

POPULATION DENSITY, LAND, AND FUTURE TRAJECTORIES OF STRUCTURAL TRANSFORMATION IN AFRICA

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Introduction: Three “stylized facts” about SSA

1. Africa is a land abundant region, with massive opportunities for crop land expansion
2. Agricultural intensification is proceeding very slowly
3. Smallholder agriculture may not be the engine of growth for structural transformation, need to consider new models...



Study objectives

1. To empirically evaluate these apparent stylized facts
 - From articles in forthcoming special issue of *Food Policy*
2. To weave the findings together into a coherent holistic picture as to the evolution of agricultural systems, land use, and possible pathways of structural transformation



Data

1. Geo-referenced spatial data (10km²)
2. Household / farm survey data
3. FAO annual country-level data on population, crop production, farm size, input use, irrigation, other measures of intensification



Main conclusions

1. Potential for major crop land expansion in SSA, but concentrated in 8 countries:

- DRC
- Republic Congo,
- Madagascar
- Sudan
- Mozambique
- Zambia
- Tanzania
- Cameroon



Main conclusions (cont):

2. Potential for crop land expansion that does not involve forest destruction in the remainder of SSA is very limited.
3. Agricultural intensification is occurring in response to rising rural population density
 - mainly through more continuous cultivation and shifts to high-valued crops
 - not through input intensification or cereal yield growth.

Main conclusions (cont):

4. Increasing contestation over access to SSA's remaining crop land, with the "default" condition being that
 - Gradual demise of chiefs' control over customary lands
 - "emergent" farmers and large farms having the advantage in access to remaining lands
 - Land markets developing after land converted from customary to titled land

Issue 1:

paradox of population pressures
amidst land abundance?

Clustering of rural populations in SSA

Region	top 1%	top 5%	top 10%	top 20%
East/Central	17%	44%	61%	78%
Southern	14%	37%	53%	73%
West	13%	36%	51%	70%
SSA	16%	42%	58%	76%

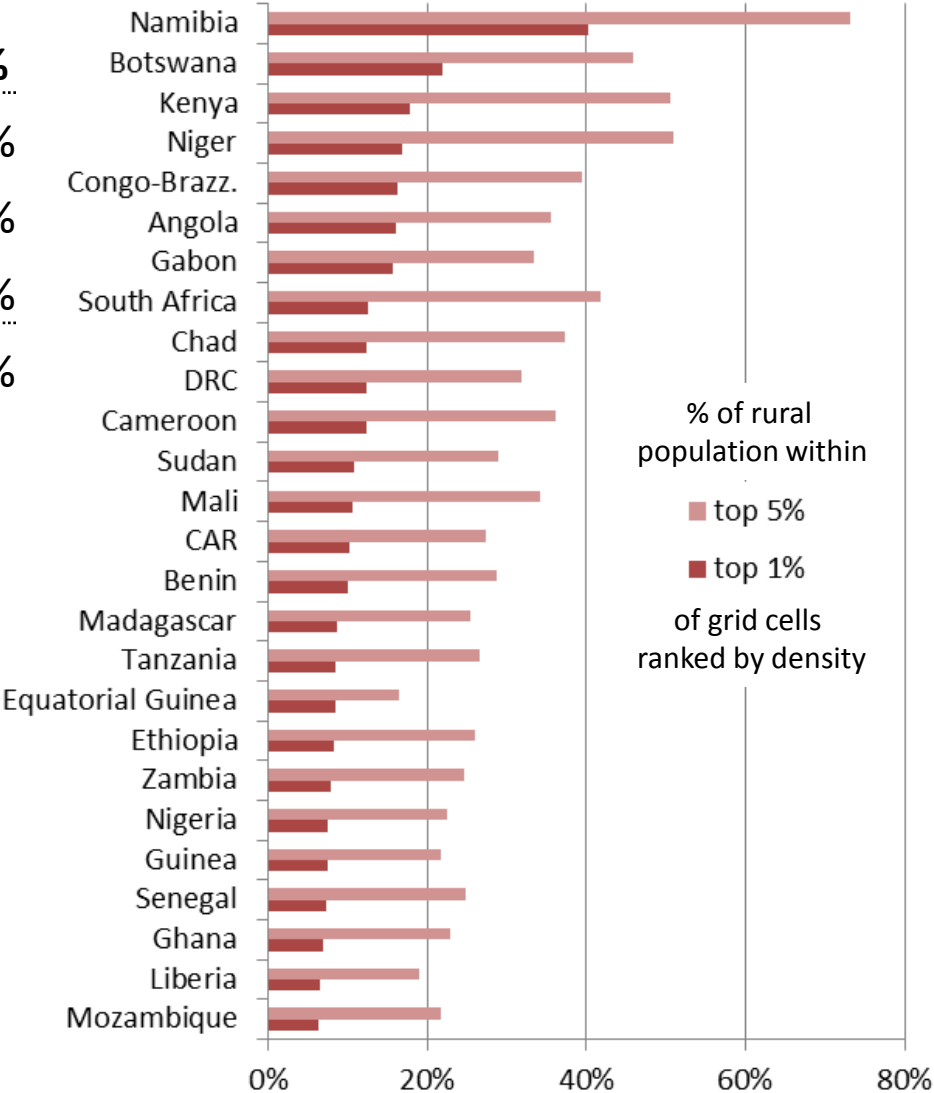
1% of SSA's rural areas contain 16% of its rural people

20% of SSA's rural areas contain 76% of its rural people

Clustering of rural populations in SSA

Region	top 1%	top 5%	top 10%	top 20%
East/Central	17%	44%	61%	78%
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Rural populations are highly spatially concentrated

