

Poverty eradication and food security through agriculture in Africa: Rethinking objectives and entry points

A Gassner¹, D Harris^{2,3}, K Mausch⁴ , A Terheggen⁴, C Lopes⁵, RF Finlayson⁶ and P Dobie⁴

Outlook on Agriculture
1–7

© The Author(s) 2019



Article reuse guidelines:

sagepub.com/journals-permissions

DOI: 10.1177/0030727019888513

journals.sagepub.com/home/oag



Abstract

Agriculture in Africa is expected to meet the dual objectives of providing food and helping people to escape poverty. African agriculture is dominated by smallholdings and donors generally target their agricultural support at the smallholder sector. The expectation is that if the gap between actual and potential yields can be closed, smallholders will grow sufficient crops to feed their families, with a surplus to sell, thus meeting food security needs and bringing in an income to move them out of poverty. In practice, this is often not possible. While technologies already exist that can raise smallholder farmers' yields 3 or 4 times, even under rainfed conditions, the small size of land available to them limits how much can be grown and the per capita income from agriculture is insufficient to allow people to move above the current World Bank-defined poverty line of US\$1.90 per day. We link this finding with farmer typologies to further explain that there are large differences between individual farming households themselves in terms of their investment incentives and capability to benefit from field-level technologies that are aimed at increasing farm productivity. We argue for more differentiated policies for agricultural development in Africa and suggest that policymakers should be much more aware of the heterogeneity of farms and target interventions accordingly. It is important to understand where and for whom agriculture will have the main purpose of ensuring food and nutritional security and where and for whom there is the potential for significant increases in incomes and a contribution to wider economic growth. Let us recognize the distinctiveness of these targets and underlying target groups and work towards solutions that address the underlying needs.

Keywords

Targeting, agricultural research for development, rural development, intensification, Africa, smallholder farmers

The (agriculture for) development debate over the past decades

Poverty and hunger remain the biggest development challenges of our time. Food security and undernutrition remain problems throughout the less developed parts of the world (HLPE, 2017) despite the conclusion that 'All developing regions except Sub-Saharan Africa reached the Millennium Development Goal of halving poverty between 1990 and 2015' (UN, 2010). Sub-Saharan Africa (SSA) remains the world's most food-insecure region, with almost one-fourth of people – over 230 million – being undernourished (FAO et al., 2019). While poverty and hunger are clearly inextricably linked (Watts and Bohle, 1993), they are two distinct concepts with distinct alleviation measures.¹ Food security is about access to safe, nutritious and sufficient food all year round; the World Bank defines poverty as a multidimensional concept encompassing low income and consumption, low educational achievement, poor health and nutritional outcomes, lack of access to basic services, and a hazardous living environment. It uses a poverty line

of US\$1.90 per day as an indicator of extreme poverty (World Bank, 2018). The 2030 Agenda for Sustainable Development recognizes this and now addresses poverty and hunger as two distinct global goals (UN, 2015).

In the context of agricultural development, both issues have very distinct target groups based on the role that farming plays in individual and household income

¹ World Agroforestry (ICRAF), 2/F Khush Hall, International Rice Research Institute (IRRI), Los Baños, Laguna, Philippines

² International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Nairobi, Kenya

³ School of Natural Sciences, Bangor University, Bangor, UK

⁴ World Agroforestry (ICRAF), Nairobi, Kenya

⁵ Oxford Martin School, Oxford, UK

⁶ World Agroforestry (ICRAF), Bogor, Indonesia

Corresponding author:

A Gassner, World Agroforestry (ICRAF), International Rice Research Institute, College Los Baños, UPLB, World Agroforestry (ICRAF) House, PO Box 35024, Laguna 4031, Philippines.

Email: a.gassner@cgiar.org

portfolios (Dorward et al., 2009; Gatzweiler and Braun, 2016; Tittone et al., 2010) and these different groups require different types of technical and policy interventions. Nevertheless, there has been a persistent paradigm in the development debate on SSA that sees the agricultural productivity of smallholders as the key to achieving these goals of alleviating poverty and ensuring food security simultaneously. The latest iteration of this debate is still evolving around the idea of sustainable intensification (Godfray and Garnett, 2014).

