Future Agricultures

Working Paper

Dynamics of Maize Seed Production Systems in the Brong Ahafo Region of Ghana: Agricultural Modernisation, Farmer Adaptive Experimentation and Domestic Food Markets

Kojo Sebastian Amanor

June 2013

Abstract

This Working Paper examines the dynamics of maize production in distinct environments and localities in Brong Ahafo Region, Ghana, and the various factors that have influenced patterns of agricultural adaptation, innovation and transformation. Specifically, it analyses the influences of neoliberal policies on the institutional framework of maize seed policy, on the technical recommendations of state institutions and on farmer production systems. Drawing on detailed interviews with market traders and small-scale producers, it also contrasts the priorities of farmers with the recommendations of agricultural services and the extent to which research recommendations reflect or fail to reflect the actual developments in maize production systems. Finally, it explores the implications of policy support for the commercialisation of seeds for the wider seed system, including interactions between the formal, informal and market sectors.

Introduction

Maize is a major crop in Ghana produced for household consumption and for urban markets. It is estimated that maize production has been growing by 3 percent per annum from the 1990s to 2000s. The dominant policy narratives on maize production depict this growth as largely arising from aerial expansion in a sector characterised by low productivity and low uptake of modern inputs by farmers, or a mixture of increased productivity from progressive farmers using inputs and expansion of acreages of other farmers (Scoones and Thompson 2011, Breth and Dowswell 2003). Aerial expansion is deplored because it is assumed to lead to land degradation, although few case studies exist on the impact of commercialisation within a framework of bush fallowing on the environment, and those that do address such issues often attest to the capacities of smallholder farmers to maintain and build upon biodiversity (see Brush 2004, Brookfield *et. al.* 2002 for more recent contributions to this theme).

In contemporary policy discourses on agriculture and inputs the maize sector is often framed as being inefficient and uncompetitive, characterised by low yields and high transaction costs, and low use of inputs including improved seeds and synthetic fertiliser. Use of modern inputs is seen as being the key to enhanced production and this involves a process of making farmers aware of the benefit of improved seeds and creating a more comprehensive network of commercial dealers through which farmers can acquire inputs.[i] It is argued that as farmers invest in inputs for maize production they will realise more disposable income, which they can reinvest in production. As the production base of modernised agricultural production expands, incomes will become incrementally larger, enabling farmers to lift themselves out of poverty to a commercial level (IFDC 2002, WABS Consulting 2008). In many ways this rhetoric is a return to the old modernist discourse of diffusion theory (Rogers, 1976), in which the notion of trickle down from 'progressive farmer' has now been supplanted by that of the commercial farmer integrated into modern value chains.

The insights of farming systems research that developed in the 1970s and support for farmer adaptive experimentation are now increasingly marginalised in international agricultural policy. The aim of policy is to strengthen the reach of input commodities to farmers, rather than the processes of creating a more inclusive participation in enhancing public sector research. In contemporary discourse the products of commercial agribusiness are assumed to be so superior that the only problem is that of uptake and creating lower transaction costs to facilitate adoption among the majority of smallholders. Although this framework is clearly beneficial to agribusiness and major input distributors, it is questionable to what extent it reflects the interests of farmers, many of whom continue to be self reliant and depend upon their own adaptive experimentation rather than follow the prescriptions of extension services. The widespread adoption of the rhetoric of commercialisation within public sector institutions also has profound implications for the future role of public agricultural research, the accountability of public research to farmers and their interests, the *in situ* preservation of local genetic materials, and for the emergence of frameworks and platforms that critically assess the impacts of commercialisation on society and environment, as reflected in contemporary concerns with food sovereignty, open access rights in genetic materials and environmental and health concerns.

Behind this framework of agrarian development through commercialisation of seeds lie a number of assumptions about the nature of maize production. These include the following:

1. Current technical recommendations pertaining to seeds and input usage are demonstrably superior on farmers' fields in different environments and agro-ecosystems than farmers' own solution. The answer is therefore to educate farmers on the use of new inputs and make them more accessible.

2. Current production is characterised by a dualist structure of modern production and traditional farming practice. Outside of the adoption of modern inputs farmers' strategies are static. They do not adapt inputs, new formal science based technologies and their own technical innovations to dynamic and changing farming systems. Therefore farmers' own autonomous adaptive experimentations are inconsequential.

3. The constraints on modern technology lie in the high transaction costs of marketing inputs in Africa, which when solved within a free market framework will facilitate uptake of commercial inputs by farmers.

This study critically investigates these assumptions in the context of the development of commercial maize production in Brong Ahafo Region, the major maize producing area of Ghana. To understand the nature of commercialisation of seeds within the region, four distinct spheres of production and marketing of maize are examined. Firstly, this includes the characteristics of varietal material entering regional maize markets, including the nature of the demand and supply of maize, and trader assessments of the various varieties of maize. This gives an idea of both the disposition of the national urban demand for distinct varieties of maize and the characteristics of maize varietal production in different localities. Moreover successful adoption of modern varieties is dependent upon market demand and the acceptance of these varieties by urban consumers and food processors. The varietal mixture on the market will reflect both the certified varieties available to farmers, farmers' adoption of these varieties, and the resulting mix of varieties that emerge from farmers' purchase of certified varieties and selection and multiplication of breeding materials of their own choice. Secondly, the study assesses the various institutional and political economic factors that have influenced the development of a public plant breeding infrastructure for modern varieties; the capacity of these varieties to respond to farmers' needs and the developments of commercialisation; and the impact of liberal market policies on public sector research. This includes both public and private seed production and agricultural extension initiatives, and involves interviews with both seed growers on the nature of their production and the demand for their seeds, as well as with agro-dealers on the varieties of maize they stock and the demand from farmers for certified seed and other inputs. Thirdly, the study examines farming strategies, farmers' use and assessments of the available varietal material in the context of their strategies and their various endowments; their responses to social and environmental factors; and their priorities in the allocation of limited resources managing labour, synthetic inputs, seeds, herbicides, etc. Finally, the study looks at farmers' use of maize seeds and perceptions of the advantages and disadvantages of different varieties of seeds.

Methodology

The study on which this Working Paper is based involved in-depth semi-structured interviews with government agricultural officers, agro-dealers, market traders and smallholder farmers in Brong Ahafo in January 2012. Agricultural officers were consulted about the changing dynamics of maize production in Sunyani (the regional capital of Brong Ahafo), and in Wenchi, Nsawkaw, Kintampo and Subinso. Five seed growers were interviewed in the Kintampo and Wenchi districts. Fourteen agro-dealers were interviewed in Sunyani, Wenchi, Subinso, Seikwa, Badu and Nsawkaw. A further 35 interviews were conducted with traders and groups of traders at various regional maize markets. Finally, 148 farmers were interviewed with the help of three research assistants at Subinso and Badu, of which 40 percent consisted of women and 38 percent were under 40 years old. These were sampled from different sections of the settlements, allowing for a wide representation of different categories of people, including migrants. Both of these settlements are significant maize centres with wholesale maize markets visited by specialised maize traders from urban centres.

The two settlements are characterised by contrasting environments and styles of farming. Badu is a more significant maize centre with a large maize market visited by traders from Accra and Kumasi. Subinso is situated in the northern transition zone, in an environment characterised by guinea savannah parklands. This has enabled widespread stumping of land in the past and use of tractor ploughing. Subinso is situated in the vicinity of the Branam State Farms and during the late 1970s and 1980s it became a major centre for the dissemination of mechanised farming and inputs to smallholders. It has a large migrant population from northern Ghana. Whilst originally situated in the yam belt of the transition zone, the introduction of mechanisation and inputs resulted in the rapid uptake of maize during the 1980s. However, with the introduction of liberalisation policies and removal of subsidies, cultivation of maize declined during the 1990s and many farmers turned to cassava – since the ploughed soils were no longer suitable for yam production. In contrast, Badu is situated in the transitional dry semi-deciduous forest zone. The nature of forest cover does not allow ploughing, since the dense root structures destroy tractor ploughing, and attempts to remove the root structures result in serious land erosion (Obeng 1973, Ahn 1970). With the removal of subsidies in the 1980s Badu emerged as one of the most significant maize production centres in Brong Ahafo, in which maize was largely based on local varieties produced without use of inputs. These two settlements do not represent some vision of archetypal maize production settlements in Brong Ahafo, but illustrate the different trajectories of production that occur in different areas as a result of availability of land, labour markets, environmental factors, changing access to government services and input markets, and the impacts of policy change.

Structure of paper

The first section of this Working Paper examines conceptual problems in the modernist discourse of discrete traditional and modern sectors and local and modern varieties. It argues for an approach based on the concept of hybrid modernisation (Escobar,) , Smallholder farmers adopt and experiment with various elements of modernisation, and incorporate what they find to be useful into their own autonomous styles of farming. They incorporate and preserve modern plant varieties that are discarded by research institutions as part of their local culture. The second section analyses the dynamic mixture of varieties entering the market. In the third section, the development of formal plant breeding policies and strategies are situated within the broader agrarian history of policy shifts taking place in Ghana during the 1980s, and the expansion of agricultural commercialisation within Brong Ahafo during the same period in the context of the market liberalisation policies. The fourth section assesses the developments of

