

Agricultural productivity in Kenya: barriers and opportunities

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Question

What are the most significant barriers to and opportunities for increasing long term sustainable agricultural productivity in Kenya? Please investigate where possible:

- 1. Barriers and opportunities that factor broader concepts such as climate change, urbanisation, or population growth.*
- 2. Reasons for the decline or stagnation of agricultural productivity in Kenya in recent years, relative to neighbouring countries.*
- 3. Barriers and opportunities across the entire value chain, rather than just at-farm.*

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1. Executive summary

The principal barriers to agricultural productivity in Kenya are clustered in six areas:

- **Land and population pressures:** Average farm size is falling and land distribution is becoming more concentrated, leading to significant constraints on production, particularly for smallholders.
- **Agricultural research and development and agricultural extension¹:** The proportion of farmers accessing extension advice is low, while extension services tend to favour wealthier farmers. Government spending on agricultural research has fallen steadily over the past decade.
- **Markets:** Government intervention in cereal markets distorts production and diverts resources from investments that might be more effective and efficient in improving productivity. While physical access to markets has generally improved, farmers report a number of institutional barriers and transaction costs related to market information and marketing processes. Access to credit is a constraint across the sector.
- **Climate change:** Changes in temperature and in the variability of rainfall are likely to have significant effects on agricultural production, but impacts may be different for different crops.
- **Soil fertility and land degradation:** Adoption of sustainable land management practices is low, and land degradation increasing.
- **Public expenditure:** Kenya is not meeting African Union commitments on public spending in agriculture, and spends less than its immediate neighbours. Its subsidy schemes are regressive and distortionary.

Some of the opportunities to increase agricultural productivity concern the following:

- **Re-orienting public expenditure from private to public goods,** particularly to agricultural research and development, extension and training, and measures that reduce market transaction costs.
- **Farmer-centred approach:** The knowledge of farmers themselves is often overlooked. There is also an association between women's empowerment and productivity. New forms of farmer organisation may be required.
- **Farmer services:** Index insurance in the agriculture sector is expanding and demonstrating results, as are digital technologies that facilitate market access. Measures to bring financial and agricultural markets closer together could improve productivity.

The scope of this report does not include the livestock sub-sector. Pastoral and agro-pastoral livestock production is covered in a separate report. No good quality information about the relationship between agricultural productivity and devolution since 2013 was found.

¹ Agricultural extension is the application of scientific research and knowledge to agricultural practices through farmer education. See for example: <https://ag4impact.org/sid/socio-economic-intensification/building-human-capital/agricultural-extension/>

2. Overview of the agriculture sector in Kenya

The agriculture sector contributes 51 percent of Kenya's GDP (26 percent directly and 25 percent indirectly) and accounts for 60 percent of employment and 65 percent of exports (World Bank, 2018, p. 35). The sector is dominated by smallholder production on farms of between 0.2 and 3 hectares, which account for 78 percent of total agricultural production and 70 percent of commercial production (World Bank, 2015, pp. 2-3). Agricultural GDP is driven by horticulture and cash crops, but productivity is low, particularly for cereals. Given that most of the poor are in the agriculture sector, productivity also matters for poverty reduction. Agriculture sector growth accounted for the largest share of poverty reduction between 2005 and 2015 (World Bank, 2018, pp. 20, 35).

Historical analysis of agricultural total factor productivity in sub-Saharan Africa shows that Kenya was one of the few countries to record steady, if modest, long-term growth between 1961 and 2008 (Fuglie and Rada, 2013, pp. 15, 37). However, there are concerns that productivity is declining: maize yields per hectare were lower in 2014 than in 1994 (World Bank, 2018, p. 35). Between 1990/92 and 2014/16, Kenya was one of the few countries in sub-Saharan Africa to experience an overall decline in maize yields (Wiggins, 2018, p. 27). More positively, Kenya's horticulture sub-sector continues to record dynamic growth (Matchmaker Associates, 2017).

Table 1 provides a selection of data from Kenya, Ethiopia and Uganda, illustrating changes over time and comparisons between countries. Some striking features are the scale of government expenditure in Ethiopia, compared with Kenya and Uganda, and that both Ethiopia and Uganda have overtaken Kenya in terms of cereal yield.

Table 1: Agriculture sector indicators, Kenya, Ethiopia and Uganda

	1995			2005			2016		
	Kenya	Ethiopia	Uganda	Kenya	Ethiopia	Uganda	Kenya	Ethiopia	Uganda
Population (total, millions)	27.3	57.3	20.6	36.0	76.7	28.5	49.7	105.0	42.9
Rural population (total, millions)	22.4	49.1	18.3	28.0	64.2	25.0	36.1	82.7	35.6
Government expenditure on agriculture (% total outlays)	-	-	-	3.9	15.9	3.1	1.5	17.5 ²	4.0
Employment in agriculture (%)	45.9	89.4	81.3	41.4	80.2	82.1	38.1	69.0	75.8
Agriculture value added per worker (constant US\$)	1,496	281	664	1,868	321	656	2,013	538	575
Agriculture, value added (% GDP)	26	52	37	21	42	27	33	34	23
Cereal yield (kg/hectare)	1,753	1,034	1,571	1,646	1,361	1,574	1,628	2,325	2,019

Source: <http://www.fao.org/faostat>

² Figure for 2014. www.fao.org/3/a-i4691e.pdf

3. Barriers to agricultural productivity

Demographic and land pressures

Sub-Saharan Africa is the only region of the world where the rural population will continue to grow beyond 2050 (Jayne et al, 2017, p. 3). Figures 1 and 2 compare Kenya’s overall population growth and rural population growth with that of other countries in sub-Saharan Africa. In common with most other countries on the continent, the number of Kenyans employed in farming continues to increase in absolute terms, but is falling as a share of the workforce (Yeboah & Jayne, 2016, p. 15).

