AGRODEP

Household survey data course

Dakar, 8-10 October 2012

Integrating data from different sources: improved spatially-disaggregated livestock measures for Uganda

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Livestock Data Innovation in Africa

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Outline

- Introduction and motivation
- Conceptual framework
- Objectives
- Literature and methods
- Data and pitfalls
- Model(s)
- Findings
- Conclusions and roadmap
- (Initial results on nutrition)

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Introduction and motivation

- Importance of livestock due to “the next food revolution”
- Perceived low contribution of livestock to total income (and livelihoods)
- Lack of quantitative and spatially-disaggregated livestock measures
- Little use of integrated data and spatial micro-level models

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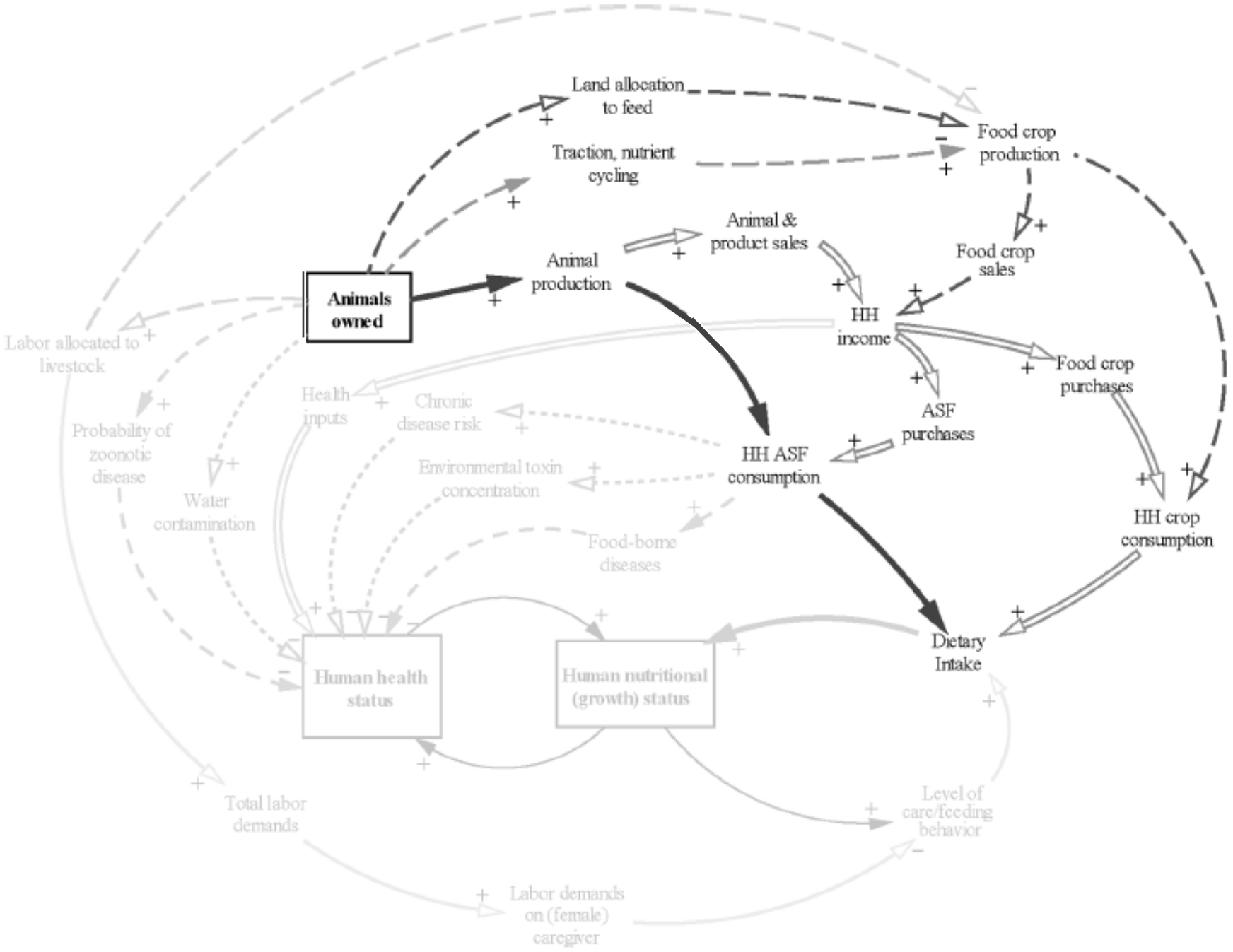

T. F. Randolph et al., "Invited Review: Role of livestock in human nutrition and health for poverty reduction in developing countries," *Journal of Animal Science* 85, (2007): 2791.

Objectives

- Providing policy-makers and analysts with reliable and detailed information on livestock
- Improving the spatial resolution of information
- Showing how integration of different data sources can greatly enhance analysis and knowledge
- Using alternative method based on a wide array of data (surveys, census, satellite, FAO…)

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Literature

- Norton-Griffiths, 1978 on “counting animals”
- Rogers, 1994, 1996, 1997, 2000, 2004 on “tsetse distribution and trypanosomiasis”
- Thornton *et al.*, 2002 on “mapping poverty and livestock”
- Wint&Robinson, 2007 on “gridded livestock of the world”
- WRI, 2010 on “spatial analysis in Uganda”
- Benson&Mugarura, 2010 on “livestock development planning in Uganda, areas of opportunities and change”

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Methods

- Interpolation using **Kriging techniques** (used by ESRI to improve point data)
- **Logistic regression** (used mainly to "fill the gaps" in binary presence/absence)
- **Weighting techniques** (mostly for "suitability mapping")
- **Link methods** b/n domestic livestock and human densities in allocating figures (population, production, commodities) within AEZ
- **Density prediction** using raster (i.e. pixel) images of observed data and predictor variables (obtained from census reports, livestock surveys, data archives)
- **Extrapolation** or distribution modelling (predicting animal distributions) using area data
- **Small Area Estimation**: ELL model (2003)

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Data

- **UNPS 09/10**: 2,975 (2,375)* HHs from 322 EAs (out of 783 of the UNHS 05/06), nationally + Kampala&other urban, and rural Central, Eastern, Western, Northern representative. Two visits (one for cropping season), twelve-month period
- **UNLC 08**: 964,047 HHs from all 80 districts (for a total of 8,870 EAs with at least 50 HHs/EA). Visit in February only

*45 interviews were not complete; 555 hhs are mover (364 are split-offs and 191 original movers)

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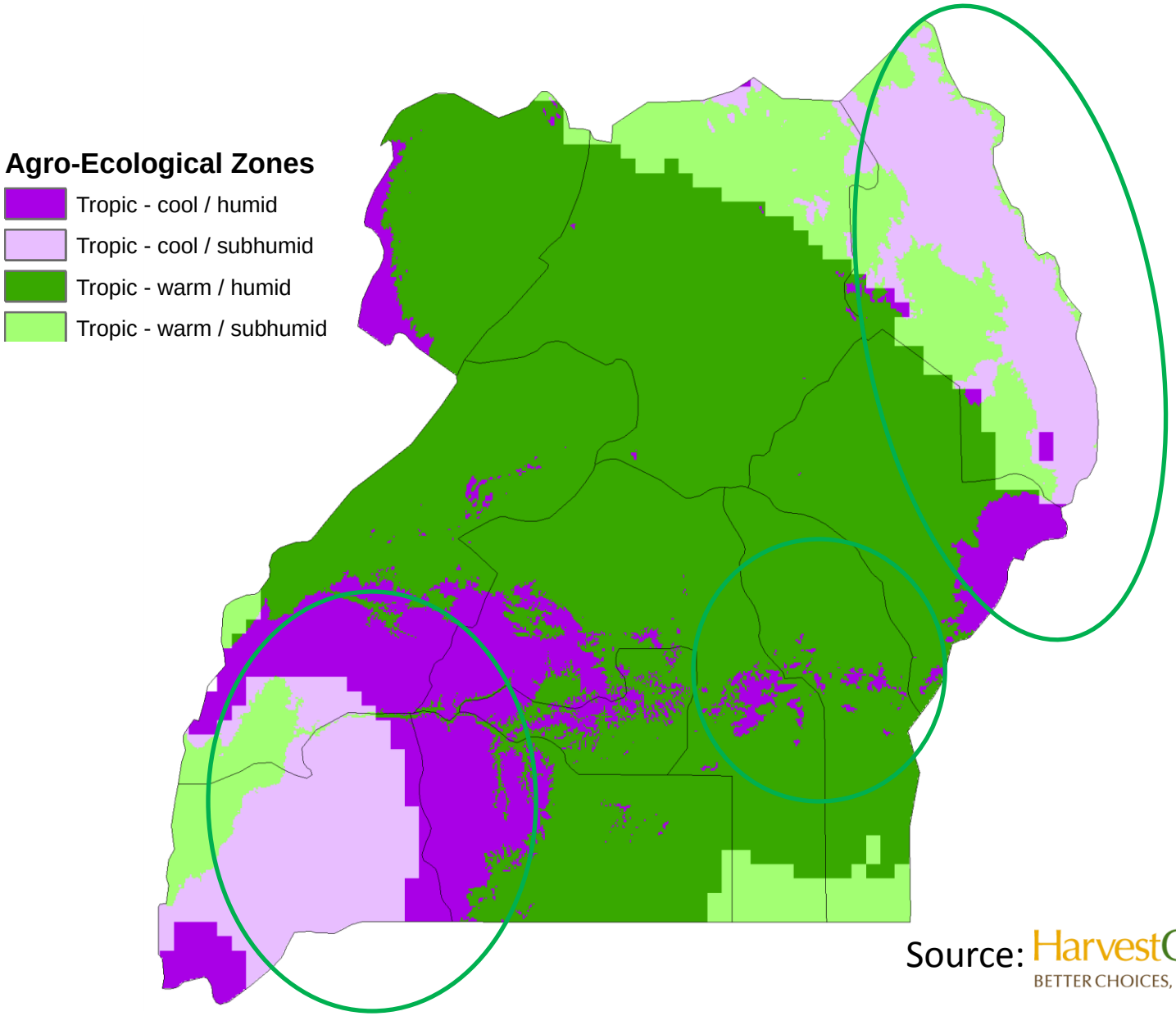

