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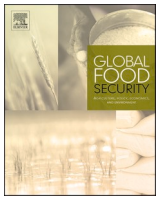

Perspective

The Food Security Conundrum of sub-Saharan Africa

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ABSTRACT

National food security in countries of sub-Saharan Africa requires an abundant supply of cheap and nutritious food for the burgeoning population. At the same time agriculture is a major contributor to the balance of payments for African economies. So agricultural production in Africa needs to increase strongly to meet the demands of both national and international markets. Yet fragmentation of land due to population pressure in rural areas, and the low prices farmers are paid for their produce, mean that in many rural areas in sub-Saharan Africa the farms are already too small to provide food security or a living income for the household. There is a high dependency on off-farm income and little incentive to intensify production. Thus rural households are often 'reluctant' farmers, lacking resources or the economic incentives to invest in agriculture. The conundrum that must be addressed is how to provide cheap, nutritious food to feed the growing urban and rural populations while creating incentives to stimulate increased agricultural production. This will require major transformations of the smallholder farming systems alongside creation of alternative employment.

1. Introduction

Achieving Sustainable Development Goal 2 – Zero Hunger – is arguably one of the most important and difficult challenges faced by mankind. Central to Agenda 2030 is the idea of "no-one left behind" (United Nations, 2015), building on the foundation of "The Future We Want" laid by the Rio+20 Earth Summit (United Nations, 2012). The SDGs are aspirational – and inspirational – goals which focus on the need for transformation to achieve sustainable development. Far more than step-wise incremental progress is required to address the scale of the problems.

Much current discussion on SDG 2 focuses on Africa which faces unprecedented population growth, against a backdrop where the continent faces particularly severe impacts of climate change (Niang et al., 2014). There is uncertainty as to how serious the food insecurity situation is in Africa given a general lack of confidence in the production statistics (cf. Jerven, 2013). Nevertheless, some broad trends are clear. The prevalence of undernourishment in Africa rose from 17.6% of the population in 2014 to 19.1% in 2019, more than twice the world average and highest of all regions of the world (FAO et al., 2020). By 2030, sub-Saharan Africa's population will rise from its current 1.07 billion to 1.40 billion and may reach 3.78 billion by the end of the century (United Nations, 2019). Africa has a very young population, with 41% under 15 years and a further 19% in the 15–24 years range. This means that even if growth rates are curbed immediately more than half of this projected increase will still occur (United Nations, 2017). Even the recent study of Vollset et al. (2020), which finds that current projections of the global population are overestimated, suggests the population of sub-Saharan Africa will reach 3.07 billion by 2100. Sub-Saharan Africa is the region of the world most at risk of food insecurity given current dependence on cereal imports, the rapid rate of population growth and stagnant agricultural productivity (van Ittersum et al., 2016).

SDG 2 is not only about reducing hunger. It also aims to ensure food security and improved nutrition and to do this through promoting sustainable agriculture. The triple burden of malnutrition – undernutrition, obesity and micronutrient deficiency – occur side-by-side. Addressing these requires not only an increase in food production but also major advances in access to affordable and nutritious food, and education and behavioural change regarding diets. Sustainable agriculture is central to achieving SDG 2, and as some 70% of households depend on agriculture for a large part of their livelihood, SDG 2 is inextricably linked with SDG 1 which aims to end poverty in all its forms (United Nations, 2015). So what are the prospects of achieving SDG 2 in Africa? In the remainder of this article I sketch the opportunities and constraints – and the conundrum faced in addressing these two interacting goals simultaneously.

2. The opportunity: large yield gaps

Although agricultural production has increased substantially in sub-

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Saharan Africa over the past decades, this has largely been due to cultivation of more land rather than increases in land productivity (Sanchez, 2002). A notable exception is Ethiopia where statistics suggest a remarkable – perhaps too good to be true – increase in productivity since the Government committed to their Agricultural Growth Plan (Abate et al., 2015; van Dijk et al., 2020). The large gaps between current productivity in Africa and the yields that farmers could achieve point to a major opportunity to increase food production (Tittonell and Giller, 2013; van Ittersum et al., 2016).

In 2004 Kofi Annan[1] called for a uniquely African Green Revolution based on the widely-held belief that proven technologies were available that could improve agricultural productivity. This ambitious vision needed to address hunger, nutrition, poverty, soil health and infrastructure and should take root within the rich diversity of the African continent in terms of history, culture and agroecological conditions (soils and climate). The concern with productivity enhancement was incorporated into the notion of sustainable intensification (Garnett et al., 2013; Vanlauwe et al., 2014), a central tenet of which is to avoid further expansion of cultivated land while ensuring environmental sustainability of more intensive production. However, despite some localised successes, the African Green Revolution has failed to take off. While the diversity of contexts means that generalisations are dangerous, in the next section I consider why it continues to prove so difficult to close yield gaps in SSA.

3. Agronomic and farm size constraints to enhancing productivity

Although African farmers work some of the oldest land surfaces on the planet, with heavily leached, nutrient-poor soils, not all soils are infertile. Deposition of alluvium along rivers and uplifting of land due to volcanic activity created younger, more fertile soils, as seen, for example in the highlands of the East African Rift. These inherently fertile soils combined with bimodal rainfall have been densely-populated and cropped intensively for more than a century (Crowley and Carter, 2000). Intensive cultivation without fallowing of the land and with few inputs has exhausted the soil nutrient reserves, and led to the paradoxical situation where some of the potentially most productive environments are also the most strongly depleted of nutrients.

