

Field evaluation of Rocket design stoves- fuelwood use and user preferences



Jin Wang & Erika Tyler

Edwin Adkins, Vijay Modi

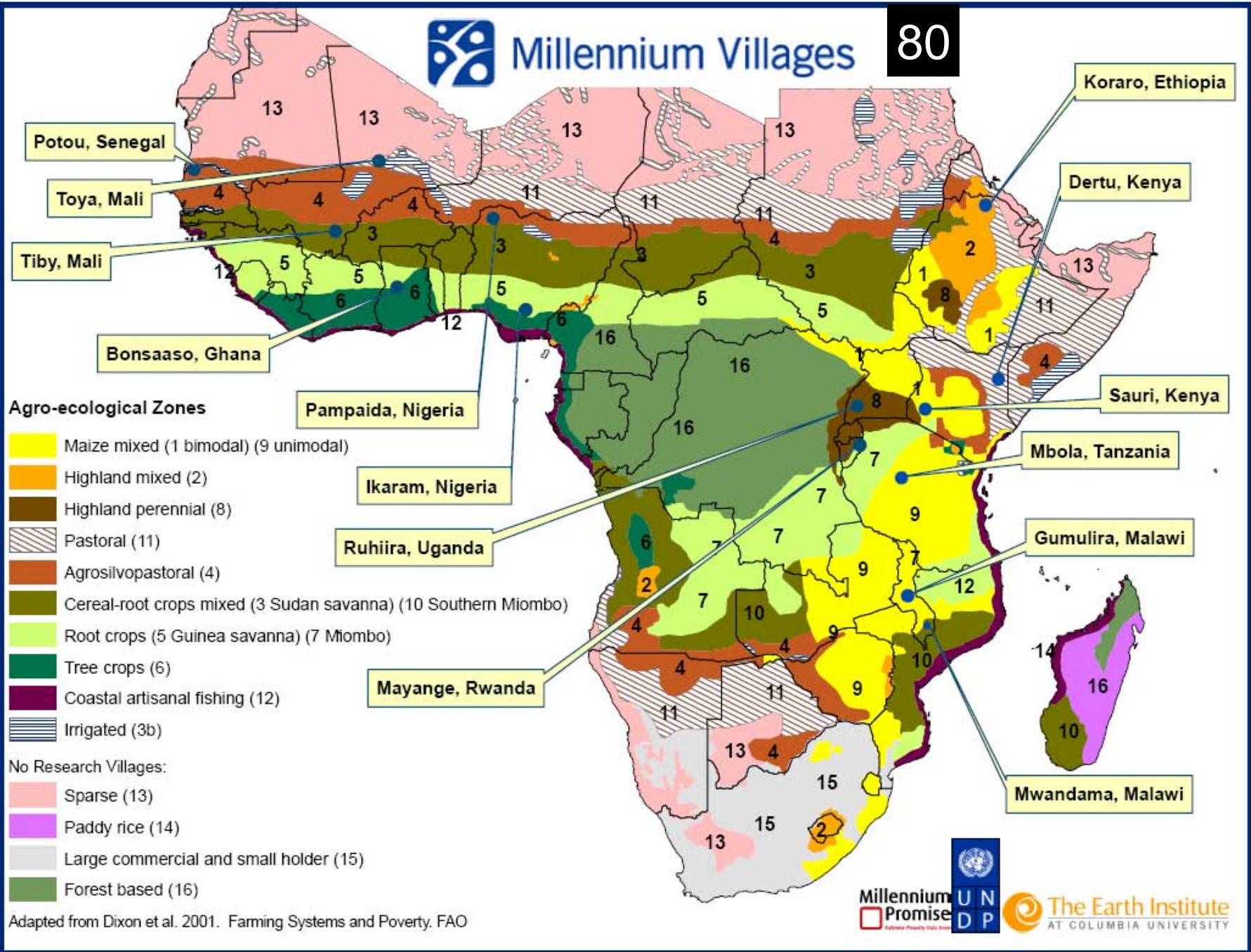
Columbia University

Ruhiira, Uganda; Mbola, Tanzania; Mwandama Malawi

2008 - 2009

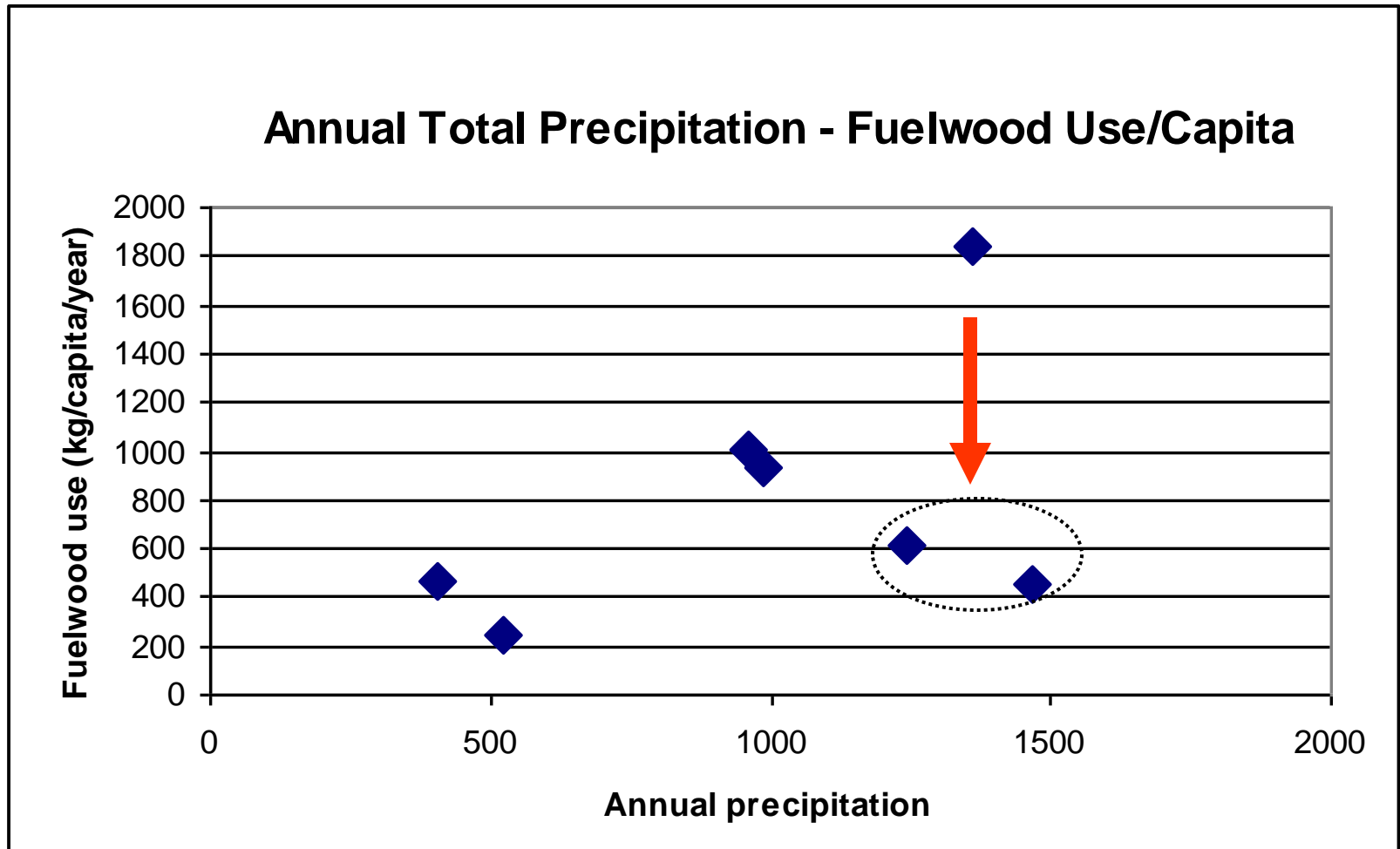
A Tribute to Women on the International Women's Day



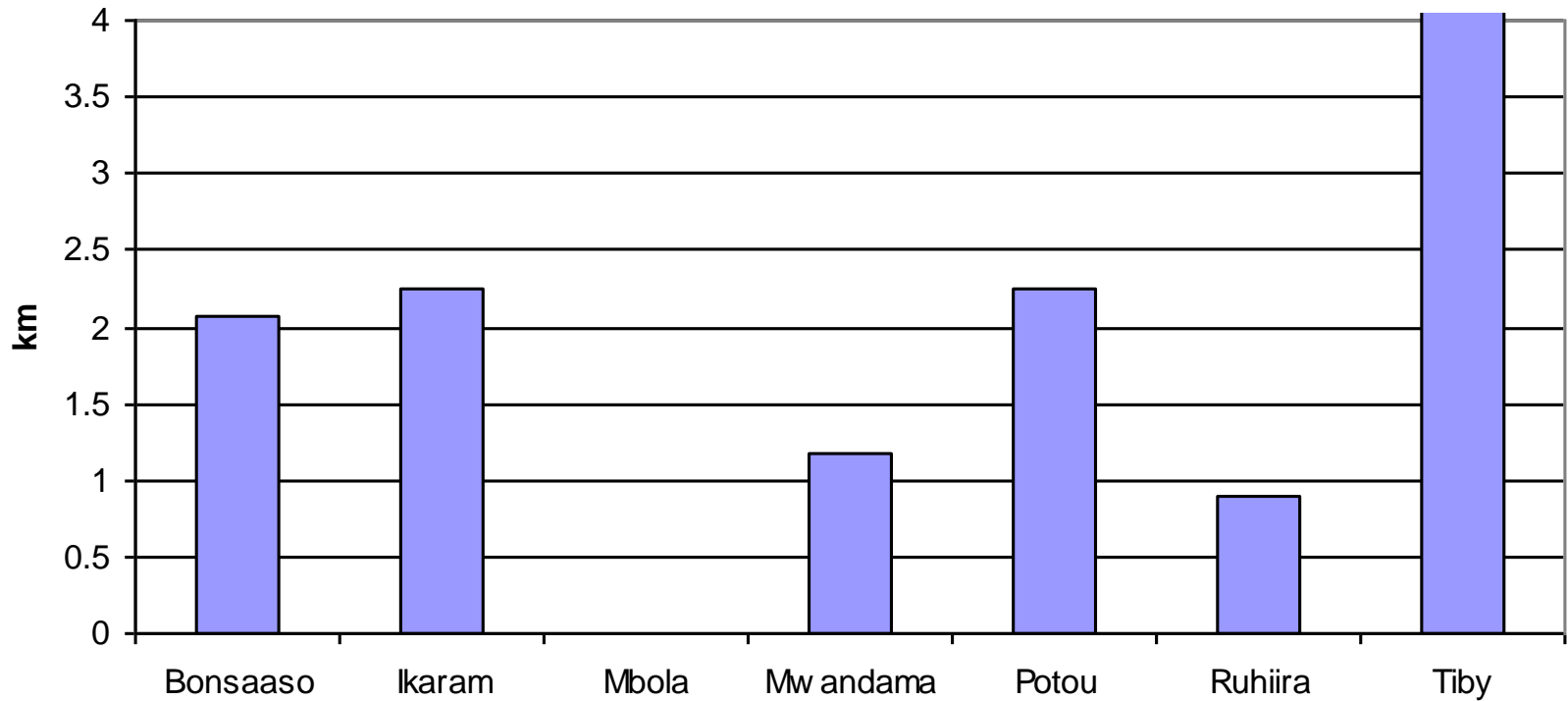


Adapted from Dixon et al. 2001. Farming Systems and Poverty. FAO

precipitation and pop density



Furtherst Distance Traveled to Collect Fuelwood in km, One Way



n's: Bonsaaso 298, Ikaram 262, Mbola 273,
Mwandama 291, Potou 251, Ruhiira 296, Tiby
190

What was the goal of this work?

