GM and seed industry eye Africa's lucrative cowpea seed markets:

The political economy of cowpea in Nigeria, Burkina Faso, Ghana and Malawi

African Centre for Biodiversity

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Contents

On the 7th of April 2015 the African Centre for Biosafety officially changed its name to the African Centre for Biodiversity (ACB). This name change was agreed by consultation within the ACB to reflect the expanded scope of our work over the past few years. All ACB publications prior to this date will remain under our old name of African Centre for Biosafety and should continue to be referenced as such.

We remain committed to dismantling inequalities in the food and agriculture system in Africa and our belief in peoples' right to healthy and culturally appropriate food, produced through ecologically sound and sustainable methods, and their right to define their own food and agriculture systems.

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Design and layout: Adam Rumball, Sharkbouys Designs, Johannesburg

Illustrations: Ms Vanessa Black. The cowpea varieties on right in the cover are arranged as Adinkra symbols (from Ghana and Nigeria) and means from top to bottom: abundance, wisdom/prudence, commitment and defiance.

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Disclaimer
Conducting this research was challenging: very little current information is available about trends in cowpea production and/or the farmers who grow cowpea in the countries studied. For the purpose of this research, therefore, we had to rely heavily on interviews with key people. Relevant people were selected for interviews, especially from the cowpea breeder value chain, but some of them did not respond to our queries.

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Glossary

AATF	African Agricultural Technology Foundation
ACB	African Centre for Biodiversity
ADP	Agricultural Development Programmes [Nigeria]
AMSP	Association Minim Sông Pânga [Burkina Faso]
ASSMAG	Association of Smallholder Seed Multiplication Action [Malawi]
CFA	Basic monetary unit of Cameroon, Congo, Gabon, and the Central African Republic, equal to 100 centimes
CfE	Commons for EcoJustice
CGIAR	Consultative Group for International Agricultural Research
CIAT	International Center for Tropical Agriculture
CIRAD	*Centre de coopération internationale en recherche agronomique pour le développement* [International Cooperation Centre in Agronomic Research for Development]
CRI	Crop Research Institute [Ghana]
CRSP	Bean Cowpea Collaborative Research and Support Programme
CSIR	Council of Scientific and Industrial Research [Ghana]
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DARS	Department of Agriculture Research Services [Malawi]
DfID	United Kingdom's Department for International Development
EPA	Environmental Protection Agency
FAO	United Nations Food and Agriculture Organisation
FAOSTAT	Software used by the Statistics Division of the United Nations Food and Agriculture Organisation
FERT	French Association for international cooperation for agricultural development
FMARD	Federal Ministry of Agricultural and Rural Development [Nigeria]
FSG	Food Sovereignly Ghana
GLDB	Grains and Legumes Development Board (Ghana)
GoSA	Government of South Africa
GM	Genetically Modified
IAR	Institute of Agricultural Research [Nigeria]
ICRISAT	International Crops Research Institute for the Semi-Arid-Tropics
IFAD	International Fund for Agricultural Development
IITA	International Institute of Tropical Agriculture
INERA	Institut de l'Environnement et de Recherches Agricoles [Burkina Faso]
IPCC	Inter-governmental Panel on Climate Change
ISSD	Integrated Seed Sector Development
ISSER	Institute of Statistical, Social and Economic Research [Ghana]
LABOSEM	*Centre de contrôle de la qualité des semences* [Seed quality insurance control Centre] [Burkina Faso]
LUANAR	Lilongwe University of Agriculture and Natural Resources [Malawi]

MAFAP	Monitoring and Analysing Food and Agricultural Policies; a programme of the FAO
MoAFS	Ministry of Agriculture and Food Security [Malawi]
MoAIWD	Ministry of Agriculture, Irrigation and Water Development [Malawi]
MOFA	Ministry of Food and Agriculture [Ghana]
NABDA	National Biotechnology Development Agency [Nigeria]
NAFASO	SA Faso Agricultural Neema
NAFSN	G8 New Alliance on Food Security and Nutrition
NARI	National Agricultural Research Institute [Nigeria]
NASC	National Agricultural Seed Council [Nigeria]
NASFAM	National Smallholder Farmers' Association of Malawi
NGICA	Network for the Genetic Improvement of Cowpea for Africa
NSS	National Seed Service [Nigeria]
pers. comm.	Personal communication
SARI	Savanna Agricultural Research Institute [Ghana]
SEEDPAG	Seed Producers Association of Ghana
SSU	Seed Services Unit [Malawi]
TL II	Tropical Legumes II project
UCR	University of California Riverside
UPOV	Union for the Protection of Plant Varieties
USAID	United States Agency for International Development
WIPO	World Intellectual Property Organisation

Background: Coinciding agendas of Genetic Modification (GM) and the seed industry in the cowpea seed market in West Africa

The push for genetically modified (GM) cowpea

The biotech machinery has set its sights on cowpea, a crop that is indigenous to Africa, and is intent on introducing genetically modified (GM) cowpea into Africa's food and agriculture systems. Cowpea, one of the most ancient crops known to humankind, with its centre of origin in Africa, provides the earliest food for millions of Africans during the 'hungry season' before cereals mature. It is also a major source of affordable protein. Small-scale farmers mostly grow cowpea intercropped with other cereals; they derive benefits from this crop through nitrogen fixing, animal fodder and erosion protection, which are all aspects that cannot be translated in monetary terms. The largest cowpea exporting country in the world is Niger. Nigeria is the largest cowpea producer in the world (followed by Brazil) with an annual average production of 2.7 million metric tons over the last decade; Nigeria is also the largest importer of cowpea in the region. Niger, Burkina Faso, Benin, Mali, Cameroon, Chad and Senegal are net exporters, while Nigeria, Ghana, Togo, Côte d'Ivoire, and Mauritania are net importers. Important producers in Southern Africa are Botswana, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe. Small-scale farmers grow cowpea intercropped with maize, millet, sorghum, sugar cane and cotton. The majority of the seed planted by farmers is sourced from on-farm seed saved from past harvests.

The African Agricultural Technology Foundation (AATF), an extremely influential and well-resourced pro-GM organisation based in Nairobi, Kenya, is spearheading a GM cowpea project targeted at Nigeria, Ghana, Burkina Faso and Malawi. The GM cowpea project is funded by the United States Agency for International Development (USAID), the United Kingdom's Department for International Development (DFID) and the Rockefeller Foundation. Genetically modified cowpea contains the Cry1Ab Bt gene, developed by Monsanto and donated now that it has come off patent, to the Cowpea Project, ostensibly on a 'humanitarian basis'— royalty free. The Cry1Ab gene is an old throw-away technology, now discontinued in South Africa where the cultivation of Monsanto's GM maize, MON 810 containing the same transgene caused massive pest resistance and infestation. Genetically modified cowpea is engineered to be resistant to the Maruca legume pod borer on the basis that "farmers in West Africa have identified Maruca insects as major problems in cowpea production" (AATF 2015). Maruca is a Lepidopteran in the family *Phyralidae* and its larvae inflict damage to cowpea from the initiation of flowering to pod maturity. It is further claimed that the Maruca pod borer is a serious field pest of cowpea, contributing to yield losses of up to 90% (Bunda College Campus, 2015–2019).

It is instructive to note that genetic engineering of the Bt cowpea was conducted by the Australian Commonwealth Scientific and Industrial Research Organisation (CSIRO), which was previously involved in a biosafety scandal. In the early 2000s CSIRO developed a genetically modified **field pea** seed that expresses a protein found in kidney beans that causes the weevil to starve to death (Kruger 2005). Trials came to an abrupt halt in 2005 when it was found that the transgenic pea triggered important immune responses and inflammation in the lungs of mice (Prescott *et al*., 2005). CSIRO subsequently pledged to destroy the GM pea's DNA but it transpired that it was kept for further development in Europe (Wilson 2013). This story was just the beginning of CSIRO's dabbling with transgenic peas, before it became involved in research on Bt cowpea.

While GM cowpea is not grown commercially anywhere in the world, field trials of the Bt cowpea are underway in Nigeria and Burkina Faso and are at advanced stages. Commercial release applications are expected to be lodged as early as 2016, with GM cowpea seeds available for sale to farmers during 2017. Although Nigeria does not have a fully

functioning biosafety regime, multi-location trials were conducted in Zaria, Minijibir and Bajura during 2014, to generate data in order to support an application for general release. In Burkina Faso, multi-location trials are being conducted in Farako Ba and Kamboinse, similarly to generate regulatory data to support an application for general release. In Ghana, where field trials have been underway since 2012, further trials were approved during 2014 to support efficacy demonstration and regulatory studies in Tamale. The validity of the trials in Ghana are being vehemently disputed by Food Sovereignty Ghana, who has applied to court for an interdict to stop the commercial release of *inter alia*, GM cowpea in that country (FSG, 2015). The first field trial application lodged in Malawi by Bunda College was also vehemently resisted by a coalition of civil society organisations, led by the Commons for EcoJustice (CfE) (2015).[15]

Burgeoning cowpea seed market in West Africa

Over the past ten years, the cultivation of cowpea has increased significantly in Burkina Faso, Ghana and Nigeria, with only Malawi showing a decline in production and yield. The greatest production of cowpea by far comes from West Africa where a very lucrative regional cowpea seed market is emerging, supported by high demographic growth and urbanisation. There is indeed little doubt that there is increased demand for cowpea for human consumption and for generating income.[16] These burgeoning markets are proving to be key drivers in the intensification of cowpea production in West Africa.

National research institutes have a monopoly in research and development (R&D) of cowpea breeder seed and the private sector is not involved or interested in this side of the cowpea value chain. There is, however, very strong interest from the seed industry in the production of new cowpea varieties. The foundation and certified seed part of the value-chain is proving to be a lucrative market, given the rising demand for cowpea. Indeed, as we have previously shown with regard to cowpea production in Ghana, as an example,[17] the public sector is expected to shoulder the extremely expensive improved cowpea breeder seed costs, which will enable the private sector to profit in seed multiplication and distribution. Breeder seed is prohibitively costly because of low multiplication rates. Nevertheless, there is a lucrative demand so the private sector wants to be involved, but only in the parts of the production process identified as profitable.

The GM cowpea push is inextricably bound up in this agenda, which coincides with the strong interest from multinational and local seed companies in the development and production of foundation and certified seeds, both GM and non-GM. Lucrative seed markets are just too good an opportunity to miss, given the rising demand for cowpea. Demand is sometimes found in pockets rather than uniformly across a country, and demand at national level may be inadequate to justify investment. However, if regional seed markets can be constructed, where varieties released onto a regional variety release list that are immediately made available at national level without further trials, then investment will be considered. It is within this context that the push for the harmonisation of seed laws at regional levels must be understood. The corporate push, with USAID and G8 (G8 New Alliance on Food Security and Nutrition (NAFSN)[18] backing to harmonise seed laws and intellectual property rights on

15. See: Commons for EcoJustice (CfE). 2015. *Objection to the application from Lilongwe University of Agriculture and Natural Resources' Bunda College for confined field trial of genetically modified pod borer resistant cowpea varieties*. The objection contains a comprehensive biosafety and socio-economic assessment of the GM cowpea application.
16. Although the demand for cowpea is on the rise, some analysts report an overall decline in the inclusion of cowpeas in diets, attributable to "erroneous perceptions about cowpea being a 'poor person's meat' ... shifts in dietary patterns due to rapid urbanisation, the moderately long cooking time of cowpeas, and increases in cowpea grain prices globally" (Widders 2012). However, as mentioned further on, some contend that cowpea is, on the contrary, gaining in popularity, even in urban environments (Mishili *et al*., 2009; Abizari *et al*., 2013).
17. White men meet in London to plot ways of profiting off Africa's seed systems. http://www.acbio.org.za/index.php/media/64-media-releases/475-white-men-meet-in-london-to-plot-ways-of-profiting-off-africas-seed-systems.
18. https://new-alliance.org/

the basis of the Union for the Protection of Plant Varieties (UPOV) 1991 Protocol seeks to create such regional markets for crops that otherwise would not have the economies of scale for corporate investment.[19] Organisations such as AATF and initiatives such as Scaling Seeds and Technologies Partnership (SSTP), which are being led by the Alliance for a Green Revolution in Africa (AGRA, started by the Gates and Rockefeller Foundations in 2006), operate under the umbrella of coordinated state-donor strategies and interventions. For example, the four countries being targeted in AATF's cowpea project are all partnering with the NAFSN. This alliance is laying the ground for the expansion of commercial agriculture, including developing the necessary legal and institutional frameworks (e.g. private land titling, private ownership of germplasm and channelling of public resources to support private advance in the form of public-private partnerships).