Figure 1: Population growth, 1990-2015

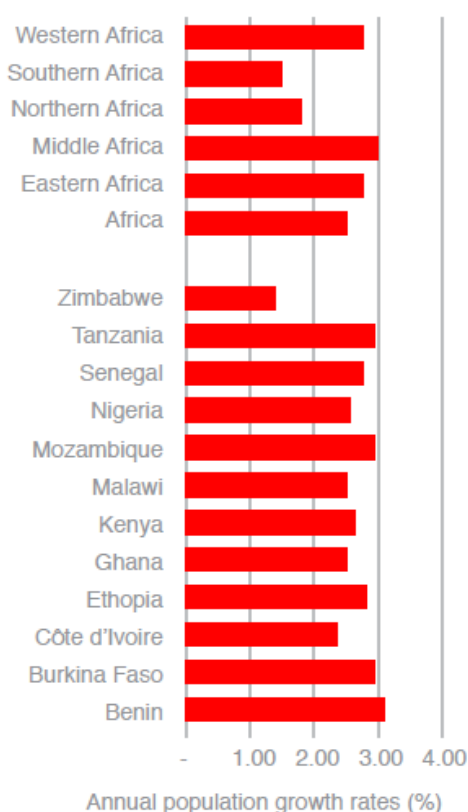
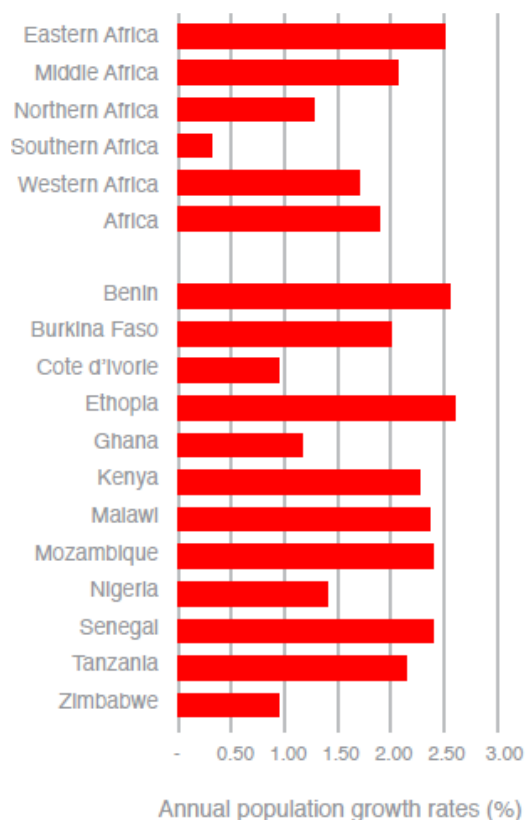


Figure 2: Rural population growth, 1990-2015



Source: Wiggins, 2018, p. 23

The average age of the Kenyan farmer is widely referred to as being 60 years, although the original source for this statistic has not been found in the time available for this review.³ An alternative perspective is offered by Jayne et al (2017, pp. 16-18) in their cross-country study on the future of work in African agriculture. Drawing on census data, they calculate that the mean age of Kenyans above 15 years engaged in agriculture rose from 35 in 1999 to 37 in 2009. Of the nine countries studied, three had experienced a small increase in the mean age, three a small decrease, and three were stable.

³ Some media articles attribute it to FAO. The FAO Country Programming Framework for Kenya, 2014-2017, mentions a figure of 55 years (p. 9), the source for which is given as a September 2017 article on The Young Agropreneur blog. www.fao.org/3/a-bp634e.pdf.

Whatever the actual figure, young people in rural areas of Kenya face particular challenges associated with population growth and land pressures. For example, by the late 1990s in Nyeri, land was no longer possible as an inheritance, leading parents to substitute education for land as an endowment to their children (Keats & Wiggins, 2016, p. 52). Around one-quarter of young Kenyans start their family lives without having inherited any land from their parents (Yeboah & Jayne, 2016, p. 50).

An increase in the average age of farmers may be a consequence not only of young people leaving the sector but of older people moving in. The fastest growing segment of the population entering farming is urban investors above 45 years (Table 2).