This article is a contribution to the debate about the effectiveness of interventions for rural development through investments in the smallholder sector, by arguing that the debate would benefit from distinguishing between agricultural interventions for food security and those for poverty reduction. The conflation of these two development challenges within any one intervention is highly problematic. It has resulted in unrealistic expectations that a large share of investments in agricultural development should contribute to helping smallholders to farm themselves out of poverty while at the same time providing sufficient food for all. It has also resulted in questioning the utility of investments in international agricultural research that aim to restore and conserve soil productivity and fertility without sufficient positive measurable impacts on poverty reduction (Kelley et al., 2008; Renkow and Byerlee, 2010).

We build our argument around two main points. First, the well-recognized fact that smallholders in SSA are a very heterogeneous group, with different resources and capabilities (Glover et al., 2019; Tittone et al., 2010), incentives and aspirations (Dorward et al., 2009; Mausch et al., 2018) and that farm-level technologies need to be designed accordingly if farmers are expected to adopt them. Second, that farm-level technologies that are effective for improving food security are not necessarily as effective in reducing poverty or vice versa (Dorward et al., 2004; Harris, 2019; Lalani et al., 2017; Renkow and Byerlee, 2010). The two groups of farming households – those that have limited incentives and resources and those with the potential and incentives to effectively invest in increased production – should be treated as separate groups. The first needs interventions that help to achieve food security and increase resilience while the second needs help to maximize economic growth. Given the dominance of the first group across SSA, we call into question many countries' policies that favour investment into small-scale agriculture that places heavy emphasis on farmers as 'agents of change'. Policymakers, agricultural researchers and practitioners should recognize the need to separate food-security and economic-growth challenges.

The rationale for mixing poverty and food security

Most of the food crops in SSA are produced by approximately 33 million smallholding farms (AGRA, 2016) and to increase domestic food security it has been argued that it is necessary to close those farms' yield gaps, which are the

differences between the actual yields farmers are achieving and the yields they could achieve if they were to adopt better agricultural inputs and technologies.

The argument for focusing on closing the yield gap (most often through intensification) of the smallholding agricultural sector in SSA is built on the fact that it is underperforming and that the majority of the agricultural produce is grown by smallholders living below the official poverty line (Dercon and Gollin, 2014; Toenniessen et al., 2008). Yields in Africa are among the lowest in the world. In the 1960s, the average cereal yield in Africa was only 57% of that of the world; by the 1980s and 1990s, the gap had widened with Africa achieving cereal yields of only 47% when compared to the rest of the world. It remains today at the 1990s level (Dzanku et al., 2015).

Further, because most of the people living on less than US\$1.90 a day are in rural areas and depend to a greater or lesser extent on agriculture for their livelihoods (World Bank, 2016), it is assumed that beyond increasing domestic food security, a transition from subsistence to commercial farming via higher agricultural productivity will lead to higher labour demand both on farms and in the processing sector. Thus, together with more income for the farmers themselves and subsequent higher overall rural cash flows, increased agricultural production becomes the motor for wider rural development (Sachs, 2005).

The trouble with mixing food and income targets

Certainly, at first glance these arguments make it appealing to simultaneously address hunger and poverty by targeting the productivity of smallholders' households (Dercon et al., 2009; Pingali et al., 2006). The potential double benefit of agricultural intensification by employing the poorest people while providing enough food for all is enticing (Vorley et al., 2012). Asia led the way in the 1960s with improvements to agricultural technology that were embedded in enabling infrastructure and institutional environments, resulting in the 'green revolution' that dramatically increased cereal production and led to regional food surpluses and relative prosperity within 25 years (Smale et al., 2013). In the persistent absence of a transformation of the agricultural sector in SSA, there is a rich debate about the right strategies to achieve a 'New Green Revolution for Africa' (Dercon and Gollin, 2014; Godfray et al., 2010; Toenniessen et al., 2008), pointing to the different macroeconomic conditions of Asia in the 1960s and SSA today. What is largely missing from the debate is a critical reflection on the microeconomic part of the narrative that sees smallholders as agents of change for rural transformation.