- Piggy back “testing” as a means of both sensitization AND data gathering
- field teams worked with home cooks, no emissions measurements
- make the case for CDM credits
- convince project staff that a \$10 stove could save fuelwood and be adopted
- Test stoves that have a supply chain

Test Sites: all rural, UG, TZ, MW

- East Africa: highlands get cold at night
- E. Africa: households are dispersed
- 98% of hh use 3-stone fire (from a 300 hh survey in each site)
- nearly 95% of all wood/crop residue used is gathered and not purchased
- Not significant charcoal use

Cookstoves Tested



Three-stone fire

Traditional



Stovetec/Envi B1100



Envirofit, G3300

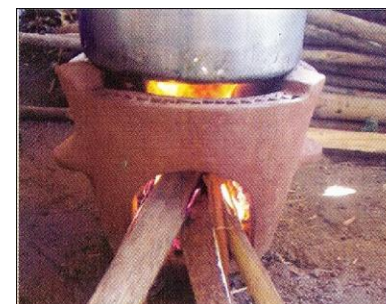
Imported



Ugastove, UG



Advent, TZ



Chitetezo, MWI

Local

Methodology

- Pick foods commonly cooked, modified CCT
- Households randomly selected for testing
- Households given 4 weeks to use prior to measurement
- All tests were “paired”, wood, fuel, cook, food same
- Min of 24 sets of tests each repeated twice
- Performed household qualitative survey after allowing use

	Uganda	Tanzania	Malawi
Stoves Tested	StoveTec, Ugastove	StoveTec, Envirofit, Advent	Chitetezo
Foods Tested	Plantains	Maize flour, Beans	Rice

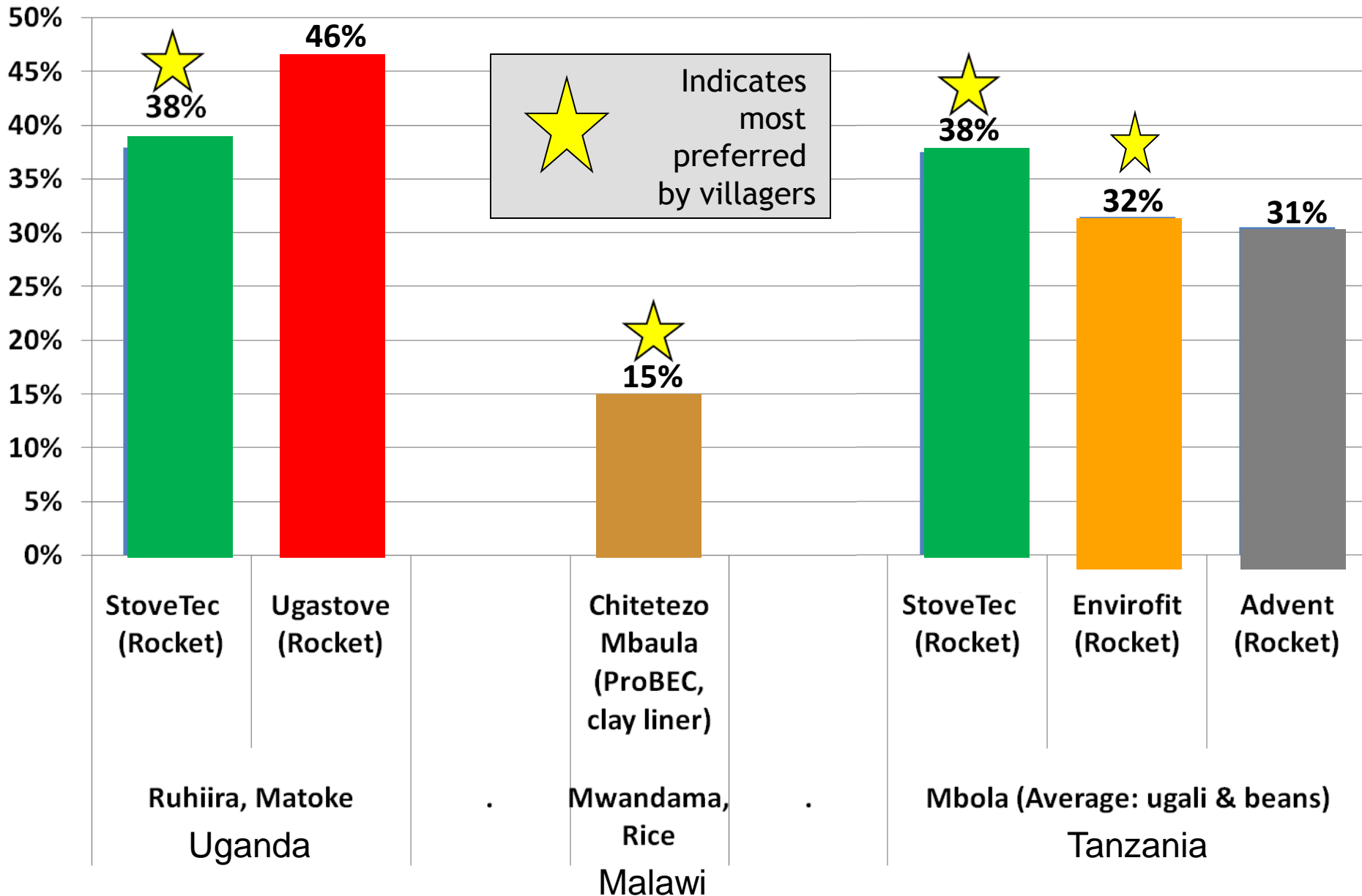
Burnrate (kg fuelwood/hour)

	Ugali	Rice	Matoke	Starches	Beans	All foods
Advent	1.32 (24)			1.32 (24)	.91 (36)	1.07 (60)
Chitetezo		.86 (88)		.86 (88)		.86 (88)
Envirofit	1.49 (24)			1.49 (24)	1.16 (35)	1.29 (59)
StoveTec	1.55 (24)		1.26 (60)	1.34 (84)	1.03 (36)	1.25 (120)
Three stone	3.05 (24)	1.26 (88)	2.25 (60)	1.86 (172)	1.67 (36)	1.82 (208)
Ugastove			.93 (60)	.93 (60)		.93 (60)
All stoves	1.85 (96)	1.06 (176)	1.48 (180)	1.40 (452)	1.19 (143)	1.35 (595)

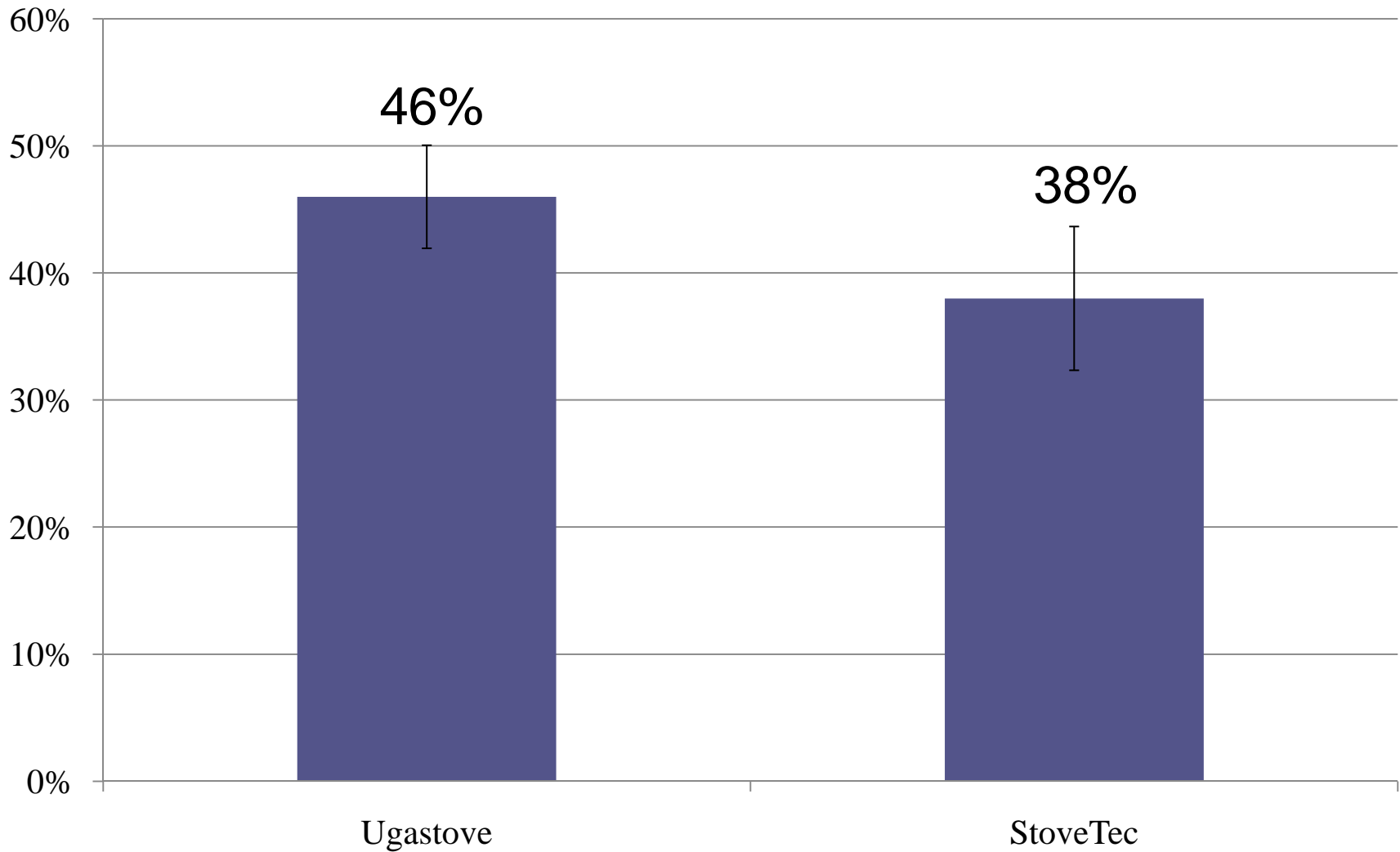
Specific Fuel Consumption (kg fuelwood/kg food)

