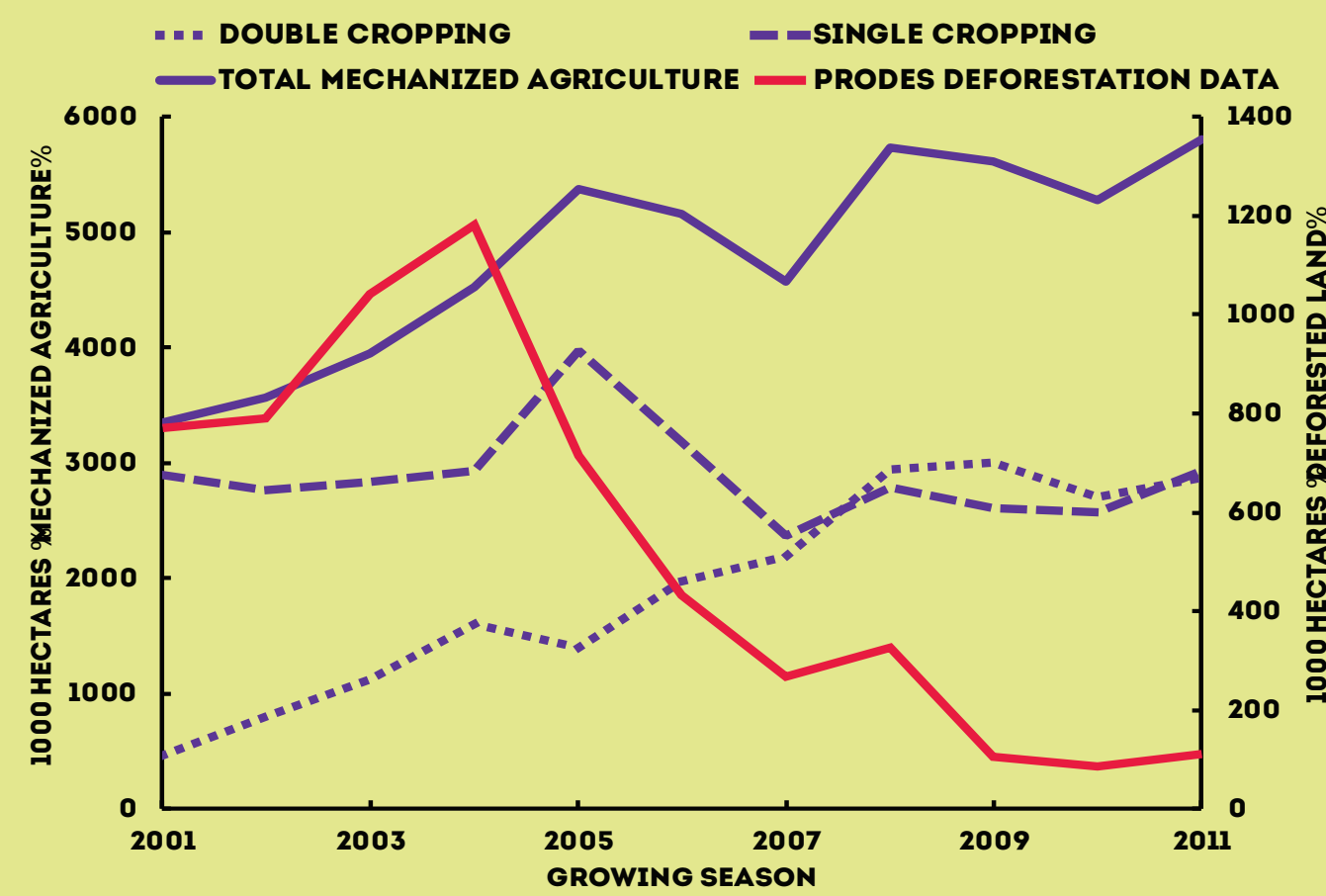


QUANTIFYING AND ASSESSING LAND USE AND LAND COVER CHANGE DYNAMICS IN A GLOBAL BREADBASKET



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MATO GROSSO, BRAZIL



WHAT IS DRIVING THE DECOUPLING OF MATO GROSSO'S AGRICULTURAL PRODUCTIVITY AND DEFORESTATION RATES?

