Agricultural Extension, Climate Smart Agriculture, and Food Security in southern Malawi

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Objectives of this study

1. To determine the adoption of climate smart agriculture (CSA) practices in southern Malawi.
2. To determine the effect of extension on CSA adoption and food in southern Malawi.
3. To quantitatively analyze the effect(s) of CSA on food security.
4. To contribute to the literature on the evidence for extension and CSA adoption in sub-Saharan Africa.

“Food security exists when all people at all times have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (FAO, World Food Summit 1996).

Study background and description

- An impact evaluation of CSA adoption through a large aid project [Wellness and Agriculture for Life's Advancement (WALA)] in southern Malawi.
- WALA was implemented by a consortium led by Catholic Relief Services (CRS) and several NGOs such as Total Land Care and World Vision.
- WALA included a watershed development program under the project's third strategic objective (SO3) which focused on community resilience to various shocks.
- Goal of WALA's watershed development was to contribute to food security among project communities by enhancing high crop yields through increased ground water.

WALA was an $81m *multi-year program (MYP)*, funded by USAID with the goal of food security among program participants

Throughout, I shall refer to WALA's watershed management practices as CSA.

Background information

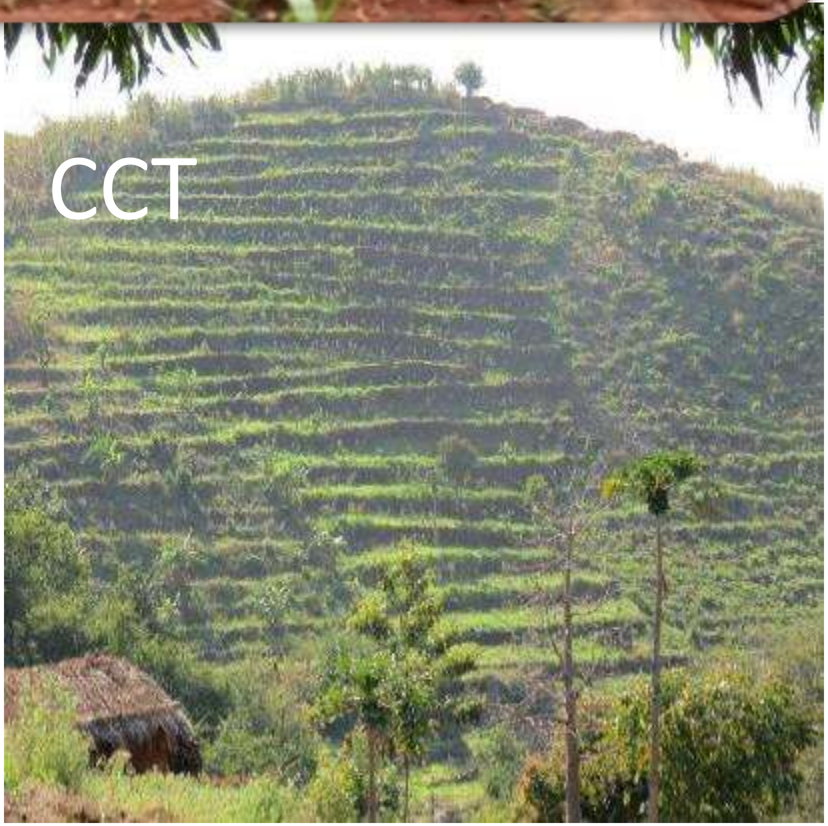
- Climate change and environmental degradation affect food security in SSA and elsewhere (FAO, 2014).

- Adaptation to climate change is vital for long-term food production, in many places.

CSA practices promoted under WALA's watershed interventions includ the following:

- Stone bunds
- Vetiver grass (serves as cover crop)

- Agroforestry
- water-absorption trench (WAT)
- Continuous contour trench (CCT)



WALA's CSA approaches, contd

- Marker ridges, also known as "ridge-to-valley (for erosion control and water harvesting).

Literature review

- By 2050, global food production must increase by about 70% in order to feed the world's population (Long et al., 2015).

- Climate change affects agriculture through weather extremes (Long et al., 2015; Arslan et al., 2015; Poppy et al., 2014).

- Agriculture significantly contributes to climate change through green house gas emissions (at least 18% (Long et al., 2015; Harvey et al., 2014; Poppy et al., 2014)).

- CSA has become a popular toolkit for tackling the problem.