From an agronomic perspective, poor soil fertility is the primary factor that limits agricultural productivity in sub-Saharan Africa (Sanchez, 2002; Sanchez and Swaminathan, 2005). Even in the dry savannas of the Sahel, agricultural productivity is nutrient limited (Penning de Vries and Ditèye, 1991). The critical shortages of nutrients within African farming systems indicate that mineral fertilizers are needed (Buresh et al., 1997; Giller et al., 1997). Equally, it is recognised that management of soils solely using mineral fertilizers without attention to maintenance of soil organic matter cannot sustain crop production. This has led to the paradigm of integrated soil fertility management (ISFM) (Vanlauwe et al., 2010) that recognises the need for efficient nutrient recycling and use of crop residues and organic manures together with judicious use of mineral fertilisers. ISFM further recognises that good crop varieties and agronomic management are essential to achieving efficient use of nutrients and increased productivity. Intercropping and rotations with grain legumes are a key component within ISFM, enabling capture of atmospheric nitrogen through their symbiosis with rhizobia (Giller, 2001; Vanlauwe et al., 2019). Legumes also offer the potential for both diversification of cropping systems and intensification, giving extra benefits in terms of human nutrition, suppression of pests and diseases and enhancing yields of other crops in rotations (Franke et al., 2018). So, from a technical standpoint, can we conclude that the agronomists have done their job? We know how to close yield gaps – this has been demonstrated many times in farmers' fields across SSA. But the poor institutional environment, coupled with land constraints which I consider below, conspire to make investment of finances and labour in agricultural production a less attractive option for smallholder farmers than seeking other forms of income.

Smallholder farms predominate throughout sub-Saharan Africa and produce the vast majority of the food (Dixon et al., 2001). Farming systems are highly diverse reflecting climate, soils and cultural preferences. In many places high population density, with concomitant pressure on land leads to small farms, and low capital availability (Jayne et al., 2014a; Muyanga and Jayne, 2014). Using data from 13,000 rural households across 93 locations in 17 countries of sub-Saharan Africa we found that a staggering 37% of the households were food insecure – unable to achieve household food security even if all forms of income were converted into calories (Frelat et al., 2016). Food insecurity is an important dimension of poverty, and across these 13,000 households it was associated with more household members, limited livestock and land holdings, which together explained 72% of the variability in food availability. Market access and off-farm employment were also important (Frelat et al., 2016). Even within a single locality there is huge diversity in food insecurity among households: Wichern et al. (2018) found as much diversity in food insecurity in each region of Uganda as across the whole of the country. This suggests that food insecurity is everywhere, meaning that targeting cannot be restricted to particular regions. Further, poor farmers often have the poorest soils (Giller et al., 2011; Franke et al., 2019) – so small farms and poor soils become double poverty traps.

4. The Food Security Conundrum

What I coin as the Food Security Conundrum is the nexus of three issues which I consider in turn below:

1) National food security in African countries requires an abundant supply of affordable and nutritious food for the burgeoning rural and urban populations;
2) Agricultural exports are a major contributor to the balance of payments for African economies, and attract more government attention than support for smallholders;
3) Rural households lack sufficient land or economic incentives to invest in agriculture (and are therefore often reluctant farmers).

4.1. National food security requires abundant affordable and nutritious food for the burgeoning rural and urban populations

Alongside the general rapid population growth, the urban population in sub-Saharan Africa is growing rapidly. Urban dwellers are key in election of African governments, and the riots that have ensued after hikes in food prices (FAO et al., 2017) demonstrate the need to ensure food is affordable. Rates of urbanization are perhaps not as fast as often assumed (Potts, 2017), and much of the increase in urban population is due to natural growth rather than migration from rural areas (Andersson Djurfeldt, 2015). Alongside the continued growth of large urban conurbations and the rise of smaller towns, which will provide markets for farmers, rural populations will also continue to grow. A large proportion of rural households are net consumers of food – they depend more on buying food or earning food in payment for work than on consumption of what they produce on their own farms – as I explore further below. So food needs to remain affordable to prevent increases in hunger and undernutrition among the urban and rural poor. Simply increasing farm-gate prices or subsidising inputs are not solutions to increase farmers' incomes.

[1] Secretary-general calls for 'uniquely African green revolution' in 21st century, to end continent's plague of hunger, in Addis Ababa - https://www.un.org/press/en/2004/sgsm9405.doc.htm.

