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**Article:**
Brooks, Sally orcid.org/0000-0002-1005-1245 (2014) Enabling Adaptation? : Lessons from the new 'Green Revolution' in Malawi and Kenya. Climatic change. pp. 15-26. ISSN 0165-0009

https://doi.org/10.1007/s10584-013-0992-0

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# Enabling adaptation? Lessons from the new 'Green Revolution' in Malawi and Kenya[1]

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## Abstract

This article explores the extent to which efforts to improve productivity of smallholder *agriculture through a new 'Green Revolution' in Sub Saharan Africa are likely to enhance* the capacity of smallholder farmers to adapt to the impacts of climate change. Drawing on empirical material from Malawi and Kenya, the paper finds more trade offs than synergies between the pursuit of higher productivity through the promotion of hybrid maize adoption and crop diversification as a strategy for climate change adaptation. This is despite an oft-*assumed causal link between escape from the 'low maize productivity trap' and* progression towards crop diversification as an adaptive strategy. In both countries, a convergence of interests between governments, donors and seed companies, combined with a historical preference for, and dependence on maize as the primary staple, has led to a narrowing of options for smallholder farmers, undermining the development of adaptive capacities fin the longer term. This narrowing of options is be linked to a conflation of market-*based 'variety' of agricultural technologies, as seen 'from the top down' with 'div*ersity-in-*context' as represented by site*-specific and locally derived and adapted *technologies and institutions that can only be built on 'from the bottom up'.*

## Keywords

Climate change, adaptation, agriculture, maize, Kenya, Malawi, 'Green Revolution'

This is the author accepted manuscript. The final publication is available at Springer via http://dx.doi.org/10.1007/s10584-013-0992-0

## Introduction

Food security is one of the main challenges facing countries in Sub Saharan Africa (SSA). This has been highlighted by recent food crises and famines, notably the food crisis in the Horn of Africa in 2010-2011, resulting from the most severe drought to hit the region in 60 years (Oxfam, 2012). Moreover, 'the Food and Agriculture Organization (FAO) estimates that 26 percent of Africa's population is undernourished' (Kimenyi et al., 2012:2). Factors contributing to the emergence of food crises and 'new famines' (Devereux, 1998) in the

[1] Correct citation: Brooks, S. (2014) Enabling Adaptation? Lessons from the new 'Green Revolution' in Malawi and Kenya, *Climatic Change,* 122(1) 15-26.

region have been much debated, and include a combination of production, market and policy failures (Devereux, 2009). In addition, new competition from biofuels (Borras et al., 2010) and speculation in food futures (Spratt, 2013, Ghosh, 2010) have exacerbated the growing instability of global food systems and their unpredictable, localised effects. In the midst of these new and old sources of food system instability, production remains an enduring concern, particularly in SSA (Devereux, 2009:26). While aggregate crop output in the region has been increasing in recent years 'this has been driven by the expansion of cultivated land rather than productivity gains' (Scoones and Thompson, 2011:2). Stagnation of crop yields is exacerbated by the impacts of climate change and variability. 'Current projections are that higher temperatures and lower rainfall in parts of Sub Saharan Africa combined with a doubling of the population, will lead to 43 per cent increase in food insecurity' over the next twenty years (Scoones and Thompson, 2011:2).

The impact of these uncertainties on smallholder farms has been the focus of intervention and analysis in recent years (Foresight, 2011, Vermeulen et al., 2012, Alarcon and Bodouroglou, 2011), since 'the bulk of Sub Saharan Africa's 33 million farms are both physically small - of less than two hectares of good arable land or its equivalent - and operated at the household level using mainly family labour' (Scoones and Thompson, 2011:1). Investment in the smallholder agriculture sector is therefore increasingly favoured by aid donors as a poverty reduction strategy, as well as an entry point for building adaptive capacity in the context of climate change (Vermeulen et al., 2012:128). The smallholder sector is far from homogenous, however, so 'there is a particular call for research in climate, agriculture and food systems to address highly local contexts while also giving the requisite attention to wider-scale institutional mechanisms for spreading solutions, developing shared visions of the future and negotiating differential roles and responsibilities' (Vermeulen et al., 2012:128, see also Thornton et al., 2011). This article reviews agricultural innovations in Malawi and Kenya promoted under the banner of a new 'Green Revolution' and, following Vermeulen et al. (2012), considers whether they are likely to a) 'address highly local contexts' and b) support 'appropriate institutional mechanisms, in ways that enable smallholder farmers to adapt to the effects of climate change'.