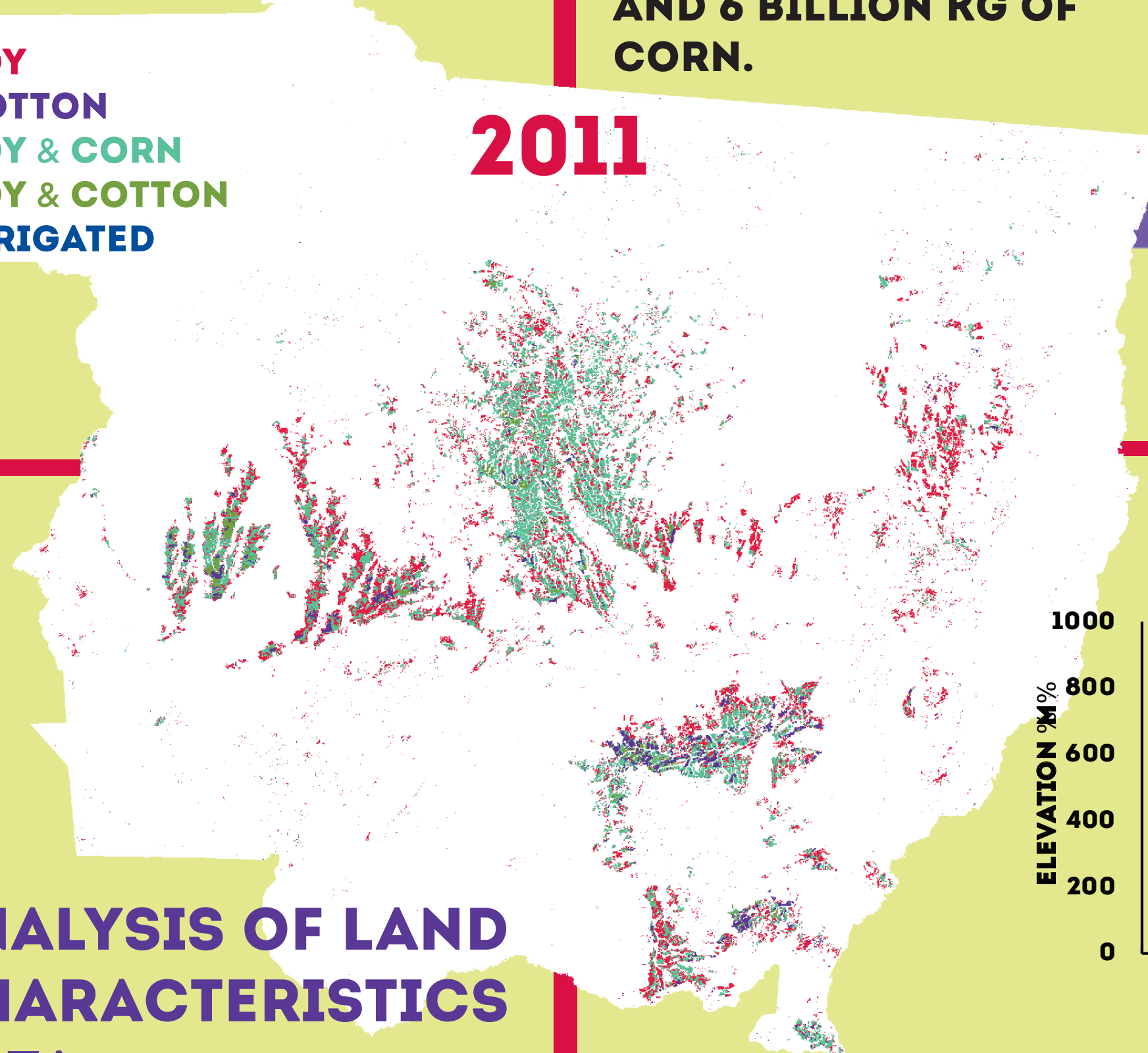
GLOBAL SOY PRODUCTION: 8%%

BRAZILIAN CORN PRODUCTION: 16%

BRAZILIAN COTTON PRODUCTION: 50%

SOY
COTTON
SOY & CORN
SOY & COTTON
IRRIGATED

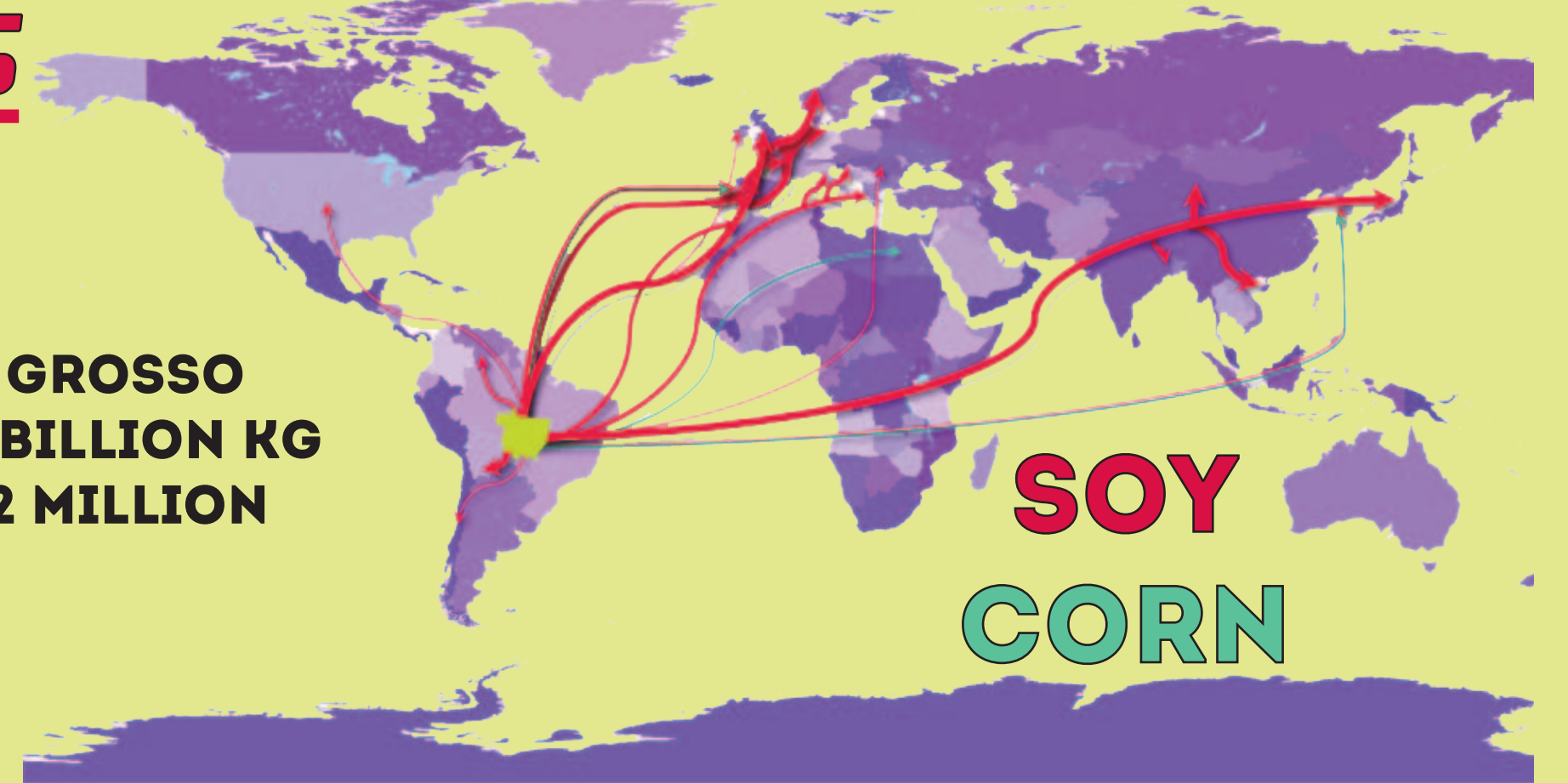
2011



EXPORTS

IN 2001, MATO GROSSO EXPORTED 4.5 BILLION KG OF SOY AND 62 MILLION KG OF CORN.

IN 2011, MATO GROSSO EXPORTED NEARLY 9.7 BILLION KG OF SOY AND 6 BILLION KG OF CORN.

