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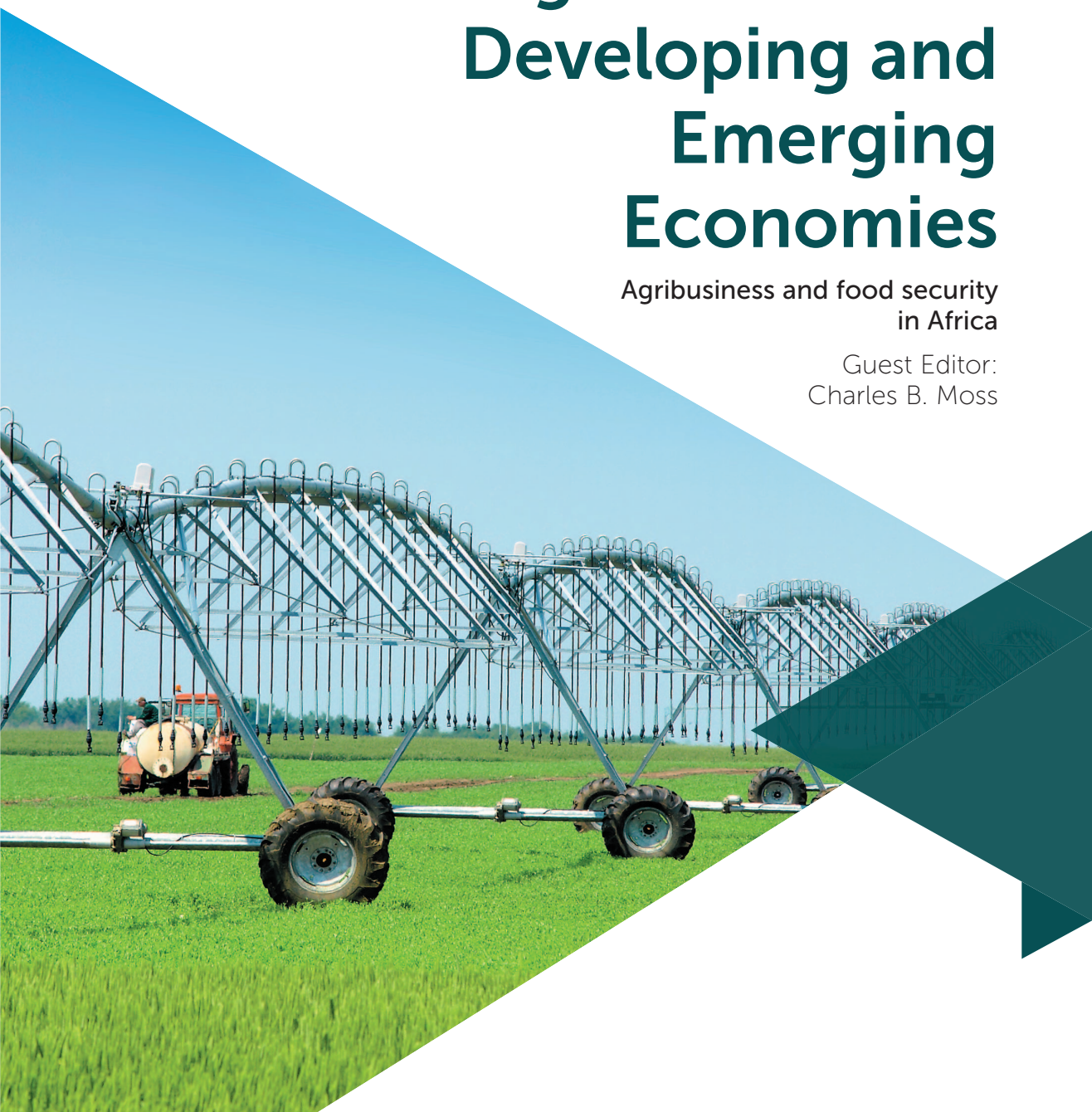
Agribusiness and food security in Africa

Guest Editor:
Charles B. Moss



Editorial boards

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Guest editorial

Impact analysis of interventions in feed the future countries in Africa

The papers in this issue examine the impact of a variety of Feed the Future efforts in North Africa. The first paper (Nagarajan, Naseem and Pray) examines the impact of maize development policies in Kenya. Maize yields in Kenya have been stagnant since the 1980s. While a variety of issues from macroeconomic considerations to shifts in the importance of trade liberalization has been identified, a large portion of the stagnation can be attributed to the slow adoption of new varieties. Nagarajan, Naseem and Pray examine the extent to which the slow adoption of new varieties of maize can be attributed to changes in government policy. They find that past R&D efforts have made marginal contributions to increase the yield. In fact, the largest impact appears to be the introduction of plant breeder rights. Based on these findings, they suggest that the R&D efforts in Kenya be directed to the adoption of new varieties that target the replacement of old varieties. In particular, the focus should be on traits that manage biotic and abiotic stresses.