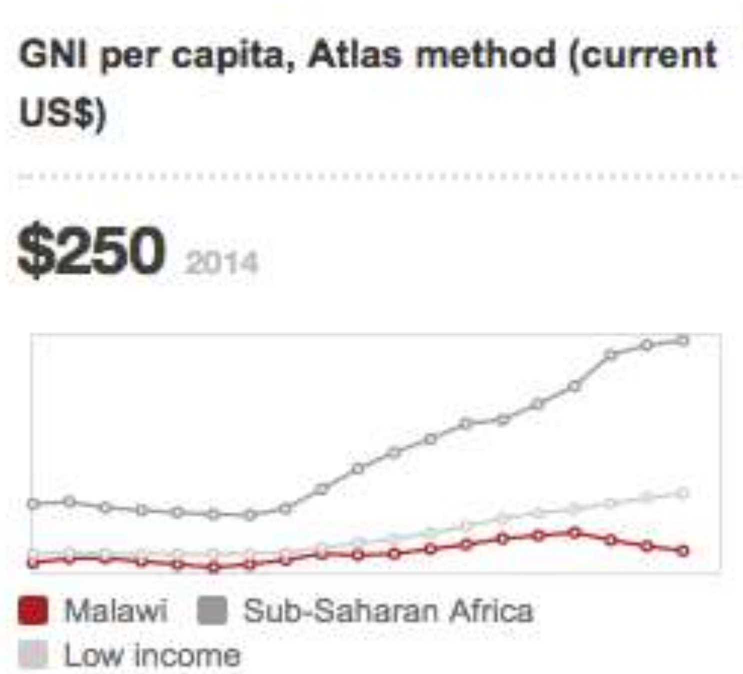
- Extension agents could guide farmers to adopt CSA practices, as with many other technologies.

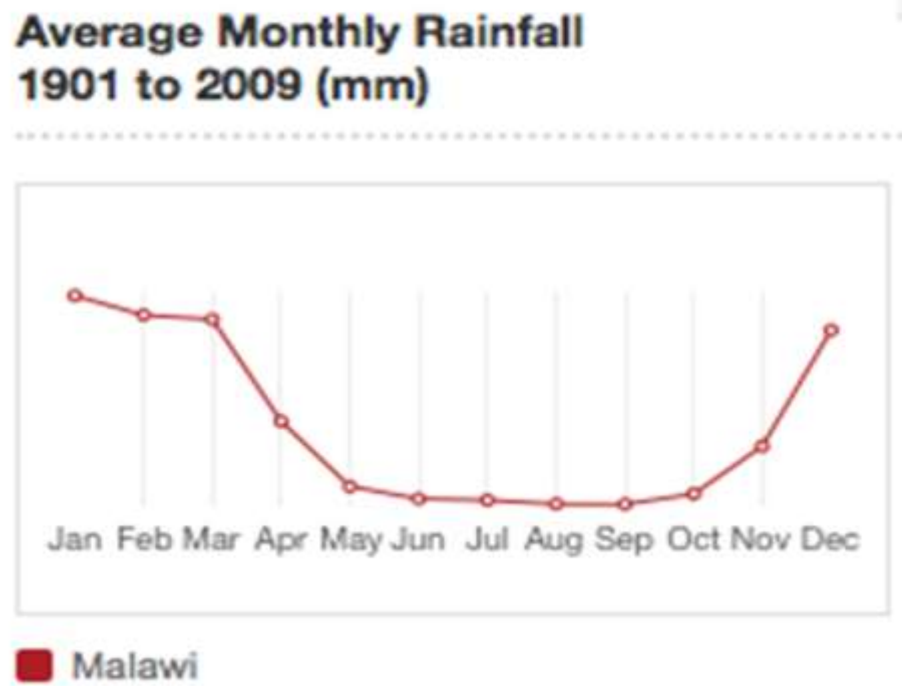
Country context: Natural resource issues in Malawi

- High population growth, and uneven distribution across regions (GoM, 2015; Zulu & Richardson, 2013).
- High levels of rural poverty and over-exploitation of natural resources (GoM 2015; World Bank, 2015).
- Institutional problems regarding natural resource management in Malawi (Bandyopadhyay, Shyamsundar, & Baccini, 2011; Mazunda & Shively, 2015).

Country context: Socio-economic issues in Malawi

- Malawi's national income (GNI) lies below the average for SSA
- Rainfall patterns are sporadic and uncertain





Source: World bank, at data.worldbank.org

Target area

WALA watershed communities, many having steep slopes, and degraded environment.