As outlined above, the argument that agricultural productivity of smallholders is the key to achieving both the alleviation of poverty and ensuring food security depends on smallholders adopting farm-level technologies that increase their productivity and production. This productivity focus has resulted in an obsession with farm-level technologies that maximize yields (AGRA, 2016; Renkow and Byerlee, 2010), assuming that increases in yield will be

sufficient to make these technologies attractive to farmers (Harris, 2019).

Smallholders, especially in SSA, are characterized by operating on small land areas: globally around 80% of farms comprise less than 2 ha and in SSA farms of under 2 ha are the norm, despite some evidence that medium-sized farming is emerging (Jayne et al., 2016; Lowder et al., 2016). Farming in SSA, as compared to other regions, is further challenged by being almost exclusively rainfed rather than under irrigation (Dercon et al., 2009), making agriculture a high-risk livelihoods' strategy. As a result, farming households have very complex livelihoods' portfolios with various degrees of diversification of on- and off-farm income sources (Ellis and Freeman, 2004; Haggblade et al., 2010).

Technologies that both increase yields and reduce the ecological footprint of production are knowledge intensive (Godfray et al., 2010), require farmers to not only acquire new skill sets and understanding, but are also often very labour intensive in their implementation (Glover et al., 2019). For smallholders to be willing to invest the time and effort into changing the way they do things and to adopt these technologies requires a sufficiently large incentive.

The poor economic incentives for households with small farms to adopt an agricultural intervention can be easily demonstrated: Harris and Orr (2014) conducted an analysis of crop-improvement technologies available for rainfed agriculture in the drylands. They confirmed that many effective technologies were available for these systems, which, if adopted appropriately, would allow smallholders to increase production and net profit by up to 4 times, albeit from small base values. The problem was that while these technologies were effective in significantly increasing profitability per hectare, the resulting median net income of US\$560 per ha per season was not enough to lift households out of poverty. For example, a family of five people using this 'best practice' to farm their 1 hectare but only able to grow one crop per year would generate just 30 cents per person per day. Even if irrigation were available to facilitate two- or even three crops per year, incomes of 60 cents and 90 cents are still nowhere near the poverty line.

The consequences of what has become known as the 'small farm problem' are visualized in Figure 1. The farm profitability per hectare required to generate an income target of US\$1.90 a day for each member of any given household is a simple function of household size and farm size (Harris, 2019; Harris and Orr, 2014). The figure shows that for the average SSA farm and household size of 2 ha and five people (FAO, 2017), the profitability of the farm has to be at least US\$1730 per hectare per year (the point at which the curve crosses the x -axis) for household members to reach the World Bank's poverty line. Corresponding levels of profitability required to reach US\$1.90 a day are US\$4440 per hectare per year for an Ethiopian site (HH size = 7.2, farm size = 1.1 ha), US\$1470 per hectare per year for Petauke in Zambia (HH size = 5.5, farm size = 2.6 ha) and US\$980 per hectare per year in Kaffrine, Senegal (HH size = 16.8, farm size = 11.9 ha). The response to a

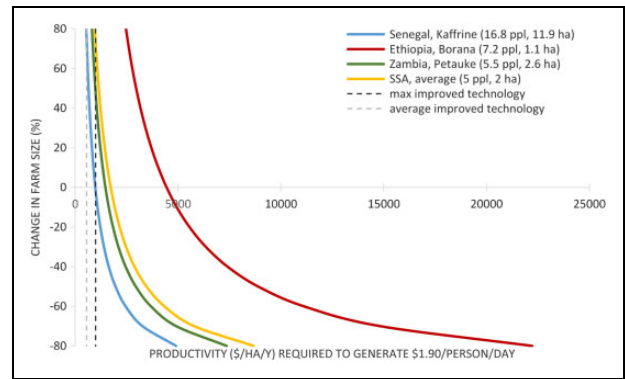


Figure 1. Effect of change in current mean farm size on the return to land (US\$ per hectare per year) required to generate a personal daily income of US\$ 1.90 per person per day. Household data sources: CCAFS (2015), based on data from Indaba Agricultural Policy Research Institute (IAPRI 2012) and FAO (2015).