Table 2: Changes in primary employment of working age population in Kenya

	# people in working age population			Annual % change in # working age population in age categories				
	1999	2009	Annual % change	15-24	25-34	35-44	45-54	55-64
Urban								
Male	199,500	290,280	4.6	1.8	4.7	5.4	7.6	10.9
Female	295,820	547,510	8.5	7.8	9.2	7.6	9.2	10.0
Rural								
Male	2,345,220	2,423,090	0.3	-1.8	1.3	2.0	1.8	2.5
Female	3,217,540	3,229,510	0.0	-1.6	0.8	0.6	1.3	1.2

Source: Drawn from Yeboah & Jayne, 2016, p. 78 (based on Kenya Population and Housing Census)

Between 2009 and 2014, the percentage of Kenya's landholdings held by urban households increased from 22 percent to 32.1 percent (Jayne et al., 2016, p. 207). While some of these medium-scale farms are sources of dynamism and commercialisation, they present possible risks for smallholder farmers, such as worsening land scarcity and inequalities in access to power and resources. For example, larger farmers are better placed than smaller farmers to make use of evolving land markets and to influence agricultural policies and public expenditure in their favour. Moreover, there may be less direct benefit for local rural economies if a larger part of the revenue from agriculture is spent by urban-based investors (Jayne et al., 2016). However, rural-urban distinctions are not always clear-cut; more than one-third of Kenyan households divide themselves between rural and urban homes (Moore, 2018, p. 10).

Population growth is driving a steady fall in the average farm size in Kenya (Masters et al., 2013; Muyanga & Jayne, 2014; Casaburi et al., 2016; Moore, 2018). Between 1997 and 2010, the mean size of smallholder farms fell from 2.28 to 1.86 hectares (Masters et al, 2013, p. 3). By 2010, 40 percent of the rural population was living on five percent of rural land (Muyanga & Jayne, 2014, p. 99). Ever-smaller farm sizes may undermine the capacity of households to generate a surplus and thus to finance, among other things, the inputs needed to improve productivity. Land size is positively associated with commercialisation; limited access to land and other assets constrains participation in markets, even in situations where the conditions to access them may otherwise have improved (Olwande et al, 2015).

While Muyanga & Jayne (2014, p. 10) find that productivity improves with rising population density, this applies only up to around 550-600 persons/km². Beyond that point – which they

estimate is relevant to a significant minority of the rural population (20 percent and growing) - the net value of crop output per unit of labour declines.

Land distribution is becoming more concentrated. Between 1997 and 2010, the Gini coefficient for farm size distribution increased (Masters et al., 2013, p. 3). Table 3 illustrates the change in the proportion of land in Kenya operated by small- and medium-scale farms (up to 100 hectares) over a 12-year period. The authors attribute the growth of farms below five hectares and the sharp decline of those between five and ten hectares to subdivision. They also highlight evidence that in countries where land distribution is less equal, agricultural growth is associated with widening inequality, and that more inclusive agricultural growth will have stronger impacts on poverty (Jayne et al., 2016, p. 212; also Kirsten et al., 2013).

Table 3: Percentage of total operated land on farms between 0-100 hectares

Farm size (hectares)	1994	2006
0-5	61.5	72.0
5-10	21.4	2.3
10-100	17.1	22.7
Total	100	100

Source: Jayne et al, 2016, p. 204.

Inter-ethnic conflict and the theft of crops and livestock are some general risks facing the agriculture sector (D'Alessandro et al., 2015), but there is also evidence that land disputes undermine agricultural productivity. Research by Muyanga and Gitau (CEEPA, 2011) explored the effect of land disputes on farmers' decisions about input use and crop management. The study focused on two types of intervention: the use of manure (regarded as a long-term investment in productivity, since nutrients are released slowly) and the use of fertiliser (regarded as a short-term investment, since nutrients are absorbed directly by plants).

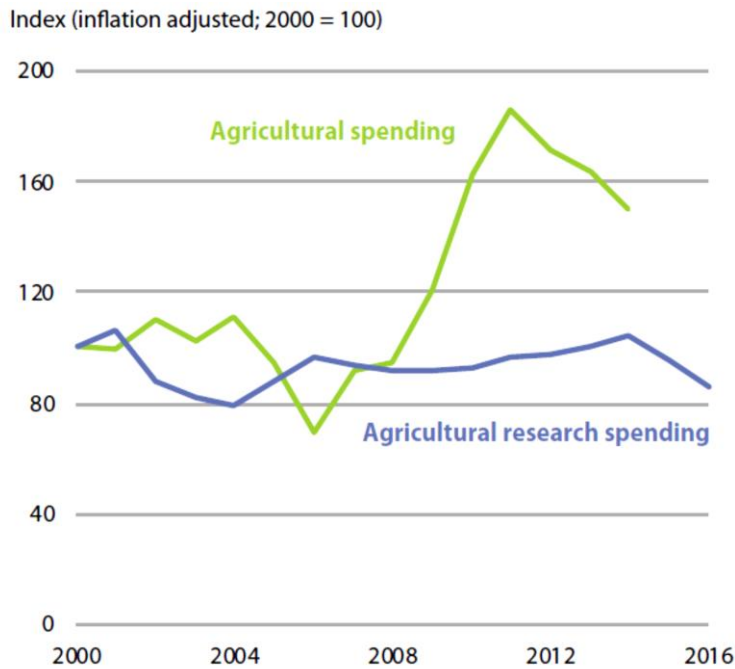
The authors found that land conflicts undermine the optimal use of plots. Actual land disputes were found to reduce land productivity by about 13 percent, while concerns about future disputes reduced it by about nine percent. Those farming disputed plots tend to plant fewer crops, use fewer inputs, and practice less crop care. Farmers' concerns about actual or potential disputes (particularly those related to inheritance) affected their decisions about manure, but not fertiliser. Land conflicts also influenced the type of crops planted: for example, perennial crops, which are often cash crops, were more likely to be planted on plots whose ownership was not contested. The study also explored other factors influencing the use of inputs: for fertiliser, these were found to be plot size, household income, and distance from home; for manure, they were plot slope, distance, the gender of the household head, household income, and the number of cows owned. Given the challenges already associated with population pressure and soil fertility, the authors emphasise the importance of effective mechanisms to resolve land disputes.