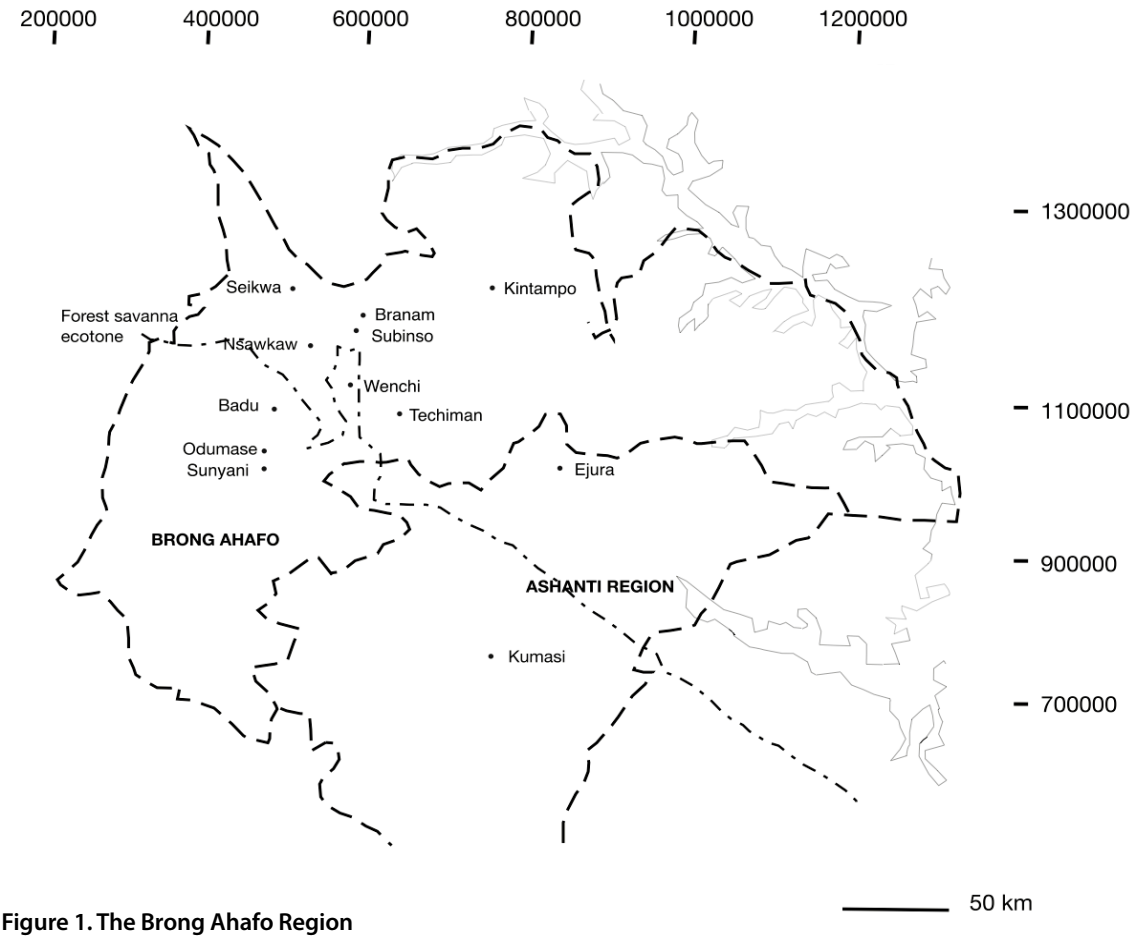

Figure 1. The Brong Ahafo Region

agro-dealers within Brong Ahafo and the demand for improved maize seeds by farmers. The final section examines the uptake of new technologies by farmers, the nature of their information on new technologies and their experimentation with technology and adaptation.

The concept of modern and traditional varieties

Mirroring modernisation discourse with its roots in economic dualism, research on modern varieties has been structured within a framework of discrete traditional and modern farm practices and traditional or local and modern varieties. Within this discourse, modern varieties (both improved open pollinated and hybrid seeds) are assumed to have superior yield characteristics. From this premise, the development of agriculture is reflected in the uptake of new varieties and inputs by farmers, and the displacement of indigenous technologies. This framework informs the criteria for estimating the relative development of agriculture. In this regard CIMMYT has attempted to collect global statistics on the uptake of new maize varieties based on impact assessment questionnaires distributed to relevant developing agencies who make assessments of the distribution of varieties in specific areas of the world based on uptake of hybrids, the cultivation of open pollinated varieties (OPVs) that have not been planted from certified seeds for more than five years and local varieties. On the basis of this, CIMMYT estimated that in 1990 approximately 57 percent of the developing world's non-temperate maize area was planted to unimproved local materials, which represents a much higher percentage than estimates for rice at 41 percent and wheat at 30 percent (López-Pereira and Morris 1994). It is not clear how such figures are estimated, particularly in areas where smallholders engage in multicropping, in which a number of different crops can be intercropped within the same field.

Lopez-Perieira and Morris (1994) introduce the caveats that it is difficult to accurately estimate the proportion of improved maize planted given the diversity of maize production environments and maize-based farming systems. They argue that the introduction of new maize varieties into areas where unimproved maize is grown results in considerable mixing of varieties, 'that it is not always possible to distinguish between the two' (Lopez-Pereira and Morris 1994: 25). As a result 'many so-called unimproved local' materials may include substantial amounts of improved germplasm, which implies that conventional estimates of the areas planted to improved varieties may understate the true extent (and impact) of the use of improved germplasm' (Lopez-Pereira and Morris 1994: 25). On the other hand, improved germplasm is often combined with local varieties to better adapt new varieties to local conditions, or as Lopez-Pereira and Morris (1994: 6) write:

> CIMMYT materials may not be ready to be released directly to farmers; frequently, breeders working in the national program make additional selections

to identify materials that are well adapted to local production conditions and conform to local producer and consumer preferences. If the national program cannot perform these functions effectively, even the best CIMMYT germplasm may not find its way into farmers' fields.

Hence, the distinction between local and improved varieties is not so clearly demarcated in reality, since all improved varieties that are delisted in effect become local varieties, whose continued survival depends upon the selection and conservation practices of farmers. In a study of maize varieties in northern Ghana, Gyasi et. al. (2003: 372) write, 'Some of the local varieties are thought to be old improved varieties'. Similarly Morris *et al*. (1999: footnote 2,:6) define local varieties as 'farmers' traditional varieties (also known as landraces) that have never been worked on by a formal breeding program, as well as older improved OPVs and hybrids'. [ii]

The superiority of modern over traditional varieties is often asserted with reference to yields that suggest that where improved OPVs have replaced indigenous varieties yield gains average around 15–25 percent, and are much higher for hybrids (Lopez-Pereira and Morris 1994). However, detailed yield data is rarely collected from farmers' fields under farmer cultivation, and most of these projections are based on varietal trials on experimental stations. As Lopez-Pereira and Morris (1994: 39) observe:

> Although varietal trials are done routinely to determine yield differences between improved materials and local checks, results from conventional varietal evaluation trials usually cannot be used to calculate research benefits because they do not reflect farmers' management practices. Conducted under tightly controlled experimental conditions which typically involve recommended management practices and levels of inputs, conventional varietal evaluation trials almost invariably overstate the *absolute* yield advantage conferred by improved materials when they are grown under the less-than-optimal levels of management typically provided by farmers. Although the *relative* yield advantage achieved in conventional varietal evaluation trials may provide a more reasonable approximation of the yield gains likely to be achieved in farmers' fields, even the assumption of the same relative increase in yield may not hold when the crop is subject to extreme moisture and/or temperature stress. Thus if the yield advantage of improved materials is to be estimated realistically, breeders will have to be much more systematic about including farmer-managed, on-farm yield trials in the varietal evaluation process (Lopez-Pereira and Morris 1994: 39).

While the term 'indigenous' or 'local knowledge' is often counterpoised to 'scientific knowledge', and imbued with an essentialist quality implying cultural purity or resistance to western scientific knowledge, this is something of a misnomer since the knowledge of farmers often draws upon and uses scientific knowledge and technical products. As Brush (2004: 32) explains:

> Knowledge systems, as part of culture, tend to be naturally permeable to outside terms and information. Like crop species, both indigenous and scientific knowledge systems are open and fluid rather than hermetic and fixed. Thus Andean potato taxonomy freely combines Quechua, Aymara, and Spanish terms. The same is true for Mexico, where speakers of numerous native languages have pooled their knowledge about maize and joined European information systems to this American knowledge.

In place of discrete and dualist local and scientific knowledge systems, it is more appropriate to see local knowledge systems as sites of cultural hybridity in which farmers retain elements of their own practice and knowledge, and combine it with new techno-scientific knowledge to create new knowledge, in which the hegemonising concepts of development and modernity are resisted, transformed and 'hybridized with local forms' (Escobar 1995: 54). Through farmers exerting their right to be creative and adaptive, and to experiment with the products of science in their own right and in accord with their own cultural frameworks and predilections, the imposition of standardised packages and recommendations is resisted. The wide variability and diversity within local farming and seed management practices must be factored into discussions on yield, as opposed to projecting some notion of average yield in local smallholder agricultural which is then counterpoised to equally homogenised yields under the use of inputs, as this does not take into consideration differences in fields and farming systems.

The stability and essentialist dichotomy between modern and local varieties tend to be less discrete than projected since they are often disrupted by epidemiological factors. Outbreaks of epidemics undermine the efficacy of existing genetic materials and result in searches for resistant strains on which a new genetic base can be built. This was the case during the late 1940s with the outbreak of American Rust disease in maize, rapidly spreading from West into Central and East Africa. The outbreak of American Rust decimated maize production in the Gold Coast in 1950 leading to the importation of 12,300 tons of grain (McCann 2005). This resulted in a concerted effort to find new sources of international maize germplasm that were resistant to rust disease and the importation of new genetic materials into West Africa. While new varieties were created by the mid 1950s in Africa, the rust epidemic had inexplicably receded by 1951. The response to this epidemic created the beginning of an infrastructure for research into new maize varieties to replace local ones, and most likely altered the genetic base of local varieties (McCann 2005).

Similarly, in the early 1980s the emergence of maize streak virus (MSV) in Ghana resulted in high farm losses

in many areas. Consequently, many of the newly created modern varieties that were susceptible to streak were replaced by new modern varieties. In 1985 a number of high yielding varieties were introduced in Ghana, including *La Posta, Dobidi, Kwanzie, Aburotia* and *Safita-2*. These included varieties with short growing seasons such as Aburotia, and Safita-2. These varieties were not resistant to MSV and by 1988 new varieties were bred to replace them, including *Okumasa, Abeleehi, Dorke* and *Obatanpa* (Tweneboah, 2001). Most of these varieties have not withstood the test of time and the current listed varieties in circulation include *Obatanpa*, and the hybrids Mamaba and Dadaba. However, these hybrids are not readily available since seed growers are reluctant to expend the considerable increase of labour on their cultivation. The only improved nationally certified seed widely available to date is Obatanpa. However, the germplasm of delisted improved varieties continues to exist in farmers' fields, where they are selected and recombined into new varietal materials, forming part of the pantheon of local varieties while continuing to bear the names of their certified ancestors. Little is known of the yield characteristics of these farmer perpetuated varieties, or the extent to which farmers are able to select, identify and classify them.

Within the Brong Ahafo region a plethora of varieties continue to bear names of former modern varieties or local nicknames for these varieties (*Dobidi* is often called 'Para', which alludes to its large seeds, which are compared to paracetemol). Varieties are usually classified according to a dual category based on 'local' or 'agricultural', and on the size of the seeds and the maize cobs. Local varieties, which go by the name of *Apia* and *Ahumansia* in most Bono areas, *Atia* in Badu and Anyafia at Seikwa, are characterised by numerous small slender seeds and long thin cobs, and the 'agric' varieties by broader cobs and a smaller number of large grains. The 'agric' varieties are also referred to by specific varietal names including *Dobidi* and *Obatanpa*. However, these varietal names are often used generically to apply to all public research varieties. Obatanpa may be referred to by some farmers as *Dobidi, Aburotia,* or *Akumasa*. While farmers may adopt specific improved varietal names, most of these varieties are mixtures of a large number of improved and local varieties. This was evident at Badu where in addition to identifying the local variety as *Atia*, and 'agric' varieties, some farmers and traders identified another variant of *Atia* as '*Agric Atia*' – a cross between local and improved varieties.