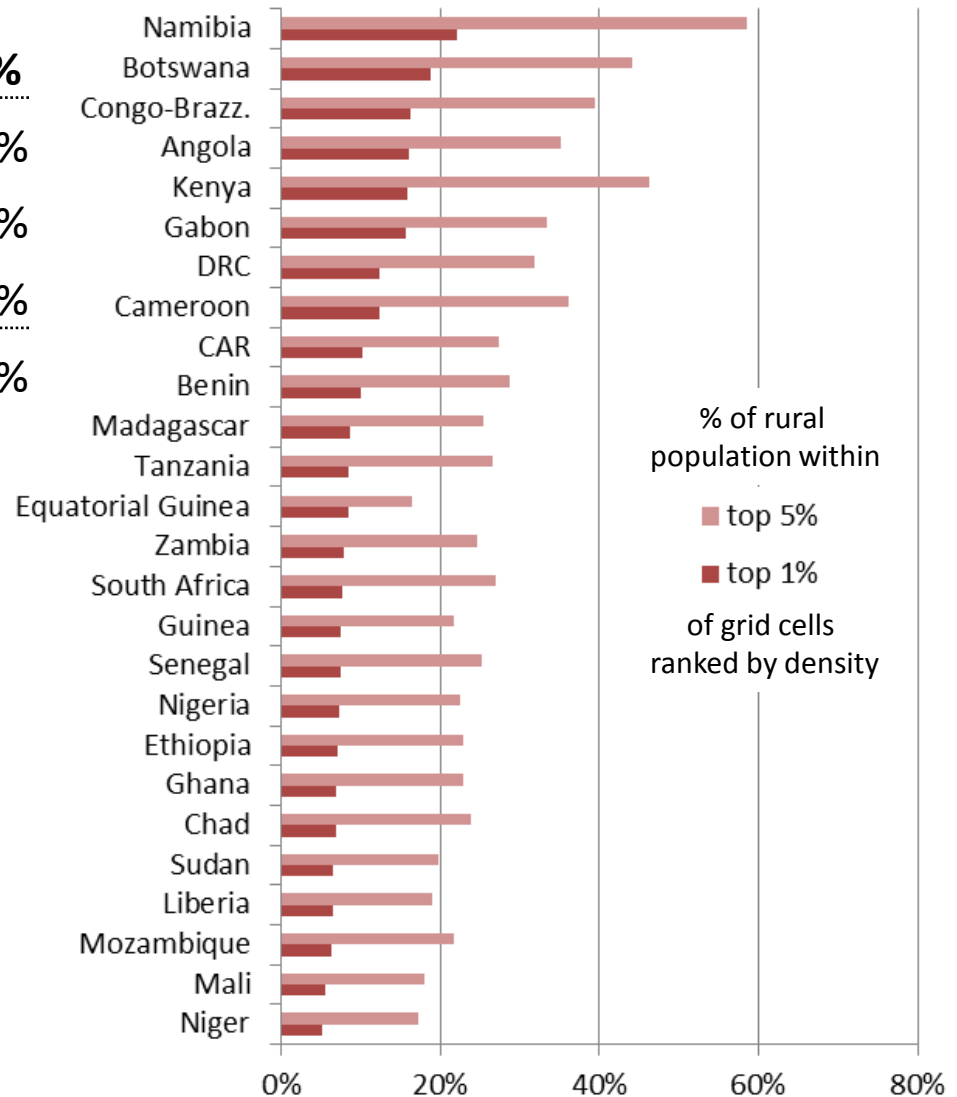


Source: AfriPop (rural areas only)

Clustering of rural populations in SSA

Region	top 1%	top 5%	top 10%	top 20%
East/Central	15%	40%	57%	74%
Southern	12%	32%	47%	66%
West	10%	29%	43%	60%
SSA	14%	36%	52%	70%

even after throwing out areas
with <400 mm rainfall



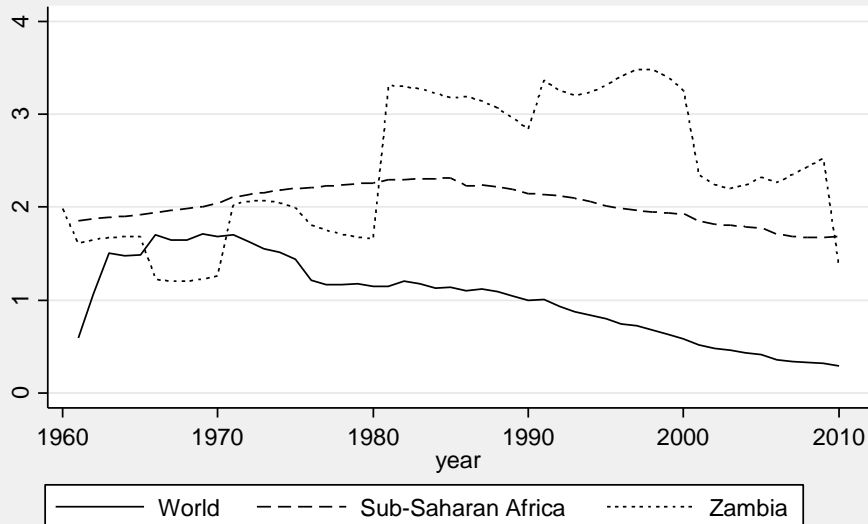
Africa is typically thought of as land abundant -- this neglects the heterogeneity within Africa

Region	Period	Hectares per agric. worker (FAO)	Hectares per holding (censuses)
Africa - high density (n=5)	1970s	0.84	1.99
	2000s	0.58	1.23
Africa - low density (n=11)	1970s	1.65	2.65
	2000s	1.37	2.82
South Asia (n=5)	1970s	0.78	2.01
	2000s	0.55	1.19
China & S.E. Asia (n=4)	1970s	0.80	2.08
	2000s	0.68	1.58