Climate change 'adaptation refers to actions taken to adjust to the consequences of climate change, either before or after impacts are experienced' (Lemos et al., 2007:25); actions taken by State intervention or through activities of individuals, communities, NGOs

or private sector actors. Climate change and, increasingly also development communities focus on building adaptive capacity of some or all of these actors (IPCC, 2007, Lemos et al., 2007). Adaptive capacity has been defined as 'the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences' (Gallopin, 2006:300). This capacity is not easy to identify and measure, however, since adaptive capacity is 'a latent condition that can only be observed when realized through some form of concrete adaptation' (Lemos et al., 2007:25). Furthermore, IPCC assessments of adaptive capacity in different national contexts tends to conflate domestic institutional capacity with measures of economic development such as GDP (Adger, 2006), thus underplaying the role of community-level adaptive capacity rooted in indigenous knowledge and experience of coping with climate variability; and embedded in informal networks and institutions. Nevertheless, a degree of consensus now exists that the creation of adaptive capacity is achievable though investment in a combination of knowledge production and dissemination, institutional development and material resources (Lemos et al., 2007:25). As Adger (2006) has observed, however, this discourse of consensus is surprising given that climate change is a 'classic multi-scale problem' (Adger, 2006:273), in which cross-scale dynamics generate conflicts and tradeoffs as well as synergies (Adger et al., 2005). Such conflicts often remain latent, however, since more powerful actors are able to 'tilt the playing field', influencing the framing of problems and, consequently, conclusions as to the 'appropriate' scale of analysis (Adger et al., 2006).

The idea of enablement is taken from 'systems of innovation' literature, which identifies an 'enabling environment' (that is, policies and institutions that enable the development and use of particular technologies) as an essential component of a successful innovation system (Freeman, 1995, Edquist, 1997, World Bank, 2006). An agricultural innovation system (AIS) has been defined as 'the set of agents (individuals, organizations and institutions) that contribute to the development, diffusion and use of new agricultural technologies, and that directly or indirectly influence the process of change in agriculture' (Temel et al., 2003). The AIS framework represents a break with conventional, linear understandings of agricultural innovation (in terms of technology 'push' or market 'pull') in favour of the 'reconceptualisation of research as part of increasingly complex, interactive and learning-based systems' (Sumberg, 2005: 24). Significantly, in the case of climate change adaptation - and the need for context-responsive solutions and institutions able to deliver them - the AIS framework places greater emphasis than previous models on the

importance of appropriate institutional design and evolution and the need to pay as much attention to the demand side, as to the supply side of the innovation system.

While the AIS framework is concerned with the enablement of technology development and use, in this paper we are concerned specifically with the enablement of adaptation to climate change, and of capacity for climate change adaptation, and, by extension, technology development that would support these goals. Brooks and Loevinsohn (2011) identify the following features of an AIS responsive to food insecurity and climate change: (i) 'recognition of the multifunctionality of agriculture' (see IAASTD, 2009 for an extended discussion of 'multifunctionality') '(ii) access to diversity as the basis for flexibility and resilience; (iii) concern for enhancing capacity of decision makers at all levels, from the bottom up; and (iv) continuity of effort aimed at securing well-being for those who depend on agriculture' (Brooks and Loevinsohn, 2011:186). In this paper we highlight two key elements from this framework in particular: Firstly, diversity is a key concept which means 'more than mere variety' of technologies or farm inputs. Rather, it acknowledges the heterogeneity embedded in farming systems 'as it exists in particular places', in local institutions and everyday practices (Brooks and Loevinsohn, 2011:187). Secondly, in focusing on capacity the framework emphasises the need for formal institutions at different scales to learn from and build on the adaptive capacities of communities and households already experienced in living with and adapting to rapid change (cf. Lemos et al., 2007).