The maize trade in Brong Ahafo

This mixing up of varieties was confirmed by interviews with market traders in the main Brong Ahafo markets. Thirty-five interviews were held with maize traders in Kintampo, Wenchi, Seikwa, and Subinso. Badu, Sunyani and Suyani-Odumase in January 2010. A large number of maize markets have sprung up in Brong Ahafo. Many of these form parts of periodic wholesale food markets, such as at Techiman (the largest market, originally a Friday market), Wenchi (Thursday), Kintampo (Wednesday), Subinso (Friday), and Seikwa (Friday). Others are specialised maize depots situated in the main producing centres, which large wholesale traders from the major urban centres visit, such as at Badu and Sunyani Odumase. Within these markets there are three important agents: the large wholesale traders from the major urban centres, such as Accra, Kumasi and Tamale who purchase large quantities of maize; the regional bulkers, who purchase crops from farmers and sell it to the urban wholesalers; and farmer agents who bring maize from the villages to the regional bulkers. The regional bulkers usually begin trading by going out to the villages. They establish relations with producers who often bring the maize to them at the market. As the maize trader Salifu Abdul Rahim explained at Kintampo market:

> We go to the villages to buy maize. The villagers actually don't come to the market. We normally have an agreement with them. When they need money to farm we give it to them and we take the maize as payment after the harvest….When we go to buy in the villages we sit down to negotiate the price, deducting the cost of transport, lorry fares, tollbooth tickets, and labourers from the going market price. We bring it to the market and add some small profit margin. But sometimes when we

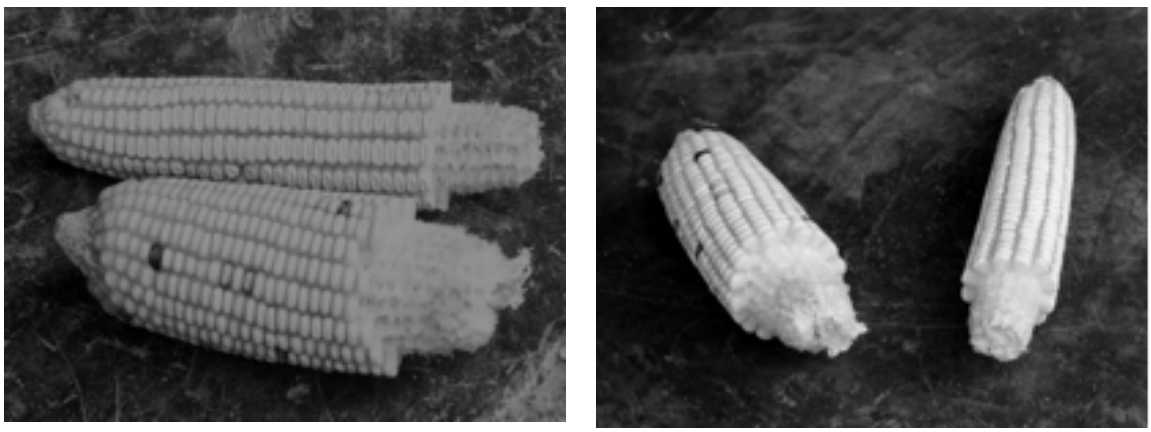

Figure 2. The basic characteristics of local and improved maize. The local varieties are those with long slender cobs and small seeds (top and right). The improved varieties have broader cobs with larger but fewer seeds.

> go to the market and buy and come back, prices on the market have reduced and our customers from Accra and other places refuse to pay the original market price and we make a loss.[iii]

At Wenchi market Joseph Agyei Boadu narrated:

> I started trading in maize about two years ago. At times I buy from the villages and at times they bring it here. … Every trader has customers from whom they regularly buy. Mine are mainly from Beposo and Droboso. You don't leave your customers and buy elsewhere.[iv]

According to Salifu Abdul Rahim the regional bulkers are organised in an association. This often has an office, a chairman, treasurer, secretary and may be presided over by a 'Queen Mother', a prominent trader in her own right. The association is responsible for organising the maize market, providing storage facilities, organising labourers for loading lorries, parking facilities, and receiving urban wholesale traders. When the large urban wholesalers arrive in the market they place an order for the total amount of maize they require and the regional bulkers are responsible for meeting this demand. For these services they charge a commission which was three cedis per bag in August 2010 and four cedis per bag in January 2012. This includes the labour costs of loading the bags of maize onto lorries.[v]

The main demand for maize is from urban wholesale traders catering for consumers in the southern towns who prepare maize into fermented dough. A second important demand, particularly at Sunyani and Seikwa market is from poultry farmers. At Sunyani maize market poultry farmers frequently prefer to buy yellow maize (which gives a deep yellow colour to egg yolks). Yellow maize is produced at Bekyem, Tanoso, Yamfo, and Tainkyire, Sukulman. At Seikwa poultry farmers from Kumasi and Dormaa usually buy white maize. White maize overwhelmingly dominates the markets. At Wenchi trader Emmanuel Abawere observed:

> I buy all types of maize as long as the seeds are of good quality. Apia is the best maize. The seed are small and of good quality. Para [*Dobidi* but more likely *Obatanpa*?] has large seeds and weighs a lot. Poultry farmers like Para. Some traders prefer mixtures of white and yellow maize. Apia is most common variety that I buy from farmers. They come from Tromeso, Agubie, Asarekorkor, Atuna, Abenkro, Tainso, Wirempo, and Nyankuman. I sell to Accra traders and poultry farmers from Domma.[vi]

In these markets maize is differentiated on the basis of colour (yellow or white), improved ('agric') or local, by variety name (which includes *La Posta Dobidi, Para, Akumasa, Obatanpa* for the improved varieties and *Apia, Atia, Ahomansia, Anyafia* for the local varieties in different areas) and by season (*nsusu eburoo* for major season corn planted from March to May or *ewia eburoo* for minor season corn planted around August to October). Within these categories the only price differentials is between yellow and white maize, with yellow maize sometimes having a higher price as a result of scarcity, and between minor and major season maize based on the demand for each at a particular time of year. Major season maize attains a price premium at the beginning of the minor harvest when it is better dried but scarce as compared to the minor season maize that begins to flood the market. There are no price differentials for different varieties of maize, and the main differential is for the quality of the stored grain, with powdery mildew-affected grains receiving lower prices. However, certain varieties are known to store better. Generally, the local varieties are known for attractive small grains that store well and produce superior flour, and *Dobidi* (or Para) is reputed to have poor storage qualities and to easily turn powdery. As Alhaji Zongo commented at Wenchi Market:

> Apia stores well but *Dobidi* stores poorly. After one month the seeds begin to develop a powder around them. Apia can store for four to five months without any problem.

While the urban traders may not know the different varieties of maize, the qualities they value in maize leads them to prefer the features of the local over the improved varieties. At Seikwa, the regional bulkers stated that Accra traders sometimes specifically requested for *Anyafia*, the local variety. Many of the traders also stated that farmers preferred cultivating the local variety because 'it yields many small seeds on one cob and if you plant a little you get a lot'.

The variety names mentioned by regional bulkers may not accurately depict the particular variety but refer to a nebulous category of the descendents of improved variety. Thus, *Obatanpa* may be referred to as *Dobidi* or *Para* or *Akumasa*, because this is the improved variety that traders and farmers have became conversant with, and by extension it is made to apply to all later improved varieties characterised by large seeds. Since *Obatanpa* is the only certified seed currently being produced on the market, none of the other varieties mentioned are certified true varieties, but descendants of former certified varieties that are preserved by farmers.

Although maize varieties can be identified by distinct characteristics, most of the maize purchased from farmers is a mix of varieties. While Accra traders may prefer the small-grained local varieties that are easily milled to provide soft flour that easily rises, it is impossible to acquire pure bags of such maize in quantity. Thus, it is the mixture of local and improved varieties that prevails in different localities that come to determine the quality of maize of that locality rather than specific varieties. At Kintampo market Sulamana Abu Razak commented: '*Obatanpa* and *Apia* are the main varieties. The wholesalers from the south prefer *Apia*. But all have one price. We do not separate them they are all mixed up'.[viii] As Ibrahim Tonko, a trader in Kintampo Market, noted:

> The varieties are all mixed up. All maize has one price. The maize from the Northern Region does

not rise [when fermented] as well as that of the south. That is why the Accra and Kumasi traders prefer the maize from Brong Ahafo than from Tamale. The varieties in both the North and the transitional zone are mixed up. But the nature of varieties varies in different areas. Maybe the difference comes more from the land more than from the variety.[ix]

At Wenchi market Alhaji Zongo concluded:

Every area has its own strengths and each area of maize has its local characteristics. Sunyani maize is different from Wenchi and from Kintampo maize. The traders don't select by variety. They buy all.

This mix of varieties varies over time in different localities results from the pattern of uptake of varieties, and seasonally as a result of different varieties planted in major and minor seasons. Thus, in the minor season, *Obatanpa* tends to be more prevalent than it is in the major season, because many farmers have taken to planting it in the minor season. This is a result of it being more drought tolerant and earlier maturing than *Apia*. Early maturing varieties will also be more dominant in the mix of varieties in the early harvest season than later, particularly since the longer maturing local varieties also store better. At Wenchi market several of the regional bulkers suggested that *Apia* was losing its dominance in the market and 'agric' varieties becoming more prevalent. At Seikwa the regional bulkers identified Anyafia (the local variety) as dominant in the major season and *Obatanpa* as dominant in the minor season.

The evidence from regional maize markets suggests that farmers cultivate a complex mix of maize varieties on their farm, which results from availability, choice and cross fertilisation between different varieties. Consequently, the varieties are constantly changing and the local varieties become mixed up with improved varieties. It is not clear if farmers are able to select new lines that perform better from these crossovers. Within the market many traders prefer the local varieties for their aesthetic, milling, fermenting and storing qualities. The most significant gains in the cultivation of improved varieties has been in the minor season, where *Obatanpa* is considered to have advantages resulting from its drought tolerance and also from its earlier maturity than local varieties, which enables farmers to adapt better to erratic rainfall.

Agricultural modernisation and commercial maize seed in Brong Ahafo

The Brong Ahafo region is the major zone of maize production in Ghana, accounting for about 30 percent of national production (Statistical, Research and Information Directorate 2006). The rise of Brong Ahafo to prominence in food production is comparatively recent, occurring during the late 1970s and early 1980s, when rural periodic wholesale markets emerged as the major markets serving the major urban town in Ghana. During the colonial period agricultural development was neglected in Brong Ahafo, since the colonial authority focused on the development of cocoa in the high forest zone. It was not until the 1950s that the colonial authority began to develop an infrastructure for food crop improvement as a result of discontent about high cost of food in the 1940s and the maize rust epidemic of 1949-53 (Amanor 2010, Grischow 2006, McCann 2005).