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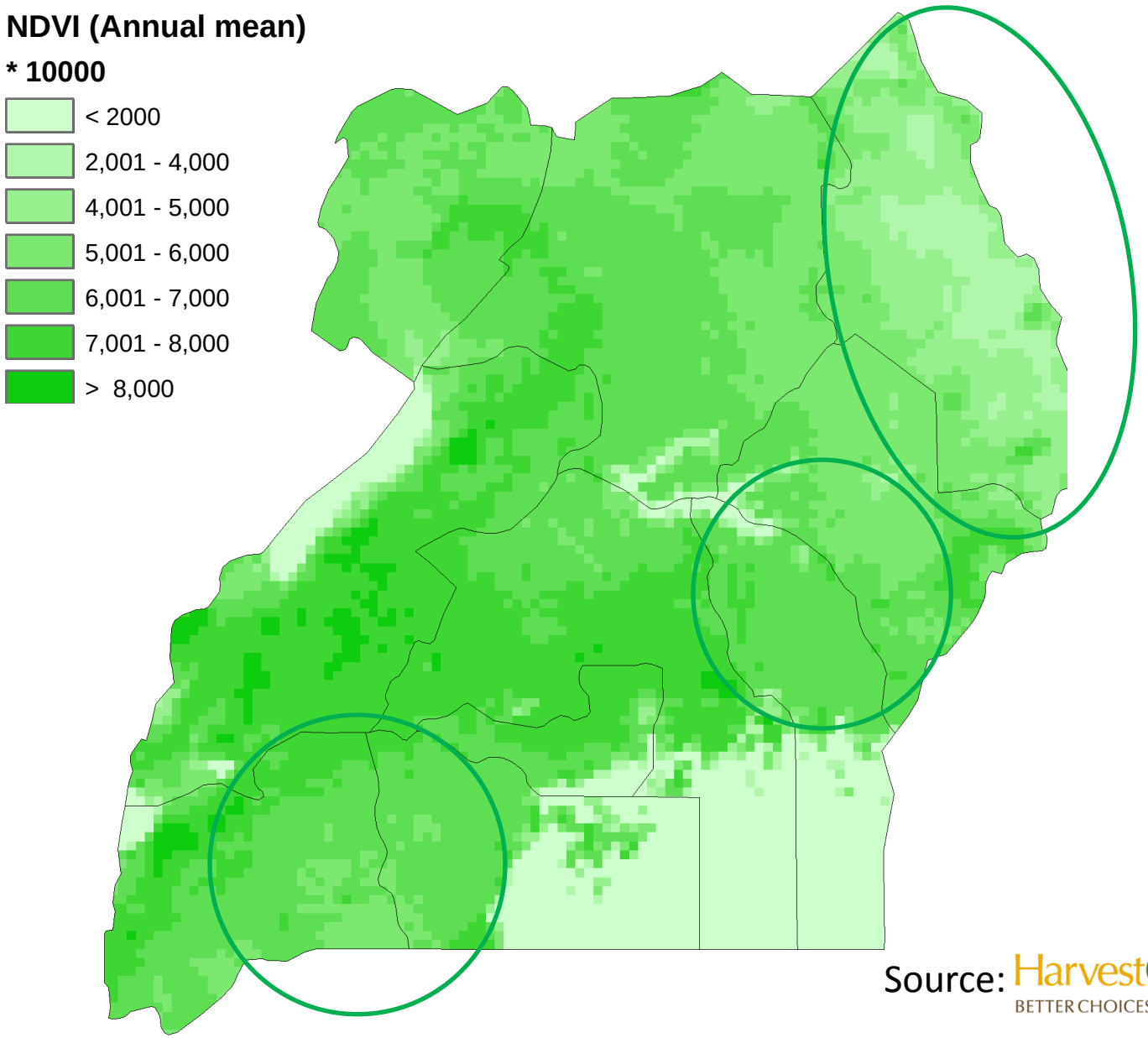

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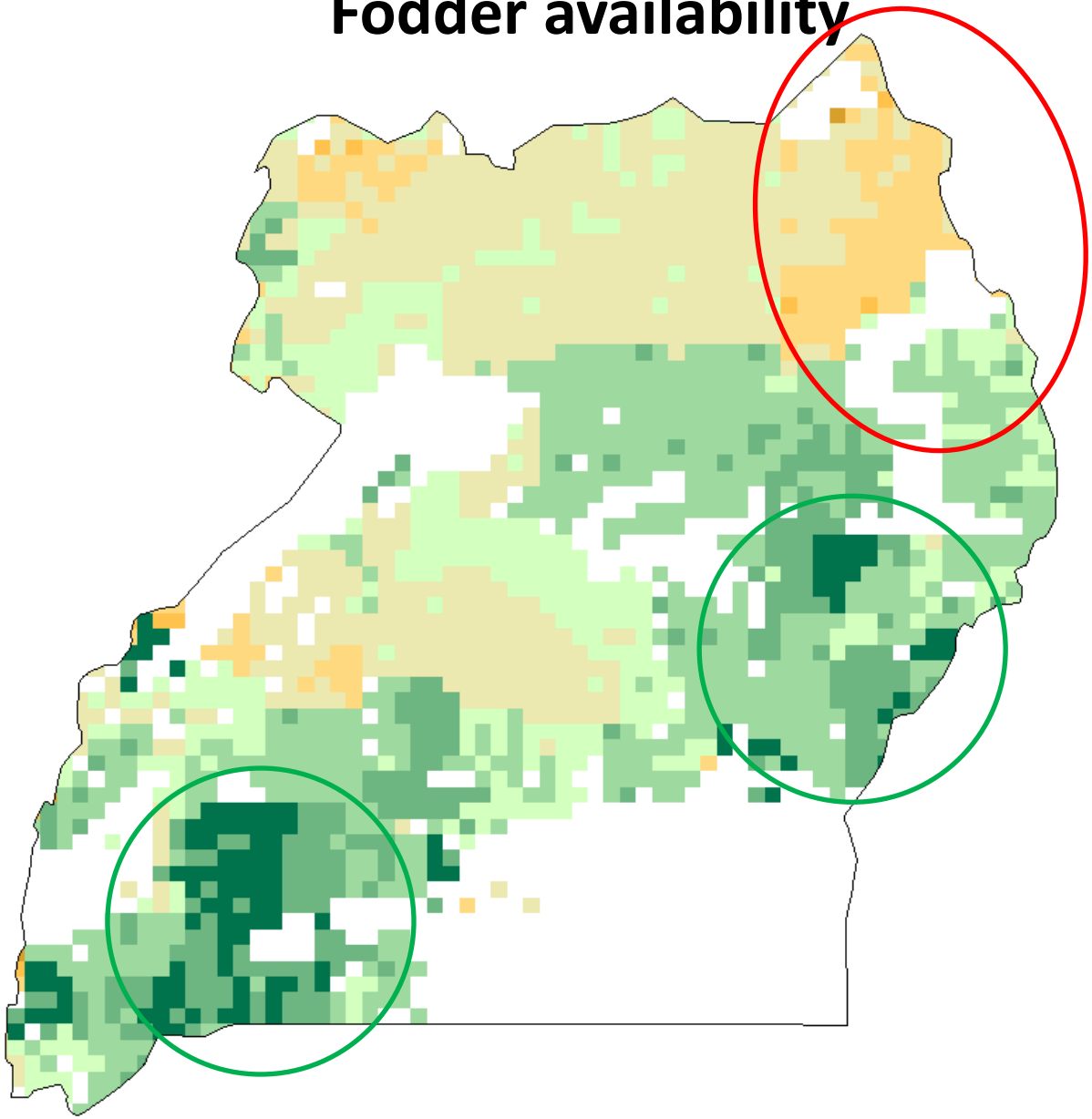
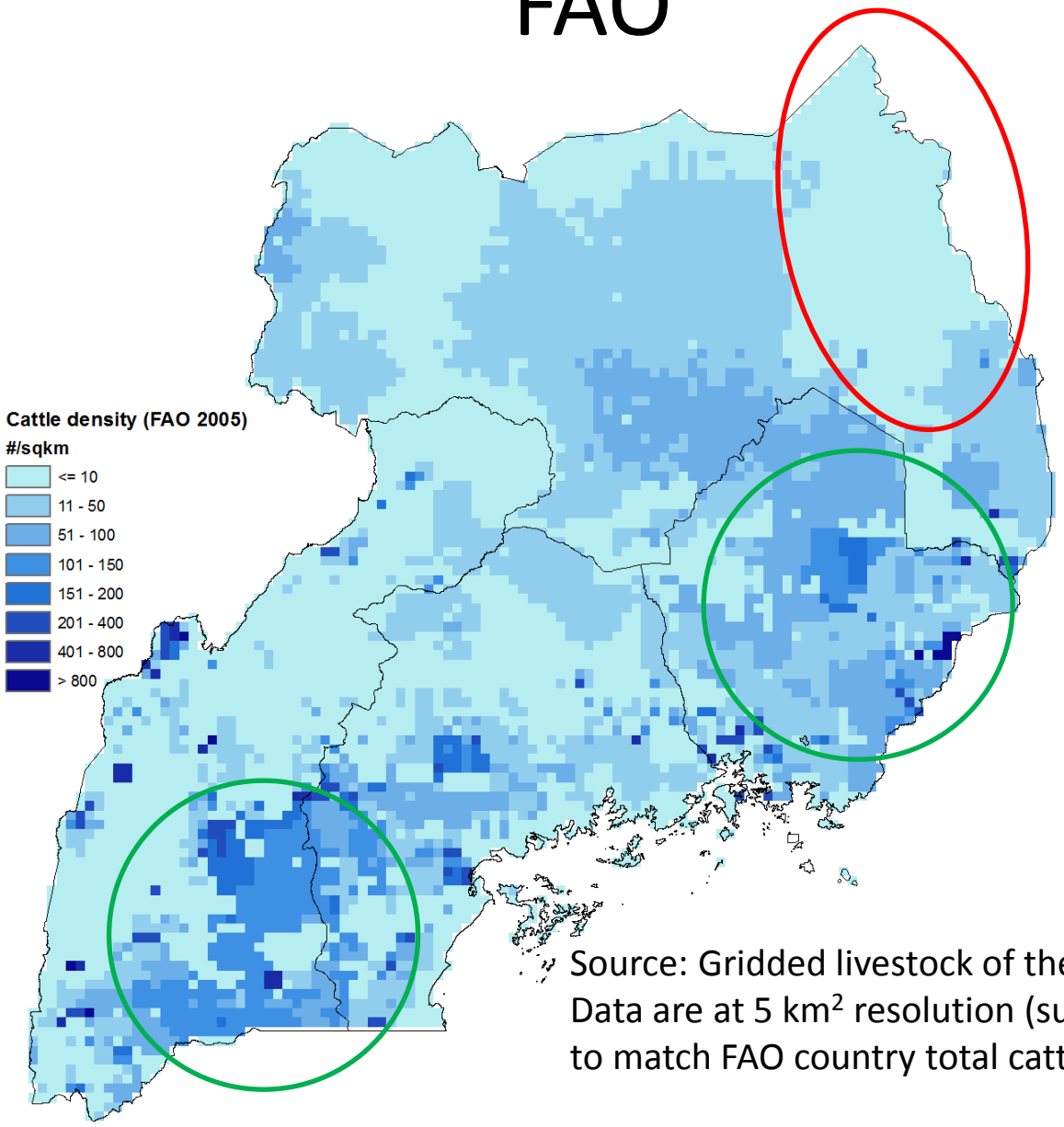
Fodder availability