	Ugali	Rice	Matoke	Starches	Beans	All foods
Advent	.58 (24)			.58 (24)	6.7 (36)	4.27 (60)
Chitetezo		.79 (88)		.79 (88)		.79 (88)
Envirofit	.47 (24)			.47 (24)	8.3 (36)	5.14 (60)
StoveTec	.45 (24)		.35 (60)	.38 (84)	6.9 (36)	2.32 (120)
Three stone	.88 (24)	.95 (88)	.59 (60)	.81 (172)	10.7 (36)	2.52 (208)
Ugastove			.31 (60)	.31 (60)		.31 (60)
All stoves	.60 (96)	.87 (176)	.42 (180)	.63 (452)	8.1 (144)	2.44 (596)

Fuel savings for improved stoves relative to 3-stone fire

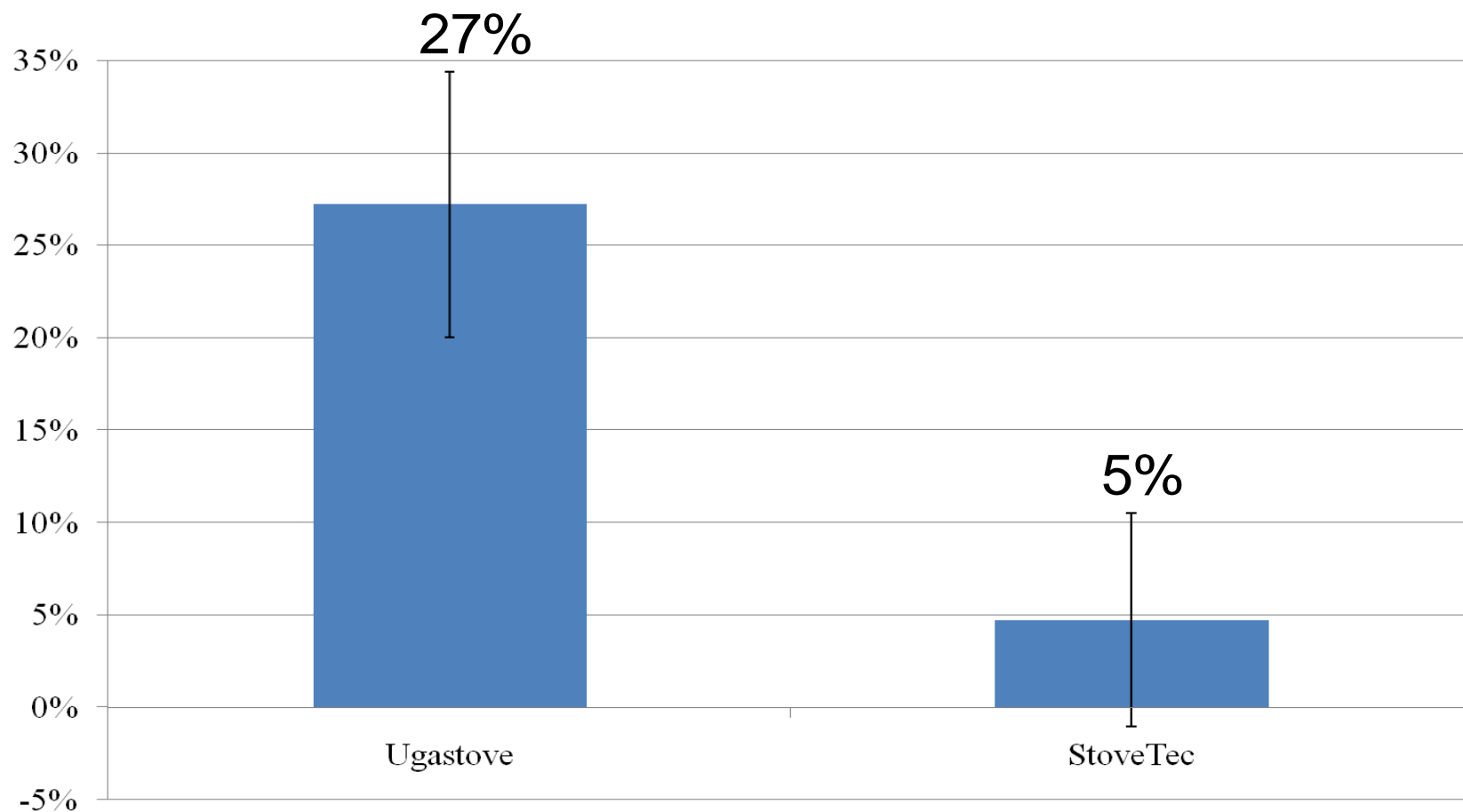


Average Fuel Savings Compared to Three-stone Fire Ruhiira, Uganda



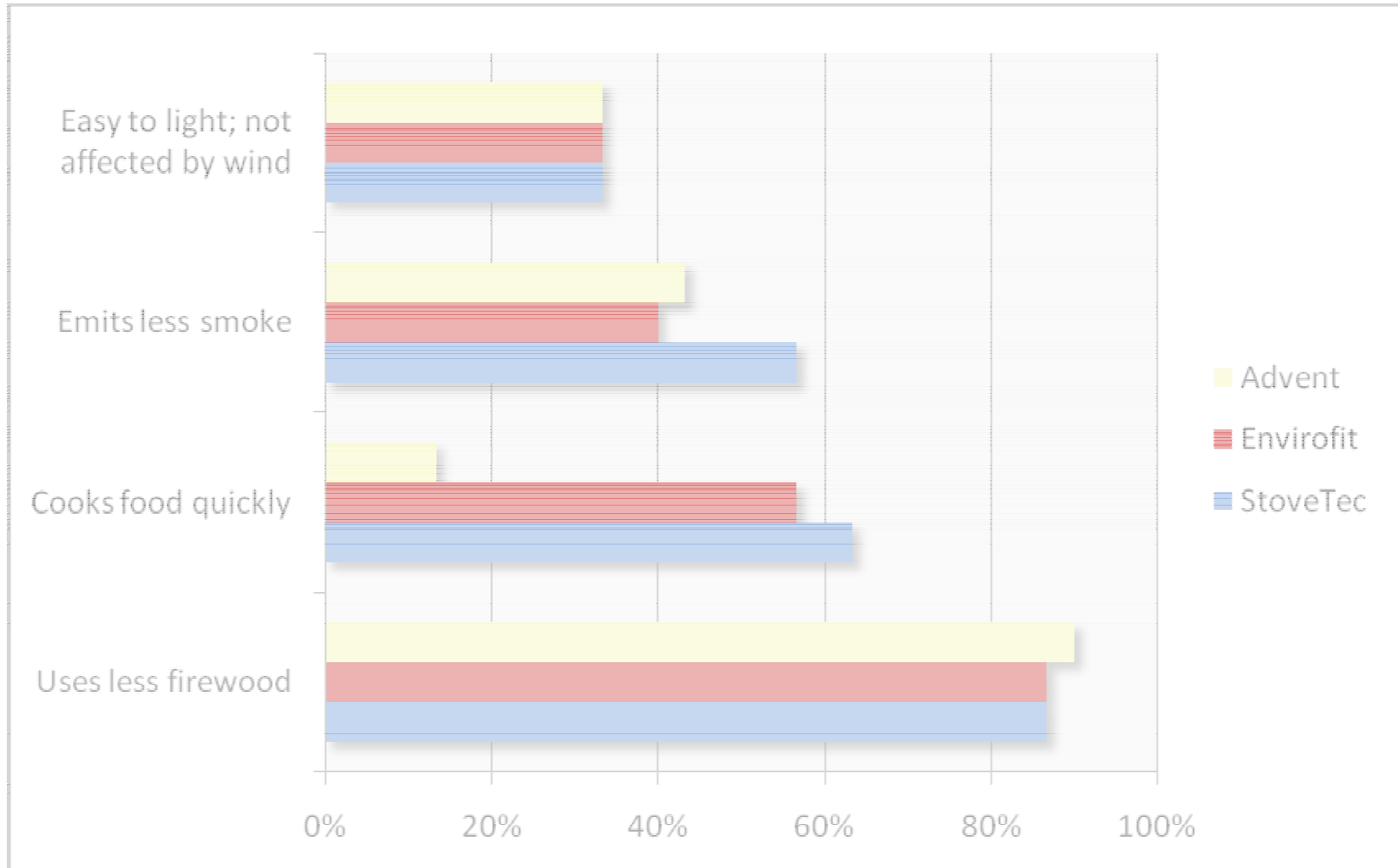
Error bars are 95% confidence intervals

Average Increase in Cooking Time Compared to Three-stone Fire Ruhiira, Uganda

