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Ghana's Commercial Seed Sector:

New Incentives or Continued Complacency?

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Ghana's seed sector has undergone some significant changes in the past few years, including the establishment of a new seed law and regulations, the appointment of a National Seed Council, and the emergence of a more diversified commercial seed sector. This paper begins by reviewing the principal elements in Ghana's commercial seed sector. It then examines three factors that will be critical to the direction of seed sector development: the adequacy of public sector crop varieties, the nature of farmers' seed demand, and the composition of the local seed industry. The paper then reviews six areas where policy decisions will be of particular importance in shaping the nation's seed system development: variety release, seed quality control and certification, consumer protection, access to breeder seed, the provision of information to farmers, and seed prices and subsidies. The paper concludes by emphasizing that despite the recent changes in policies, regulations and private investment, there remain a number of unanswered questions and a need for cogent policies if Ghana is to develop a viable commercial seed sector.

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ACRONYMS

AGRA	Alliance for a Green Revolution in Africa
CRI	Crops Research Institute
CSIR	Council for Scientific and Industrial Research
ECOWAS	Economic Community of West African States
FASDEP	Food and Agriculture Sector Development Policy
GAIDA	Ghana Agricultural Input Dealers Association
GLDB	Grains and Legumes Development Board
GSC	Ghana Seed Company
GSID	Ghana Seed Inspection Division
IARC	international agricultural research center
MiDA	Millennium Development Authority
MNC	multinational corporation
MOFA	Ministry of Food and Agriculture
NARI	national agricultural research institute
NVRRC	National Variety Release and Registration Committee
OPV	open pollinated variety
PPRSD	Plant Protection and Regulatory Services Directorate
PVP	plant variety protection
SARI	Savannah Agricultural Research Institute
SEEDPAG	Seed Producers Association of Ghana
SG2000	Sasakawa Global 2000
TVRC	Technical and Variety Release Committee
WACCI	West Africa Center for Crop Improvement
WASA	West Africa Seed Alliance
WASNET	West African Seed Network

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1. INTRODUCTION

This paper examines the current status and recent changes in Ghana's commercial seed system for field crops. It includes a review of present performance and an examination of the factors that might influence the course of seed system development in the near future. The paper is timely because a number of changes in policies, regulations, responsibilities, and commercial interests mean that this could be a period of significant transition for Ghana's seed sector, perhaps marking an end to the stagnation and complacency that have characterized the sector for the past several decades. Whether or not a significant transformation is in store will depend on how some of the issues discussed in this paper are addressed.

The arguments in the paper have been developed through a review of the relevant literature, analysis of statistics, and several weeks of fieldwork in which the authors interviewed public officials and regulators, agricultural researchers, seed companies, input dealers, farmers and donors throughout the country. An initial version of the paper was presented and discussed during the IFPRI 'Transforming Agriculture' Conference in Accra in November 2012.

The paper begins with a brief review of recent policy and commercial changes that affect seed provision in Ghana. This is followed by a summary of the major elements of the commercial seed system and their current performance. The next section of the paper then looks at several economic and agronomic factors that will affect the course of seed system development in Ghana, including variety performance, seed demand, and industry structure. Although the direction of seed system growth is uncertain, there are a number of actions that Ghana's policy makers should consider to provide the best opportunities for effective development, and these are considered in the following section. The final section of the paper provides some conclusions to the analysis.

2. RECENT CHANGES IN GHANA'S SEED SYSTEM ENVIRONMENT

There are a number of recent developments that may have a considerable influence on Ghana's ability to provide commercial seed for its major field crops. These include the enactment of a new seed law, the development of regulations for implementing the law, new national agricultural policy, the activities of domestic and foreign seed companies, and donor interests.

A new law, The Plants and Fertilizer Act of 2010, has recently been brought into force. The need for a law to replace the Plant Quarantine Act of 1965 and the National Redemption Council Decree 100 of 1972 (Alhassan and Bissi, 2006) had been discussed for more than a decade, but it was not until recently that the final version was approved. The law includes designation of responsibilities for seed import and export, establishes a register of varieties that can be marketed, outlines procedures for seed quality control and testing, and establishes a National Seed Council and associated committees. But almost all details on implementation and standards are left to the regulations and to those who will interpret and enforce them. Perhaps the most significant aspect of the new law is that it allows the production of any class of seed by any approved entity and permits both domestic private sector activity as well as access to foreign (public and private) varieties.

At the time of writing this paper, the regulations were still in draft form and the final document was to be considered by Parliament. The current draft regulations outline procedures for variety release and the conduct of seed certification, including standards for each of the major crops.

