

Regional Network of Agricultural Policy Research Institutes



Road Map Towards The Malabo Declaration:

Increasing Smallholder Farm Productivity through Improved Farm Management Practices



The importance of a holistic approach to sustainable agricultural productivity growth

The FAO's "Year of Soils" highlights a growing recognition that soil degradation is a massive problem that is threatening the sustainability of farming systems throughout the world. In most of sub-Saharan Africa, it is increasingly clear that goals related to agricultural input intensification and higher levels of agricultural productivity will require much greater attention to sustainable land and soil fertility management practices.

Agricultural intensification's impact on soil

Numerous studies point to unsustainable land management practices in densely populated rural areas of Africa where land pressures have contributed to soil degradation (e.g., Stoorvogel and Smaling, 1990; Drechsel et al, 2001; Tiftonell and Giller, 2012)¹. Continuous cultivation of existing plots would not necessarily pose problems for sustainable intensification if soil quality were maintained or improved over time. Instead, loss of micronutrients and soil organic matter are creating unique challenges: the soil cannot be improved by conventional inorganic fertilizers application and the depleted soil tends to depress the efficiency of inorganic fertilizer in contributing to crop output (Shaxson and Barber, 2003; Marenja and Barrett, 2009; Vanlauwe et al, 2011). Giller et al (2006) and Tiftonell et al (2007) conclude that many smallholder farmers are largely unable to benefit from the current yield gains offered by plant genetic improvement due to farming on depleted soils that are non-responsive to fertilizer application. The problem of soil mining has the classic elements of a "social trap" (Platt, 1973), in which people adopt behaviours consistent with their short-term livelihood objectives, but which produce unsustainable and potentially disastrous long-term consequences (Jayne et al, 2014). Rising rural population density and associated land pressures are important underlying drivers of these processes, yet they are within the scope of policy to ameliorate (Snapp et al, 2010; Powlson et al, 2011).

Key Messages

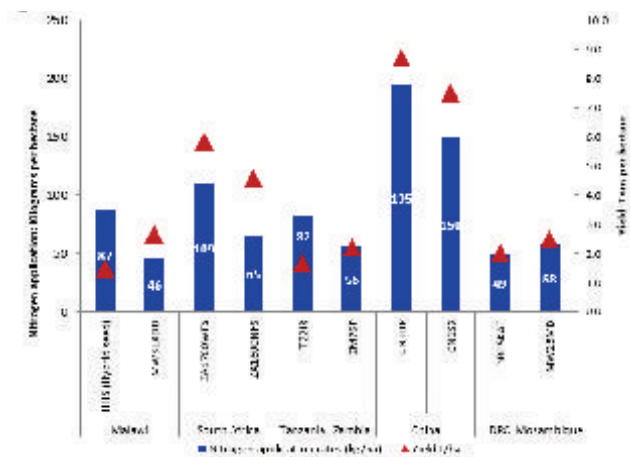
- The sub-Saharan smallholder farmers' productivity challenge is multi-dimensional in nature; therefore, the solution needs to be multifaceted.
- Population growth in densely populated smallholder farming areas is contributing to growing land pressures and unsustainable forms of agricultural intensification.
- Loss of micronutrients and soil organic matter depress the efficiency of inorganic fertilizer in contributing to crop output.
- Despite the combined use of fertilizer and hybrid seeds, maize yield levels are low for many African farms when compared to Chinese smallholder farms.
- Improved farm management techniques can mitigate the impact of soil degradation, contribute to efficient use of fertilizer, and promote productivity growth for smallholder agriculture in Africa.

¹ Common forms of soil degradation include declining nutrient balances ("soil mining"), erosion and loss of topsoil, acidification, and loss of organic matter. An important contrasting study by Tiffen et al (1994) argues that population pressures between 1950 and 1980 in the Machakos District of Kenya induced households to make land-augmenting investments that contributed to sustainable intensification. However, in a more recent revisit to these same areas in 2014, Kyalo and Muyanga (forthcoming) note that population densities during the period studied by Tiffen et al., were generally below 400 persons per km², that densities of some divisions have risen well over 800 km², and that there is now widespread evidence of soil degradation and unsustainable forms of intensification.