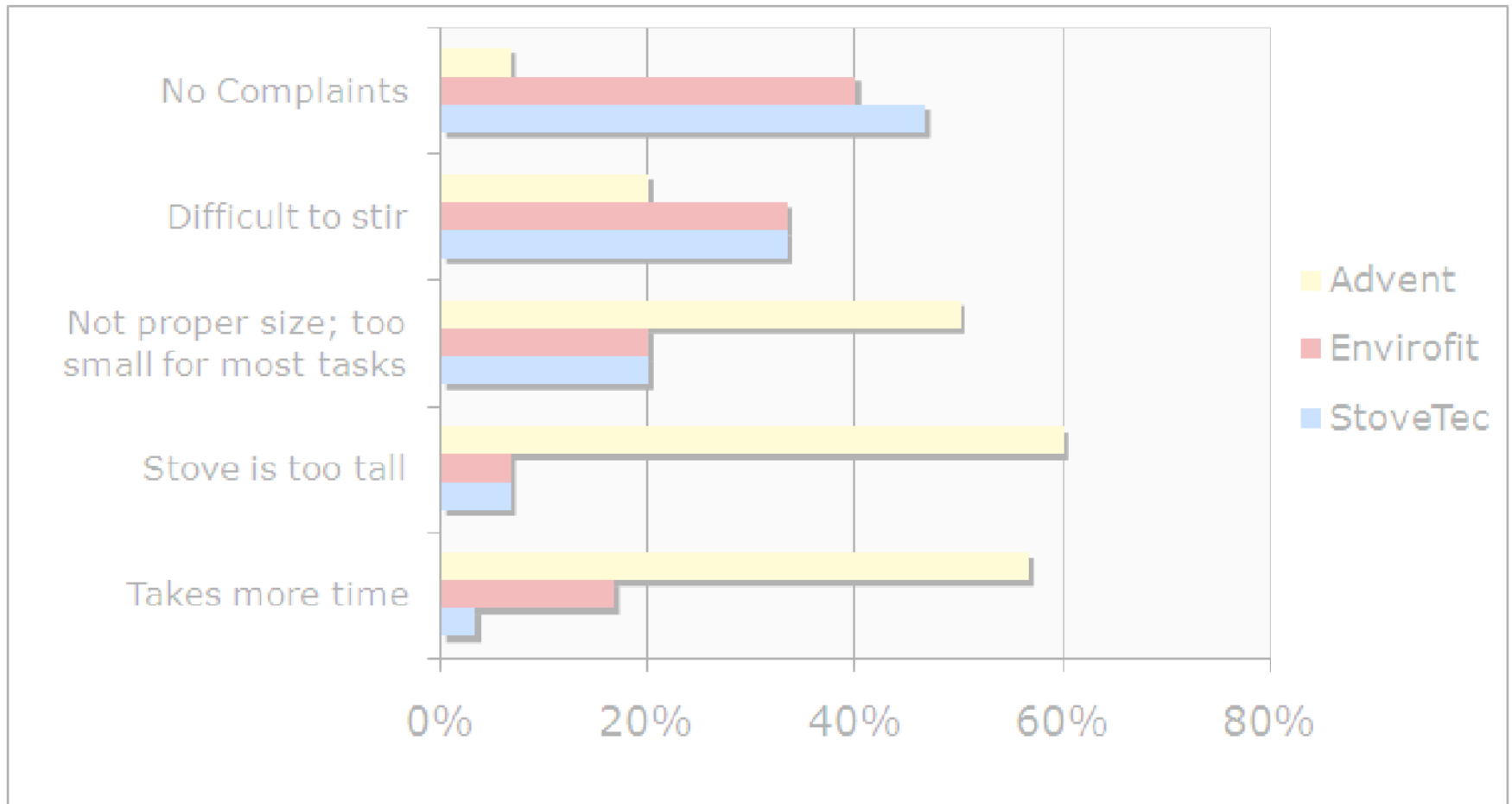


Error bars are 95% confidence intervals

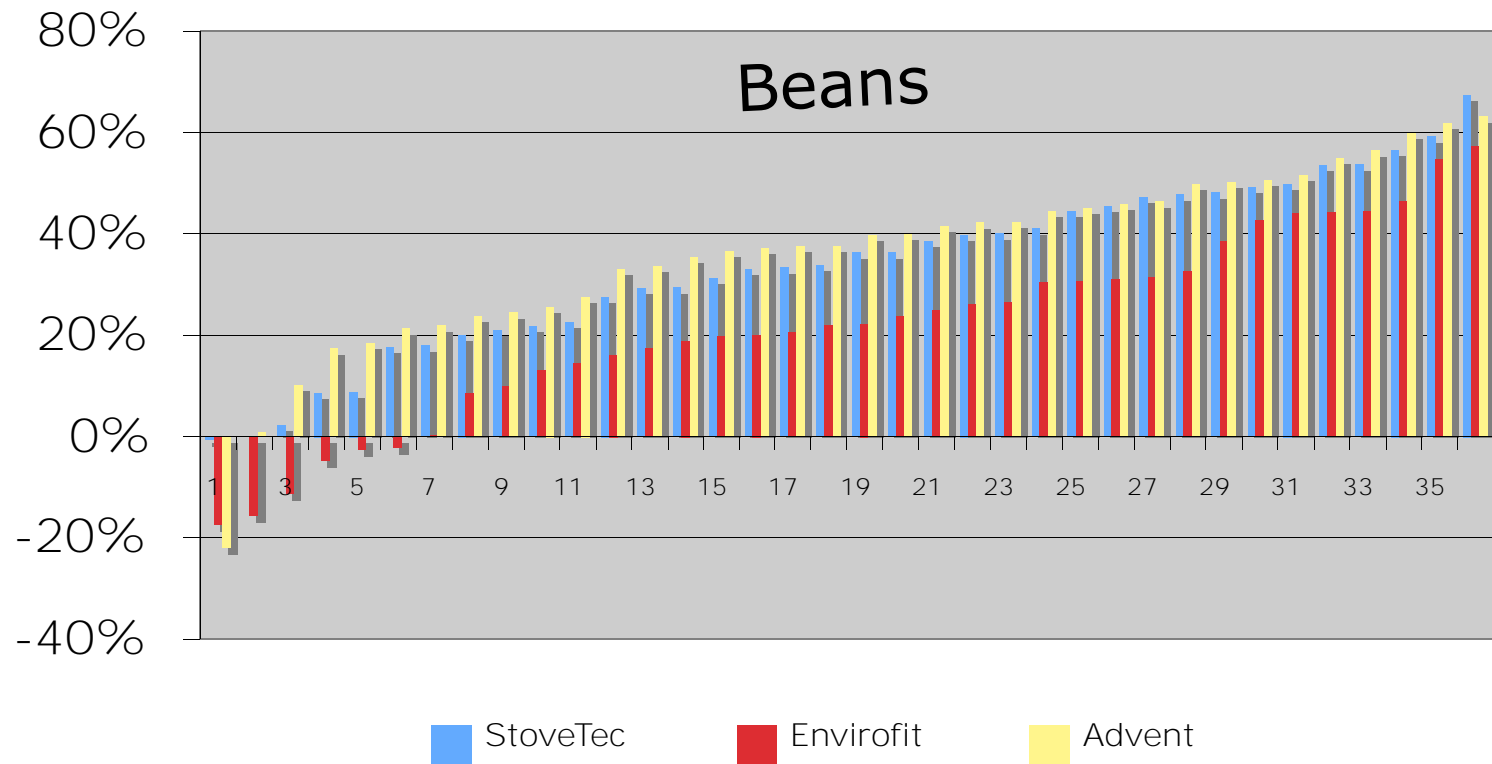
What users liked: TZ



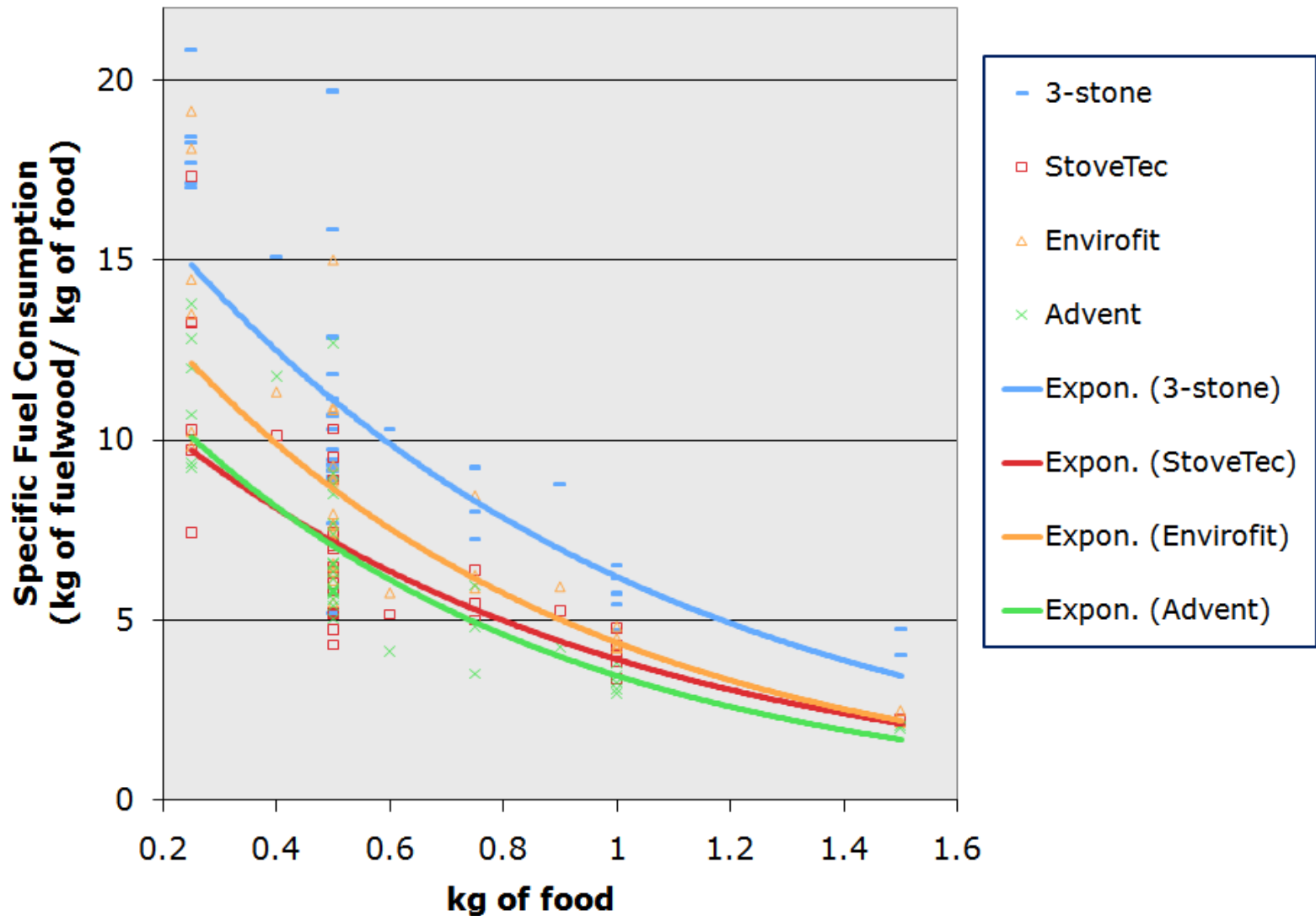
What users disliked: TZ



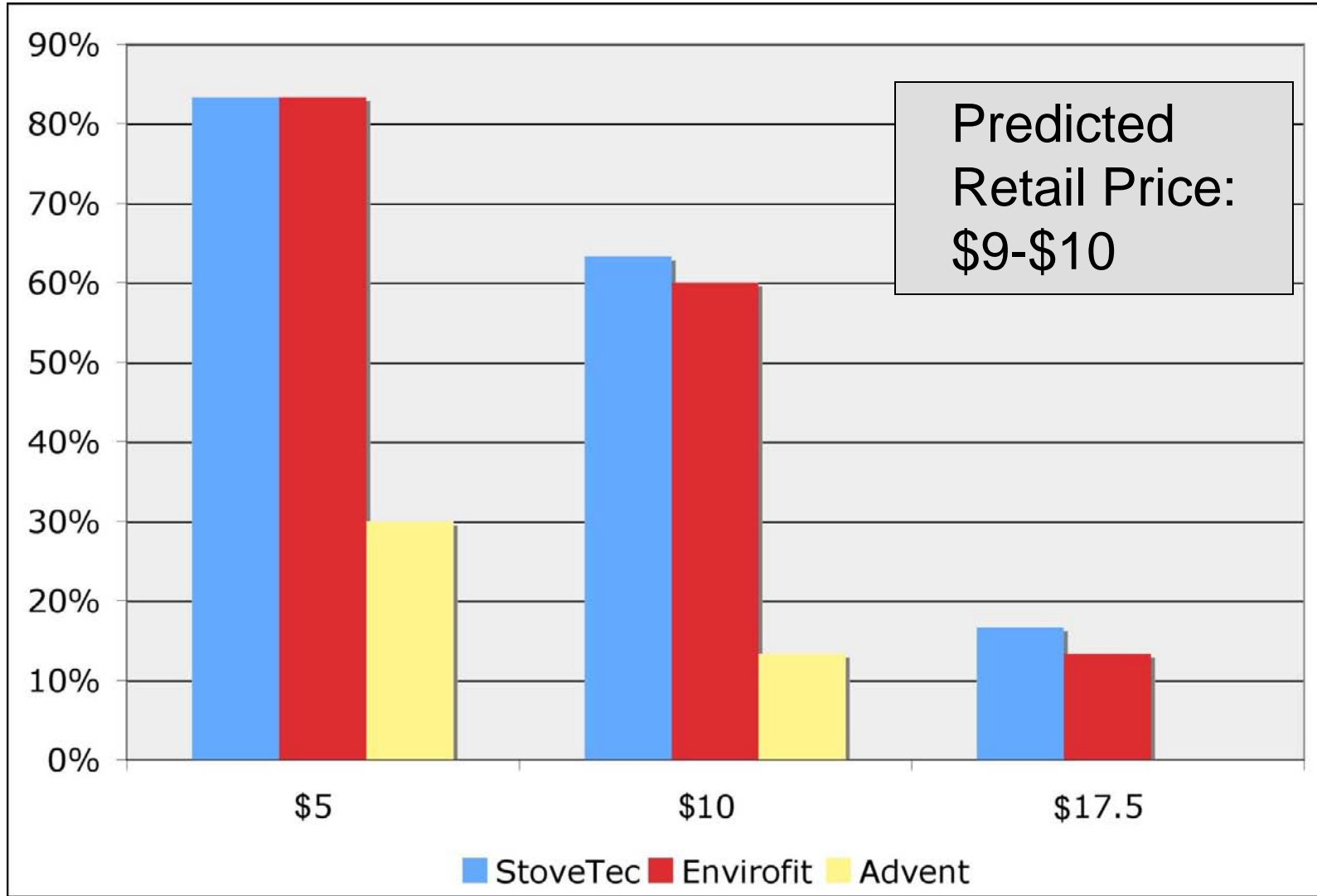
Is variability due to stove user?



SFC vs. kg of food cooked (beans)



Percentage of users that would buy cookstoves at specified price - Mbola, Tanzania



Decisive qualitative factors

- **Perception of quality and warranty**
- **built-in skirt vs adjustable skirt**
- **Cooking time a major issue**
- **Height/stability of stove**
- **Less tending needs better**
- **Smoke emitted**

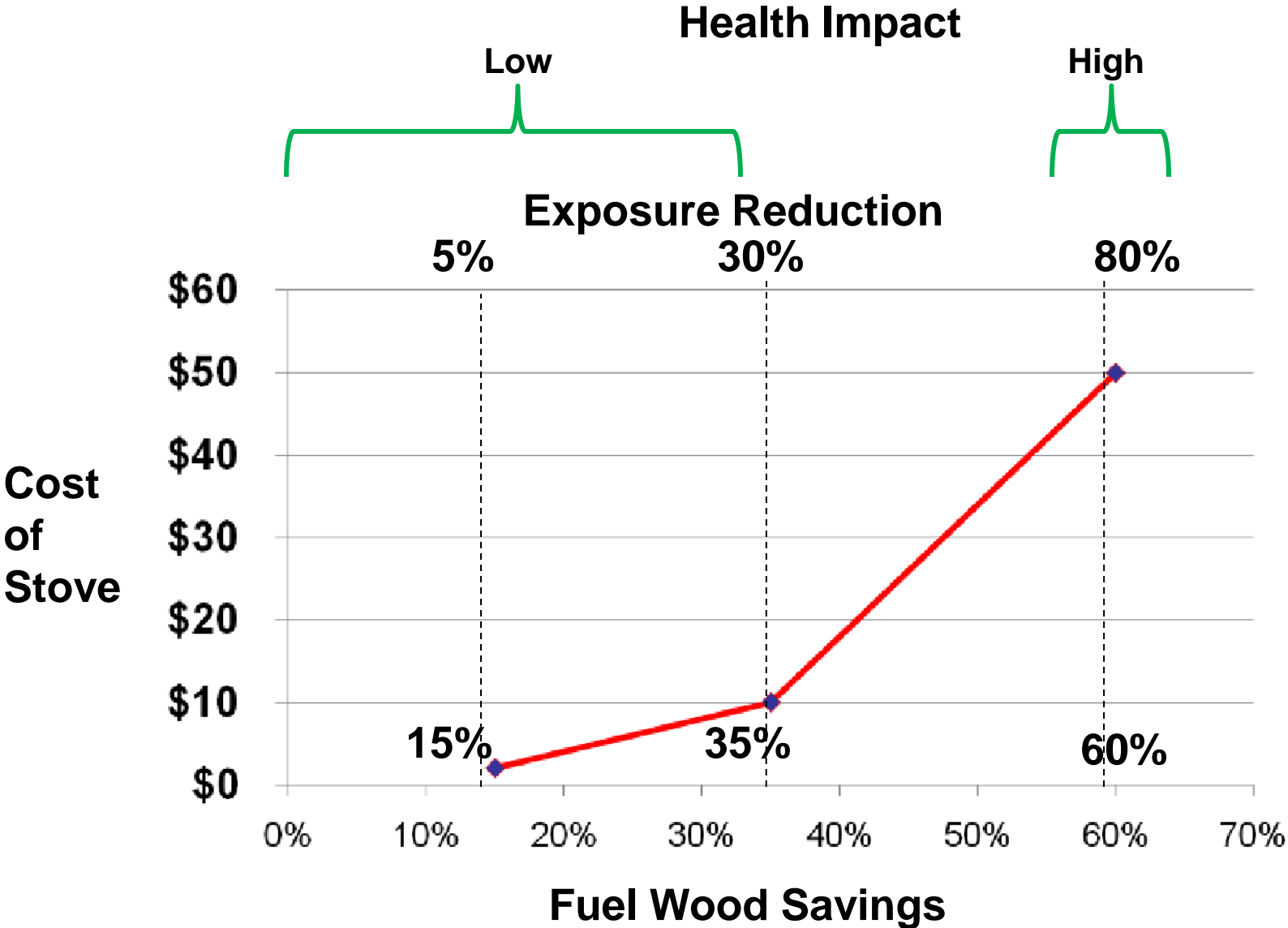
Need statistically significant results