No information has been provided regarding ownership of the new GM varieties or the conditions of the licensing agreements. Nevertheless it is anticipated that the AATF, which has permanent international observer status with the World Intellectual Property Organisation (WIPO), will be intimately involved in the negotiation of seed licensing agreements with the private sector for the production and distribution of certified GM cowpea seed. This is notwithstanding the ostensible benevolence of Monsanto, which is behaving towards GM cowpea as it is doing with regard to the Water Efficient Maize for Africa Project (WEMA).[20] At the time of writing, Monsanto's Drought Tolerant maize stemming from WEMA was approved for commercial release in South Africa, in the face of opposition from farmer organisations and NGOs.[21] The seed used in the genetic modification of the GM cowpea is sourced from farmers' varieties, bred over the millennia and sold back to farmers at the high prices that characterise the prohibitively expensive cost of GM seed. These farmers will be required to purchase fresh certified seed every season under licensing agreements typical of the marketing of GM seed and or seed laws that prohibit the marketing of recycled certified seed. These measures will dislodge the current age-old practice of recycling farm saved seed. Cowpea in particular is a crop well adapted to local conditions. Farmers should have the choice of additional germplasm to enhance their own varieties, but this should be made available on a public basis through the public seed institutions. It is not acceptable for private companies - or states following their line - to control and determine who has rights to reproduce seed.

Cowpea is an indigenous crop. It is an African crop; a woman's crop

Although women are involved in the farming of cowpea, this is only a secondary activity as women derive their main source of income from processing cowpea. The crop represents an important form of livelihood throughout the value chain, from seed producers who sell their product through farming, processing, wholesaling and retailing (distribution), and selling cooked cowpea in various forms (prepared food). A study that profiled consumers in Northern Ghana showed that women were greater consumers of cowpea than men (65% versus 35%). As caregivers, women regard cowpea as an important food to sustain the growth of children and to prevent iron deficiency; they perceive cowpea as a 'blood giving' plant (Abizaru *et al*., 2013). Cowpea leaves are cooked in stews and used as a weaning food/porridge. Malawian women, in particular, value cowpea because its green pods and leaves are the earliest food available during the 'hunger months' prior to the main grain harvest and because it plays an important role as a weaning food for infants (Quaye *et al*., 2009a). In Malawi there is a distortion of production towards maize as a mono-crop,

19. Alliance for Food Sovereignty in Africa (AFSA) 2014 'AFSA submission for urgent intervention in respect to draft ARIPO Plant Variety Protection (PVP) protocol and subsequent regulations', http://afsafrica.org/
20. Profiting from the Climate Crisis, undermining resilience in Africa: Gates and Monsanto's Water Efficient Maize for Africa (WEMA) project.
21. African Civil Society Slams Monsanto's Junk GM maize deal. June 2015. http://www.acbio.org.za/index.php/media/64-media-releases/483-african-civil-society-slams-monsanto-junk-gm-maize-deal

sponsored by public-private partnerships in the form of the Farm Input Subsidy Scheme (FISP), which contributes to hunger and malnutrition (ACB, 2014). A solution to malnutrition is a diversity of crops including indigenous crops like cowpea. A project to enhance this crop in various ways, which includes but is not limited to yield increases, may have a place if it does not take away from the lives of farmers and other inhabitants of farming areas. In our assessment, the AATF cowpea project—and similar interventions elsewhere in seed and agriculture more broadly - threatens the sustainability of ecologically balanced livelihoods by removing control over seed/germplasm as a key element of any farming system.

Presenting unacceptable health risks

Since Bt Cowpea has not yet been commercialised anywhere in the world, it is instructive for us to look at the latest findings for Monsanto's GM maize event, MON810, containing the same Cry1Ab gene, which has been approved for human and animal consumption in many countries in the world.

A recent study has found toxic effects in human liver cells during in vitro experiments exposing the protein produced by MON810, which contains the Cry1Ab gene (Mesnage et al., 2012.) In November 2008 Italian researchers concluded that "the consumption of Bt MON810 maize ... induced alterations in intestinal and peripheral immune response of weaning and old mice. ... [T]hese results suggest the importance of considering the gut and peripheral immune response to the whole GM crop, as well as the age, in the GMO [GM organism] safety evaluation" (Finamore *et al*., 2008). In a more recent study, the different results of MON810 feeding trials were re-evaluated using an analytical-statistical system different from those previously employed (de Vendômois *et al*., 2009). Results showed that GM-maize-linked effects are generally detected either after 14 weeks of consumption or at a high GM feed dose in the diet. The parameters affected relate to: blood cells, adrenal gland and kidney weights, an increase in blood urea nitrogen and higher spleen weight. In males, significant disturbed parameters were found in liver function. The authors have requested additional long-term (up to 2 years) animal feeding studies, preferably also multi-generational. There is no knowledge about the potential impact of this modification in cowpea on human health, which goes against the precautionary principle and prior informed consent imperatives inherent in good biosafety practice.

Contaminating an African heritage crop

Cowpea is an indigenous African crop. It is a variable species composed of wild perennial sub-species, wild annual forms and cultivated forms (Nagalakshmi *et al*., 2010) and it is self-pollinating. The cowpea wild progenitor (*Vigna unguiculata* var. *spontanea*) is encountered over most of Africa and it hybridises freely with domesticated cowpea. Widespread introgression phenomena between wild and domesticated cowpea have been observed (Ba *et al*., 2004. A study of pollinator behaviour and population genetic analysis of natural West African wild cowpea populations show that the Bt-gene will escape as soon as Bt-cowpea is grown within the pollinator range of wild cowpea (Pasquet 2012). The transgene could move from the genetically modified lines to non-modified lines of both cultivated and wild cross compatible relatives (Fatokun *et al*., 2012). The escape of the Bt-gene is a major concern as this will cause weediness (other plants gaining a resistance trait that causes an alteration in the ecological balance) and pose unacceptable and adverse ecological effects.

Bt cowpea: a reductionist approach

According to farmers, they are confronted with a myriad of agronomic and post-harvest challenges. The Bt solution responds only to one narrow aspect of production (pod borer), it requires a significant increase in input costs (certified seed with technology costs added, synthetic fertiliser, infrastructure, land rent and interest repayments), and it threatens to destabilise functioning socio-ecosystems. The single silver bullet approach promised by Bt cowpea is reductionist and simplistic. Our research demonstrates that sudden drops in production can be attributable to drought and pest infestation, as evidenced by the production and yield curves for Nigeria, which analysts attribute mostly to drought or policy interventions.[22] The principal parasitic weeds

attacking cowpea and causing important economic losses are *Striga gesnerioides* and *Alectra spp*., particularly in the semi-arid regions. The main pests during the growing season are pod sucking bugs (*Riptortus spp., Nezara viridula* and *Acantomia sp*.), aphis (*Aphis fabae, Aphis craccivora*), blister beetle (*Mylabris spp*.) and pod borer (*Maruca vitrata*). Post-harvest losses are also critical factors, attributable notably to the cowpea weevil *Callosobruchus maculatus* (Coleoptera: Bruchidae). In addition, price fluctuations are further important factors. In Burkina Faso, for instance, cowpea as a cash crop competes with sesame which in 2013 offered much more lucrative prices to farmers (O. Coulibaly, Project Co-ordinator at the International Institute of Tropical Agriculture, Benin, 2015, personal communication (pers.com)).

From an entomological perspective, since cowpea is confronted by a myriad of other pests that are not controlled by the Bt-toxin, other compatible control methods can easily be employed. For example, plant-based (e.g. neem) or fungal-based (endophytic strains of *Beauveria bassiana*) bio-pesticides offer profitable and very efficient alternatives to chemical control (Sokame et al., 2015). These in any case will need to be used for other pests. Moreover, biological control has regained importance especially in light of the recent discovery that Maruca vitrata is in fact indigenous to Asia, where far more efficient natural enemies have already been discovered and are currently being tested (Tamò 2015, pers. comm.).

22. This drop can also be interpreted as the result of the Nigerian policy adopted in 2012, which focuses on subsidising fertiliser for maize rice, cassava and wheat, an orientation which has possibly distorted the market in favour of these crops (Coulibaly 2012, personal communication).

Key findings

1. Cowpea is an essential food security crop as it provides the earliest food available in the 'hungry season' before cereals mature. It also represents a major source of protein that is far more affordable than meat or dairy products in Africa.
2. The crop is greatly appreciated for its culinary versatility across West, Central and Southern Africa and is consumed in many different ways, thus offering significant income streams for cowpea processors and food sellers, mostly women.
3. Cowpea is not only a source of food, but also of animal feed and is therefore essential to animal breeders.
4. As a legume, cowpea fixes nitrogen in the soil and forms the basis for crop rotations and intercrops. This includes with maize, which is a heavy nitrogen feeder. For this reason it also forms a potential secondary sought after commercial market in association with maize and climate smart agriculture, like soya (which is also genetically modified).
5. The greatest production of cowpea comes from West Africa and an increasingly lucrative regional cowpea seed market has emerged, supported by high demographic growth and urbanisation. This market is proving to be a key driver in the intensification of cowpea production in West Africa.
6. Over the past ten years the cultivation of cowpea has significantly increased in Burkina Faso, Ghana and Nigeria, with only Malawi showing a decline in production and yield. Ghana, Malawi and Nigeria are not able to meet their domestic demand and are importing cowpea from neighbouring countries.
7. Cultivating and storing cowpea comes with challenges. Biotic stresses that hamper productivity include drought and heat. Abiotic stresses include fungal, viral, and bacterial diseases, and parasitic weeds. Post-harvest losses pose huge problems for farmers.
8. The majority of seed planted by farmers is sourced from on-farm seeds saved from past harvests. The penetration of improved cowpea seed in the four study countries appears still to be limited, ranging from 10% in Malawi (CfE 2015) and 11% in Burkina Faso to 22% in Ghana (Quaye *et al*., 2011). (However, this estimate for Ghana is based only on research conducted in a northern district of the country). Quantified data on the penetration of improved cowpea seeds in Nigeria was not found but the use of improved varieties in Nigeria is reported to be very low. Kamara *et al*. (2012) report that despite the development of a large number of cowpea varieties, farmers in northeast Nigeria have continued to grow predominantly local varieties.
9. Cowpea is grown mainly by small-scale farmers and is often intercropped with other crops. Evidence on the ground shows a definite trend towards a greater intensification of cowpea farmed as a monoculture, although this remains undocumented in the literature. In monoculture systems farmers require petro-chemical inputs and usually use improved seed varieties to maximise yields, whereas for self-consumption purposes farmers usually use traditional, farm-saved seeds. These two farming systems often co-exist on the same farm and the commercial production is then purchased on-farm by merchants for local, national or regional markets.
10. The characteristics that farmers seek in cowpea differ by country and purpose (self-consumption, fodder or commercial). Yield is the single most important factor for commercial producers, followed by resistance to pests and diseases (Coulibaly *et al*., 2012) yet many other context-specific agronomic, morphological and grain quality traits also shape farmers' choices. Other criteria are also present for own consumption (flavour, storability etc.).
11. National research institutes have a monopoly in research and development (R&D) of cowpea breeder seed and the private sector is not involved or interested in this side of the cowpea value chain. There is, however, a very strong interest from the seed industry in the production of new cowpea varieties, from foundation seed on. The foundation and certified seed parts of the value chain are proving to be very lucrative markets given the rising demand for cowpea.

Introduction: cowpea, an African crop

Cowpea (*Vigna unguiculata*) is a food and animal feed crop that originated and was domesticated in Southern Africa. It was then cultivated in East and West Africa and Asia and today it is grown mostly in semi-arid tropical zones across Africa, Asia, Europe and the Americas (IITA 2015).

In 2013 the African continent produced almost 95% of the global cowpea production on a surface area of more than 11 million hectares (IITA 2015), followed by Asia (3,2%), the Americas (1,3%) and Europe (0,5%) (FAOSTAT 2015a).

Cowpea is a drought tolerant plant; it is able to extract underground water thanks to its deep root system (Dabat *et al*., 2012a). It performs well in a wide variety of soils. As a leguminous plant, its leaves and root systems replenish nitrogen-depleted soils thus increasing soil fertility.[23] Farmers often grow creeper varieties with groundcover properties thus preventing erosion (Singh et al., 2003) and soil evaporation.

Mainly small-scale farmers in Africa grow cowpea, and being a shade tolerant plant it is often intercropped with other crops such as maize, millet, sorghum, sugar cane and cotton, as well as with several plantation crops (Singh *et al*., 2003). Cowpea has a symbiotic relationship with these other crops and a yield boost is frequently observed in the cereal crop when planted with cowpea (Widders 2012). Low productivity of most food crops in Sub-Saharan Africa is attributed mostly to the naturally low fertility of soils, shortages in access to organic compost, water constraints and soil degradation (Lahmar et al., 2011). Leguminous plants such as cowpea have thus been promoted as a means to remedy some of these problems (Dabat *et al*., 2012a).

Cowpea is widely known as the crop of the poor because it provides the earliest food available before cereals mature (Wood and Morniere 2013). Cowpea is also known as the 'poor man's meat' (Aykroyd *et al*., 1982) as it provides a source of protein that is much cheaper than meat or dairy products. Energy constrained populations who do not have access to refrigeration can thus store this protein source over several months (Mishili *et al*., 2009). For smallholder farmers cowpea therefore constitutes the assurance of minimum food security during the hungry season (Wood and Morniere 2013), as a source of food and animal feed, but also as a source of income.

