Variable Soils, Variable Fertilizer Quality, and Variable Prospects

Author: Michelson, Hope

Source: Tropical Conservation Science, 10(1)

Published By: SAGE Publishing

URL: https://doi.org/10.1177/1940082917720661

Tropical Conservation Science
Volume 10: 1–4

DOI: 10.1177/1940082917720661
journals.sagepub.com/home/trc
SAGE

Variable Soils, Variable Fertilizer Quality, and Variable Prospects

Hope Michelson[1]

Abstract

This article argues for research and policy emphasis on two often-ignored factors critical to increasing regional agricultural productivity in Sub-Saharan Africa: the presence of agronomically and economically important variability in farmer soils; and the capacity of existing agricultural input supply chains in the region to provide the types, quantities, and quality of agricultural inputs that farmers will need to increase yields and respond to market changes. Along with problems of credit access, market incentives, production risk, and infrastructure, understanding the specific soil nutrient limitations and needs of small farmers and building the capacity of agrodealers to provide the services farmers require will influence how the agricultural sector develops, who benefits, and who loses.

Keywords

fertilizer, quality, agrodealer, soil, policy

As urbanization, changing diets, regional economic integration, and upstream investment in processing and logistics are transforming agricultural markets in parts of Sub-Saharan Africa (Reardon, Timmer, Barrett, & Berdegué, 2003), two important lessons from these changes are coming clear: First, the process is already creating economic winners and losers among farmers; second, the design and implementation of services to support small farmer agricultural production will influence which farmers succeed and fail in the near future.

While agronomic factors such as climate, terrain, and water and access to roads, irrigation, and cellular phone networks critically affect production and transaction costs and influence participation in commercial agricultural markets (Aker & Mbiti, 2010; Barrett, 2008; Michelson, 2013), this article focuses on two related factors that have received less attention in the literature to date: the presence of agronomically and economically important variability in farmer soils; and the capacity of existing agricultural input supply chains to provide the types, quantities, and quality of inputs that farmers will need to improve productivity and respond to market changes.

Soil Variability

Farm soils of SSA exhibit substantial variability within subnational regions, across villages within a region, and even within villages (Harou et al., 2017; Tjernström, 2015). For example, Figure 1 presents soil nutrient limitations across the primary maize plots of 1,001 randomly selected farmers located in 47 villages in Tanzania's Morogoro District. Within these 120 square miles, an area the size of Omaha, Nebraska, fields exhibit eight unique types of nutrient limitation. The most common deficiency type, soils limited in both nitrogen (N) and sulfur (S), was found on 63% of fields. Other notable types include N limited (3% of the measured fields) and N, P (phosphorous), K (potassium), and S limited (5%). Analysis of variance indicates that the village where each plot was located explained 36% of soil electrical conductivity. Electric conductivity (EC) is a measure which corresponds to soil properties related to overall crop productivity including texture, cation exchange capacity, and organic matter; EC complements the nutrient limitation assessments. Even so, important differences exist in

[1]Department of Agricultural and Consumer Sciences, University of Illinois at Urbana-Champaign College of Liberal Arts and Sciences, IL, USA

Received 29 May 2017; Accepted 30 May 2017

Corresponding Author:
Hope Michelson, Department of Agricultural and Consumer Economics, University of Illinois at Urbana-Champaign College of Agriculture, Consumer, and Environmental Sciences, Urbana, IL 61801-3693, USA.
Email: hopecm@illinois.edu