Source: ILRI (Herrero *et al.*)

High resolution cattle density from FAO



Source: Gridded livestock of the world, FAO (2005)
Data are at 5 km^2 resolution (sum of the pixels is scaled to match FAO country total cattle headcount)

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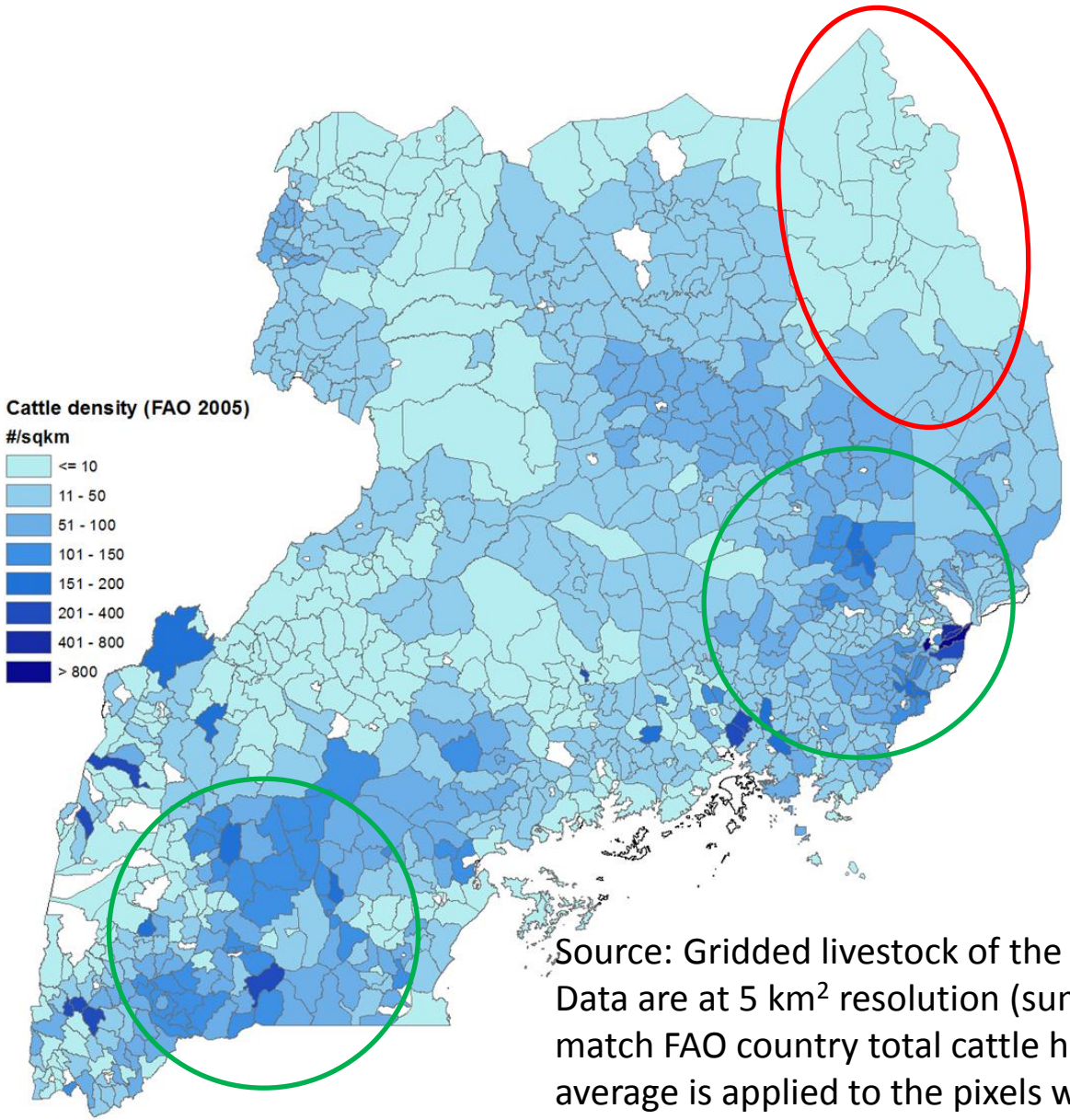
Sub-county cattle density from FAO



Source: Gridded livestock of the world, FAO (2005)
Data are at 5 km^2 resolution (sum of the pixels is scaled to match FAO country total cattle headcount, and weighted average is applied to the pixels within subcounty)

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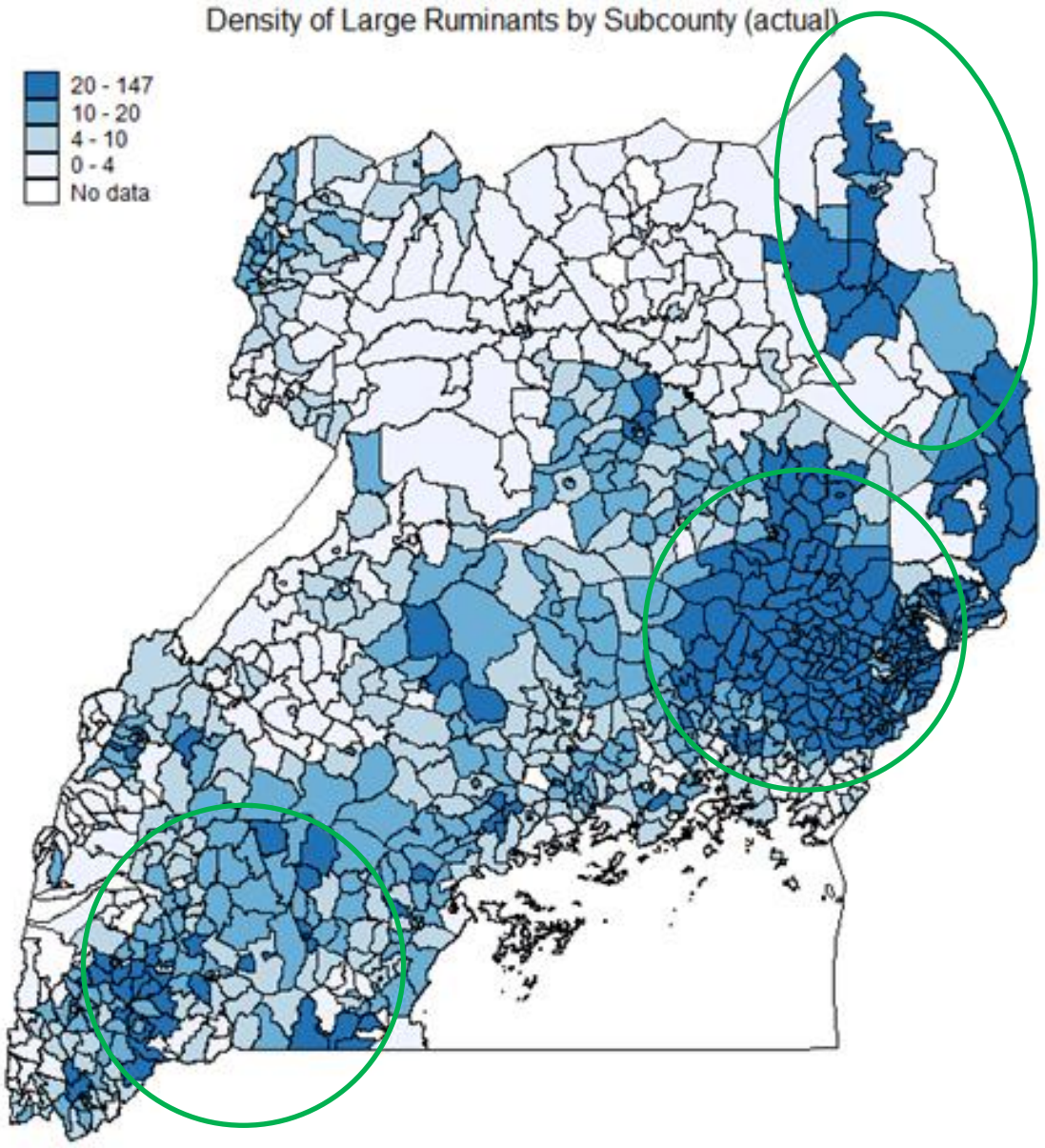
Sub-county cattle density from NLC 08



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Model/1

- Small Area Estimation (SAE):

1. identifying characteristics with common definitions (and distributions) in both NPS and NLC, used as potential explanatory variables (correlates) in a regression using the survey data:

$$y_i = X^{survey}{}_i * \beta + u_i$$

$$u_{si} = \eta_s + \varepsilon_{si}$$

Model/2

2. combining the results of the first-stage regression model with census variables:

$$\hat{y}_{ci} = X^{census}{}_i * \tilde{\hat{\beta}}^{survey} + \tilde{\eta}_s + \tilde{\varepsilon}_{si}$$

- **Assumptions**: spatial correlation b/n EA and subcounty, area homogeneity

- **Predictors (*X*)**: farm size, pasture land, other land, # of livestock heads by type (including exotic/indigenous bulls, cows, calves, and small ruminants), # of eggs and liters of milk weekly produced, age and sex of household head, whether the household hired agricultural labor, dummies by agro-ecological zone, NDVI)