The law and (draft) regulations leave a number of issues unsettled about implementation. Much of the burden appears to fall on the newly designated National Seed Council, whose duties include formulating seed policies, developing variety registration procedures, and designating the conduct and authority for seed certification. The council has nine members; four are ex-officio positions occupied by ministers or directors within MOFA; three are representatives from the seed growers

association, farmers association and biotechnology research institute, respectively; and two will be nominated by the President of the Republic. It remains to be seen if this membership has the combination of time and experience to effectively direct the implementation of the new law. Although one would expect a national seed policy to be developed before laws and regulations, the reverse has been the case, and a national seed policy is still in draft form. The Food and Agriculture Sector Development Policy (FASDEP II) (MOFA, 2007) makes little mention of seed, except to 'support production of certified seeds/planting materials and increased farmer usage through intensification of awareness campaigns'.

There have been a number of donor efforts over the past few decades to support seed production activities. In the early 1990s, Sasakawa Global 2000 (SG2000) was instrumental in establishing a system of small-scale seed producers. From the mid-1990s, a GTZ West African Seed Network (WASNET) supported the development of the commercial seed sector for more than a decade. More recently a USAID-funded West Africa Seed Alliance (WASA) sponsored activities such as training for input dealers and seed producers in Ghana; the US-funded Millennium Development Authority (MiDA) promoted the use of commercial seed; a USAID-ADVANCE project has supported seed system development; and several donors, including the African Development Bank and JICA, have funded various initiatives to improve access to rice seed. The most prominent current donor in the seed sector is the Alliance for a Green Revolution in Africa (AGRA), which has been active since 2007 in providing grants and support for small private seed companies, funding plant breeding in Ghana's NARIs, providing post-graduate training for plant breeders, and supporting the development of agricultural input dealers. Additional donor funding to develop Ghana's seed sector is being planned by: the G8's New Alliance for Food and Nutrition Security, which includes a 'Scaling Seeds and Other Technologies Partnership'; USAID's 'Feed the Future' initiative which contemplates support to seed production and regulatory reform; and a Dutch 'Integrated Seed Sector Development in Africa' project that targets various types of seed entrepreneurs.

Another recent change in Ghana's seed sector has been the emergence of about ten small, domestic seed companies within the past few years. They account for a small but growing proportion of the formal seed market, which until recently has been dominated by very small-scale seed producers. In addition, there are a few examples of imported maize hybrids from multinational corporations (MNCs) that are beginning to appear, mostly for use in a contract maize growing scheme or in a few government projects, such as National Service farms. But there are plans that these will be more widely available commercially in the next few years.

3. THE FORMAL SEED SYSTEM IN GHANA

Because Ghana's formal seed system is in the midst of change, it will be helpful to outline the responsibilities and performance of its major components until recently and to indicate how these may be modified in the near future.

3.1. Crop Varieties

Most of the crop varieties that are sold as seed have been developed by Ghana's national agricultural research institutes (NARIs), principally Crops Research Institute (CRI) and Savannah Agricultural Research Institute (SARI), which are under the Council for Scientific and Industrial Research (CSIR). A few varieties have also been developed by Ghanaian universities. These public plant-breeding efforts draw on germplasm available through various international networks, most notably those managed by the international agricultural research centers (IARCs). Much of the funding for this plant breeding research has come, directly or indirectly, from donor projects, resulting in a pattern where specific crops are privileged or neglected during a particular period depending on which projects command attention. There is some hope that new, local seed companies could develop their own plant breeding capacity, an idea supported by AGRA's new West Africa Center for Crop Improvement (WACCI) at the University of Ghana. There has been little evidence of imported seed of field crops, until recently. A major agribusiness firm (Wienco) has been importing two Pannar maize hybrids from South Africa, mostly for use in its own contract grower programs that produce grain for the feed market but also for limited over-the-counter sale, and another firm (AgriServ) has been testing various Pioneer hybrid maize varieties with a view to developing the seed market.

3.2. Variety Approval and Registration

Any plant variety offered for sale as commercial seed must be officially approved and registered. In the past, this required two years of multi-location tests that were reviewed by the national variety release committee. More recently, a requirement for two years of on-farm trial data has been added, but these two sets of trials may be run simultaneously. The new (draft) regulations require that a breeder submit sufficient seed to the National Variety Release and Registration Committee (NVRRC) which will provide this to an independent body for testing. Little detail is given on the nature of the tests, and a separate Technical and Variety Release Committee (TVRC) apparently has the responsibility for developing the standards

used for variety registration. Until recently, all varieties have come through the NARIs, but the new law allows the approval of privately developed varieties from both domestic and foreign sources.

3.3. Breeder Seed

Seed production involves several generations of multiplication. For the purposes of this paper, the earliest generation is breeder seed, which has been the responsibility of the NARI that released the variety. The production and maintenance of breeder seed requires significant resources and without specific donor funds the availability of sufficient breeder seed of many varieties has often been a problem, limiting the possibilities for further seed multiplication (as discussed in section 5.4).

