Modelling technology adoption decisions by smallholder cassava producers in East Africa

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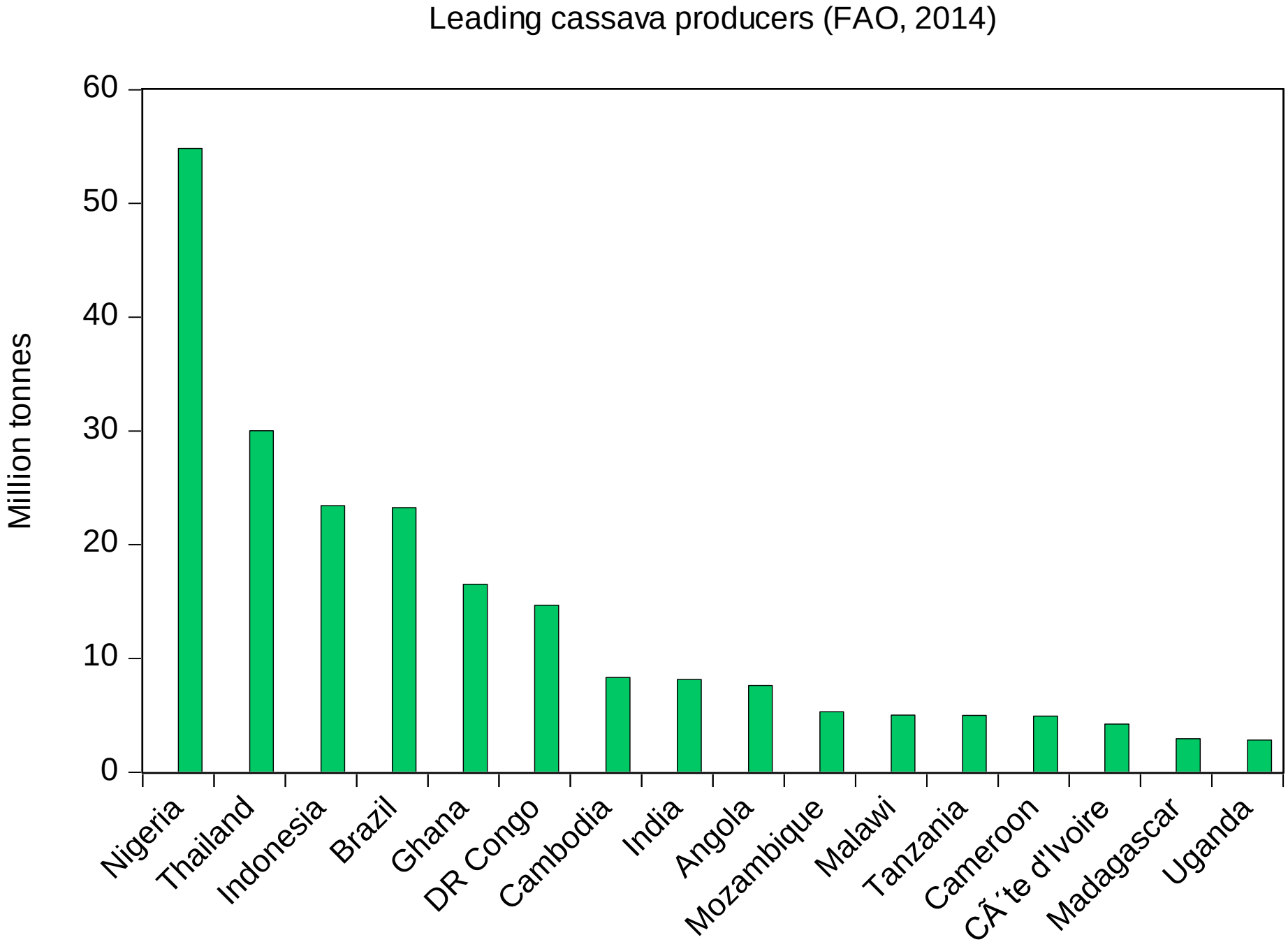
CSIRO