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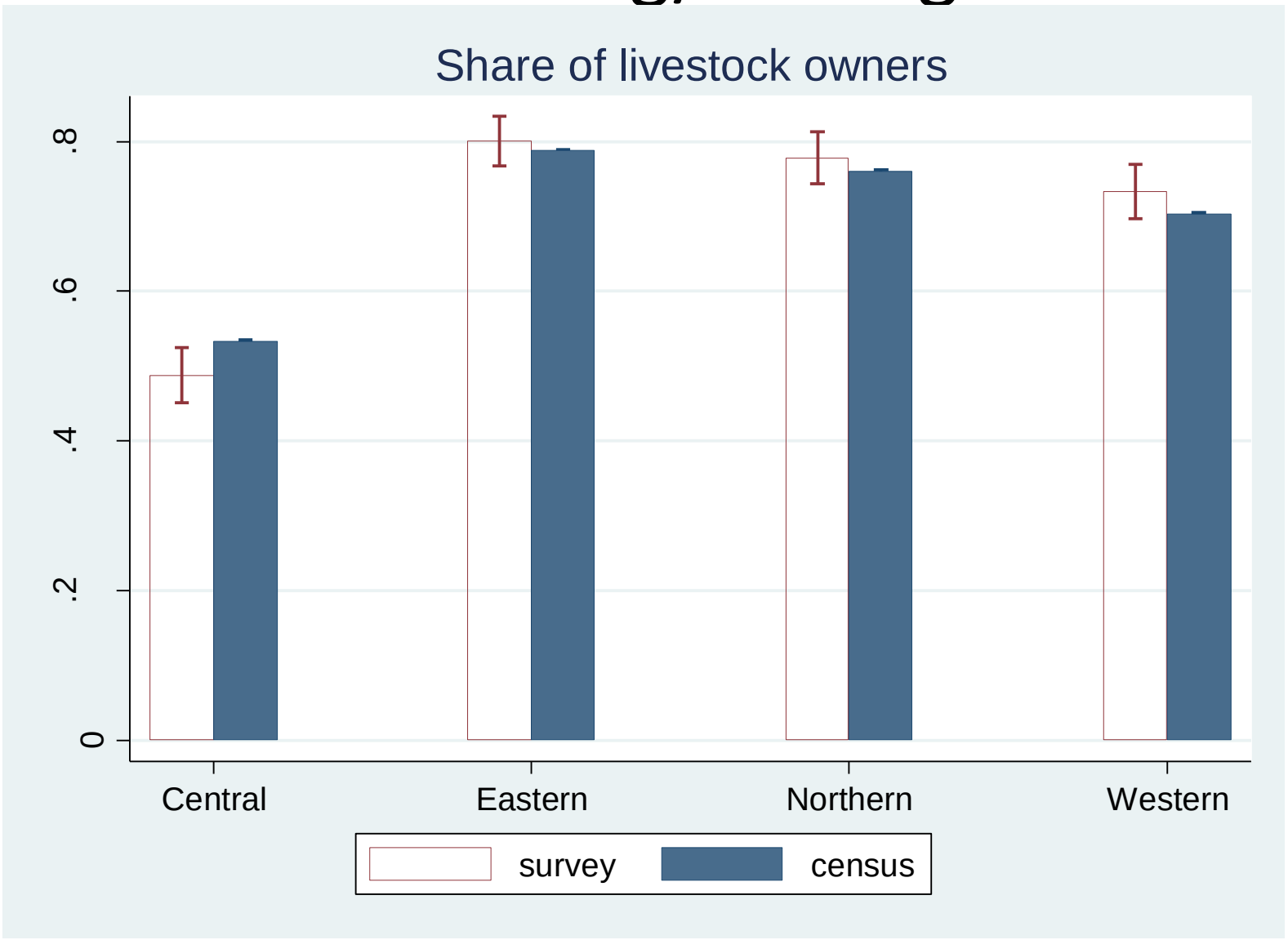
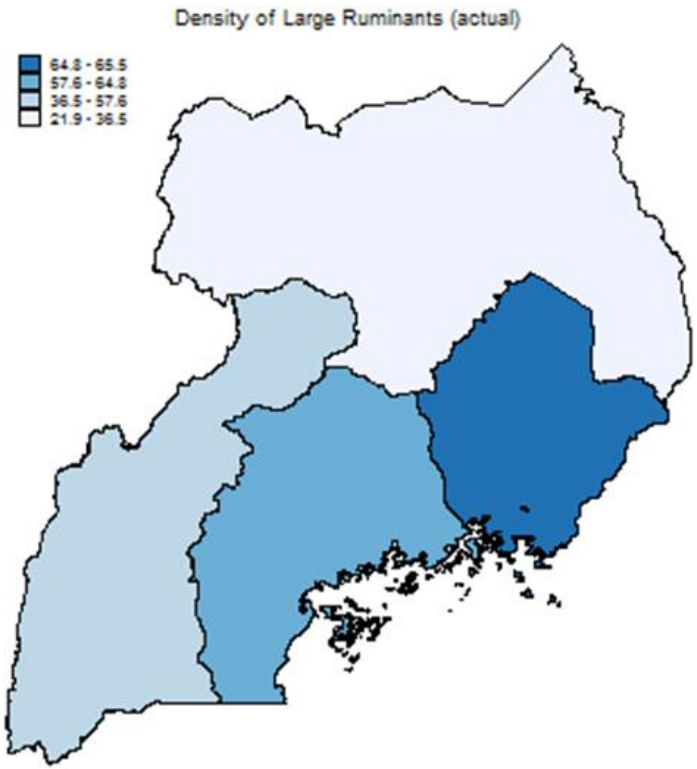
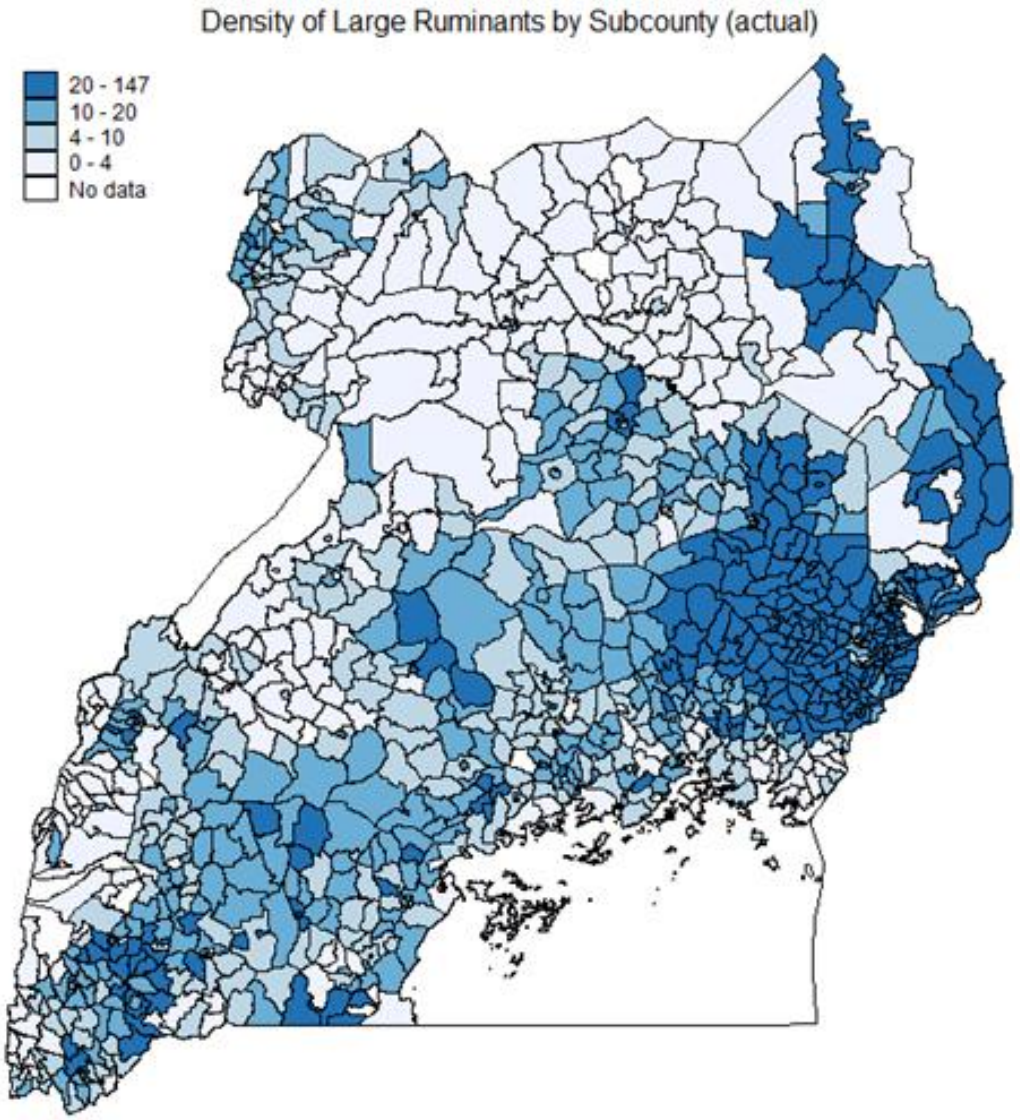
70% of Hhs owning/rearing livestock