3.4. Foundation Seed

Breeder seed is used to produce the next generation, foundation seed. Until recently, this has been the sole responsibility of the Grains and Legumes Development Board (GLDB), which was assigned this task on the demise of the Ghana Seed Company (GSC) in 1989. GLDB inherited some of the infrastructure of the GSC and was given a monopoly on foundation seed production, although in fact the NARIs have also often produced foundation seed, particularly for donor or government projects. NARIs provide breeder seed to GLDB who in turn produces foundation seed that is sold to commercial seed producers. There have been a number of concerns about the efficiency and performance of this arrangement and one of the features of the new seed law is that it allows other entities to produce and market foundation seed.

3.5. Commercial Seed Production

There were several efforts at public seed production beginning in the colonial era, but a major step was taken in 1979 with the establishment of the parastatal GSC. The company never found its feet and was closed ('privatized') ten years later. With no obvious alternative in sight, in the early 1990s SG2000 organized and supported a system of small-scale seed producers, many of whom had been contract growers for GSC. The seed growers obtain foundation seed from GLDB and grow certified seed on their farms. In many cases, the raw seed is transported to GLDB facilities where it is dried, cleaned, and graded. The project provided packaging material, through the Ghana Seed Inspection Division (GSID). The individual seed producers are responsible for selling the seed to input dealers who then sell it to farmers. Although SG2000 support diminished by the mid-1990s, other donor projects took up the mantle, particularly WASNET, which helped establish the Seed Producers Association of Ghana (SEEDPAG) in 2005. Some of the new generation of private seed companies have emerged from these small-scale entrepreneurs.

Table 1 shows certified seed production for the past decade. The table shows that over the past five years the average annual certified seed production for maize and rice has been about 3,000 MT and 1,400 MT, respectively. Seed production for other crops is much lower (215 MT soybean, 30 MT cowpea, 7MT groundnut and 4 MT sorghum). Swings in seed production are partly a function of the weather, as well as demand or support from various government and donor projects. Most of this production has come through the small-scale producer sector and, more recently, the new seed companies. There are also various government and donor projects that have produced their own seed, especially for rice. The small seed companies that have emerged in the past few years have also concentrated on maize, although they have also produced legume seed, particularly in response to demand from several donor projects. Finally, there are several large irrigated rice production projects, described as public-private partnerships, producing seed for their own use that is not included in official statistics.

Table 1. Certified Seed Production, Ghana, 2001-2011 (MT)

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010[1]	2011
Maize	996	1,498	1,341	1,356	2,035	1,672	1,677	2,474	3,789	4,327	2,670
Rice	732	457	407	495	233	516	344	550	2,378	1,450	2,367
Soybean	87	190	179	-	356	218	92	154	295	340	189
Cowpea	34	28	27	47	30	35	57	38	16	27	14
Sorghum	7	15	36	36	14	5	1	5	6	5	1
Groundnut	-	-	9	9	63	23	3	7	9	18	-

Source: PPRSD

1 Figures for 2010 do not include seed production by MOFA Block Farms (97MT maize, 2,456 MT rice and 14MT soybean).

3.6. Seed Quality Control and Certification

The former seed law stipulated that seed of all field crops offered for sale in Ghana must be certified. The GSID is part of the Plant Protection and Regulatory Services Directorate (PPRSD) of MOFA. It has regional offices, and its inspectors visit fields and are present at conditioning sites to do seed tests. The GSID is seriously under-resourced and is not able to carry out all of the duties expected of it. The new seed law includes mandatory seed certification, which will be a challenge for GSID, but the law also contemplates the possibility of alternative certification modalities.

3.7. Seed Marketing

The small-scale seed producers have usually established agreements or contracts with one or more input dealers, who buy the seed for sale in their shops. Most of the new seed companies also sell through these input dealers. A recent study (Krausova and Banful, 2010) found a total of 3,425 agricultural input dealers, ranging from very small retailers to large input wholesalers; 53 percent of these sold maize seed and a much smaller proportion sold seed of other field crops (soybean, cowpea, etc.). The majority of input dealers belong to the Ghana Agricultural Input Dealers Association (GAIDA), which was established with donor assistance in 2003. There is also demand for seed from government programs such as Block Farms and various donor projects. Most rice seed is provided through projects rather than input dealers.