This paper explores these inter-related dynamics of scale, diversity and capacity through two country case studies in technological change in agriculture: Kenya, 'in many ways the 'poster child' for Africa's new Green Revolution' (Odame and Muange, 2011:78) and Malawi, where the contested politics of 'climate proof' agriculture pits a popular national input subsidy programme against more sustainable alternatives (Chinsinga et al., 2012, Javdani, 2012). In each case, and despite national and international policy discourses highlighting crop diversification as a favoured pathway to more sustainable farming systems and food futures, the effects of the policies and programmes reviewed in this paper have been to encourage further dependence on a single crop (maize) and particular technologies (hybrid seeds and inorganic fertilisers) purchased (albeit at subsidised rates) from networks of private providers (agro-dealers) that have been able to take root in some places but not others. This paper argues that such paradoxical outcomes 'make sense' when placed in the broader context of a thread of continuity that links liberalisation policies enacted during the era of structural adjustment with more recent policies and programmes

sanctioning a return to direct government intervention, in which, to paraphrase Adger et al. (2006) powerful actors have been able to 'tilt the playing field', framing the problem in such a way as to demand the type of solution that they have to offer. The facilitation of climate resilient smallholder agriculture therefore requires, in the first place, a re-examination of the (re)emerging orthodoxy and recognition of its limitations and perverse effects, in order to create space for the identification of more sustainable alternatives.

**On the road to crop diversification? The case of Malawi**

Malawi is considered 'one of the twelve most vulnerable countries to the adverse effects of climate change in the world; and this vulnerability is 'heightened by its excessive dependency on rain-fed agriculture' (Chinsinga et al., 2011:110). In Malawi, 85 per cent of the population make their living from agriculture, which accounts for over 90 per cent of national export earnings, 39 per cent of GDP and 85 per cent of total employment (Chinsinga et al., 2011:110). An integrated national household survey conducted in 2005 revealed that 'five out of eight of the most serious shocks [experienced] were agricultural in nature. These shocks, in order of severity, include large rises in food prices, lower crop yield due to drought or floods, large falls in crop sales, death or theft of livestock, and crop diseases or pests' (Chinsinga et al., 2012:4). It is not surprising, therefore, that debates about economic development, poverty reduction and climate change adaptation in Malawi converge on the agriculture sector. More specifically, these debates focus on the smallholder sector. This is because, while Malawi 'maintains a largely dualistic agriculture sector comprising smallholder and estate sub sectors', it is the the smallholder sector that contributes most to the national economy. 'It is estimated that the smallholder sector accounts for 80 per cent of Malawi's food production and 65 per cent of agriculture's contribution to the the country's GDP' (Chinsinga et al., 2012:4).

The dominant crop in Malawi's smallholder sector is maize. 'Overall, an estimated 97 per cent of smallholder farmers grow maize, and more than half of households grow no other crops.' Vulnerabilities stemming from dependence on maize tend to be compounded by 'a paradox ... that only 10 per cent of these maize growers are net sellers, with as high as 60 per cent being net buyers' (Chinsinga et al., 2012:4). This state of affairs has been explained in terms of a vicious cycle called the 'low maize productivity trap', in which 'inter-year maize price instability' deters investment in agricultural inputs, so that 'large amounts of cultivated land ... are used for maize production with very low yields, and this depresses

land and labour productivity across the agriculture sector and indeed across the whole economy' (Chirwa et al., 2011:8).

There is a growing consensus that crop diversification strategies to reduce maize-dependence represent 'a desirable strategy for safeguarding rural livelihoods in the context of uncertain climates' (Chinsinga et al., 2011:112). Crop diversification is seen by climate change project planners as a 'cushion' against the multiple adverse effects of climate change, by farmers as a means to ensure food availability, by district level officials as an entry point for improving soil health, and by donors as a 'means to improve the nutritional status of a society deeply wedded to maize food products'. As such, while hardly a novel prescription for sustainable agriculture-based livelihoods, efforts to promote of crop diversification have been re-energised by a discourse that has 'extended beyond food security to how it can serve as a sustainable [climate change] adaptation strategy' (Chinsinga et al., 2011:112, emphasis added). Nevertheless, major challenges remain, not least the political, economic and cultural dominance of maize. The narrative of crop diversification for climate change adaptation is thus confronted by 'the political imperative to ensure food security, which is equated with having enough maize at both national and household levels' as well as 'a strong cultural orientation that equates food with maize' (Chinsinga et al., 2011:112). The following account highlights the inherent contradictions and tradeoffs between policies and programmes promoting, on the one hand, on-farm diversification, and on the other hand, acceleration of aggregate maize production to meet national food security goals.