CASSAVA WHITEFLY PROJECT
WHITEFLY CONTROL FOR AFRICAN SMALLHOLDERS

Overview of presentation

- Introduction
- Methodology
- Results and Discussion
- Conclusions and policy implications
- Further work


Leading cassava producers (FAO, 2014)
Million tonnes
60
50
40
30
20
10
0
Nigeria
Thailand
Indonesia
Brazil
Ghana
DR Congo
Cambodia
India
Angola
Mozambique
Malawi
Tanzania
Cameroon
CÃ´te d'Ivoire
Madagascar
Uganda

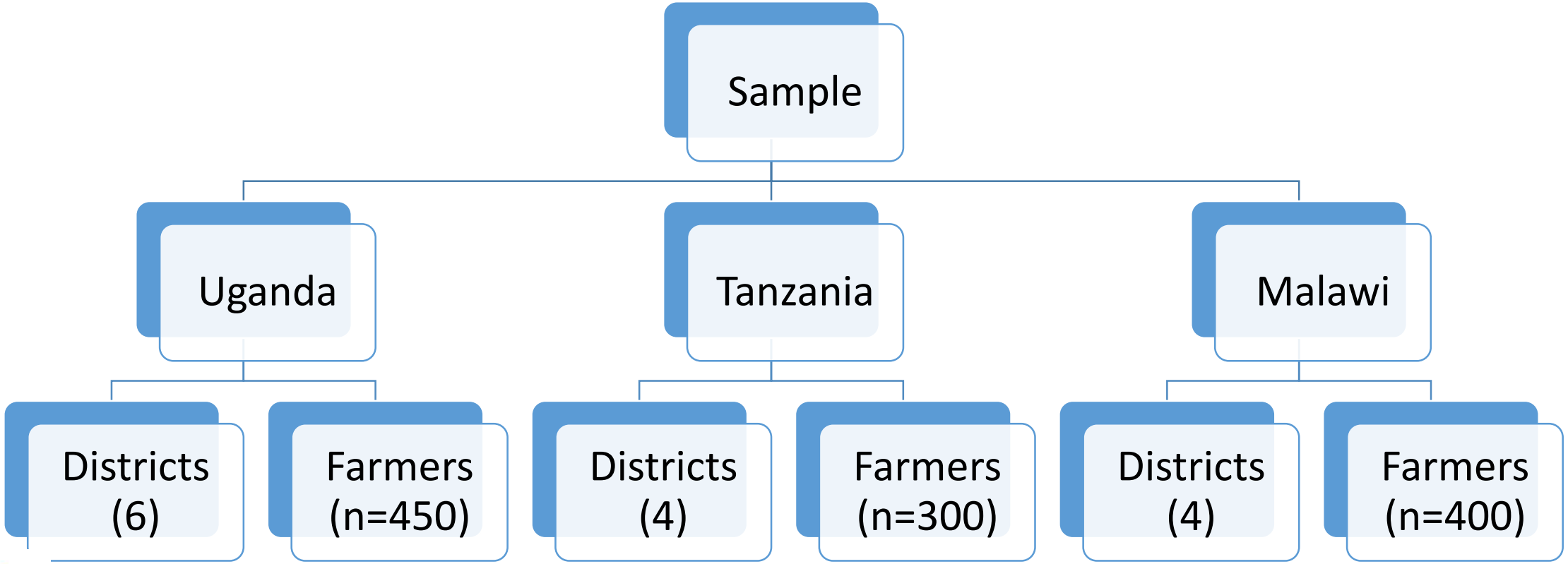
Research questions

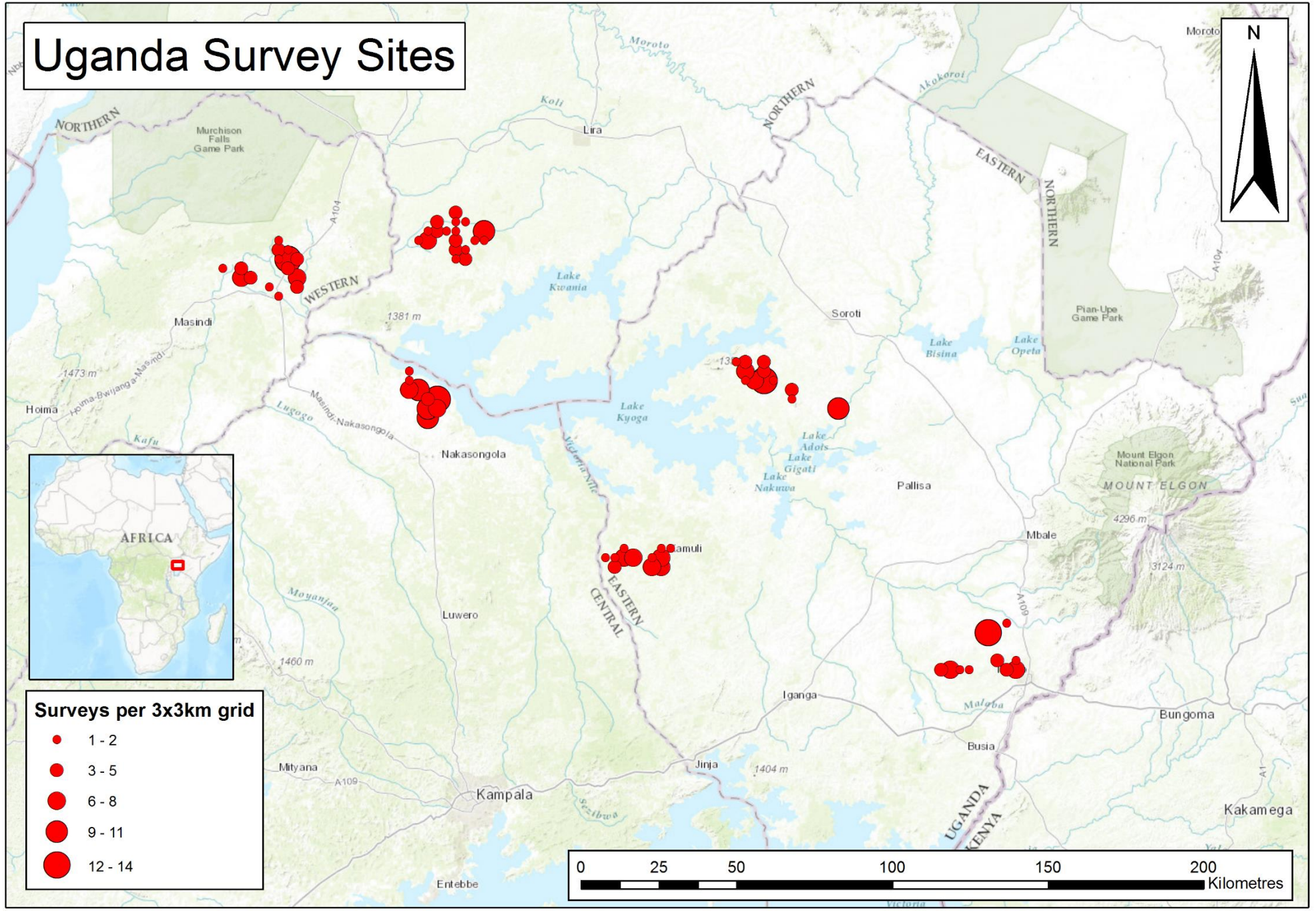
- What is the current status of cassava production and productivity in Uganda, Tanzania and Malawi?
- What is the current adoption rate of improved cassava production technologies?
- What is the economic impact of *B. tabaci* on smallholder farmers?

