Exploring fertilizer use with maize, legumes and sweet potato to intensify and diversify cropping systems in Malawi

D. van Vugt[a,b], N. Jones[c], K. E. Giller[b] and A. C. Franke[d]

[a] International Potato Center, CGIAR Research Program on Roots Tubers and Bananas. Area 11 Plot No. 36 Chimutu Road, P.O. Box 31600, Capital City, Lilongwe 3, Malawi
[b] Plant Production Systems, Wageningen University, PO Box 430, 6700 AT Wageningen, The Netherlands
[c] TechnoServe. Area 6 Plot No. 199, Lilongwe, Malawi.
[d] Soil, Crop and Climate Sciences, University of the Free State, PO Box 339, Bloemfontein 9300, South Africa

INTRODUCTION AND OBJECTIVES

Maize, the main staple food of smallholder farmers in southern Africa, is cultivated on a large share of the agricultural land. Limited nutrient input results in soil nutrient depletion over time. There is need for productive farming systems that are better adapted to a changing climate, and that produce more diverse food to achieve both food and nutrition security.

This study was conducted to:

1. Evaluate the effectiveness and profitability of fertilizer and lime application to maize, soybean, groundnut and sweet potato.
2. Explore farmer perceptions on intensification with fertilizers

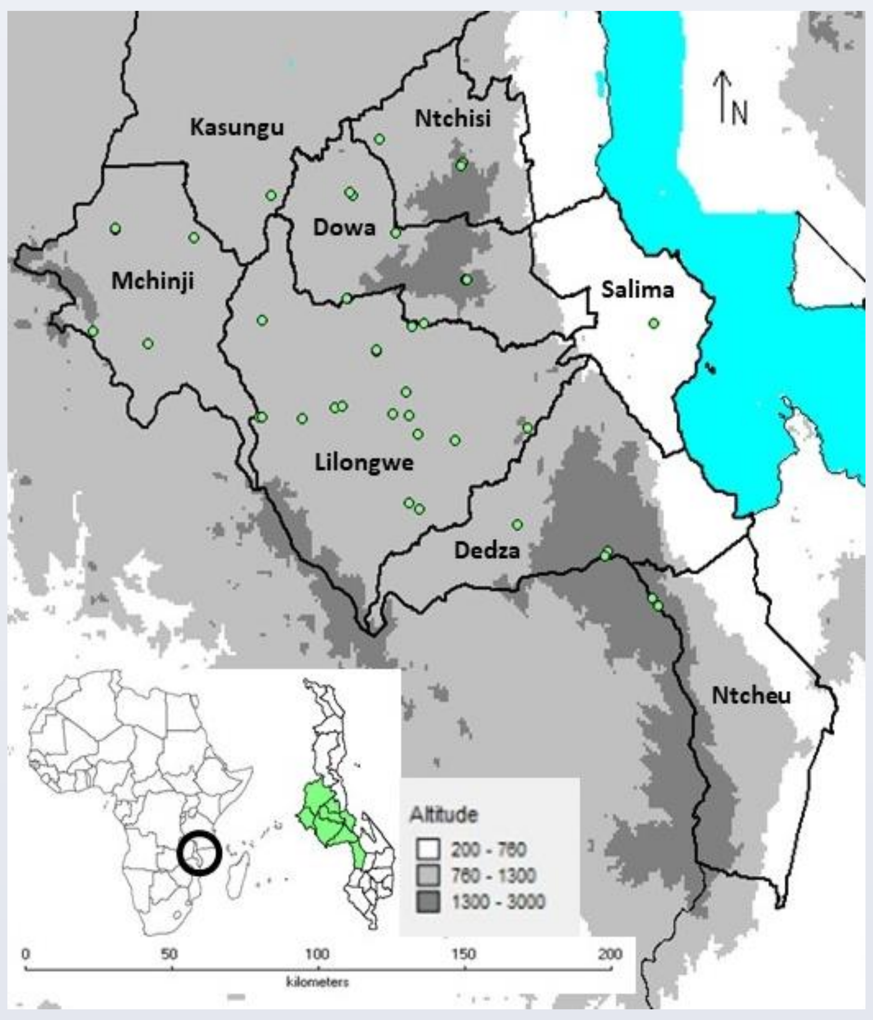

Figure 1. *A soybean demo plot in a maize-based cropping system in Central Malawi (left) and locations of demo sites (right).*

METHODS

We combined yield results of 50 maize, 28 soybean, 24 groundnut and 26 sweet potato on-farm input trials with economic analysis and focus group discussions to explore input options for crop intensification and diversification. Table 1 shows the inputs applied in each crop and treatment. The fertilizers were special blends produced by Farmers World Limited following analysis of over 2000 soil samples in the catchment areas.

Table 1. Input treatments in the maize, soybean, groundnut and sweet potato plots.