Over the years cowpea has increasingly become a source of food across various socio-economic strata (Abizari *et al*., 2013) and it is readily consumed not only by rural populations but also by the more affluent and rapidly expanding urban populations of West and Southern Africa. Mishili *et al*. (2009) have found a positive correlation between increases in farmer income and increase in cowpea consumption in West and Central Africa.

However, cultivating and storing cowpea also comes with challenges. In much of West Africa, insect pests are reported to be the single most important constraint to cowpea production (Singh *et al*., 1990). Abiotic constraints include poor soil fertility, inappropriate agronomic practices, fungal, viral, and bacterial diseases, and parasitic weeds (Wood and Moriniere 2013). Different biotic stresses such as drought and heat hold back productivity. Post-harvest losses are mostly attributable to the cowpea weevil.

23. Research conducted in Ghana showed that cowpea fixes nitrogen up to 240kg/ha and leaves about 60-70kg nitrogen for succeeding crops (MOFA 2005, as cited in Quaye *et al*., 2009).

Background to cowpea production and consumption in West and Southern Africa

Cultivation trends

1. Cowpea production is concentrated in the drier areas of sub-Saharan Africa (West, Central and Southern Africa). Depending on the source, the northern limit of cowpea production is approximately the 200 mm rainfall isohyet (Huynh *et al*., undated) or 300 mm rainfall isohyet (Langyintuo et al., 2003; Mishili *et al*., 2009), which in West Africa is where the Sahara Desert starts. [An isohyet is a line on a map connecting points having the same amount of rainfall in a given period.]
2. The southern limit is the 400 mm rainfall isohyet (Huynh *et al*., undated), although cowpea is also cultivated south of this line, notably in South Africa.

In the early 1990s, Western and Central African countries produced close to 2,6 million tons of cowpea on 7,8 million hectares, which represented about 69% of the global production and 80% of the total global surface area planted to cowpea (Langyintuo et al., 2003).

However, increased demand for cowpea for human consumption and income generation has been noted. In the 2000s production trends were declining, due to the high marketing costs associated with dispersed production and the lack of price information along the market value chain provided to farmers and traders (Mwaga *et al*., 2008). Nevertheless, over the past few years production has generally been on the increase in the studied countries, apart from Malawi, as illustrated by Figure 1.

This general increase is attributable to a variety of factors, starting with increased production to meet rising demand. Area planted to cowpea are generally on the increase and the use of improved varieties has contributed to improved yields noticeable in Ghana and Nigeria (Tamò 2015; Coulibaly 2015, pers. comm.). According to the IITA (2012) preface, cowpea grain yield

Map 1: Cowpea production zones in Africa
(http://www.slideshare.net/GCProgramme/pag-xxii-cowpea-molecular-breeding-huynh-*et-al*).

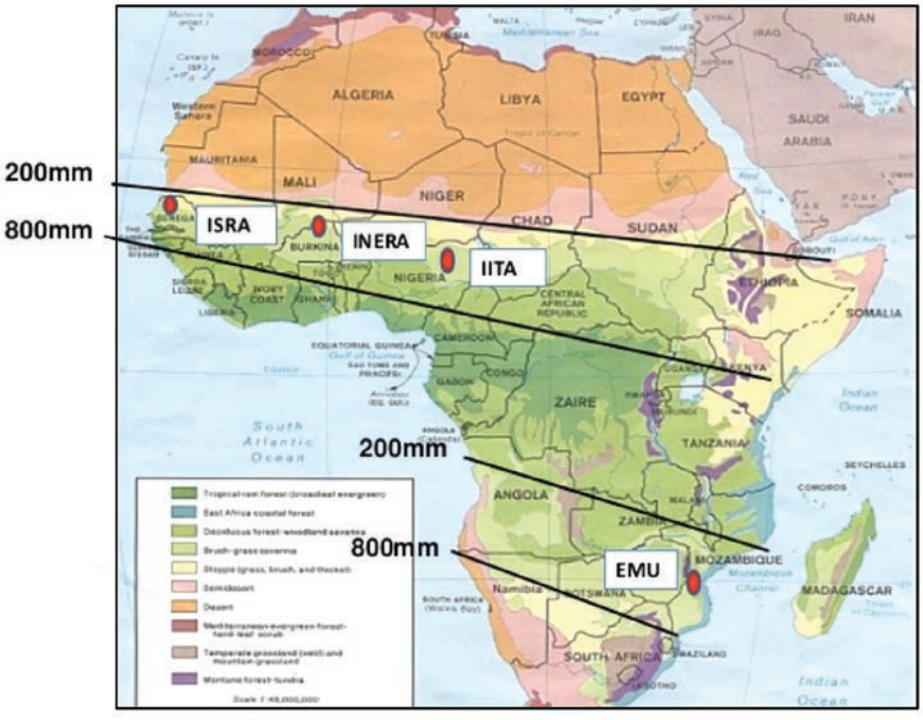
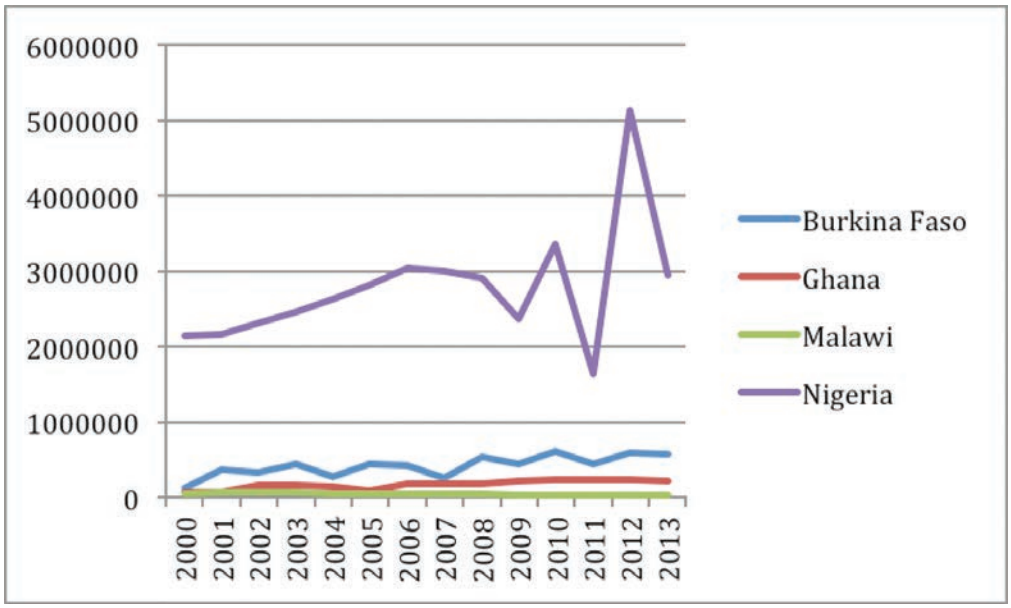
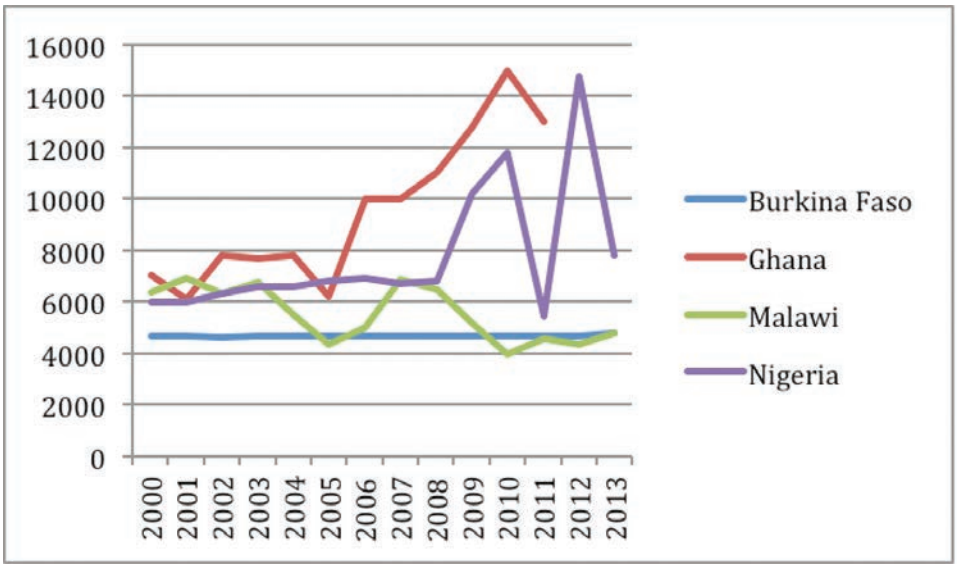


Figure 1: Cowpea production in the study countries (tons) (FAOSTAT 2015a and the Ministry of Food and Agriculture (MOFA) in Ghana.[24]



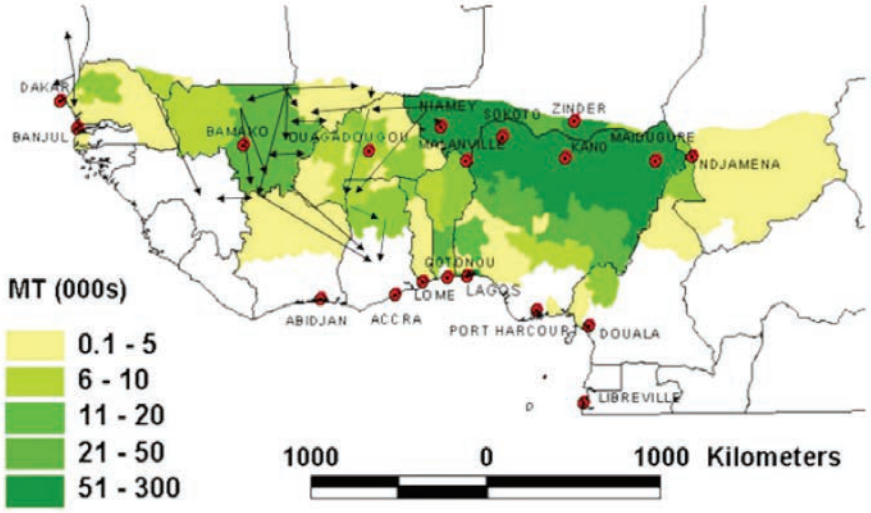
increased from an average of 728 kg/ha to 1,512 kg/ha between the 1970s and the 2000s, indicating steady progress in yield gain across Africa. In Burkina Faso increased production is mostly attributable to intensification (K. Vom Brocke and G. Trouche, Researchers at the CIRAD, Montpellier, 2015, Pers. Com; Dabat 2015, pers. comm.). However, Malawi is showing a general trend towards a drop in production and in yield. Sudden drops in production can be attributable to drought and pest infestation, as evidenced by the production and yield curves for Nigeria, which most analysts ascribe to drought.[25] The principal parasitic weeds attacking

Figure 2. Cow pea yield in the study countries (Hg/Ha)



24. FAOSTAT data is not available for Ghana.
25. However this drop can also be interpreted as the result of the Nigerian policy adopted in 2012, which focuses on subsidising fertiliser for maize rice, cassava and wheat, an orientation which has possibly distorted the market in favour of these crops (Coulibaly 2012, personal communication).

Map 2: Cowpea production and distribution in West and Central Africa (in ,000 /ha). (Source: Langyintuo *et al*., 2003)



cowpea are *Striga gesnerioides* and *Alectra spp*., particularly in the semi-arid regions, causing important economic losses. The main pests during the growing season are pod sucking bugs (*Riptortus spp., Nezara viridula* and *Acantomia sp*.), aphis (*Aphis fabae, Aphis craccivora*), blister beetle (*Mylabris spp.*) and pod borer (*Maruca vitrata*). Post-harvest losses are also important, attributable notably to the cowpea weevil *Callosobruchus maculatus* (Coleoptera: Bruchidae) (Dabat *et al*., 2012a). Price fluctuations are another important factor explaining these variations; in Burkina Faso, for instance, cowpea as a cash crop competes with sesame, which in 2013 offered much better prices to farmers (R. Kaboré, President of the Association Minim Sông Pânga (AMSP) peasant organisation in the North-Centre (Kaya), Burkina Faso, 2015, pers. comm.).

Cowpea local, national, regional and international markets and production value chain

The largest cowpea exporting country in the world is Niger. Nigeria is the largest cowpea producer in the world, followed by Brazil, with an annual average production of 2.7 million metric tons over the last decade; it is also the largest importer of cowpea in the region (Mishihili *et al*., 2009). Niger, Burkina Faso, Benin, Mali, Cameroon, Chad and Senegal are net exporters; Nigeria, Ghana, Togo, Côte d'Ivoire, and Mauritania are net importers (Langyintuo *et al*., 2003). Important producers in Southern Africa are Botswana, Malawi, Mozambique, Tanzania, Zambia and Zimbabwe (Singh *et al*., 2003).