Agricultural research and development and agricultural extension

Government spending on agricultural research as a proportion of GDP has fallen steadily over the past decade. By 2016 it was 0.48%, approximately one-third of its value in 2006 (Beintema et al., 2018) and well below the African Union target of one percent (Figure 3). Kenya has 1,158 full-time equivalent agricultural researchers, compared with 3,025 in Ethiopia. The freeze on hiring in the civil service, and the large proportion of senior researchers approaching retirement age, will exacerbate these capacity challenges (Beintema et al., 2018).

The under-investment in agricultural research is striking when set against its potential rates of return, which are estimated at an average of 34 percent in sub-Saharan Africa (Goyal & Nash, 2017, p. 17). Beintema et al. (2018) suggest establishing an agricultural research fund, and re-allocating revenue from commodity taxes (coffee, sugar, tea) back to research.

Figure 3: Spending on agriculture and agricultural research



Source: Beintema et al, 2018.⁴

The proportion of Kenyan farmers who receive extension advice is low. In a survey across 38 of the 47 counties, 21 percent of sampled households accessed extension services in 2013-14, 81 percent of them male-headed and 19 percent female-headed. Most (59 percent) used the public extension system.⁵ A major constraint is insufficient qualified personnel: the ratio of national extension staff to farmers is 1:1,000, compared with the recommended 1:400 (Wanyama et al., 2016, p. 23). By contrast, Ethiopia has one extension agent for every 472 farmers, and spends almost all of its (large) agriculture budget on extension (World Bank, 2018, p. 36). Extension services in Kenya also tend to favour the wealthy: Wanyama et al. (2016) found that public extension providers and private for-profit providers were better represented among higher income groups, with the distribution of private non-profit providers slightly more equal.

⁴ The authors note that data on agricultural spending are from SPEED 2015 (www.ifpri.org/publication/statistics-public-expenditures-economic-development-speed). Agricultural spending only includes funds derived from national governments; agricultural research spending includes funds derived from governments, donors, development banks, producer organizations, and revenues generated internally by research agencies.

⁵ On the contrary, Mulinge et al (2016) found that agro-dealers were farmers' primary source of information about sustainable land management practices.

Markets

The Kenyan government continues to intervene in cereal markets, particularly in the supply of inputs. The fertiliser market was liberalised in the early 1990s, and the bulk of fertilisers are now imported and distributed by the private sector, but the government still procures and distributes substantial quantities through its subsidy programmes. This has led to “uncertainty over the timing of delivery and year-on-year support... poor targeting of subsidies... late planting and high farmer dependency” (D’Alessandro et al., 2015, p. 41).

In their comparative review of the impact of agricultural input subsidy programmes (ISP) in seven countries,⁶ Jayne et al (2018) find that:

- These programmes tend to partially crowd out commercial fertiliser demand and divert the benefits of subsidies, hence reducing their impact. The magnitude of these effects varies across countries, but as the authors note (p. 8), they are “logically largest in Kenya, where private sector fertiliser markets were well developed and most farmers already used fertilizer before the introduction of subsidies”. An additional 100kg of ISP fertiliser is estimated to crowd out up to 50kg of commercial fertiliser in Kenya (compared with 13kg in Zambia).
- Crop yield response to fertiliser on most smallholder-managed fields is lower than expected, partly because farmers are using the inputs under adverse agro-ecological conditions. This leads the authors to recommend complementary actions that may increase the returns to ISPs, such as agricultural research, development and extension, but which may currently be crowded out by heavy government spending on subsidies.

Kenya’s previous input subsidy programme which ended in 2014 (the National Accelerated Agricultural Inputs Access Programme, *Kilimo Plus*), was more effectively targeted to poorer households than the current universal programme implemented through the National Cereals and Produce Board. Mason et al (2017) find that *Kilimo Plus* increased yields and reduced the severity of poverty. Even so, the authors conclude by questioning whether ISPs are the best use of scarce resources. They recommend a more holistic approach to enhancing productivity and reducing incomes, which may entail “complementary public/private investments in research, extension, irrigation, transport infrastructure, information as well as affordable and appropriate innovations” (p. 3). As Sitko et al (2017) explain, there are powerful political economy reasons why these subsidies persist, although the authors note that the scope and scale of state involvement relative to some other countries is moderated somewhat by Kenya’s structural maize deficit, competitive small-scale milling sector, and diverse agricultural economy (p. 248).

