correlation	Nr of districts
Share of the agri land in estate	0.41	0.001	+	22
Landhold size	0.13	0.1	+	22
Level of Irrigation	0.09	0.19	-	21
Plantation area	0.05	0.36	+	17
Cultivation area	0.05	0.34	-	21
Tobacco land size	0.05	0.36	-	19
Population	0.03	0.45	+	23
Changing productivity	0.02	0.59	+	22
Soil erosion	0.007	0.7	+	22
Plot size (GPS)	0.000	0.9	-	22

Table. 1 Lists of variables that are used to analyze their linear correlation between with cropland expansion.

Discussions

- Cropland expansion might not only be dominated by small holder farming area but also large estate shared agricultural land.
- The district with higher irrigation level, the less forest area was cleared and converted to agricultural land.
- Population growth is not a driver for cropland expansion.

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