Findings: density of large ruminants/1

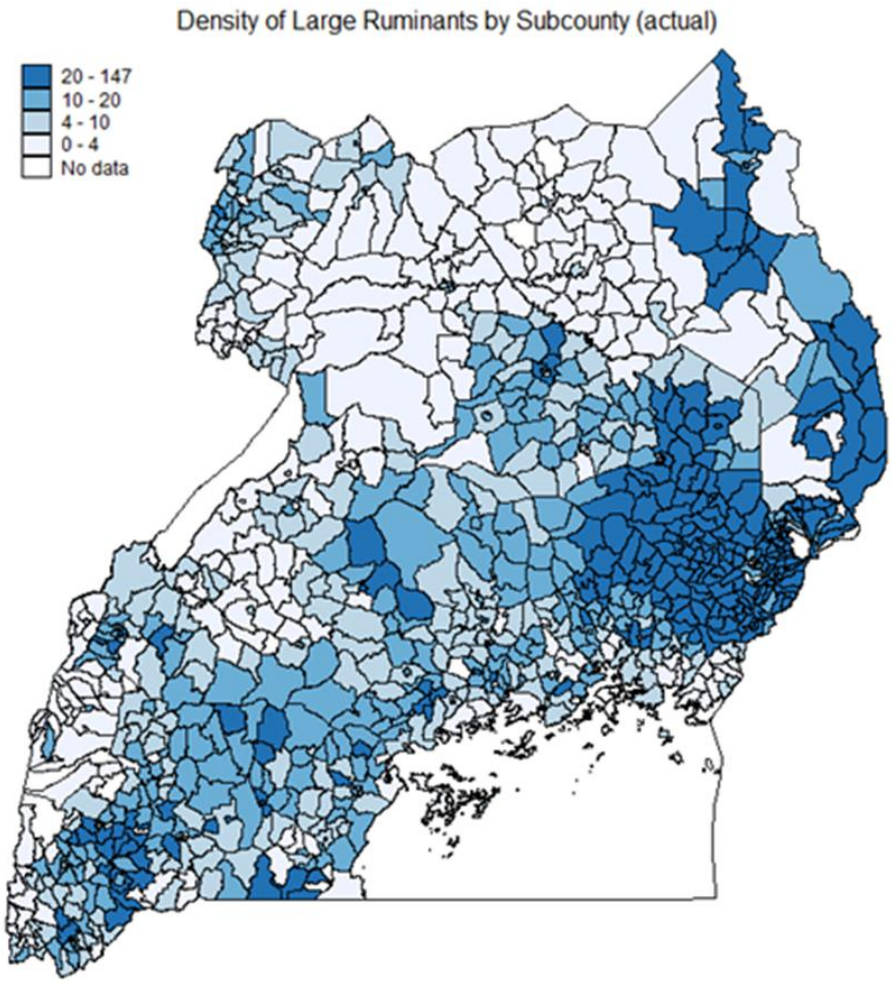


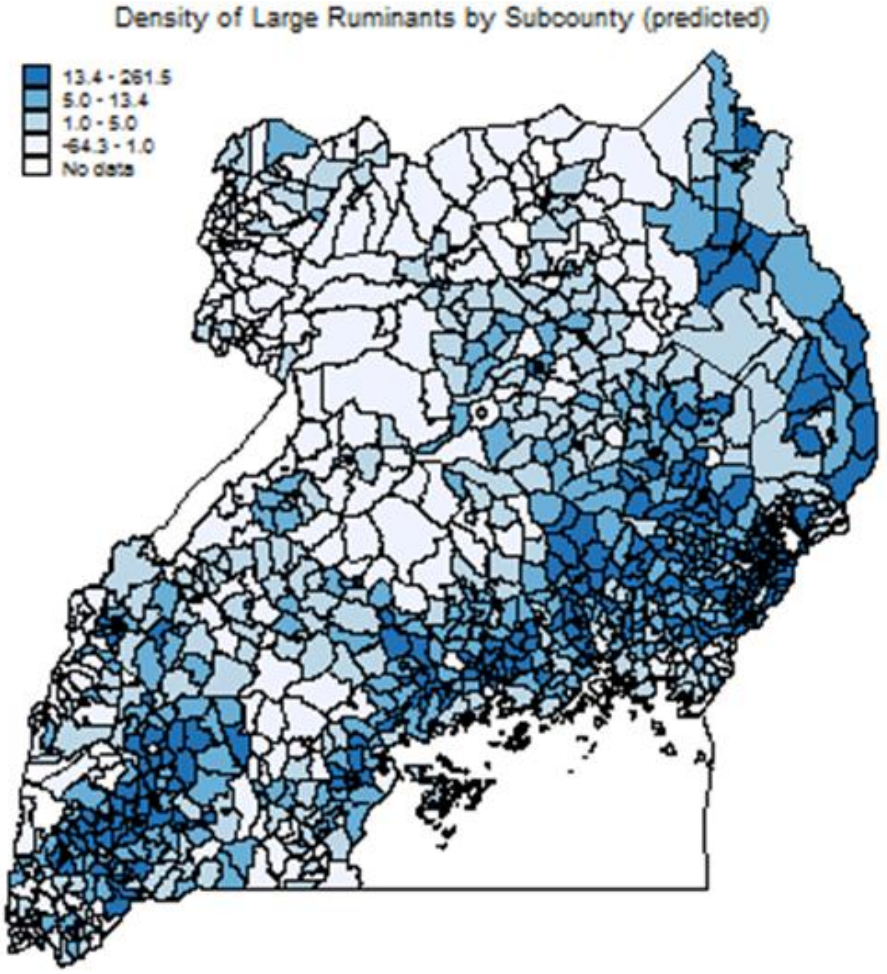
survey



census

Findings: density of large ruminants/2





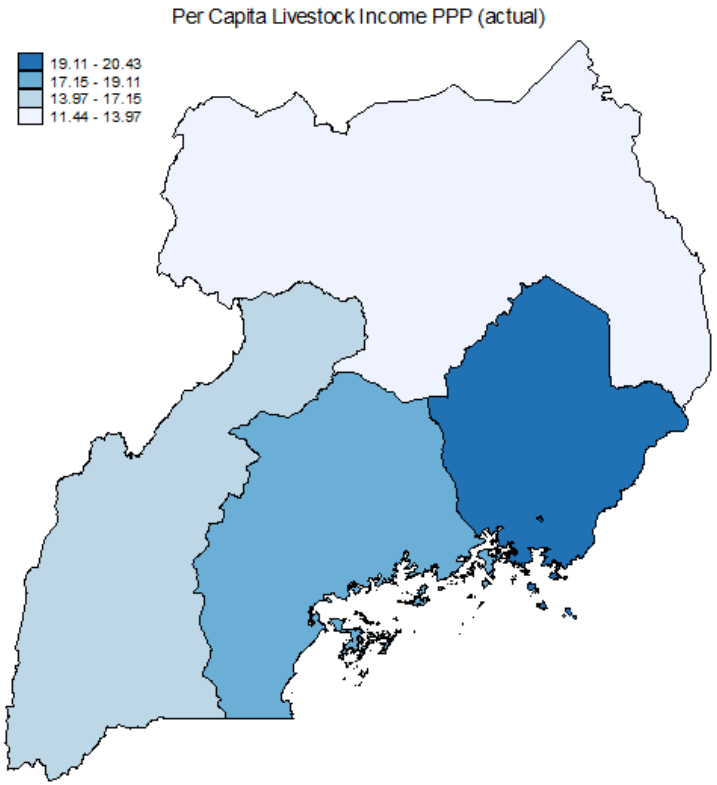
actual

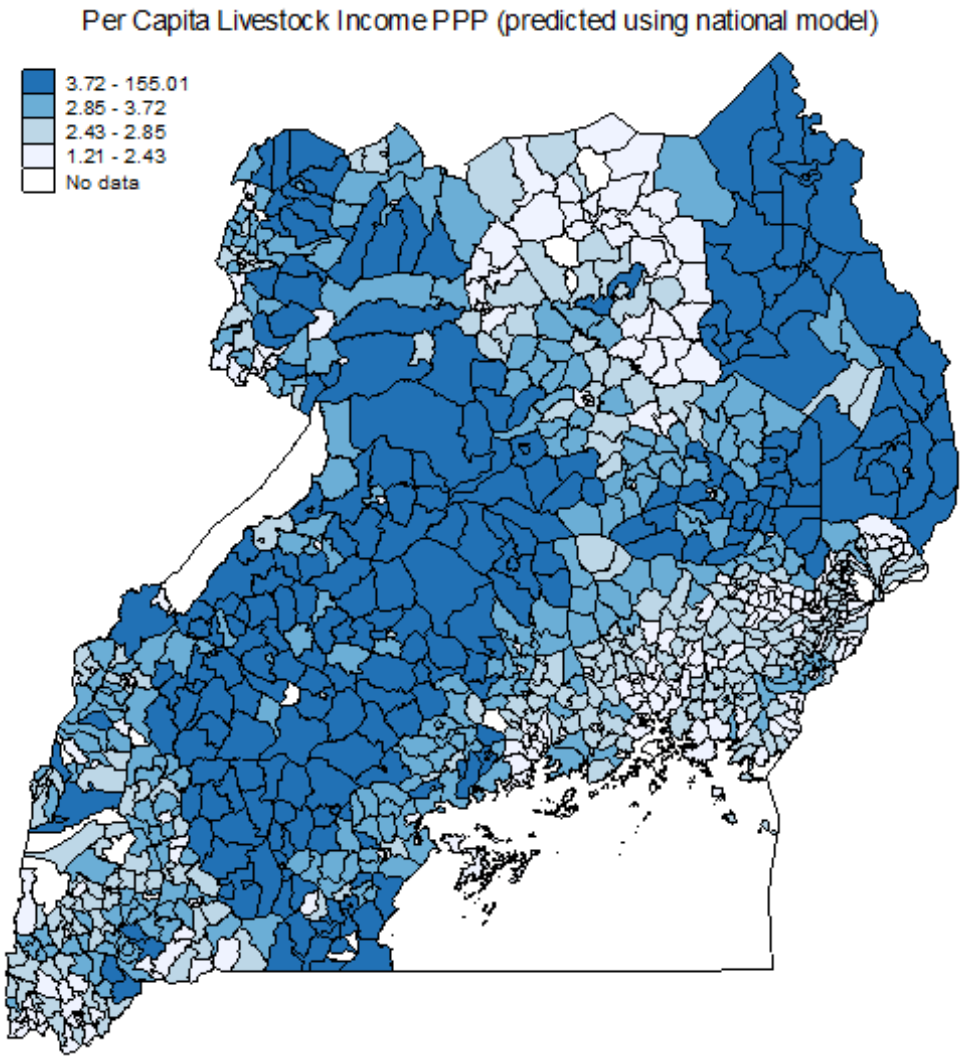
predicted

R^2 .56

Adj-R^2 .56

Findings: per-capita liv. income PPP/1

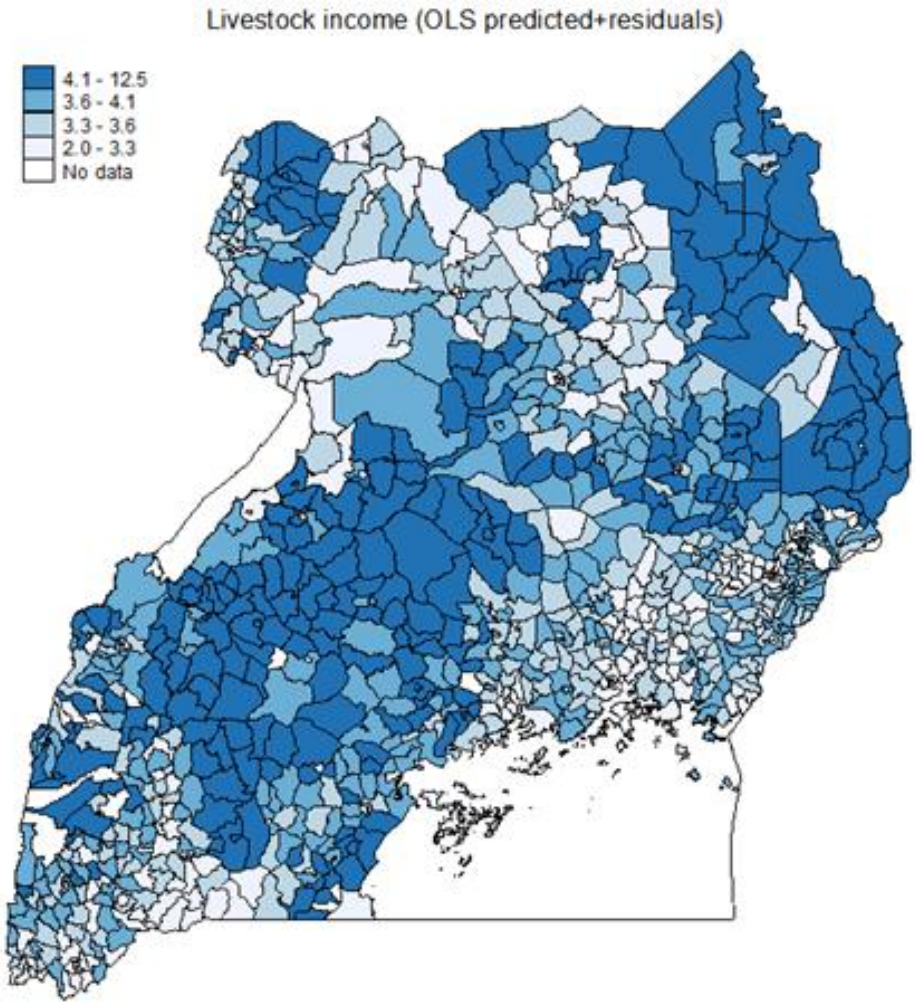


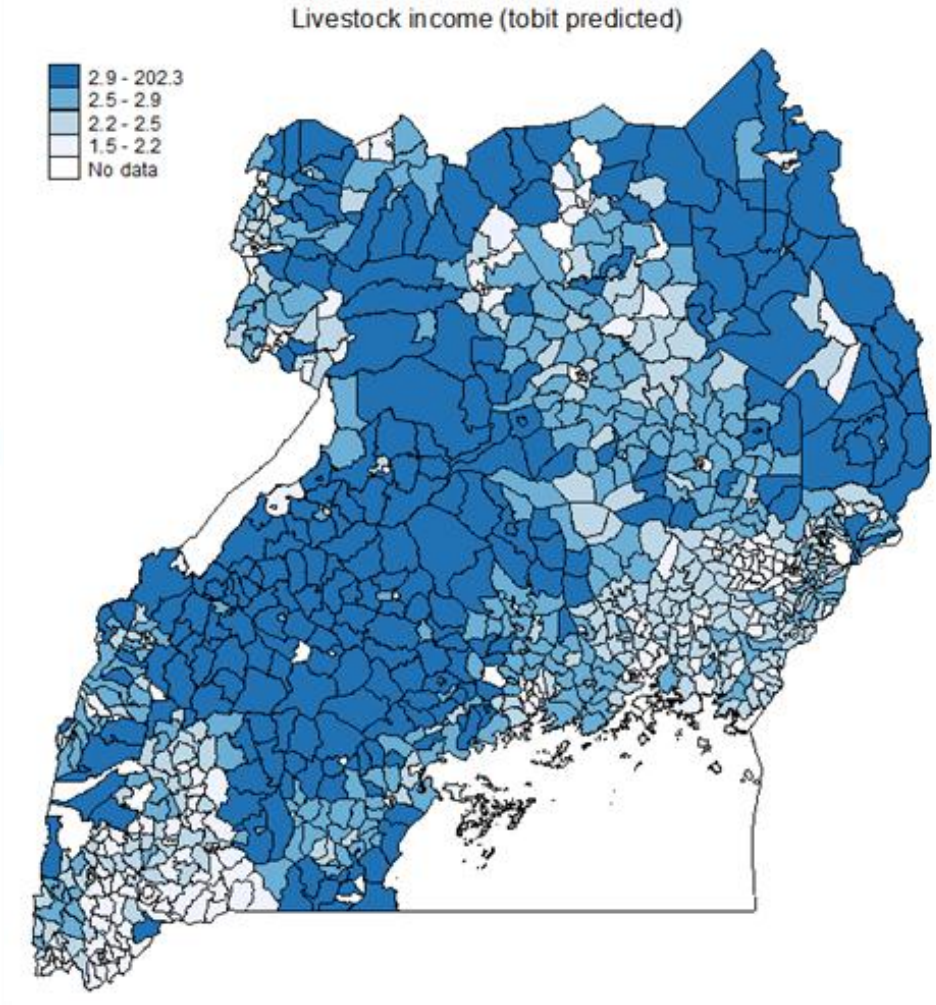


R^2 .24

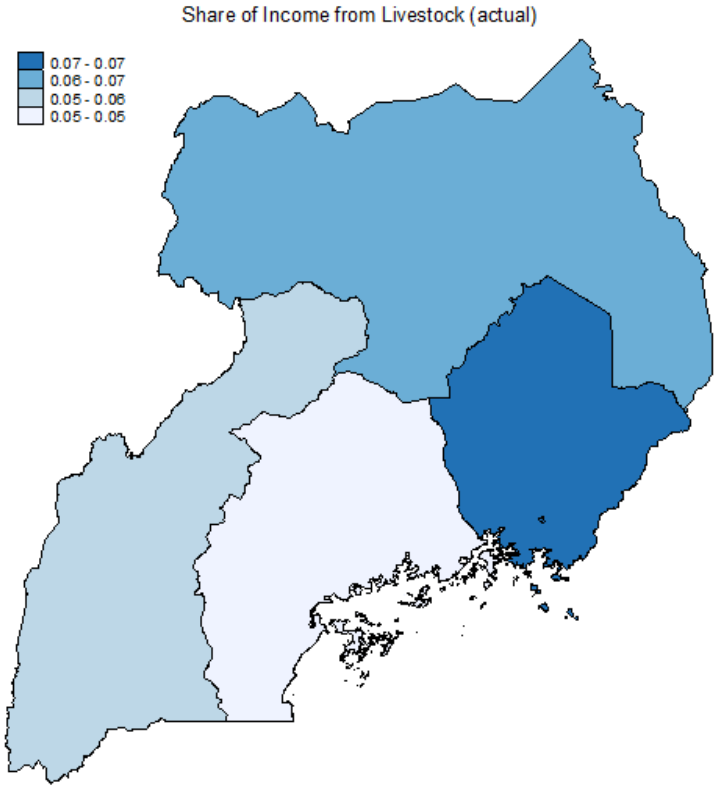
Adj-R^2 .20

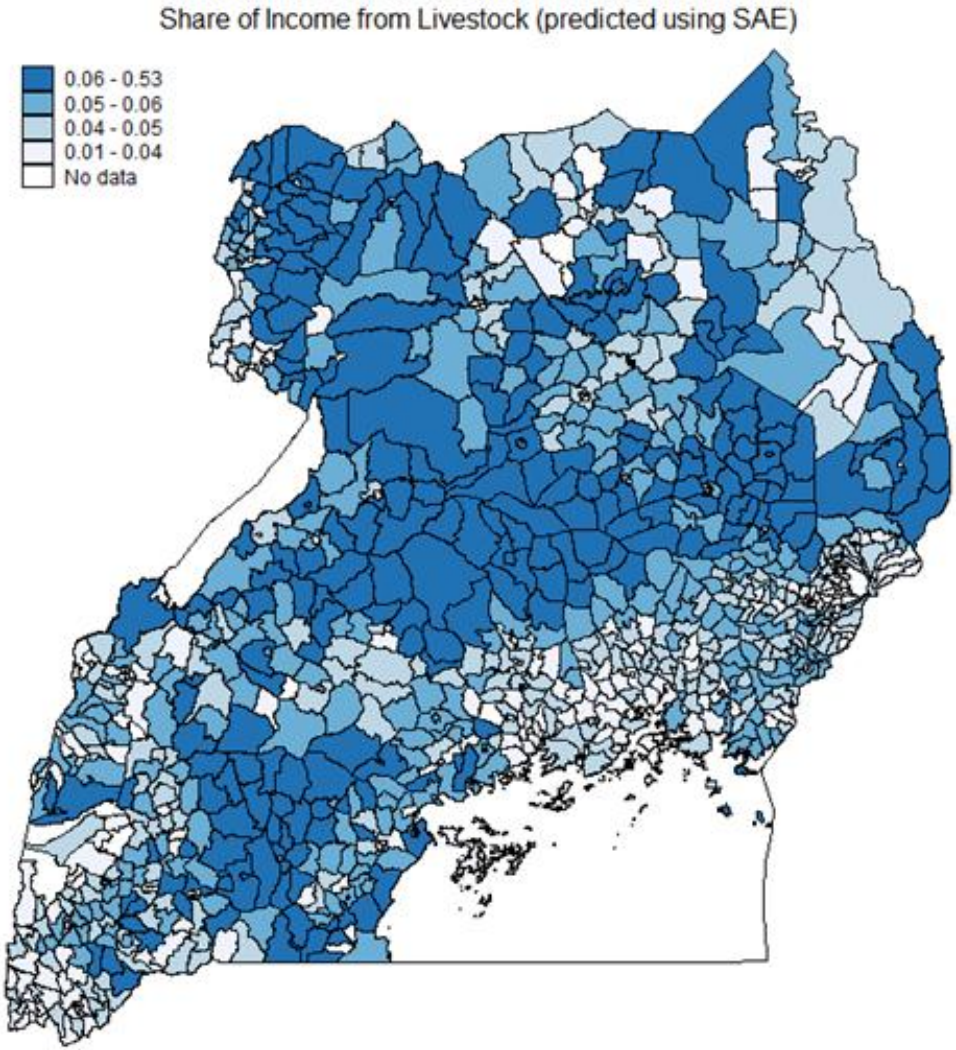
Findings: per-capita liv. income PPP/2





Findings: share of livestock income/1