In West Africa, cowpea grain passes through a well-established value chain with regional trade flowing mainly from the semi-arid production areas in the Sahel to the more urbanised coastal zones (Langyintuo *et al*., 2003). In West Africa, farmers typically sell their marketable surplus grains to rural assemblers, who in turn sell to urban wholesalers directly or through commission agents, who also provide storage (Langyintuo *et al*., 2003). Map 2 below shows the cowpea production zones in West Africa, with the darker shades indicating the most important production areas.

The greatest production of cowpea comes from West Africa where a regional cowpea seed market has emerged, supported by high demographic growth and urbanisation. This market is proving to be a key driver in the intensification of cowpea production in West Africa (Aune and Bationo 2008).

There are three main outlets for cowpea production. The crop is either consumed in the rural areas where it is produced—often for own consumption—or transported to urban areas, or it is exported to other countries in West Africa. As with most protein products in West Africa, general cowpea trade flows follow a north/south direction. Sahelien countries

export cowpea to the more humid and densely populated coastal areas (Mishili *et al*., 2009) as well as to Central Africa, to countries that produce cowpea in small quantities but which have high consumption levels, such as Ghana and Nigeria (Langyintuo *et al*., 2003) and where the use of cowpea in culinary traditions is more pronounced (L. Saré, Representative of the FERT association, Burkina Faso, and Co-ordinator of the cowpea project, 2015, pers. comm.).

The largest cowpea market in the world is Dawanau market in Kano, in northern Nigeria, where cowpea represented over 50% of the grain handled (Langyituo *et al*., 2003). The market has a cowpea storage capacity in excess of 200,000 metric tons. Merchants from the Dawanau market are reported to finance a network of cowpea buyers throughout Niger and the neighbouring countries. Merchants from southern Nigerian cities also source their cowpea from the Kano market (Mishili *et al*., 2009).

Sub-Saharan Africa is characterised by significant variations in the level of market development across regions, with some regions (notably peri-urban and coastal areas) offering far better market integration than infrastructure-constrained locations. There are therefore important variations in the price, quantities, and quality of cowpea handled in each market (Takeshima *et al*., 2011) and across cities (Langyintuo *et al*., 2003). Mishili *et al*., 2009) found important price variations in cowpea available in markets across Southern Ghana (US$ 0.54 per kg across six markets, ranging from US$ 0,46 to US$ 0,6 per kg), Mali (US$ 0.39 per kg) and Nigeria (US$ 0.36 per kg).

Consumption of cowpea

Cowpea is cultivated for the grain, the green pods, the leaves and the haulms (stalks or stems). Beyond its contribution as a food the cowpea plant also plays a vital role in farming systems—when left in the soil the root system plays an important role in fixing nitrogen and therefore in increasing soil productivity.

People consume the green pods and fresh peas, which are harvested when the grain is still fresh, as well as the grains, which are harvested when dry. The nutritional value of cowpea is often emphasised in terms of the role the crop can play regarding food security (Quaye *et al*., 2009a). The crude protein content in the grain (on a dry weight basis) ranges from 22 to 30% (Nielsen *et al*., 1997, as cited in Singh *et al*., 2003). Cowpea grains also contain several vitamins and minerals including iron and zinc (Garrow *et al*., 2000). In West Africa, cowpea is the only crop available for sale during the lean season (between September and December) when other agricultural products are no longer available (Dabat *et al*., 2012).

Cowpea is a very versatile grain and lends itself to a variety of culinary forms. Philip *et al*., (2003) has mentioned over 50 different cowpea dishes in both the whole grain and milled forms. These are discussed in more detail below, for each case study country.

There are some notable regional differences regarding how the product is consumed and appreciated. For instance, Ghanaians are willing to pay a premium for black-eyed peas, while Cameroonians would lower their prices for them (Langyintuo *et al*., 2003, 2004). According to Kormawa *et al*. (2002), (as cited in Mishili *et al*., 2009), Nigerian consumers prefer brown cowpeas over white, and in Malawi about 80% of consumers and 90% of traders prefer brown seeds. However in Tanzania, this factor is irrelevant as most cowpea entering commercial markets is de-hulled prior to sale (Hello *et al*., 2010). This indicates healthy local diversity, which is met through the cultivation of many varieties.

Tarawali and Hiernaux (2002) write that the cowpea haulms, green pods and fresh peas are fed to animals—mostly traction animals and small ruminants—and the sale of the haulms as animal feed provides a vital income for farmers. The haulms are also dried to store them for the dry season.[26] Farmers cut them while still green and roll them into bundles containing

26. Sun-dried leaves can be stored for up to a year and they are not damaged by insects as much as dried seeds (GoSA 2011).

leaves and vines, which are placed on roof tops or makeshift barns. These dry haulms can fetch fairly high prices, up to 50 to 80% of the grain price (Singh *et al*., 2003). The name 'cowpea' is said to derive from the fact the crop once represented an important livestock feed for cows in the United States (IITA 2015).

Characteristics that farmers want from cowpea

The characteristics that farmers seek in cowpea depend on several context specific factors. Based on local studies conducted in the four case study countries, the traits include the following (typology based on Takeshima *et al*., 2011):

Agronomic traits: high yield (of grain and/or haulms) and resistance to biotic stress.
Morphological traits: farmers and consumers generally prefer cowpeas of a large size and also place a value on the texture of the skin and the colour of the eye. These preferences are country and even region specific (Mishili *et al*., 2009).
Grain quality traits: taste, cleanliness (i.e. free from stones and other waste materials), storage and processing potential and the time required for cooking.

Early maturity: this is an important trait increasingly sought by farmers in a context of climate change and longer and more frequent drought episodes (Inter-governmental Panel on Climate Change (IPCC) 2013). Farmers are progressively resorting to early maturing improved cowpea varieties as prolonged drought episodes can result in crop losses for the traditional, longer maturing varieties (Coulibaly 2015, pers. comm.).

Profile of farmers: this is another important differentiating factor when considering the desired traits of cowpea seeds. For instance, commercial farmers may place more importance on the potential yield of the seeds, as well as uniformity for mechanical processing purposes, whilst palatability may be more important for small-scale farmers who do not produce on a commercial scale (Takeshima *et al*., 2011).

Profile of farmers who are involved in cowpea cultivation and trends

The profile of farmers involved in cowpea cultivation is country specific and includes local differences with regard to the socio-economic circumstances of farmers, depending on their geographic location (with biophysical parameters influencing production and yields, etc.), proximity to markets and opportunities to engage in alternative forms of income generating activities.

However, there are some noticeable common trends. Cowpea is mostly farmed by smallholder farmers with average farm sizes not exceeding 3 ha in Burkina Faso (Dabat *et al*., 2012); an average size of 0,6 ha in Northern Ghana, in the Tolon Kumbungu district (Quaye *et al*., 2009b); an average 2 ha in Nigeria (Wakili 2013); and, depending on the sources, an average of 0,28 ha (International Fund for Agricultural Development (IFAD) 2002) to 1 ha (World Bank 2003) in Malawi.

Small-scale farmers tend to intercrop cowpea with other cereals, mostly staple crops such as maize, millet and sorghum. Evidence on the ground reports a trend towards greater portions of land being allotted to cowpea monoculture (Saré 2015; Coulibaly 2015; Enoch 2015, pers. comm.) but this is not obvious in the literature.

Socio-economic opportunities associated with cowpea are not limited to farming. Cowpea also represents an important form of livelihood throughout the value chain, from seed sales, through processing, wholesale and retail, to selling cooked cowpea in various forms (prepared food). Processing and sale of prepared food are mostly performed by women, often with very low levels of education or none at all. Informal types of entrepreneurship such as selling processed cowpea on the street enables women to generate income that is often higher than the basic standard of living (Otoo *et al*., 2011).

Agro-ecological practices involving cowpea

The most important agro-ecological practice involving cowpea relates to intercropping, a practice that is widespread for rain fed agriculture across Africa. Intercropping has evolved as the practice preferred by traditional farmers and research has shown that an efficient cropping system can often prove more profitable than monoculture (Rose and Adiku 2001; Sawadogo et al., 2010). In West and Southern Africa farmers traditionally

farm cowpea intercropped with sorghum, maize or millet, depending on the region. The combination of sorghum with cowpea is said to limit erosion while hydric resources in the soil are optimised for the other cereal; the practice also limits pests on cowpea while enhancing nitrogen intake for sorghum.

Cowpea also lends itself well to conservation agriculture (CA) approaches (Dabat *et al*., 2012). Conservational agriculture promotes no-till farming (which minimises mechanisation to avoid soil disturbance); a permanent soil cover (either a growing crop or a dead mulch); and the alternation of crops (FAO 2015). Cowpea is also a nitrogen fixer that performs well in intercropped systems (Widders 2012), making it an ideal CA crop. We should note that these three core practices of CA and of its cousin, climate smart agriculture (CSA), are held in common with agro-ecological practices. Nevertheless, both CA and CSA are widely used as techniques to promote Green Revolution technologies, especially hybrid (and potentially GM) seed, micro-dosed synthetic fertiliser and industrial pesticides. This is the basis of Integrated Soil Fertility Management (ISFM) and Integrated Pest Management (IPM) as espoused by AGRA and others.

The informal cowpea seed sector and farmer practices

Cowpea is a self-pollinating crop, meaning that farmers can recycle their seeds across several production seasons (Takeshima *et al*., 2011). Some degree of cross-pollination does happen between species and this leads to the alteration of breeding lines (M. Tamò, Entymologist at the International Institute of Tropical Agriculture, Benin, 2015, pers. comm.). This cross-pollination may be beneficial in adapting the seed to the ecology, and in other instances it may cause a decline in performance or undesired traits. Recommended practice for improved cowpea varieties is replacement on average every three years, a period that is said to be shorter than for other self-pollinating crops (Takeshima *et al*., 2011). According to Tamò (2015, pers. comm.) this period is between three and seven years, indicating good potential for on-farm saving. Evidence in the four case study countries shows that smallholder farmers mostly recycle their own seeds or source them informally over an average three-year period.

According to Minot *et al*., (2007), there are three main reasons why farmers in Sub-Saharan Africa purchase seeds from off-farm sources. These include seed replacement, variety change and emergency response. In addition, five critical factors influence farmers in terms of the choice and purchase of seeds: agro-ecological, natural and man-made disasters, uneven market development, preferences relating to channels and the timing of seed distributions, and the awareness of farmers regarding improved seeds. These factors explain the wide diversity in the type, quantity and timing of seed purchased by farmers. These factors are very context specific and have not been the focus of much research (Takeshima *et al*., 2010). In the context of specific projects access to improved varieties is also influenced by the simple opportunity of free or subsidised access through public or non-governmental sources (Vom Brocke and Trouche 2015, pers. comm.).

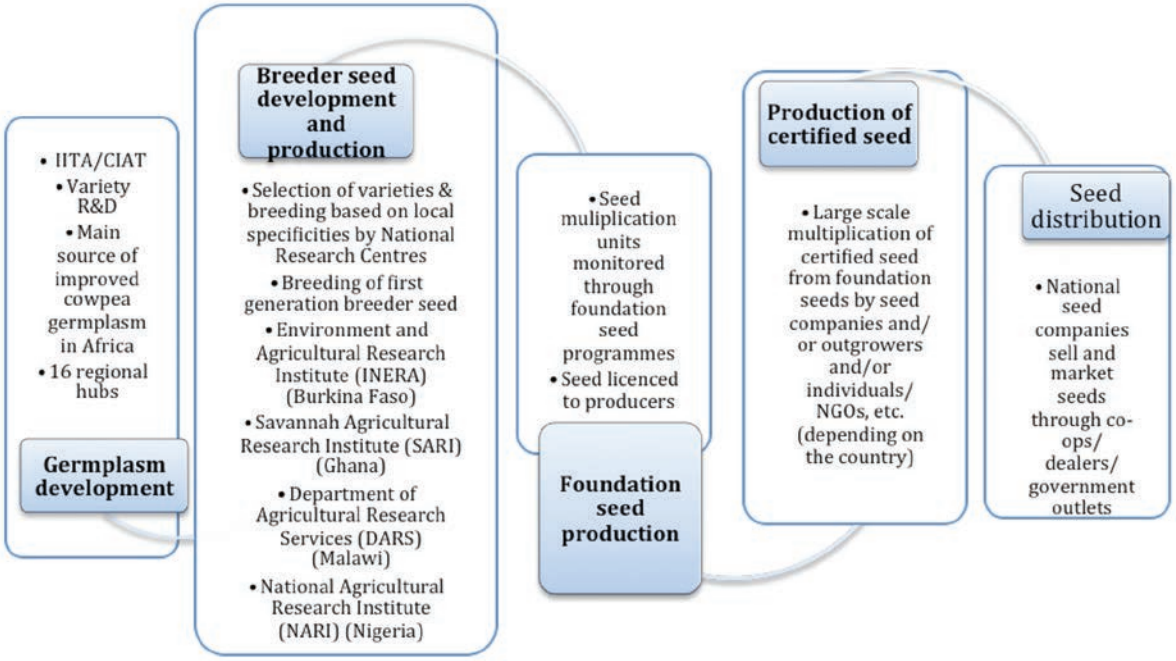
The formal cowpea seed sector

Since the 1970s the IITA, based in Ibadan, Nigeria, has held the global mandate for improving cowpea cultivars. The IITA accounts for a total of 16 hubs and research stations across Africa, including in Ghana, Nigeria and Malawi, and develops and distributes a range of improved cowpea breeding lines. Up to 1988 the IITA exclusively focused on the development of improved grain-type cultivars but since 1989 it has also aimed to develop dual-purpose cowpea varieties, both for grain and fodder purposes. Most countries source their improved cowpea germplasm exclusively from IITA (Singh *et al*., 2003).