Next slides: Not statistically significant

- Question
- Does a \$10 stove reduce emissions enough to lower PM_{2.5} concentrations in the kitchen?
- What level of reductions in emissions and exposures lead to reductions in disease burdens?

Trying to construct a slide for policymakers



Test Hut – Sauri, Kenya



Similar to local kitchen in size and ventilation characteristics



Emissions (CO and PM_{2.5}) monitoring at consistent distance from center of pot



Patricia Yiembe: extensive experience with firewood cook-stoves and local cooking practices

Improved Stove Types

Clay Liner
(Kenya)



Clay Rocket
(Rwanda)



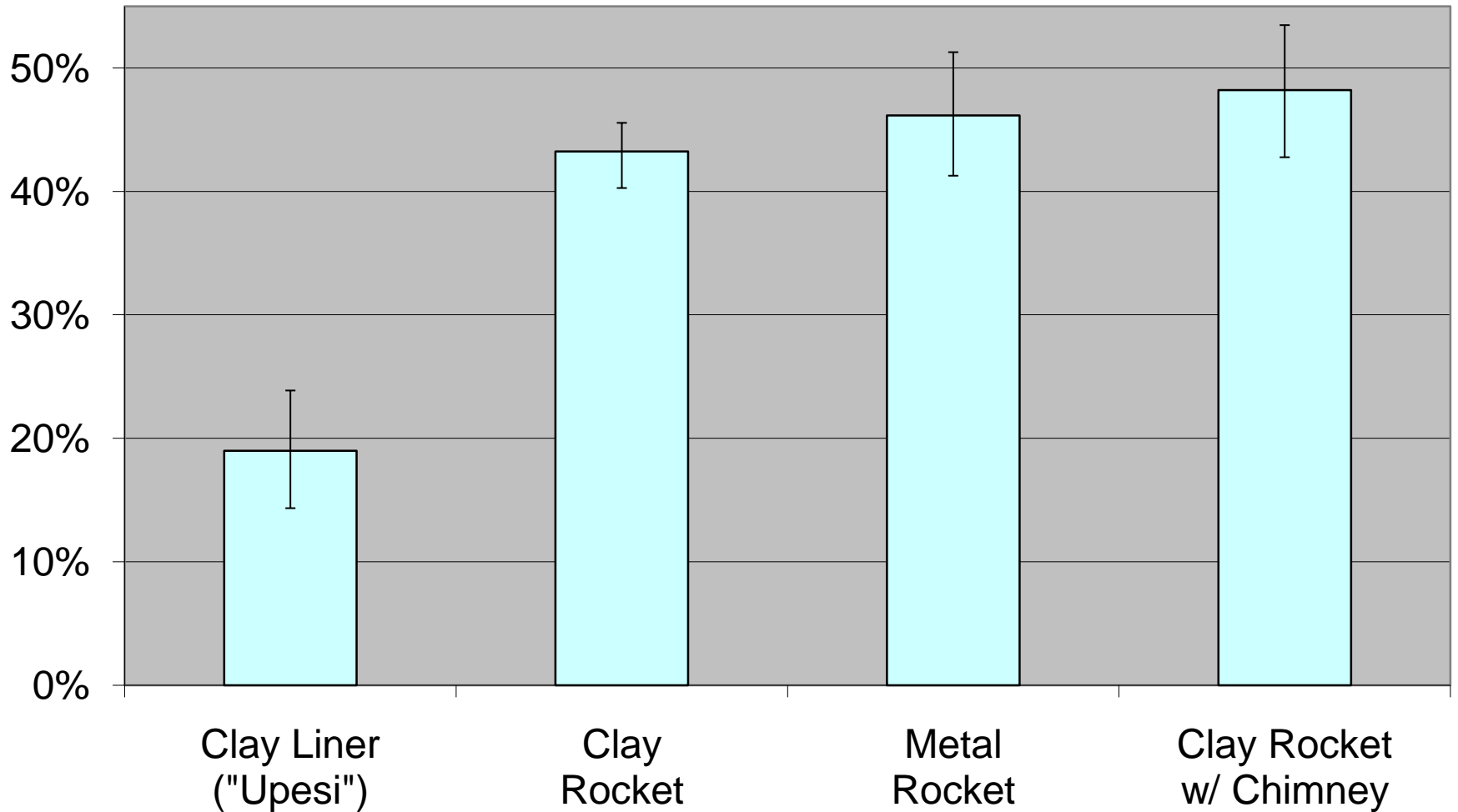
Clay Rocket
w/ "pot skirt"
& chimney
(Rwanda)