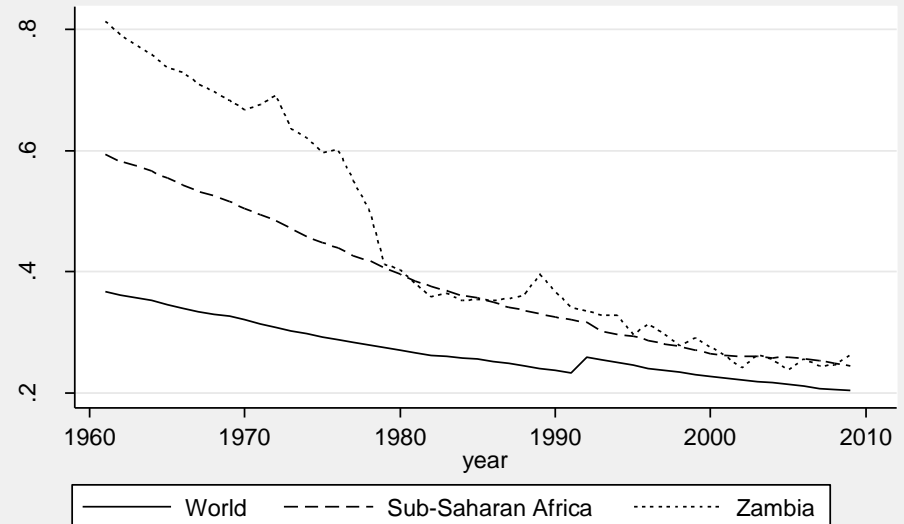
Growth of rural populations in SSA

Rural population growth
1960-2010



Source: World Development Indicators, World Bank

Arable land per capita
1960-2010



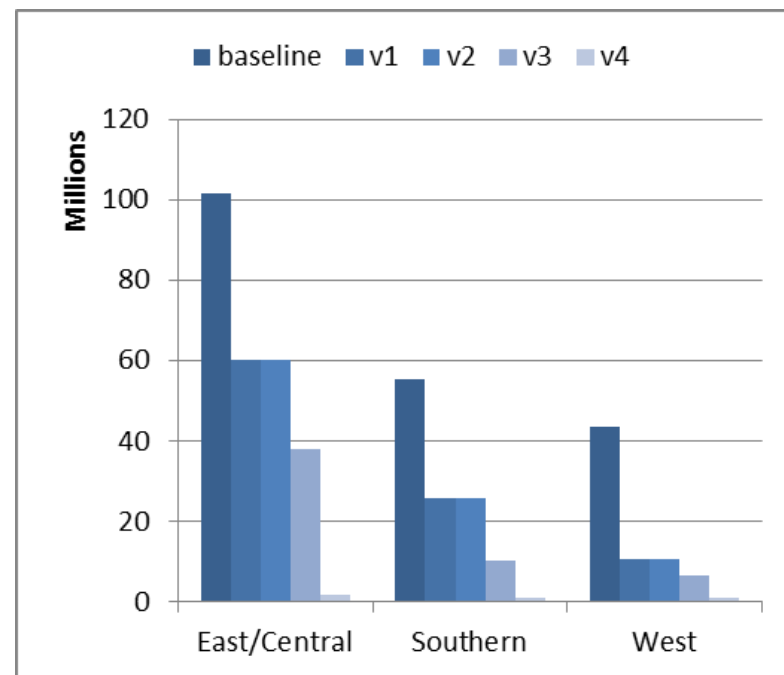
Source: World Development Indicators, World Bank

000 hectares potential cropland available

	<i>baseline</i>	<i>v1</i>	<i>v2</i>	<i>v3</i>	<i>v4</i>
Angola	7,138	4,331	1,873	4	4
Cameroon	4,008	2,198	1,658	730	17
CAR	9,128	4,713	4,713	1,487	0
Chad	4,642	561	561	561	561
DRC	27,200	26,700	26,700	22,800	900
Congo, Rep.	14,200	14,200	14,200	12,500	220
Ethiopia	7,030	4,651	1,662	0	0
Gabon	2,161	2,161	2,161	1,639	0
Kenya	4,767	3,180	3,180	0	0
Madagascar	28,000	23,250	19,200	10,200	869
Mali	8,075	2,556	556	556	556
Mozambique	7,511	4,649	2,649	78	0
Sudan	26,400	3,938	3,438	153	153
Tanzania	7,323	6,450	4,450	120	0
Zambia	4,656	3,181	190	0	0
East/Central	101,701	75,098	60,045	37,889	1,835
Southern	55,239	33,746	25,746	10,315	907
West	43,403	13,630	10,683	6,456	1,127
SSA	200,343	122,474	96,474	54,660	3,868

4. Gross margins > \$500,
yields based on survey data

**Imposing economic
criteria & more realistic
attainable yields leads to
declines >90% in area
estimates!**



Unutilized arable land concentrated in a small number of countries

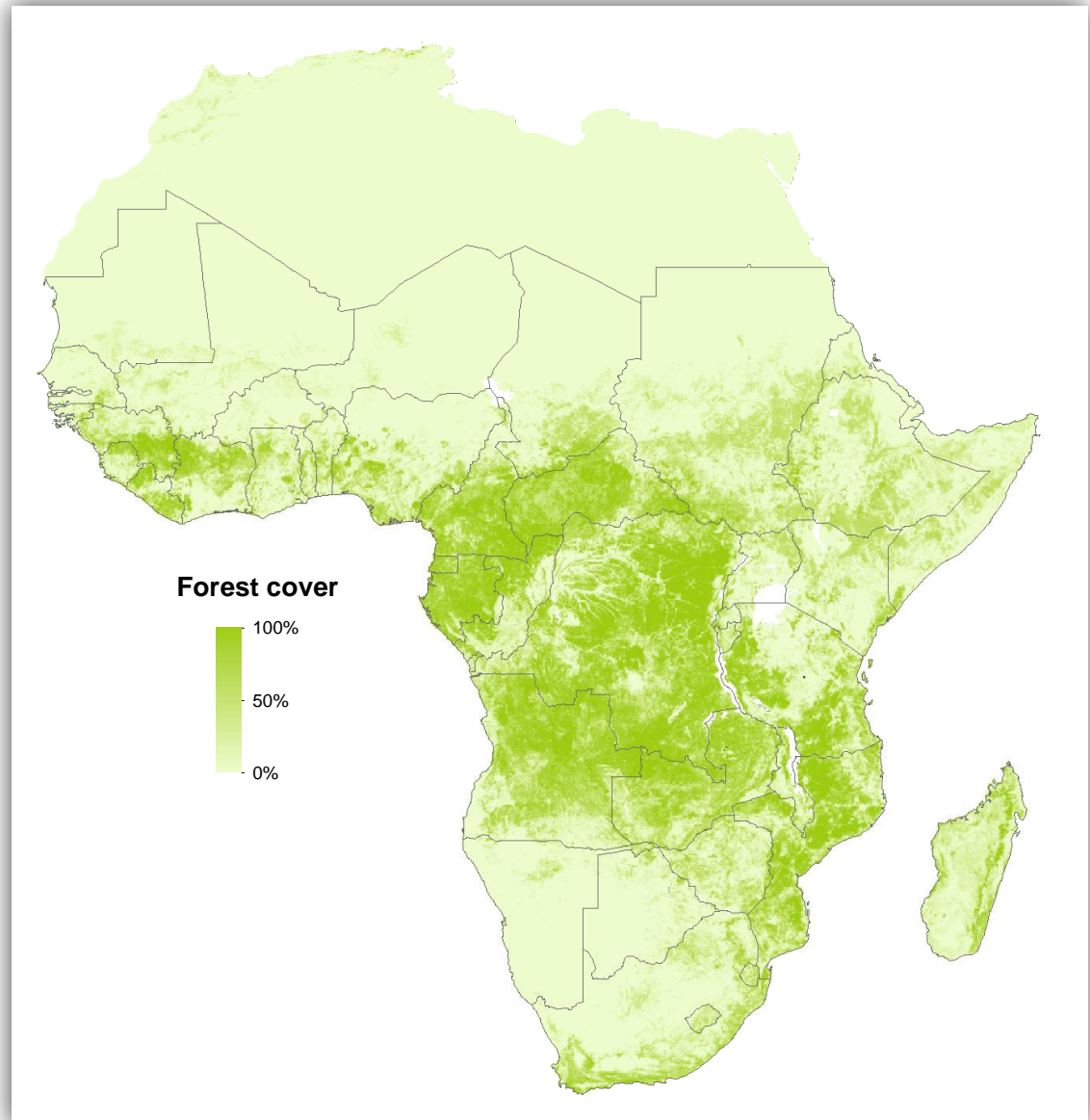
% of total	baseline	v1	v2	v3	v4
60%	7	4	3	2	2
80%	13	8	8	3	3
Rank					
1st	Madagascar	DRC	DRC	DRC	DRC
2nd	DRC	Madagascar	Madagascar	Congo-Brazz.	Madagascar
3rd	Sudan	Congo-Brazz.	Congo-Brazz.	Madagascar	
4th	Congo-Brazz.	CAR	CAR		
5th	CAR	Tanzania	Tanzania		
6th	Mali	Sudan	Sudan		
7th	Mozambique				
8th	Tanzania				
9th	Angola				
10th	Ethiopia				

