SOILS: WHERE FOOD BEGINS

Selenium biofortification of staple maize: a way to combat hidden hunger in Malawi

Ivy Sichinga Ligowe, PhD.

Global Symposium on Soils for Nutrition | 26-29 July 2022

GLOBAL SOIL PARTNERSHIP

Should we worry about Se deficiency?

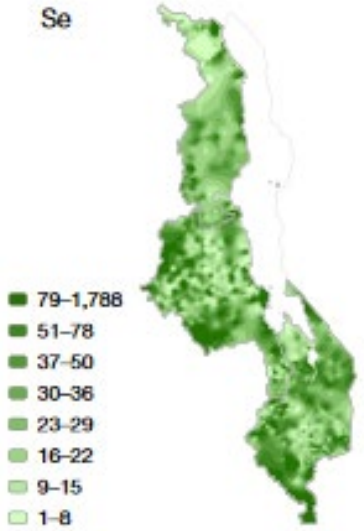
Deficiency associated with

- Immunodeficiency, some cancers, & NCDs
- Human infertility
- Heart diseases
- Chronic and degenerative disorder (Keshan–Beck disease)

Deficiency common in HIV^{+} persons

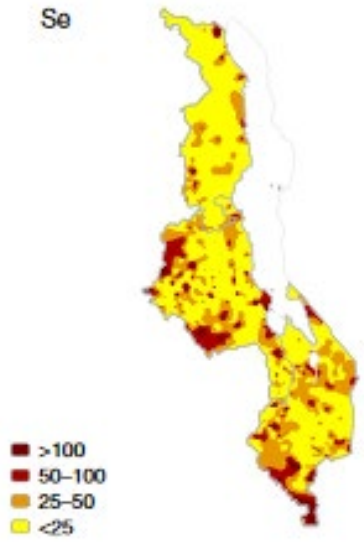
**EAR for women 18-24 yrs*

Se intake is determined by geography, especially soil properties, as well as food consumed



Maize Se (µg/kg DM) varies geographically across Malawi.

Maize is typically consumed by the household that grew it. It is the dominant dietary energy source for most Malawian households.



Modelling with typical daily maize consumption shows the maize would contribute <25% of the EAR of 45 µg/person/day across most of the area of Malawi.

*EAR for women 18-24 yrs

nature

Explore content ⌄ About the journal ⌄ Publish with us ⌄

nature › articles › article

Article | Open Access | Published: 19 May 2021

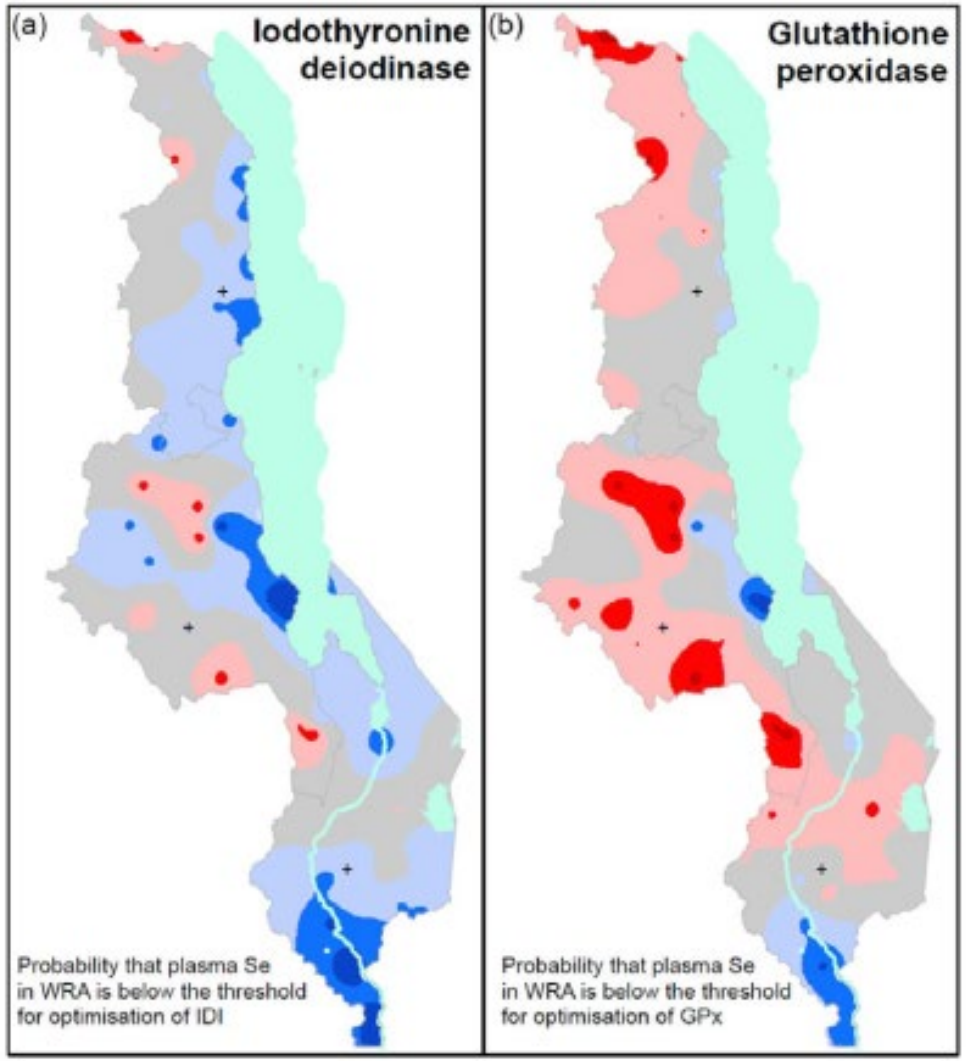
The nutritional quality of cereals varies geospatially in Ethiopia and Malawi

