

Role of Universities in development of improved crop varieties, seed production, dissemination and impacts: Case studies of dry, canning, snap and runner beans, pigeonpea and onions

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Abstract

Mandates of universities in east, central and southern Africa have considerably changed from their traditional teaching and research roles, to greater active involvement in the development agenda of their countries, a phenomenon referred to as the 'third mission'. This has necessitated a change in national laws to better anchor the third mission. For example in Kenya, a new Universities Act (2012) was enacted, which demands universities to play a more active role in national development over and above their traditional teaching and research roles. Universities hold probably the highest concentrated pools of highly trained manpower in virtually all key disciplines essential for diverse facets of national development but which has hitherto been underutilized. In agricultural sciences, universities have played pivotal role in the development of improved crop varieties, seed production, dissemination and impact creation in the last two decades. A review of bean (*Phaseolus vulgaris* L), pigeonpea (*Cajanus cajan* Millsp), onion (*Allium cepa* L.) and runner bean (*Phaseolus coccineus* L) improvement activities in Kenya from 1985 to date showed that University of Nairobi breeders developed and released eight dry bush bean varieties, three pigeonpea varieties including Africa's first short duration pigeonpea variety NPP 670, four bulb onion varieties, Kenya's first three climbing bean varieties with high yield potential and market preferred grain types; the first biofortified bean varieties (four bush and three climbing bean types) in Kenya and eastern Africa. The first locally developed snap bean and canning bean varieties in eastern Africa are being validated by the regulatory authority and are expected to be released in 2014/2015. The first locally short-day vegetable and dry grain runner bean lines are in advanced yield tests. Bean germplasm developed at the University of Nairobi was distributed to more than 32 countries in six continents between 2000 and 2013. Dry bean and snap bean lines have been released in several countries in east, central, southern and west Africa. A wider impact strategy and market led breeding strategy developed by the institution and its partners has been adopted in more than 25 African countries and helped to reach more than 5million households with bean based technologies between 2003 and 2010.

Key words: Bean, breeding, onion, pigeonpea, runner bean, universities

Résumé

Les mandats des universités en Afrique de l'Est, Centrale et Australe ont considérablement changé à partir de leurs rôles d'enseignement et de recherche traditionnels, à une plus grande implication active dans le programme de développement de leur pays, un phénomène dénommée la «troisième mission». Ceci a provoqué un changement dans les lois nationales afin de mieux ancrer la troisième mission. Par exemple, au Kenya, une nouvelle loi sur les universités (2012) a été mise en vigueur, ce qui exige aux universités de jouer un rôle plus actif dans le développement national au-delà de leurs rôles d'enseignement et de recherche traditionnels. Les universités détiennent probablement les pools les plus concentrés de la main-d'œuvre hautement qualifiée dans pratiquement toutes les disciplines clés essentielles pour diverses facettes du développement national, mais jusqu'à présent qui a été sous-utilisée. En sciences agricoles, les universités ont joué un rôle essentiel dans le développement de variétés améliorées, la production de semences, la diffusion et la création de l'impact dans les deux dernières décennies suivantes. Un examen de haricot (*Phaseolus vulgaris* L.), le pois (*Cajanuscajan* Millsp), l'oignon (*Allium cepa* L.) et le haricot (*Phaseoluscoccineus* L) montre des activités d'amélioration au Kenya de 1985 à ce jour, que les éleveurs, grâce à l'Université de Nairobi ont développé et publié huit variétés de haricot nain sec, trois variétés de pois d'Angole dont la première courte variété de pois d'Angole de l'Afrique, variété NPP 670, quatre variétés d'oignon rond, les premières trois variétés d'haricots escalade du Kenya avec des types de grains à haute rendement potentiel et préférer du marché; les premières variétés de haricots bio-fortifiés (quatre à trois types de haricot nain et d'escalade) au Kenya et en Afrique de l'Est. La première variété en Afrique de l'Est de haricot de conserves développés localement est en cours de validation par l'autorité de régulation et l'on s'attend à ce qu'il soit publié en 2014-2015. Les premiers légumes de jours courts et des lignes de haricot grain de canaux secs produit localement sont en essais avancés de rendement. Le matériel génétique de haricot mis au point à l'Université de Nairobi a été distribué à plus de 32 pays sur les six continents entre 2000 et 2013. Les haricots secs et les lignées de haricot ont été distribués dans plusieurs pays de l'Afrique de l'est, du centre, australe et de l'Ouest. Une stratégie de l'impact plus large et la stratégie de reproduction guidée par le marché ont été développées par l'institution et ses partenaires, ont été adoptées dans plus de 25 pays africains et a permis d'atteindre plus de 5 millions de ménages avec des technologies à base de haricots entre 2003 et 2010.

Mots clés: Haricot, élevage, oignon, le pois d'Angole, haricot, les universités

Background

Science encompassing research, education and extension, can drive transformation of agriculture in Africa (FARA, 2013). Science for agriculture in Africa is too important to be outsourced. Crop science is key to increasing crop productivity, quality, incomes, raw materials for industries, livestock and fish productivity, employment, environmental conservation, reclaiming degraded lands, poverty reduction and overall standard of living. Many universities in east, central and southern Africa have crop improvement programs. These programs not only conduct advanced research in topics in plant breeding, but have also been developing

improved varieties of cereals, grain legumes, root crops, vegetables and other crops of national and regional importance. In addition to offering courses in seed science and technology, the university programs have been actively involved in seed production and dissemination with considerable impacts. However, unlike developed countries where universities are considered major sources of innovations, strategies and contributors to agricultural development, food security, nutrition, sustainable environment technologies, universities in developing countries are hardly recognized as key sources of agricultural technologies and innovations essential for national development. Traditionally, universities are often regarded as 'ivory towers' for human resource development and basic research. This misconception can be attributed to lack of documentation and dissemination of information on high quality research that has been going on in these institutions especially in the last three decades. However, in recent years, this perception is changing, with governments in the region demanding more active participation by universities in development agenda..