Concept of “sustainable intensification”

“Increase food production from existing farmland in ways that place far less pressure on the environment and that do not undermine our capacity to continue producing food in future”

(Garnett et al., *Science*)

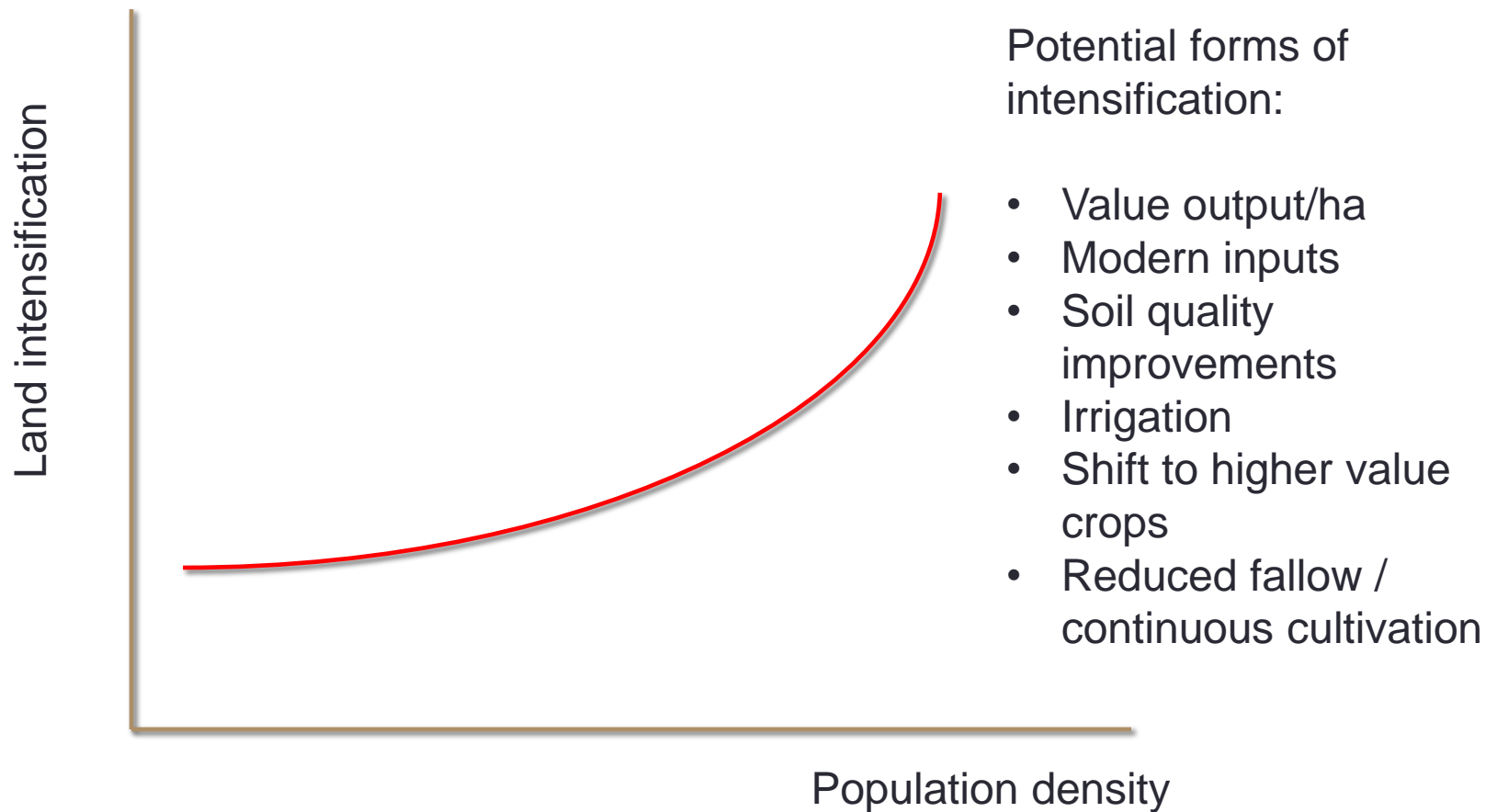
Increasing recognition that current farming practices damage environment and are major source of GHG emissions