Franklin and Oehmke develop a model of trust in building agribusiness channels in Africa. The "hold-up" models found in Oliver Williamson's research are well known in a developed economy context. In these models, the uncertainty of valuation in a vertical marketing channel can be overcome by one firm purchasing ownership in the next firm in the marketing channel. However, in a development context as developed in the models of Elinor Ostrom, the firms in the vertical channel lack access to capital so vertical integration is not an option. As a result, some other social convention – such as trust – must be used in place of integration. Franklin and Oehmke examine the use of trust, accountability and mutual accountability and the implementation of each factor to establish a marketing channel in African agribusiness. As a case study, they analyze the quality channel for Rwandan coffee. In general, the coffee channel developed within the context of two USAID efforts – the Partnership to Enhance Agriculture in Rwanda through Linkages and Sustainable Partnerships to Enhance Rural Enterprises and Agricultural Development. During the active intervention by USAID, trust and accountability were easier to maintain. However, the study finds that after the termination of the programs, the international market price for higher valued coffee softened and the gains in trust and accountability were more difficult to maintain.

The paper by Raile *et al.* takes a somewhat different approach to impact analysis. Specifically, this paper examines both the political and public will required to make a policy commitment in a developing economy. Specifically, Raile *et al.* examine whether the political or public will is sufficient in Senegal to make the policy commitment for Climate Smart Agriculture (CSA). From a political will perspective, Senegal has a well-defined system of leadership and that leadership has a common understanding of the problem. However, there may be a disconnect between the state problem – adoption of agricultural technologies that are resistant to climate variations and will not contribute to further climatic degradation – and the perceived political program which is the need for Senegal to be self-sufficient in rice. While rice production is a component of CSA, increased production of rice may have an adverse impact on some climate dimensions (i.e. increased production of rice will probably imply increased irrigation which means increased use of energy (and, hence, carbon emissions), and increased use of chemical fertilizers). Similarly, there may difficulties in defining a small number of policy prescriptions. Raile *et al.* find that there are 200 different efforts led by different donors and other agencies which purport to represent CSA.

Musafili *et al.* examine the willingness of farmers in the area around Rwanda's Volcanoes National Park to adopt production rules, which benefit the environmental quality of the

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national park. The Volcanoes National Park is located in Northern Rwanda on the border with Uganda. It is probably best known for its Mountain Gorillas. Agriculture in the area of the park yields several different crops from Pyrethrum (a pesticide derived from chrysanthemum), mushrooms, jatropha and honey. The environmental consequences of each production process can be managed to a greater or lesser extent by a variety of production systems. Using a choice experiment, Musafili *et al.* examine the willingness of farmers in the area to adopt these modified production systems.

Moss and Schmitz take a more traditional welfare approach to examine the implications of investments in supply chains in developing countries. Specifically, Moss and Schmitz examine the export vs domestic market scenario to examine the potential benefits and costs of a variety of potential interventions. They begin by examining the costs and gains of cassava improvements in Uganda. First, they assume that cassava is largely consumed as a food stuff in the local market. These results are contrasted with the possibility that improvements in cassava production are used in the production of ethanol. Building on the concept of domestic demand vs export demand, they develop an extensive model of Rwanda coffee. In this framework, high-valued coffee is exported. Hence, the gains within the economy are improved income to coffee producers.

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Contribution of policy change on maize varietal development and yields in Kenya

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Abstract

Purpose – Since the start of seed and other market reforms in the 1990s, the annual number of improved varietal releases for maize in Kenya has increased substantially. Prior to the reforms, private firms were restricted in introducing new varieties, could not protect their intellectual property and farmers had to rely exclusively on improved seeds developed and marketed by the public sector. Reforms have resulted in not only private firms entering the market and releasing improved varieties, but also an increase in varietal releases by the public sector. The purpose of this paper is to review some of the key policy reforms related to maize in Kenya, and their impacts on varietal development and yields.