The imperative to break out of the 'low maize productivity trap' and the choice of crop diversification as the preferred adaptation strategy converged in the promotion of 'Malawi's famous input subsidy programme[2] ... as a mechanism for facilitating crop diversification'. In fact, the decision of aid donors to pledge support was made 'on the condition that it would promote other crops besides maize' (Chinsinga et al., 2011:112), following its successful first year which had been funded in its entirely by the Government of Malawi. This decision, by major aid donors, to endorse and financially support a programme (which they had initially opposed), represented a break with a long-standing policy orthodoxy under which government mechanisms for addressing food security had been 'dismantled under agricultural liberalisation reforms imposed by the World Bank and other agencies in

[2] This programme is alternately referred to as the Farm Input Subsidy Programme (FISP) and Agricultural Input Subsidy Programme (AISP).

the 1980s and 1990s' (Devereux, 2009:29) Initially condemned by donors as a market-distorting measure that would undermine liberalisation, this position was overturned just one year later, with Malawi and its subsidy programme being transformed into 'the darling of Green Revolution advocates the world over' (Chinsinga, 2011:59).

As a means of 'ushering in a much acclaimed Green Revolution' and raising national maize production, the input subsidy programme has been an undoubted success. 'Since its introduction, Malawi has consistently produced a maize surplus over and above its annual requirement estimated at 2.1 metric tonnes' (Chinsinga, 2011:62). Furthermore, while the initial aim was to 'kick start farmers into using higher yielding hybrid seed and inorganic fertilisers' as a way to break the low maize productivity trap (Dorward and Chirwa, 2011), the programme has also functioned as a social protection mechanism that has reduced the need for food aid (Brooks and Loevinsohn, 2011:193). However, 'the input subsidy programme has failed to promote crop diversification even though it was designed as such' (Chinsinga et al., 2011:113). Chinsinga (2011) identifies three key elements of the programme which have begun to attract criticism: Firstly, 'multinational companies have ... seized on the apparent success of [the programme] to justify the use of hybrid seed' and to challenge the perception that hybrid maize ... is 'inappropriate for small-scale farmers'. And while the Government's policy has been to promote improved varieties in general - both OPVs [open-pollinated varieties; which can be saved and replanted, from one year to the next] and hybrid - 'there has been a silent switch from OPVs to hybrids as the subsidy programme has evolved' (Chinsinga, 2011:63).

Modes of delivery have favoured private sector actors and mechanisms. Donors, in particular, 'wanted greater involvement of the private sector in both the procurement and distribution of subsidised fertiliser and other farm inputs'. Their rationale was that involvement of the private sector would facilitate the diversification of the input subsidy programme 'which, in turn, would stimulate progressive and sustainable private sector growth and development' (Chinsinga, 2011:63). In practice, however, a concentration, rather than diversification of private provision is underway, with only large companies able to absorb the 'huge transaction costs incurred through voucher redemption'. As a result, although the scheme has expanded the demand for improved seeds, this has not led to the hoped-for development of a vibrant indigenous seed sector to meet this demand. In the event, local seed companies have been unable to exploit the commercial benefits arising from the programme 'because of their reliance on multinational seed companies to

process the seeds'. Furthermore, among the multinational seed companies, one provider, the Monsanto company, has emerged as the main beneficiary, since it controls more than 50 per cent on the hybrid maize in the country' (Chinsinga, 2011:64).

In summary, the failure of the programme to promote crop diversification can be traced to the convergence of interests between government, donors and seed companies that secured the sustainability of the programme in the long term. Ultimately, 'while constantly making reference to the ideal of crop diversification' the government's main preoccupation is with food security at the national level, which is it equates with maize security (Chinsinga et al., 2011:113, emphasis added). For the government, therefore, 'food security can be guaranteed by the use of high yielding hybrid maize varieties. Seed companies are keen to promote hybrid maize seeds since they are their main product' - which must be purchased each season -'and through the subsidy programme [they] are guaranteed a ready market. Donors are interested in promoting a private sector driven supply system ... to fill the vacuum following the dismantling of the state-driven supply system through liberalisation.' (Chinsinga et al., 2011:113).