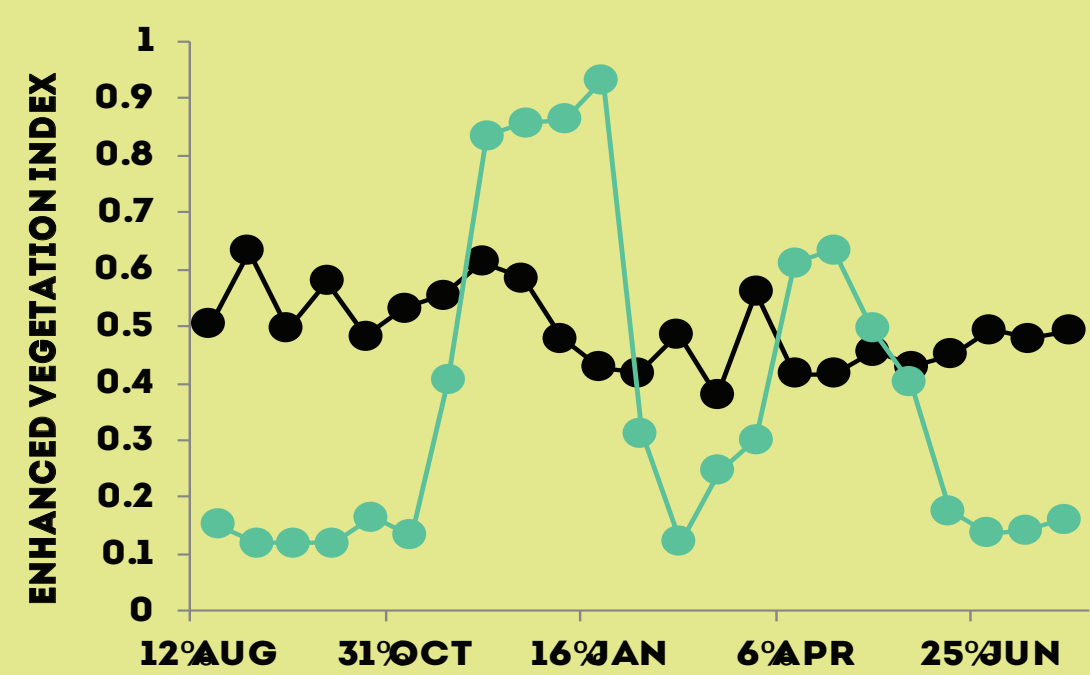


Arrow thicknesses are related to the magnitude of aggregate soy and corn exports in that year.

METHODOLOGY

LAND COVER MAPPING DATA

- MODIS Enhanced Vegetation Index (EVI) and Day of Year (DOY) for August 2000 - July 2011



Vegetation phenology of forest (black) and a soy-corn rotation (blue) in Mato Grosso.