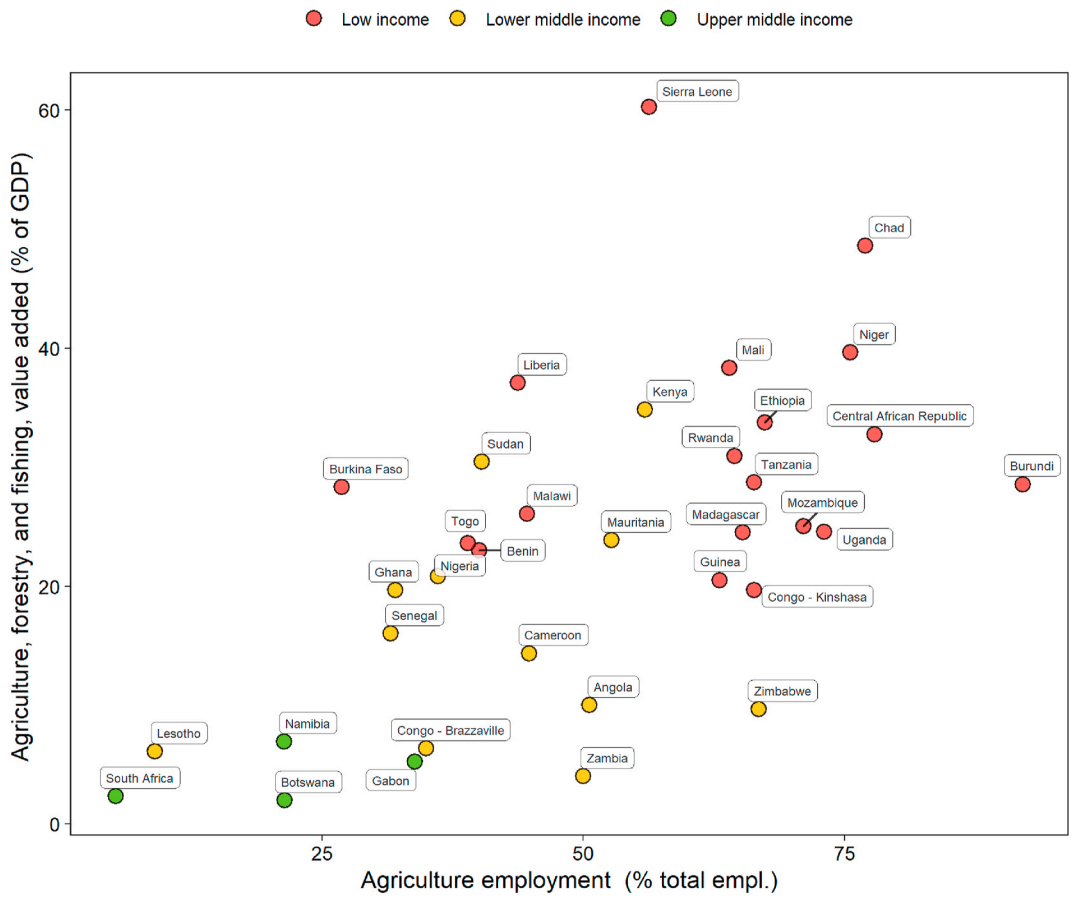

Fig. 1. The proportion of GDP earned from agriculture, forestry and fishing plotted against employment in agriculture for countries of sub-Saharan Africa in 2017 (after Silva, 2017, p. 4). (Data sources: Y-axis – World Bank Data, World Bank national accounts data, and OECD National Accounts data files, https://data.worldbank.org/; X-axis – ILOSTATS, Labour Force Survey and other country specific sources, https://ilostat.ilo.org/data/.).

4.2. Agricultural exports are a major contributor to the balance of payments for African economies

Agriculture accounts for 20–50% of the gross domestic product (GDP) of most countries of sub-Saharan Africa, as well as being the major source of employment (Fig. 1). The major agricultural exports are the typical cash crops of cotton and tobacco, beverages (cocoa, coffee, tea) and horticultural products (fruit, vegetables and flowers). Exports of pulses to the Indian sub-continent are also important, particularly from East and southern Africa. The relative importance of agriculture for export varies depending on the country's revenues from oil, metals and minerals. When discussing with the Ethiopian Minister of Agriculture, I was surprised that the discussion turned quickly from food security to export, until I realised that agriculture accounts for more than 70% of exports from Ethiopia.[2] If export targets are not met in terms of the contribution to GDP, the country would grind to a halt. It is hardly surprising that high-level debates among ministers of agriculture of African countries tend to focus on exports rather than food security.[3]

No doubt agricultural export commodities present important opportunities for smallholders and for the national economies. But despite the many commitments to stimulating agricultural development, such as the Comprehensive Africa Agriculture Development Programme (CAADP)[4] and the Malabo Declaration on Accelerated Agricultural Growth[5] which are framed in the language of transformation, of shared prosperity, improved livelihoods and reducing poverty, little seems to be *transformative* in terms of policies to directly support smallholder farmers and lift them out of poverty.

4.3. Rural households lack sufficient land or economic incentives to invest in agriculture

In 2012, I asked the question "How small is beautiful?"[6](Hengsdijk et al., 2014). It had become apparent that the land available for production to farmers in many of the areas in which we worked in Africa was insufficient. Given current yields many households were food insecure. What was most alarming was that even if crop yields were increased as far as feasibly possible, the households with small farmland area could not produce enough calories to be food sufficient (Hengsdijk et al., 2014). Although commonly referred to as smallholder or 'subsistence' farmers, the majority of rural households are net consumers of

[2] https://www.indexmundi.com/ethiopia/economy_profile.html.
[3] https://agrf.org/africas-ministers-pledge-to-commercialise-regions-agricultural-sector/.
[4] https://www.un.org/en/africa/osaa/peace/caadp.shtml.
[5] https://www.nepad.org/caadp/publication/malabo-declaration-accelerated-agricultural-growth.
[6] Plenary Keynote "How Small is Beautiful?" Ken Giller. Agricultural Research for Development conference: Innovations and Incentives. 3rd annual conference organised by the networks Agri4D, SIANI, Focali, Future Agriculture, Future Forests and SLU Global. September 26 & 27, 2012. Uppsala, Sweden.

food – they cannot subsist on farming alone.

Given the risk of crop failure in the face of drought, on small plots there is little incentive to invest in inputs given the poor profitability of most crops (Ritzema et al., 2017). The small farm sizes mean that even if farm gate prices were doubled, land limitations would preclude households from achieving an acceptable income (Harris and Orr, 2013). Often the poorest farmers sell much of their produce at harvest when prices are low in order to meet their immediate cash needs (e.g. Leonardo et al., 2015), and end up buying back food later in the year when prices are high (Stephens and Barrett, 2011; Burke et al., 2018). The meagre marginal returns to farming lead to strong dependence on off-farm income among rural households, irrespective of their resource endowment (Ellis, 1998, 2000; Loison, 2015).

Thus many rural households are neither food self-sufficient nor do they earn a living income; that is enough to afford a decent standard of living that provides nutrition, shelter, health, education and a small margin for other needs (van de Ven et al., 2020). When asked of aspirations for their children, frequent responses highlight occupations with a regular income; working for a salary in government as teachers or doctors. After food and health care, investment in school fees for the education of their children is often cited as the top priority for expenditure. Becoming a farmer is not an attractive proposition for many young people in rural areas (Sumberg et al., 2017), although some find agriculture appealing if they consider it offers future perspective (Glover and Sumberg, 2020). Where young people are engaged in agriculture, their activities are largely small-scale with a strong subsistence element (Yeboah et al., 2020). So, despite the huge demand for affordable and nutritious food in African countries, incentives to stimulate local production are lacking.