change in farm size (with no change in household size) is asymmetrical, with the necessary profitability rising steeply to unfeasibly high levels as farm size declines. For very small farms, such as found in Ethiopia, even a 60% increase in average farm size would not propel any households out of poverty, assuming the average reported returns of US\$558 per hectare from improved agricultural technologies.² Even assuming a maximum profitability of US\$1000 does not change this picture significantly.

With farms too small to generate agricultural incomes above the current poverty line, they are also unlikely to make a significant contribution to rural economic growth. Given the limited income that can be generated from small farms, new farm technologies must compare favourably not only with farmers' existing practices but also with alternative livelihoods' enterprises. Already in many countries a large proportion of households that identify themselves as full-time farmers generate much of their income from local non-farm activities and remittances either from urban areas or abroad (Ellis and Freeman, 2004 (Uganda, Kenya, Tanzania and Malawi); Haggblade et al., 2010 (Namibia, Zambia, Sudan and Ethiopia); Verkaart et al., 2018 (Kenya)). In addition, poor households operate in risky environments and poor investment decisions can expose them to severe losses to livelihoods (Ihli et al., 2016). As a result, small-scale farmers tend to be risk-averse, even to the extent of not adopting technological advances that could significantly improve incomes (Rosenzweig and Binswanger, 1993).

Beyond blanket agricultural interventions

Most agricultural practitioners and decision makers find it indisputable that any improvement to smallholders' productivity, whether it is marginal or not, is better than no improvement at all (although additional yield with additional costs will have consequences for profitability and net incomes). Especially for food security, an additional meal per day makes a huge difference to hungry households. It is also indisputable that in the reality of scarce resources, on the farmer's side as well as on the

government and donor sides, agricultural practitioners have the mandate to ensure that farm-level interventions are designed based on a clear diagnostic of the problem at hand. We have noted that the diagnostic should not rely only on technical aspects alone but also needs to consider the realities of smallholders' households.

Tittonell et al. (2010) first introduced the economic concept of resource endowment into the discussion of smallholders' adoption of farm-level technologies. Their seminal work demonstrated that the economic potential of farms cannot only be predicted based on available area or suitability of the agroecological context but that there are huge differences between individual farming households themselves in terms of their capability to benefit from field-level technologies that are aimed at increasing farm productivity. While there are numerous ways of classifying farmer typologies (Gatzweiler and Braun, 2016), we adopt Dorward's (2009) concept of dynamic livelihood strategies. Dorward distinguishes three different strategies with respect to agriculture: 'hanging in', which are households that essentially have no other livelihood opportunity other than agriculture and their main concern is simply to survive; 'stepping up', which are households that generate sufficient surplus from their farming activities to reinvest and expand; and 'stepping out', which are households that are successful in moving into higher paid, non-farm labour sectors, either by investing in children's education or by reinvesting into non-farm businesses.

Based on the different livelihoods' strategies, some households will be more inclined than others to invest time and effort into learning a new technology and to actually adopt it as part of their farm management. What is needed is a portfolio of farm-level interventions for smallholders that are mindful of the differences between households (Mausch et al., 2017). They need to be inclusive, responsive to demand and embedded in the realities of the macro-economic context (Gassner et al., 2013).