Design/methodology/approach – The authors estimate a yield model that relates national maize yields to a number of input policy variables. The authors employ a two-stage least square regression, as one of the explanatory variables – the number of varietal releases – is likely endogenous with yield. The authors use policy variables such as public R&D, the number of plant breeder's rights issued, and the years since private varieties have been introduced as instrument variables to estimate their influence new varietal releases directly, and then new varieties, inputs and other policies to measure their impact on yields.

Findings – The results show that policy changes such as the introduction of intellectual property rights had an important impact on the number of improved maize varieties released. However, the outcomes of the policy change such as the number of varieties and the share of area under improved varieties has no impact on increasing maize yields. The authors argue that this is because farmers continue to use older improved varieties because of the dominance of a parastatal in the maize, seed market and that newer improved varieties may not have the assumed yield advantage. Future policy and programs should be directed toward increasing the adoption of improved varieties rather than simply releasing them.

Originality/value – This paper provides evidence that while policy change may lead to new varietal development and release, its aggregate productivity impacts may be limited without additional reforms and intervention.

Keywords Kenya, Maize, Policy impact, Private sector development

Paper type Research paper

1. Introduction

Raising productivity is essential to sustain economic and income growth. In turn, technical change is the main driver of increased productivity, underlining the ongoing importance of focusing on technology as a primary change agent. The experience of industrialized countries confirms this insight where empirical findings consistently show that technical advances have been the main contributor to growth. This has also been the case within agriculture where rapid increase in productivity is often due to the adoption of specific technologies, such as hybrid maize, genetically modified crops, mechanization and the use of chemical inputs.

Despite the recognition that technology is important for growth, it remains under utilized in many countries, particularly in Sub-Saharan Africa (SSA). Modern input use remains low, exemplified by the low rates of fertilizer application. For SSA, fertilizer use intensity averaged less than 16 kg/ha of arable land in 2014, whereas it averaged 160, 345 and 130 kg/ha for

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South Asia, East Asia and Latin America, respectively (FAO, 2018). The use of improved seed varieties (IVs) – a key ingredient to the success of the Asian Green Revolution – is also low, accounting for 35 percent of all food crops grown in SSA in 2010 (Walker and Alwang, 2015).

The low use of farm inputs in SSA is at odds with the considerable farm-level evidence that shows SSA farmers benefit when they use improved varieties, especially for maize (Doss *et al.*, 2003; Evenson and Gollin, 2003; Renkow and Byerlee, 2010; Mathenge *et al.*, 2014; Fuglie and Marder, 2015). Evenson and Gollin (2003) estimate that 88 percent of the cereal yield growth in Asia between 1960 and 1986 was due to crop genetic improvements and the use of IVs, but only 28 percent for SSA, reflecting the limited role that IVs have played in yield growth in SSA.

There are many reasons for the low use of modern inputs and technology in African agriculture, and significant differences exist across and even within countries (e.g. Sheahan and Barrett, 2017). Ultimately, the non-adoption of productivity improving technologies rests on a combination of economic (the technology is not profitable), institutional (regulatory barriers and poor governance may limit availability) and social constraints. Policy – or lack thereof – can also be an important determinant of technology adoption. Providing subsidies and other incentives are the most direct ways that governments encourage IV adoption. More subtle are policies related to market competition and innovations that can lower input prices and increase choices for farmers to suit their specific economic and agro-ecological needs.

Whether or not a given a policy or a set of policies has the desired outcome is an empirical question and is the focus of this study. Specifically, our interest is to understand the role that policy changes have had on the supply of improved maize varieties in Kenya and maize productivity. In particular, we examine whether market-friendly policies designed to encourage private sector participation in Kenya's seed sector have contributed to improvements in maize productivity. Since the late 1990s, Kenya's market reforms have resulted in the entry of a number of private firms in the maize seed market and a marked increase in the number of IVs that have been released (Swanckaert, 2012). As shown in the following sections, of the 354 IVs of maize released between 1964 and 2015, 333 (94 percent) were introduced after 1999. Identifying the role of policy change in increasing the number of maize IVs and changing maize yields is the main objective of this paper.