Colonial interventions during the 1950s in the food crop sector involved the creation of a network of experimental crop stations and the development of large-scale state farms. Following independence these initiatives were built upon and both the Northern Region and the Brong Ahafo region became a focus for state interventions in food production through the development of state farms and promotion of mechanised and high input farming (Amanor 2010, Amanor and Pabi 2007). With low population density, readily available land and suitable land for mechanised cultivation, the northern sector of the transition zone became a major focus for the development of state farms and commercial maize cultivation, as exemplified by the Wenchi, Branam, and Ejura state farms. The Wenchi and Branam state farms both lie in Brong Ahafo and were established in 1962 on former experimental stations of the Ministry of Agriculture. At Wenchi the main crops grown were maize, sorghum, and yams. Between 250-300 acres were planted under maize. At the larger Branam State farms 2000 acres were planted under maize, 700 under cotton, and 200 under yam and rice (Amanor, et. al. 2002). Although mechanisation was central to the state farms, this was still largely in an experimental stage. For instance at Branam, Russian MTZ tractors were used, but these were unsuitable to the conditions of the soils of the transition zone and were so heavy that they often got stuck. They ploughed too deep, destroying the organic matter layer within the topsoil and turning the subsoil over the topsoil. This led to a rapid loss of soil fertility (Obeng 1973). Similarly, attempts to cultivate yams under mechanised ridges were a disaster and the yields were so bad that the state farms abandoned this strategy and hired manual labour to prepare indigenous mounds (Amanor *et. al.* 2002).

In spite of the management and technical problems that the state farms experienced, the development of an infrastructure for the state farms had a knock on effect on the smallholder farmer sector. The development of a road network facilitated transport of crops to market and the development of new wholesale crop markets for servicing the urban areas (Amanor and Pabi 2007). The development of state farms also created demands for labour, which resulted in an influx of labourers, particularly from the Upper West and Northern regions. The influx of migrants enabled Brong Ahafo farmers to employ farm labour. Chiefs and landowners gave out large areas of land to migrant farmers resulting in increased food production. The expansion of agricultural production for the market resulted in a growing labour market and many youth came down from the Upper West region during the clearing season to work on farms.

A servicing infrastructure for mechanised farm equipment and synthetic inputs developed, resulting in tractor hire services, government distribution of subsidised inputs and credit facilities for commercial farmers. During the 1970s large commercial farms emerged around the perimeters of the state farm, including Alhaji Salia Farms, Damballa Farms, Dinchini Farm, Wenchi Farm, Akrobi Centronella Farms (Amanor, et. al. 2002). A large number of projects also developed promoting use of inputs, including the Catholic Church sponsored Subinso Agricultural Project, the Ofuman Agricultural Project, the National Reconstruction Corps Project at Kokoago, and the Subingya Irrigation Project. Within the perimeters of these state farms, state agricultural services and projects significant numbers of smallholder farmers began to take up new modern seeds, inputs and permanent cultivation on plots cultivated with mechanised technology. The radius from service centres from which farmers could get reliable access to ploughing facilities was often very limited. Beyond this distance, farmers experienced problems in getting tractors to plough in time, before the planting season. For instance in a 1993 study of input usage among farmers in Brong Ahafo, 51 percent of farmers at Subinso used tractor ploughing while 10 km away at Mansie this had dropped to 18 percent (Amanor 1993).

By the late 1970s two distinct zones of maize production had emerged in Brong Ahafo. In the more northerly transitional zone in the ecotones dominated by Guinea savannah woodland around state farms many smallholders had adopted tractor ploughing on permanent plots, using moderate amounts of fertiliser and new varieties. Subinso represents this type of settlement in this study. On the richer soils of dry semi-deciduous forest, characterised by tall tropical forest trees and undergrowths of elephant grass and forest shrubs many farmers adopted maize cultivation within an intensified short bush fallowing system, investing in hired labour to intensify and expand production, largely using local varieties without synthetic inputs. This type of settlement is epitomised in this study by Badu.

The relative position of these two types of farming system changed during the 1980s as structural adjustment policies were implemented and subsidies removed on inputs. As prices of inputs increased, many farmers found investments in inputs to be no longer cost effective. However years of stumping the land, and ploughing sub soils over top soils had rendered the soils to be highly unproductive without the use of synthetic fertilisers. With increasing fertilisers costs farmers began experimenting with new cropping patterns, incorporating more groundnuts and cowpeas and cassava, which make less demands on the soil than maize, experimenting with crop rotations and reintroducing fallowing systems. At Subinso there was a significant shift in production from maize to cassava. In a survey conducted in 1993, 44 percent of farmers at Subinso used fertilizer and 51 percent of farmers ploughed their lands with tractors (Amanor 1993). However in a subsequent survey of 85 farmers in Subinso conducted in 2002 only 11 percent of farmers were using synthetic fertiliser while 18 percent hired tractor-ploughing services (Amanor et. al. 2002).

The increasing urban demand for maize and shortfall of maize in the declining mechanised belt resulted in further expansion in the semi-deciduous forest areas into maize. Maize also became an important supplementary crop in the yam belt intercropped with yam on plots not using mechanised ploughing or synthetic fertilisers. Thus removal of subsidies resulted in a shift in national maize production from mechanised cultivation on permanent plots to cultivation under systems of bush fallowing using increasing investment in hired labour and expansion of areas cultivated in low population areas.

The legitimacy of international and national public agricultural research had been dependent upon interventions that provided modern inputs to farmers at attractive prices. The shift towards liberalised markets and the expansion of indigenous forms of accumulation based on farmers own autonomous production threatened to undermine international agricultural research. As a consequence, the negative outcomes of the shift towards subsidy removal was ameliorated by the interventions of high profile transnational NGOs, of which the most prominent was Sasakawa Global (SG) 2000 (Amanor 2010, Puplampu 2003, Breth and Dowswell 2003, Dawson 2002, Tripp and Marfo 1997). Sasakawa Global 2000 (SG 2000) worked with agricultural and extension services throughout Africa to encourage the uptake of new seeds, inputs and cultivation methods. In Ghana, SG 2000 largely focused on the maize belt in the transition zone of northern Ashanti, Brong Ahafo, and the Northern Region. It trained over 1,000 extension agents. It distributed new varieties in the rural areas through demonstration plots and farmer multiplication programme. It vigorously supported the CIMMYT inspired Quality Protein Maize programme of the Crop Research Institute for the uptake of *Obatanpa* maize. It provided loans for farmers to take up the cultivation of certified maize produced by the Ghana Seed Company and later by private seed growers organised in the Seed Producers Association of Ghana (SEEDPAG). SG 2000 actively supported the programme of privatisation of agricultural services, working with the Agricultural Development Bank and commercial agro-dealers to organise input distribution packages in which the ADB paid agro-dealers to stock input packages for distribution to approved farmers and farmers repaid the ADB after harvest. In addition to supporting improved maize SG 2000 worked with Monsanto to introduce Monsanto herbicides in a programme promoting minimal tillage cultivation. This perhaps has been the most successful initiative of SG 2000. Although the improved *Obatanpa* seeds were enthusiastically taken up by farmers under the three years of credit supplied by SG 2000, once the loans ended farmers often reverted back to their own seeds. By the late 1990s, as elements of subsidy were removed, SG 2000 began to collapse as loan recovery began to falter and in 2003 the programme was closed down (Breth and Dowswell 2003). The SG 2000 programme has made a lasting impression in the rural areas, and the distribution of large amounts of new

varieties and promotion of seed multiplication programmes has altered the genetic mix of varieties, resulting in changes in the composition of local varieties and an increasing mix up of varieties. Since the closing down of SG 2000 several government agricultural programmes have attempted to replicate the formula. In 2005 the Agricultural Production Support Programme (APSP) distributed packages of inputs, fertiliser and cash to farmers. In the Brong Ahafo Region 12000 farmer were targeted under this programme in 2006 (WABS Consulting 2008). However the programme faltered as loan recovery only reached 50 percent. The most recent variant of this approach is the Block Farming Programme, which is also suffering from problems of loan recovery.

The reality of the history of cultivation within Brong Ahafo is at variance with the framing of the modernisation discourse, which presents a picture of gradual uptake of new technology resulting from the education of farmers who become more familiar with new cultural practices. In reality the uptake of modern technology is not without unforeseen problems emerging from ecological constraints, the consequences of macroeconomic policies, and the unfolding of a complex series of adaptive practices of farmers to ecological and economic factors, new technologies, changing commodity and labour markets and policy environments. Much of this framing is drawn from received knowledge in international development rather than from detailed empirical data drawn from specific localities, or studies of the changing dynamics within farming systems.

The institutional framework of maize seed production

The period of most significant development in the capacity to breed maize varieties in Ghana coincided with structural adjustment and the imperative to privatise agricultural services (Amanor 2011). As a result of this seed production capacity became increasingly fractioned as the state was pressurised into privatising the production of certified seed, through the creation of the parastatal Ghana Seed Company (GSC), which was intended to operate as a commercial entity with the mandate to produce certified seed. In 1989 the GSC was restructured and opened to privatisation. However, no private sector investors were willing to invest in the GSC. As a consequence the development of private seed markets has taken the form of the creation of SEEDPAG (Seed Producers Association of Ghana), an association of private seed growers, who were originally contracted by government services to provide seeds, and a separate Seed Inspectorate Division under the Ministry of Agriculture with the mandate to certify and regulate seeds, and process and store them for the seed growers (Amanor 2011).

Within Brong Ahafo, commercial maize production and a commercial infrastructure largely developed during the period of adjustment. As a consequence, state maize seed production facilities were not built within Brong Ahafo, and seed growers within this region had to rely on facilities within the Ashanti Region, and incur great costs in transporting their seeds to Kumasi for drying and processing. Moreover the high demand for drying facilities in Kumasi means they often have to wait for a long period before getting their maize dried and stored. This contrasts with the Central, Volta, Ashanti, and Northern Regions which produce much lower levels of maize but have facilities for storing certified seed. As a consequence, many seed growers in the Brong Ahafo Region either sell their seeds in Kumasi after processing, or do not process them through the Kumasi Seed Inspectorate. One large seed grower in Wenchi has established his own drying facilities. Most seed growers not using the storage facilities of the Seed Inspectorate focus on minor season production, when the dry season allows better sun drying of grains. These developments have been accommodated within the formal structures of seed production, within the Brong Ahafo Seed Inspectorate, which certifies seeds produced within the region and distributes foundation seed to seed growers. Around thirty registered seed growers operate within the Brong Ahafo Region. The majority of the seed growers concentrate on minor season seed production. In 2009 in the major season 16 growers planted 222 acres of maize and gained an output of 21,117 bags (95.2 tons) of certified maize. In contrast during the minor season 29 seed growers planted 975 ha of maize and gained an output of 17,780 bags (8000 tons) of certified maize[xi]. Although Brong Ahafo is potentially the most favourable environment for maize production and the multiplication of maize seeds, the lack of regional support structures constrains certified seed production.

Seed growers within Brong Ahafo sell their products to agro-dealers, and individual farmers, but also rely on the patronage of NGOs and the Ministry of Food and Agriculture. The recently introduce Block Farming Programme is an important outlet for seed growers. The Block Farming Programme supplies seed growers with foundation seed, inputs and labour. The seed growers reimburse these loans in kind, and the certified seed produced is distributed to farmers as part of a package of seed and inputs. Within the Wenchi district there are ten registered seed growers. One of these, Zaidu Samu, plants 140 acres of minor season foundation seed and 40 acres during the major season. While he sometimes sends maize to Kumasi for processing, the transportation cost is high. This encourages him to focus on sun drying minor season maize. He produces between 1,000 to 1,800 bags of maize, of which 200-300 bags are taken by agro-dealers. In the last year one NGO purchased 500 bags. Farmers individually also purchase small amounts of maize. When the cost of maize is low on the market the demand for certified seed dwindles and he is often forced to sell his seed as grain on the market.