A Campbell systematic review of agricultural input subsidies found that while they can increase yields and income, their effectiveness depends significantly on programme design.⁷ The review also notes “much evidence that subsidy schemes are prone to inefficiency, bias and corruption” (Hemming et al, 2018, p. 6).

Access to markets, such as those for agricultural inputs, depends on both infrastructure and institutions. Chamberlin and Jayne (2013) note that access to markets and services generally

⁶ Ghana, Nigeria, Kenya, Tanzania, Malawi, Zambia, and Ethiopia.

⁷ The review was of 31 studies, 27 in sub-Saharan Africa, though none in Kenya.

improved during the period they examined (1997 to 2010). Areas conventionally characterised as “remote” in terms of their physical access still had competitive local marketing conditions, with large numbers of independent traders buying directly from farms; the spread of telecommunications technology had helped reduce transaction costs for the private sector. However, farmers still reported market-related barriers which were (in order of frequency mentioned): (i) traders under-weighting commodities; (ii) traders offering low prices; and (iii) traders having more access to information than farmers.

A systematic review of the literature on agricultural commercialisation in sub-Saharan Africa reached similar conclusions. Kirsten et al. (2013) identify four factors hindering successful commercialisation:

- i. *The socio-economic characteristics of smallholder producers*, such as their education, gender, asset base, and access to labour, suggesting that market incentives alone are insufficient for commercialisation. Olwande et al. (2015) find the same for Kenya in their study of maize, kale and milk, noting that diversifying to higher-value sub-sectors such as horticulture and dairy will face the same underlying constraints on productivity.
- ii. *Lack of access to sufficient agricultural support services*, such as market information, credit, advisory services, and input markets.
- iii. *Transaction costs and other institutional factors*: examples include the power imbalance between producers and buyers, and challenges with contract negotiation, transportation, processing and storage.
- iv. *Infrastructure gaps*, particularly irrigation, electricity, roads and ICT.

Like Chamberlin and Jayne (2013), Kirsten et al. (2013) note that the conventional emphasis on transport in discussions of transaction costs can obscure important institutional issues; they give some examples of police protection, contract enforcement, the standardisation of goods, and mechanisms for inspection and certification.

Where input and output markets are weak, and access to insurance is limited, smallholder farmers are using crop diversification as a mechanism to manage risk (Ochieng et al., 2016). However, revenue does not necessarily rise as crop production systems become more diversified. The authors speculate that the larger number of crops may be a disincentive to invest in improved seed varieties and fertilisers.

Despite the strong performance of the horticulture sub-sector, it also faces a number of productivity challenges, several of which are associated with market failings. They include: (i) constraints on credit to finance inputs and capital investments; (ii) lack of processing facilities closer to sites of production in order to reduce post-harvest losses; (iii) lack of an effective market information system and associated infrastructure; (iv) infrastructure gaps, such as electricity for cold storage facilities, irrigation, and agro-processing; and (v) multiple forms of taxes at both national and local levels (Matchmaker Associates, 2017, p. 3).

Agricultural finance as a whole is a constraint. Financial service providers generally perceive agriculture as high-risk and seek to reduce their exposure to the sector, illustrated by the fact that agricultural credit is only 4.3 percent of total private sector credit (Nathan Associates, 2017). The credit needs of key commodity chains in 2015 were estimated to be Kshs. 130 billion, but the credit to the sector only Kshs. 40 billion (World Bank, 2018, p. 37).

Climate change

While *average* annual rainfall is likely to increase due to climate change, changes in the *variability* of rainfall are expected to be more significant for agricultural production (Bryan et al., 2011). Ochieng et al. (2016) suggest that temperature has a greater impact on production than rainfall. Climate impacts are likely to be crop-specific. In their study of smallholder maize and tea production, Ochieng et al (2016) find that temperature increase has a positive effect on revenue from tea but a negative effect on revenue from crops, while the impact of increased rainfall is the reverse (positive for crops and negative for tea).

Measures to reduce climate risk in the agriculture sector may also improve growth and productivity (D'Alessandro et al., 2016, p. 23). In their review of land management practices and adaptation strategies, Bryan et al. (2011) found that soil nutrient management (combining inorganic fertiliser, mulching and manure) was a key triple-win strategy that increases soil carbon sequestration, boosts yields, and increases revenue. It therefore has benefits not just for climate adaptation and mitigation but for productivity. However, the authors note potential trade-offs as new practices are introduced (such as short-term drops in production), and caution that the most effective strategies will be specific to different crop types, planting calendars, and agro-ecological zones.

Further policy measures to help climate-proof the agriculture sector include: (i) increasing the adoption of drought-tolerant varieties, which can achieve 20-30 percent higher yields than non-drought tolerant varieties; (ii) improving water management systems, such as efficient surface irrigation, precision irrigation, and sustainable harvesting of aquifers; and (iii) developing agro-weather forecasting, monitoring and dissemination tools (World Bank, 2017, pp. 22-23).