QUANTITATIVE PHENOLOGY-BASED METRICS

- Growing season standard deviation
- EVI maximum
- Crop calendars

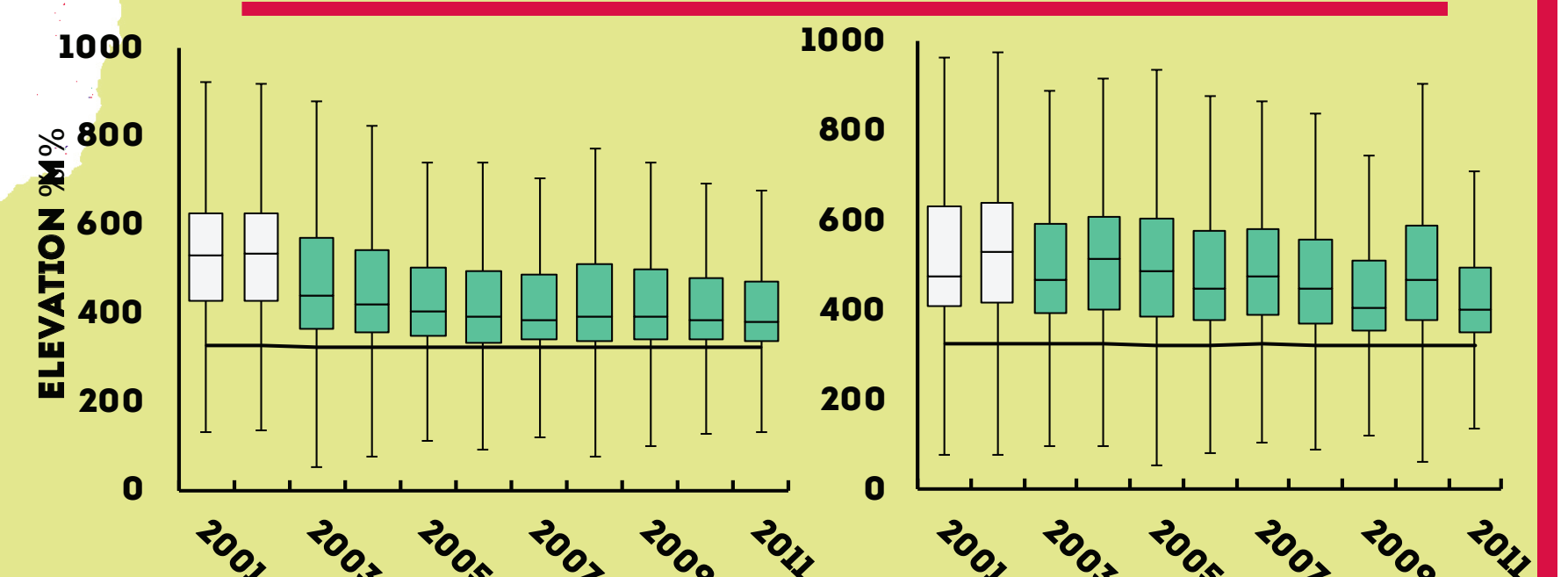
92% accuracy, 2011 results in center

ANALYSIS OF LAND CHARACTERISTICS DATA

- Climate Research Unit (CRU): Soil moisture, temperature, precipitation
- Shuttle Radar Topography Mission (SRTM): Elevation, slope
- Derived: Soy cost map, agricultural extent, expansion, abandonment

Results shown in adjacent panel

LAND CHARACTERISTICS