WALA's CSA implementation areas in southern Malawi

District	TA treated	GVH	Size (ha) of treated watershed
1. Chikwawa	Kasisi	Chavala Kanden	217 17
	Makwira	Mpama	361
2. Nsnaje	Malemia	Mbangu	27
	Mlolo	Gatoma	203
3. Thyolo	Nchilamwera	Chilembwe	51
	Thukuta	Gombe	360
	Khwethemule	Nkusa	286
4. Mulanje	Mthilamanja	Chonde & Kululira	55
	Chikumbu	Robeni	122
		Mitumbira	80
5. Balaka	STA Sawali	-Toleza -Chikolo-lere	107 158
	STA Kachenga	Pyioli	124
6. Machinga	Chamba	Mitawa	135
	Mlumbe	Makanda	132
		Mbeluwa	102
		Sikamu	22
		Kaunde	7
7. Zomba	Chikowi	Mbembesha	35
		Katunga	14
	Malemia	Minama	77
		Mlongolo	43
8. Chiradzulu	Ntchema	Nyimbiri	24
	Chitera	Chitera	33
Totals	**17 Tas**	**25 GVHs**	**2792**

Research questions

1. What is the level of CSA adoption in WALA watershed management communities post –WALA?
2. What socioeconomic and biophysical factors affect CSA adoption?
3. What is the Impact of extension on CSA adoption?
4. Does CSA adoption leads to food security?
5. What socioeconomic factors affect food security in southern Malawi?
6. What socio-economic and biophysical factors explain variation in food security in southern Malawi?

Hypotheses

1. CSA adoption depends on farmers' socio-economic status, their level of exposure to information about CSA, and their geo-climatic region, such as proximity to watershed, hills or being in a flood plain (Angston, 2015; Arslan et al., 2015).
2. Households that participate directly in farmers' groups associated with the WALA project are more likely to adopt CSA practices through social learning, compared to households that do not belong to groups (Foster & Rosenzweig, 2010; Liverpool-Tasie & Winter-Nelson, 2012; Krishnan & Patnam, 2014).
3. Households that adopt CSA practices are more likely to be food secure than non-adopters (Besada & Werner, 2014; Kabunga, Dubois, & Qaim, 2014).

Key dependent variables

1. Adoption of CSA practices as a function of extension and other covariates (including socioeconomic and biophysical factors).
2. Food security as a function of CSA adoption and other covariates.
3. Variation in food security as a function of variation in CSA adoption, which is also a function of variation in socio-economic and biophysical factors.

Analytic approach

- Quasi-experimental analysis of the effect of CSA adoption on household food security.
- Multivariate regression to identify the major socio-economic and biophysical factors that determine CSA adoption
- Multi-level modelling to analyze food security as a function of CSA adoption
- Matching estimation and IV regression to determine food security outcomes.
- Compute average treatment effects (ATE) of CSA adoption on food security.

Data collection

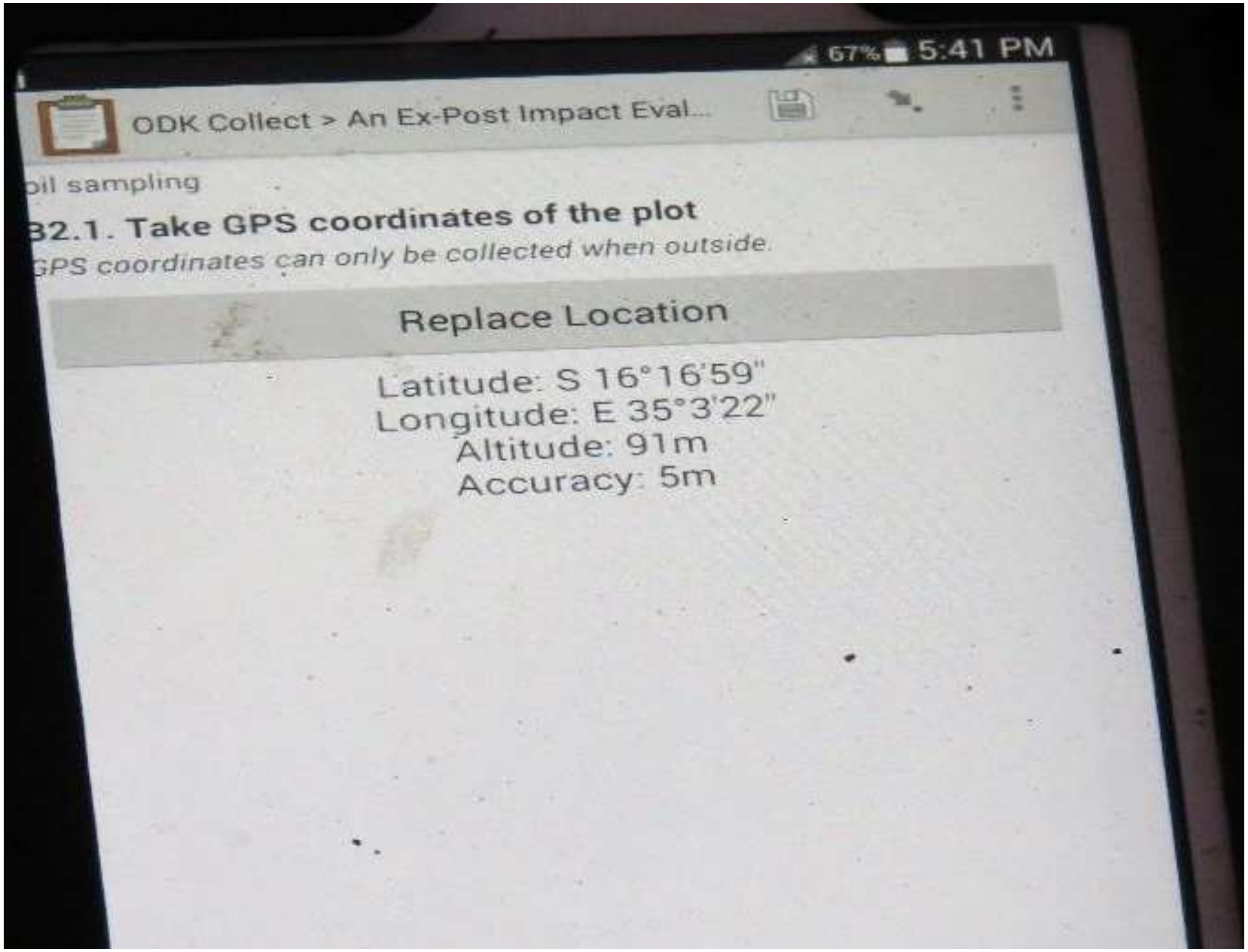
i. Cluster sampling of 800 households from 16 GVHs (including 8 treatment and 8 control) from EPAs across five WALA watershed districts.
ii. Use of a well-developed questionnaires for socioeconomic data on household farming practices and food security.
iii. Key informant interviews to elicit community perceptions on CSA adoption, environmental conservation, food security.
iv. Plot- level assessment of actual CSA adoption and retention, based on existing CSA practices on farmers' agricultural plots.
v. Collection of two composite per agricultural plot per household, in order to determine potential changes in soil properties across treatment and control sites.