5. How to address the conundrum?

5.1. Increasing food production - sustainable intensification?

As indicated above a plethora of technologies exists that, from a purely technical perspective, could be deployed to raise agricultural productivity in a sustainable manner. Yet although development pathways are often framed as smallholders 'climbing the ladder of intensification' (Aune and Bationo, 2008), or the 'livestock ladder' (Udo and Cornelissen, 1998), we start to observe the opposite. In densely-populated regions of Ethiopia, households are deliberately descending the livestock ladder: selling cattle and switching to goats and sheep because of rising populations and the lack of grazing land or other feed resources (Mellisse et al., 2018). Where population densities are very high, households have switched from diverse agroforestry systems to monocultures of khat (*Catha edulis*), a narcotic from which they can maximise income from tiny farms of 0.2 ha or less (Mellisse et al., 2018). In addition, poorer farming households are often less able to benefit from technologies and interventions (Franke et al., 2014; Ritzema et al., 2017), making it even harder to achieve SDG 2 through agriculture directly. In the cotton belt of southern Mali, a 16-year study revealed that whilst wealthier households were able to accumulate more cattle and increase crop productivity, poorer households achieved few gains (Falconnier et al., 2015).

Not all regions suffer from severe population pressure: Jayne et al. (2014a) highlighted that 25 times as many people inhabit the most densely-populated 20% of land compared with the least densely-populated 20%. Yet where land is more abundant there are few incentives for intensification. Particularly if animal traction is available, households are predisposed to increase their production by cultivating more land, through extensification, rather than through increasing yields (Baudron et al., 2012; Ollenburger et al., 2016). Thus, Africa's Sleeping Giant – the grand vision of agricultural intensification across large, sparsely-populated areas of the West African Guinea savanna (Morris et al., 2009) – is likely to remain in hibernation (Ollenburger et al., 2016). The lack of change witnessed in a longitudinal study encompassing a 15-year period in the Guinea Savanna of Mali was likened to 'stagnation' rather than intensification or extensification (Ollenburger et al., 2016). So long as farming remains less profitable and attractive than alternative off-farm employment this is unlikely to change (Ollenburger et al., 2019).

Farming will no doubt remain a core component of rural livelihoods both for provision of food and as a source of income. Given that food purchases constitute half or more of household expenditure in less-developed countries (van de Ven et al., 2020), self-consumption of food grown on the farm is key for food security. Thus a focus on diversification of cropping systems to provide food baskets that meet the household's nutritional needs is warranted, including attention to seasonality of supply and demand (de Jager et al., 2018). Rather than viewing intensification of agriculture as *the* engine for economic growth, a more nuanced understanding of its role in the livelihoods of rural households is required. Increasing and diversifying production is certainly important for household food and nutrition security. But given land constraints and the poor profitability of farming, smallholders are unlikely to intensify their production which limits their ability to contribute to their own, or national food self-sufficiency.

5.2. What policies can address the conundrum?

There are arguments to suggest that Africa has experienced the opposite of enabling policies for agricultural growth. Policies of structural adjustment that began during the 1990s led to major reductions in fertilizer use in Malawi (Carr, 1997), and have been linked with soil degradation in Tanzania (Wiig et al., 2001). Later, starting early in the 2000s, input subsidy programmes were reintroduced, with varying degrees of success (Jayne et al., 2018). While grain yields and national production increased, the welfare benefits were disappointing and the crop responses to fertilizer were far less than expected (Jayne et al., 2018). Although agronomic use efficiencies of 30–50 kg grain/kg N are possible with good agronomic management (Zingore et al., 2007), most surveys report values below 15 kg grain/kg N (Jayne et al., 2018). The poor profitability of crop production, combined with land constraints, provides little incentive to invest in the careful and timely attention to agronomic management needed for efficient use of fertilizer. Further, rural infrastructure is often poor, which contributes to lack of access to agricultural inputs and to markets for produce. Many African countries are land-locked meaning that the costs of transport to import agricultural inputs such as fertilizers are high (Collier, 2008). On top of these constraints, the increase in rural population drives further fragmentation and subdivision of land.

The current development policy from the UK[7] and from the recent Dutch Food Security Evaluation[8] refer to the work of Andrew Dorward (2009) who describes the diversity of development pathways for smallholder farmers as "stepping up" or "stepping out" or those remain "hanging in". If smallholder farmers are to be able to step up, others - including the poorest – will need help to step out. Further, development policy in Europe focuses on the mantra of "Trade not Aid" with a strong reliance on value chain approaches. Yet this conflicts with the vision behind Agenda2030 that no one should be left behind. No doubt the private sector has an essential role to play in agricultural development. But public-private-partnerships (PPPs) tend to support the better off and more entrepreneurial farmers. PPPs do not address the needs of the poor – nor should we expect them to. There is consensus that "trickle down" does not work; none of the evidence supports this idea (Arndt, 1983; Falconnier et al., 2015). PPPs do not address SDG2 in terms of achieving

[7] DFID (2015) DFIDs Conceptual Framework on Agriculture. pp. 1–36. Department for International Development, London.

[8] Ministry of Foreign Affairs of the Netherlands (2017) Food for Thought: Review of Dutch Food Security Policy 2012–2016. Ministry of Foreign Affairs of the Netherlands, den Haag.

Box 1
The approach taken by Sicco Mansholt to enhance production of the agriculture sector in the Netherlands in response to food insecurity in the early 1950s (my interpretation based on van Merriënboer, 2011).

- Policies to support modernisation of agriculture and the use of new technologies
- Consolidation of fragmented fields into viable economic farm units
- Policies to encourage small, unviable farms to quit farming
- Tariffs and price support to provide a **living income** for farmers
- Special measures to support farmers on poor sandy soils
- Based on a large injection of foreign aid from the USA through the Marshall Plan

zero hunger and availability and access to safe and nutritious food for all at local levels. Thus a policy focus solely on "Trade not Aid" is not acceptable. There is an essential role for the public sector, and social programmes targeted specifically to the poor such as the Productive Safety Net Programme in Ethiopia (Debela et al., 2015). Recent attention has been given the need for an ultra-basic, universal basic income (e.g.Banerjee and Duflo, 2019), which could allow farmers to focus on producing their own nutritious diet.