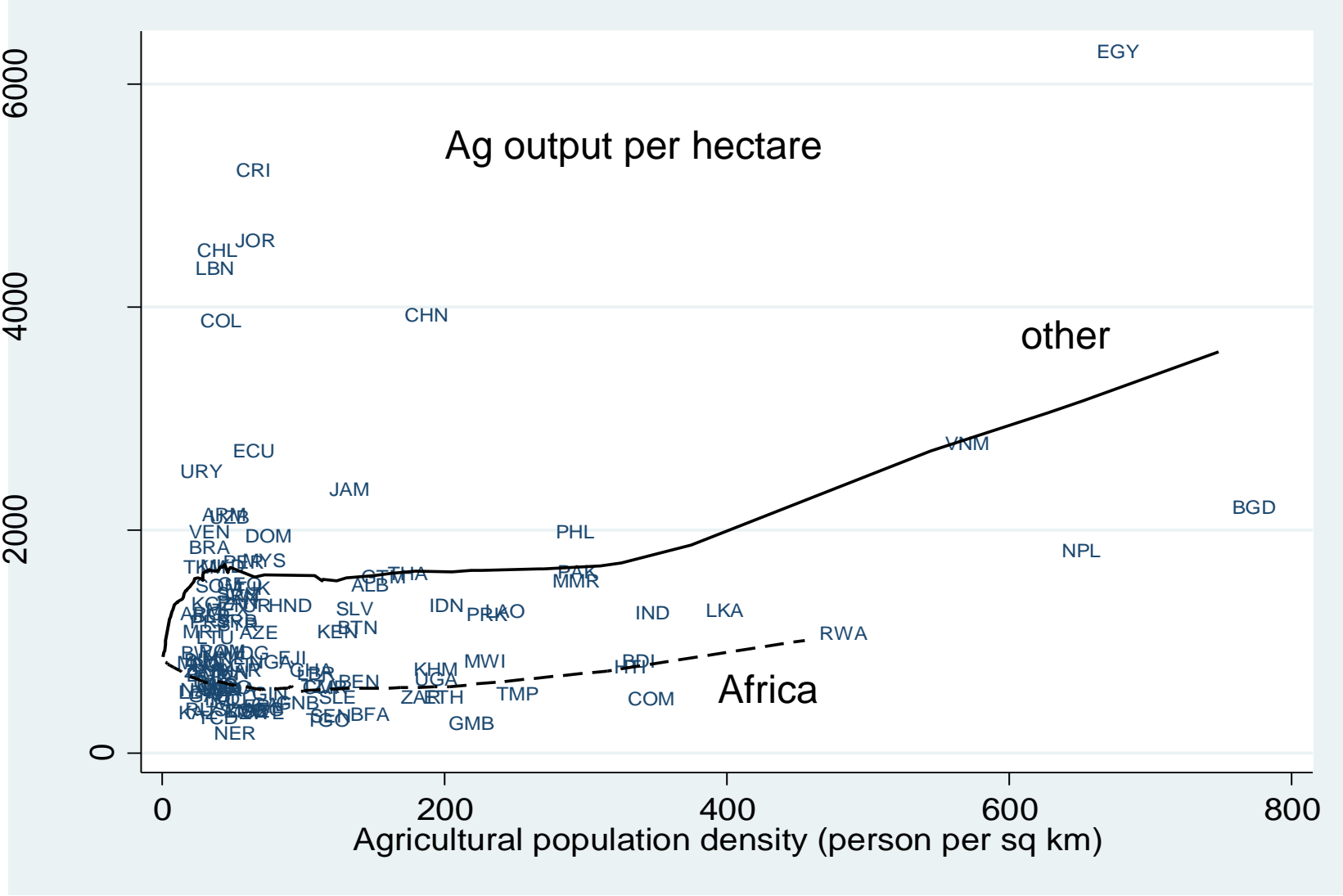
Issue 2:

Is African agriculture intensifying in response to rising population density?

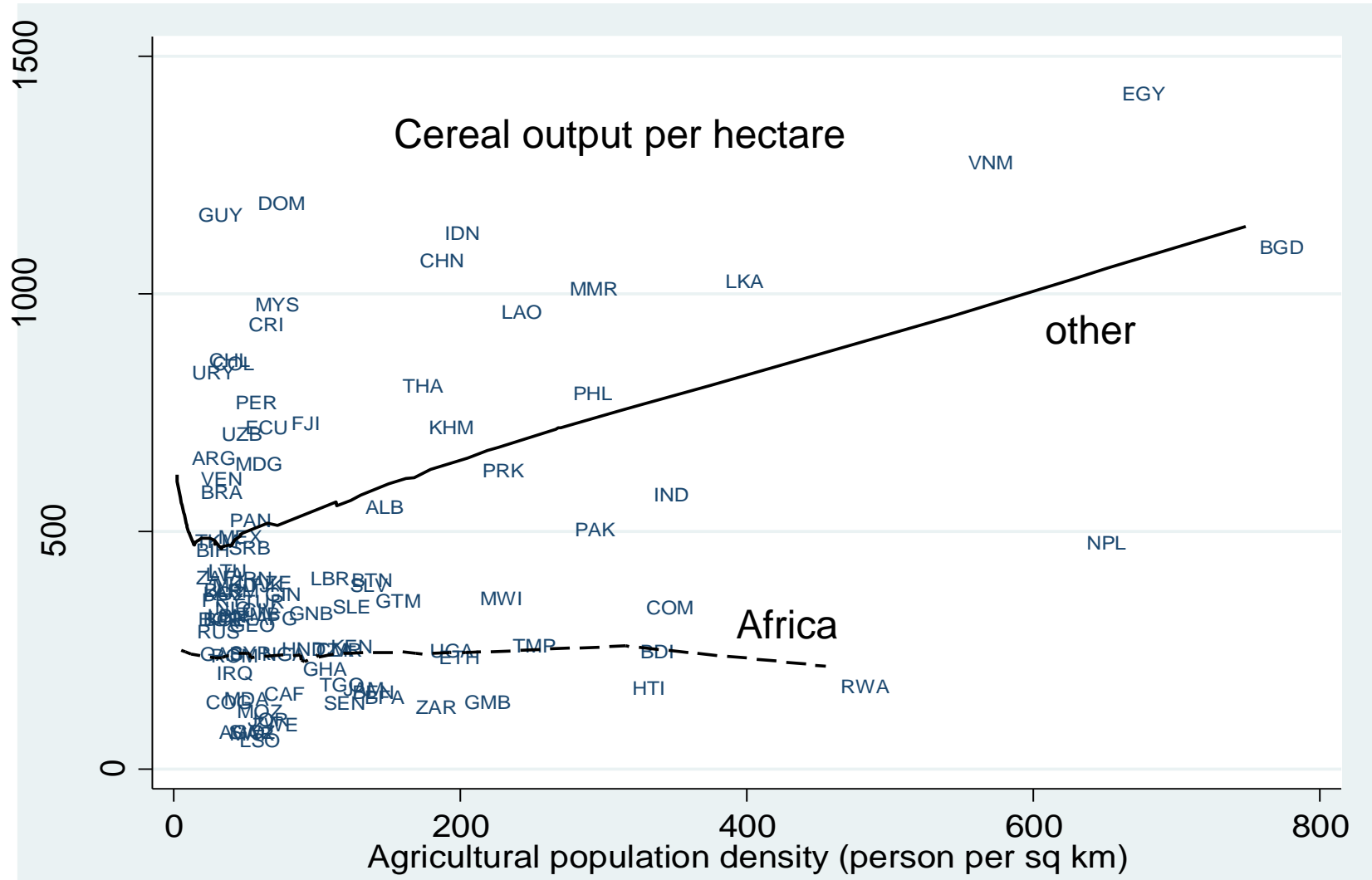
Boserup: land use intensity responds to pop density



