Farming for food security

Probabilistic simulations of farm contribution to nutrition in southwest Uganda

C. W. Whitney[1,2,*], J. Gebauer[1], J. Bahati[3], Eike Luedeling[4]

[1] Rhine-Waal University of Applied Sciences, Kleve, Germany; [2] University Kassel, Witzenhausen, Germany; [3] Makerere University, Kampala, Uganda; [4]World Agroforestry Centre (ICRAF), Nairobi, Kenya & Center for Development Research, University of Bonn, Germany

*contact: cory.whitney@hsrw.eu

Introduction

- Uganda's high population growth rate and low average age exacerbate land scarcity, poverty, & food insecurity
- Southwest is ideal for farming: fertile soils, 1500-2000 mm annual rainfall, and mean annual temperatures of 12.5-30 °C
- Small scale homegardens (HG) are currently the source of most food in the region
- Ugandan agricultural authority (UA) aim to industrialize farming systems (Vision 2040)
- Robust science-based information for decision support is lacking
- Here we used Monte Carlo decision analysis to generate probabilistic simulation of the two scenarios

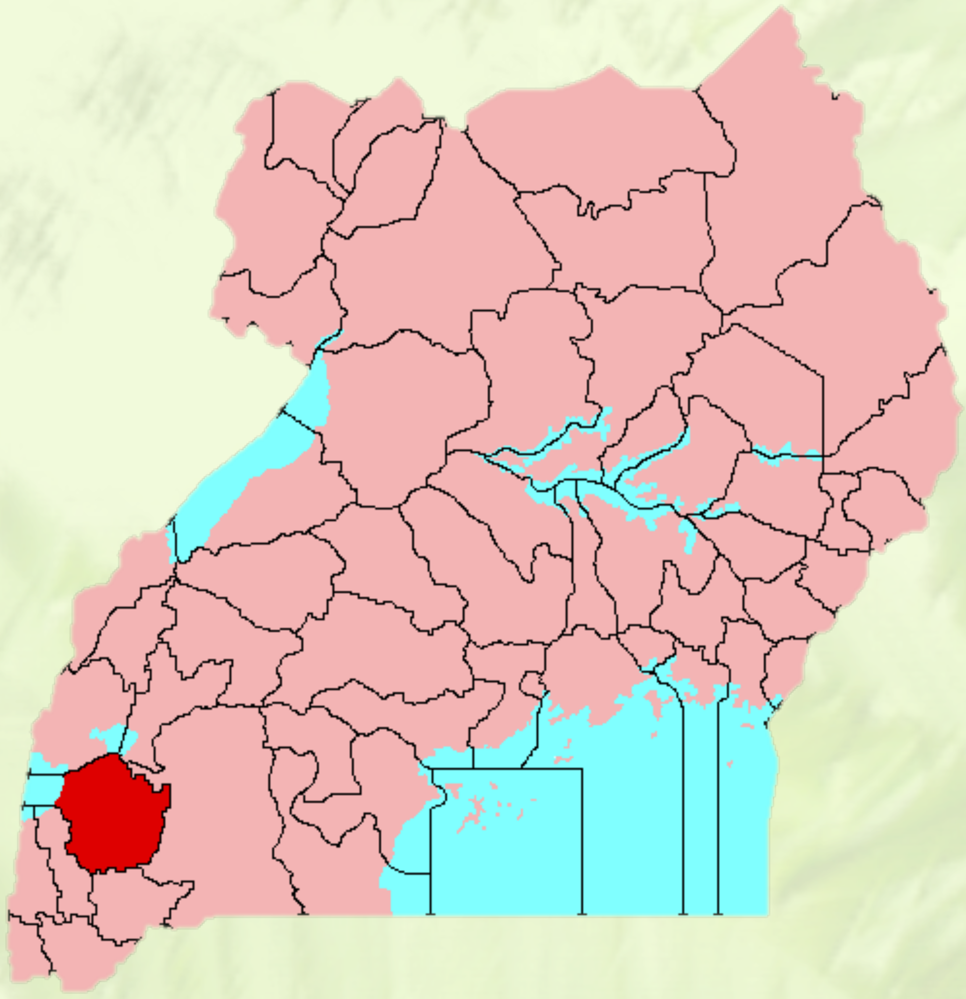


Figure 1. Greater Bushenyi Region of Uganda (UBOS 2013) developed in QGIS 2.0.1-Dufour