Elevation box plots of new land in agriculture [AG] (left) and new land in double cropping [DC] (right) beginning in 2003. The 2001 and 2002 box plots encapsulate the variability of the cultivated area in those years.

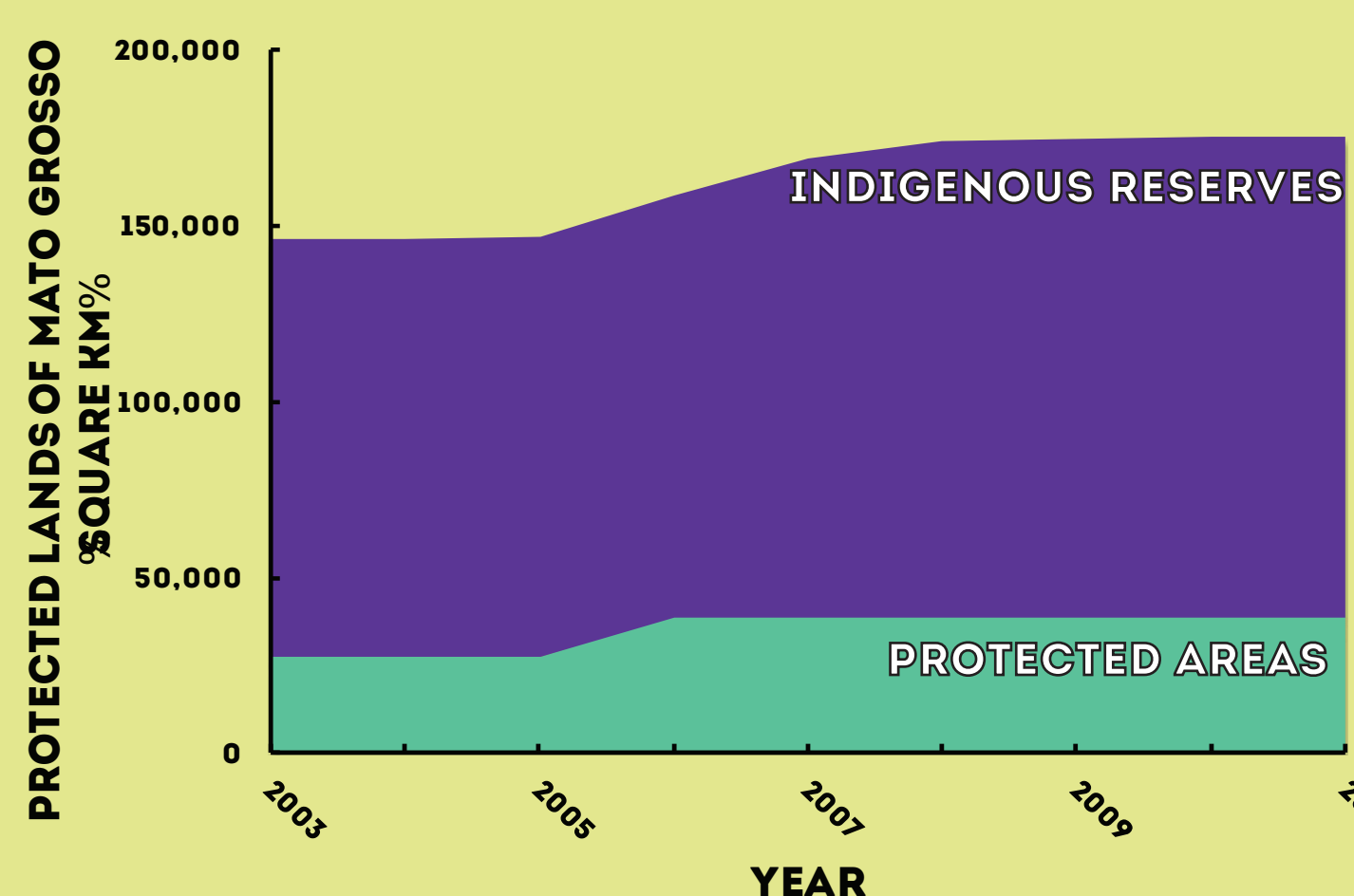
	AG EXTENT	DC EXTENT	AG EXPANSION	DC EXPANSION	AG ABANDONMENT	DC ABANDONMENT
MAXIMUM TEMP.	+	+	+	+	-	-
MINIMUM TEMP.	-	-	-	-	+	+
PRECIPITATION	+	m	+	+	-	-
SOIL MOISTURE	-	-	m	-	+	+
SOY TRANSPORT COST	-	-	-	-	+	+
ELEVATION	+	+	+	+	-*	-*
SLOPE	-	-	-	-	+	+
UPLAND SOILS	+	+	+	+	-*	-*
PROTECTED AREAS	-	-	-	-	+	m
INDIGENOUS RESERVES	-	-	-	-	+	m