Meanwhile, the success of the programme, and the resulting 'lock-in' to a hybrid maize-based agri-food system, may have obscured important lessons from the 2001/2 famine; and therefore prevented the emergence of more sustainable pathways to climate change adaption in the longer term (Loevinsohn, 2011). Research by Loevinsohn (2011) has shown how, in the more severely affected areas of the country, community level responses to some of the worst effects 2001/2 famine are rich in lessons regarding the adaptive capacity latent in households and communities. These included, not only farm-based adaptation strategies, but also migration, facilitated via familial and informal networks, to areas where food could be accessed. In particular, 'distress migration patterns during the famine showed people gravitating towards cassava growing areas, highlighting its role as a famine crop' (Brooks and Loevinsohn, 2011:193). The advantage of cassava is that it says in the ground until it is needed. It 'is a perennial crop, with a 2-4 year productive life span, farmers harvest cassava all year round, over a period of years, in small quantities, mainly for household consumption. Farmers rely on this safety valve, adjusting their cassava harvest upwards in years when the maize crop fails and downwards when the maize does well' (Haggblade et al., 2009:12).

Lessons from these household and community-level adaptive strategies might, if not for the the singular focus on the role of the input subsidy programme in temporarily plugging the food gap - understood as a maize gap - have informed a very different set of national food and agriculture policies. Interestingly, although at the national level maize productivity and crop diversification goals were in conflict, these lessons from community level responses have informed an innovative - but less well known - regional initiative: 'Cassava Transformation in Southern Africa' (CATISA) (Haggblade et al., 2009:12). In this case, local adaptation strategies have informed the design of a food security planning system which employs cassava strategically as a regional 'buffer crop' (Brooks and Loevinsohn, 2011:193, emphasis added). In this way, synergies between regional and local levels have been found, in striking contrast with the conflicts that have arisen between encouragement of on-farm crop diversification and a national input subsidy programme that has served to intensify reliance, not only on maize, but on commercial maize, and the additional costs this incurs. This is not to say that cassava is the 'magic bullet' in the way that hybrid maize is not; or that regional planning is somehow preferable to a national level intervention. Rather, it is the provenance (rather than the nature) of the solution - emerging from attention paid to 'latent' adaptive capacity embedded in patterns of household and community-level response - that offers useful lessons for the development and enablement of adaptive capacity, at all levels, in the longer term.

**A model technology delivery system? The case of Kenya**

In Kenya, as in Malawi, agriculture is central to the national economy, so 'climate change is a critical cause for concern' (Maina et al., 2012:1). Data gathered during the formulation of Kenya's 'Strategy for Revitalising Agriculture 2004-2014' highlight the importance of agriculture for the country: 80 per cent of Kenya's population of 34 million live in rural areas and depend on agriculture for their livelihoods, while the sector accounts for 26 per cent of the GDP and 60 per cent of export earnings (GoK, 2004).

Maize is the most important crop in Kenya, politically, culturally and economically (Brooks et al., 2009). It is important both as a subsistence and commercial crop, 'grown on an estimated 1.4 million hectares by large scale farmers (25%) and smallholders (75%)' (de Groote et al., 2005:33). In this context, the decline in aggregate productivity since the mid 1990s has concerned policymakers and food policy analysts, and confounded expectations raised by Kenya's brief 'maize Green Revolution' which peaked and then

leveled out in the mid 1980s (de Groote et al., 2005). Since then, aggregate levels of maize consumption (estimated at 103kg per person) have steadily exceeded national production, so that Kenya has to import increasing volumes of maize to make up this shortfall. The productivity of maize agriculture has therefore become a national research and policy priority in recent years (de Groote et al., 2005:33).

As in the case of Malawi, the stagnation of the agricultural sector and the design of contemporary responses to it have to be understood against the background of structural adjustment reforms imposed during the 1980s by the World Bank and International Monetary Fund (IMF) (Odame and Muange, 2011). Thereafter, 'in 1990, the Government continued this reform process by abolishing quotas and licenses and deregulating prices in the fertiliser industry' and 'in 1996 the seed industry became fully liberalised and an autonomous industry regulator, the Kenyan Plant Health Inspectorate (KEPHIS) was established' (Odame and Muange, 2011:79). These reforms, it was hoped, would 'pave the way for a market-based economy, in which the private sector would take over functions such as input distribution from the state'. In practice, however, 'market development has been slow, due to capital constraints, complex trade and licensing arrangements and restrictive domestic laws in the seed industry', all of which have hindered adoption of new technologies, particularly 'by poor smallholder farmers, especially in low rainfall areas' (Odame and Muange, 2011:79).