Soil fertility and land degradation

Soil fertility in Kenya is already poor and associated with low yields (Bryan et al., 2011). For example, most smallholder maize yields in Kisii are less than two tons per hectare, compared with on-station yields of about nine tons per hectare, the result of continuous cropping, soil erosion, and the absence or underuse of organic and inorganic fertilisers (Mulinge et al., 2016, p. 473).⁸ Mulinge et al. (2016) estimate the annual costs of land degradation in Kenya between 2001 and 2009 at US\$ 1.3 billion.

Sitko and Jayne (2018, pp. 13-16) estimated that in 2010, 37 percent of the rural population was living on degraded land, and 78 percent of these (29 percent of the total rural population) were in non-remote⁹ areas. The authors suggest that “the social challenges of land degradation are largely concentrated in more market-accessible regions, where rural populations typically cluster, and where incentives for land intensification are greatest” (p. 15) and recommend enabling farmers to make long-term investments in improving soil fertility, helping farmers identify best practices for their specific micro-environment, and making “labor and financial markets more flexible and supportive of climate-smart outcomes” (p. vi).

⁸ However, Jayne et al (2018, p. 4) note that on-farm trials generally take place in more favourable agronomic conditions than those available to smallholder farmers.

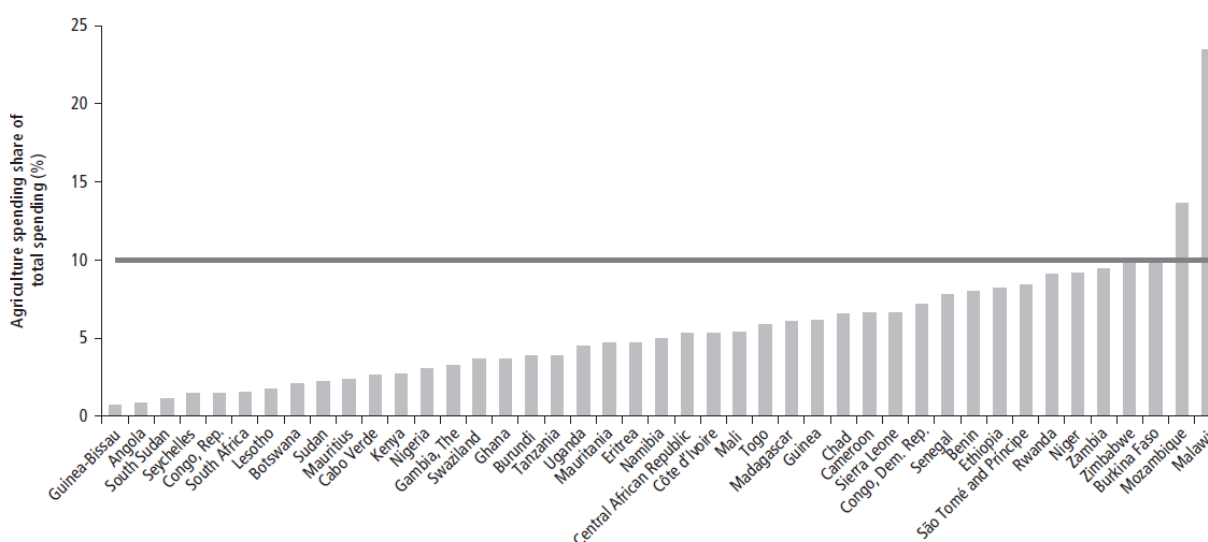
⁹ 'Remote' is defined as more than five hours' travel time from an urban market of 50,000 people or more.

Analysis of baseline data for the Agriculture Sector Development Support Programme revealed that only 40 percent of surveyed households practised some form of sustainable land management (SLM). The primary constraint was reported to be cost, followed by lack of information, lack of expertise, and lack of access at the right time. Agro-dealers were the main source of knowledge and extension, followed by the government extension system. The adoption of SLM technologies increased by 43.7 percent for those with access to government extension officers and by 12.3 percent for those with access to market information (Mulunge et al., 2016).

Public expenditure

Most countries in sub-Saharan Africa are not meeting the target of allocating at least ten percent of public expenditure to agriculture, reaffirmed in the Malabo Declaration in 2014, but Kenya spends less than its regional neighbours (Figure 4). In 2016/17, its allocation to the agriculture sector was less than two percent of total expenditure, well below the average for sub-Saharan Africa of 4.5 percent (World Bank, 2018).

Figure 4: Agricultural spending as a share of total spending, 2014



Source: Goyal & Nash, 2017, p. 68.¹⁰

However, the commitment in the Malabo Declaration is not just to increase public spending on agriculture but to “ensur[e] its efficiency and effectiveness”, the concern being the quality, as well as the quantity, of investment. Goyal and Nash (2017) suggest that too much public spending on agriculture in Africa goes on activities which generate low returns, and that improving the quality of public spending would strengthen the case for increasing its quantity.