Such an analysis is important for a number of reasons. First, the main rationale for liberalizing agricultural input markets has been to encourage competition, innovation and higher productivity. An analysis of productivity trends before and after liberalization will help establish whether this occurred in Kenya. Second, some have suggested that the liberalization policies for Kenya's seed markets have only been partially implemented as evidenced by the continued dominance of the Kenya Seed Company (KSC) (a public sector firm) in the market (Swanckaert, 2012) and the presence of older maize varieties (Smale and Olwande, 2014). If it can be shown that there is an association between the number of new maize varieties released and increased productivity, it would lend support to further reforms that enable greater varietal releases in Kenya, as well as in other countries. For example, Gisselquist *et al.* (2013) contend that regulatory hurdles discourage firms from releasing new varieties in Africa, with the implication that it limits productivity. Finally, while there are a number of studies that assess the impacts of modern inputs, nearly all have been at the farm-level, seeking to understand either farm impacts or determinants of farm adoption. To our knowledge, there has been no macro-level assessment of productivity changes from policies designed to increase input use in SSA.

As such in this paper, the macro-level determinants of maize productivity in Kenya are examined, with a focus on policies to encourage private sector participation and the role of improved varieties. The analysis consists of first examining production and yield trends to see whether yields changed post-liberalization by employing a yield model to relate national maize yields with a number of exogenous factors. One of the explanatory variables – the

number of varieties – is likely endogenous with yield. As a result, public research and development (R&D), the number of plant breeder's rights (PBRs) issued, and the years since the introduction of varieties as instrumental variables for the number of varieties are deployed in a two-stage least square (2SLS) regression.

This paper proceeds by providing a background to maize production in Kenya, in particular a description of the maize seed system and policies and institutions affecting maize development. Section 3 presents the empirical model relating policy change ion innovation and maize productivity to innovation. The results are discussed in Section 4. Section 5 concludes the paper.

2. Background

2.1 Maize in Kenya

Maize is the main staple in Kenya, accounting for nearly 40 percent of the cultivated area, 2.4 percent of Kenya's GDP and 12.65 percent of the agricultural GDP (FAO, 2018). More than 75 percent of the maize production comes from small farms, although only 20 percent of what is produced by smallholders is sold in the market (Chemonics, 2010). Kenya's per-capita maize consumption (measured in kilograms (kg)) is estimated to average 103 kg/person/year (average for 2012–2014), compared to 73 kg/person/year for Tanzania, 52 kg/person/year for Ethiopia, and 31 kg/person/year for Uganda (FAO, 2018).

In spite of maize's importance for food security and Kenya's economy, maize productivity and production growth rates are well below global averages. Figure 1 plots the trends in production, area and yields, while Figure 2 presents the same trends as indices (with 1961 = 100). As is evident from these trends, while production has increased from 1 MT in 1961 to 3.5 MT in 2015, much of it was due to the increase in area (increased by 180 percent) rather than yields (increased by 32 percent) (FAO, 2018).

Compared to other regions, Kenya's maize yield is below that for SSA as a whole, and even below the regional average for East Africa (Table I). Maize yields in Kenya are even lower than what US farmers were able to obtain prior to the widespread adoption of hybrid maize. Adoption rates of IVs appear to have leveled off at 70 percent since the mid-1990s in spite of the large number of new varieties that have been released since 1999 (Figure 3).

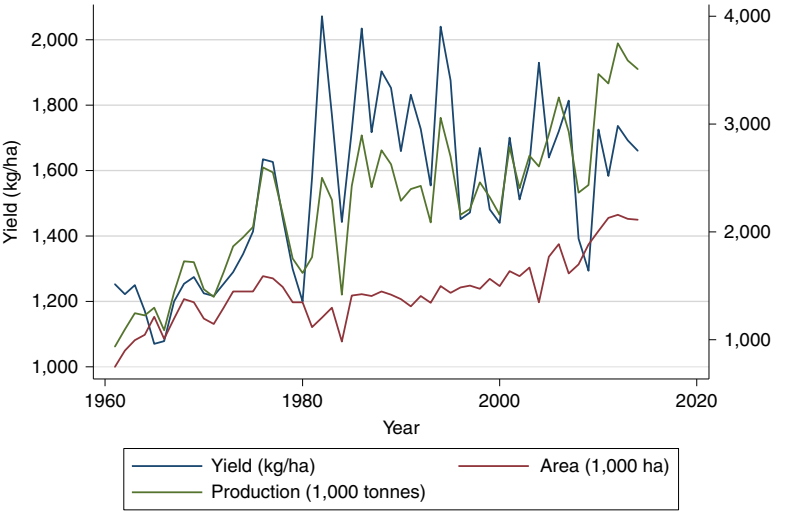
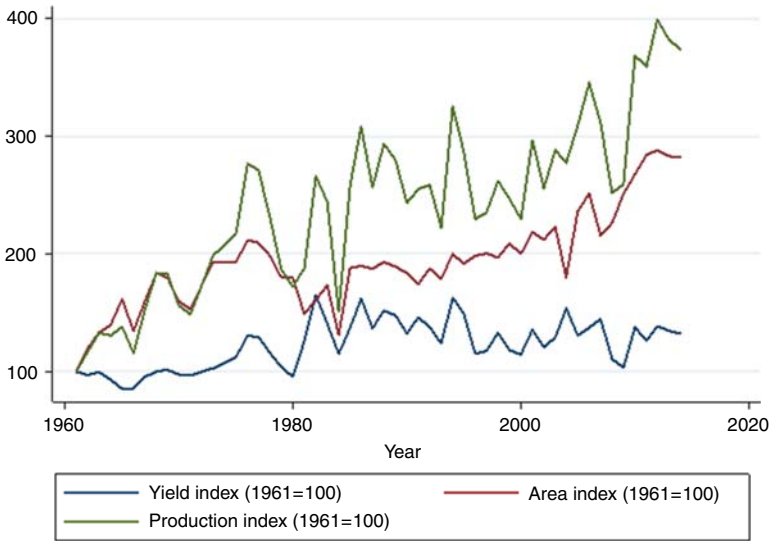