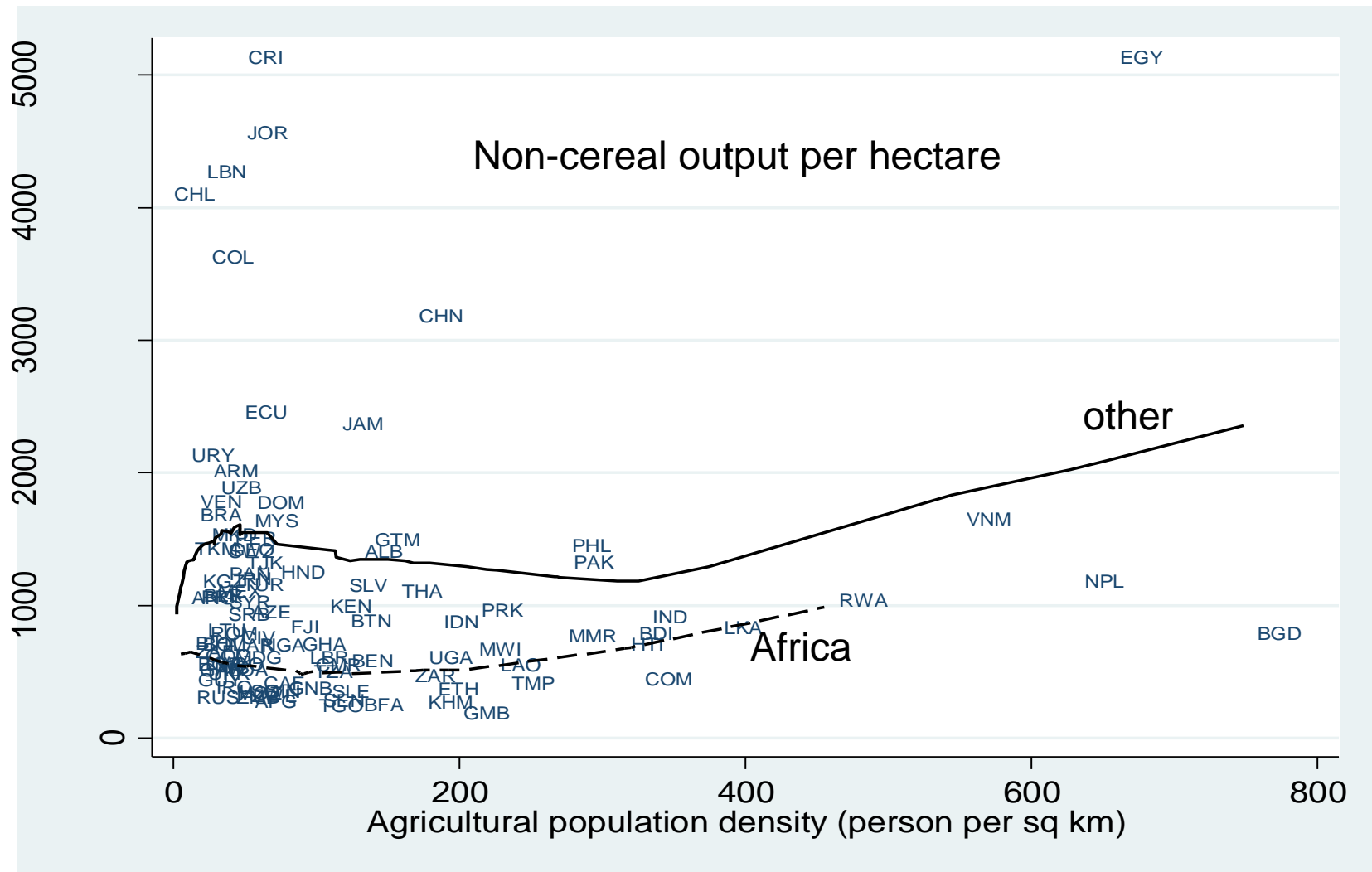
Agricultural intensification



Agricultural intensification



Agricultural intensification



Log-log estimates of agricultural value per hectare and its three components

Regression No.	R1	R2	R3	R4
Dep. var.	Agric. output per ha	Cereal output per ha	Cereal crop intensity	Non-cereal output per ha
Population density	0.33***	0.18***	0.20***	0.28***
Density*Africa	-0.11**	-0.23***	-0.01	-0.01
Road density	0.14***	0.09**	-0.03	0.19***
Number of ports	0.14***	0.21***	0.03	0.15***
Urban agglom (%)	0.29***	-0.09	0.31***	0.31***
Regional fixed effects?	Yes	Yes	Yes	Yes
Sign of SSA dummies?	+ in E.Africa	Zero	Neg.	+ in E.Africa
AE controls	Yes	Yes	Yes	Yes
No. Obs	243	243	243	243
R-square	0.8	0.74	0.67	0.79

Table 5. Log-log estimates of specific agricultural inputs

Regression No.	R1	R2	R3	R4
Dep. var.	Fertilizers per hectare	Cattle/oxen per hectare	Irrigation per hectare	Capital per hectare
Population density	0.76***	0.42***	0.59***	0.24***
Density*Africa	-0.32**	0.15*	-0.47***	-0.10***
Road density	-0.08	0.31***	0.04	0.07**
Number of ports	0.50***	0.07	0.24***	0.12***
Urban agglom (%)	0.38	0.03	0.24**	-0.03
Regional fixed effects	Yes	Yes	Yes	Yes
Sign of SSA dummies?	Zero	Neg.	Zero	Zero
AE controls	Yes	Yes	Yes	Yes
No. Obs	0.73	0.77	0.92	0.77
R-square	0.69	0.74	0.91	0.73

Non-farm income shares: Zambia

Area cultivated	Income shares		
	crops	Animal products	Non-farm
0-0.99	57%	4%	39%
1-1.99	69%	5%	26%
2-4.99	74%	5%	21%
5-9.99	74%	7%	18%
10-20	76%	8%	16%
overall	66%	5%	29%

Non-farm income shares: Kenya

Area cultivated	Income shares		
	crops	Animal products	Non-farm
0-0.99	46%	13%	41%
1-1.99	60%	13%	26%
2-4.99	43%	24%	34%
5-9.99	31%	27%	42%
10-20	27%	51%	22%
overall	49%	16%	34%

Non-farm income shares: Ghana

Area cultivated	Income shares	
	Crops and Animal products	Off-farm
0-0.99	8.1	91.9
1-1.99	37.3	62.7
2-4.99	54.2	45.7
5-9.99	64.6	35.2
10-20	69.6	30.4
overall		

Issue 3:

Who is getting access to remaining
good quality land?