Figure 2. Three generations in hilltop homegarden Rubirizi, Uganda

Research Aims

- Compare total nutrient outputs of HG and UA
- Use decision analysis methods for probabilistic simulations of food nutritional implications of HG and UA

Model Parameters

- Compare total nutrient outputs: HG banana plantations intercropped with fruits and vegetables[1]; UA dominated by grains, tubers, cooking bananas, and legumes
- Monte Carlo simulation with 10,000 model runs
- Crops categorized by food group
- Partial least-squares regression (PLS) of Monte Carlo used as a knowledge gap identifying tool

Table 1. Basic statistics of model parameters: land area for food production

	Garden Area (m2)	HG percentage unused	UA percentage unused
Mean ± Standard deviation	1,880.27± 1,390.75	2.3±1.08	0.25±0.44
Coefficient of Variation	0.74	0.47	1.76

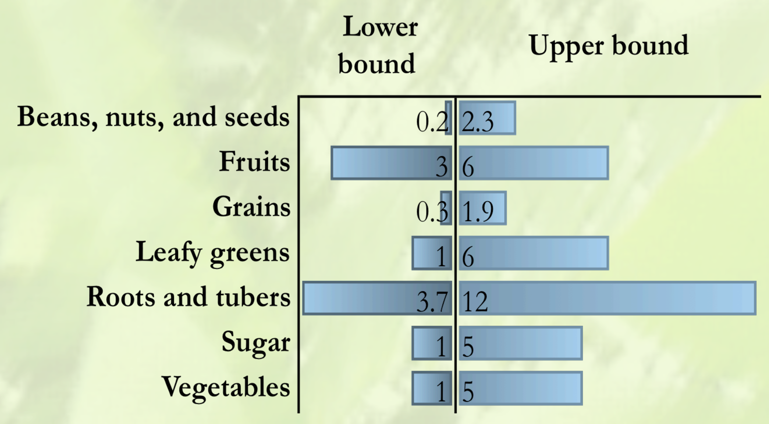


Figure 6. Upper and lower bounds of yields *ton/ha/yr*

- Land area (Table 1) from field surveys[1]
- Yield estimates (Table 2)
  - HG yield from field surveys[1]
  - UA = HG + 5-60% with chemical fertilizers
- Nutrient contribution[2]
  - based on yields (Table 3)