Metal Rocket
(Uganda)

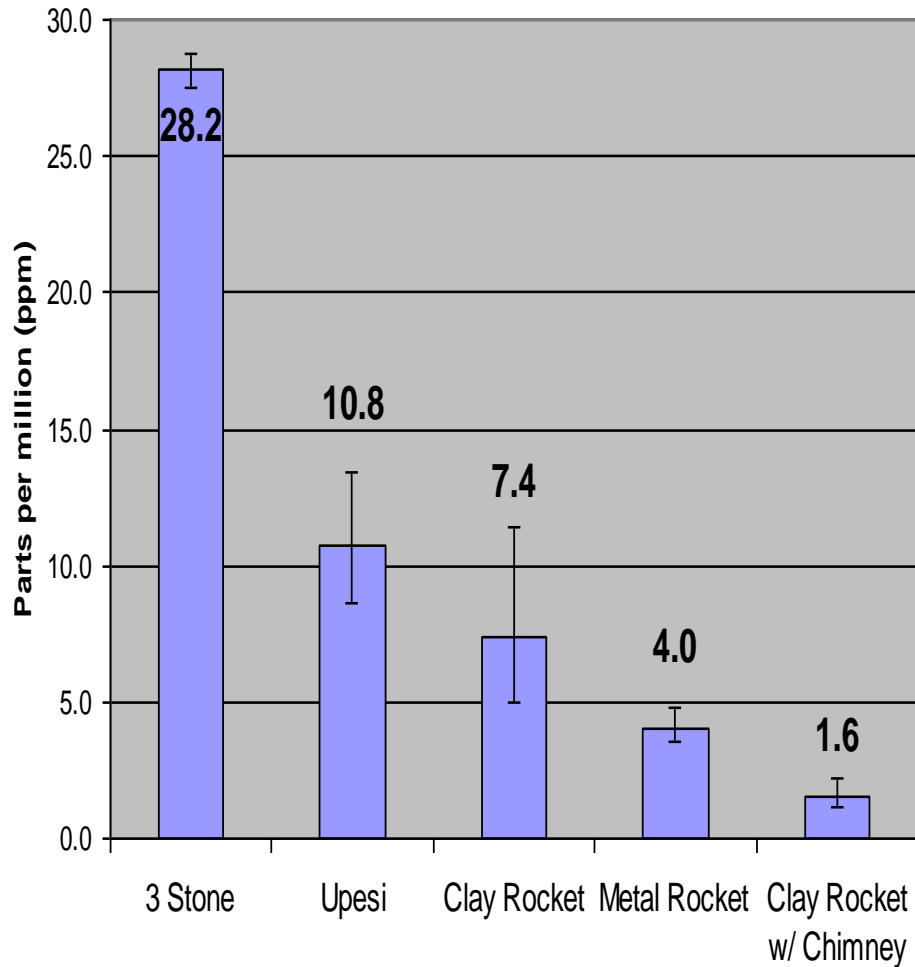


Reduced Fuelwood Use for improved stoves vs. 3 Stone Fire

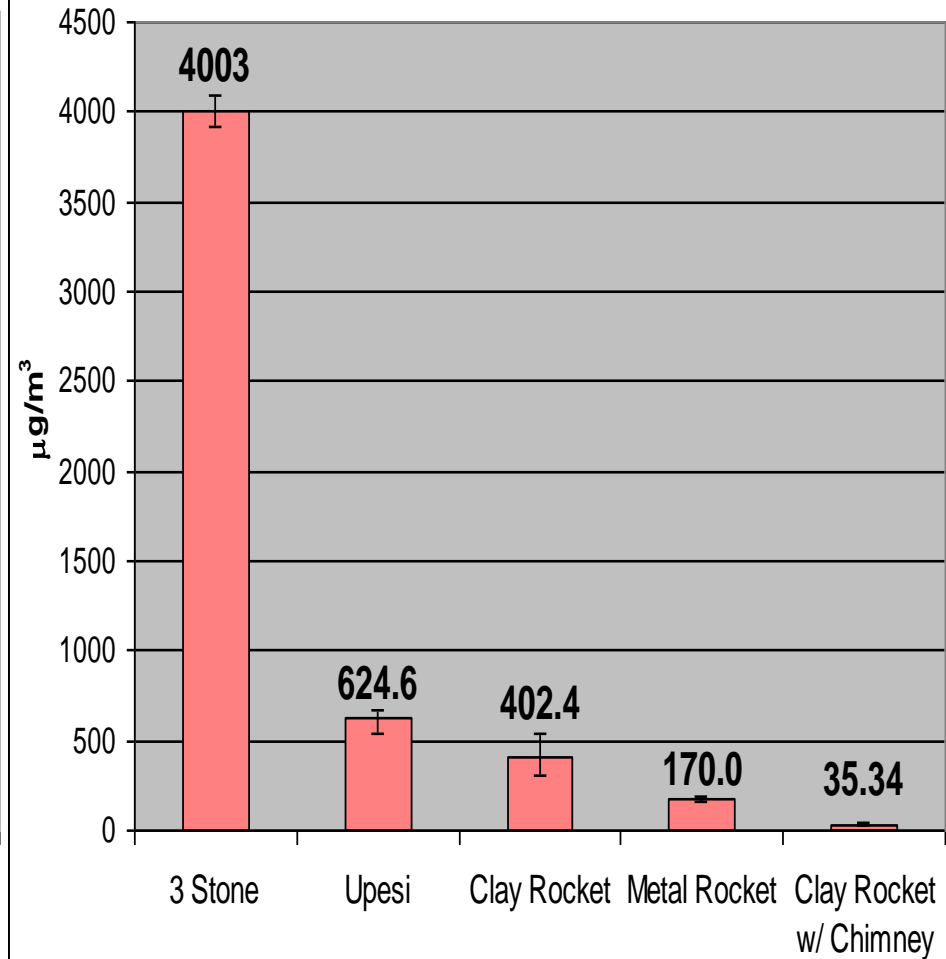


PM2.5 and CO concentrations (3.5 hr mean)

Carbon Monoxide Concentration



Particulate Matter (PM2.5) Concentration



Stove sales

- fuelwood pressure high, no purchased fuel, >60% below \$1/day
- Local tests/demos seem to create a buzz
- Ambassadors/Vendors
- Reduce capital risk
- Purchases at \$8-\$10 are high
- Group sales are VERY effective.



Some observations- Africa

- Need to offer users choice
- We don't have generalizable results
- 50 to 500 to 5,000 to 50,000 stoves
- Supply chains: tough challenge
- Warranties are critical to users
- Need lot more of stove trials to create a feedback loop between field and lab

Thanks to everyone involved!

EI, NYC: Edwin Adkins, Erika Tyler, Rahul Kitchlu

MVP Ruhiira, Uganda: David Siriri, Robert Ayesiga, Moses Nuwagaba, Mathias Kibosi, Nelson Tugume

MVP Mwandama, Malawi: Joy Pankomera, Stevie Kazembe, Florida Mwale, Collins Chipagala, Maria Lupasa, Kingsley Mkwalula, Jacob Phiri

MVP Mbola, Tanzania: Gerson Nyadzi, Stanley Kayabu, Gerald Ntiritobora, Juma Khalid, Bond Kayabu, Peter Saoke