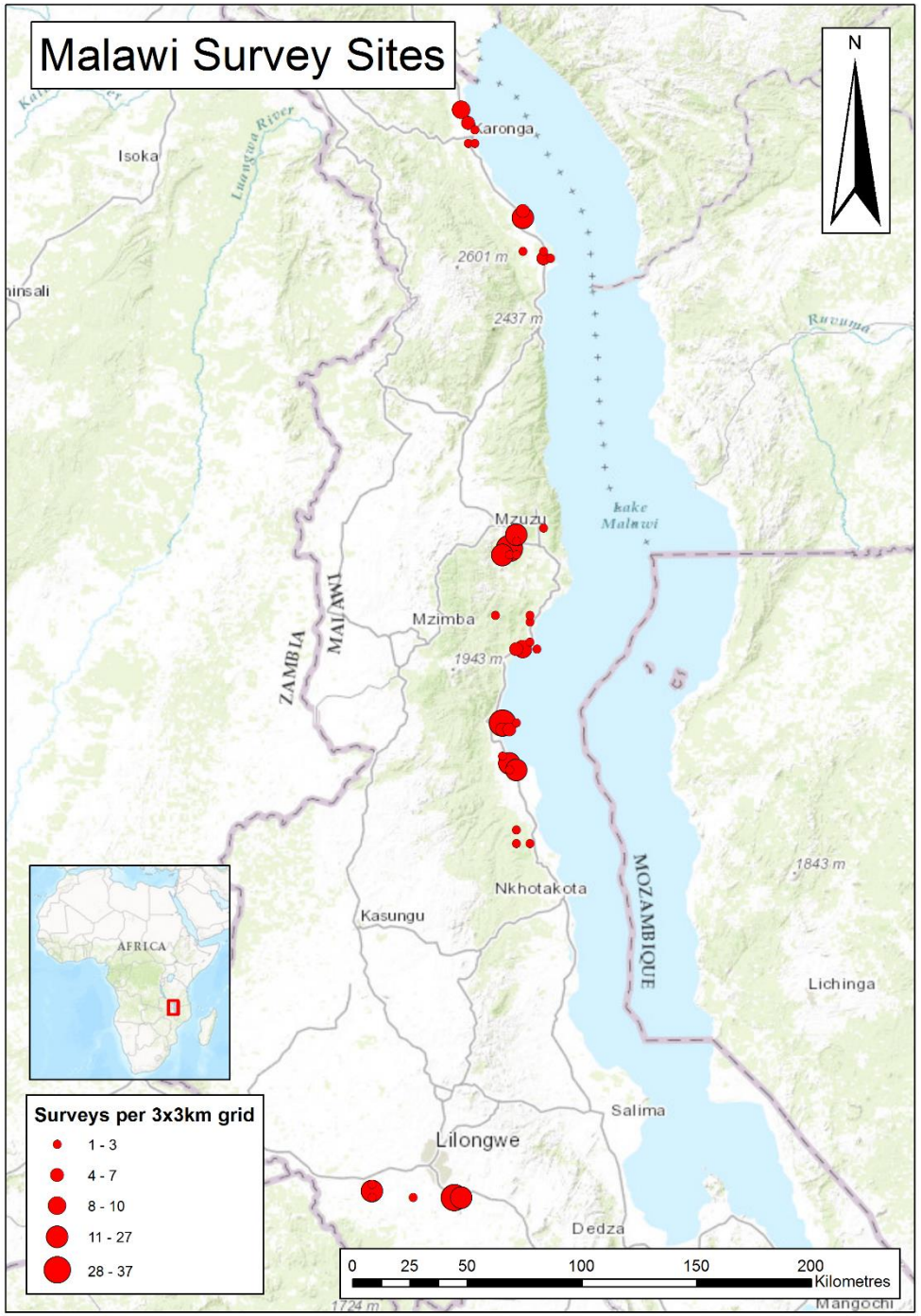
Methods

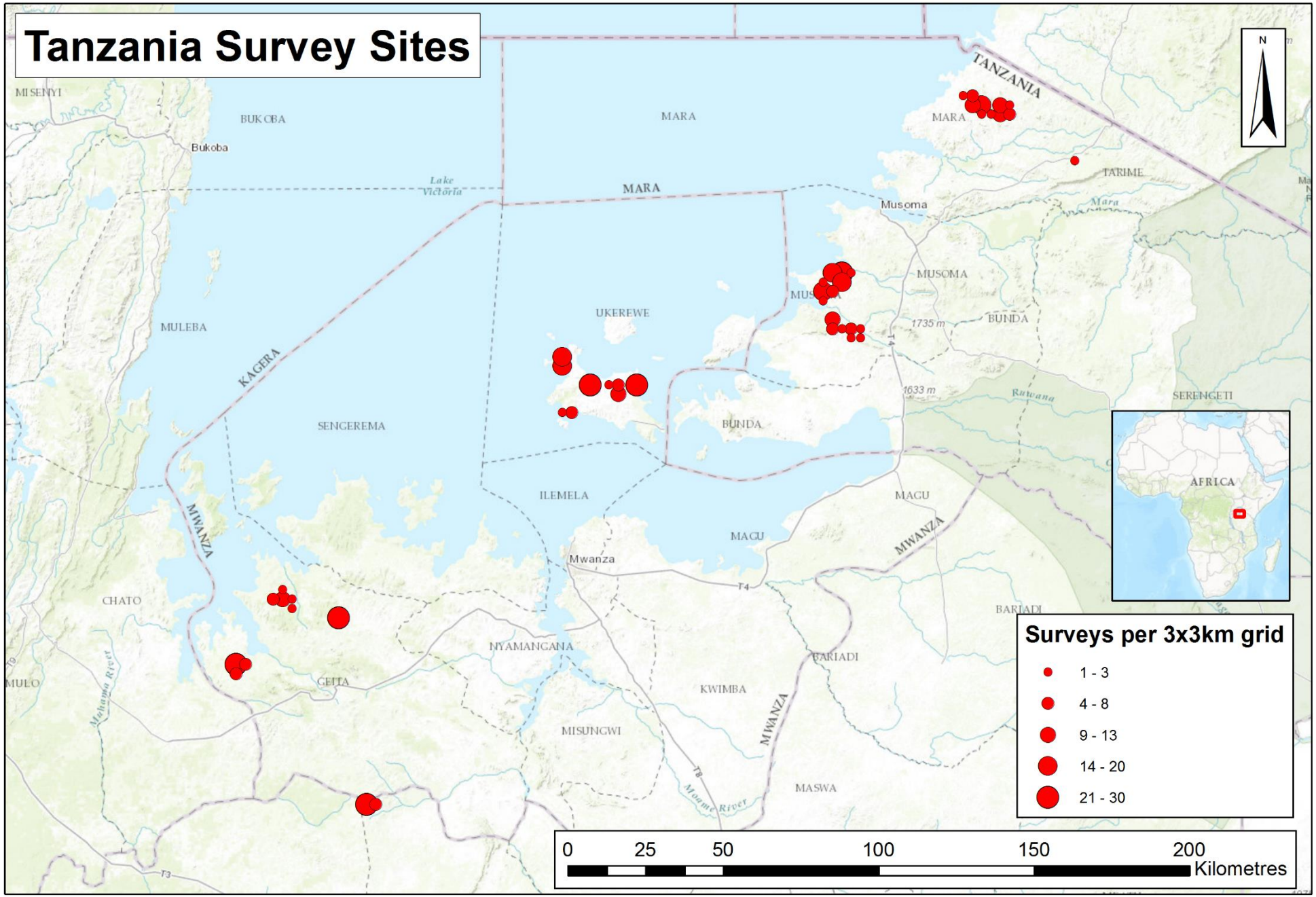
- Literature review
- Questionnaire development
  - Pre-survey workshops
  - Pilot surveys
- Farmer surveys using multi-stage random sampling procedure
- A total of 1200 farmers interviewed
- Econometric modelling

Methods (cont.)