D. Gashu, P. C. Nalivata, T. Amede, E. L. Ander, E. H. Bailey, L. Botoman, C. Chagumaira, S. Gameda, S. M. Haefele, K. Hailu, E. J. M. Joy, A. A. Kalimbira, D. B. Kumssa, R. M. Lark, I. S. Ligowe, S. P. McGrath, A. E. Milne, A. W. Mossa, M. Munthali, E. K. Towett, M. G. Walsh, L. Wilson, S. D. Young & M. R. Broadley

Nature **594**, 71–76 (2021) | Cite this article

13k Accesses | **31** Citations | **153** Altmetric | Metrics

Biomarker data indicate widespread (63% prevalence for WRA) and spatially variable Se deficiency in the population



Probability that plasma Se in WRA is below the specified threshold

- Exceptionally unlikely (0–1%)
- Very unlikely (1–10%)
- Unlikely (10–33%)
- About as likely as not (33–66%)
- Likely (66–90%)
- Very likely (90–99%)
- Virtually certain (99–100%)

SCIENTIFIC REPORTS

OPEN

The risk of selenium deficiency in Malawi is large and varies over multiple spatial scales

Received: 7 November 2018
Accepted: 11 April 2019
Published online: 25 April 2019

Felix P. Phiri[1,2], E. Louise Ander[3], Elizabeth H. Bailey[1], Benson Chilima[4], Allan D. C. Chilimba[5], Jellita Gondwe[4], Edward J. M. Joy[6], Alexander A. Kalimbira[7], Diriba B. Kumssa[1], R. Murray Lark[1], John C. Phuka[8], Andrew Salter[1], Parminder S. Suchdev[9], Michael J. Watts[3], Scott D. Young[1] & Martin R. Broadley[1]

Selenium (Se) is an essential human micronutrient. Deficiency of Se decreases the activity of selenoproteins and can compromise immune and thyroid function and cognitive development, and increase risks from non-communicable diseases. The prevalence of Se deficiency is unknown in many countries, especially in sub-Saharan Africa (SSA). Here we report that the risk of Se deficiency in Malawi is large among a nationally representative population of 2,761 people. For example, 62.5% and 29.6% of women of reproductive age (WRA, n = 802) had plasma Se concentrations below the thresholds