UNDP

ProBEC Tabora: Mabhamba Majogoro

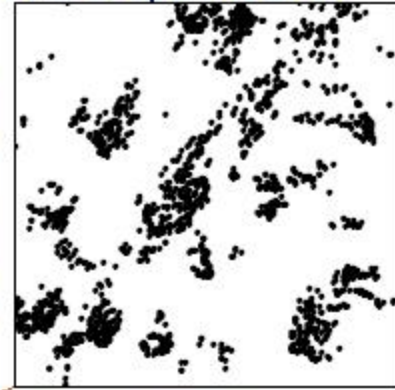
Ceil & Michael E. Pulitzer Foundation

Different agro-ecologies

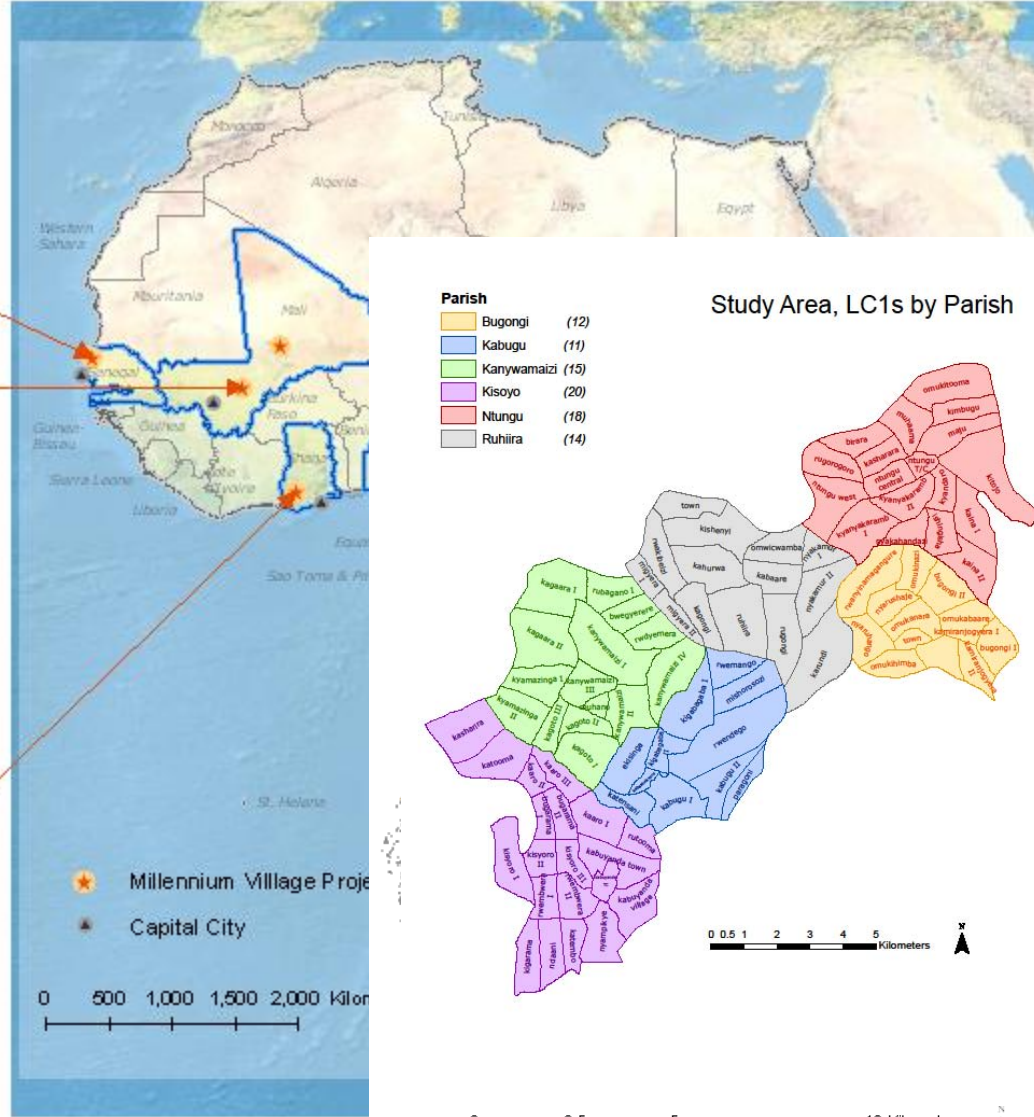
Potou, SENEGAL



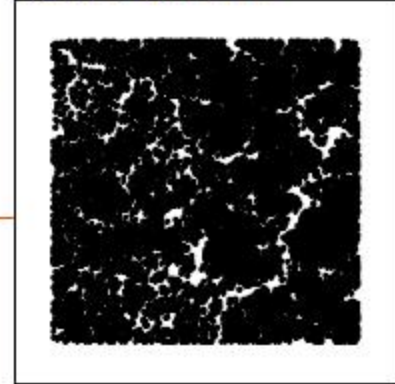
Koraro, ETHIOPIA



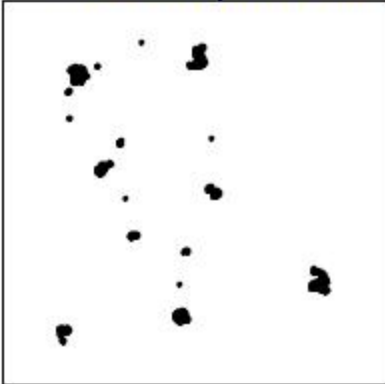
Tiby, MALI



Sauri, KENYA



Bonsaaso, GHANA



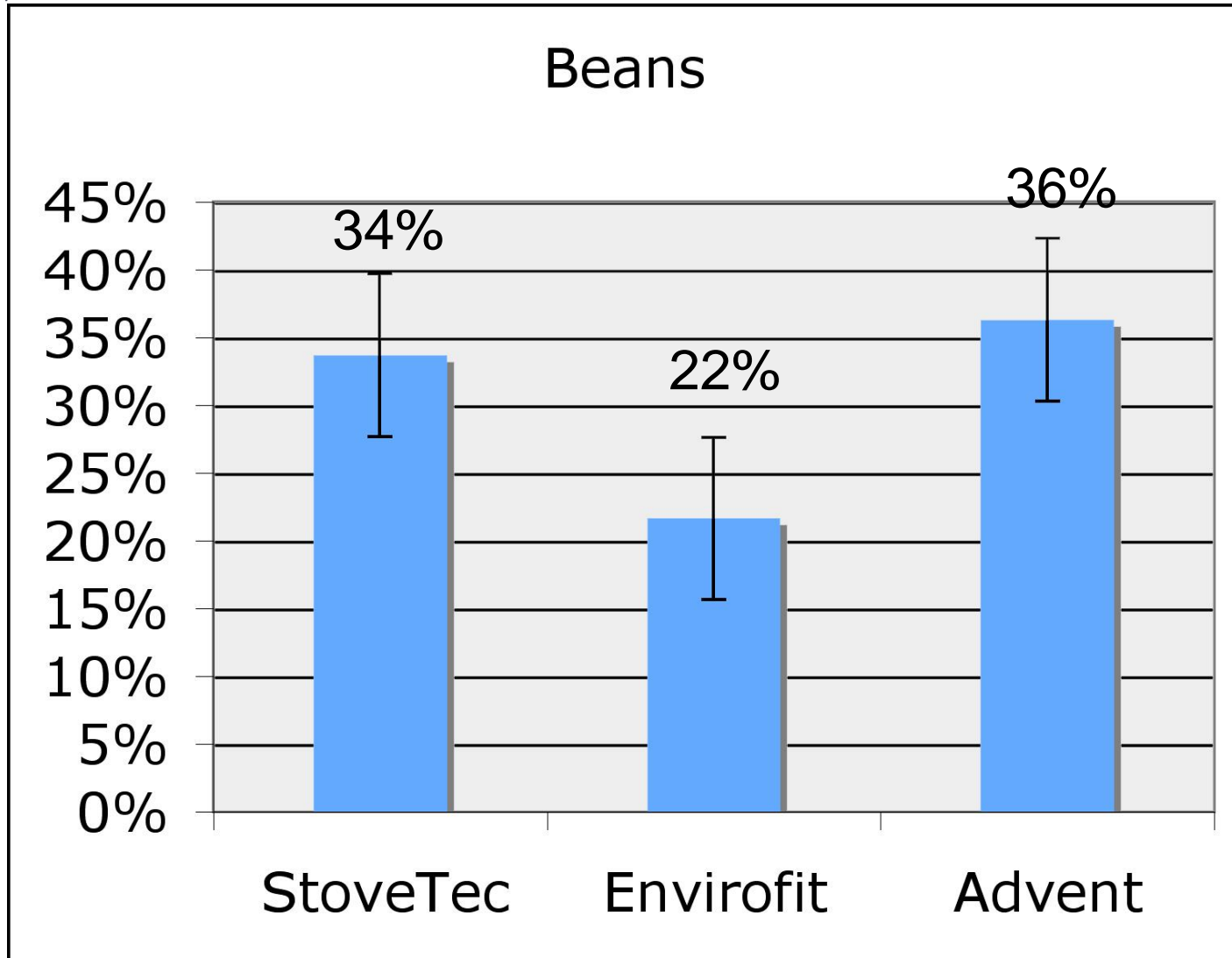
Ruhiira, UGANDA



0 1 2 3 4 5 Kilometers

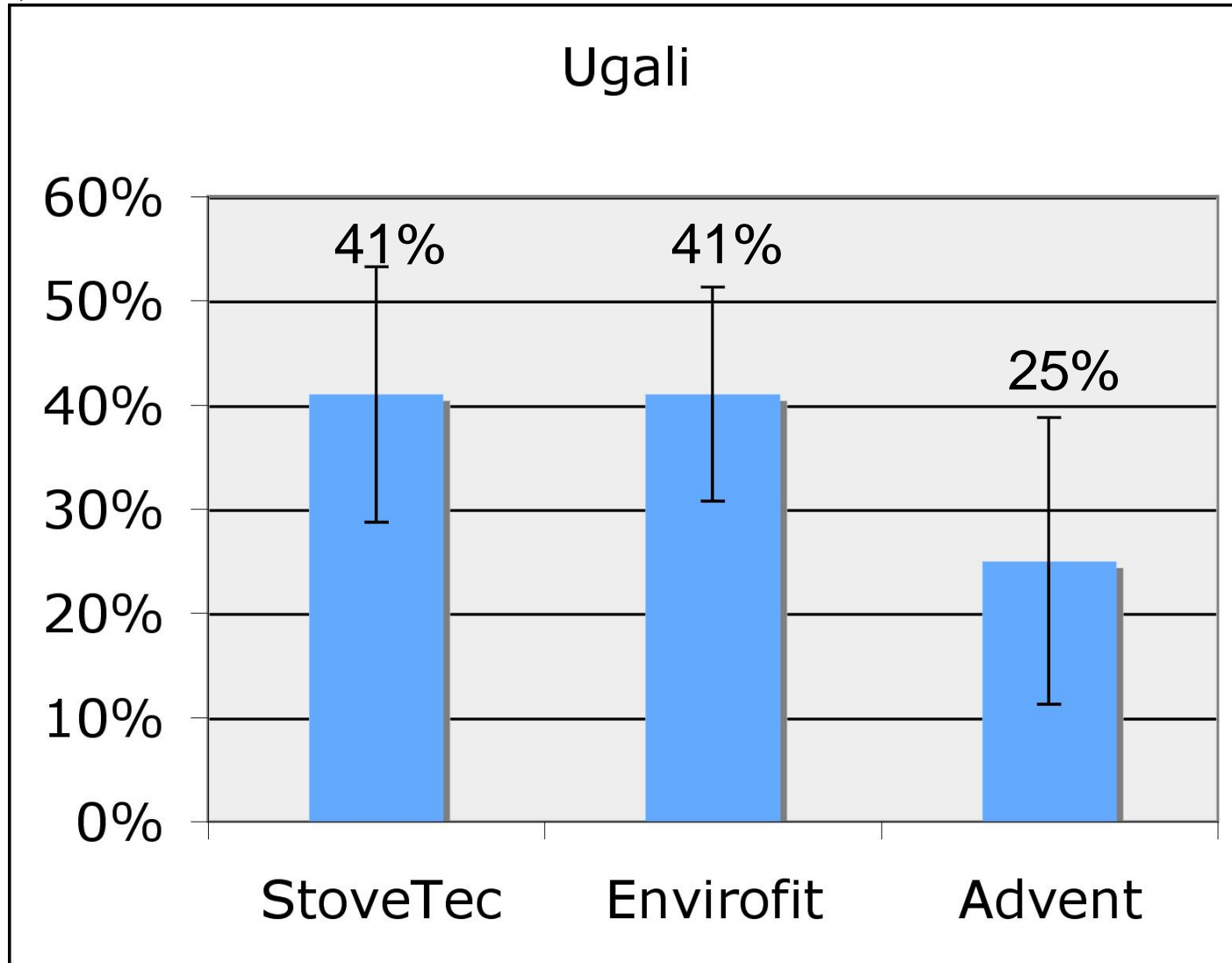
0 1 2 3 4 5 Kilometers

Average Fuel Savings Compared to Three-stone Fire Mbola, Tanzania