Uganda Survey Sites
N
AFRICA
Surveys per 3x3km grid
1 - 2
3 - 5
6 - 8
9 - 11
12 - 14
0
25
50
100
150
200
Kilometres
Kampala
Entebbe
Jinja
Mbale
Soroti
Lira
Masindi
Hoima
Nakasongola
Luwero
Pallisa
Iganga
Bungoma
Busia
Mityana
Kakamega
Kamuli
Lake Kwania
Lake Kyoga
Lake Bisina
Lake Opeta
Lake Adois
Lake Gigati
Lake Nakuwa
Victoria Nile
Mount Elgon National Park
MOUNT ELGON
Pian-Upe Game Park
Murchison Falls Game Park
NORTHERN
EASTERN
WESTERN
CENTRAL
UGANDA
KENYA


Malawi Survey Sites
N
Karonga
Isoka
Luangwa River
2601 m
2437 m
Rukuru
Lake Malawi
Mzuzu
Mzimba
1943 m
ZAMBIA
MALAWI
MOZAMBIQUE
1843 m
Nkhotakota
Kasungu
Lichinga
AFRICA
Salima
Lilongwe
Dedza
Mangochi
1724 m
Surveys per 3x3km grid
1 - 3
4 - 7
8 - 10
11 - 27
28 - 37
0 25 50 100 150 200
Kilometres


Tanzania Survey Sites
TANZANIA
MARA
MARA
MARA
MISENYI
BUKOBA
Bukoba
Lake Victoria
TARIME
Mara
Musoma
MUSOMA
BUNDA
1735 m
1633 m
Ruwana
SERENGETI
MULEBA
KAGERA
UKEREWE
SENGEREMA
BUNDA
ILEMELA
MAGU
MAGU
MWANZA
MWANZA
Mwanza
CHATO
BARIADI
NYAMANGANA
BARIADI
GEITA
KWIMBA
MULO
Muhuma River
MISUNGWI
MWANZA
Mbarne River
MASWA
T4
T3
T9
AFRICA
Surveys per 3x3km grid
1 - 3
4 - 8
9 - 13
14 - 20
21 - 30
N
0
25
50
100
150
200
Kilometres

Multivariate probit model

$$Y_{ijm}^{*} = X_{ijm}^{'}\beta_{m} + \varepsilon_{ijm} \quad (1)$$

$$Y_{ijm} = \begin{cases} 1 & if \quad Y_{ijm}^{*} > 0 \\ 0 & otherwise \end{cases} \quad (2)$$

where: m denotes technology choices for household i and plot j. Y*ijm is a latent variable which captures the unobserved preferences for technology m. This latent variable is assumed to be a linear combination of observed plot and household characteristics Xijm, and unobserved characteristics captured by the stochastic error term, εijm. βm is the vector of parameters to be estimated is βm.

Cappellari L, Jenkins S, 2003. Multivariate probit regression. The Stata Journal 3(3): 278-294

Multivariate probit model (cont.)

$$\Omega = \begin{bmatrix} 1 & \rho_{12} & \rho_{13} & \dots & \rho_{1m} \\ \rho_{12} & 1 & \rho_{23} & \dots & \rho_{2m} \\ \rho_{13} & \rho_{23} & 1 & \dots & \rho_{3m} \\ \dots & \dots & \dots & 1 & \dots \\ \rho_{1m} & \rho_{2m} & \rho_{3m} & \dots & 1 \end{bmatrix}$$

where the off-diagonal elements in the covariance matrix, ρjm, represents the unobserved correlation between the stochastic components of the jth and mth technology options. This specification with non zero diagonal elements allows for correlation across the error terms of several latent equations, which represent unobserved characteristics that affect the choice of technology

Results: Descriptive statistics of the sample

	Uganda	Tanzania	Malawi
Age (years)	46.03 (14.65)	51.07 (13.49)	47.42 (15.16)
Male (%)	65	80	76
Education (years)	8.13 (4.13)	8.72 (5.94)	5.88 (3.39)
Household size	8.52 (3.95)	7.52 (3.75)	6.31 (2.65)
No. of Children	4.26 (2.37)	4.40 (2.47)	2.91 (1.69)

Source: Field surveys. Figures in brackets are standard deviations

Results: Descriptive statistics (cont.)

