A Contemporary Decennial Global Sample of Changing Agricultural Field Sizes

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1. Why Study Field Sizes ?

The size of agricultural fields is:

- a fundamental description of rural landscapes
- an indicator variable for agricultural intensification
- useful to derive yields
- of biophysical, ecological and economic importance
- provides a lens on the drivers of rural Land Cover Land Use Change (LCLUC)

2. Why use Landsat data ?

The Landsat satellite series is the only satellite data record with sufficient resolution to capture changing field sizes on a decadal scale with a global sample.

3. Hotspot Selection

3.1 WHAT CROPS ?

Top 4 FAO staple food crops:

- Maize, Wheat, Rice and Soybeans

Biofuel crops (included due to growing contemporary demand):

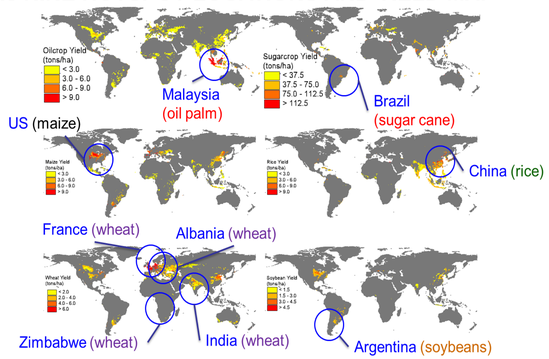
- Sugar Cane and Oil Palm

3.2 WHERE ?

- **Locations of high agricultural yield** defined by a 2000 global yield map (Monfreda et al. 2008*) with the assumption that recent high yields will be associated with changing agriculture
- **Additional locations with non-high yield but documented rapid field size change**
- **Specific locations selected as representative of different drivers/modifiers of agricultural change:** Technological innovation, Socio-economic change, Government policy, Historic pattern of land cover land use, Environmental setting
- **Locations limited by Landsat availability:** Not all path/rows are in the US Landsat archive, clouds, missing pixels due to SLC-off, locations restricted to cloud-free scenes, Landsat 5 TM and pre-SLC-off Landsat ETM+ (from 1982 to present), and where possible scenes from the same month sensed 10 years apart.

* MONFREDA, C., RAMANKUTTY, N. & FOLEY, J. A. 2008. Farming the planet: 2. Geographic distribution of crop areas, yields, physiological types, and net primary production in the year 2000. *Global Biogeochemical Cycles,* 22

3.3 NINE HOTSPOT LOCATIONS AND YIELD MAP*



- **US** Corn Belt (Maize): Technological innovations and use of larger machinery.
- **Argentina** (Soybeans): Technology, use of GM seed.
- **France** (Wheat): Technology/ EU Policy.
- North **China** Plain (Rice): Policy, household responsibility system.
- **Albania** (Wheat): Historical, collapse of collectivized agriculture.
- **Zimbabwe** (Wheat): Social, land redistribution.
- **India**, Punjab (Wheat): Environment/ Social, expansion of irrigation.
- **Brazil** (Sugarcane): Economic/ Policy, biofuel demand.
- **Malaysia** (Oil Palm): Economic/ Policy, food and fuel.

4. Methodology

Multi-temporal Landsat data with WELD processing to provide temporal consistency

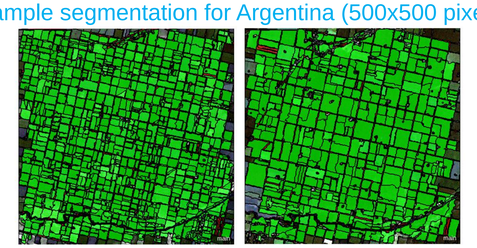
- TOA reflectance
- Cloud masks

E-cognition rule sets

- Interactive multispectral segmentation
- Classification refined by shape attributes