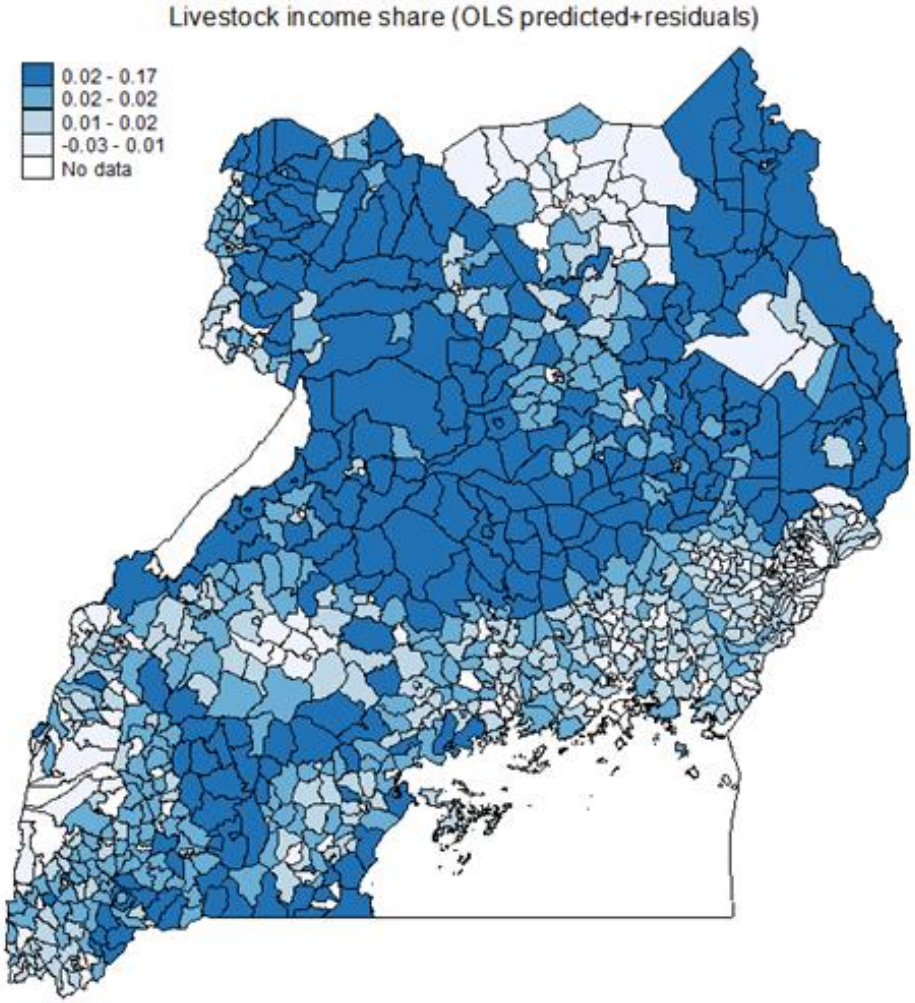


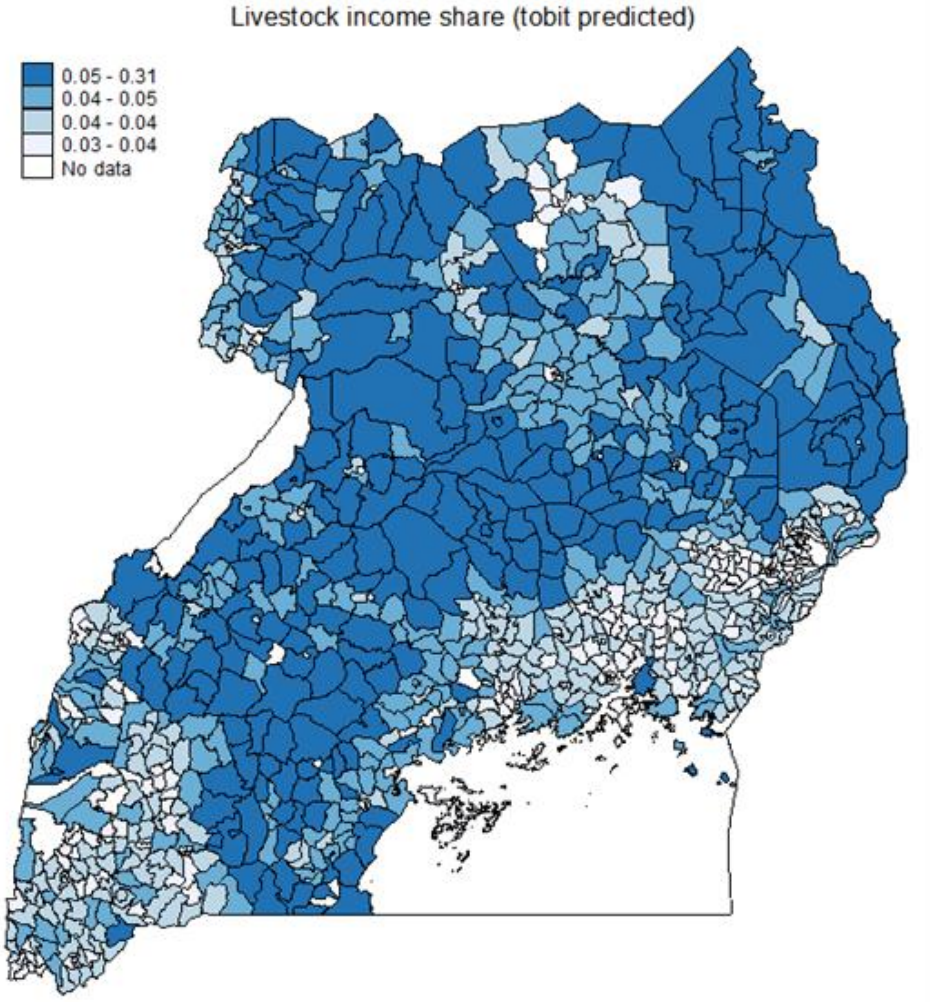


R^2 .15

Adj-R^2 .11

Findings: share of livestock income/2





Conclusions

- Results are internally and externally consistent, strengthening reliability of methodology
- Concrete possibility of combining multi-topic household surveys with specialized databases to estimate contribution of livestock to household livelihoods
- Integration b/n different data sources allows for finer spatial resolution
- Spatially-specific data have been successfully used for targeting poverty programs…potentially useful tool for informing livestock policy?