Plot	Fertilizer type	Fertilizer applied (kg ha^{-1})	Nutrients applied in fertilizer (kg ha^{-1})	Lime application (kg ha^{-1})
Maize[1]				
T1	No	0	0	0
T2[2]	NPS 23:9:4	150	81N, 14P, 6S	0
	N Urea 46	100		
T3	NPKSZnB 15:10:13:6:0.5:3	175	71N, 18P, 42K, 11S, 1Zn, 5B	1000
	NK 30:13	150		
T4	NPKSZnB 15:10:13:6:0.5:3	350	143N, 35P, 85K, 21S, 2Zn, 11B	1000
	NK 30:13	300		
Soybean				
T1	No	0	0	0
T2	NPK 6:9:20	150	9N, 14P, 30K	0
T3	NPK 6:9:20	150	9N, 14P, 30K	1000
T4	NPK 6:9:20	250	15N, 23P, 50K	1000
Groundnut				
T1	No	0	0	0
T2	NPK 6:9:20	200	12N, 18P, 40K	0
T3	NPK 6:9:20	200	12N, 18P, 40K	1000
T4	NPK 6:9:20	300	18N, 27P, 60K	1000
Sweet potato				
T1	No	0	0	0
T2	NPKS 10:9:17:6	250	25N, 23P, 43K, 15S	1000

[1]In maize T2-4, the first fertilizer type is applied as basal and the second type as top dressing. [2]National fertilizer recommendation using commonly available fertilizers.

RESULTS

Due to proper crop management and the use of good varieties in a season with above-average rainfall, excellent mean trial yields of 5.0 t ha^{-1} for maize, 3.4 t ha^{-1} for soybean, 2.5 t ha^{-1} for groundnuts and 13.2 t ha^{-1} for sweet potato were achieved. Responses to various combinations of inorganic fertilizer and lime were highly variable, but applications enhanced yields in all crops (Figure 2, Table 2).