3.8. Seed Utilization

There is relatively little information available on actual seed acquisition. Morris et al (1999) estimated that 54 percent of Ghana's maize was planted with CRI varieties in 1997, but only 26 percent of farmers who acquired seed of a modern variety that year reported purchasing it from an input dealer, and the proportion who had acquired their seed from dealers in previous years was much lower. Other studies (GGDP, 1991; Tripp et al, 1998) show similar results. The studies showed that most farmers first acquired seed of a new maize variety from other farmers or from extension agents (often connected to projects such as SG2000). Maize seed production varies considerably from year to year. In the past three years it has averaged about 3,600 MT, enough to plant about 18 percent of Ghana's maize area, but it is not clear how much of that seed is actually sold. There are no reliable statistics on actual certified seed sale, but one knowledgeable observer estimated that only 60 percent of seed production is actually sold, with the rest ending up in the grain market.

The only other crop for which there is substantial seed production is rice. Until 2009, the amount of certified seed produced would have been sufficient for perhaps 5 percent of rice area. In the past three years rice seed production increased significantly but most of this was through government or donor projects, including an unknown quantity that was not certified. Seed production of legume crops is very low. There are almost no studies on seed utilization for these crops. A small survey in one area of the country where most farmers plant modern varieties of cowpea recorded seed practices over a four-year period; 75 percent of seed was farm-saved and the remaining 25 percent was obtained from the grain market or neighboring farmers; there were no instances of purchases from a seed dealer (Tripp et al, 1998).

Table 2. Total number of varieties in seed production, and percent of seed production in top variety / top 2 varieties (*in italics*), by crop and year.

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Maize	5 *92/ 95*	5 *97/98*	5 *96/98*	5 *96/98*	2 *99/100*	5 *95/99*	4 *95/98*	5 *96/98*	8 *96/97*	6 *97/98*	6 *99/99*
Rice	4 *57/77*	3 *58/88*	3 *57/88*	3 *62/83*	4 *65/99*	8 *27/54*	4 *61/93*	8+ *70/83*	8 *46/80*	5 *65/83*	4 *98/99*
Soybean	3 *57/97*	3 *67/94*	4 *37/65*	-	1 *100*	2 *61/100*	4 *68/89*	3 *78/98*	3 *80/99*	2 *68/100*	1 *100*
Cowpea	3 *62/93*	2 *84/100*	4 *48/93*	4 *41/72*	4 *48/78*	3 *41/71*	3 *57/81*	3 *65/89*	6 *36/57*	8 *39/55*	3 *64/89*
Sorghum	1 *100*	1 *100*	1 *100*	1 *100*	1 *100*	2 *75/100*	1 *100*	4 *38/67*	3 *38/71*	1 *100*	1 *100*
Groundnut	-	-	3 *40/77*	1 *100*	3 *40/72*	1 *100*	2 *96/100*	5 *55/85*	1 *100*	2 *55/100*	-

Calculated based on PPRSD seed certification data.

The lack of variety diversity in commercial seed production also deserves attention. Table 2 shows that few varieties of each crop are produced as seed in any year and there is a general dominance of one or two varieties for each crop. The situation is most extreme for maize, where in the past decade a single variety (Obatanpa, released in 1992) accounts for over 95 percent of seed production. For rice, the pattern is for two varieties to dominate in any year, although the lead has shifted among three different varieties over that period. There is nothing in Table 2 to indicate any trend towards greater varietal diversity in seed production.

In summary, the commercial seed system is producing small quantities of seed of a few crops. A minority of farmers have any regular experience purchasing seed from input dealers. The seed that is on offer represents a very restricted range of varieties and the commercial seed system has apparently not been an effective mechanism for assisting the diffusion of new crop varieties. Before examining possible policy interventions to ameliorate this situation (Section 5) it will be useful to take a step back and examine some of the determinants of Ghana's seed system development that are not immediately susceptible to seed policy. The following section examines some of the economic and agronomic factors that will determine whether the recent changes in Ghana's seed law, policies and regulations can be expected to result in more effective commercial seed provision.

4. DETERMINANTS OF SEED SYSTEM DEVELOPMENT

In order to formulate policy, it would be useful to have a clear idea of the future dimensions and composition of Ghana's seed industry. But there are enough unknowns to make such predictions risky. Some of the major determinants of seed industry development are related to agronomic and/or economic factors. Three of the most important unknowns are the performance of the crop varieties on offer, the nature of seed demand, and the factors that influence the development of the private seed sector. Each of these is briefly discussed in this section.

4.1. Variety Performance

An effective commercial seed system can make a number of contributions to a nation's agriculture. A commercial seed supply can be an attractive option to saving and storing seed, which may involve much management time or special storage facilities, and farmers may be willing to pay for the convenience of a reliable seed supply 'on the shelf'. In addition, commercially produced seed may be of higher uniformity and purity than farm-saved seed, which can be important if farmers are selling produce in a market that demands high quality output. But at this stage of Ghana's grain and legume economy, the first thing to examine is whether the commercial seed system is able to deliver new, more productive modern varieties (MVs). In most cases, farmers would be able to save and reuse the seed of any new variety for at least a few years, except in the case of hybrids, whose yield and uniformity declines with second generation seed. It is the availability of a stream of MVs (non-hybrid and hybrid) that would be the most likely initial driving force behind commercial seed system expansion.