Since then, the last ten years has seen a shift in attitudes towards state intervention in the agricultural sectors in SSA, and in Kenya the 'government is is not about to exit from input distribution just yet' (Odame and Muange, 2011:79). Emboldened by Malawi's input subsidy 'success story' and the donor community's subsequent change of heart, what has been referred to as a new 'African consensus' has displaced the 'Washington Consensus' as the received wisdom on the advisability (or not) of government intervention in the agricultural sector. The following passage, taken from a speech given by a senior AGRA official at a national agriculture conference held in Nairobi in 2008 captures the mood of the time, as one era gave way to the next:

> Farmers' get subsidies everywhere except Africa … [In the US and EU] they are doing the right thing, so can we also do the right thing? [Referring to structural adjustment] no, that is bad economics, that is morally wrong … that kind of policy is for the past … in the 1980s we were told by the World Bank, "tighten your belt", we

were told to tighten everything we could tighten … what we need today is not a Washington Consensus, we need an African Consensus'.[3]

In this context, 'since the mid-2000s, a strong coalition of actors has emerged in Kenya with a focus on stimulating a new Green Revolution through the application of new technologies, particularly certified seeds and fertilisers' (Odame and Muange, 2011:79) and two parallel national and international initiatives are currently underway - the 'Strategy for Revitalising Agriculture' (SRA) and 'Alliance for Green Revolution in Africa' (AGRA), respectively. These initiatives share an emphasis on collaboration between the public and private sectors, and the identification of the agro-dealer - a locally-based, private business dispensing seed, fertiliser and information to smallholder farmers - as the central actor in new input delivery systems (Odame and Muange, 2011). Implicit in the design of these programmes is an acknowledgement of the extent of the decline of government extension and the difficulty (and prohibitive cost) of rebuilding it. In the new Green Revolution, therefore, the agro-dealer becomes the de facto extension officer (Brooks et al., 2009).

These programmes driving the new Green Revolution have, in common with Malawi's input subsidy scheme, adopted 'an international narrative that identifies low productivity to degraded soils and lack of access to modern inputs' as the 'national narrative in Kenya'. Its wholesale adoption as a national narrative is highly problematic, however, 'since it ignores important regional agro-ecological and socio-economic variations' (Odame and Muange, 2011:83). The country is divided into several (variously between six and eight) agro-ecological zones, ranging from the high altitude, high potential zones in Western Kenya and the Rift Valley, the country's 'maize basket', at one end of the spectrum, to the 'low potential' arid and semi-arid areas to the East and North of the country at the other. Similarly, wide socio-economic variations (in terms of land holding, water access, livestock numbers and access to regular or irregular off-farm income) differentiate farming and livelihood systems within and across these different zones (Kibaara et al., 2009).

These agroecological and socioeconomic variations intersect with impacts of climate change and variability in complex and multiple ways (Brooks et al., 2009, Kibaara et al., 2009). For example, in a recent study of seed systems in Kenya, farmers in the Machakos district in Eastern Kenya identified unreliable rainfall, rather lack of access to inputs, as

[3] Akin Adesina, speaking on behalf of AGRA at a conference to review progress in implementing Kenya's 'Strategy for Revitalising Agriculture' (SRA), Nairobi 11th November 2008.

their key productivity constraint. 'In such areas ... inadequate soil moisture renders yields of most crops unresponsive to inorganic fertiliser use and in some cases the fertiliser may even harm the crop by burning it' (Odame and Muange, 2011:83). Furthermore, farmers in dryland areas like Machakos traditionally practice diversified farming, as a way to spreading risk in uncertain weather conditions as well as to meet dietary needs. Under these programmes, however, farmers are incentivised to devote more land and other resources to maize cultivation. As a result, they are discouraged from diversifying - their tried and tested adaptation strategy - and steered instead towards higher levels of maize dependence, and the vulnerability this induces (Odame and Muange, 2011:83).