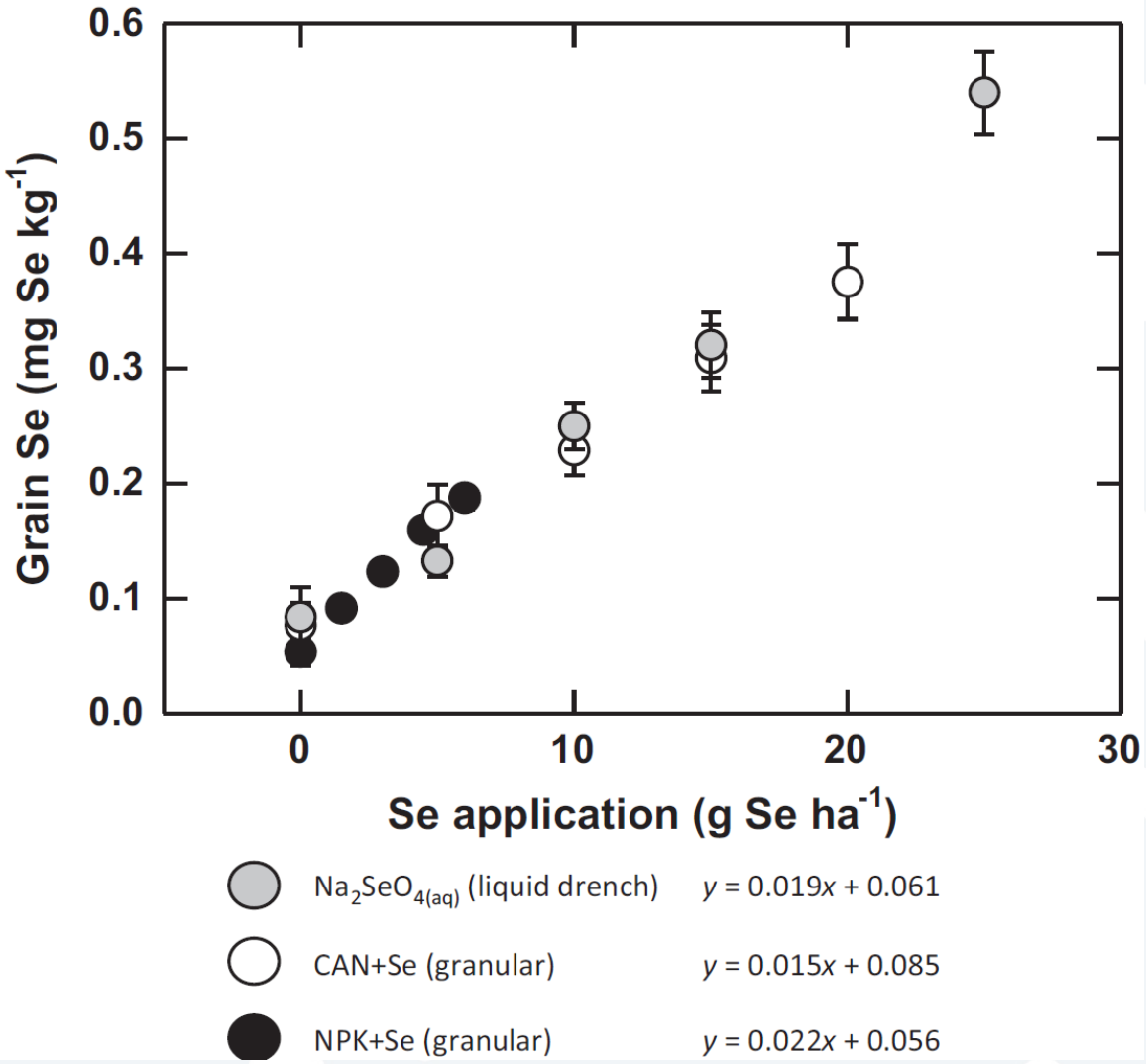
Se agronomic biofortification studies.

Objectives

- To determine the potential for biofortifying maize (*Zea mays* L.) in Malawi through application of sodium selenate ($Na_2SeO_{4(aq)}$ and granular);

- To investigate whether Se fertilizer, applied to maize and legumes, is affected by common soil management approaches and cropping practices, including differences in uptake and residual effects.

Field trial: maize grain Se increases with increased Se fertiliser concentration.