In the search for ideas of what types of policies are needed to support agricultural growth, I find inspiration in the biography of Sicco Mansholt (van Merriënboer, 2011). Mansholt was highly successful in driving the agricultural reform in the Netherlands in the wake of the 'hunger winter' at the end of World War II. His policies (summarised in Box 1) led to consolidation of fragmented farmland, a deliberate and dramatic reduction in the number of farms, modernisation and mechanisation and a massive boost in agricultural productivity.[9] Apart from the Netherlands receiving a substantial injection of foreign aid to fund land reform (through the Marshall Plan), the broader economic conditions were also favourable. Post-war industrialisation led to the massive employment opportunities in the cities leading to rapid urbanisation of the population. A large number of Dutch farmers emigrated, seeking new opportunities to farm in Africa, Australasia, Eastern Europe and North America. As a result, the number of farms in the Netherlands fell from 410,000 in 1950 to 185,000 in 1970 – and the downward trend continues today with only 54,000 farms remaining by 2018 (CSO, 2020). The key reasons for the rapid decline in the number of farmers in the 1950s and 60s were the rise in employment opportunities outside agriculture in urban areas and migration out of rural areas. But clearly, technological change on the farm and changes in farm structure (consolidation of land) went hand in hand with structural changes in the economy.

Against a backdrop of increasing population pressure and fragmentation of farms, there is evidence of a countervailing trend. A new cadre of medium-scale "investor farmers" with land areas of 5–100 ha is expanding rapidly (Jayne et al., 2016). These investor farmers are urban professionals or rural elite households (Sitko and Jayne, 2014) who already control 20–50% of the total farmland in Kenya, Ghana, Tanzania and Zambia. Jayne et al. (2016) highlight that the share of arable land under the control of urban based households is rising, leading to rapid increases in land prices within 100 km of urban centres. Often only a small proportion of the land acquired is initially used (Jayne et al., 2014b), and although such farms can help to stimulate local input and output markets the implications for local or national food security are unclear. Given the continuing population growth in rural areas it seems inevitable that the consolidation of land in the hands of investor farmers will contribute to further marginalisation of poorer households (Jayne et al., 2014b).

Land has much more meaning in Africa than simply its productive potential – as a place of belonging, often where ancestors are buried and as a place to retire (Andersson, 1999). When family members travel to work in towns or cities it is usual that some household members remain on the family land to farm and maintain the rural home (Andersson, 2001, 2006). Another disturbing trend observed in Uganda and Tanzania is the planting of large tracts of potentially-productive land to forestry by absentee landlords as a means to secure land ownership and prevent occupation by squatters, whilst providing income for relatively little investment (Baijukya et al., 2005; P. Ebanyat, pers. comm. 2019; F. Baijukya, pers. comm. 2019). Thus it seems unlikely that rural areas of Africa will be emptied by migration to urban centres which would allow consolidation of farms into larger, more economically viable units. This could occur in the Netherlands under the policies of Mansholt because of the rapid growth of industry and employment in urban centres which was a completely different backdrop to what we see today in Africa.

The rapid population growth could provide a 'demographic dividend' – or a 'youth dividend' given that the median age of the population in sub-Saharan Africa is 18 or less. The huge available labour force coupled with the growing market for agricultural products in Africa could drive economic growth: it has often been suggested that the rural population in Africa was too sparse in the past to stimulate growth. Yet there is a major crisis of unemployment in Africa of young, often well-educated, people seeking jobs (Christiaensen, 2020). As urban centres expand the majority of employment is the service sector rather than in manufacturing, with a lack of productive jobs to drive economic growth. Enhanced employment opportunities in rural and urban areas are critical to provide the stimulus for development in the agricultural sector.

6. Concluding remarks

It is clear that some out-of-the-box thinking is required to create the 'Future We Want' and achieve the vision of the SDGs. To begin with, whose 'we' counts? (cf. Chambers, 1997). Addressing this Food Security Conundrum certainly needs radical transformation and not just incremental change. A huge shift in policy is required to make smallholder agriculture profitable – while keeping the urban population well fed. Incremental changes in yields cannot achieve this. Technologies for smallholder farms can enhance food self-sufficiency but in general are insufficient to achieve a living income for the households. Our analyses increasingly suggest that major structural change to the farming systems is needed - to allow farms to grow in size to be economically *and* agronomically viable. This further requires massive structural change outside agriculture, to encourage creation of rural and urban jobs, it needs industrialisation to move along hand in hand with agriculture and other forms of social protection are required in the form of social safety nets.

In this discussion of food security in sub-Saharan Africa I raise more questions than I have answers. Yet if it was clear what needs to be done

[9] Mansholt's success in agricultural reform in the Netherlands led his key role in developing the Common Agricultural Policy (CAP) of the European Community, which proved to be too successful in stimulating agricultural productivity. In later life, Mansholt realised that the CAP needed to be reigned in, but by this time political lock-in meant that reform of the CAP was virtually impossible.

to address this 'wicked problem' – it would not be a conundrum!