Meanwhile, a degree of recognition of the 'basic biophysical constraints' that present the main challenge to agricultural production in dryland areas has led to the initiation (with substantial funding from the Bill and Melinda Gates Foundation) of two major research programmes for the development of drought tolerant maize varieties[4] (Scoones and Thompson, 2011, Brooks and Loevinsohn, 2011). These programmes build on a long history of breeding drought resistant maize varieties for Kenya's dryland regions, starting in the 1970s (Heisey and Edmeades, 1999). However, they represent a point of departure in that the design of both programmes incorporates the same model of input delivery - commercial hybrid seeds and fertilisers purchased from agro-dealers - as programmes designed with high potential zones in mind, despite evidence of the limits of this approach (Odame and Muange, 2011:86). Odame and Muange (2011) identify a series of constraints to agro-dealers' ability to act as an effective substitute for public extension, particularly in drought-prone regions, which include: 'the uneven geographical coverage with relatively fewer 'legal' and well-capitalised agro-dealer in the poorer, lower potential areas; the focus of delivery on a limited number of seeds and varieties (mostly hybrid maize, adapted to medium and high potential areas; the dominance of a few companies in the supply chain, with knock on consequences for price competitiveness and technology diversity; the limited technical knowledge of those serving in [as opposed to the owners of] agro-dealerships; the restrictive nature of regulations, which limits wider competition in the local market; [and] underdeveloped infrastructural support, which increases operating costs and therefore prices, especially in the low rainfall areas' (Odame and Muange, 2011:86).

[4] The CIMMYT-led 'Drought Tolerant Maize for Africa' (DTMA) http://dtma.cimmyt.org/ and an AATF-brokered public-private partnership named Water-Efficient Maize for Africa (WEMA), both with substantial support from the Bill and Melinda Gates Foundation http://wema.aatf-africa.org/ (1 March 2013).

Finally, these programmes display a 'blind spot' with regard to the role of informal systems of seed selection, saving and exchange in ensuring food security in drought-prone regions, over the years. In dryland environments, the cost of commercial inputs is prohibitive given that a decent harvest, or even a harvest at all, if far from assured. In this context, farmers rely on informal seed systems to provide locally adapted varieties that, while perhaps not 'optimal', offer what for smallholder farmers is a more acceptable balance of cost and (uncertain) benefit (Brooks et al., 2009). These informal systems have evolved over time, through intergenerational transfer of knowledge and expertise and traditions of reciprocity and mutual support, as well as continued access to localised crop and varietal diversity. In some instances, the role of these systems has been recognised by NGOs acting locally to organise seed fairs for the facilitate the exchange of locally adapted seed following periods of drought (Orindi and Ochieng, 2005). Furthermore, examples exist of innovative attempts to bridge formal and informal seed systems in community-based, on-farm 'seed bulking' programmes, supported by government scientists and extension agents and using improved 'composite' materials adapted to local conditions (Brooks et al., 2009:36-37).

Policies and programmes advancing the 'Green Revolution' model, on the other hand, undermine these informal systems of seed and food security both directly - by setting out explicitly to replace informal systems with what are viewed as superior, formal seed systems - and indirectly, though the enactment of regulatory systems that marginalise or even outlaw the dissemination of seed that has not been subject to full certification (Brooks et al., 2009). Meanwhile, participatory plant breeding methodologies that engage with informal seed systems are increasingly marginalised in mainstream crop research (Brooks and Loevinsohn, 2011). Here, as was illustrated earlier in the Malawi case, multinational seed companies have played a role in restricting options available to farmers, in this case by lobbying the government to abandon plans to integrate informal seed systems into national seed policies and laws[5] (Odame and Muange, 2011).

## Conclusion - adaptation, diversity and choice

This article has explored the extent to which efforts to improve productivity of smallholder agriculture as part of a new 'Green Revolution' in Sub Saharan Africa are likely to enhance the capacity of smallholder farmers to adapt to the impacts of climate change. The high

[5] These issues are brought into sharp focus in a short film by the University of Sussex-based STEPS Centre, entitled 'Seeds and Sustainability' http://vimeo.com/20239062 (1 March 2013).

profile interventions that have been examined in this paper share a commitment to a model of agricultural modernisation that combines a familiar 'technical fix' with a 'market fix' that casts farmers as discerning consumers of predetermined technologies (Scoones and Thompson, 2011:4). These dynamics have been explored through two country case studies, Malawi and Kenya. In each case, despite the identification of maize dependence as a source of increasing vulnerability in the context of climate change, policy measures and programmes intended to increase the resilience of smallholder agriculture are reinforcing and intensifying trends which are likely to exacerbate existing vulnerabilities.