Whether enough new, productive varieties are currently available is a matter for further investigation. Maize is by far the major crop in Ghana's commercial seed system and virtually the only maize variety offered by the seed system for more than a decade has been an open-pollinated variety (OPV), Obatanpa; it has also been released in several other African countries and was the first maize OPV ever included in the US crop registration system (Badu-Apraku, et al, 2006). Although it is an excellent variety, it is now more than 20 years old and is surely the most common single maize variety in Ghanaian farmers' fields. It is thus very unlikely to play a significant role in any further growth of the commercial seed industry. Several earlier-maturing OPVs have been released since the early 1990s, but they have never had significant commercial seed production. Is this because their field performance is not satisfactory or because farmers don't know about them and hence don't demand them? This is a question that is asked about many new crop varieties in many developing countries. This paper is not intended to attempt answers, but it is important to emphasize that the immediate future of Ghana's seed system depends heavily on the quality and competence of public plant breeding. If the new varieties do not offer distinct advantages (or those advantages are not well known), farmers will certainly not be interested in acquiring them as commercial seed. Just because a new variety has been released, after having passed various official performance tests, there is no guarantee that it will be demanded by farmers or offer an opportunity for the seed industry.

With respect to maize, most seed sector participants are placing their hopes on hybrids. In many countries hybrid maize has been the principal engine of growth of the seed industry (because it requires yearly seed purchase) and of maize productivity (because of hybrids' generally superior yields) (Morris, 1998; Byerlee and Eicher, 1997). Ghana has released several public maize hybrids (the first in 1996), but their seed has never been produced in any significant quantity – a total of less than 400MT of certified hybrid maize seed (enough to cover 2 percent of Ghana's annual maize area) has been pro-

duced in the past decade. Are the current hybrids sufficiently superior to encourage farmers to invest annually in seed? Data reported by Sallah et al (2007) show that the best hybrids outyielded Obatanpa by 8-23 percent, depending on season and location. These are fairly encouraging figures, although they come from carefully managed trial sites whose overall yields (4.5-5.7 MT/ha) are approximately three times those found for the average farmer's field. In trials in the coastal savannah, a hybrid (Mamaba) outyielded Obatanpa by 23 percent in the major season, but in the minor season the yields were statistically equivalent; again, the experimental plots featured high levels of management (Frimpong et al, 2011). It is not clear how much advantage hybrids will demonstrate under average management. A set of on-farm trials of Mamaba with high fertilizer levels at sites in northern Ghana produced yields of less than 2.5MT/ha (Buah et al, 2009). National Service Farms currently use an imported (Pioneer) maize hybrid because they found it performed better than Obatanpa.

If farmers need 20 kg of maize seed to plant a hectare and if hybrid seed costs 8 times the farm gate price of maize (see section 5.6 for a discussion of seed price), then a farmer would require at least an extra yield of 160 kg/ha to just break even with the purchase of hybrid seed and probably at least 300 kg to be convinced to make the investment (CIMMYT, 1987). Current maize yields (2006-2010) in Ghana are about 1,700 kg/ha, so the 'average' farmer would need about an 18 percent yield increase to be interested in purchasing hybrid seed. This example is simply exploratory, and there is, of course, great variation in farming conditions; a farmer already getting 3,000 kg/ha would only ask for a 10 percent yield increase from the investment in hybrid seed. Such yields are obtainable; a very large set of on-farm trials in the 1980s with OPVs, modest fertilizer application, and adequate weed control had average yields over 3,000kg/ha (Tripp et al 1987). The maize contract grower scheme run by Wienco achieves yields of 4,800kg/ha, with imported hybrids and good crop management practices (M. Kok, pers. comm.).

The principal point is that much more thought needs to be devoted to understanding what proportion of Ghana's maize farmers would likely be immediately interested in hybrid maize seed. The answer depends on the quality of the hybrid varieties on offer, but also on the relative advantages of investing in crop management or hybrid seed in Ghana's varied maize production environments (e.g. Pixley and Bänziger, 2001). Prior or simultaneous improvement in crop management (fertilization, weed control, etc.) may well be a prerequisite to widespread hybrid use. Farmers also need to understand what a hybrid is and the fact that its seed cannot be saved like the OPV maize varieties with which they may be more familiar. This knowledge is currently not widespread in Ghana, and some local companies who have produced small quantities of hybrid maize seed have had trouble selling it.