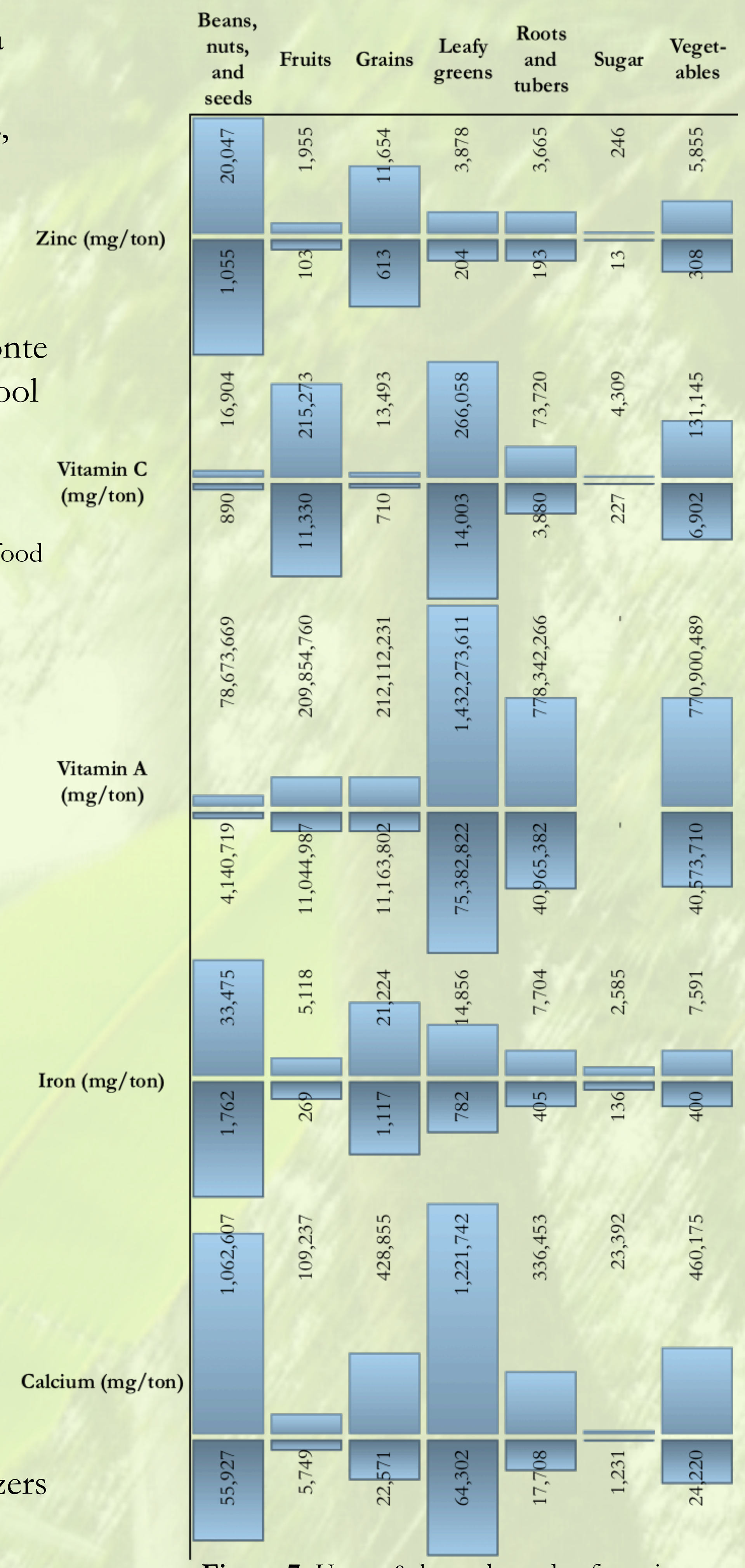


Figure 7. Upper & lower bounds of nutrients from yields

Results

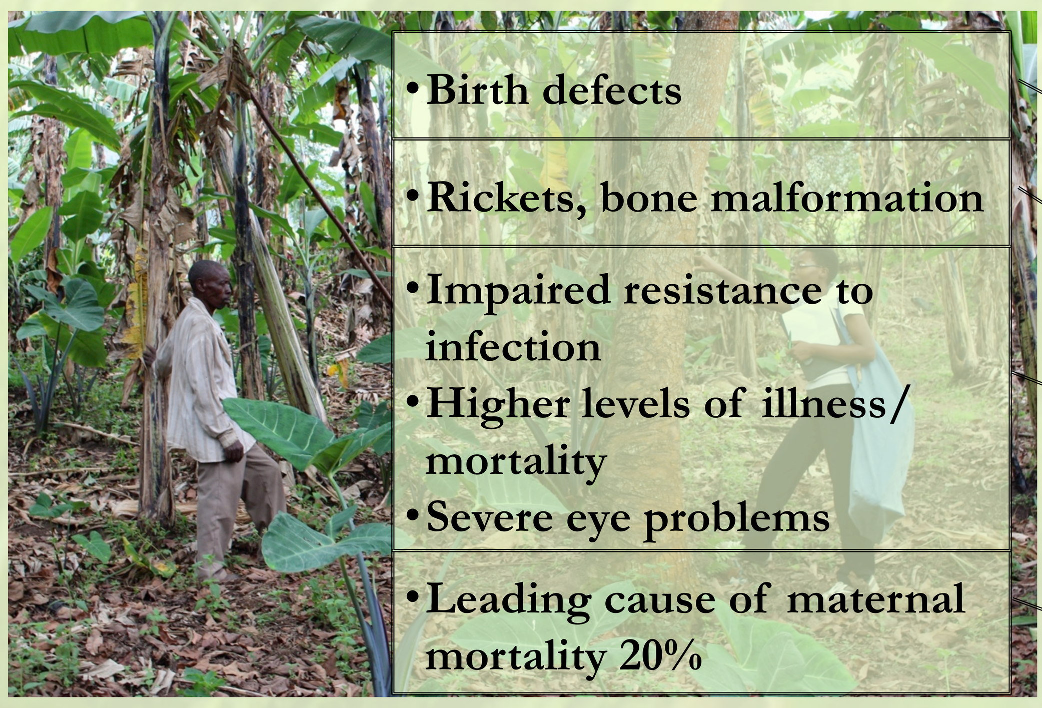


Figure 3. Typical multilayered tropical homegarden structure with a diversity of edible species.