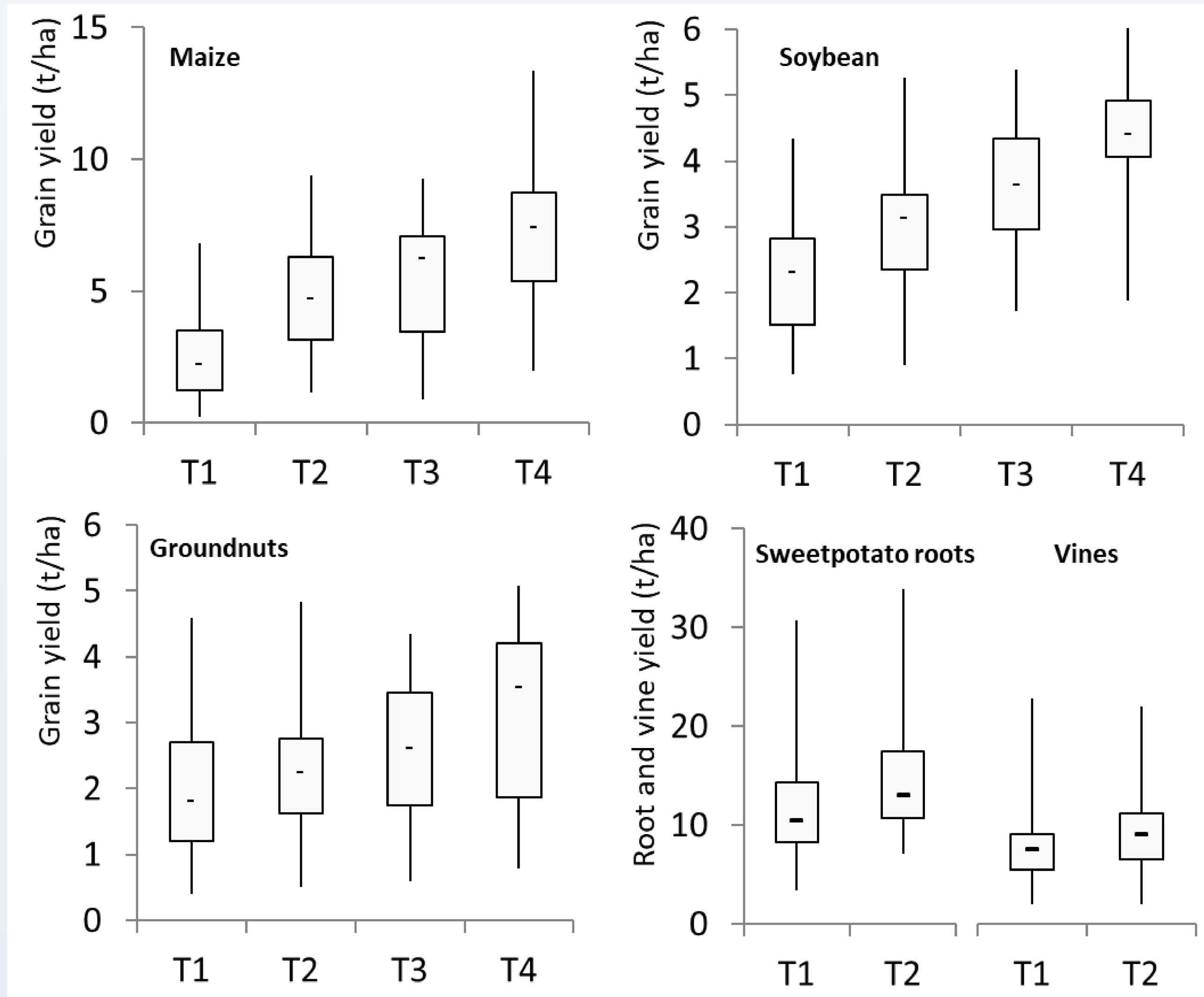

Figure 2. *Variability in yield of maize (n=50), soybean (n=28), groundnuts (n=24) and sweet potato (n=26) under different input treatments.*

Although maize production and investments in maize fertilizer were not as profitable as the other crops, fertilizer application to maize gave the best returns of food per amount of money invested. Better yield responses and value cost ratios showed that investments in fertilizer and lime in soybean was more worthwhile than in groundnut, though the financial benefits were somewhat hidden by high groundnut prices.

Table 2. Mean grain and root yields, costs and value of production for different input treatments.

	Yield (t ha^{-1})	Farm-gate value of produce (USD ha^{-1})	Partial gross margin[1] (USD ha^{-1})	Additional produce per USD invested in inputs[2] (kg USD^{-1})	VCR[3] (-)	VCR>2 (% of fields)
Maize						
T1	2.5 (1.6)	230 (146)	230			
T2	4.8 (2.0)	437 (178)	292	15.7 (9.0)	1.4 (0.8)	24
T3	5.6 (2.2)	510 (196)	315	15.9 (7.8)	1.4 (0.7)	20
T4	7.2 (2.7)	655 (243)	300	13.2 (5.8)	1.2 (0.5)	6
SED[4]	0.43***	38.8***		1.53 n.s.	0.14 n.s.	
Soybean						
T1	2.3 (0.9)	475 (191)	475			
T2	3.1 (1.0)	623 (194)	539	8.6 (4.7)	1.8 (0.6)	36
T3	3.7 (1.0)	750 (198)	631	11.3 (5.9)	2.3 (0.8)	57
T4	4.5 (1.1)	910 (220)	735	12.2 (6.1)	2.5 (0.8)	64
SED	0.26***	53.8***		1.50*	0.31*	
Groundnut						
T1	2.0 (1.1)	821 (450)	821			
T2	2.2 (1.0)	905 (414)	792	1.8 (4.7)	0.7 (2.0)	25
T3	2.6 (1.2)	1080 (499)	933	4.3 (5.0)	1.8 (2.1)	46
T4	3.1 (1.4)	1295 (565)	1092	5.6 (4.7)	2.3 (2.0)	54
SED	0.34**	140**		1.39*	0.57*	
Sweet potato						
T1	11.8 (7.1)	1380 (834)	1380			
T2	14.5 (7.5)	1701 (877)	1478	12.5 (24.8)	1.5 (2.9)	39
SED	0.84**	97.9**				

[1]The farm gate value of the produce minus the costs of the fertilizer and lime inputs. [2]Relative to T1. [3]Value Cost Ratio. The value of the additional produce per USD invested in the input treatment. [4]SED = Standard error of the difference between means, with *** = p<0.001, ** = p<0.01, * = p<0.05 and n.s. = not significant.

The top eight priority crops produced by farmers who participated in a focus group discussion from most to least important were maize, groundnuts, soybean, common bean, sweet potato, potato, tomato and tobacco. Maize is crucial for food security and all farmers agreed that an absolute minimum area of 0.4 hectare should be planted with maize. If funds for fertilizer are available and market prices are good, the area under maize could be expanded. After maize, farmers prioritized legumes because they believe they do not need fertilizer, can be stored relatively well, and have multiple uses for household utilization and income generation. An important reason for farmers to allocate land to legumes such as groundnut, soybean and common bean is their strong belief that these crops do not need fertilizer, coupled with their financial constraints to buy enough fertilizer for their whole arable land area.

CONCLUSION

While there is potential to derive better financial returns from diversification and intensification with legumes and sweet potato, farmers prioritize maize in terms of land area and resource allocation.

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CONTACT

The author can be contacted by emailing d.vanvugt@cgiar.org or calling +265 999678889