The second leading seed crop is currently rice, but much of this seed is produced and distributed on behalf of projects rather than offered over the counter to farmers. There have been three major rice varieties in certified seed production over the past decade; two are older varieties (released in 1986 and 1997, respectively) and one (Jasmine 85) was released in 2009 but had been known (and grown) by farmers for many years previously. It was originally developed by IRRI, based on a Thai aromatic rice variety, and was released in the US by the USDA and Texas A&M University in 1989 (Marchetti et al, 1998; Hargrove, 1997). A small quantity entered Ghana through unknown channels and began to be grown and multiplied by farmers, before eventually being officially released in 2009. There has also been considerable effort in promoting a set of new NERICA rice varieties developed by the Africa Rice Center, but the current evidence indicates they have not achieved widespread adoption (Glenna et al, 2012; Asuming-Brempong et al, 2011).

There is little data available on the utilization of MVs of most other crops in Ghana. Several cowpea varieties have been released since the 1980s and have been adopted as cash crops; they are earlier maturing and more upright than the spreading local varieties and their determinate growth habit usually requires chemical insect control. One study found them to be widely adopted in villages in the transition zone of Brong-Ahafo but hardly grown in villages in the Volta Region where cowpea is important as a subsistence crop (Tripp et al, 1998). A study in Northern and Upper West Regions found 16 percent of cowpea area sown to MVs (Abatania et al, n.d.). Soybean production has only recently received support, and the area remains well under 100,000 ha. The varieties in use are MVs, although local investment in soybean breeding has so far been modest. There is no evidence of any significant adoption of recently released groundnut MVs, and it appears that most farmers rely on old varieties. There is some use of a sorghum MV for sale to breweries, but most sorghum farmers still use local varieties (e.g. Amanor, 2011).

In summary, although farmers are growing MVs of some crops, there are few examples where varieties released in the past decade have entered the commercial seed system or have been taken up by large numbers of farmers. Whether the problem lies with the varieties themselves or the lack of promotion is an open question, but at this point it is not obvious that there is a wide selection of MVs that could immediately contribute to an expanding seed system.

4.2. Seed Demand

The previous discussion focused on the importance of a stream of new varieties to motivate commercial seed development. With the important exception of maize (and perhaps sorghum), we are talking about non-hybrid varieties whose seed can be saved from one season to the next. The widespread (and rational) practice of seed saving means that commercial seed sale for these crops will be a fraction of total seed use. This is not necessarily a barrier to seed industry development, as long as there is a relatively constant annual demand from farmers who wish to change varieties or to occasionally renew their seed for the same variety. In the US in the 1960s (before the advent of intellectual property protection and biotechnology) only a minority of seed for crops such as wheat and soybeans was from commercial sources, but the demand was sufficient to support many, mostly small, seed companies.

In the US example, most of the crop production was being sold into relatively efficient output markets. Farmers, of course, may buy seed for crops that meet their own subsistence needs, but in Ghana any significant growth in the commercial seed sector will more likely be driven by crop marketing opportunities. The importance of output markets in determining commercial seed use is illustrated by the fact that most of the current instances of importing commercial seed in Ghana depend upon well-functioning commodity markets. The agribusiness firm Wienco manages a contract grower scheme in northern Ghana where imported hybrid seed for yellow maize is provided to farmers and the produce is purchased and sold in the feed market, where it is possible to arrange straightforward marketing contracts. Several agribusiness firms are considering contract grower schemes for hybrid sorghum (domestic or imported) that would be sold to the breweries. Two large commercial rice schemes produce the same variety (Jasmine 85) grown by many small-scale producers, but they get a much better price for their output by paying particular attention to grain quality (including managing their own seed production, sometimes based on imported foundation seed) and packaging the output for middle class consumers. The likelihood that farmers will be frequent consumers of commercial seed products depends to a considerable extent on the nature and diversity of output markets and the ability of those markets to provide incentives to farmers to invest in production inputs.

Maize is the most likely candidate to lead commercial seed system development in Ghana. It is instructive to compare Ghana's maize seed situation with that of countries in eastern and southern Africa. The use of commercial maize seed in many of those countries is much higher than in Ghana (Table 3). One explanation is the greater importance of maize in those countries, where it is the principal dietary staple. This makes the crop a political priority and governments exert considerable pressure to ensure adequate maize production. While maize is an important staple in Ghana, it is not equated with food security, and roots and tubers provide half the calories. Not only do many eastern and southern African countries have a better developed maize seed system, but hybrid use is important and increasing. The three countries where hybrids are particularly important (Kenya, Zambia and Zimbabwe) all have long histories of large-scale commercial maize production in productive mid-altitude or highland environments. Hybrid use is increasing in a number of other countries in the region, but not as yet on the same scale.