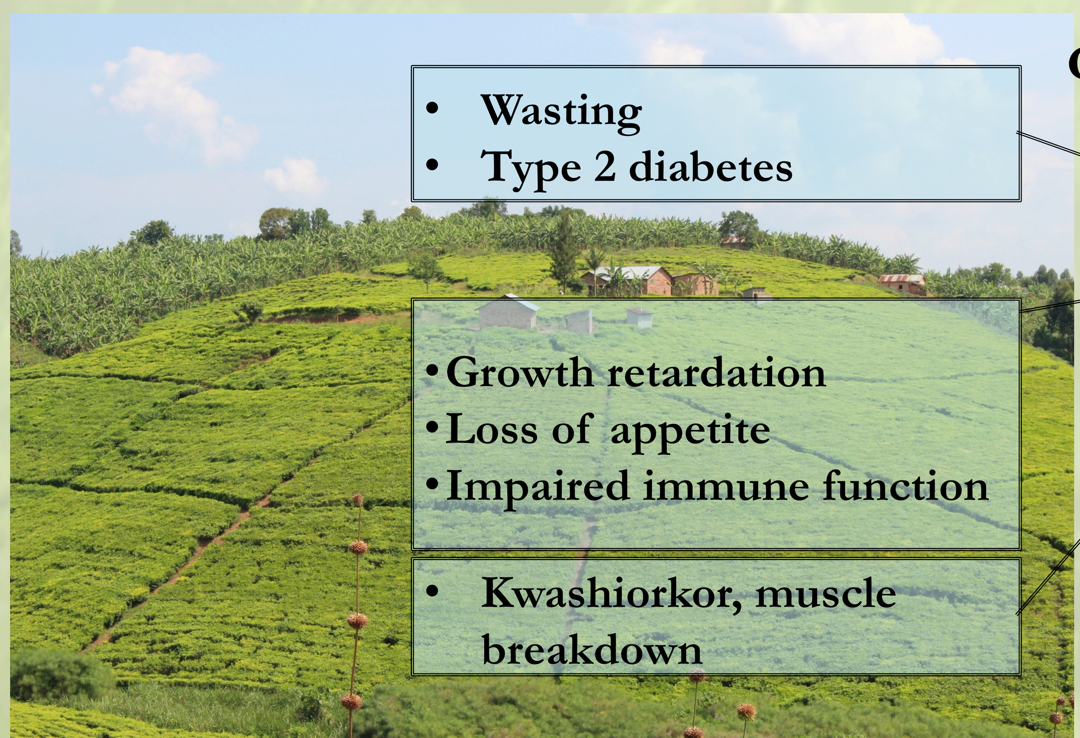
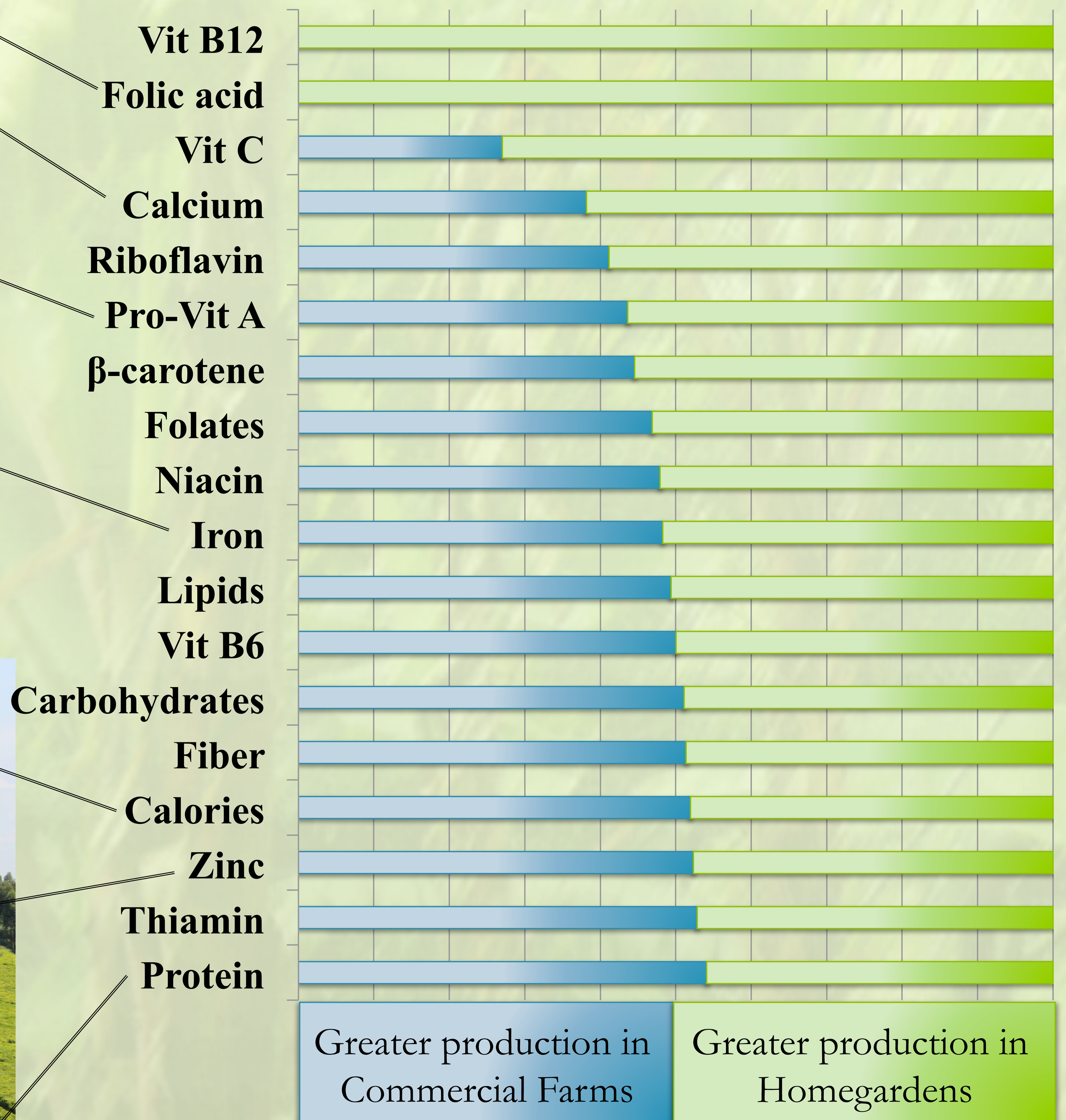