Farming households that are struggling to make ends meet ('hanging in') need access to, and understanding of, farm interventions that ensure the long-term productivity and fertility of their land without overburdening their limited resources. Interventions need to be aimed at raising their potential and decreasing their risks without drawing on already scarce labour and cash resources or requiring unrealistic behaviour changes. These interventions do not need to be game changers that substantially increase people's incomes and have a significant impact on rural poverty alleviation but they do need to ensure sustainable, and if possible increasing, food supplies for the producing households themselves. These households need access to affordable agricultural inputs, such as seeds, high-performing varieties and fertilizers. However, based on their very limited resources, this group will likely rely on subsidies or other forms of support to be able to afford them (Duflo et al., 2011).

Farming households that have both the resource endowment and the incentive to invest in their farming operations and to increase their productivity ('stepping up') are more likely to take up new technologies that go beyond improved

agricultural inputs and aim for long-term transformational change. They also need innovative models of economic and social cooperation to lower their transaction costs and be competitive in local and globalized food and agricultural markets. Farming households that are 'stepping out' but are not selling their land need to be nudged to keep their land productive; targeted policies that lower transaction costs within land rental markets are essential (Jayne et al., 2014; Kimura et al., 2011).

For national and global food supply, however, it is of critical importance to significantly raise overall food production. Managing SSA's emerging food security crisis requires a 335% increase in cereal production over the next 40 years to meet the projected population and per capita food demand (Dzanku et al., 2015). These daunting numbers include both rural and urban consumers. With the majority of farms too small to generate agricultural incomes sufficient to make the necessary investment to significantly increase their production and move from largely subsistence to more commercial agriculture, there is a clear need to invest public funds beyond the smallholder sector into raising the productivity of medium-sized and larger sized farming operations (Jayne et al., 2016).

Recognizing the larger contribution of these farms to ensuring food security, especially for the urban population, is a critical insight that is often overlooked when targets are set, such as 'lifting X million households out of poverty' and 'ensuring food security of Y million households'.

Policy implications

The African Agriculture Status report emphasizes that the root cause of food insecurity is the limited adoption of more productive and diversified agricultural technologies (AGRA, 2016). We have argued that in SSA, most farms are too small to generate agricultural incomes sufficient for farming households to rely solely on agriculture for their livelihoods and thus have very little incentive to invest more of their time, labour or scarce assets in agriculture. We argue that a policy narrative that relies on these households to be the agent for transformational change of the rural sector needs to be revised. We concur with the emerging decision science and behavioural economic thinking in the micro-development literature that development strategies can only be effective if they take into consideration the constraints of the actors whose behaviour they are trying to change (World Bank, 2015). We need policies and programs that put a stronger emphasis on providing the enabling conditions for farmers to change, rather than focusing solely on the technical aspects.

Policymakers and agricultural researchers and practitioners need to recognize the need to separate food security and income/economic growth challenges. While the majority of smallholders' farms do not have the potential to generate significant inclusive rural growth, they do provide vital safety nets for the families depending on them. Poor farming households do have the right to access sufficient, safe, nutritious food all year round. An important policy

implication is that agriculture may not be the sole or preferred development strategy for those households in the ‘hanging in’ category. While we argue that agriculture for food security is vital for those rural households, we also recognize that they should be prime candidates for non-agricultural social safety net interventions to help them cope with their current poverty and to transition them or their children to alternative forms of livelihoods.

Thanks to advances in agricultural research, there is a huge array of interventions available that have been proven to secure household food security but, in smallholders’ contexts, they do not necessarily make significant changes to a household’s poverty status, let alone create the necessary spin-off effect to have an impact beyond the household. This dissonance can be observed in the Millennium Villages. In the Kenyan village of Sauri, the agricultural interventions did result in an almost doubling of farm income but when disaggregated into valued home consumption and cash income most of this increase was allocated to home consumption, thereby contributing significantly to food security while offering limited effects on cash income and the potential to reinvest (Wanjala and Muradian, 2013). Similar effects have also been observed among Ethiopian *teff* farmers (Orr et al., 2019).