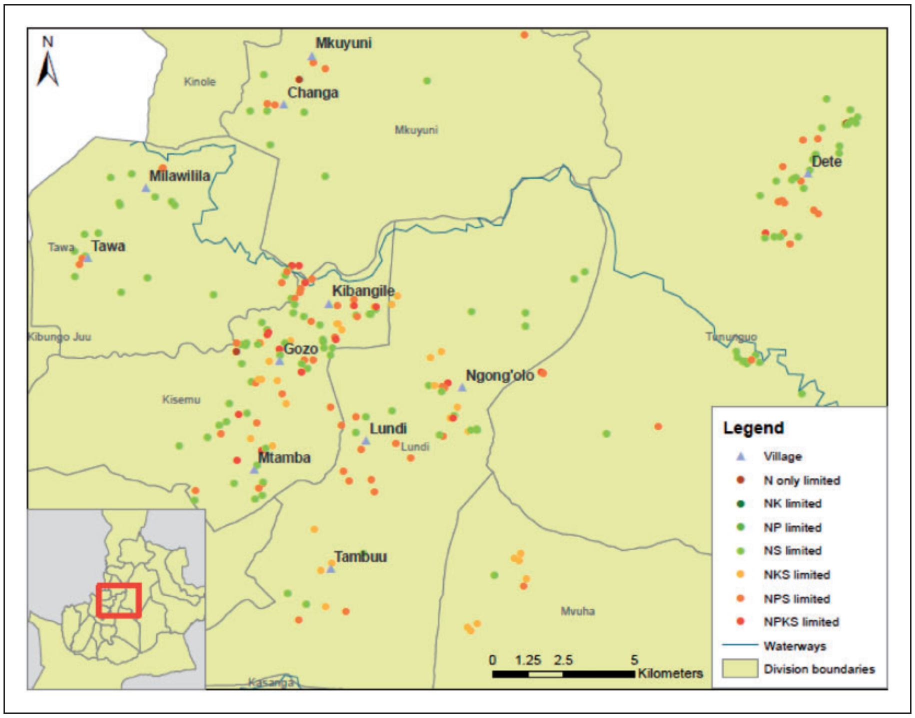

Figure 1. Nutrient limitations measured on 1,100 small farmer maize plots in Morogoro District, Tanzania (from Harou et al., 2017). Individual farmer fields appear as dots and corresponding village names are labeled on the map.

the degree to which location can account for the measured soil parameters. Although village cluster, for example, explains 44% of the variance in available nitrate, it explains only 0.38% of the field's measured active carbon and only 2% of the Sulfur. Similar spatial variation is found across plots tested in Central Malawi (Maertens & Michelson, 2017).

Considerable within-region variance in soil nutrient deficiencies is important economically and agronomically for three primary reasons. First, blanket nutrient application recommendations made by governments for entire regions or countries may not meet the needs of many growers. For example, though the Tanzanian government's current regional fertilizer recommendation for Morogoro advises the application of N and P, we find that less than 1% of the fields tested in our Morogoro study are both N and P limited; instead, S is a critical constraint for most fields and completely absent from the government recommendations. Second, research suggests that rates of adoption of agricultural technologies and new market options correspond to heterogeneity in growing condition within farm communities because it influences how farmers learn from one another (Munshi, 2004). Extension networks should be attentive to underlying soil variability as areas characterized by high within-community variability will have more own-farm experimentation by farmers and less social learning about new technologies, while more homogeneous areas can be expected to have more learning from neighbors' experience (Tjernström, 2015).

The presence of within-region soil heterogeneity in parts of Sub-Saharan Africa means that it will be especially important to have capable agricultural input supply chains to deliver the type, quantity, and quality of inputs that farmers need. If all farmers within a region required the same fertilizers, the same blends, and the same advice, the challenge for input supply chains would be different and, likely, easier. Instead, evidence of considerable variation in growing conditions considerably expands the potential role of agrodealers, especially in regions where public extension networks have limited reach, financial support, and capacity.

Limited Capacity of Agricultural Input Suppliers

The success of agricultural commercialization and modernization efforts in Sub-Saharan Africa will depend on the functioning of upstream agricultural factor markets, especially the capacity and willingness of agrodealers to meet the needs of small farmers for credit and agricultural inputs.

Evidence of considerable farm soil variability, and of associated variation in soil nutrient deficiencies, means that in some regions, farmers require agricultural inputs and blends of fertilizer that input dealers currently do not provide. Moreover, because of credit constraints, farmers are also likely to acquire inputs in smaller quantities than the 50 kg and 25 kg bags of mineral fertilizer that are currently packaged by manufacturers and stocked by input dealers.

Ideally, input dealers would help solve a combination of established problems related to farmer liquidity (by selling inputs on credit, for example) as well as new problems related to underlying agronomic variation, including field-level soil testing services, and the sourcing, stocking, and recommending of a range of nutrient blends appropriate for the farmers in their region. Agrodealers, especially rural agrodealers, would serve as responsive intermediate links between blenders and farmers, and between government and fields. The fact that agrodealers are not currently engaged in these roles suggests the presence of one or multiple market failures but more research should focus on this critical sector to better understand its limitations. Although available evidence suggests that input dealer networks lack the capacity to function in such a role, addressing that problem could be an immediate objective in a pragmatic and affordable initiative to raise regional agricultural productivity.