Declaration of competing interest

The author declares that he has no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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References

Abate, T., Shiferaw, B., Menkir, A., Wegary, D., Kebede, Y., Tesfaye, K., Kassie, M., Bogale, G., Tadesse, B., Keno, T., 2015. Factors that transformed maize productivity in Ethiopia. Food Sec. 7, 965–981.
Andersson Djurfeldt, A., 2015. Urbanization and linkages to smallholder farming in sub-Saharan Africa: implications for food security. Global Food Sec. 4, 1–7.
Andersson, J.A., 1999. The politics of land scarcity: land dispute in Save Communal Land, Zimbabwe. J. Southern Afric. Stud. 25, 553–578.
Andersson, J.A., 2001. Reinterpreting the rural-urban connection: migration practices and socio-cultural dispositions of Buhera workers in Harare. Africa 71, 82–112.
Andersson, J.A., 2006. Informal moves, informal markets: international migrants and traders from Mzimba District, Malawi. Afr. Aff. 105, 375–397.
Arndt, H.W., 1983. The "trickle-down" myth. Econ. Dev. Cult. Change 32, 1–10.
Aune, J., Bationo, A., 2008. Agricultural intensification in the Sahel-The ladder approach. Agric. Syst. 98, 119–125.
Baijukya, F.P., de Ridder, N., Masuki, K.F., Giller, K.E., 2005. Dynamics of banana-based farming systems in Bukoba District, Tanzania: changes in land use, cropping and cattle keeping. Agric. Ecosyst. Environ. 106, 395–406.
Banerjee, A.V., Duflo, E., 2019. Good Economics for Hard Times: Better Answers to Our Biggest Problems. Allen Lane.
Baudron, F., Andersson, J.A., Corbeels, M., Giller, K.E., 2012. Failing to Yield? Ploughs, conservation agriculture and the problem of agricultural intensification: an example from the Zambezi Valley, Zimbabwe. J. Dev. Stud. 48, 393–412.
Buresh, R.J., Sanchez, P.A., Calhoun, F. (Eds.), 1997. Replenishing Soil Fertility in Africa. ASSA, CSSA, SSSA, Madison, Wisconsin.
Burke, M., Bergquist, L.F., Miguel, E., 2018. Sell low and buy high: arbitrage and local price effects in Kenyan markets. Q. J. Econ. 134, 785–842.
Carr, S.J., 1997. A green revolution frustrated: lessons from the Malawi experience. Afr. J. Crop Sci. 5, 93–98.
Chambers, R., 1997. Whose Reality Counts?: Putting the First Last. Intermediate Technology Publications, London.
Christiaensen, L., 2020. Agriculture, jobs, and value chains in Africa. Job Notes Issue No 9. https://openknowledge.worldbank.org/handle/10986/33693 (Washington DC).
Collier, P., 2008. The Bottom Billion. Why the Poorest Countries Are Failing and what Can Be Done about it. Oxford University Press, Oxford & New York.
Crowley, E.L., Carter, S.E., 2000. Agrarian change and the changing relationships between toil and soil in Maragoli, western Kenya (1900 – 1994). Hum. Ecol. 28, 383–414.
de Jager, I., Giller, K.E., Brouwer, I.D., 2018. Food and nutrient gaps in rural Northern Ghana: does production of smallholder farming households support adoption of food-based dietary guidelines? PLoS One 13 e0204014-0204026.
Debela, B.L., Shively, G., Holden, S.T., 2015. Does Ethiopia's productive safety net program improve child nutrition? Food Sec. 7, 1273–1289.
Dixon, J., Gulliver, A., Gibbon, D., 2001. Farming Systems and Poverty: Improving Farmers' Livelihoods in a Changing World. FAO, Rome.
Dorward, A., 2009. Integrating contested aspirations, processes and policy: development as hanging in, stepping up and stepping out. Dev. Pol. Rev. 27, 131–146.
Ellis, F., 1998. Household strategies and rural livelihood diversification. J. Dev. Stud. 35, 1–38.
Ellis, F., 2000. The determinants of rural livelihood diversification in developing countries. J. Agric. Econ. 51, 289–302.
Falconnier, G.N., Descheemaeker, K., Van Mourik, T.A., Sanogo, O.M., Giller, K.E., 2015. Understanding farm trajectories and development pathways: two decades of change in southern Mali. Agric. Syst. 139, 210–222.
FAO, IFAD, UNICEF, WFP, WHO, 2017. The State of Food Security and Nutrition in the World. Building Resilience for Peace and Food Security. FAO, Rome.
FAO, IFAD, UNICEF, WFP, WHO, 2020. The State of Food Security and Nutrition in the World. Transforming Food Systems to Deliver Affordable Healthy Diets for All. FAO, Rome.
Franke, A.C., Baijukya, F., Kantengwa, S., Reckling, M., Vanlauwe, B., Giller, K.E., 2019. Poor farmers – poor yields: socio-economic, soil fertility and crop management indicators affecting climbing bean productivity in northern Rwanda. Exp. Agric. 55, 14–34.
Franke, A.C., van den Brand, G.J., Giller, K.E., 2014. Which farmers benefit most from sustainable intensification? An *ex-ante* impact assessment of expanding grain legume production in Malawi. Eur. J. Agron. 58, 28–38.
Franke, A.C., van den Brand, G.J., Vanlauwe, B., Giller, K.E., 2018. Sustainable intensification through rotations with grain legumes in Sub-Saharan Africa. A review. Agric. Ecosyst. Environ. 261, 172–185.