Today the IITA gene bank holds the world's largest and most diverse collection of cowpea with 15,122 unique samples from 88 countries, representing 70% of African cultivars and nearly half the global diversity. Improved high-yielding varieties that combine multiple disease and insect resistances with early or medium maturity and preferred seed traits have been released in 68 countries (IITA 2015).

The formal organisation of the cowpea sector follows that of most other seeds in Africa. The pathway of certified seeds to farmers is as follows: national research centres source cowpea germplasm from the IITA; these

Figure 3: Generic organisation of the formal cowpea seed sector in Africa



centres then breed seeds from this germplasm with input from the national departments of agriculture, which specify the traits sought by a specific region. These breeder seeds are then multiplied to produce foundation seeds and this step is followed by the large-scale multiplication of certified seed by seed companies and/or out-growers and/or individuals/NGOs, etc., depending on the country (see Figure 3). The private sector is not involved in research on cowpea breeding as this offers little economic interest (apart from collaboration on breeding Bt cowpea, as discussed below). However, several private seed companies are involved in the production of foundation and certified seeds (Coulibaly 2015, pers. comm.).

At an international level the IITA collaborates with several other research initiatives, including the Bean Cowpea Collaborative Research and Support Programme (CRSP) which has been funded by USAID since the 1980s. This programme focuses its research on production, marketing, post-harvest insect pests and utilisation of cowpea in West Africa (Mishili *et al*., 2009).

The University of California Riverside (UCR) has been actively involved in the CRSP since its inception and has established partnerships with national research centres in Africa for cowpea seed development, notably in Burkina Faso, Ghana, Nigeria, Senegal and Mozambique. The UCR has developed several cowpea germplasms with unique traits[27] with the intention of breeding new cowpea cultivars for the African and the American markets (Hall *et al*., 2003).

A major innovation in cowpea conservation that is worth mentioning is 'triple plastic bagging'. This was originally developed in Cameroon and subsequently has been branded as Purdue Improved Cowpea Storage (PICS) bags—because of the role played by Purdue University in coordinating the programme, with financial support from the Bill and Melinda Gates Foundation. Since 2007 these bags

27. These varieties include: "snap-type pods, green manure/cover crop capabilities, heat tolerance during reproductive development, chilling tolerance during emergence, delayed leaf senescence as a mechanism of adaptation to mid-season drought and high grain yields, differences in stable carbon isotope discrimination, harvest index, rooting and plant water- and nutrient-relations traits, broad-based resistance to root-knot nematodes and Fusarium wilt, and resistance to flower thrips, cowpea aphid, lygus bug and cowpea weevil, and various quality traits including all-white and sweet grain." (Hall *et al*.,2003).

have been disseminated on a large scale in several countries in West and Central Africa, including Burkina Faso and Nigeria. These bags are produced by local manufacturers and made available to farmers through agro-dealer networks in several countries (Baributsa *et al*., 2010). Bagging the grain in three hermetically sealed bags has proven efficient at curbing pest infestation during storage (Murdock et al., 2003).

Recent trends in the development of cowpea seed

In the early 2000s the Australian CSIRO developed a genetically modified **field pea** seed by adding a protein found in kidney beans that causes weevil pests to starve to death (Kruger 2005). Trials came to a stop in 2005 when it was found that the transgenic pea triggered important immune responses and inflammation in the lungs of mice (Prescott *et al*., 2005). Subsequently CSIRO pledged to destroy the DNA of the GM pea but it has transpired that it was kept for further development in Europe, with CSIRO even casting doubt about the study's findings (Wilson 2013). This story was just the beginning of CSIRO's dabbling with transgenic peas, before it became involved in research on Bt cowpea, as explained below.

Since the mid-2000s the AATF has been spearheading 'public-private' research of a GM cowpea that is resistant to the maruca legume pod borer. Field trials were first initiated in Nigeria in 2009 (Field 2014). This Bt cowpea was developed using the Cry1Ab gene from *Bacillus thuringiensis*, which encodes the Cry1Ab protein (accession 1310234A), the same protein expressed in GM maize line MON810 by Monsanto (Higgins as cited in Goodman and Ofori-Anti 2012). A second GM cowpea is also under development by CSIRO for resistance to bruchid beetles. This GM cowpea incorporates the gene for the alpha-amylase inhibitor (aAI) gene from *Phaseolus vulgaris* var. Tendergreen, also called the common bean or green bean (Higgins, as cited in Goodman and Ofori-Anti 2012).

This Bt cowpea research was initiated by the Network for the Genetic Improvement of Cowpea for Africa (NGICA) project, hosted by Purdue University in the United States. AATF's core funding comes from USAID, DFID, the Rockefeller Foundation, and the Bill and Melinda Gates Foundation (AATF 2015a). The AATF reports that "the Bt and nptII genes were donated to AATF by a private company (Monsanto) on a humanitarian basis under a royalty free license. These genes were transferred into cowpeas by scientists at an Australian public research centre" (AATF 2015b), namely CSIRO. The AATF further reports that "the varieties to be modified with the Bt gene have been identified as farmer preferred varieties and come from the national research centres in participating countries" (AATF 2015a), namely the Council of Scientific and Industrial Research—Savannah Agriculture Research Institute (CSIR-SARI) in Ghana; the Institute of Agricultural Research (IAR), Nigeria; the *Institut de l'Environnement et de Recherches Agricoles* (INERA) in Burkina Faso and the National Biotechnology Development Agency (NABDA) in Nigeria. The genetically modified strains that performed best have been used as parents in the breeding programme (Field 2014) and thus far field trials have been conducted for several years in Nigeria, Burkina Faso and Ghana, with an application pending in Malawi. Local plant breeders are said to be taking part in "introgressing the Bt gene into farmer-preferred lines" (CSIRO 2015).

In the following section, these different aspects of the cowpea socio-economy are scrutinised in more detail in four countries: Burkina Faso, Ghana, Malawi and Nigeria.

Detailed overview of the cowpea sector in four countries

Cowpea in Burkina Faso

Cultivation trends (Burkina Faso)

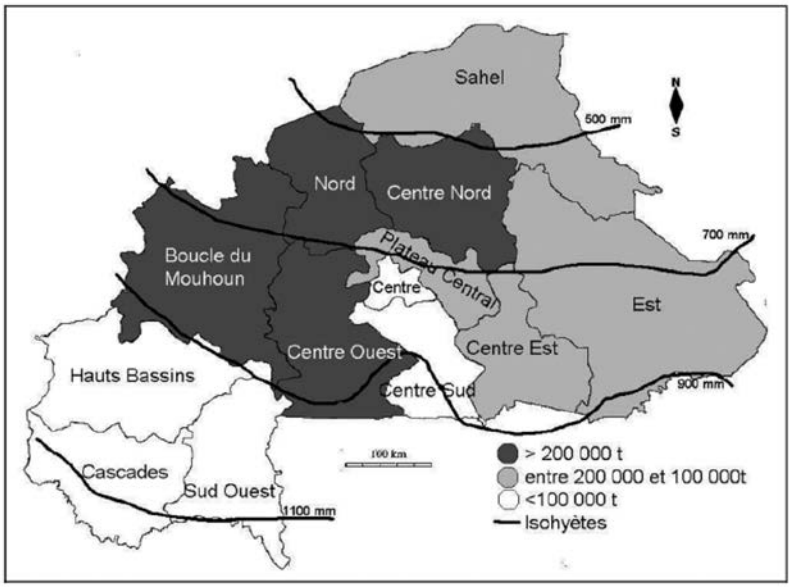
Burkina Faso is the third largest producer of cowpea in the world, following Nigeria and Niger. Cowpea is farmed across large parts of the country, especially in the Centre-North, North, the Bouce du Mouhon and the Centre-West regions, which are drier than the southern regions where soils are more sandy (Saré 2015, pers. comm.) and where there is less parasite pressure (Dabat *et al*., 2012a).

Since the 1980s the production of cowpea in Burkina Faso has been characterised by strong upward movement in production levels, although these vary significantly from one year to the next (Dabat *et al*., 2012a). During the 1980s cowpea production was, on average, below 50,000 tons per annum (t/pa), but this increased to a production level well above 200,000 t/pa from the early 1990s onwards.

Over the past few years this incremental trend has been maintained and, in general, production has reached over 400,000 t/pa. In 2010 cowpea represented 2,1% of the agricultural income in the country (Dabat *et al*., 2012a). In 2013 Burkina Faso produced just over 589,000 tons of cowpea and was the third largest dry seed producer in the world, with a production of just over 18,000 tons (FAOSTAT 2013). The area under cowpea cultivation increased significantly between 2000 and 2013, with an average annual increase of 7,2%. Between 1990 and 1999 Burkina Faso had the second highest average yield in the entire west and central African region, behind Cameroon with an average of 0,777 tons per hectare (t/ha) (Langyuntuo *et al*., 2003). However, yield increase per annum remains at a low constant of 0,1% (FAOSTAT 2011).

The key factor behind this recent increase in production was the increase in area planted (M-H Dabat, Economist at the CIRAD, 2015, pers. comm.), driven by the existence of rewarding markets—cowpea fetches an average of US$ 0.34[28] per kg on local markets (Kaboré 2015, pers. comm.). Other factors explaining this increase are the distribution of subsidised improved varieties and the provision of training

Map 3: Cultivation map of cowpea in Burkina Faso in 2010 (Dabat *et al*., 2012, based on Environmental Protection Agency (EPA) 2009–2010)



28. Equivalent to 200 CFA (the West African franc).

and support by Government (I. Drabo, Cowpea Breeder at the INERA Saria Centre, Burkina Faso, 2015, pers. comm.), and the broad adoption of methods to contain post-harvest losses, notably PICS bags (Kaboré 2015, pers. comm.).

Local, national and international cowpea market (Burkina Faso)

Burkina Faso seems to play the role of a major cowpea-trading platform in the sub-region. In 1998, Burkina Faso imported cowpea from Niger and most of its surplus was exported to Togo, Côte d'Ivoire, Ghana and Benin (Langyintuo *et al*. 2003.).Generally speaking, the price of large and small grain cowpea is the same across the Eastern and Centre-East region, although large grain cowpea is a better seller. However, large grain cowpea usually fetches a 15% premium in the Dori region, a central market place from which Burkina Faso's cowpea is exported (Dabat *et al*. 2012b.).

The country exports the mainstay of its production. In the absence of official statistics on the volume of exports of cowpea, Dabat et al. (2012a) estimated that the total volume of exports to the sub-region averages 300,000 t/pa, i.e. 60 % of the total average production. The country exports to Benin and Ghana, mostly, but also to other countries depending on the years and the volumes produced, such as Nigeria, Togo, Ivory Coast, Senegal, Mauritania, and Mali (Dabat *et al*. 2012a).

Consumption and uses of cowpea (Burkina Faso)

In Burkina Faso findings pertaining to the volumes of annual per capita cowpea consumption vary greatly, according to the sources and the areas considered. Lancon et al. (2009) estimate that the average annual per capita consumption is 7,7 kg, with higher consumption levels in the Northern, Centre-North and Centre-West regions, where people consume over 10 kg per capita per annum.

Two main types of cowpea are produced: white and red cowpea. The variety most consumed and preferred is the large white cowpea while the smaller red cowpea is most appreciated for its sweeter taste by consumers in the Sahelien and Guinean regions, which represent the greatest market for this variety (Dabat *et al*., 2012b).

From a culinary perspective cowpea (called *benga* in the Mooré language, one of the two official regional languages in Burkina Faso) is appreciated both in rural and urban areas; the crop is highly rated for its food value and in urban areas people appreciate it for the diversity it brings to their diets, as well as the savings to their food basket (Dabat *et al*., 2012a). Some people consume cowpea from a sense of tradition while others, paradoxically, see cowpea as a modern form of food (Bengaly, 2010).

Profile of farmers who are involved in cowpea cultivation (Burkina Faso)

Cowpea is grown mostly by smallholder farmers on small plots, mostly on farms of less than 3 hectares, and is generally intercropped with other main cereal crops—sorghum or millet. The volumes produced are very small: on average two-thirds of the country's farmers produce fewer than three 100 kg bags of cowpea each, while the other third produces no more than 10 bags of cowpea per annum (Statistika, 2003).