Compounding the problem: Evidence from the region suggests that supply chains have limited access to capital to finance adequate storage and logistics, raising doubts as to whether inputs dealers, given their current scale and configuration, can provide the array and quality of nutrients that nearby small farmers require. For example, agrodealers sell mineral fertilizers of compromised quality. Fairbairn et al. (2017) find that on average 10% of the nitrogen is missing (relative to the manufacturer standard printed on the bag) from samples of Calcium ammonium nitrate (CAN), Diammonium phosphate (DAP), and urea purchased from input dealers in Morogoro District, Tanzania, in 2015–2016. A 10% nitrogen deficit is considerable relative to the United States, where nutrient content of fertilizer tightly conforms to the manufacturer standard. It is also considerable in an economic sense; assuming a linear crop response to nitrogen application, the application of fertilizer missing nitrogen decreases production and lowers the yield response. For example, based on World Bank estimates, a Tanzanian farmer applying fertilizer short 10% nitrogen will produce 6.75 kg of maize per unit of mineral fertilizer applied rather than the predicted 7.5 kg average, decreasing net profits per kilo of fertilizer applied by 44% (Fairbairn et al., 2017).

Uganda exhibits similar quality problems for mineral fertilizers (Bold, Kaizzi, Svensson, & Yanagizawa-Drott, 2015) and glyphosate (Ashour, Billings, Gilligan, Hoel, & Karachiwalla, 2016). Moreover, Fairbairn et al. (2017) find evidence of degradation in physical quality characteristics of fertilizer (mineral fertilizer that is clumpy, powdery, and discolored); they also find that suppliers with limited credit access and poor storage are also more likely to sell mineral fertilizer of degraded visual quality and compromised content. Fairbairn et al. (2017) argue that while nutrients may be missing from mineral fertilizer due to product adulteration, the product also deteriorates from environmental causes related to poor supply chain management: for example, volatilization of nitrogen from urea due to poor storage conditions and open bags. Distinguishing between malfeasance and degradation due to resource- and capacity-limited supply chains is obviously critical for policy.

Conclusion

Small farmer participation in emerging market opportunities will require effective attention to problems that we have known for a long time: problems with credit access and infrastructure, with transport costs and market incentives, and with mechanisms of product aggregation and risk mitigation. We must also understand the scope and importance of newly recognized challenges, most notably within-region soil variation and consequences for farm productivity and farm management recommendations; and the constraints and options faced by agricultural input dealers in providing the needed resources to small farmers.

Declaration of Conflicting Interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

References

Aker, J. C., & Mbiti, I. M. (2010). Mobile phones and economic development in Africa. *The Journal of Economic Perspectives*, *24*(3): 207–232.

Ashour, M., Billings, L., Gilligan, D., Hoel, J. B., & Karachiwalla, N. (2016). *Do beliefs about agricultural inputs counterfeiting correspond with actual rates of counterfeiting? Evidence from Uganda* (Vol. 1552). Washington, DC: International Food Policy Research Institute.

Barrett, C. B. (2008). Smallholder market participation: Concepts and evidence from Eastern and Southern Africa. *Food Policy*, *33*(4): 299–317.

Bold, T., Kaizzi, K., Svensson, J., & Yanagizawa-Drott, D. (2015). *Low quality, low returns, low adoption: Evidence from the market for fertilizer and hybrid seed in Uganda*. London, England: Centre for Economic Policy Research.

Fairbairn, A., Michelson, H., Ellison, B., & Manyong, V. (February 2016). But are they lemons: Fertilizer quality and farmer perceptions in Tanzania. Draft.

Harou, A., Madajewiz, M., Magomba, C., Michelson, H., Palm, C., & Tschirt, K. (2017). *The effect of soil information on small* *farmer agricultural investment and productivity* (Working paper). Chicago, IL: University of Illinois.

Maertens, A., & Michelson, H. (2017). *Learning about integrated soil fertility practices: Evidence from a RCT in Malawi* (Working paper). Chicago, IL: University of Illinois.

Michelson, H. C. (2013). Small farmers, NGOs, and a Walmart world: Welfare effects of supermarkets operating in Nicaragua. *American Journal of Agricultural Economics*, *95*(3): 628–649.

Munshi, K. (2004). Social learning in a heterogeneous population: Technology diffusion in the Indian green revolution. *Journal of Development Economics*, *73*(1): 185–213.

Reardon, T., Timmer, C. P., Barrett, C. B., & Berdegué, J. (2003). The rise of supermarkets in Africa, Asia, and Latin America. *American Journal of Agricultural Economics*, *85*(5): 1140–1146.

Tjernström, E. (2015). *Signals, similarity and seeds: Social learning in the presence of imperfect information and heterogeneity*. Unpublished manuscript, University of California, Davis.