Key assumptions

- The relationship between CSA adoption and some covariates may not be linear.
- Assume interaction between some covariates.
- Some variables are nested within others in the analyses.
- Overlap.

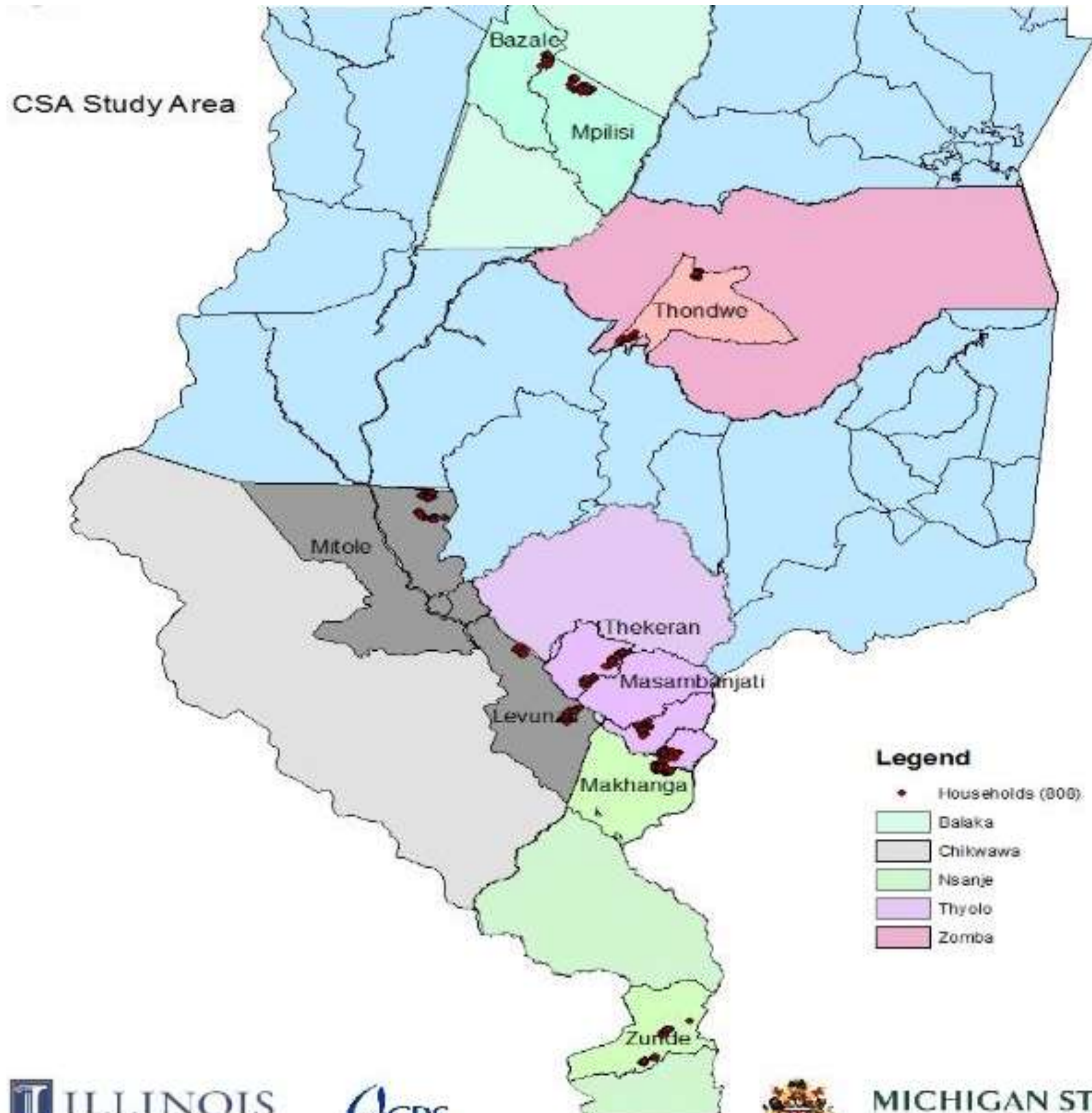
Samsung Galaxy tablets used to capture geo-referenced data on respondents' houses and agricultural plots.