An earlier section noted the government’s continued intervention in cereal markets. Kenya spends US\$ 89 million annually on input subsidies (Goyal & Nash, 2017, p. 27). The current fertiliser input subsidy scheme disproportionately benefits larger farmers while crowding out the private sector. The maize subsidy scheme is also regressive, and incentivises maize production

¹⁰ The authors note that the figure represents public agricultural spending share in sub-Saharan countries.

on marginal lands where more drought-resistant crops would be more suitable (World Bank, 2018, p. 36). Re-orienting public expenditure is an area of opportunity for the sector.

4. Opportunities to increase agricultural productivity

Theoretically, some of the challenges facing the agriculture sector are potential opportunities: population growth and urbanisation increase the demand for food, while the agricultural trade deficit provides scope for domestic production to substitute imported production (Wiggins, 2018). This section discusses a number of actions suggested in the literature to improve the productivity needed to realise these opportunities.

Policy priorities

Goyal & Nash (2017) identify four areas of public spending likely to support agricultural productivity, summarised in Table 4. They also discuss the outcomes of research into policies most likely to raise agricultural productivity in sub-Saharan Africa. While noting that investment is required across multiple sectors, productivity improvements have been led by investments in technology, the adoption of that technology, and reforms that strengthen farmers' economic incentives (Table 5).

Table 4: Types of beneficial public spending in agriculture

Pathway	Types of spending
To generate knowledge	Agricultural research and development
To disseminate knowledge and build human capital	Extension, training and information services, which are increasingly important as agricultural production becomes more knowledge-intensive
To reduce transaction costs	Soft and hard infrastructure that improves access to input and output markets, such as rural roads, market information dissemination, land market development, contract enforcement
To attract private capital	Coordination of public and private investment helps crowd in private capital (such as financing large irrigation infrastructure, which then makes it profitable for farmers to make small on-farm investments)

Source: Goyal & Nash, 2017, p. 51

Table 5: Drivers of agricultural productivity in sub-Saharan Africa

	Contribution to cumulative total factor productivity growth (%)
Agricultural research & development	51
Improvement in agriculture's terms of trade with market & trade policy reform	20
Reduction in conflict	18
Increase in farmer education	8
HIV/AIDS therapy to adult population infected	2

Source: Goyal & Nash, 2017, p. 25¹¹

¹¹ The original source for this table is a study by Fuglie and Rada (2013) of the long-term performance of agriculture in sub-Saharan Africa. Kenya was one of the nine countries among the 31-country sample for which data was available on all variables.

Ayenuw and Arquitt (2018) discuss the results of a simulation exercise using the Threshold-21 model to assess the potential effectiveness of different policies on Kenya's agricultural targets, and on the Sustainable Development Goals. The six policy scenarios they model are:

- i. Business as usual
- ii. Irrigation expansion
- iii. Improved farmer organisation to facilitate access to markets and finance
- iv. Increased input subsidy
- v. Farmer training in sustainable agriculture
- vi. A combination of ii, iii and v.

Their model suggests that the greatest impact on agricultural production, and on reducing poverty and undernourishment, might be achieved through the combined strategy; that input subsidy has the lowest impact on production; and that farmer training has the greatest impact on yield.¹² They caution that there are natural limits to some scenarios (such as irrigation) and that the diversity of agro-ecological zones and farming systems in Kenya requires modelling on a much finer scale. Nevertheless the findings reinforce points made earlier about the need to re-focus agriculture spending priorities, and the importance of research and extension as agricultural practices become more knowledge-intensive.

Farmer knowledge and organisation

While technology is important in boosting productivity, Atela et al. (2018) emphasise the knowledge and capacities of farmers themselves. Their research in Machakos, Siaya and Kisumu found that technological developments had rarely been informed by farmers' own perceptions and priorities, or by their particular socio-economic and cultural circumstances. An overly technocratic approach, which tends to characterise 'green revolution' debates, ignores the critical role of farmers in determining whether new external ideas are accepted and adopted.

Farmers in areas where soil fertility was declining had increased their use of fertiliser to boost production, but had never been asked their views on the pricing, types or quantities of fertiliser, and other inputs they required. The authors suggest that there has been no long-term or consistent approach to research and technology development, and therefore no sustained adoption of new practices. Farmers' cooperatives and farmer organisations could be channels for farmers to access technologies, influence their design, and foster grassroots innovation.

In their systematic review of the literature on agricultural commercialisation and inclusive growth in sub-Saharan Africa, Kirsten et al. (2013) identify three factors that facilitate successful commercialisation, the common feature being that they all bring the market closer to producers and reduce transaction costs:

- i. Farmer organisation, collective action and innovation
- ii. Information and direct access to markets
- iii. Finance and credit.

¹² All the scenarios assume that Kenya meets the ten percent budget allocation to the agriculture sector.

With regard to the first, the study recommends new thinking on farmer organisation. The suggested model has three inter-related components: (i) a non-profit national producer organisation, which engages in policy dialogue and supports farmer organisation; (ii) a for-profit marketing company, which sources markets, conducts contract negotiations, and ensures quality requirements, and in which farmer organisations would be shareholders; and (iii) a non-profit research and development department, which carries out research for farmer organisations and market research for the marketing company.