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Roadmap

- Through this method we can look at different outcomes, what are we after?
- Using the “improved” livestock module in NPS 11-12
- Scaling-out to other countries:
    1. Tanzania
    2. Ethiopia
    3. Malawi
    4. Niger
    5. Nigeria
- Refining data: is there scope (and leverage, especially for census)?

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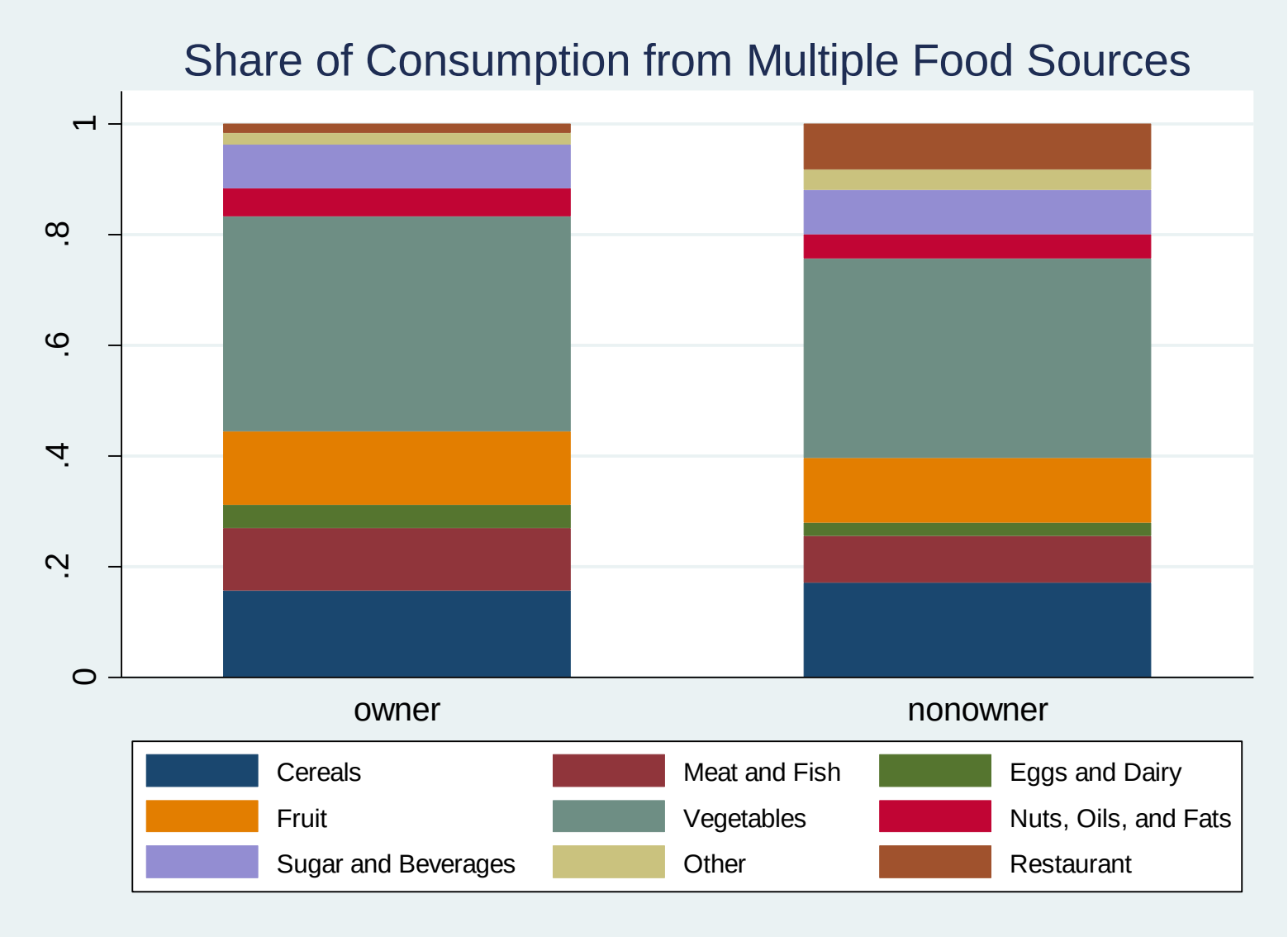
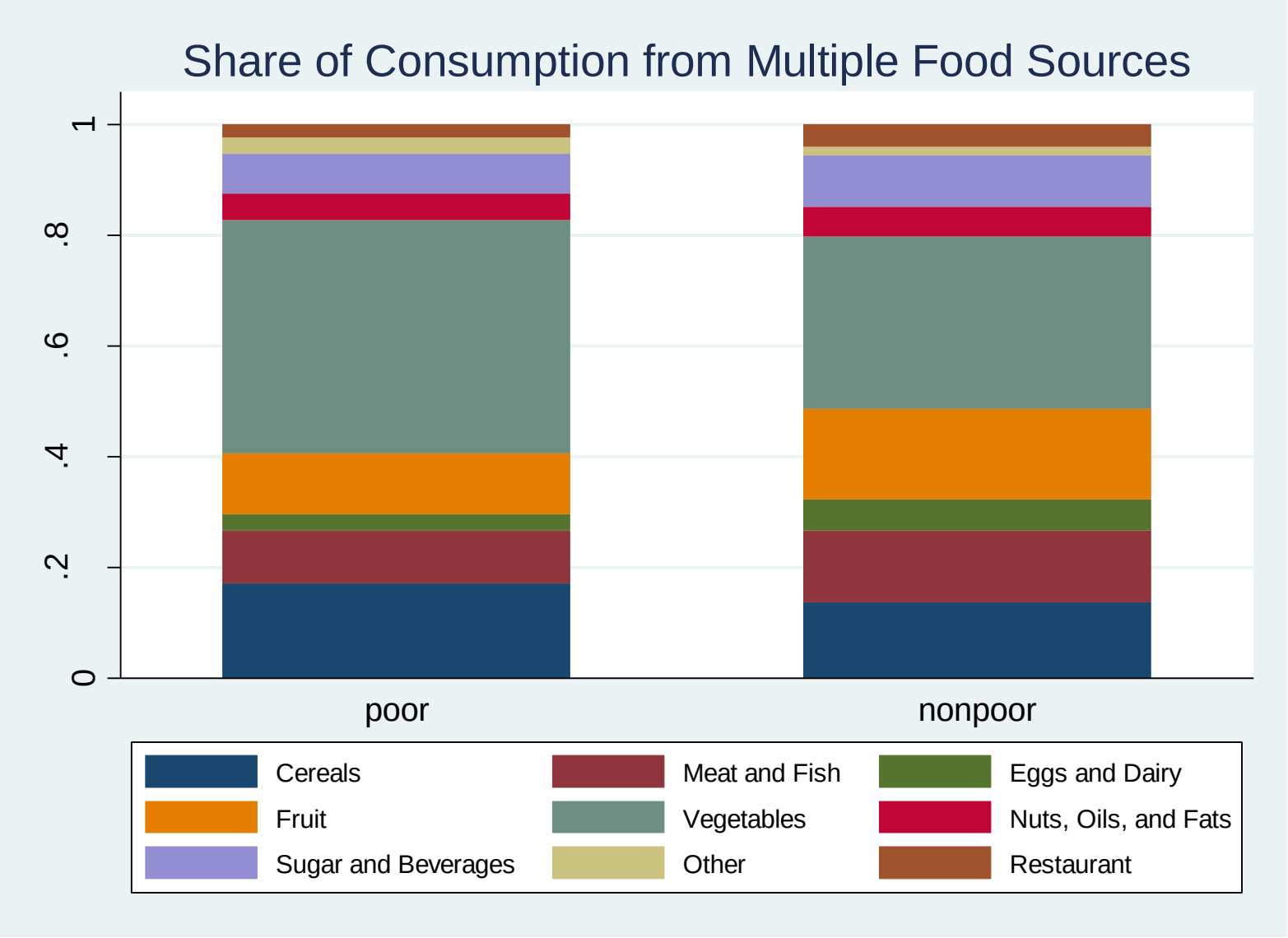
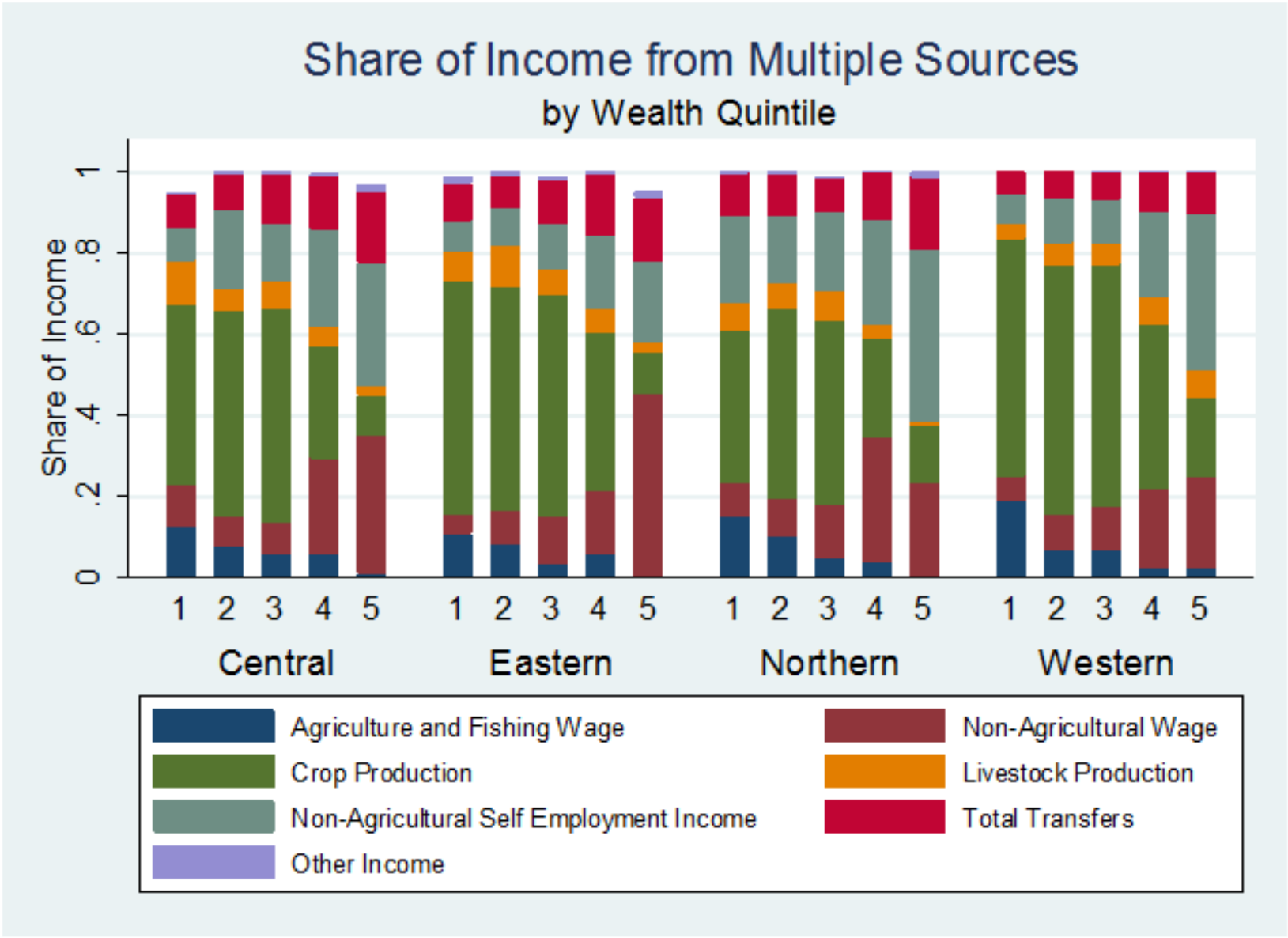
Non-owners: -meat/fish/dairy, -fruit, +meals outside