Figure 1.
Trends in maize yields, production and area for Kenya (1961-2015)

Source: FAO (2018)



Source: FAO (2018)

Figure 2.
Trends in maize yield, production and area indices for Kenya (1961 = 100; 1961-2015)

Region/Country	Average Yields (kg/ha) 2010–2014
Asia	4,896
Sub-Saharan Africa	2,188
East Africa	1,772
Kenya	1,680
West Africa	1,631
Southern Africa	4,238
Latin America	3,912
North America	9,444
Europe	6,249
World	5,268

Source: FAO (2018)

Table I.
Maize yields by key regions (2010–2014)

The low yield growth, in spite of the increasing adoption of IVs is peculiar and could be due to a variety of reasons. First, it could be that many farmers are using older varieties, even though modern varieties are available. Varietal turnover – not just simply seed replacement – has been found to be important for increasing productivity (Smale and Olwande, 2014; Spielman and Smale, 2017). New varieties not only allow farmers to aspire to the yield gains of a previous generation, but also help farmers to withstand new forms of pests and diseases, as well as drought and floods. The optimal rate of varietal turnover depends not only on the crop in question and environmental factors, but more importantly on economic factors. A weighted average[1] (WA) age of less than ten years and adoption rates of 35 percent are generally considered indicators of good progress in plant breeding (Walker and Alwang, 2015).

Studies on varietal turnover for maize in Kenya suggest that the WA age has been declining but is still above ten years. Smale and Olwande (2014) using a panel survey from 2004–2010 estimate the WA age at 17.3 years in 2010, while a more recent survey by Abate *et al.* (2017) estimates the WA age at 13 years for 2013. Our own estimates based

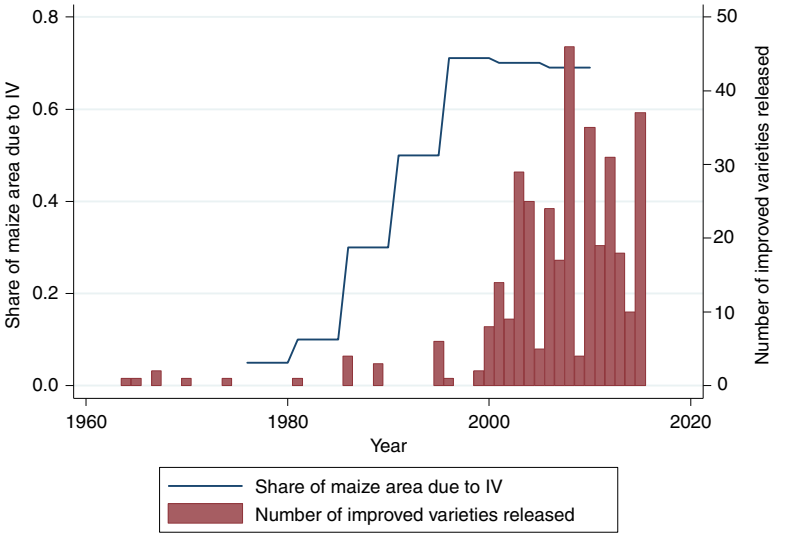


Figure 3.
Adoption of IV of maize and release of new maize varieties (1961-2014)

Source: Authors based on data from CGIAR (2015) and Kenya Plant Health Inspectorate Service (KEPHIS) (2017)

on 2009 survey data from DIIVA[2] suggest the WA age at 19 years, with nearly 43 percent of the area cultivated by varieties that are 10 years old or less (Table II).