At Kintampo there are two registered seed growers. Lawrence Effah cultivates 70 acres of minor season foundation seed, which he sun dries. The major buyers are agro-dealers in Techiman. However he also suffers from low demand for seeds, particularly when the market price of maize is low. In 2009 he was left with 2,000 45 kg bags of unsold certified maize seed.

In contrast with this, Ababio Johnson, a renowned seed grower in Wenchi does not have a problem in selling certified seed. He cultivates 100 acres of Obatanpa in the minor season and 30 acres in the major season. He also cultivates 20 acres of the hybrid Mamaba. He sells to both agro-dealers and farmers and has a network of agro-dealers throughout the country who buy from him in Accra, Kumasi, Nkawkaw and Sunyani. He has a higher demand for seed than he can produce, so he also markets the seed of other seed growers. However, he is also despondent about the market for certified seed:

> The market is not good. While the price of foundation seed has increased from 40 cedis to 110 cedis the market in Kumasi is flooded with adultered seed, so farmers often buy cheap but get poor quality seed. When the price of maize is low farmers are reluctant to spend on certified seed… Most farmers prefer to use their own seed because they say it stores better for a longer period. But when there is a prolonged dry season, then they buy improved seed.

During the early 1990s the development of a plant breeding capacity resulted in the release of many varieties with different attributes, including various maturing periods and yellow and white maize. However since the early 1990s plant breeding in Ghana has solely focused on Obatanpa. The only other listed varieties have been hybrids, which seed breeders do not find profitable to breed given their perception of depressed market prices for maize and highly volatile demand . This creates a paradox in that while choice is supposed to be a fundamental attribute of development and of market expansion, there is only one variety and one set of recommended practices promoted by extension services for all the different environments and maize faming systems in Ghana.

Beyond public plant breeding Wienco commercial input distributors, has started importing new varieties of maize from South Africa, including the hybrid Pan 53 and Agriserve has imported Pioneer hybrids for testing by farmers in Ghana. National maize variety trials are being conducted in Brong Ahafo, supported by USAID, Wienco Ghana, PANNAR Seed Company of South Africa, Pioneer Seeds of the USA, the Ghana Crop Research Institute, the Drought Tolerant Maize for Africa Network, and the regional agricultural services. These recent developments have major implications for the future of public seed breeding in Ghana and for the potential for farmers to influence seed agendas. Through these developments and new institutional configurations involving trials conducted by the Ministry of Agriculture, agricultural policy is likely to increasingly respond to powerful commercial interests rather than the specifically to the needs of farmers.

Agro-dealers

Agro-dealers are situated within the major market towns and within the larger farming settlements. Badu has two agro-dealers and Subinso three. The agro-dealers usually operate from kiosks, where they carry a small range of inputs including fertiliser, chemicals, seeds, spraying machines and other tools. Maize seeds form a relatively insignificant commodity of those marketed by the agro-dealers. Some of the agro-dealers do not stock maize seeds.

At Seikwa, Lawart Agro-Chemicals claimed to have sold 15 bags of improved Golden Jubilee yellow maize seed in 2010, although it was not clear where this was produced since it is a recently introduced variety that is not in general circulation. However, this is a specialised variety aimed at poultry farmers, so the absence of any sales of *Obatanpa* suggests low patronage of improved seed among local farmers. Tiwa Agro Chemicals of Seikwa sold no certified seed and Selina Nyarko sold two bags of *Obatanpa*. She also stated that she sold only five bags of fertiliser in the whole year. At Nsawkaw Kofi Addi Agro-dealers sold 2-3 bags of *Obatanpa*, which he purchased from Wofa Addo Agro-dealers in Techiman, while Paul Yeboah sold no certified maize seed. At Subinso James Asare of Eye Awurade Agro Chemicals claimed to sell a lot of *Obatanpa* during planting season, although he could not specify how many bags, which he acquired from Donewell agro-dealers of Wenchi. He commented that farmers like *Obatanpa* because it matures earlier, but also like the local variety Apia because it yields heavily. At Badu Connection Man Agro Chemicals estimated that they sold about 7-10 bags of *Obatanpa* during the major season and 5-7 bags during the minor season. In Sunyani, the regional capital, Bentroma Agro Chemicals did not sell maize seeds. The Young Shall Grow Agro Chemicals stated that farmers mainly bought *Obatanpa* in the minor season, when they sold about 150 45 kilo bags. Elizabeth Quaye Agro Chemicals estimated that she sold 100 bags in the major season and 150 bags in the minor season. Andy Gyan of Farmers Line Agro Chemicals sold 80 bags of seed maize. He commented that there was far more demand for vegetable seeds than for maize. Many of the Agro-dealers in Sunyani claimed to get their maize seed from the seed grower Ababio Johnson of Wenchi. Elizabeth Quaye purchased 50 bags of maize seed from him.

All the maize dealers identified herbicides as the most significant commodity that farmers purchased, from which they made their main profits. The general picture that emerges from the survey of agro-dealers is of a rather insignificant market for improved maize seed in contrast with increasing uptake of herbicides. This increase in the uptake of herbicides suggests that the major constraint is not in the existing infrastructure of access of farmers to agricultural commodities, information and education as is frequently portrayed in the literature. The low uptake of improved seeds occurs because farmers prefer to allocate scarce resources to other critical sectors of farming operations, and do not find the qualities of their

seed to be the major constraints on their yields within the context of risk and variability within the farm calendar.

Farmer production and maize seed

To gain insights into the use of maize varieties 72 farmers at Badu and 76 at Subinso were interviewed. This included 27 female farmers at Subinso and 32 at Badu. Both Subinso and Badu are significant centres of maize production, with maize markets visited by specialised wholesale traders. However, Badu is a more important producer of maize with many Accra traders visiting its Tuesday maize market. In contrast maize comprises one section of Subinso's Friday market and the specialised wholesale traders largely emanate from the Northern and Upper West regions. The relative importance of maize in these markets is reflected in farmers' perceptions of the most important crop they grow. Sixty percent of farmers cultivating maize at Subinso and 81 percent at Badu identified maize as their most important single crop (Table 1).

In addition to maize, other important crops cultivated at Subinso include yam, cassava, groundnut, cowpea and pepper. At Badu other important crops are cassava, yam, plantain and pepper (Table 2).

Table 1. Farmer perceptions of their most important crop

Most important crop grown (percentage of farmers)	Subinso	Badu	Total
Maize	60	81	71
Yam	11	1	6
Cassava	6	3	5
Groundnut	5	0	2
Maize and yam	8	1	2
Maize and cassava	2	4	3
Other	2	10	8
No of farmers	65	69	134

Table 2. Crops cultivated at Subinso and Badu (other than maize)

Percentage of maize farmers cultivating other crops	Subinso	Badu	Total
Yam	92	60	75
Cassava	62	70	66
Groundnuts	28	1	14
Cowpea	20	4	11
Pepper	13	23	13
Plantain	0	19	10
Cocoa	0	4	2
No of farmers	72	76	148

Badu is situated on the fringes of dry semi-deciduous forest. In contrast Subinso is situated in the southern Guinea savannah transition zone characterised by numerous small woodland tree species and grassy undergrowth. As a result of these vegetation differences, the land in Subinso is amenable to stumping and tractor ploughing, while that of Badu is not. The large rooting systems of forest trees frustrate the use of tractors and uprooting of these results in rapid soil erosion. Consequently, farming in Badu is carried out within a rotational bush system, while that at Subinso consists of both permanent cultivation on ploughed plots and rotational bush fallowing (Table 3). At Subinso maize production is in decline, as compared to the late 1970s and early 1980s when Subinso was a major centre of agricultural modernisation, in which subsidised inputs and mechanised tractor services were made available to smallholder farmers. The immediate next settlement to Branam State Farms, Subinso was favourably positioned for preferential access to new technologies. However, the removal of agricultural subsidies during the 1980s and 1990s has led to a decline of input usage and maize production. In a survey carried out in 1993, of 41 farmers interviewed in Subinso 51 percent used fertiliser, 44 percent used tractor services and 56 percent purchased improved seed (Amanor 1993). In a survey carried out in 2002, of 80 farmers (including 46 women and 35 men) at Subinso 11 percent of farmers used fertiliser, and 22 percent hired tractors (Amanor, et. al. 2002). During this period there was a significant shift at Subinso from maize cultivation to cassava and groundnuts as farmers responded to the high costs of fertilisers by introducing crop rotations that required less use of synthetic inputs. Many farmers turned to cassava, since the ploughed soils were no longer suitable for yam production and could not sustain maize production without application of costly fertilisers. This was reflected in the emergence of many small cassava (gari) processing workshops in the early 2000s, which continue to exist today. Since then there has been more uptake of inputs again at Subinso, as subsidies have recently been reintroduced on inputs. In the recent survey carried out in January 2012, 55 percent of maize farmers at Subinso used synthetic fertiliser as compared to 11 percent at Badu.

Table 3. Continuous cultivation and fallow regimes in the two settlements

Percentage of farmers	Subinso	Badu	Total
Continuous cultivation	49	7	27
1 year fallow	5	8	7
2 year fallow	16	9	12
3-4 year fallow	28	52	38
Over 4 year fallow	2	23	13
No of farmers	57	60	117

While Badu has been the more important maize-producing centre since the mid 1980s, this is achieved with little use of synthetic inputs and a much lower adoption of certified maize varieties than at Subinso. Badu farmers depend upon a system of rotational bush fallowing for soil restoration (Table 3). While dominant

development and environmental narratives associate intensified bush fallowing with environmental degradation and unsustainable land usage, this has not been the case at Badu, where farmers suggest that in recent years the forest has been regenerating, since the extensive 1983 bush fire. This regeneration is reflected in recent planting of cocoa by some farmer at Badu. Remote sensing evidence also supports this thesis of expanding forest regeneration in the Badu area. Analysis of the 1984 remote sensing data showed that 85 percent of the land in the Badu area was covered with a grassy fallow or annual crops. By 2000 30 percent of the land had regenerated into open woodland, and within the open woodland category 83 percent of this land had been grassy fallow or farm in 1983 (Amanor and Pabi 2007). Farmers suggested that the colonisation of fallows by the exotic herbaceous species *Chromolaena odorata* had played an important part in this regeneration by encouraging improved soil fertility and creating favourable conditions for further forest tree regeneration. Currently, *Chromolaena* is spreading beyond the dry semi-deciduous zone into transitional Guinea savannah woodland, and can also be found in patches in the Subinso area.