Non-poor: +meat/fish/dairy, +fruit, -vegetables



Livestock share decreases with wealth



Difference in means for Owners/Non-owners

Variable	Owner	Non-Owner	Difference
Value of Meat and Fish (PPP)	37.8	36.5	1.3
Value of Dairy and Eggs (PPP)	13.4	11.4	1.9
Value of Total ASF (PPP)	51.2	48.0	3.2
Share of Meat and Fish (Share of Value)	.11	.08	.03***
Share of Dairy and Eggs (Share of Value)	.04	.02	.02***
Share of Total ASF (Share of Value)	.15	.10	.05***
Large Ruminants	3	0	3***
Small Ruminants	3	0	3***
Monogastrics	8	0	8***
Max Adult Education of household	7.9	6.72	1.2***
Years of Education of Head	5.3	4.7	.6
Agricultural Land (hectares)	1.9	.7	1.2***
Total Household Income (PPP)	15,530	7,138	8,392***
Share of Income from Crop Production	.718	.406	.312***
Share of Income from Livestock Production	.046	.001	.045***
Number of Observations	1589	394	

Difference in means for Poor/Non-Poor

Variable	Poor	Non-Poor	Difference
Value of Meat and Fish (PPP)	31.1	48.8	-17.6***
Value of Dairy and Eggs (PPP)	8.9	20.0	-11.2***
Value of Total ASF (PPP)	40.0	68.8	-28.8***
Share of Meat and Fish (Share of Value)	.09	.12	-.03***
Share of Dairy and Eggs (Share of Value)	.02	.05	-.03***
Share of Total ASF (Share of Value)	.12	.18	-.06***
Large Ruminants	1	3	-2***
Small Ruminants	2	3	-1**
Monogastrics	6	8	-2***
Max Adult Education of household	6.2	10.2	-4.0***
Years of Education of Head	4.0	7.1	-3.1***
Agricultural Land (hectares)	1.434	2.050	-.615***
Total Household Income (PPP)	11,900	16,900	-5,000***
Share of Income from Crop Production	.69	.58	.11***
Share of Income from Livestock Production	.039	.032	.007
Number of Observations	1304	679	

Initial results of consumption values (all sample)

	(1) Ln (Value of Dairy and Eggs)	(2) Ln (Value of Dairy and Eggs)	(3) Ln (Value of Meat and Fish)	(4) Ln (Value of Meat and Fish)	(5) Ln (Value of Total ASF)	(6) Ln (Value of Total ASF)
VARIABLES						
Livestock Owner	0.377***	----	0.223*	----	0.461***	----
Number of Large Ruminants	----	0.0915***	----	-0.0193	----	0.0405***
Number of Small Ruminants	----	0.0142	----	0.0186	----	0.0308**
Number of Monogastrics	----	0.00136	----	0.0116	----	0.00904
Number of Large Ruminants^2	----	-0.000964***	----	0.000179	----	-0.000414**
Number of Small Ruminants^2	----	-1.24e-05	----	-7.72e-05	----	-0.000167
Number of Monogastrics^2	----	5.15e-05	----	-1.27e-05	----	-1.45e-05
Ln(Total Household Income (PPP))	0.104***	0.0884***	0.164***	0.160***	0.191***	0.180***
Share of Income from Crop Production	-1.150**	-0.794	-2.569**	-2.494**	-2.741***	-2.470**
Share of Income from Livestock Production	-0.278	-0.302	-1.997**	-1.892*	-1.672*	-1.562
Max Adult Education of household	0.0115	0.0128	0.0140	0.0171	0.0146	0.0167
Years of Education of Head	0.0185	0.0163	0.00927	0.00658	0.00443	0.00208
Agricultural Land (hectares)	-0.00440	-0.0123	0.0394***	0.0406***	0.0336***	0.0299***
Constant	-0.664**	-0.458	3.317***	3.452***	2.867***	3.084***
Observations	1,852	1,852	1,852	1,852	1,852	1,852
R-squared	0.231	0.261	0.228	0.231	0.244	0.249

*** p<0.01, ** p<0.05, * p<0.1

Initial results of consumption values (poorest 40% of households)

	(1) Ln (Value of Dairy and Eggs)	(2) Ln (Value of Dairy and Eggs)	(3) Ln (Value of Meat and Fish)	(4) Ln (Value of Meat and Fish)	(5) Ln (Value of Total ASF)	(6) Ln (Value of Total ASF)
VARIABLES						
Livestock Owner	0.358***		0.136		0.421**	
Number of Large Ruminants		0.110***		-0.0304		0.0441
Number of Small Ruminants		0.0208		0.0468*		0.0636***
Number of Monogastrics		0.00254		0.0338**		0.0258*
Number of Large Ruminants^2		-0.00106*		-0.000558		-0.000451
Number of Small Ruminants^2		-0.000690		-6.33e-05		-0.000829
Number of Monogastrics^2		4.26e-06		-0.000648***		-0.000454**
Ln(Total Household Income (PPP))	0.0616	0.0402	0.217***	0.211***	0.241***	0.220***
Share of Income from Crop Production	-0.145	0.289	-3.082***	-3.050***	-3.166***	-2.802**
Share of Income from Livestock Production	1.045	1.153	-1.989*	-1.913*	-1.200	-1.008
Max Adult Education of household	0.00639	9.23e-05	-0.0176	-0.0137	-0.0187	-0.0194
Years of Education of Head	-0.0256	-0.0216	0.0255	0.0163	0.00841	0.00439
Agricultural Land (hectares)	0.0241	0.0106	0.0301	0.0252	0.0297	0.0159
Constant	-0.237	0.0433	0.538	0.618	0.637	0.935
Observations	877	877	877	877	877	877
R-squared	0.225	0.254	0.304	0.318	0.317	0.329

*** p<0.01, ** p<0.05, * p<0.1