Women's empowerment

Research in nine counties of Western Kenya found that greater empowerment of women had a significant impact on maize productivity in plots managed by either women or men, though not on plots managed jointly (Diirro et al., 2018). The study used the six component indicators of the Abbreviated Women's Empowerment in Agriculture Index: (i) input in productive decisions; (ii) asset ownership; (iii) access to and decisions on credit; (iv) control over the use of income; (v) group membership; and (vi) workload. Five of the six indicators were found to be positively and significantly associated with higher yields, with the first (input in productive decisions) having the greatest effect. The sixth indicator (the amount of time women worked) had no effect.

The fact that almost all indicators have a significant effect on productivity leads the authors to suggest that there may be a range of possible interventions, from financial inclusion (such as savings, credit, asset-building) to social organisation (such as community associations for women). As a general recommendation, programmes seeking to improve agricultural productivity could achieve greater impact if they integrate measures to empower women.

Financial services

Recent studies of agricultural index insurance point to rapid growth and tangible benefits for farmers buying these products. In their assessment of Kilimo Salama, the forerunner of the Agriculture and Climate Risk Enterprise (ACRE), Sibiko and Qaim (2017) find that insurance uptake raises fertiliser intensity by 50 percent and seed expenditure by 65 percent, contributing to gains in maize yield of 60 percent.¹³ However, uptake is still limited, which the authors attribute in part to farmers' lack of understanding of how such schemes operate. They also question whether these effects would be as strong in regions where input markets are less well developed, and whether the greater use of external inputs such as fertiliser and improved seed displaces internal inputs such as organic manure. Nevertheless, Greatrex et al. (2015, pp. 13, 21) report that the number of farmers covered by ACRE increased rapidly from 2009 to reach nearly 200,000 by 2013,¹⁴ and cite data from ACRE that insured farmers have 16 percent higher income and 19 percent higher investments than uninsured farmers.

Two recommendations to address the specific challenge of collateral (World Bank, 2018, p. 37) are to pass the Warehouse Receipt System Bill, which would allow farmers to use these receipts as collateral, and to explore the use of crop and livestock insurance as collateral.

¹³ The ACRE model provides insurance as part of a productivity-enhancing package, in some cases linked to seed sales.

¹⁴ From 2013, contracts were also sold in Tanzania and Rwanda.

A scoping study of the market for agricultural leasing in eight African countries found that the highest potential for this is in Kenya, Zambia and Ghana (Nathan Associates, 2017). Kenya's advantages include the strength of its financial sector and the presence of major agricultural equipment suppliers. While the authors of the study acknowledge that there is limited capacity to absorb lease finance to any significant degree at present, they argue that bringing financial and agricultural markets closer together could contribute to agricultural productivity.

Digital technologies

In a review of innovative financial technologies to support livelihoods, Haider (2018) notes that digital financial services can offer more cost-effective and secure financial transactions in the agriculture sector, particularly for smallholder farmers. Kenya is a world leader in digital communication, and a number of mobile services (m-services) are already operating in the agriculture sector (Baumüller, 2016). Mobile penetration is now estimated at 88.1 percent of the population (Moore, 2018, citing data from the Communications Authority of Kenya). Baumüller (2016) groups these m-services into four categories:

- i. Information and learning
- ii. Financial services
- iii. Access to agricultural inputs
- iv. Access to output markets.

The first is widespread, while the second is common elsewhere but as yet limited in the agriculture sector. The review found no m-services focused on access to inputs, but several supporting access to output markets. These include platforms for disseminating price information or selling produce, and systems of supply chain management using mobiles. A review of the Agrimanagr system used by Virtual City found that it reduced the delay in payments to farmers from 89 to 31 days, reduced purchasing time, and increased average produce weight per transaction by 9-13 percent by using electronic weighing technologies (Baumüller, 2016, p. 156, citing Virtual City data).

M-Farm is a service that links buyers and sellers and provides wholesale market price information. Baumüller (2016) suggests that this kind of service could improve agricultural productivity in two ways:

- i. By encouraging technology adoption, since access to information about price and demand can reduce uncertainty about the likely profitability of a technology
- ii. By increasing prices, since market information can widen competition and improve farmers' bargaining position.

The study found that information about prices influences production processes, such as deciding what to grow and when to harvest, and encourages farmers to expand certain crops, but is less influential in introducing new ones. Its impact on farmers' negotiating position is inconclusive. Information about demand is often regarded as more important for decision-making than information about price. One-third of farmers using M-Farm still use radio for price information and regard it as comparable in quality. Radio is seen as a good source of information in the early stages of production, while M-Farm becomes more important closer to sale.

While the study finds potential to expand these services, given technological advances and lowering costs, it also expressed some reservations: that most of these services are still at a

young stage and have not been thoroughly assessed; that their development should be driven by customer need rather than by the available technology; and that they can only ever be part of a broader solution to the challenges facing the sector. Moore (2018) also cautions that the relevance of mobile phones for development lies not just in their potential to facilitate trade or convey technical information but in the way they strengthen social capital - by allowing both rural and urban residents to stay connected, provide mutual support, and contribute to agricultural decision-making.

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