Smallholders’ time as an investment remains largely underappreciated. With a shift in farming households’ livelihoods’ portfolios and consequent labour movement away from farms, both for those households that are successful in ‘stepping out’ in the Dorward sense by moving some households members into higher non-farm labour segments as well as for those households where members are pushed out of the farm into low-paid work (Reardon, 1997), projects and interventions have to be designed considering forgone opportunity costs. Agricultural development programs need to appreciate farming households as partners in a public–private partnership, not simply as beneficiaries of advanced agricultural technologies.

Governments need to equip their extension services with access to, and understanding of, a diverse portfolio of flexible farm-level interventions, with affordable technologies aimed at farmers with low capabilities or limited aspiration that would help to increase household food security but might not have such a significant effect in closing the yield gap. Whereas intensification technologies aimed at closing the yield gap should be targeted to medium-sized and larger sized farming operations as well as those smallholders who have the incentive and potential to invest and benefit.

Conclusions

The need to raise incomes and increase food production in SSA is obvious and has been on top of the development agenda. One of the prominent entry points has been to raise agricultural productivity of smallholders and replicate the Asian ‘green revolution’.

We argue that the debate would benefit from appreciating the wealth of literature that has pointed out that the historic macroeconomic context of the green revolution in Asia is not equivalent to the realities of SSA today. The

potential to eradicate poverty for smallholders in SSA using agricultural interventions that just increase crop productivity is very limited. The African development debate needs to acknowledge that the two targets – poverty and food security – have different target groups and need differentiated interventions. The dominant development paradigm that sees agricultural productivity of smallholders as the key to achieving both the alleviation of poverty and ensuring food security needs to appreciate that the incentives for smallholders to adopt proven yield-increasing technologies remain small.

Rural development programs targeting smallholders have to acknowledge their heterogeneity with respect to their livelihoods’ strategies and that not all households that identify themselves as farmers have the time, money or even the desire to implement new technologies. Policy-makers need to ensure that the knowledge and technologies that are generated by the agricultural research community are compatible with, and available to, the right target groups. A portfolio of flexible, inclusive farm-level interventions is needed with attractive technologies matching the diversity of producers in SSA.

Similarly, enabling governments to provide services to poor, rural households to ensure they have access to safe, nutritious and sufficient food all year round has to be a priority. To assume that farming households alone will be the agents of this change in rural areas does not acknowledge that microeconomic decisions and successes are intrinsically linked to their ability to participate in a functional, farmer-friendly rural economy. Agricultural development programs that focus on smallholders as their main clients would benefit from shifting the focus on crop yields towards agricultural products, ensuring that support services and policy incentives are provided along the entire value chain, delivering field-level interventions as part of more integrated programs.

Undoubtedly, investments onto the agricultural sector are important and necessary but the chances of making these investments work for farming households depend on the understanding of their livelihoods’ structures and the links between the agricultural and other sectors as well as rural and urban areas.

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) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The development of this article was supported by the CGIAR Research Programs on: Forests, Trees and Agroforestry (FTA), specifically the Sentinel Landscape Initiative; Grain Legumes and Dryland Cereals (GLDC); Policies, Institutions, and Markets (PIM). Additional support was provided by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the Centre for International Migration and Development (CIM). The content of the article is the sole responsibility of the authors

and does not necessarily represent the views or endorsement of these funding bodies.

ORCID iD

K Mausch  <https://orcid.org/0000-0002-2962-7646>

Notes

1. The authors recognize that some measurement issues arise from the fact that poverty measures do value home consumption and thus have some level of food security overlap embedded.
2. The analysis was confined to crop technologies; profits from livestock were not included.