Data collection by a hand-held tablet that captures geo-referenced data of plots and households



Selection for this CSA study

District	Extension Planning Area	Treatment Area	Control Area
1. Chikwawa	Levunzu EPA	TA Makwila alemia - GVH Mperma	TA Makwila alemia - GVH Nyambalo
	Mitole EPA	TA Kassisi - GVH Chavala	TA Kassisi -GVH Padzuwa
2. Nsanje	Makhanga EPA	TA Mlolo - GHV Gatorma	TA Mlomo - GVH Alufazema
	Zunde EPA	TA Malemia - GVH Mbangu	TA Makoko - GVH Davids
3. Thyolo	Thekeran EPA	TA Thukuta - GVH Gombe	Nsabwe - GVH Chalonda
	Masambajati EPA	Kwethemule - GVH Nkusa	Kwethemule - GVH Mangwalala
4. Balaka	Basalie EPA	TA Sawali - GVH Chikololere	TA Sawali - GVH Mpoto
5. Zomba	Thondwe EPA	TA Molumbe - GVH Mbeluwa	TA Molumbe GVH Khutambala



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Food security measures in this study

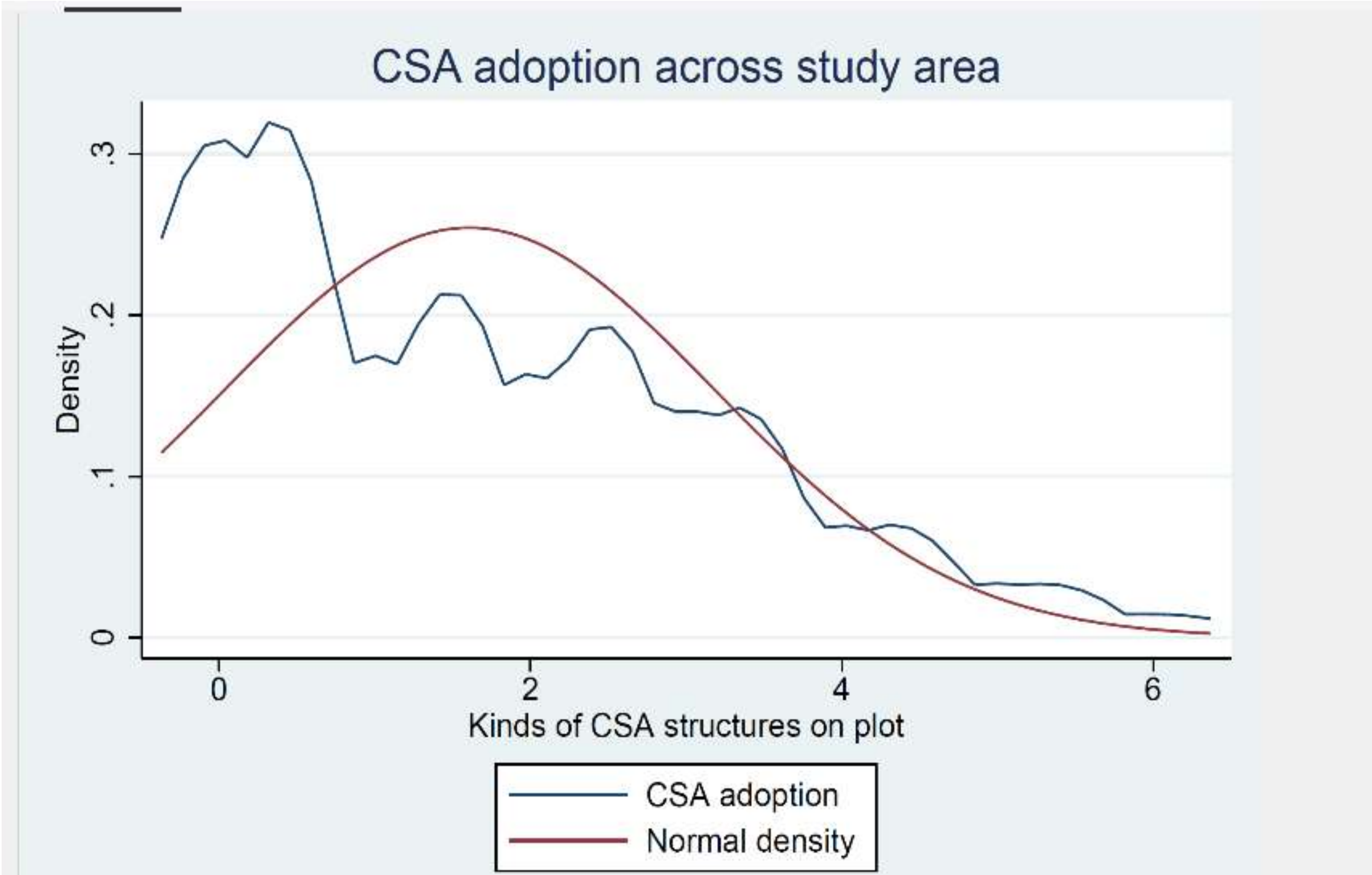
i. Per capita food consumption based on food consumption recall over a 24-hour, and 7-days, and a 30-day period (Kassie et al, 2014, Malawi LSMS, etc.).
ii. Wealth status as proxy for access to food, Measured by expenditure on food and related items (Shiferaw et al., 2014).
iii. Household food insecurity Access Scale (HFIAS) (Kabunga et al., 2014).