	Uganda	Tanzania	Malawi
Total land/farm size (acres)	1.90 (1.51)	4.25 (3.54)	1.69 (1.97)
Land under cassava (acres)	1.21 (1.31)	2.46 (1.83)	1.44 (2.19)
Access to credit (%)	16	22	33
Member of organisation (%)	47	43	34
Extension (%)	30	31	45

Source: Field surveys. Figures in brackets are standard deviations

Results: Adoption of improved cassava production technologies

	Uganda	Tanzania	Malawi
Inorganic fertiliser (%)	0.0	0.0	3.0
Pesticide use (%)	1.0	2.0	2.0
Improved cassava variety (%)	70	11	51
Intercropping (%)	31	72	36
Plant spacing (%)	70	69	50
No. of Obs.	400	428	400

Source: Field surveys

Results: Multivariate probit model (Tanzania)

	Improved cassava varieties	Legume intercropping	Plant spacing
Farm size	0.662 (1.96) **	-0.321 (-2.45)**	0.176 (2.03)**
Distance to market	-0.112 (2.46) **	-0.403 (-1.81)*	-0.403 (-2.26)**
Extension	0.737 (3.05) **	0.155 (2.72) **	0.395 (2.49)**
Livestock	0.982 (2.80) ***	0.694 (1.76) *	0.206 (1.02)
Credit	0.173 (2.56)**	0.3516 (1.81)*	0.237 (1.02)
Household size	0.348 (1.61)**	0.118 (2.65)**	0.155 (2.34)**

Note: *t* statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001

Results: Multivariate probit model (Tanzania)

	Improved cassava varieties	Legume intercropping	Plant spacing
Male	0.142 (0.49)	0.696 (3.15)***	0.484 (2.08)**
Age	-0.606 (-1.79) **	0.564 (1.83)*	-0.293 (-0.96)
Education	0.034 (0.15)	0.0441 (0.25)	0.122 (1.65)
Constant	-1.629 (-1.11)	0.997 (0.86)	2.026 (1.67)
Wald Chi2 (d.f.=40)	941.29		
Log pseudo likelihood	-370.69		

Note: *t* statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001

Correlation coefficients for MVP equations

	Improved cassava varieties	Legume intercropping	Plant spacing
Improved varieties		-0.29 (-2.06)**	0.25 (1.59)*
Legume intercropping	-0.29 (-2.06)**		-0.29 (-2.58)**

Note: *t* statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001

Likelihood ratio test of rho21 = rho31 = rho32 = 0:
chi2(3) = 19.21 Prob > chi2 = 0.0167

Conclusions

- Both socio-economic and farm characteristics are significant in conditioning farmer's decisions to adopt improved technologies
- Results suggest that adoption covariates differ across technologies. Farm size positively influences adoption of improved cassava varieties but negatively influences legume intercropping
- Access to markets significantly influences farmers' adoption decisions. Households located closer to markets are more likely to adopt improved cassava production technologies
- The size of the household has a positive effect on the adoption of improved cassava production technologies, probably because of increased labor availability

Conclusions (cont.)

- Older farmers are significantly less likely to adopt improved cassava varieties and plant spacing, perhaps because young farmers are stronger and better able to provide the labor needed
- The decision to adopt improved cassava varieties is positively and significantly influenced by livestock ownership
- Credit constrained households are less likely to adopt improved cassava production technologies, because adoption of such technologies requires purchased inputs (hence cash outlay)
- Institutional factors such as access to extension services increase adoption of all improved cassava production technologies

Further work

- Field trials to validate surveys
- Publications in the pipeline…..
  - Mwebaze P, et al. Socio-economic and baseline survey data for future impact assessments of cassava production in East Africa (in prep for *Agricultural Economics*)
  - Mwebaze P, et al. Modelling technology adoption by cassava farmers in East Africa (in prep for *Food Policy*)

Thank you!

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- Any questions or comment? Please email: paul.mwebaze@csiro.au