Cowpea is marginally farmed as a secondary crop (in intercropped systems) only on farms that are over 10 hectares in size. Cowpea is cultivated as a monoculture crop in the Hauts Bassins and Cascades areas—high production areas—but not so much in the dominant production regions (Dabat *et al*., 2012a). This is because cowpea yields are fairly low when the crop is grown as a monoculture and, accordingly, economic studies recommend the extensification rather than the intensification of cowpea (Dabat 2015, pers. comm.). However, evidence from the field indicates an increase in the cultivation of cowpea as a monoculture, due mostly to the greater availability of improved seeds and chemical inputs. Cowpea monoculture is often practiced by the same small-scale producers who use cowpea for intercropping (Saré 2015, pers. comm.).[29]

29. Information about exact cultivation trends might be contradictory. It is also contended that cowpea monoculture is in fact the prevailing trend in Burkina Faso (Kaboré 2015, pers. comm.).

Characteristics of cowpea sought by farmers (Burkina Faso)

Farmers in Burkina Faso cultivate two varieties of creeping cowpea—a short cycle variety (for grain) and a long cycle variety (for fodder)—(Singh *et al*., 2003). Dual-purpose varieties (for grain and fodder) have been promoted and are cultivated mostly in the northern regions where more people farm animals (Saré 2015, pers. comm.). However, the effective viability of such dual-purpose varieties has been called into question; some cowpea experts contend that cowpea farmed in intercropped systems for subsistence actually is used mostly for animal fodder, and that grain then becomes a marginal return (Coulibaly 2015, pers. comm.).

For farmers producing cowpea for commercial purposes, the single most important factor is yield. From a morphological perspective, white cowpea is the most widespread and also the most sought after by international markets (Saré 2015, pers. comm., Kaboré 2015, pers. comm.). It is also the crop most consumed locally and is therefore a favoured variety amongst farmers, whereas red cowpea represents only 5% of the national production (Dabat *et al*., 2012b). Resistance to drought, precocity, i.e. the ability to induce early fruitfulness, (Saré 2015, pers. comm.), and resistance to striga and haulm productivity (Kaboré 2015, pers. comm.) are also important traits.

Agro-ecological practices and other uses of cowpea (Burkina Faso)

Small-scale farmers generally grow cowpea intercropped with other cereals; they derive benefits from this crop through nitrogen fixing, animal fodder and erosion protection., These are all aspects that cannot be translated in monetary terms despite efforts to monetise them as 'ecosystem services' and carbon credits. Cowpea is farmed mostly as a secondary crop for subsistence purposes, with other cereals such as millet and sorghum, the country's two main staple crops (on over 68% of small scale farms), and hardly as a main plant in intercropped systems (on only 2,6% of small scale farms) (Dabat *et al*., 2012a). It is also reported that within a single plot the ratio of cowpea to millet or sorghum planted varies significantly, as farmers take into account the specific soil and ground cover conditions specific to different parts of their plots (Dabat 2015, pers. comm.). The practice of intercropping 4 lines of cow pea with 2 lines of another cereal is being promoted in Burkina Faso (Dugje *et al*., 2009), as is the planting and distribution of cowpea for dual purposes (grain and fodder) of semi-erect varieties with an intermediary cycle (78 to 90 days), resulting in yields of up to 1,5 t/ha of grain and 2,5 t/ha of haulms (Singh *et al*., 2003). The sale of cowpea haulms can yield greater economic returns than the sale of grain, especially in suburban areas where there is more pressure to find animal feed. Assuming a planting density of 5,000 plants/ha, the sale of haulms can realise up to 125,000 CFA (West African francs), whereas 300 kg of grain would bring in only 75,000 CFA (Dabat *et al*., 2012a). These 'by-products' are a crucial part of the value of the crop.

Farmers supported by the French Association for International Cooperation for Agricultural Development (FERT)[30] in the North-Centre region are reported to use exclusively traditional varieties of cowpea in intercropped systems, because of their greater resistance to parasites. The crops thus farmed are not sprayed with insecticides so that women can process young leaves for cooking without having to wash them (Saré 2015, pers. comm.). Cowpea is farmed as a monoculture for commercial purposes on 14% of small farms (EPA as cited in Dabat *et al*., 2012a) and in that instance farmers use both mineral and organic fertiliser as well as insecticides (Saré 2015, pers. comm.).

The informal cowpea seed sector and farmer practices (Burkina Faso)

Close to 90% of cowpea seeds come from the informal sector—farmers who have received improved seeds generally save seeds over three consecutive years (Kaboré 2015, pers. comm., Drabo 2015, pers. comm.). The practice of barter and donations is widespread and some farmers also purchase cowpea sold on food markets for planting (Kaboré 2015, pers. comm.).

30. http://www.fert.fr/en

The formal cowpea seed sector (Burkina Faso)

In Burkina Faso the institutional mandates regulating the production and distribution of improved seeds are clearly defined. The Institution de l'Environnement et de Recherches Agricoles [Environment and Agricultural Research Institute] (INERA), which falls under the Ministry for Scientific Research and Innovation, has an exclusive mandate of developing and distributing breeder and foundation seeds (Drabo 2015; pers.com; Damoue 2015, pers. comm.). Foundation seeds can be developed with other institutions or the private sector under the supervision of INERA (Kaboré 2015, pers. comm.). The main non-governmental actor currently giving the INERA technical and financial support regarding the development of cowpea varieties and the production of foundation seeds is the University of Riverside, California (UCR) (Drabo 2015, pers. comm.). The University's involvement is funded by the Bill and Melinda Gates Foundation and USAID. Their support also includes the promotion of PICS bags and the training of producers (Drabo 2015, pers. comm.).

The Ministry of Agriculture in Burkina Faso is in charge of certifying seed and plays a support role in guaranteeing the quality of certified cowpea seed. Agricultural extension officers play a support and advisory role to seed producers[31] for the production, storing and safekeeping of cowpea seed. Agents from the Ministry of Agriculture Centre de Contrôle de la Qualité des Semences [Seed Quality Assurance Control Centre] (LABOSEM) are responsible for seed quality control and check whether the seed production plots meet the minimum legal requirements that regulate each seed generation (S. Damoue, Technical Expert specialising in the environment and sustainable agriculture for the NGO, TIIPAALGA, 2015, pers. comm.). Contracts for the production of certified seeds are entered into with farmers' groups, NGOs, individual farmers with a minimum area of 3 ha,[32] seed companies and private companies (such as Faso Agricultural Neema (NAFASO SA)).[33] From 2007-2012, AGRA sponsored three cowpea projects in Burkina Faso.[34]

Certified seeds can be sold by designated entities including outlets selling agricultural inputs, seed producers and seed companies. A big chunk of these certified seeds are bought up by the state or NGOs who then avail them to farmers at highly subsidised prices or even free of charge (especially in the case of projects targeting women). These subsidised seeds are purchased and distributed by the Ministry of Agriculture (Vom Brocke and Trouche 2015, pers. comm.) as part of relief interventions (following the loss of crops due to climatic events) or by NGOs who have pre-identified beneficiaries. This practice is very much decried by seed companies who perceive it as undermining the seed market (Coulibay 2015, pers. comm.) Cowpea normally fetches 1,000 CFA (US$ 1,7) at market prices. Currently the production of certified seeds is unable to meet the demand; one of the main production challenges is the rotting of peas before harvest during the rainy season. It is estimated that certified seeds represent about 11% of the cowpea cultivated in 2012 (Monitoring and Analysing Food and Agricultural Policies (MAFAP) programme of the FAO 2013).

Cowpea in Ghana

Cultivation trends (Ghana)

Cowpea production in Ghana is largely concentrated in the Upper West, Upper East, Northern Regions and some districts in the Brong Ahafo Regions (the Guinea Savanna zone). Cowpea is the second most important food legume in Ghana. It is second to groundnut in terms of the area under cultivation and the quantity produced and consumed annually (Egbadzor et al., 2012). According to the Tropical Legumes II project, funded by the Bill and Melinda Gates Foundation, Ghana is the fifth highest producer of cowpea in Africa and boasts

31. Seed producers are organised under the National Union of Seed Producers.
32. The 2006 Seed Law stipulates that seed growers must have at least 3 hectares of land—this has led to farmers partnering and regrouping their land to be able to become seed growers. (Vom Brocke and Trouche 2015, pers. comm.)
33. http://www.nafaso-burkina.com/produits_sem-ameliorees.html
34. http://www.agra-alliance.org/AGRA/en/grants/grants/grants-database.

the highest production rate of the legume on the continent (ICRISAT 2012).[35]

The area under cowpea cultivation peaked at 190,400 ha in 2003 and has since followed a general downward trend, measuring 161,966 ha in 2013 (MOFA 2015). This drop in the area harvest has been offset by strong production and yield increases over the past two decades. Ghana's production levels increased from an average of 57,000 t/pa between 1990 and 1999 (Langyintuo et al., 2003) to an average of about 177,000 t/pa between 2000 and 2013, which is equivalent to a 70% increase. The annual cowpea yield over the same period was about 32% and averaged close to 9,600 hectograms per hectare (Hg/ha), making it the country with the highest yield, ahead of Nigeria, Malawi and Burkina Faso (all data based on MOFA 2015). This yield increase is attributed to improved farming practices and the use of higher yield varieties (Egbadzor *et al*., 2012).

Despite this incremental trend in production, cowpea demand historically has been outstripped by supply (Egbadzor *et al*., 2012). In the decade 1990–1999, the country's average deficit was 112,000 t/pa (Langyintuo *et al*., 2003). Ghana imports cowpea mostly from Burkina Faso and Niger (Seferiadis 2009 as cited in Quaye *et al*., 2011) and to date Ghana remains a net consumer and importer of cowpea (Tettey Asare 2015, pers. comm.)[36]

Local, national, regional and international markets (Ghana)

Ghana is not producing enough for its domestic markets and local varieties are being crowded out by foreign varieties, which threaten local production (A. Tettey Asare, Department of Molecular Biology and Biotechnology, School of Biological Sciences, University of Cape Coast, Ghana, 2015). Traders on Ghanaian markets emphasise how locally produced cowpea tends to be less well-conditioned for market (i.e. it requires a lot of cleaning as it contains many stones and foreign materials) and how it is difficult to store, being easily infected by weevil. As a result, locally produced cowpea is not common on the southern markets three months after harvesting (Quaye *et al*., 2011). The influx of foreign cowpea into Ghana comes mostly from Togo, Niger, Nigeria and Burkina Faso, with about 30% of cowpea being imported from the latter. Local traders point out how consumers increasingly tend to buy foreign cowpea, which shows better properties overall (especially cleaner) than local cowpea and are cheaper than most imports, apart from those from Nigeria (Quaye *et al*., 2011).

Consumption and uses of cowpea (Ghana)

Cowpea is widely consumed in Ghana, with an estimated 9 kg of cowpea being consumed per person annually (*Bulletin of Tropical Legumes* 2012).

The traditional way in which women process cowpea in rural areas entails soaking and then milling the sorted grain into flour. Water is added to the flour to make balls that are then deep-fried, making a dish called *koos* or *koosai* or *akara* in coastal areas (Otoo *et al*., 2011) and which is one of the most common street foods in the region (Mishili 2009).

Cowpea is also consumed whole with cereals like rice (the dish is called *waakye*) as well as other popular staples such as processed cassava or *gari*, maize and beans or *nagbechinge*, yams and ripe plantains (Quaye *et al*., 2009a). *Apprepensa* is prepared from roasted maize meal and cowpea flour while *tubani* or *gablee* is prepared from cowpea flour (Quaye *et al*., 2011). Leaves are also added to the preparations of some dishes such as *nyombeica* (a mixture of cowpea leaves and whole maize or cowpea flour which is then steamed) and *goara* (boiled cowpea leaves usually eaten with *koose*) (Quaye *et al*., 2011).

35. The *Bulletin of Tropical Legumes* is a monthly publication of the Tropical Legumes II (TL II) project, funded by the Bill and Melinda Gates Foundation, and jointly implemented by the International Crops Research Institute in the Semi-Arid Tropics (ICRISAT), the International Center for Tropical Agriculture (CIAT) and the International Institute of Tropical Agriculture (IITA), (ICRISAT 2012).
36. This statement is disputed by the research (most probably predictive) shared by the Institute of Statistical, Social and Economic Research (ISSER), University of Ghana Legon. According to ISSER, Ghana now has a positive cowpea balance with a production surplus averaging 61,000 tons per annum between 2010 and 2013 (based on Asante 2015 as cited by Enoch 2015, pers. comm.).

There are noticeable gender differences in cowpea consumption in parts of Ghana. A study that profiled consumers in Northern Ghana showed that women were greater consumers of cowpea than men (65% versus 35%). Women as caregivers regard cowpea as an important food to sustain the growth of children and to prevent iron deficiency—they perceive cowpea as a 'blood giving' plant (Abizaru *et al*., 21013). Cowpea leaves are also cooked in stew and used as a weaning food or porridge (Quaye *et al*., 2009a).