Table 4. Use of modern agricultural inputs

Percentage of farmers	Subinso	Badu	Total
Synthetic fertiliser	55	11	32
Depend on purchased certified seed	37	14	25
Tractor ploughing	36	0	17
Herbicide	75	96	86
Hired labour	81	95	88
No of farmers	70	76	146

These differences in environment and farming systems result in significant variations in the allocation of resources to inputs in the two settlements. While Subinso farmers allocate significant resources to tractor ploughing and use of improved seed and fertiliser those in Badu focus more on hiring labour and labour saving technologies. About 36 percent of farmers at Subinso use tractors for ploughing their land and nearly 50 percent cultivate their plots on a permanent basis. Fifty percent of farmers cultivating plots on a permanent basis use synthetic inputs. Over one third of farmers incorporate fertiliser use with 3-4 year fallowing strategies (Table 5). However, within both settlements more farmers allocate resources to hiring labour and using herbicides than to fertilisers and seeds. Eighty-eight percent of farmers hire labour and 86 use herbicides. Ninety six percent of farmers at Badu use herbicides as compared to 75 percent at Subinso. While herbicides are often promoted as a zero tillage technology that has the potential to replace and displace shifting cultivation, farmers have integrated and indigenised herbicides into bush fallowing cycling in which the first application of herbicides follows clearing of the land with fire. Farmers also experiment with herbicides and often combine them with small amounts of ammonia fertiliser. Herbicides are recognised by farmers as a labour saving technology, which also enhances the fertility of the soil. The widespread use of herbicides shows both the access of farmers to technology and to complex information since the right type of herbicide needs to be adapted to the nature of the environment, which includes herbaceous and grassy species, and inappropriate application of certain herbicides on maize can destroy the maize crops.

Table 5. Fallowing and fertiliser use

Percentage of farmers	No fertiliser	Use of fertiliser	Total
Continuous cultivation	16	50	27
1 year cultivation	7	8	7
2 year fallow	18	3	13
3-4 year fallow	43	37	41
Over 4 years fallow	17	3	12
No of farmers	77	38	115

Maize farming is carried out under different farming styles in both settlements. In Badu multicropping prevails in which yam is usually intercropped with cassava and pepper. In Subinso maize is often intercropped with yam or cassava, but also cultivated in pure stands. This makes it difficult to collect meaningful comparative data on maize yields since the yield in any one field will vary inversely with the extent of cultivation of other crops, which also yield important value, as much as with the adoption of inputs and new cultivation techniques. Thus at Badu, many women farmers cultivate small areas of land in which they intercrop maize with cassava, vegetables and plantain, in which maize yields are low, but other crops make significant contributions to their income. About half the farmers at Subinso and a quarter at Badu focus on monocropping maize in both minor and major seasons. About half the farmers at Badu practice multicropping in both seasons. A quarter of farmers in both settlements practice multicropping in the major season and maize monocropping in the shorter minor season (Table 6). These differences in cropping make it difficult to collect accurate and comparatively relevant data on areas under particular crops and yields of particular crops. Given this caveat, farmer assessments of maize yields per acre show a huge divergence with yields varying from one to two bags per acre to 25 bags. The mean estimation of maize yields varies between 15.1 for women and 40.6 for men and between 6.0 of maize per acre for women and 8.2 bags for men. The average estimated yield per acre at Badu is 6.6 bags as compared to 8.3 bags for Subinso. However average estimates of total yields per year vary between 17.3 for Subinso and 34.7 for Badu. This suggests that Badu farmers achieve their domination in maize production by expansion into readily available land rather than through investments in maximising yields and through investments in labour rather than in inputs.

Table 6. The prevalence of multicropping and monocropping in maize cultivation			
Types of maize cropping (percentage of farmers)	**Subinso**	**Badu**	**Total**
Monocropping in major and minor seasons	**47**	**23**	**36**
Multicropping in major and minor seasons	**8**	**45**	**26**
Multicropping in major and monocropping in minor season	**25**	**22**	**23**
Monocropping in major and multicropping in minor season	**1.4**	**0**	**1**
Multicropping in major and no minor season maize	**3**	**4**	**4**
Monocropping in major and no minor season maize	**4**	**0**	**3**
Monocropping in minor season and no major season maize	**10**	**3**	**6**
Multicropping in minor season and no major season maize	**1**	**3**	**2**
No of farmers	**72**	**69**	**141**

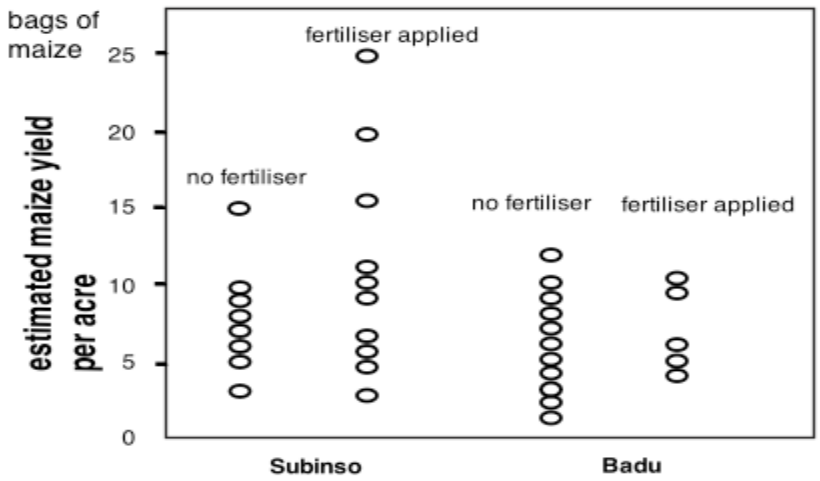

Figure 3. Estimated yield per acre in relation to application of synthetic fertilisers

While the use of synthetic inputs is more significant at Subinso than at Badu, there is no pronounced pattern of use of inputs being associated with superior yields at Subinso. At Badu there is even less evidence that fertiliser use transforms into higher yield per acre (although very few farmers use fertilisers). Figure 3 presents a scatter plot of farmer estimates of their yield per acre against the use or non-use of synthetic fertilisers, which shows considerable variability in results for application and non-application of synthetic fertilisers. In the category of farmers who estimated they gained yields of eight bags of maize and more per acre, only 57 percent used fertiliser at Subinso. Similarly in the category of farmers gaining yields of five bags and less 50 percent of these at Subinso were using fertiliser (Table 7).

Table 7. Use of inputs by farmers with different maize yields			
Percentage of farmers	**Subinso**	**Badu**	**Total**
Estimate yield of 8 bags or more per acre:			
Use of fertiliser	**63**	**13**	**33**
Use of *Obatanpa*	**57**	**16**	**32**
No of farmers	**16**	**25**	**41**
Estimate yield of 5 bags or less per acre:			
Use of fertiliser	**50**	**15**	**24**
Use of *Obatanpa*	**38**	**19**	**24**
No of farmers	**8**	**26**	**34**

At Subinso, both large farmers who use synthetic fertiliser to gain high yields and small farmers who use fertiliser to manage exhausted soils can be found. For instance in the latter category, Alhaji Imam of Subinso stated:

> We plant two acres of maize. We only get two bags yield per acre because the land is not good. We apply one bag of NKP fertiliser and one bag of Ammonia per acre. Although the yield is not good it is better than going to the market to buy maize, which now costs over 100 cedis a bag. We don't sell out maize. We use it to feed the children.

It is often alleged that farmers fail to apply fertilisers according to the recommended dosage. However, within

the survey 64 percent of farmers using fertilisers applied the extension recommended dosage of one bag of NPK per acre ten days after planting, followed by a side dressing of one bag of sulphate of ammonia at the first weeding.

Farmers are equally divided by the variety of maize they prefer. At Subinso 50 percent of farmers preferred the improved *Obatanpa* variety while 21 percent preferred the local variety (*Apia*). At Badu 45 percent preferred *Atia* (the local variety) and 27 percent *Obatanpa*. Unsurprisingly, preference for the improved variety is more pronounced in Subinso, where more farmers use modern agricultural inputs. However, a significant number of farmers in both settlements (15 percent at Subinso and 24 percent at Badu) like using both varieties, preferring *Atia/Apia* in the major season and *Obatanpa* in the minor season (Table 8). The main reason for preferring *Atia/Apia* include a belief among farmers that it yields higher than Obatanpa and that it stores well (Table 9). As Idrissu Adbdul Rahim of Badu stated:

> *Obatanpa* yields heavily but its seeds are large so you do not get as much. I prefer *Atia* because it yields heavily. It is tall and can have four cobs on a plant while *Obatanpa* only has two. It yields heavily because the seeds are small.

Table 8. Seed varieties preferred by farmers

Percentage of farmers preferring the seed variety	Subinso	Badu	Total
Apia/Atia	21	45	34
Obatanpa	**50**	**20**	**35**
Apia and Obatanpa	**15**	**24**	**20**
Para	**3**	**1**	**2**
Any variety	**7**	**8**	**7**
Other	**4**	**2**	**2**
No of farmers	**72**	**76**	**148**

The main reasons farmers site for preferring *Obatanpa* include early maturing, (and thus more drought resistant) and high yielding (Table 9). Many farmers prefer planting *Obatanpa* in the minor season, because it enables them to get a better yield than the longer maturing *Apia/Atia*, in case of rain failure, or to harvest the crop before late rains set in and spoil ripening maize cobs. Thus, many farmers use the local varieties in the major season and *Obatanpa* in the minor season, or plant a mixture of local and *Obatanpa* in the minor season to ensure some yield in case the rains are erratic. Grace Obuor of Badu stated:

> I like Obatanpa as it comes early, but it does not yield as heavily as Atia. In the minor season I plant a mixture of Atia and Obatanpa in case the rains fail. Atia doesn't do well if the rains fail.

A significantly large number of farmers at Subinso purchase certified seed, consisting of around 50 percent of the farmers interviewed (Table 10). *ObatanpaObatanpaObatanpa*

Table 9. Reasons identified by farmers for preferring particular maize varieties

Percentage of farmers	Subinso	Badu	Total
Reason for preferring Apia/Atia:			
High yielding (yields many small seeds)	69	59	57
Stores well	13	27	23
No of farmers	**16**	**36**	**52**
Reasons for preferring Obatanpa:			
Early maturing	**60**	**52**	**58**
High yielding	**20**	**37**	**26**
No of farmers	**35**	**19**	**54**

Table 10. Origins of planted maize seed

Origins of seeds planted (percentage of farmers)	Subinso	Badu	Total
Own seed	23	43	33
Buy certified seed	37	14	25
Buy from grain sellers in market	16	3	9
From friends	**3**	**16**	**10**
Own seed and buy certified	**7**	**0**	**4**
Own seed and buy from grain market	**1**	**7**	**4**
Certified and buy from grain market	**9**	**3**	**6**
Buy from farmer	**1**	**6**	**4**
Certified seeds and from friends	**4**	**10**	**7**
No of farmers	**71**	**73**	**144**

In contrast the overwhelming majority of farmers at Badu use their own seeds. Farmers who use certified seeds often purchase them regularly. For instance, Aisha Yaya, a farmer at Badu commented:

> I buy *Obatanpa* from an agro-dealer. I like it because it matures early and if the rain fails you will get some yield. I buy it from the dealers every two years because the seeds begin to change.