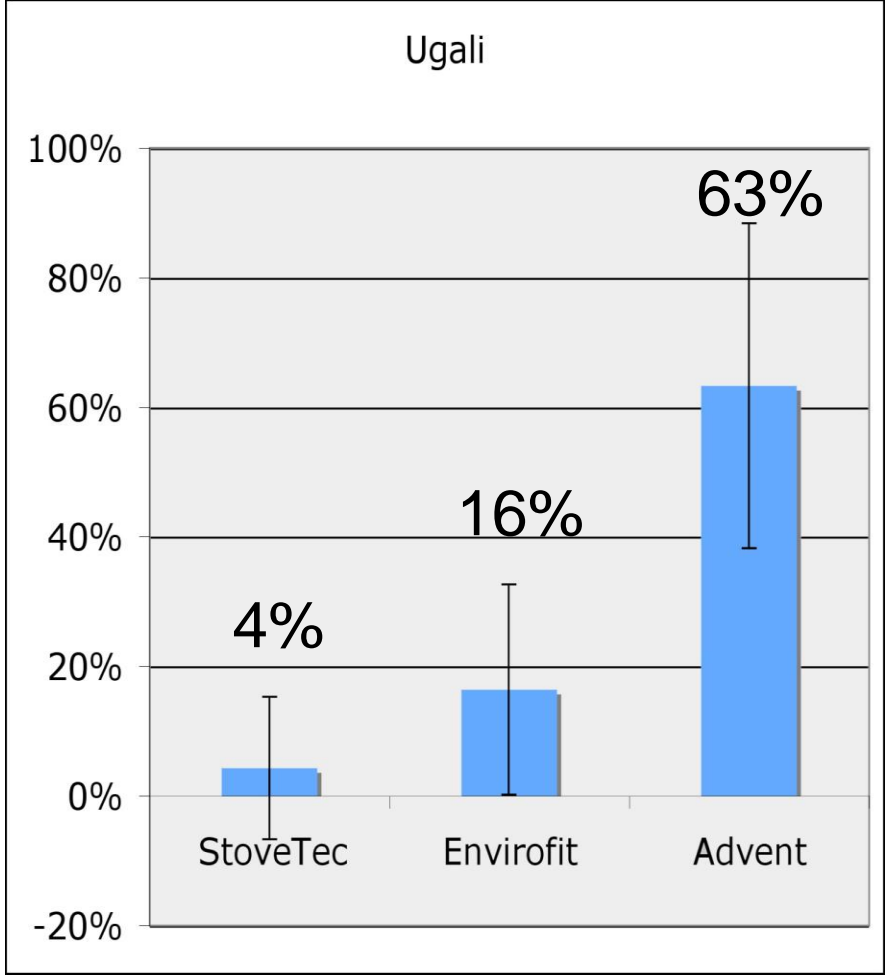
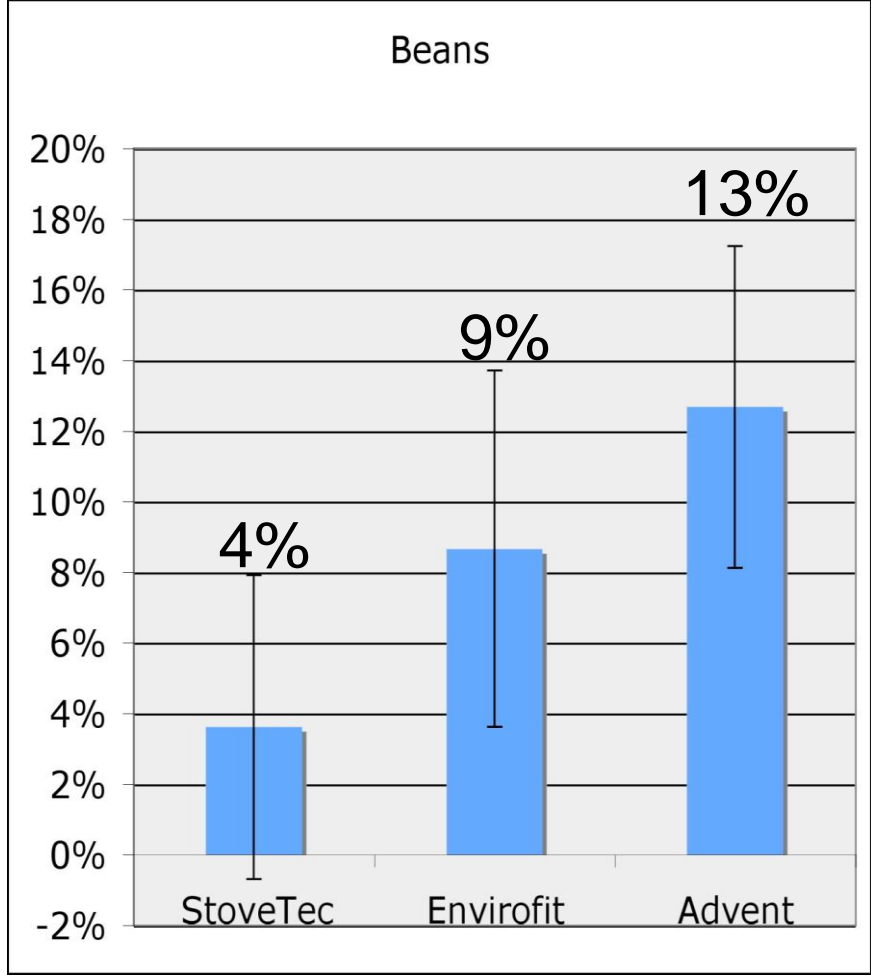
Error bars are 95% confidence intervals

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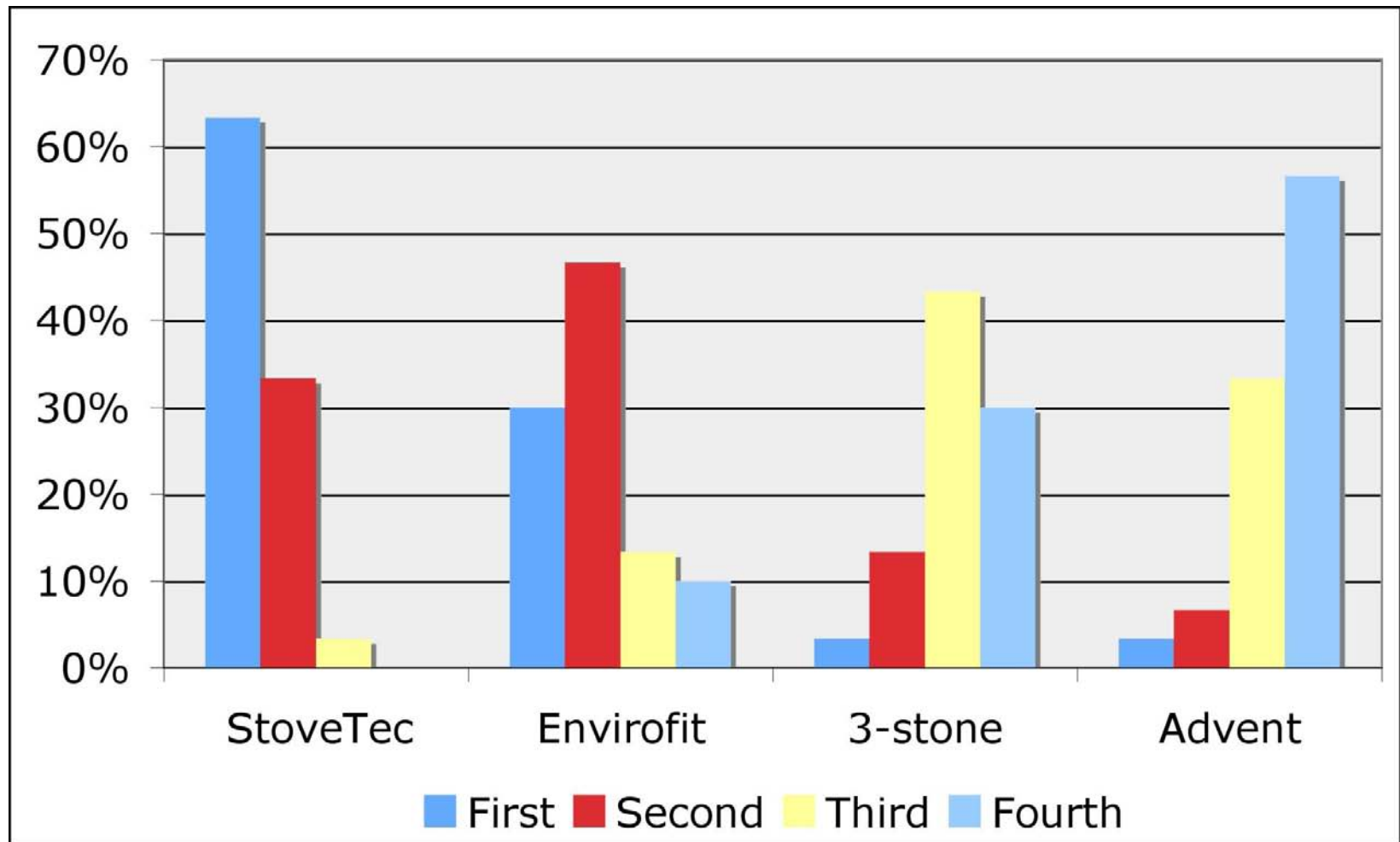
Error bars are 95% confidence intervals

Average Increase in Cooking Time Compared to Three-stone Fire



Error bars are 95% confidence intervals

Rank of Cookstoves in Order of Users' Preferences



- Nearly all rank StoveTec and Envirofit as the top two choices
- 57% of cooks ranked the Advent last below the three-stone fire