Contents lists available at SciVerse ScienceDirect

Field Crops Research

journal homepage: www.elsevier.com/locate/fcr

Agronomic biofortification of maize with selenium (Se) in Malawi

Allan D.C. Chilimba[a,b], Scott D. Young[a], Colin R. Black[a], Mark C. Meacham[a], Joachim Lammel[c], Martin R. Broadley[a,*]

[a] School of Biosciences, University of Nottingham, Sutton Bonington Campus, Loughborough, LE12 5RD, UK
[b] Ministry of Agriculture and Food Security, Department of Agricultural Research Services, Lunyangwa Research Station, P.O. Box 59, Mzuzu, Malawi
[c] Yara International, Research Centre, Hanninghof, 48249 Duelmen, Germany

ARTICLE INFO

Article history:
Received 17 July 2011
Received in revised form 27 August 2011
Accepted 28 August 2011

Keywords:
Fertiliser subsidy
Food Security
Malawi
Micronutrients

ABSTRACT

Suboptimal dietary Se intake is widespread in Malawi due to low levels of plant-available Se in most soils and narrow food choices. The aim of this study was to determine the potential for biofortifying maize using Se-enriched fertilisers in Malawi. The response of maize to three forms of selenate-Se fertiliser was determined. Crops were treated with a liquid drench of $Na_2SeO_{4(aq)}$ (0–100 g Se ha^{-1}), a compound NPK + Se fertiliser (0–6 g Se ha^{-1}), or Se-enriched calcium ammonium nitrate (CAN + Se; 0–20 g Se ha^{-1}). Experiments with $Na_2SeO_{4(aq)}$ and NPK + Se were conducted at six field sites, and at a subset of three sites with CAN + Se, in 2008/09 and 2009/10 (i.e. 30 experimental units). The increase in grain Se concentration was approximately linear for all Se forms and application rates ($R^2 > 0.90$ for 27 of the 30 experimental units). On average, whole-grain Se increased by 20, 21 and 15 µg Se kg^{-1} for each gram of

An application of 5 g Se ha^{-1} to maize crops could increase dietary Se intake by 26–37 µg Se $person^{-1}$ d^{-1}

Using a long-term field experiment to assess the likely effect of soil management, and cropping patterns, on fertiliser Se uptake by maize and legumes

Treatment number	Crop(s)	Crop associates	Tillage practice	Residue management
1	Maize	Sole maize	Tilled	Crop residues Removed
2	Maize			Crop residues Retained
3	Maize		Minimum Tillage	
4	Cowpeas	Rotation		
	Groundnuts			
5	Maize			
6	Maize	Intercropping		
	Pigeon peas			
7	Maize			
	Cowpeas			
8	Maize			
	Velvet Beans			

Location: Long-term experiment, Chitedze, Malawi
Design: Complete randomized block design, 4 replicates

ELSEVIER

Geoderma

journal homepage: www.elsevier.com/locate/geoderma

Selenium biofortification of crops on a Malawi Alfisol under conservation agriculture

I.S. Ligowe[a,b], S.D. Young[c,*], E.L. Ander[d], V. Kabambe[a], A.D.C. Chilimba[b], E.H. Bailey[c], R.M. Lark[c], P.C. Nalivata[a]

[a] Lilongwe University of Agriculture and Natural Resources, Bunda Campus, P.O. Box 219, Lilongwe, Malawi
[b] Department of Agricultural Research Services, P.O. Box 30779, Lilongwe 3, Malawi
[c] University of Nottingham, School of Biosciences, Sutton Bonington Campus, Loughborough LE12 5RD, UK
[d] Centre for Environmental Geochemistry, British Geological Survey, Nottingham NG12 5GG, UK