Characteristics of cowpea sought by farmers (Ghana)

With regard to the agronomic traits desired by Ghanaian farmers, farmers from the Northern region preferred early-maturing local cowpea varieties; these generally prove to be more tolerant to insects and give relatively better yields with very little agrochemical applications (Quaye *et al*., 2009b). Research conducted in the Volta region and in the Agbobloshie market in Accra (Egbadzor *et al*., 2012) found that for farmers and traders, the most important trait is the speed of cooking—a variety that takes too long to cook would not find local acceptance. This is why cream coated cowpeas are preferred—they are softer and cook faster. At the consumer level, cleanliness tied to the extent of weevil damage was ranked most important. This was followed by seed colour (preferably white), short cooking time, size and taste (Egbadzor *et al*., 2012).

The traits in cowpea that are wanted by traders are important indicators for farmers and revealing of shortcomings in the quality traits of cowpea grains in Ghana. Quaye *et al*. (2011) found, in selected markets of Accra and Kumasi (both located in the southern part of Ghana) and in decreasing order of importance, that traders favoured varieties of cowpea for their cleanliness (stone free and no dirt); colour (preferably white seed); ease of cooking; taste; size (large or medium); limited weevil damage; dryness; and place of origin. Research conducted with local traders in these markets showed that foreign cowpea is gaining high acceptance among Ghanaian consumers, at the expense of locally produced cowpea. The selling points for foreign cowpea varieties (which appear to be lacking in locally produced cowpea) include post-harvest cleaning, quality treatment and packaging, a short cooking time, big grain size, good taste and all-year round availability (Quaye *et al*., 2011). Egbadzor et al. (2012) emphasise that Ghanaian farmers would not want to farm cowpeas that required a long cooking time as such produce would not find local acceptance.

Profile of farmers who are involved in cowpea cultivation (Ghana)

Reports indicate that cowpea is farmed mainly by elderly men and women (Tettey Asare 2015, pers. comm.). A study of cowpea farmers and processors conducted in the Tolon Kumbungu district in Northern Ghana gives detailed information about the socio-economic profiles of cowpea farmers (Quaye *et al*., 2009b). The demographic profiles of respondents showed that over 86% of the farmers (mostly men) and 100% of the processors (women only) had no education at all. The reliance of these famers on their primary activity (farming or processing) is high—most of the men are almost exclusively involved in farming and trading their farming produce, while for most women processing cowpea is their main source of income, with farming as a secondary activity. Fifty per cent of respondents ranked cowpea as the third most important income-generating crop, after groundnut and rice, and 43% ranked cowpea as the most important source of food (findings based on 2007 data). This same survey found a marked division of labour in terms of the cultivation and processing of cowpea. Men cultivate the crop (mostly) while women (mostly) are in charge of processing it (Quaye *et al*., 2009). Both men and women are involved in the wholesaling of cowpea grain, whilst it is mostly women who are involved in retailing (Quaye et al., 2011).

A study of women in Kumasi (coastal Ghana), who cook *kossaï* in hot oil over an open wood fire or a small gas stove at street-side vending locations, found that average vendor earnings were almost 16 times higher than the official minimum wage (Otoo *et al*., 2011).

Agro-ecological practices and other uses of cowpea (Ghana)

According to Tettey Asare (2015, pers. comm.), cowpea is farmed mostly as a monoculture[37] in Ghana. Intercropping is also widely practiced, notably with maize (Rose and Adiku 2011), millet, sorghum and cassava (Tettey Asare 2015, pers. com).

The informal cowpea seed sector and farmer practices (Ghana)

A study conducted in 2009 found that more than 55% of farmers from a poor northern district mostly used seed stored from their own farms, as well as from other farmers who preserve seeds for sale. Twenty-two per cent sourced seed from traders; the same number (22%) sourced seed from dealers; and suppliers of cowpea seeds for planting also included markets and traders. The same study indicated that the average farm size of cowpea farmers averages 0,6 hectares (Quaye *et al*., 2009b).

Respondents in a study conducted in southern Ghana revealed that 22% of farmers cultivated improved varieties only, for commercial purposes; 32% cultivated local varieties only; and 46% cultivated both local and improved varieties (Quaye *et al*., 2011).

The formal cowpea seed sector (Ghana)

Improved varieties of cowpea seed released in Ghana in the 1980s were developed essentially by the IITA. The Savanna Agricultural Research Institute (SARI), which is one of thirteen research institutes that fall under the Council for Scientific and Industrial Research (CSIR), together with the Crops Research Institute of the Council for Scientific and Industrial Research (CSIR-CRI), are the two institutions responsible for the release of improved breeder varieties.

The CSIR- CRI is mandated to conduct research into the production of cereals, legumes, roots and tubers, and industrial and horticultural crops, in order to develop improved varieties that provide high yields and are tolerant or resistant to both biotic and abiotic stresses. The CRI has oversight responsibility for varietal release (Tettey Asare 2015, pers. comm.). By 2008 eleven higher yielding, early and medium maturing varieties had been released in Ghana by the CSIR-CRI and CSRI-SARI (ICRISAT 2012). The University of Cape Coast is also involved in the development of new varieties, having developed a new strain called UCC-Early which has been tested in field trials (Quaye *et al*., 2011). Between 2007 and 2012 AGRA sponsored eight cowpea projects in Ghana.[38]

SARI has spearheaded the development of Bt cowpea in Ghana, in conjunction with the Australian CSIRO. The Seed Producers Association of Ghana (SEEDPAG), an agency responsible for coordinating and managing the production, distribution and marketing of seeds of various crops, handles both foundation and certified seeds, together with the Grains and Legumes Development Board (GLDB) and farmer-based organisations (ICRISAT 2012).

The Ministry of Food and Agriculture is responsible for dissemination to farmers through extension farmers as well as offering training to farmers. While the private sector and civil society in Ghana are involved in seed production, multiplication and sales to farmers (Tettey Asare 2015, pers. comm.), multinational companies do not feature prominently in cowpea seed distribution (Quaye 2015, pers. comm.)

Under the new seed law enacted in Ghana in 2011, provision was made to open the seed development industry to more private seed companies. Accordingly, cowpea breeders' seeds will be produced mostly by CSIR-SARI and CSIR-CRI, while foundation and certified seeds will be handled mostly by the GLDB, SEEDPAG and farmer-based organisations (ICRISAT 2012).

Cowpea in Malawi

Cultivation trends (Malawi)

Cowpea is an important legume crop in Malawi and has been adapted to a wide variety of local conditions, particularly in the warmer, drier areas in the south of the country (the Lower Shire valley, Bwanje valley, Lakeshore and the Phalombe plains) as well as in the dry plateau

37. This assertion could not be confirmed by the literature.
38. http://www.agra-alliance.org/AGRA/en/grants/grants/grants-database

areas of Machinga (Nkongolo *et al*., 2009).

Over the past decade the cowpea economy in Malawi has followed a downward trend, with total production over the 2000–2013 period decreasing by close to 7% per annum, the yield decreasing by about 3% per annum and the area harvested also contracting by close to 4% per annum (based on FAOSTAT 2013). In 2012 the average yield per farmer averaged 378 kg/ha on a total planted area of about 61,082 ha (Ministry of Agriculture, Irrigation and Water Development (MoAIWD) 2012, as cited in Kabambe *et al*., 2014). The main factors explaining the depression of the cowpea sector in Malawi are insect pests, diseases, and the lack of adequate varieties (Ministry of Agriculture and Food Security (MoAFS) as cited in Kabambe *et al*., 2014). In addition, parasitic weeds such as Alectra vogelli and Striga asiatica, which are widely found across Malawi, can seriously compromise production (Kabambe *et al*., 2014). While low nutrient levels in soils (especially phosphorous) have also been suggested as a possible cause for the downward trend (Kamanga *et al*., 2010), policy factors may also account for this trend. Cowpea is generally not considered a priority crop by the government,[39] which explains the general lack of support and the lack of improved cowpea varieties (L. Pungulani, Curator of the national gene bank, Malawi Plant Genetic Resources Centre, Chitedze Research Station, 2015, pers. comm.). However data from the Seed Services Unit of the Department of Agricultural Research Services (DARS) in Malawi shows that the area under commercial cowpea seed production has significantly improved over the past five years, going from close to nil in 2009–2010 to 246.4 ha in the 2013–2014 cropping season (DARS as cited by Pungulani 2015, pers. comm.). According to the Crop Trust (2015) Malawi is the main cowpea importer in Africa.

Local, national, regional and international markets (Malawi)

Malawian women in particular value cowpea because its green pods and leaves are the earliest food available during 'the hunger months' prior to the main grain harvest and, as stated earlier, the crop can play an important role as a weaning food for infants (Lungu undated). Research conducted in 2010 found that slightly more women (10% of respondents) reported growing cowpea than men (8% of respondents), (Programme for Africa's Seed Systems 2010 as cited in CfE 2015).

Consumption and uses of cowpea (Malawi)

Most cowpea is consumed where it is grown and both the seeds and the leaves are used. The most common form of consumption in Malawi and other parts of southern Africa entails boiling dry cowpea seeds in a stew. The long cooking and limited variety of cowpea-based products is reported to limit the wider use of dry whole cowpea seeds. The most important culinary traits associated with cowpea were rated by farmers as faster cooking times, ease of mashing the cooked grain and the colour of the seed, cream being the best (Nkongolo *et al*., 2009). In Malawi cowpea has been found also to be an important potential weaning food for infants and young children in the form of biscuits or porridge (Lungu undated).

Characteristics of cowpea sought by farmers (Malawi)

A survey conducted by Wageningen University that explored farmers' rationale for their use of legumes, found that the primary driver for growing a leguminous plant was to produce a grain for self-consumption or for sale. The second attribute, by order of importance, was the ability of a legume to be intercropped with maize; this is crucial in Malawi where maize constitutes the most important staple food. The third attribute sought by farmers was the ability to improve soil fertility; this aspect was assessed according to the level of biomass production by the legume. This was followed by the ability to control weeds such as the very invasive *Striga asiatica* the incidence of which, with regard to maize, can be reduced by some legumes. In a comparative assessment of cowpea over other crops farmers reported that their main reasons for planting cowpea were its use as a food relish; the fact that it is an

39. The Malawian government's Farm Inputs Subsidy Programme (FISP) specifically focuses on the promotion of quality seed of improved varieties for maize, groundnut, pigeon pea, common beans, cotton and soybean, with no support to other essential food crops, which arguably has destroyed the market (IISD 2012).

easy crop to manage; and because it matures faster than many other crops. On the downside, cowpea was seen as being susceptible to pests and diseases and aphid attack, it offered limited biomass production, and produced low yields (Kamanga *et al*., 2010).

A study that was conducted across various locations in Malawi, to test the release of a weed resistant strain of cowpea, asked farmers which traits they required. The most commonly sought after traits were large sized seeds (17%), resistance to *alectra vogelli*, one of the main parasitic plants affecting leguminous plants (15,1%), high yield production (15.1%), early maturing (13.2%) and taste preferences (11.3%) (Kabambe et al., 2014 as cited in CfE 2015).

Profile of farmers who are involved in cowpea cultivation (Malawi)
In Malawi cowpea farming takes place on fragmented small parcels of customary land (Gamula *et al*., 2013) and, depending on the source, farmers are said to farm an average of 0,28 ha (IFAD 2002) to 1 ha (World Bank 2003). Forty per cent of smallholders reported cultivating less than 0.5 ha (IFAD 2002).

Agro-ecological practices and other uses of cowpea (Malawi)
At a national level groundnuts, beans and pigeon peas are planted on large land areas in Malawi. However, information about agro-ecological practices involving cowpea in Malawi is scarce although it is profiled as an important protein source that can be farmed in areas unsuitable for bean and groundnut production (Kabambe *et al*., 2014).

The informal cowpea seed sector and farmer practices (Malawi)
Up to 90% of the cowpea grown in Malawi is from local, farm-saved varieties and the vast majority of production is consumed on-farm (CfE 2015). Purchasing new seed is not common for many farmers and if they buy it is usually from within the area from other farmers (Kamanga *et al*., 2010). This finding was corroborated by the Consultative Group for International Agricultural Research (CGIAR), which estimated that cowpea grown from improved seed accounts for only 10% of Malawi's 2009 cowpea harvest (CfE 2015). In this informal system seed is sourced from exchange, either in kind or cash and is recycled (Nakhumwa and Kaudzu undated).

A survey conducted by the African Centre for Biodiversity (ACB) found that 87% of farmers in a small survey in two districts in central Malawi who grew cowpea used non-certified seed. The study showed that 74% of cowpea seed was replanted from the previous harvest (ACB 2014).

The formal cowpea seed sector (Malawi)
The formal seed sector in Malawi includes MoAFS and the University of Malawi. These public entities regulate the sector. The Department of Agriculture's Research Services (DARS) is the only institution responsible for the release of foundation seeds.