Literature summary

Crop productivity in Africa is constrained by abiotic stresses (drought, low soil fertility, photoperiodism and other climatic factors), biotic stresses especially plant diseases and pests, poor adaptation of introduced crops to local conditions, socio-economic factors such as low and timely access to external inputs especially seed of improved varieties and fertilizers. These constraints are compounded by poor linkages among actors in commodity value chains, poor crop management practices, limited processing capacity, postharvest losses, poor infrastructure and limited access to markets (Kimani *et al.*, 2005). Although losses due to biotic and abiotic stress can be reduced by use of fertilizers in combination with other appropriate cultural, biotic, chemical and irrigation technologies and management strategies, associated costs are not practical for the widespread low input systems in sub-Saharan Africa. An integrated system based on improved crop varieties with genetic resistance/tolerance to stresses and appropriate agronomic and postharvest management practices is probably the most effective strategy for enhancing crop productivity. This has been demonstrated in a recent review of contribution of RUFORUM universities towards increasing crop productivity for smallholder farmers in east, central and southern Africa (Fitzgerald and Lindow, 2013). The objective of this paper is to provide further evidence from selected case studies of university based crop improvement research that has made considerable impact nationally and regionally.

Study description

This study reviewed the crop improvement program at the University of Nairobi, one of the oldest breeding research programs in eastern Africa. Crop improvement research at the University of Nairobi started in 1970 and has grown considerably. It has conducted breeding research on dry bean, pigeonpea, snap beans, canning beans, biofortified beans, onions, runner beans, garden peas, cowpea, pyrethrum and potato among other crops over the last 44 years. This program hosted the regional bean breeding between 2000 and 2010, trained breeders from the region, provided germplasm and technical backstopping to more than 15 national agricultural research institutes (NARIs) in east, central and west Africa (Kimani *et*

et al., 1990; Rabinowitch *et al.*, 1997; Kimani *et al.*, 2001; 2005; Ombaka *et al.*, 2012; Warsame *et al.*, 2013).

The program also initiated seed production activities for dry bean, pigeonpea and onion. The program played a key role in development of market-led breeding strategy in 2000 (Kimani *et al.*, 2005b), and wider impact strategy in 2001 (Kimani *et al.*, 2002). To ensure sustainable dissemination of varieties, the university has licensed seed companies to produce and market the released varieties. To assess impact of these varieties, adoption studies were conducted by CIAT and ICRISAT scientists (Jones *et al.*, 2001; Rubyogo *et al.*, 2009).

Research application

University of Nairobi breeders have developed and released eight dry bush bean varieties (Table 2), three pigeonpea varieties including Africa's first short duration pigeonpea variety NPP 670, four bulb onion varieties (Table 1), Kenya's first three climbing bean varieties

Table 1. Maturity, bulb size, bulb skin colour and yield of new onion varieties developed at the University of Nairobi.

Variety	Maturity	Bulb size	Bulb skin colour	Yield (t ha ⁻¹)
KON 1	153-191	Large	Light brown	32
KON 4	158-198	large	Light red	29
KON 6	154-205	medium	Bright red	22
KON 7	154-205	large	yellow	34

Source: Kimani *et al.*, 1994; Kimani and Kariuki, 1994

Table 2. Growth habit, market class and yield potential of new bean varieties developed at the University of Nairobi.

Variety	Growth habit	Market class	Yield potential (kg ha ⁻¹)*
Miezi Mbili	bush	Speckled sugar	2300
Kenya Early	bush	Speckled sugar	2150
Kenya Sugar	bush	Speckled sugar	1818
New Rosecoco	bush	Red mottled	2300
Kenya Red Kidney	bush	Red kidney	2800
Super Rosecoco	bush	Red mottled	2800
Kabete Super	bush	Red kidney	2470
Kenya Wonder	bush	Red kidney	2090
Kenya Umoja	bush	Red mottled	2300
Kenya Safi	Climber	Speckled sugar	3000
Kenya Tamu	Climber	Red mottled	3500
Mavuno	Climber	Red mottled	4500

* Yield figures based on national performance trials conducted by KEPHIS, 2005-2007.

with high yield potential and market preferred grain types (Table 2); the first biofortified bean varieties (four bush and three climbing bean types) in Kenya and eastern Africa. The first locally developed snap bean and canning bean varieties in eastern Africa are being validated by the regulatory authority and are expected to be released in 2014/2015 (Wahome *et al.*, 2013). The first locally short-day vegetable and dry grain runner bean lines are in advanced yield tests. Bean germplasm developed at the University of Nairobi was distributed to more than 32 countries in six continents between 2000 and 2013 (Kimani *et al.*, 2012). Dry bean and snap bean lines have been released in several countries in east, central, southern and west Africa (Kimani *et al.*, 2012). A wider impact strategy and market led breeding strategy developed by the institution and its partners has been adopted in more than 25 African countries and helped to reach more than 5million households with bean based technologies between 2003 and 2010 (Rubyogo *et al.*, 2010). Although this case study focused on activities on activities at the University of Nairobi, similar progress has been made in other Ruforum universities.

This review indicates that in addition to human resource development and capacity building in all key sectors, African universities are capable of conducting high quality, relevant research and developing high quality, competitive, marketable and consumer preferred products in partnership with industry, regional and international institutes of advanced research to provide solutions national and regional development agenda. Universities have facilitated rapid dissemination of new technologies to end users and created positive impacts on livelihoods.

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