References

- AGRA (2016) Africa agriculture status report 2016: progress towards agricultural transformation (Nairobi).
- CCAFS (2015) CCAFS household baseline survey 2010–2012. Harvard Dataverse. DOI: 10.7910/DVN/IUJQZV.
- Dercon S, Gilligan DO, Hoddinott J, et al. (2009) The impact of agricultural extension and roads on poverty and consumption growth in fifteen Ethiopian villages. *American Journal of Agricultural Economics* 91: 1007–1021.
- Dercon S and Gollin D (2014) Agriculture in African development: theories and strategies. *Annual Review of Resource Economics* 6: 471–492.
- Dorward A, Anderson S, Bernal YN, et al. (2009) Hanging in, stepping up and stepping out: livelihood aspirations and strategies of the poor. *Development in Practice* 19: 240–247.
- Dorward A, Fan S, Kydd J, et al. (2004) Rethinking agricultural policies for pro-poor growth. *Natural Resource Perspectives* 94: 1–4.
- Duflo E, Kremer M, and Robinson J (2011) Nudging farmers to use fertilizer: theory and experimental evidence from Kenya. *American Economic Review* 101(6): 2350–2390.
- Dzanku FM, Jirstrom M, and Marstorp H (2015) Yield gap-based poverty gaps in rural Sub-Saharan Africa. *World Development* 67: 336–362.
- Ellis F and Freeman HA (2004) Rural livelihoods and poverty reduction strategies in four African countries. *Journal of Development Studies* 40(4): 1–30.
- FAO (2017) Family Farming Knowledge Platform. Smallholders dataportrait. Available at: <http://www.fao.org/family-farming/data-sources/dataportrait/en/> (accessed 11 November 2019).
- FAO, IFAD, UNICEF, et al. (2019) *The State of Food Security and Nutrition in the World 2019. Safeguarding Against Economic Slowdowns and Downturns*. Rome: FAO.
- Gassner A, Coe R, and Sinclair F (2013) Improving food security through increasing the precision of agricultural development. In: Oliver M, Bishop T and Marchant B (eds) *Precision Agriculture for Sustainability and Environmental Protection*. Abingdon: Earthscan, Routledge, pp. 34–57.
- Gatzweiler FW and von Braun J (2016) Innovation for marginalized smallholder farmers and development: an overview and implications for policy and research. In: Gatzweiler F and von Braun J (eds) *Technological and Institutional Innovations for Marginalized Smallholders in Agricultural Development*. Cham: Springer, pp. 1–22.
- Glover D, Sumberg J, Ton G, et al. (2019) Rethinking technological change in smallholder agriculture. *Outlook on Agriculture* 48(3): 169–180.
- Godfray HC, Beddington JR, Crute IR, et al. (2010) Food security: the challenge of feeding 9 billion people. *Science* 327: 812–818.
- Godfray HCJ and Garnett T (2014) Food security and sustainable intensification. *Philosophical Transactions of the Royal Society B* 369. DOI: 10.1098/rstb.2012.0273.
- Haggblade S, Hazell P, and Reardon T (2010) The rural non-farm economy: prospects for growth and poverty reduction. *World Development* 38(10): 1429–1441.
- Harris D (2019) Intensification benefit index: how much can rural households benefit from agricultural intensification? *Experimental Agriculture* 55(2): 273–287.
- Harris D and Orr A (2014) Is rainfed agriculture really a pathway from poverty? *Agricultural Systems* 123: 84–96.
- HLPE (2017) *Nutrition and Food Systems. A Report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security*. Rome.
- Indaba Agricultural Policy Research Institute (2012) Rural Agricultural Livelihoods Survey, unpublished data. Available at: <http://catalog.ihsn.org/index.php/catalog/7201/study-description> (accessed 11 November 2019).
- Ihli HJ, Brian C, and Musshoff O (2016) Do changing probabilities or payoffs in lottery-choice experiments affect risk preference outcomes? Evidence from rural Uganda. *Journal of Agricultural and Resource Economics* 41(2): 324–345.
- Jayne TS, Chamberlin J, and Headey DD (2014) Land pressures, the evolution of farming systems, and development strategies in Africa: a synthesis. *Food Policy* 48: 1–17.
- Jayne TS, Chamberlin J, Traub L, et al. (2016) Africa's changing farm size distribution patterns: the rise of medium-scale farms. *Agricultural Economics* 47(S1): 197–214.
- Kelley T, Ryan J, and Gregersen H (2008) Enhancing ex post impact assessment of agricultural research: the CGIAR experience. *Research Evaluation* 17(3): 201–212.
- Kimura S, Otsuka K, Sonobe T, et al. (2011) Efficiency of land allocation through tenancy markets: evidence from China. *Economic Development and Cultural Change* 59(3): 485–510.
- Lalani B, Dorward P, and Holloway G (2017) Farm-level economic analysis – is conservation agriculture helping the poor? *Ecological Economics* 141: 144–153.
- Lowder SK, Skoet J, and Raney T (2016) The number, size, and distribution of farms, smallholder farms, and family farms worldwide. *World Development* 87: 16–29.
- Mausch K, Orr A, and Miller BP (2017) Targeting resilience and profitability in African smallholder agriculture: insights from ICRISAT's research programs. *FACETS* 2: 545–558.
- Mausch K, Harris D, Heather E, et al. (2018) Households' aspirations for rural development through agriculture. *Outlook on Agriculture* 47(2): 108–115.
- Orr A, Dejen A, Galen P, et al. (2019) Smallholder risk management solutions (SRMS) in Malawi and Ethiopia – replicable business model, Ethiopia: social inclusion and impact evaluation. Oxford Policy Management Working paper, UK.