ReNAPRI's study on improved farm management and productivity

The Regional Network of Agricultural Policy Research Institutes (ReNAPRI) conducted a study of the determinants of variations in maize production costs on various proto-typical farms in Kenya, Tanzania, Malawi, the Democratic Republic of the Congo, Zambia, Mozambique and South Africa (ReNAPRI, 2014). The study found that despite the combined use of fertilizer and hybrid seeds, maize yield levels were low for many African farms when compared to Chinese smallholder farms.²

Comparison of nitrogen application and yield levels from ReNAPRI study(1000 tonnes)



Source: ReNAPRI

Notes:

| | |
|-----------|---|
| HHS | Household Survey Small-scale farm |
| MW3LADD | Malawi, 3 ha, Lilongwe |
| ZA1700WFS | South Africa, 1700 ha, Western Free State |
| ZA1600NFS | South Africa, 1600 ha, Northern Free State |
| TZ2IR | Tanzania, 2 ha, Iringa |
| ZM7SP | Zambia, 7 ha, Kalomo |
| CN1HP | China, 1 ha, |
| CN1SX | China, 1 ha, |
| DRC5KAT | Democratic Republic of the Congo, 5 ha, Katanga |
| MW25MD | Mozambique, 25 ha, Moamba |

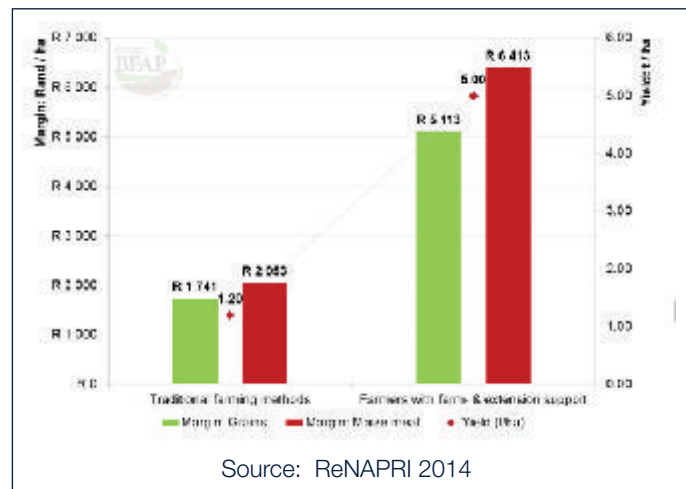
For example, national survey data from Malawi indicates an average nitrogen application rate of approximately 87kg per hectare. However, maize yields are significantly lower when compared to South African commercial and Chinese small-scale maize producers. The study recommended more research was needed to understand factors affecting maize response to inorganic fertilizer and concluded that specific farm management practices that contribute to fertilizer use efficiency should be integrated holistically into agricultural extension programs alongside the use of fertilizer (ReNAPRI, 2014).

To further investigate this conclusion, a case study³ in South Africa tested the impact of farmer training alongside fertilizer application (ReNAPRI, 2014). The study compared the productivity of two small-scale maize farms operating within the KwaZulu-Natal Province. One farm used traditional methods of farming and fertilizer application. The other used fertilizer, while also participating in GrainSA's mentorship program. The mentoring program included training on: lime application, land preparation, fertilizer use, and plant protection. The farm with the mentoring training component produced more than four times that of the farm using traditional methods⁴; thereby demonstrating the positive impact of farm management on farm productivity.

² The Agri-Benchmark is an international network which utilizes a consistent methodology for measuring production costs, coordinated by the agri benchmark Centre at Thünen-Institute in Braunschweig, Germany.

³ Conducted in partnership with BFAP and GrainSA.

Difference in yield and gross margin per hectare for traditional farming versus the farm management protocols recommended by GrainSA



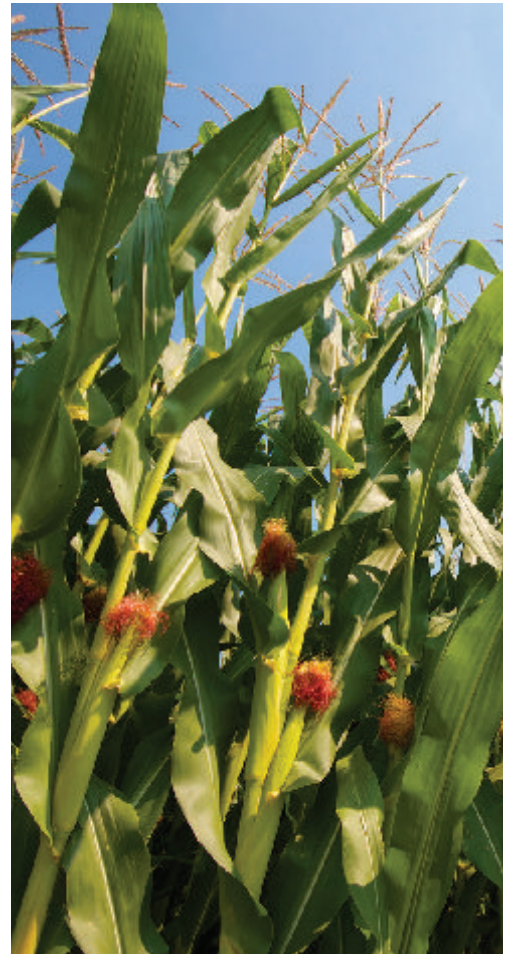
Source: ReNAPRI 2014

Working hand-in-hand: fertilizer and farm management

The smallholder farmers' productivity challenge is multi-dimensional in nature. To address these challenges the solution needs to be multifaceted. Increased use of inorganic fertilizer is indeed crucial for achieving agricultural productivity growth and food security in Africa. Yet soil degradation is increasingly recognized as depressing many farmers' ability to generate much additional production from the use of fertilizer, which then depresses farmers' willingness to continue to use it. Improved farm management techniques can mitigate the impact of soil degradation, contribute to efficient use of fertilizer, and promote productivity growth for smallholder agriculture in Africa.