Descriptive statistics – Key dependent variables

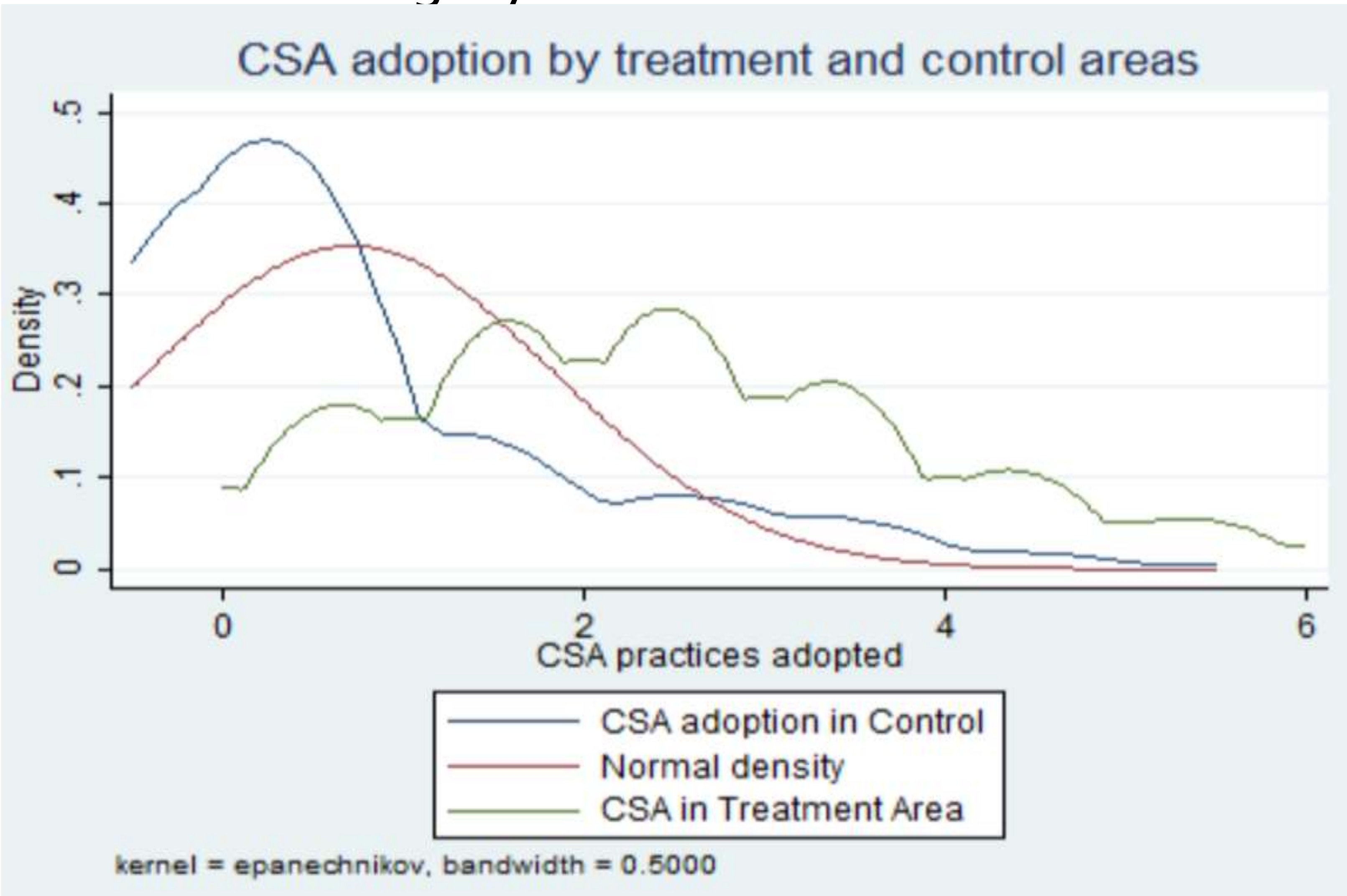
Variable	Treatment			Control area		
		Mean	Standard Dev	Obs.	Mean	Std. Dev
Kinds of CSA practices in use	441	3.36	1.48	367	0.65	1.13
CSA retention*	434	0.82	0.39	360	0.22	0.416
Plot ownership - Total holding (acres)	435 439	1.83 1.80	0.87 1.20	364 366	1.75 1.65	0.82 0.94
Years of education (schooling)	441	4.7	1.40	367	4.69	1.39
Farmer-extension agent interaction	424	4.52	1.15	346	3.47	1.29
Elevation/altitude	441	446.10	337.0	367	505.42	329.85
Household size	441	7.02	3.64	367	6.91	3.55
Farmers' social network	441	4.78	0.497	367	4.76	.50
Distance to an undeveloped watershed	441	9.62	25.2	367	3.79	6.45