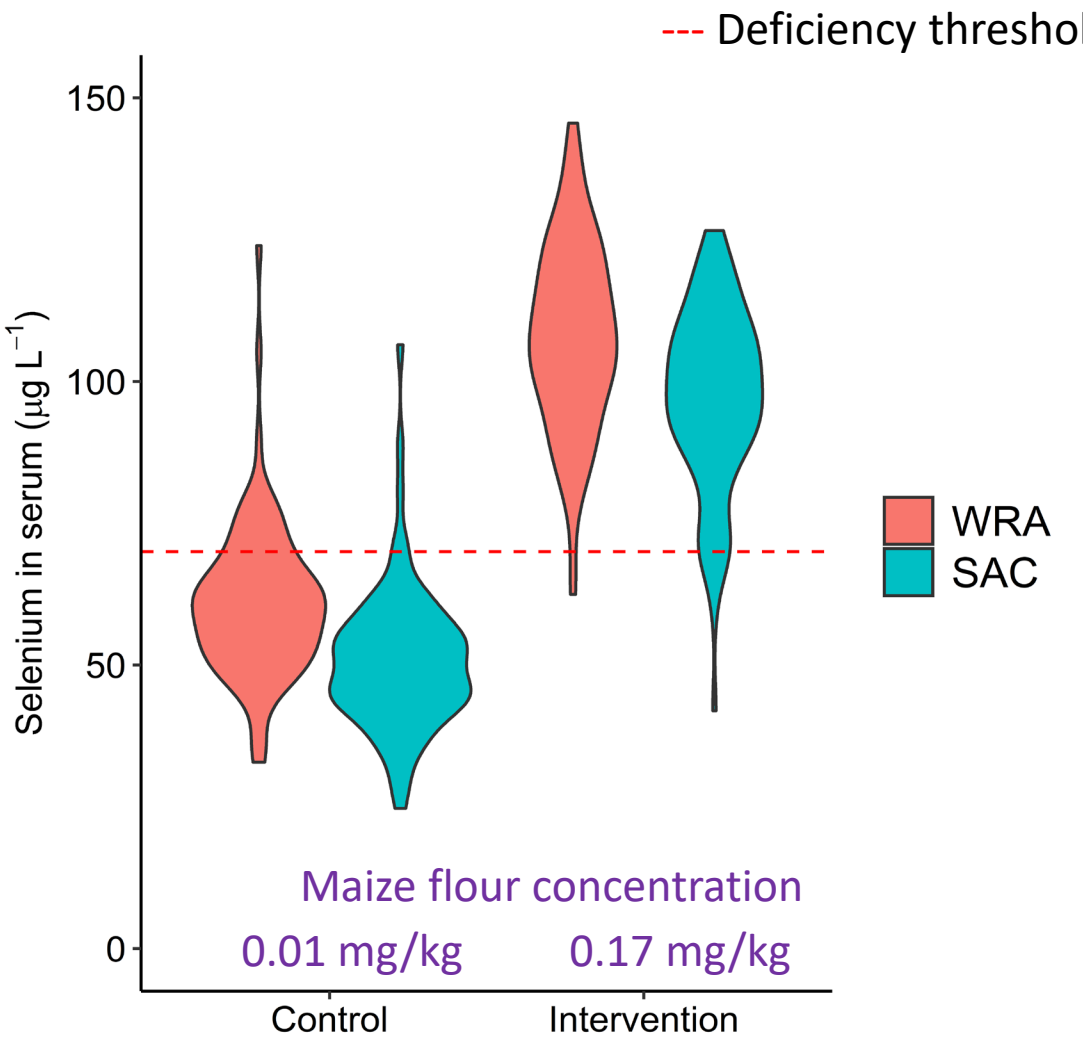
Using a long term field experiment to assess the likely effect of farmer soil management, and cropping patterns, on fertiliser Se uptake to maize and legumes

- A single application isotopically labelled Se of 20 g ha^{-1} was applied to each plot

Estimated dietary Se contribution of 51 - 64 µg day^{-1} as refined maize flour

- Average maize grain ^{77}Se was 217 ± 27 µg kg^{-1} in all maize treatments in the year of application.
- Concentrations declined to 0.7 – 3 µg kg^{-1} the following year: indicates no residual benefit.
- Different cropping systems and residue return to soil practices were not observed to affect fertiliser Se uptake to grain.
- Cowpea (400 µg kg^{-1}) and groundnuts (711 µg kg^{-1}) grain ^{77}Se exceeded that of maize, in single-cropping plots.
- Smaller concentrations (78 µg kg^{-1}) were measured in intercropped legume grain: these plants had poor growth / development

Se fortified maize flour trial in Malawian households (AHHA Trial)



frontiers in Nutrition
CLINICAL TRIAL
published: 06 January 2022
doi: 10.3389/fnut.2021.788096

Biofortified Maize Improves Selenium Status of Women and Children in a Rural Community in Malawi: Results of the Addressing Hidden Hunger With Agronomy Randomized Controlled Trial

OPEN ACCESS

At the end of the AHHA trial most maize grown with Se applied in fertilizer had adequate Se status, while most of the control group were deficient.

Conclusions

- Agronomic fortification of maize with Se applied in fertilizer is a feasible intervention to improve Se status in Malawi.

- In principle this could be implemented through the national Farm Input Subsidy Programme (FISP), if deemed to be economically and politically acceptable.


Thank you !
Global Symposium on Soils for Nutrition | 26-29 July 2022
GLOBAL SOIL PARTNERSHIP