⁴ The mean yield for the improved farming system was 5 t/ha versus 1.2 t/ha for the traditional system.



Suggested Readings:

Drechesel, P., L. Gyiele, D. Kunze, and O. Cofie (2001). Population density, soil nutrient depletion, and economic growth in sub-Saharan Africa. *Ecological Economics* 38, 251-258.

Giller, K.E., E.C. Rowe, N. de Ridder, and H. van Keulen (2006). Resource use dynamics and interactions in the tropics: scaling up in space and time. *Agricultural Systems* 88, 827.

Jayne, T.S., F. Meyer, and L.N. Traub (2014). Africa's Evolving Food Systems - Drivers of change and the scope for influencing them. International Institute for Environment and Development. Working Paper.

Kyalo, D. and Muyanga, M. (2014). Community response to population pressure in Kisii and Machakos counties: Farmers' perspectives. International development working paper. Michigan State University, East Lansing.

Marenja, P. and Barrett, C. (2009). State-conditional Fertilizer Yield Response on Western Kenyan Farms. *American Journal of Agricultural Economics*, 91(4): 991-1006.

Platt, J. (1973). Social traps. *American Psychologist* 28(8) 641-651.

Powlson, D., P. Gregory, W. Whalley, J. Quinton, D. Hopkins, A. Whitmore. (2011). Soil Management in relation to sustainable agriculture and ecosystem services. *Food Policy*, 36 (2011), S72-S87.

ReNAPRI. (2014). 1st Annual Agricultural Outlook: 2014-2023: Anticipating and responding to the region's policy challenges in the decade ahead. Available online: <http://www.renapri.org>

Shaxson, F. and R. Barber. 2003. Optimizing Soil Moisture for Plant Production: The significance of soil porosity. *Soils Bulletin* 79, Rome: Food and Agriculture Organization of the United Nations.

Snapp, S., M. Blackie, R. Gilbert, R. Bezner-Kerr, G. Kanyama-Phiri. (2010). Biodiversity can support a greener revolution in Africa. *Proc. Natl. Acad. Sci*, 107, 20840-20845. Doi: 10.1073/pnas.1007199107.

Stoorvogel, J.J. and Smaling, E. (1990). Assessment of soil nutrient depletion in sub-Saharan Africa: 1983-2000. Nutrient balances per crop and per land use system. Report No. 28, vol. 2. Winand Staring Center, Wageningen.

Tiffen, M., M. Mortimore, and F. Gichuki (1994). More people less erosion: environmental recovery in Kenya. John Wiley, London.

Tittonell, P. and Giller, K. (2012). When yield gaps are poverty traps: the paradigm of ecological intensification in African smallholder agriculture. *Field Crops Research*, 143(1) 76-90.

Tittonell, P., B. Vanlauwe, N. de Ridder, K. Giller (2007). Nutrient use efficiencies and crop responses to N, P, and manure applications in Zimbabwean soils: Exploring management strategies across soil fertility gradients. *Field Crop Research*, 100: 348-368.

Vanlauwe, B., J. Kihara, P. Chivenge, P. Pypers, R. Coe, J. Six. 2011. Agronomic use efficiency of N fertilizer in maize-based systems in sub-Saharan Africa within the context of integrated soil fertility management. *Plant Soil*, 339: 35-50.



Regional Network of Agricultural Policy Research Institutes in East and Southern Africa

Secretariat at the Indaba Agricultural Policy Research Institute, Lusaka Zambia
Please direct enquiries to the Chairman,

Mr. Chance Kabaghe
Email: chance.kabaghe@iapri.org.zm

Funding for the underlying research provided by :

Feed the Future, USAID, IWMI, and The Bill & Melinda Gates Foundation.

We recognize the contributions from researchers in ReNAPRI:

1. The Institute of Social and Economic Research (IRES), University of Kinshasa, Democratic Republic of Congo;
2. Tegemeo Institute of Agricultural Policy and Development, Egerton University, Kenya;
3. Centre for Agriculture Research and Development (CARD), Bunda College, Malawi;
4. The Research Center for Agricultural and Food Policies and Programmes (CEPPAG), Eduardo Mondlane University, Mozambique;
5. Bureau for Food and Agricultural Policy (BFAP), Universities of Pretoria and Stellenbosch, South Africa;
6. Department of Agricultural Economics and Agri-business, Sokoine University of Agriculture (SUA), Tanzania;
7. Indaba Agricultural Policy Research Institute (IAPRI), Zambia.