Pluses indicate significant positive correlations across all years investigated. Pluses with asterisks indicate positive insignificant relationships. Minuses are the reverse.

DECREASING DEFORESTATION RATES: GOVERNANCE OR SCARCITY?

GOVERNANCE

- Satellite monitoring of deforestation
- Municipalities black-listed from exporting agriculture
- Government credit limitations
- Soy Moratorium
Agreement in which leading soybean companies pledged not to export soy cultivated on land deforested in the Amazon biome after 2006



KEY FINDINGS

Land Cover Mapping

- Total land in agriculture increased from 3 to 5.8 million hectares over the study period.
- Soy-corn double cropping increased from 0.46 to 2.9 million hectares over the study period.

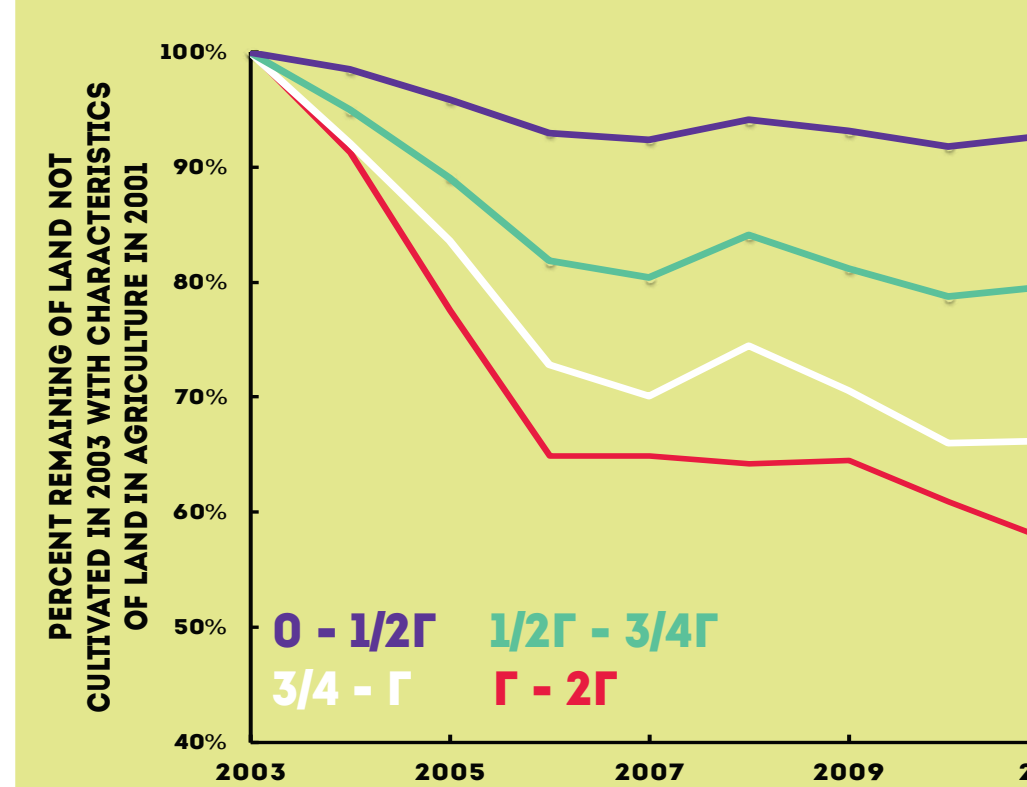
Characteristics of Agricultural Land

- Cropland created in 2011 was significantly hotter, at lower elevations, drier, farther from markets, and on higher slopes than cropland created in 2003

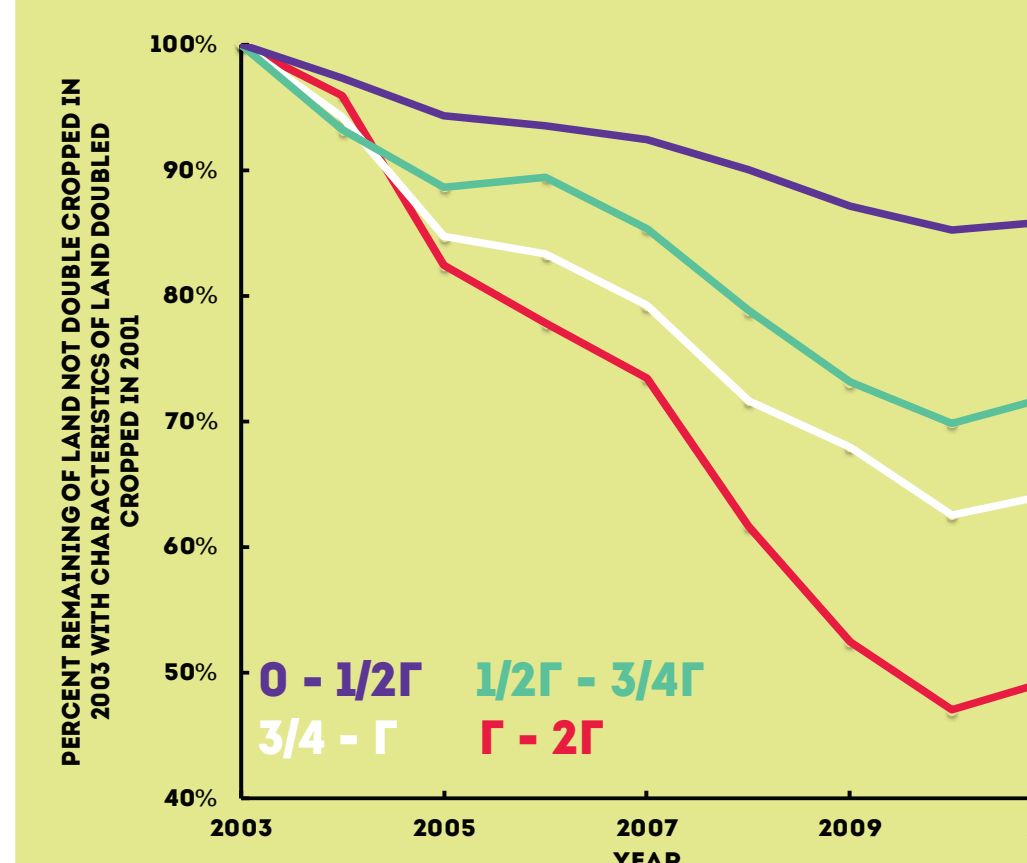
Governance or Scarcity?

- We hypothesize that the decoupling of agricultural production and deforestation are a consequence of both scarcity of high quality land worth deforesting for agricultural development and governance.

HIGH-QUALITY LAND SCARCITY



2001 agricultural land was considered across the first 7 land characteristics listed in the table above. The reserve of land not cultivated or double cropped in 2003 was then considered in terms of these seven characteristics.



For example, the purple lines represent the portion of that land that falls within 0 - 1/2 standard deviations (sigma) from the mean value of each of the 7 investigated land attributes of the 2001 agricultural area in the state.