In Malawi, an input subsidy scheme introduced with massive popular support has evolved from its initial design as a stop-gap measure to 'kick start' more productive and diversified smallholder agriculture to become an catalyst for concentration in the seed sector and thus the erosion of crop and varietal diversity. A key driver has been the articulation, by donors, of a contradictory set of conditionalities: on the one hand setting crop diversification as an explicit condition for funding; and on the other hand insisting on a private sector driven model which has created prohibitive barriers to entry for smaller providers and paved the way for an extension of market share by a small number of large companies. In this case, an underlying assumption that involvement of the private sector per se would drive crop diversification has been proved to be flawed. Rather, a convergence of interests (for donors, the promotion of a private sector driven system; for the government, the achievement of food security in the short term, and for multinational seed companies the acceptance of hybrid seed as an appropriate technology for smallholder farmers) have coalesced around a 'silent switch' to hybrid maize, and the costs, and risks, this brings.

A similar dynamic can be observed in Kenya, whereby the spread of hybrid maize is displacing alternative crops as well as certificated open pollinated varieties (OPVs - which unlike hybrids the seeds can be reused the following year) and informal, locally adapted varieties of maize. The erosion of biological and institutional diversity embedded in the informal seed systems - easier to lose than to replace - is a particular threat to food security in drought-prone environments where local seed saving and exchange is the norm. In both countries, therefore, cross scale mismatches remain unaddressed: In Malawi, the drive to maximise aggregate maize production as the primary route to national food security conflicts with and ultimately trumps donor-endorsed policies encouraging on-farm crop diversification as a climate adaptation strategy. Meanwhile in Kenya, which unlike Malawi, is extremely agro-ecologically heterogeneous, the current suite of

programmes (even those explicitly addressing biophysical constraints in dryland areas) envisage the country-wide implementation of a 'one size fits all' input delivery system; taken from Kenya's 'maize basket' to the west of the country and replicated in the precarious, mixed farming systems in the semi-arid areas of Eastern Kenya, despite emerging evidence that such a system is failing to take root in those marginal agricultural areas where the need for adaptive technologies is understood to be greatest.

Two related conceptual flaws have been identified in the design of the new generation of 'Green Revolution' programmes, as evidenced in both country cases, with respect to the development of community-level adaptive capacity. Firstly, a discourse of 'consumer choice' for farmers with respect to agricultural technologies misconstrues the very basis of on-farm agro-biodiversity on which local adaptive capacity depends (Brooks and Loevinsohn, 2011, Brooks et al., 2009). A convergence of public and private sector interests in hybrid maize adoption has led to the conflation of market-based 'variety' of agricultural technologies, as seen 'from the top down', with 'genuine diversity that reflects the many dimensions of difference inherent in the heterogeneity' [that] exists in particular places' (Brooks et al., 2013:159), and which can only be 'seen' at the local level and developed 'from the bottom up' (Brooks and Loevinsohn, 2011).This confusion of diversity-in-context with market-based variety is further obscured by an enduring tendency (carried over from the Asian 'Green Revolution', fifty years earlier) to assume interventions based on the dissemination of genetically-improved seeds (together with associated inputs) are scale-neutral, obviating the need to understand and respond to local diversity and complexity (Brooks et al., 2009). Such assumptions endure, not only in relation to technology development, but also now the market-based mechanisms though which, it is envisaged, these technologies will 'reach' smallholder farmers, thus stimulating 'demand'. Ultimately, however, these are supply-driven innovation systems which construct, rather than respond to actual demand. Such an approach runs counter to the wisdom that climate change adaptation capacity development a) 'address highly local contexts' and b) pays attention to 'appropriate institutional mechanisms, in ways that will enable smallholder farmers to adapt to the effects of climate change' (Vermeulen et al., 2012).

The challenges of climate change adaptation, and the identification and development of adaptive capacity, are new areas of learning and knowledge generation. Nevertheless, this paper has shown that valuable lessons from household and community adaptation 'in highly local contexts' and drawing on locally 'appropriate institutional mechanisms' do

exist; as do innovative projects that have been able to learn from them, and apply this learning across scales (Loevinsohn, 2011, Orindi and Ochieng, 2005, Haggblade et al., 2009). The danger is that these emerging lessons, tentative and context-dependent though they are, may be overlooked in the rush to put 'modern' systems in place, in every place. These findings suggest that, rather than focus on the development of new technologies and programmes, the priority should be to put in place alternative decision making processes (such as those advocated by Ely et al., 2011) that 'level the playing field' and allow existing and potential approaches that build adaptive capacity 'from the bottom up' to be considered and appraised alongside those that currently dominate.

**Acknowledgements**

I would like to thank the anonymous reviewers of this article for their helpful comments.

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