Figure 4. Typical monocropping system of tea and bananas in Bushenyi, Uganda.

Figure 5. Positive nutrient contributions HG & UA outputs Monte Carlo simulation means of model outputs



- HG outperformed UA in producing vitamin-C, calcium, vitamin-A, ß-carotene, vitamin B6, iron, and had folic acid and vitamin B12 whereas UA had none
- UA outperformed HG in producing protein, calories, and zinc

Discussion & Conclusions

- PLS analysis on model outputs suggests more roots & tubers yield data would improve certainty on nutrition

Critical points for the future of farming in the region:

- Vision 2040 should consider nutritional implications of agricultural systems:
  - Increase calorie, protein, and zinc production in HG
  - Diversify UA for sufficient nutrient production esp. folic acid, calcium, pro-vitamin A, and vitamin C

Figure 8. Transporting *Musa* sp. yields Kinoko, Rubirizi, Uganda

Figure 9. Drying of *Manihot esculenta* yields, Kashohe Kitome Forest, Uganda

Acknowledgements

RELOAD REDUCING LOSSES ADDING VALUE

Supported by the German Federal Ministry of Education and Research (BMBF) within the GlobE-RELOAD (031A247B), the Ugandan National Science foundation (A 477), the office of the President, Regional District Coordinators and Chief Administrative Officers of Bushenyi, Rubirizi, and Sheema and the Local Chairman surrounding Rutoto, Ishaka, and Bugongi, Uganda.

Literature

1. Whitney, C. W. & Gebauer, J. Species Diversity and Post-Harvest Practices on the Forest Edge Homegardens in Southwestern Uganda. *Tropentag 'Bridging the gap between increasing knowledge and decreasing resources'* 356 (2014).
2. Hotz, C., Abdelrahman, L., Sison, C., Moursi, M. & Loechl, C. *A Food Composition Table for Central and Eastern Uganda* (HarvestPlus, Washington, DC, 2012).