James Agyeman of Badu similarly stated:

> I plant an acre of *Obatanpa* in the major season to get seed to plant in minor season. But sometimes the seed changes so I buy new seed to get true breeds. I buy it from an agro-dealer in Sunyani.

However, some farmers also attempt to select seeds from their own stocks as they 'change'. For instance Thomas Adade of Badu narrated:

> I got my seed from an agricultural officer and I select seeds from the yield. After I have planted for about

four years the seeds begin to change, so I begin to select from the seeds those that have the characteristics of *Obatanpa*.

Farmers who prefer *Atia/Apia* also experience similar problems in getting access to pure seed. For instance Stephen Tanor of Badu stated:

I prefer *Atia* because the seeds are small and you get more. The Accra traders also like *Atia*. It also stores well. But it is difficult to get sufficient *Atia*. All of the maize is mixed up so it is difficult to get a large quantity.

Similarly, Ama Duah of Badu commented:

I like *Obatanpa* because it matures early which is good if the rain is unreliable. *Atia* yields well if it rains, but in the minor season it can fail. But my maize is all mixed up.

When approached on the topic of the yields of *Atia/Apia*, agricultural officers rejected outright the suggestion by farmers that *Atia/Apia* yields heavier in the major season than *Obatanpa*. They suggested that if this occurred, it was the result of the improper use of inputs and recommended cultural practices by farmers. However, extension services only offer one set of recommendations for one maize crop in different environments with different soil fertilities, rainfall patterns and vegetations. Ultimately the task of adapting scientific and technological knowledge to specific environments and farming systems falls on farmers. Most ominously was the response of an extension officer at Nsawkaw, who quipped that the extensions services had the solution in the Block Farming Programme, which would force farmers to cultivate *Obatanpa* and adopt modern inputs, since they all came as part of a single package. Some farmers complained that Block Farming forced them to accept inputs that they did not require, which became a burden to repay.

At present the dissemination of inputs and modern agricultural technologies continues to be top-down and fails to provide farmers with choice. It is usually carried out within a coercive framework of dissemination of technology packs through financial loan inducements and dependency through indebtedness, which usually results in farmers adopting technology that is not finely tuned to their needs. This also results in high repayment defaults. Low rates of financial recovery have plagued all agricultural sector input credit programmes since SG 2000.

If development and market integration are about expanding choice, this is clearly not the case with contemporary maize technologies. Agricultural technology dissemination tends to be based on a reiterative framework, which seeks to justify the dissemination of dominant technologies rather than understand the demands and constraints on farming strategies. This reiterative framework results in the weak collection of agricultural statistics on the uptake of technology and seeds among different groups of farmers in different localities. This both masks the relative weakness and successes of agricultural technology development. It prevents a realistic assessment of the potentials for the adoption of new technologies, and the specific environments and categories of farmers in which a particular technology is likely to succeed the most or fail.

The assumption in current agricultural policies is that there is a limited uptake of modern technologies due to farmers' lack of knowledge of these new technologies. However this does not reflect in farmers' actual use of new technology. A significant number of farmers at Subinso have taken up the cultivation of modern varieties of maize with inputs. The more pronounced preference for *Obatanpa* at Subinso may reflect the drier conditions there than in the dry semi-deciduous forests. An equally significant category of farmers also farm without the use of new seeds and inputs. At Badu, the major expansion of maize cultivation is associated with the use of local seed and a mixture of local seeds planted in the major season and improved *Obatanpa* planted in the minor season. The rapid uptake of herbicides by farmers also reflects access to technology rather than a thin presence of agro-dealers. This shows a capacity to gain complex information on agricultural technologies, evaluate this information and adapt it to the specifics of different farming systems and farming strategies.

Conclusion

The evidence from maize markets, seed grower, agro-dealers and farmers corroborate each other. They all point to high rate of adoption of *Obatanpa* seed during the minor season, and higher preference for local varieties during the major season. Traders confirm that the preferred variety on urban markets is *Apia/Atia*, but that during the minor season *Obatanpa* becomes more prevalent in the maize mix. Seed growers produce most Obatanpa during the minor season. Although seed growers suggest that the main reason for preferring minor season seed production is related to the ability to sun-dry the seeds, there may be other factors at play here, related to the relative performance of *Obatanpa* in the two farming seasons. Many farmers prefer to grow Obatanpa during the minor season and *Apia/Atia* during the minor season. This evidence suggests that farmers' decision-making in the uptake of new technologies is informed and made in the context of integration into markets rather than lack of market accessibility. Unlike the major narratives of agrarian modernisation, the perceptions of farmers are both reflective and critical, and able to evaluate both strengths and weaknesses in public sector and informal sector varieties. In Brong Ahafo the notion that small farmers lack access to input markets is belied by the high uptake of herbicides among farmers and farm labourers.

Much of the research on value chains tends to construct imaginary and idealised markets which are based on the demands of a small sector of the agri-food industries for uniform and graded standards of particular

varieties of grain, rather than on the large urban market for maize with its demand for mixtures of grain originating from particular localities that may attract a premium price. This social construction of barriers of entry based on particular grades serves to promote the uptake of particular improved varieties and input packages, since cultivation of these become a requirement to access to the market. However, they do not reflect the nature of the main demand for maize on national urban markets, which value local over improved varieties, and mixtures of maize with a high local varietal content.

The dominant framing of contemporary seed policies portrays the main constraints in input usage as rising from poorly developed market infrastructures, high transaction costs that result in high input prices, and poor education and extension reach. Several programmes are now attempting to develop networks of agro-dealers and providing support for subsidies on input packages that accrue to commercial dealers, to encourage deeper penetration of input dealers into rural areas and the dissemination of knowledge on new technologies. This is an approach that is being promoted across Africa, from Malawi to Kenya to Nigeria (Scoones and Thompson 2011, Chinsinga 2011, Odame and Muange 2011). While the prices of inputs within rural African settings are often high, and bringing down the costs of inputs is a laudable objective, focusing on input supplies to the exclusion of other factors may be inappropriate. This approach tends to promote the aggressive marketing of inputs and provide little support for farmer experimentation and adaptation. There is also an extremely limited range of technical options for farmers, which results from constraints within the public sector research institutions, and the reluctance of seed growers to engage in breeding more difficult varieties, such as the hybrid *Mamaba*. As it stands since the early 1990s seed breeding in Ghana has been dominated by one variety, *Obatanpa*, which is disseminated to farmers in all the agro-ecosystem in Ghana. The increasing commercialisation of seed may also result in the erosion of the national public breeding sector through imported hybrid varieties produced by international seed companies. While this is not yet a reality in Ghana, recent varietal trials hosted by the Ministry of Agriculture with seeds imported by multinational companies, and the recent intense interest in Pan 53 are important indicators of this trend.

The evidence from the Brong Ahafo districts reveals that seed usage is highly dynamic and involves complex mixtures of local and improved varieties. Farmers experiment with both types of varieties, often incorporating the two into their farming systems. In addition some farmers also preserve delisted certified varieties, which contribute to the diversity of seeds. Since there is cross fertilisation between different maize varieties there is considerable varietal mixing up, and sometimes farmers experience difficulties in getting sufficient quantities of the local variety for planting. This suggests that there is scope for initiatives that combine local plant selection and multiplication of seeds with the initiatives of plant breeders and seed growers to preserve a diversity of different seed varieties, and create seed selection processes for recovering and multiplying local varieties that have been transformed by the planting of improved varieties and for maintaining a diversity of genetic materials, which is essential for the posterity of seeds.

Since the 1990s public seed breeding has received less support as the overriding macro policies have supported privatisation and market liberalisation. This has resulted in declining funding for both national agricultural research and capacity building programmes between international agricultural research centres and national crop breeding. However, privatisation within the global seed industry has also undergone considerable transformation from the emergence of small specialised companies carrying out cutting edge applied science in the 1980s and 1990s, to the domination of the industry by large monopolies with a concern with maximising profit, a focus on a narrow technology base, a lack of interest in conducting innovatory research, and an aggressive policy of acquisitions and market concentration by 2000 (Murphy 2007). As a result many of the small companies have gone out of business or have been acquired by competitors. Competition has resulted in aggressive strategies of controlling the market through acquisition of intellectual property rights. As Conway (2003: 16) comments:

> Fierce competition and low margins in the seed industry compel companies to stockpile IP that does not have sufficient market value for development, so as to keep it out of the reach of competitors. This tends also to make it unavailable to public scientists still willing to work on crops for poor farmers. The number and complexity of ownership rights that must be negotiated—and paid for—to take a product to market have multiplied so quickly that some useful products are sitting in greenhouses going nowhere and some useful ideas are not being pursued. Increasingly, only big corporations—not public scientists—are able to assemble the mosaic of IP rights necessary for 'freedom to operate'.

Although the development of the market is seen as a panacea for enabling farmers to access new technology, this is clearly not the universal case and in many instances the development of open market competition can impede the development of new technology and raise the transaction costs. At the same time scientists working within public sector institutions are increasingly under pressure to be increasingly competitive, and subscribe to the ethos of the market. Yet the controversies that arise out of the development of the market, including intellectual property rights, environmental concerns around erosion of genetic diversity, the implications of transgenic research, and the health hazards of agrochemicals all call for a strong independent public sector that is able to mediate these debates and create pressures for regulations. In the context in which three to four transnational companies can dominate seed and

input markets, a strong public research sector can act as an important buffer against monopoly capture (Murphy 2007).

Within the context of crop development in Africa the pressures towards liberalisation do not create favourable conditions for promoting agriculture among smallholders. These pressures tend to create a focus on a narrow range of improved seeds that are dependent upon applications of inputs to achieve superior yields. The adoption of the seeds and inputs guarantee profits to the input distributors, but do not satisfactorily take into account the diversity of farming conditions and the risk of erratic rainfall that can wipe out investments in costly seed and synthetic fertiliser. They create a dependency on these inputs, which can be most clearly seen in the US where farmers who replant proprietary seeds may be sued by the seed companies (Conway 2003, Center for Food Safety and Save Our Seeds 2013). Within the African context new varieties are often selected that require the use of inputs such as fertilisers, in which many small farmers are reluctant to invest. The promises of miracle seed have largely failed to materialise and adoption rates have often been low. With limited resources plant breeders have attempted to focus on creating new varieties with broad adaptability to different environments and seasons, as well as varieties that perform well in particular environments but not others, however these are often rejected in selection trials to make way for more generic varieties. However, these generic varieties often fail to perform as expected under farmer conditions and therefore may become adapted by farmers to particular conditions (as in the case of *Obatanpa* in minor season maize production in the transition zone) or rejected. The pursuance of generic varieties often results in a limited range of technologies that farmers can choose between and experiment with in their farm conditions.