3 main groups:

1. Indigenous communities (small-scale)
2. Large-scale investors
3. “Emergent” farmers

Who's acquiring the remaining land?

- Cotula et al (2009) estimate that foreign investors have acquired 0.5% to 2% of SSA's land suitable for crops
- Number of medium-scale “emergent” farms rising rapidly where data is available to measure:
 - +130% increase in medium-scale farms 2001-2011 (Zambia) compared to +31% increase in small-scale farms
 - Mostly urban-based
 - Driven by increased incomes of top 20% of urban population
 - Driven by higher food prices
- Erosion of traditional chiefs' power
 - Pressures to convert land from customary to state/titled land
 - Lands commission data on land transactions tends to be top secret

Medium-scale farmers' characteristics: Kenya (n=300)

	Farm-led growth strategy	Non-farm led growth strategy
Heads had non-farm job	17%	84%
_civil servant	71%	68%
_private sector	29%	32%
Heads had business	52%	42%
Heads level of education:		
_informal	12%	7%
_primary	43%	24%
_secondary	27%	22%
_post-secondary	18%	47%
Father to household head:		
_landholding owned (ha)	94.68	45.06
_non-farm job	33%	38%
_some formal education	35%	40%

Medium-scale farmer characteristics: Kenya

Variable	Farm-led growth strategy (n=82)	Non-farm led growth strategy (n=118)
Land under crop	54%	46%
Land acquired through purchases (%)	64%	85%
Land owned with title (%)	59%	79%
Decade when land was acquired (prop)		
1969 or earlier	29%	6%
1970 through 1979	24%	18%
1980 through 1989	20%	20%
1990 through 2000	18%	32%
2000 or later	9%	25%

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Conclusions

1. Land pressures are severe in high density SSA, where small farms are getting smaller, and will continue to get smaller as pop. grows
 - ❑ Rising rural population density is an important variable – yet its influence on farm behavior and structural transformation processes in Africa largely unexplored
 - ❑ Land pressures conspicuously absent from
 - ❑ CAADP, national development plans, poverty reduction plans, etc.

Conclusions re: Agricultural intensification

- 2. Africa has intensified agriculture**, but largely through high value crops (HVCs) and more continuous cultivation / reduced fallows
 - ❑ Much less historical success with cereals
 - ❑ Much less intensification through modern input use
 - ❑ Much less intensification through irrigation

Conclusions: re non-farm diversification

3. Weak evidence. Consistent with historical evidence that nonfarm sector doesn't just grow without engines like education, infrastructure, agriculture

Conclusions: re land availability

4. Earlier estimates (Deiningger and Byerlee) appear very optimistic
 - Sensitive to assumptions about prices & costs
5. With few, very *conservative additional assumptions* about economic feasibility, the estimate of land available for crop expansion *declines by up to 90%*

Conclusions

6. Medium-scale farm expansion primarily driven by political and economic processes related to land administration and public spending
 - Largely urban-based / higher education

-
7. Global goals of “Sustainable Intensification”
 8. But irresistible pressures for governments to wrest control of remaining arable land from chiefs and allocate it:
 - national food security
 - patronage

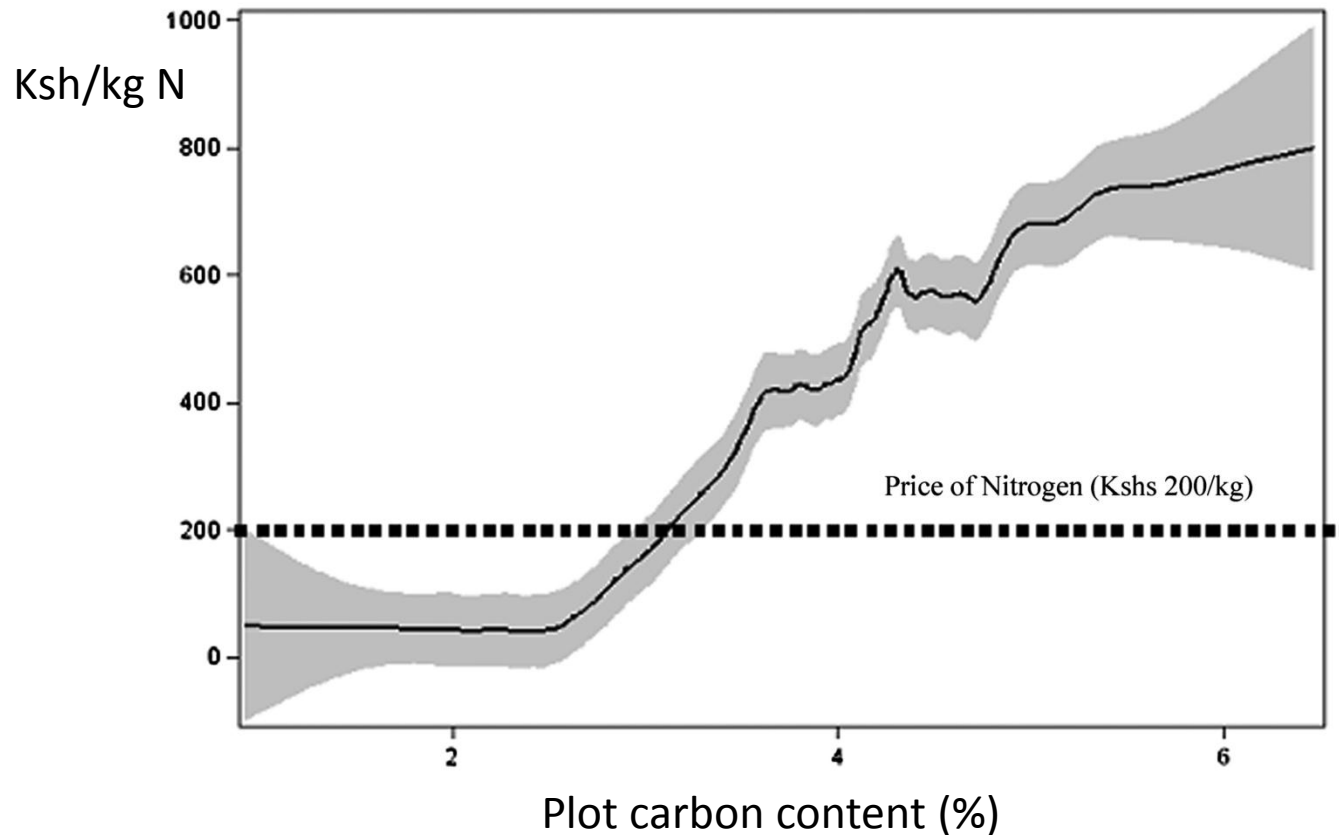
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9. Chiefs likely to lose influence over time
 10. Land markets will develop, but only after much of it is converted to state land with title conferred to urban-based elites and emergent farmers

Meanwhile...