Descriptive statistics. Contd.

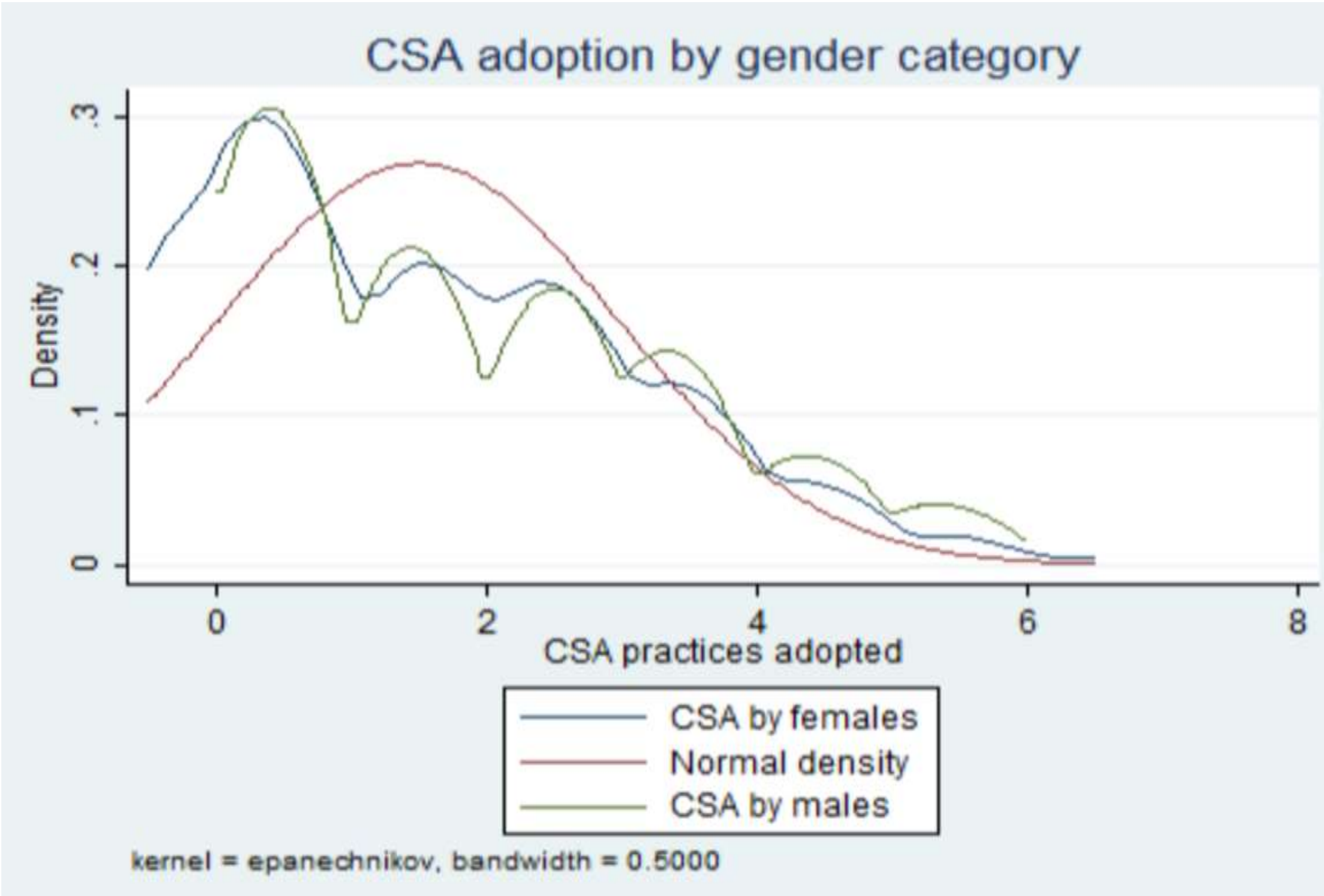
Variable	Treatment			Control area		
		Mean	Standard Dev	Obs.	Mean	Std. Dev
Yield before 2010 (50 kg bag)	441	11.66	11.07	367	8.79	10.09
Yield in 2013 (50 kg bag)	441	8.80	9.34	367	6.36	6.87
Yield in 2015 (50 kg bag)	441	1.34	4.07	367	0.86	2.70
Twenty-four hour expenditure on staple (Kwacha)	441	973.10	1681.82	367	1100.72	2082.01
Weekly expenditure on staple (Kwacha)	430	3046.97	3203.07	362	2926.66	2947.42
Distance to the nearest Admarc market (km)	441	6.57	5.51	367	7.99	8.74
Perceived change in river condition	440	0.37	0.48	367	0.32	0.477
Gender*	441	0.59	0.49	367	0.54	.50