- Pingali P, Stamoulis K, and Stringer R (2006) Eradicating extreme poverty and hunger: towards a coherent policy agenda. FAO Working paper, Rome, Italy.
- Reardon T (1997) Using evidence of household income diversification to inform study of the rural nonfarm labor market in Africa. *World Development* 25: 735–747.
- Renkow M and Byerlee D (2010) The impacts of CGIAR research: a review of recent evidence. *Food Policy* 35(5): 391–402.
- Rosenzweig MR and Binswanger HP (1993) Wealth, weather risk and the composition and profitability of agricultural investments. *Economic Journal* 103: 56–78.
- Sachs J (2005) *The End of Poverty: How We Can Make It Happen in Our Lifetime*. London: Penguin.
- Smale M, Byerlee D, and Jayne T (2013) Maize revolutions in sub-Saharan Africa. In: Otsuka K and Larson DF (eds) *An African Green Revolution*. Berlin: Springer, pp. 165–195.
- Tittonell P, Muriuki A, Shepherd KD, et al. (2010) The diversity of rural livelihoods and their influence on soil fertility in agricultural systems of East Africa – a typology of smallholder farms. *Agricultural Systems* 103(2): 83–97.
- Toenniessen G, Adesina A, and DeVries J (2008) Building an alliance for a green revolution in Africa. *Annals of the New York Academy of Sciences* 1136: 233–242.
- UN (2010) *The Millennium Development Goals Report*. Washington, DC: United Nations.
- UN (2015) United Nations millennium development goals. Available at: <http://www.un.org/millenniumgoals/> (accessed 11 November 2019).
- Verkaart S, Mausch K, and Harris D (2018) Who are those people we call farmers? Rural Kenyan aspirations and realities. *Development in Practice* 28(4): 468–479.
- Vorley B, Cotula L, and Chan MK (2012) Tipping the balance: policies to shape agricultural investments and markets in favour of small-scale farmers. *Oxfam Policy and Practice: Private Sector* 9: 59–146.
- Wanjala BM and Muradian R (2013) Can big push interventions take small-scale farmers out of poverty? Insights from the Sauri millennium village in Kenya. *World Development* 45: 147–160.
- Watts MJ and Bohle HG (1993) The space of vulnerability: the causal structure of hunger and famine. *Progress in Human Geography* 17: 43–67.
- World Bank (2015) *World Development Report 2015: Mind, Society, and Behavior*. Washington, DC: World Bank. DOI: 10.1596/978-1-4648-0342-0.
- World Bank (2016) *Poverty and Shared Prosperity 2016: Taking on Inequality*. Washington, DC: World Bank. DOI: 10.1596/978-1-4648-0958-3.
- World Bank (2018) *Poverty and Shared Prosperity 2018: Piecing Together the Poverty Puzzle*. Washington, DC: World Bank.