Frelat, R., Lopez-Ridaura, S., Giller, K.E., Herrero, M., Douxchamps, S., Djurfeldt, A.A., Erenstein, O., Henderson, B., Kassie, M., Paul, B.K., Rigolot, C., Ritzema, R.S., Rodriguez, D., van Asten, P.J.A., van Wijk, M.T., 2016. Drivers of household food availability in sub-Saharan Africa based on big data from small farms. Proc. Natl. Acad. Sci. U.S.A. 113, 458–463.
Garnett, T., Appleby, M.C., Balmford, A., Bateman, I.J., Benton, T.G., Bloomer, P., Burlingame, B., Dawkins, M., Dolan, L., Fraser, D., Herrero, M., Hoffmann, I., Smith, P., Thornton, P.K., Toulmin, C., Vermeulen, S.J., Godfray, H.C.J., 2013. Sustainable intensification in agriculture: premises and policies. Science 341, 33–34.
Giller, K.E., 2001. Nitrogen Fixation in Tropical Cropping Systems. CAB International, Wallingford.
Giller, K.E., Cadisch, G., Ehaliotis, C., Adams, E., Sakala, W.D., Mafongoya, P.L., 1997. Building soil nitrogen capital in Africa. In: Buresh, R.J., Sanchez, P.A., Calhoun, F. (Eds.), Replenishing Soil Fertility in Africa. ASA, CSSA, SSSA, Madison, Wisconsin, pp. 151–192.
Giller, K.E., Tittonell, P., Rufino, M.C., van Wijk, M.T., Zingore, S., Mapfumo, P., Adjei-Nsiah, S., Herrero, M., Chikowo, R., Corbeels, M., Rowe, E.C., Baijukya, F., Mwijage, A., Smith, J., Yeboah, E., van der Burg, W.J., Sanogo, O.M., Misiko, M., de Ridder, N., Karanja, S., Kaizzi, C., K'ungu, J., Mwale, M., Nwaga, D., Pacini, C., Vanlauwe, B., 2011. Communicating complexity: integrated assessment of trade-offs concerning soil fertility management within African farming systems to support innovation and development. Agric. Syst. 104, 191–203.
Glover, D., Sumberg, J., 2020. Youth and food systems transformation. Front. Sust. Food Syst. 4, 762-715.
Harris, D., Orr, A., 2013. Is rainfed agriculture really a pathway from poverty? Agric. Syst. 123, 84–96.
Hengsdijk, H., Franke, A.C., van Wijk, M.T., Giller, K.E., 2014. How small is beautiful? Food self-sufficiency and land gap analysis of smallholders in humid and semi-arid sub Saharan Africa. Plant Res. Int. Wageningen UR. 68.
Jayne, T.S., Chamberlin, J., Headey, D.D., 2014a. Land pressures, the evolution of farming systems, and development strategies in Africa: a synthesis. Food Pol. 48, 1–17.
Jayne, T.S., Chamberlin, J., Traub, L., Sitko, N., Muyanga, M., Yeboah, F.K., Anseeuw, W., Chapoto, A., Wineman, A., Nkonde, C., Kachule, R., 2016. Africa's changing farm size distribution patterns: the rise of medium-scale farms. Agric. Econ. 47, 197–214.
Jayne, T.S., Chapoto, A., Sitko, N., Nkonde, C., Muyanga, M., Chamberlin, J., 2014b. Is the scramble for land in Africa foreclosing a smallholder agricultural expansion strategy? J. Int. Affairs 67, 35–52.
Jayne, T.S., Mason, N.M., Burke, W.J., Ariga, J., 2018. Review: taking stock of Africa's second-generation agricultural input subsidy programs. Food Pol. 75, 1–14.
Jerven, M., 2013. Poor Numbers: How We Are Misled by African Development Statistics and what to Do about it. Cornell University Press, Ithaca, NY.
Leonardo, W., van de Ven, G., Udo, H., Kanellopoulos, A., Giller, K.E., 2015. Labour not land constraints agricultural production and food self-sufficiency in maize-based smallholder farming systems in Mozambique. Food Sec. 7, 857–874.
Loison, S.A., 2015. Rural livelihood diversification in sub-saharan Africa: a literature review. J. Dev. Stud. 51, 1125–1138.
Mellisse, B.T., Descheemaeker, K., Giller, K.E., Abebe, T., van de Ven, G.W.J., 2018. Are traditional home gardens in southern Ethiopia heading for extinction? Implications for productivity, plant species richness and food security. Agric. Ecosyst. Environ. 252, 1–13.
Morris, M., Binswanger-Mkhize, H.P., Byerlee, D., 2009. Awakening Africa's Sleeping Giant: Prospects for Commercial Agriculture in the Guinea Savannah Zone and beyond. The World Bank, Washington, D.C.
Muyanga, M., Jayne, T.S., 2014. Effects of rising rural population density on smallholder agriculture in Kenya. Food Pol. 48, 98–113.
Niang, I., Ruppel, O.C., Abdrabo, M.A., Essel, A., Lennard, C., Padgham, J., Urquhart, P., 2014. Africa. In: Barros, V.R., Field, C.B., Dokken, D.J., Mastrandrea, M.D., Mach, K. J., Bilir, T.E., Chatterjee, M., Ebi, K.L., Estrada, Y.O., Genova, R.C., Girma, B., Kissel, E.S., Levy, A.N., MacCracken, S., Mastrandrea, P.R., White, L.L. (Eds.), Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, pp. 1199–1265.
Ollenburger, M., Crane, T., Descheemaeker, K., Giller, K.E., 2019. Are farmers searching for an African Green Revolution? Exploring the solution space for agricultural intensification in southern Mali. Exp. Agric. 55, 288–310.
Ollenburger, M.H., Descheemaeker, K., Crane, T.A., Sanogo, O.M., Giller, K.E., 2016. Waking the sleeping giant: agricultural intensification, extensification or stagnation in Mali's Guinea savannah. Agric. Syst. 148, 58–70.
Penning de Vries, F.W.T., Ditèye, M.A., 1991. La Productivité des Pâturages Sahéliens: Une Étude des Sols, des Végétations et de l'Exploitation de cette Ressource Naturelle. Pudoc, Wageningen.