DARS works jointly with other stakeholders in developing and promoting improved varieties. The Lilongwe University of Agriculture and Natural Resources (LUANAR) and the Bunda College of Agriculture also play a role in research. An Alectra vogelii resistant cowpea variety was developed by DARS in conjunction with the Bunda College and the McKnight Foundation (Hella *et al*., 2013) and was released as ITK99-494-6 in 2011. Once a variety is released breeder seed is sold to seed multipliers who increase seed under the close supervision of the Seed Services Unit (SSU) within DARS. Certified seeds are sold at research stations located in various districts; major stations are located in Lilongwe (Chitedze Research Station), Thyolo (Bvumbwe Research Station) and Mzuz (Lunyangwa Research Station) (Pungulani 2015, pers. comm.)

The SSU is responsible for quality control and the certification of all seeds and thus also supports the private sector (Integrated Seed Sector Development (ISSD) 2012). However, according to the ISSD (2012), public sector focus on the development of the same commercial crops as the private sector (notably maize and other cash crops) is indicative of a form of competition between public and private research entities in the improvement of selected crops and the neglect of other crops such as cowpea (ISSD 2012). Research on cowpea in Malawi is not well developed, as evidenced by the limited number of varieties—only 3 improved varieties have been released in Malawi (Pungulani 2015, pers. comm.) as

opposed to 14 varieties of groundnut, 30 varieties of the common bean, and 6 varieties of pigeon pea (ICRISAT 2013).

In Malawi the private sector plays an important role in seed development, especially maize, and multinational companies such as Monsanto and Pioneer Hi-Bred and local seed companies feature prominently in the commercial seed sector. National private seed companies engaged in seed multiplication and marketing include Demeter Agriculture Limited, Seed Tech, Funuwe Farms, Peacock Enterprises (MASA Seed) Limited and Pantochi Farm. These companies contract with farmers for seed production and distribution (ISSD 2012).

Other important players in the formal sector include NGOs and farmer associations (Nakhumwa and Kaudzu undated), which promote the use of local and improved food crops and cash crop varieties at the community level. Improved cowpea varieties are promoted mostly through these actors. Many of these associations are connected to the Association of Smallholder Seed Multiplication Action Group (ASSMAG), or to the National Smallholder Farmers' Association of Malawi (NASFAM) (IISD 2012).

Cowpea in Nigeria

Cultivation trends (Nigeria)

Nigeria is the world's largest producer and consumer of cowpea, accounting for 61% of production in Africa and 58% worldwide (IITA 2015). Despite its leading position, between 1990 and 1999 Nigeria had the highest cowpea demand deficit among twelve selected West and Central African countries, averaging 469,000 t/pa. It has been the world's largest cowpea importer since 2004.

Between 2000 and 2013 the country produced an average of 2,7 million metric tons of cowpea. In 2011 Nigeria's contribution to global cowpea production dropped to 37.8%, the lowest in the last 50 years (FAO 2012). The following year, in 2012, production reached a record high of over 5 million metric tons (FAOSTAT 2015a). The year after that, in 2013, production dropped below 3 million metric tons. This severe drop in production is partly attributable to drought but also to policy interventions—in 2012 the Nigerian government initiated a fertiliser subsidised programme that focused on maize, rice, cassava and wheat, an orientation which has oriented the market in favour of these crops (Coulibaly 2015, pers. comm.).

Between 2000 and 2013, the area of the cowpea harvest decreased by 1,28% per annum. This was offset by a substantial increase in the annual yield which reached just over 4% per annum, resulting in an average annual production increase of 2,7% (FAOSTAT 2013). The crop is grown mostly in the semi-arid Central and North West, but also in North-Central and North-Eastern Nigeria, where it constitutes the most important grain legume crop (Enoch 2015, pers. comm.).

The demand for cowpea in Nigeria is driven by its large population of over 177 million people (CIAT 2014), with the 33rd highest population growth rate in the world at an average of 2,47% per annum (CIAT 2014). Since the 1980s the increased demand for cowpea has reportedly led to the cultivation of cowpea as a sole crop in many parts of the country (Gibbon and Pain 1985 as cited in Wakili 2013).

Local, national, regional and international markets (Nigeria)

Nigeria, the largest producer and consumer, accounts for 61% of cowpea production in Africa and 58% worldwide (IITA 2015); it is also the largest cowpea importer in the region. It is estimated that Nigeria's average annual imports of 260,000 tons per year from Niger accounts for about 73% of Niger's surplus production. Nigeria also imports from Cameroon, Chad and Benin (Langyintuo *et al*., 2003).

Consumption and uses of cowpea (Nigeria)

Cowpea is widely consumed in Nigeria and there is a large market for processed cowpea. The preparation and sale of akara (peeled cowpeas formed into a ball and deep-fried in oil) is an important source of income for women and some entrepreneurs have developed large business ventures selling this staple food. For example, the Iyadunni Akara processing enterprise uses approximately 100 kg of cowpea grains as raw material, on a daily basis, and has opened five branches across Nigeria (IITA 2011).

Cowpea consumption in Nigeria is reported to depend on four major factors: the income level of consumers, the taste of the product, the market price of cowpea and its close substitutes, and the population density of towns (Kormawa *et al*., 2002 as cited in Mishili *et al*., 2009).

Characteristics of cowpea sought by farmers (Nigeria)

The key trait in cowpea, as sought by farmers and especially when farming cowpea commercially, is productivity, hence the interest shown by growers in improved cowpea varieties. According to an economic study conducted by the IITA, Nigerian farmers who use improved varieties combined with improved management practices have experienced an average 55% rise in their incomes (IITA 2011).

Profile of farmers who are involved in cowpea cultivation (Nigeria)

Smallholder farmers constitute about 95% of farming households in Nigeria and produce most of the food crops consumed in the country (Adesina 1991 as cited in Wakili 2013). Wakili (2013) studied the profile of farmers in Adamawa State, Nigeria and found that the average farm size in the area was 2 ha and that the production of cowpea was very labour intensive. The average labour used for cowpea production was measured at 600 man-days on each farm. He found also that farmers used significant amounts of petro-chemical input to sustain their production—an average of *naira* 1,872 (equivalent to US$ 9.4) was spent on cowpea production. Similar to other West African countries, small-scale farmers plant cowpea in intercropped fields although many farmers also farm cowpea as a monoculture, a trend which is on the increase. Cowpea also is farmed on much larger farms, with commercial farms averaging 50–60 ha, up to 250 ha (Coulibaly 2015, pers. comm.). Intercropping generally gives average yields of 200–250 kg/ha, while sole cropping systems with the use of improved technologies can yield 1,500–2,000 kg/ha of cowpea (FAO 2012 as cited by Enoch 2015, pers. Com.).

Agro-ecological practices and other uses involving cowpea (Nigeria)

Cowpea production is mostly limited to the north, including the central region, and grown as part of a mixed crop except in the Savannah agro-ecological zone (Oladele 2005).

Agro-ecological practices generally combine intercropping of cowpea with pearl millet and sorghum. Other systems involve intercropping cowpea and corn and even adding beans and squash to the system to optimise resources and land use (R. Enoch, Director of the Nigeria Centre for Environment and Education Development (CEED), 2015 pers. comm.). In monoculture fields, farmers often rotate cassava production with cowpea (Coulibaly 2015, pers. comm.).

The informal cowpea seed sector and farmer practices (Nigeria)

In Nigeria it is estimated that about 90% of farmers recycle cowpea seeds and that farmers typically save about 3% of their cowpea harvest as seeds for the next production season. The proportion of farmers who replace seed every year is therefore fairly low, with 74% of respondents indicating that they do not purchase cowpea seeds (National Living Standard Survey in Nigeria 2004). However, this does not mean that they do not refresh seeds through in-kind or barter systems with neighbouring farms.

Kamara et al. (2012) report that despite the development of a large number of cowpea varieties that offer better yields than traditional varieties, farmers in North-east Nigeria have continued to grow predominantly local varieties, such as Kanannado Brown. Farmers prefer to use this traditional variety as it has proven suitable for relay intercropping, especially with maize, and its creeping habit enables it to smother weeds after the maize has been harvested. In Nigeria the brown seeds also fetch higher market prices. These are all traits that researchers aspire to emulate in the hope of increasing the penetration of improved varieties.

Paradoxically, the purchase of off-farm seed is more frequent in poor rural households, where farmers tend to sell off or eat most of their harvest and have a limited capacity to save seed for the next sowing season (David and Sperling 1999).

The formal cowpea seed sector (Nigeria)
In Nigeria the production of the different types of seeds—breeder, foundation, and certified seeds—has been assigned to different seed-related institutions. The National Agricultural Research Institute (NARI) is the only institution responsible for seed breeding in the formal sector.

In the 1970s the production of foundation and certified seeds was the sole mandate of the former National Seed Service (NSS). This institution was later joined by the seed multiplication units of the Agricultural Development Programme (ADP), for the production of foundation seeds. These are distributed through the farm-service centres of the Federal Ministry of Agricultural and Rural Development (FMARD) and the ADP (Adejobi *et al*., 2005). The National Agricultural Seed Council (NASC), established by the 1992 Seed Decree 72, is another important public entity in the seed sector. It holds regulatory functions such as the control and registration of released varieties, testing, and certification of seeds (NASC 2015). The National Biotechnology Development Agency (NABDA) was established under the aegis of the Federal Ministry of Science and Technology in the wake of the 2001 approved National Biotechnology Policy. Its mandate is to promote, coordinate, and establish research and development priorities in biotechnology for Nigeria (NABDA 2015).

In recent years private companies have been increasingly involved in the production of foundation seeds and the distribution of certified seeds to farmers. According to Takeshima *et al*. (2011) there were more than twenty registered private seed companies in 2010. Private companies have also been contracting out-growers to produce foundation seeds. The ADP and NASC also work with out-growers to expand the production of foundation seeds (Omonona 2006). Between 2007 and 2012 AGRA sponsored two cowpea projects in Nigeria.[40]

Nigeria's Agricultural Seeds Decree 72 of 1992 makes provision for the establishment of various institutions to streamline the implementation of regulatory functions, both at the national and state levels. Arguably, the Decree remains unsupported by evidence-based policy guidelines (Takeshima *et al*., 2011). The NASC is currently in the process of drafting a seed policy document but very little appears to have transpired from this process thus far (Bassey 2015, pers. comm.).

40. http://www.agra-alliance.org/AGRA/en/grants/grants/grants-database

Conclusion

The introduction of Bt cowpea in Burkina Faso, Ghana, Malawi and Nigeria poses serious threats to food sovereignty in these countries. Cowpea occupies a clearly defined social, economic, nutritional and agro-ecological niche in these countries: it is a seminal crop that can act as leverage for small scale farming operations to ensure food sustainability and sovereignty and to increase farmers' incomes. It is drought tolerant, nitrogen fixing, protects against erosion and is a major source of affordable protein. It connects agriculture to the local environment; consumers to locally produced healthy foods; and farmers to productive resources such as locally enhanced seeds. The commercialisation of cowpea seed production in Africa will dislocate such a locally interconnected system. An equitable and sustainable solution to seed production and distribution can only come from direct engagement with farmers and their organisations to ensure their active involvement in these activities. Public-farmer partnerships to improve seed that integrates farmer and scientific knowledge will generate a more accountable process, and produce longer-lasting and more meaningful solutions for African agricultural production, rather than profit-driven, exclusive and narrow interventions.

The high certainty that the Bt-gene will escape from domesticated to wild and cultivated cowpea, as soon as the latter is grown within the pollinator range of wild cowpea could trigger unknown and irreversible adverse ecological impacts. The potential impacts of increased weediness in West Africa, which has a very long dry season and a lesser chance of rodents containing the growth of wild species, have not been researched. Nevertheless, the increased weediness of wild cowpea is just the tip of the iceberg that science has uncovered. Bt cowpea has been developed using the Cry1Ab gene, the same gene contained in Monsanto's GM maize event, MON810. The health risks associated with MON810 have been clearly established and are deeply concerning.

Farmers are confronted with a myriad of biotic and abiotic stresses in growing and storing cowpea, of which resistance to lepidopterans is but one. Viable methods of biological control are already available, and Bt cowpea threatens to destabilise the socio-ecological balance by introducing not only a seed, but a damaging package of technologies with widespread negative effects.

Traditional farming practices based on recycling farm-saved seed and the use of locally-adapted seed varieties are threatened by a transgenic variety of cowpea that would set a precedent for the systematic commodification of cowpea seeds. Farmers can ill afford the costs of GM seeds and the associated agro-chemical inputs required by the use of these seeds. The high prices that characterise the GM technological package will contribute to jeopardising already fragile socio-economic systems.

The time is long overdue for African farmers to take the lead, with renewed vigour, to push forward the successful agro-ecological and economic alternatives that have developed genuinely sustainable agricultural production methods that contribute towards the eradication of localised poverty. New methods on how to raise yields, protect soils, conserve water and enhance agro-biodiversity, while ensuring that economic, social and ecological benefits are distributed equitably, have given new hope to such farmers. Rather than promoting a tragically flawed agricultural development model that brings enormous risks, Africans are urged to look at these and their own resource base and skills which could lead to a more sustainable social, economic and agro-ecology revolution.

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