Table 3. A comparison of African countries' maize production, dietary dependence and seed sale, 2006.

Country	Maize area (ha)[1]	Maize yield (MT/ha)[1]	Maize as % of total calories[2]	Maize seed sale as % maize area[3]	Hybrids as % of maize seed sale[3]
Zambia	750,000	1.90	50	73	93
Zimbabwe	1,713,000	0.87	43	80	92
Malawi	1,762,840	1.48	52	22	32
Kenya	1,888,190	1.72	34	72	94
Tanzania	2,570,150	1.33	24	18	65
Uganda	819,000	1.54	9	35	39
Ghana	793,000	1.50	7	6[4]	2[4]

1 FAOSTAT

2 FAO Food Balance Sheets

3 Langyintuo et al, 2008, estimated seed sales 2006/07

4 Calculated from PPRSD seed certification data (2006), assuming 60% seed sale.

Thus, the examples from eastern and southern Africa do not necessarily predict the future for Ghana's seed sector. But there are several types of evidence that may provide a more positive outlook. Perhaps the most relevant country for com-

parison in Table 3 is Uganda, where maize has a position in staple crop diversity similar to that of Ghana and maize area and yields are also similar. Until recently, there was little commercial maize seed available in Uganda, but in the past decade, several local seed companies have emerged (see section 4.3). Uganda is also similar to Ghana because maize is grown more for income generation than for subsistence (Chemonics 2010). This contrasts with many of the other maize-dependent countries, where a remarkably small proportion of farmers are maize sellers. Surveys showed that only 24 and 30 percent of farmers in Zambia and Kenya, respectively, were net sellers of maize (Jayne et al, 2006). In Ghana, on the other hand, maize is widely seen as a source of cash. Morris et al (1999) found that about half of Ghanaian maize growers in a national survey listed maize as their primary source of income. An earlier survey found that farmers in several major maize-producing areas of the Transition Zone and northern Ghana sold over 70 percent of their harvest (GGDP, 1991). The fact that maize is an important cash crop in Ghana makes it more likely that farmers would be interested in purchased maize seed, as long as they could see reasonable commercial returns on the investment.

However, the provision of more productive seed should be matched by expanding and efficient output markets. A technology such as hybrid maize may allow productivity increases, and farmers could take advantage of these by expanding maize production or by saving land and labor for other enterprises. However, any significant production increases, without expanded demand, could lower output price to the point that farmers would not find the technology worthwhile (Howard et al, 2003). Any increase in maize demand for direct human consumption beyond that linked to population growth seems unlikely; as incomes rise consumers are shifting to other cereals such as rice and wheat. It is estimated that over 40 percent of marketed maize currently goes for poultry feed. This quantity could increase, especially if more effort is put on import substitution of yellow maize for layers in the poultry sector and if Ghana can develop an efficient broiler industry (Gage et al, 2012). Other industrial uses for maize are also possible. However, markets for maize in Ghana are characterized by several levels of intermediaries and attendant inefficiencies, contributing to often low farm-gate prices (Chamberlain et al 2007). Improvements in market efficiency to pass a higher proportion of the final price to the producer and additional uses for maize would certainly make commercial maize seed more attractive.

Although it is likely that maize will be the leading commercial seed crop, it is important to look for other opportunities that can help diversify the seed industry and deliver more productive technologies to farmers. The demand for high quality rice is growing in Ghana, with most of this currently being met by imports. There has been a significant shift towards several aromatic rice varieties among growers in Ghana, but whether smallholders can take advantage of these and earn higher returns (as several large-scale irrigation schemes in the South have been able to do), depends in part on improvements in milling and marketing. Similarly, the ability of rice growers in northern Ghana to expand their markets further south will depend on improvements in crop management (especially timely harvesting), milling, and transportation links (Gage et al, 2012). On-farm seed saving for rice is relatively straightforward and efficient, but where markets demand a cleaner, purer product, and where seed production capacity is already in place, there is evidence of growing use of commercial rice seed (e.g. Tripp and Pal, 2001). But it is also worth pointing out that growing higher value cultivars to meet urban tastes does not automatically result in higher farm incomes (e.g. Minten et al, 2013).

Among the other field crops:

- Soybean is another possibility. Most of the output is marketed. It is more difficult to maintain the viability of stored soybean seed in the tropics than for many other crops, hence there could be a reasonable demand for good quality commercial seed. The majority of soybean is used for the poultry industry, and increased production could substitute for the significant imports of soybean cake. Some contract farming schemes for soybean have been attempted in northern Ghana that provide more efficient links between farmers and mills (Tahidu, 2012), but the processing sector is currently weak and requires significant upgrading before soybean production can be expected to experience any significant growth (Gage et al, 2012).
- Cowpea might be another possibility, as there are clear consumer preferences for particular grain colors and types. However, the current market seems to give little emphasis to grain quality. Ghana's annual commercial cowpea seed production is only sufficient for about one percent of the crop area.
- Groundnut is exceptionally unattractive as a commercial seed crop anywhere in the world because of its high planting rates and difficult seed processing.