CSA adoption across study area
Density
0
.1
.2
.3
0
2
4
6
Kinds of CSA structures on plot
CSA adoption
Normal density

Kernel density plots of CSA adoption by treatment category



Kernel density plots of CSA adoption by gender category



Main estimates: Adoption of CSA practices

Variable	OLS	OLS with Robust Std Errors	OLS with Interactions terms
Treatment status	1.755***	1.707***	1.414***
	(0.113)	(0.101)	(0.155)
Farmers' social	0.340**	0.0201	0.0795
network size	(0.107)	(0.0578)	(0.0640)
Household distance to	-0.0000603	-0.0000653**	-0.00371**
nearest watershed	(0.000219)	(0.0000234)	(0.00122)
Farmer-agent-interaction	0.145**	0.0993*	-
	(0.0455)	(0.0428)	
Plot distance to a treated	-0.00196	-0.00230**	-
watershed	(0.00158)	(0.000828)	
Gender is male	0.217*	0.151	-
	(0.106)	(0.105)	-
Gender-social network			0.320*
			(0.133)
Nearest watershed &			0.000735**
Agent-farmer interaction			(0.000243)
Agent-farmer interaction			0.0298*
& landholding size			(0.0119)
Being male & in treatment			0.565**
area			(0.199)
Constant	-2.248***		
	(0.601)		
Observations	646	646	646

Standard errors in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Results

- There is CSA adoption in the WALA watershed development area, as evidence by the levels of practices and retention over time post-WALA.
- As expected, being exposed to treatment (i.e., being in watershed development area) significantly increases the likelihood of CSA adoption.
- Farmer-agent interactions significantly affects CSA adoption. Every additional meeting between an extension agent a farmer increases the CSA adoption by about 0.1 units.
- Social networks are also very important in determining CSA adoption. This result is well supported by the impact assessment literature

Results, contd.

- Interaction terms are such as extension services (agent-farmer interaction) and gender –socil network are very significant in CSA adoption in southern Malawi.
- There is retention of CSA practices. A a good indicator of environmental conservation.
- The effect of distance (for households and plots) to the nearest watershed is negative. Seems plausible as farmers are more likely to adopt CSA practices when in close proximity to a watershed (especially when such watershed is developed).

Results, contd.

- Gender main effect, though significant, is not very strong compared to the interaction with the size of social network, which seems plausible. Thus, giving equal treatment, female farmers are similarly likely to adopt CSA practices as their male counterparts.

Next steps

- To do a more rigorous econometric analysis to determine food security outcomes based on various measures.
- To implement various matching techniques to determine CSA on household food security.
- To use soil testing data to determine CSA adoption on environmental conservation.
- Absent clear baseline data, explore the plausibility of IV estimation for determining the impact of CSA on food security.

Thank you!

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