Second, the new varieties that are adopted may not significantly improve yields compared to those of the varieties they are intended to replace. Karanja (1996) found for

1993		2009	
Variety	% Area	Variety	% Area
By variety			
H614D	41.8	H614D	22.6
H625	22.9	SC DUMA 411	7.2
H626	12.8	H624	4.7
H511	7.2	Katumani	3.8
Katumani	5.3	H6210	3.1
Rest (5 var)	7.6	Rest (60 var)	35.5
Total	97.6	Total	76.9
By type (public vs private)			
Public			
(KARI/KSC)	100		74.8
Private			25.2
Seedco			9.8
Pannar seed			7.3
Pioneer			3.9
Western seed company			3.8
Monsanto			3.7
By age			
< 10 years	55.4		42.7
10–20 years			14.2
> 20 years	42.8		43.1
Weighted age	23		19

Table II.
Maize varietal adoption in Kenya (1993 and 2009)

Source: Hassan and Karanja (1997) for 1993 and CGIAR (2015) for 2009

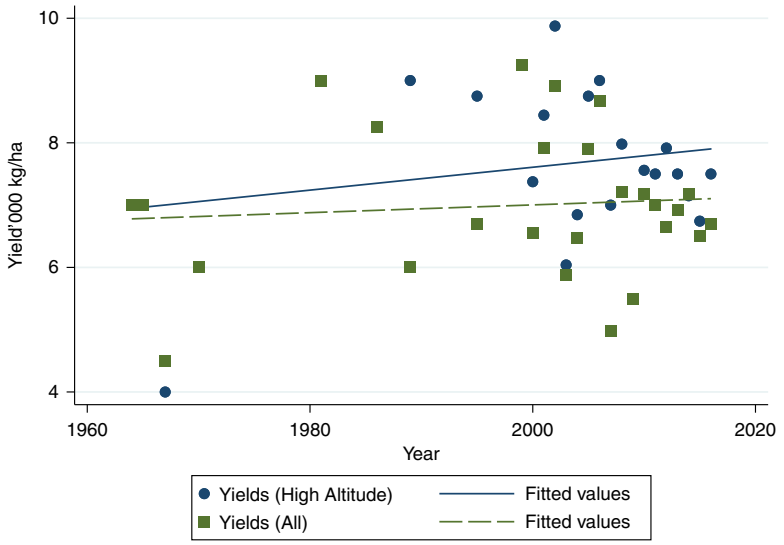
the 1960–1990 period that some of the released varieties of that era had small yield advantages, with research yields then exhibiting something of a "plateau" effect. For example, H626, which was released in 1989, had only a 1 percent yield advantage over H625, which had been released eight years earlier.

Figure 4 presents more recent data on average research yields of released varieties by year of release as documented by the Kenya Plant Health Inspectorate Service (KEPHIS) together with fitted linear trends. Average yields of high-altitude, late-maturing varieties have increased more than all varieties combined (at more than 150 kg/ha/year), although yields across all varieties have been stagnating and may have even declined in more recent years.

Finally the mere release of new IVs – whether private or public – on its own will not necessarily and positively affect yields. To have a positive impact on overall yields, the new varieties have to be superior to what is currently being grown, widely adopted and perhaps complemented with other inputs, especially fertilizer. Based on a survey of smallholder maize farmers in Kenya, Nyangena and Juma (2014) find that inorganic fertilizers and improved varieties result in an increase in maize yields if adopted as a package, rather than separately. Similarly, Muraoka *et al.* (2016) find significant positive impacts on land productivity in the highlands of Kenya from agricultural intensification (i.e. the use of high-yielding varieties, fertilizer and intercropping).

2.2 Seed development and policies

Maize has been grown in Kenya since the sixteenth century when it was introduced by Arab traders to the coastal areas; it expanded farther with the arrival of European settlers. By the mid-twentieth century, nearly 44 percent of Kenya's agricultural land was under maize cultivation – a proportion that has not changed much since then. Formal development of the seed industry began in the 1950s when the colonial government initiated a maize



Notes: Each scatter point represents the average experimental yield of varieties released that year. we differentiate between all released varieties and varieties intended for the high altitude (high potential) areas

Source: Generated using Kenya Plant Health Inspectorate Service (KEPHIS) (2017)

Figure 4.
Average experimental yields of released varieties (1960-2015)