- Evidence that continuously cultivated lands in high-density rural areas are experiencing a reduction in responsiveness to standard intensification recipes (Dreschel *et al.* 2001)
- Reduced fallow → soil organic carbon losses → reduced responsiveness to inorganic fertilizer
- Soil rehabilitation in severely mined areas is expensive and lengthy

Fertilizer response rates in degraded areas

Estimated marginal value product of nitrogen fertilizer conditional on plot soil carbon content



Concept of “sustainable intensification

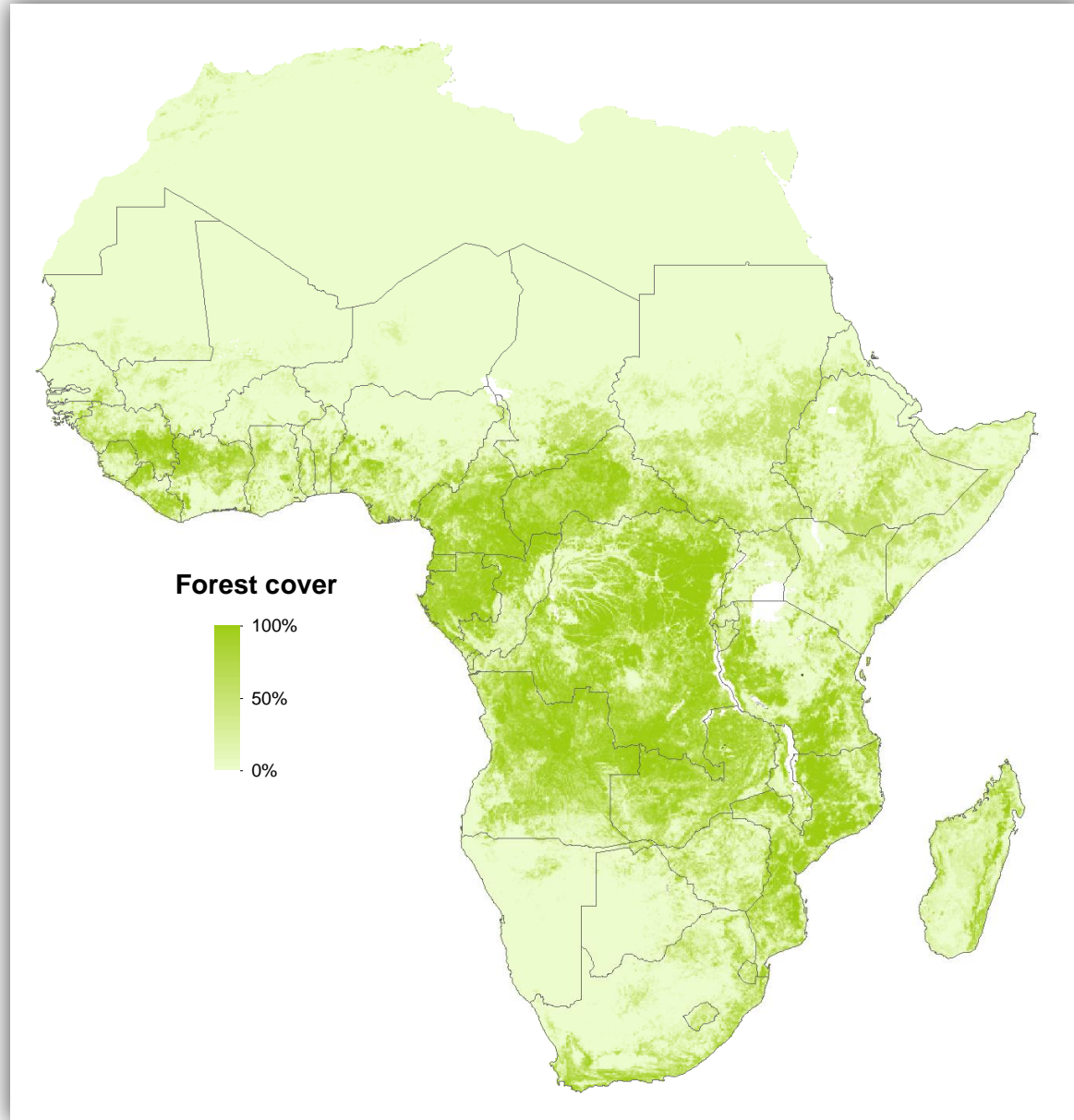




Table 9. Speculative estimates of rural nonfarm employment shares for men and women in the 2000s

<u>High density Africa</u>			<u>Low density Africa</u>			<u>Other LDCs</u>		
Country	W	M	Country	W	M	Country	W	M
Benin	50.4	23.7	Burkina Faso	12.9	8.1	BGD	53.4	44.5
Congo (DRC)	14.0	23.5	Chad	13.7	9.6	Bolivia	71.4	25.9
Ethiopia	34.3	9.7	Cote d'Ivoire	31.7	22.1	Cambodia	36.0	
Kenya	47.1	37.3	Ghana	50.1	26.6	Egypt	69.4	
Madagascar	17.8	15.3	Mali	44.6	16.0	Guatemala	79.1	
Malawi	41.5	36.0	Mozambique	5.2	23.0	Haiti	24.0	19.0
Nigeria	65.5	37.0	Niger	60.2	35.8	India	22.4	
Rwanda	7.3	14.2	Senegal	63.7	37.1	Indonesia	59.2	39.5
Sierra Leone	25.2	20.1	Tanzania	7.2	10.5	Nepal	90.5	34.2
Uganda	15.5	20.3	Zambia	30.1	19.5	Philippines	16.2	42.6