Potts, D., 2017. Urban data and definitions in sub-Saharan Africa: mismatches between the pace of urbanisation and employment and livelihood change. Urban Stud. 55, 965–986.
Ritzema, R.S., Frelat, R., Douxchamps, S., Silvestri, S., Rufino, M.C., Herrero, M., Giller, K.E., Lopez-Ridaura, S., Teufel, N., Paul, B.K., Wijk, M.T., 2017. Is production intensification likely to make farm households food-adequate? A simple food availability analysis across smallholder farming systems from East and West Africa. Food Sec. 9, 115–131.
Sanchez, P.A., 2002. Soil fertility and hunger in Africa. Science 295, 2019–2020.
Sanchez, P.A., Swaminathan, M.S., 2005. Cutting world hunger in half. Science 307, 357–359.
Silva, J.V., 2017. Using Yield Gap Analysis to Give Sustainable Intensification Local Meaning. PhD thesis. Wageningen University, Wageningen, p. 354.
Sitko, N.J., Jayne, T.S., 2014. Structural transformation or elite land capture? The growth of "emergent" farmers in Zambia. Food Pol. 48, 194–202.
Stephens, E.C., Barrett, C.B., 2011. Incomplete credit markets and commodity marketing behaviour. J. Agric. Econ. 62, 1–24.
Sumberg, J., Yeboah, T., Flynn, J., Anyidoho, N.A., 2017. Young people's perspectives on farming in Ghana: a Q study. Food Sec. 9, 151–161.
Tittonell, P., Giller, K.E., 2013. When yield gaps are poverty traps: the paradigm of ecological intensification in African smallholder agriculture. Field Crop. Res. 143, 76–90.
Udo, H.M.J., Cornelissen, A.M.G., 1998. Livestock in resource poor farming systems. Outlook Agric. 27, 237–242.
United Nations, 2012. Rio+20 united Nations conference on sustainable development. In: Agenda Item 10 Outcome of the Conference: the Future We Want: A/CONF.216/L.1. United Nations, Washington DC, pp. 1–53.
United Nations, 2015. Resolution Adopted by the General Assembly on 25 September 2015. 70/1 Transforming Our World: the 2030 Agenda for Sustainable Development. United Nations General Assemby, Washington DC.
United Nations, 2017. World Population Prospects: the 2017 Revision. Department of Economic and Social Affairs, Population Division, United Nations, New York.
United Nations, 2019. World Population Prospects: the 2019 Revision. Department of Economic and Social Affairs, Population Division, United Nations, New York.
van de Ven, G., de Valença, A., Marinus, W., de Jager, I., Descheemaeker, K., Hekman, W., Mellisse, B.T., Baijukya, F., Omari, M., Giller, K.E., 2020. Living income benchmarking of rural households in less-developed countries. Food Sec. https://doi.org/10.1007/s12571-020-01099-8.
van Dijk, M., Morley, T., van Loon, M., Reidsma, P., Tesfaye, K., van Ittersum, M.K., 2020. Reducing the maize yield gap in Ethiopia: decomposition and policy simulation. Agric. Syst. 183, 102828.
van Ittersum, M.K., van Bussel, L.G.J., Wolf, J., Grassini, P., van Wart, J., Guilpart, N., Claessens, L., de Groot, H., Wiebe, K., Mason-D'Croz, D., Yang, H., Boogaard, H., van Oort, P.A.J., van Loon, M.P., Saito, K., Adimo, O., Adjei-Nsiah, S., Agali, A., Bala, A., Chikowo, R., Kaizzi, K., Kouressy, M., Makoi, J.H.J.R., Ouattara, K., Tesfaye, K., Cassman, K.G., 2016. Can sub-Saharan Africa feed itself? Proc. Natl. Acad. Sci. Unit. States Am. 113, 14964–14969.
van Merriënboer, J., 2011. Mansholt: A Biography. Peter Lang S.A., Brussels.
Vanlauwe, B., Bationo, A., Chianu, J., Giller, K.E., Merckx, R., Mokwunye, U., Ohiokpehai, O., Pypers, P., Tabo, R., Shepherd, K., Smaling, E.M.A., Woomer, P.L., 2010. Integrated soil fertility management: operational definition and consequences for implementation and dissemination. Outlook Agric. 39, 17–24.
Vanlauwe, B., Coyne, D., Gockowski, J., Hauser, S., Huising, J., Masso, C., Nziguheba, G., Schut, M., van Asten, P., 2014. Sustainable intensification and the African smallholder farmer. Curr. Opin. Environ. Sust. 8, 15–22.
Vanlauwe, B., Hungria, M., Kanampiu, F., Giller, K.E., 2019. The role of legumes in the sustainable intensification of African smallholder agriculture: lessons learnt and challenges for the future. Agric. Ecosyst. Environ. 284, 106583.
Vollset, S.E., Goren, E., Yuan, C.-W., Cao, J., Smith, A.E., Hsiao, T., Bisignano, C., Azhar, G.S., Castro, E., Chalek, J., Dolgert, A.J., Frank, T., Fukutaki, K., Hay, S.I., Lozano, R., Mokdad, A.H., Nandakumar, V., Pierce, M., Pletcher, M., Robalik, T., Steuben, K.M., Wunrow, H.Y., Zlavog, B.S., Murray, C.J.L., 2020. Fertility, mortality, migration, and population scenarios for 195 countries and territories from 2017 to 2100: a forecasting analysis for the Global Burden of Disease Study. Lancet. https://doi.org/10.1016/S0140-6736(20)30677-2.
Wichern, J., van Heerwaarden, J., de Bruin, S., Descheemaeker, K., van Asten, P.J.A., Giller, K.E., van Wijk, M.T., 2018. Using household survey data to identify large-scale food security patterns across Uganda. PLoS One 13 e0208714-0208723.
Wiig, H., Aune, J.B., Glomsrød, S., Iversen, V., 2001. Structural adjustment and soil degradation in Tanzania. A CGE model approach with endogenous soil productivity. Agric. Econ. 24, 263–287.
Yeboah, T., Chigumira, E., John, I., Anyidoho, N.A., Manyong, V., Flynn, J., Sumberg, J., 2020. Hard work and hazard: young people and agricultural commercialisation in Africa. J. Rural Stud. 76, 142–151.
Zingore, S., Murwira, H.K., Delve, R.J., Giller, K.E., 2007. Soil type, historical management and current resource allocation: three dimensions regulating variability of maize yields and nutrient use efficiencies on African smallholder farms. Field Crop. Res. 101, 296–305.