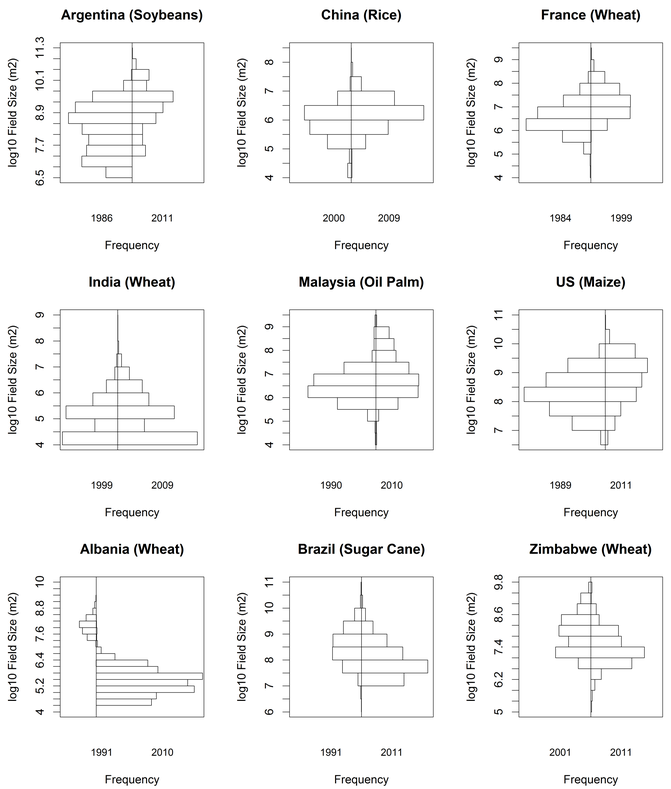
Field areas calculated using ArcGIS

Example segmentation for Argentina (500x500 pixels)



02/10/**1986** 02/15/**2011**

5. Results: Decadal Hotspot Field Size Histograms



Histograms illustrate:

- Increasing field sizes in Argentina, China, France, India, Malaysia and US
- Decreasing field sizes in Albania, Brazil and Zimbabwe

Issues:

- Brazil; generally decreasing field size (Pasture -> Sugar Cane conversion) but small fields also disappearing
- Malaysia; increases in the number of Palm Oil plantations on new land, field introduction is a form of change
- India; very small fields difficult to delineate in Landsat

Initial results indicate:

- Significant ~ decadal changes in field sizes !
- Generally increasing field sizes, primarily due to technological innovation (e.g., improved mechanization, new and improved crop varieties),
- Decreasing field sizes, associated with socio-economic and policy changes (Albania and Zimbabwe).

6. Discussion

The free US Landsat archive enables global examination of contemporary field size changes.

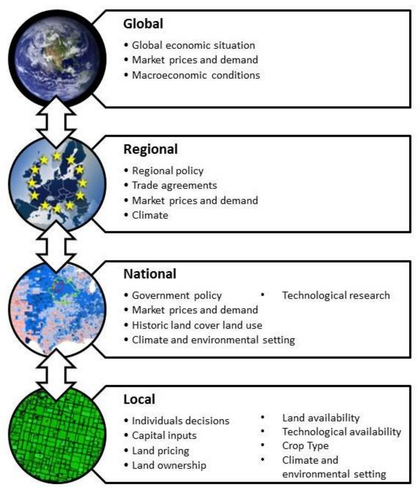
Both increasing and decreasing field sizes observed for this limited sample.

Inferring global patterns dependent on:

- number of hotspots
- hotspot location and size
- landscape complexity and heterogeneity of field size distributions and changes
- ability to unambiguously delineate:
  - small fields
  - fields with low-contrast edges
  - handle crop rotation and mixed cropping

The attribution of drivers of field size change is challenging as there are multiple drivers acting at different scales, here is our preliminary conceptualization:

Drivers of field size change



Clear future need for a fully automated Landsat field size extraction method for large area application – see sister poster (Yan, Roy, Amatulli, Baraldi).