The development of an alternative framework is required that promotes working in a more incremental method and works with farmers' existing technology and gradually introducing elements of choice and capacity building that engage farmers in managing their own seeds more effectively. It would also enhance farmers' capacities to manage seeds rather than make them dependent upon commercially produced seeds. It would introduce them to technologies for variety selection that can be used in both multiplying new seeds and selecting particular breed characteristics from seeds that have become mixed up. This can also be enhanced through more dynamic private public private sector partnerships in which the public sector takes the initiative in outsourcing parts of its seed research in which there are the most constraints to specialised small companies working within models of open source technology and farmer participation to enhance the technologies within the reach of smallholders and to improve the range of technologies made available to farmers to enhance their productivity in specific environments (Murphy 2007). Rather than focus on the production of miracle seeds, this would aim to build both farmers capacities within localities to enhance their productivity and information, and the capacities of national public sector researchers to provide technologies responding to particular farmer needs within existing markets. Within each crop sector the characteristics of the existing market will determine the types of seed production strategies that are feasible, if these are constrained by requirements of a standardised adequate mixed grain.

These objectives can only be met by creating better farm data collection methods at the national and local levels, which accurately reflect the cropping systems of farmers and enable the performance of various varieties to be more accurately assessed, monitored and to inform policy. At present agricultural research continues to be informed by researcher-managed trials, which reify the technologies produced in research centres and the use of inputs. Extending this approach to the private sector, including seeds and input suppliers, in public-private partnerships carries many unsettling implications related to extending the commercial reach and profits of farm input suppliers through assumptions about the performance of new varieties and inputs under farm conditions, rather than empirical farm data. Thus a much more critical framework is required that places agricultural technology development within the development of the various agricultural markets, and examines the political interests involved in the framing of seed policy. This will serve to create a better understanding of the conditions under which varieties perform well, and the major constraints in their usage in existing farming systems. This data needs to reflect on the dynamics and development of various farming systems in different areas and provide critical feedback on the performance of varieties and combinations of varieties under specific farm conditions.

Acknowledgements

I wish to thank Patrick Nsiah, Sadia Issaka, Antoinette Annan and Tontieh Kanton for the great efforts they put into carrying out field research on this project. I also thank Mawuli Leychar for his great patience and time in explaining the regional institutional set up for seed administration in Brong Ahafo.

Notes

[i] The dominant recent intellectual ancestry of this approach emanates from the work of Sachs (2005) and Sanchez *et al*. (2005) from where it has infiltrated into most policy literature based on a value chain approach. For application to maize in Ghana see IFDC (2002), and WABS Consulting (2008). In the context of policy projects this approach builds upon the framework of the SG 2000 programme in Africa.

[ii] See also Amanor (2010) for a similar framework with regard to rice in northern Ghana.

[iii] Interview with Salifu Abdul Rahim, Alahaji Amidu, Alhassan Abdala, and Ibrahim Tanko at Kintampo market on 11 January 2012.

[iv] Interview with Joseph Agyei Boadu at Wenchi market, 6 August 2010.

[v] Interview with Salifu Abdul Rahim, Alahaji Amidu, Alhassan Abdala, and Ibrahim Tanko at Kintampo market on 11 January 2012.

[vi] Interview with Emmanuel Abawere, Wenchi market, 6 August 2010.

[vii] Interview with Alhaji Zongo and Ibrahim Saliah, Wenchi Market, 6 August 2010.

[viii] Interview with Sulamana Abu Razak and Narud Gati, Kintampo market, 5 August 2010.

[viii] Interview with Ibrahim Tanko, Kintampo market, 5 August 2010.

[ix] Interview with Alhaji Zongo and Ibrahim Saliah, Wenchi Market, 6 August 2010.

[x] Interview with Mawuli Leychar, Regional Seed Inspector, Sunyani, 24 January 2012.

[xi] Although six new varieties of maize have been released by the Crop Research Institute between 2007-2010 none of these are yet in general production. These include yellow QPM varieties for the poultry industry, and drought resistant and early maturing white varieties, and new commercial hybrids that are easier to produce than Mamaba.

[xii] See "Farmers Get New Maize Varieties", Ghana New Agency, 16 December 2010. http://www.ghananewsagency.org/details/Science/Farmers-get-new-maize-varieties/?ci=8&ai=23503. Accessed February 12 2012.

References

Ahn, P. (1970) *West African Soils*, Oxford: Oxford University Press.

Amanor, K.S. (1993) Wenchi Farmer training project: Social/environmental baseline survey, Institute of African Studies, Legon.

Amanor, K.S. (2010) *Participation, Commercialisation and Actor Networks: The political economy of cereal seed production systems in Ghana*, Futures Agriculture Working Paper 16, Brighton; Futures Agricultural Consortium.

Amanor, K.S. (2011) 'From Farmer Participation to Pro-poor Seed Markets: The political economy of commercial cereal seed networks in Ghana', *IDS Bulletin* 42(4): 48-58

Amanor, K.S. and Pabi, O. (2007) 'Time, Space and Rhetoric in Agricultural Change in the Transition Zone in Ghana' Human Ecology, 35:51-67

Amanor, K.S. Brown, D. and Richards, M. (2002) Poverty Dimensions of Public Governance and Forest Management in Ghana, Oversees Development Institute: London and Institute of African Studies, Legon.

Breth, S. and Dowswell C.R. (2003) *Sasakawa Africa Association, Annual Report* 2002-2003, Tokyo, Japan: Nippon Foundation

Brookefield, H. Padoch, C., Parsons, H. and Stocking, M. (2002) *Cultivating Biodiversity: understanding, analysing and using agricultural diversity*, London: ITDG Publishing

Brush, S. B. (2004) *Farmers' Bounty: Locating crop diversity in the contemporary world*. New Haven and London: Yale University Press

Center for Food Safety and Save Our Seeds (2013) *Seed Giants vs. U.S. Farmers*. Washington Center for Food Safety

Chinsinga, B. (2011) 'Seeds and Subsidies: The political economy of input programmes in Malawi' *IDS Bulletin*, 42(4): 59-68

Conway G. (2003) From the Green Revolution to the Biotechnology Revolution: Food for poor people in the 21st century, Directors Forum, Woodrow Wilson International Center for Scholars, Washington D.C. March 12. Accessed 12 February 2012 at:www.unc.edu/courses/2006spring/geog/021/001/Conway.pdf

Dawson, J. (2002) 'Empowering Ghana's cereal producers in the marketplace', in Kapila, S. and Mead, D. (eds.) *Building businesses with small producers: Successful business development services in Africa, Asia and Latin America*, Ottawa, Canada: The International Development Research Centre

Escobar, A. (1995) Encountering Development: The making and unmaking of the third world, Princeton, NJ: Princeton University Press

Grischow, J. (2006) Shaping Tradition: Civil society, community and development in colonial northern Ghana, 1899-1957, Leiden, The Netherlands: Brill

Gyasi, K.O., Abatania, L.N, Paulinus, T. Abdulai, M.S. Langyintuo, A.S. (2003) 'A study of the adoption of improved maize technologies in Northern Ghana' in B. Badu-Apraku, M.A.B. Fakorede, M. Ouedraogo, R.J. Carsky, and A. Menkir (eds.) Maize revolution in West and Central Africa, Ibadan: IITA, pp. 365-378.

IFDC (2002) *An Action Plan for Developing Agricultural Input Markets in Ghana*, Muscle Shoals AL, USA: International Fertiliser Development Center

Lopez-Pereira, M.A. and Morris, M.L. (1994) *Impact of International Maize breeding research in the developing world 1966-1990*, Mexico D.F.: CIMMYT

McCann, J.C. (2005) *Maize and Grace: Africa's encounter with a new world crop 1500-2000*, Cambridge, MA: Harvard University Press

Morris, M.L, Tripp, R. Dankyi, A.A. *Adoption and Impacts of Improved Maize production Technology: A case study of the Ghana Grains Development Project*, Economics Programme Paper 99- 01. Mexico D.F.: CIMMYT

Murphy, D.J. (2007) Plant Breeding and Biotechology; Societal context and the future of agriculture, Cambridge: Cambridge University Press

Obeng, H.B. (1973) 'Problems of soil erosion in cereal crop production in Ghana', *African Soils* 17:75-79

Odame, H. and Muange E. 'Can Agro-dealers Deliver the Green Revolution in Kenya?' in I*DS Bulletin*, 42(4): 90-101

Puplampu, K. (2003) 'State-NGO Relations and Agricultural Sector Development', in Tettey, W. Puplampu, K. and Berman, B. (eds.) *Critical Perspectives in Politics and Socio-Economic Development in Ghana*, Leiden, The Netherlands: Brill

Rogers, E.M. 'Communication and development: the passing of the dominant paradigm', *Communication Research* 3(2):213-240

Sachs, J.D. (2005) The End of Poverty: *Economic possibilities for our time*, New York: Penguin Press

Sanchez, P., Swaminathan, M.S., Dobie, P., Yuksel, N. (2005) Halving Hunger: it can be done, UN Task Force on Hunger, New York: Earthscan.

Scoones, I. and Thompson, J. (2011) 'The Politics of Africa's Green Revolution: Alternative narratives and competing pathways', *IDS Bulletin*, 42(4): 1-23

Statistical, Research and Information Directorate Ministry of Food and Agriculture (2006) *Agriculture in Ghana: Facts and Figures*, Accra: Ministry of Food and Agriculture

Tripp, R. and Marfo, K. (1997) 'Maize Technology Development in Ghana During Economic Decline and Recovery', in Byerlee, D. and Eicher, C.K. (eds.) Africa's Emerging Maize Revolution, Boulder CO, USA: Lynne Rienner

Tweneboah, C.K. (2001) *Modern Agriculture in the Tropics with special reference to Ghana: Food Crops*, Accra: Co-Wood Publishers

WABS Consulting Ltd (2008) Maize Value Chain Study in Ghana: Enhancing efficiency and competitiveness. http://www.valuechains4poor.org/detail_publication.php?pub_id=62. Draft Report. Accessed 4 February 2012

World Bank (n.d.) 'Support for Improved Technologies through Large-Scale Field Demonstrations in Ghana, SG 2000 Project in Ghana (May 1986-December 2003)', in World Bank Fertilizer Toolkit: Promoting efficient and Sustainable Fertiliser use in Africa, http://www.worldbank.org/afr/fertilizer_tk/..GhanaSGDemoProgram.pdf [accessed 20 July 2010]

Future Agriculturesthis Working Paper was written by **Kojo Sebastian Amanor** for the **Future Agricultures Consortium**. The FAC Working Paper series publishes work in progress by FAC members. All papers are technical research papers which have been peer reviewed, and are available in open access format. The series editor is **Beatrice Ouma**. Further information about this series of Working Papers at: **www. future-agricultures.org**

The Future Agricultures Consortium aims to encourage critical debate and policy dialogue on the future of agriculture in Africa. The Consortium is a partnership between research-based organisations across Africa and in the UK. Future Agricultures Consortium Secretariat at the University of Sussex, Brighton BN1 9RE UK **T** +44 (0) 1273 915670 **E** info@future-agricultures.org

Funded by UKaid from the British people

The views expressed do not necessarily reflect the UK Government's official policies.