- In contrast, sorghum and millet are not likely commercial seed crops because their low planting rates imply a very small potential volume of demand. This would change if farmers turned to hybrids, as they have in India (Pray et al, 1991). But hybrid sorghums and millets have had a poor track record among West African growers, who have specific grain and stover requirements. These have so far been unmet by hybrid varieties, although this may change with further advances in plant breeding. On the other hand, sorghum is increasingly in demand as an input for commercial breweries and there are various explorations of appropriate hybrids for this market.

In summary, the nature of Ghana's grain markets will play an important role in providing incentives for commercial seed use. Hybrid maize is by far the most likely candidate to lead to a stronger commercial seed sector in Ghana. But in addition to identifying the best hybrids and adequate crop management options, the seed sector would receive a significant boost from improved maize output market efficiency and expansion. Even an increase in demand for OPV maize seed would be more likely with better maize market incentives. Once commercial maize seed production, processing, and marketing capacity is established, it should be possible to expand to other crops, but there are relatively few current candidates. One of the few other hybrid possibilities is sorghum, but that depends on matching hybrid qualities and productivity to farmer and market needs. For other, non-hybrid, crops, the demand for commercial seed will be a function of the rate of delivery of new, superior varieties and the demands of the market for high quality or differentiated produce. Rice varieties aimed at replacing some of the imported rice in the market and soybean to replace imported meal would be two possible candidates. Other options, such as cowpea, would require the seed industry to offer a superior product to farmers who are selling into a market that demands good quality.

4.3. Seed Industry Structure

This paper is concerned with the evolution of a commercial seed sector, but such evolution is not necessarily straightforward or easy to predict. Until very recently, virtually all of Ghana's commercial seed came from small-scale producers, often growing only a few hectares, who sold it on to input dealers, in a system developed by SG2000 (Lyon and Afikorah-Danquah, 1998). The system concentrated on OPV maize and, to a lesser extent, rice and cowpea, but has since expanded to a few other crops (soybean, sorghum, and groundnut). It is not difficult to understand what attracted farmers to become seed growers, particularly in the early years of the scheme. Assistance was often available from SG2000 and there was demand for seed in the extension demonstration programs. Growers can sometimes arrange pre-financing with an input dealer. OPV maize seed production management is not onerous and the price for seed is considerably higher than the farmer could expect for grain; even if not all is sold as seed, the remainder can at least be sold in the grain market at little or no loss. Some of the small-scale producers operate independently, while some manage input acquisition and marketing as a group. The system continues to operate in the face of what appears to be low but fairly constant over-the-counter demand. Various government and donor projects are important but variable sources of additional demand for seed. The small-scale producers are not risk takers and are content to produce whatever varieties have had a good sales record.

We might call this the 'unconventional private sector'. In the past few years, more conventional seed companies have begun to appear. These have been established by entrepreneurs from various backgrounds (agribusiness, input trading, contract seed production, agricultural research) in a pattern similar to seed business development in many other countries (Tripp, 2001). These firms would seem to have significant efficiency advantages, particularly in acquiring source seed, arranging for certification and conditioning, and marketing the seed. One might predict that the small-scale producers would gradually fade away, many of them absorbed into the new structure as contract seed growers.

The extent to which this conversion of the unconventional to the conventional actually takes place and the nature of the resulting private seed sector depend on several factors. These include access to seed production resources, the nature of the division between public and private sectors, the organization of foundation seed, the conduct of donor assistance, and the possibility of foreign competition.

There are two principal resource issues to consider regarding seed sector development: land and seed conditioning equipment. Although commercial seed production in most countries is done largely on the fields of contract growers, if seed demand is low and a company has its own land, it may not need to look for growers. This is the situation with at least a few of the new seed companies, which dampens immediate demand for contract growers who might otherwise be found among the small-scale seed producers. In addition, most of the new companies still depend on the same ancient seed conditioning equipment used by the small-scale producers. This machinery has been inherited by government agencies (principally GLDB) from GSC (or in one case by SEEDPAG from a former IFAD project). Some companies hope to acquire their own

conditioning equipment, or other people can acquire such facilities and rent them out. The type and distribution of seed conditioning equipment in the near future will help determine the relative efficiency of small-scale versus conventional commercial seed production.

We must acknowledge that talk of 'the private sector' is a bit misleading, at least in the sense of something completely separated from public sector interests and activities. If we examine the current system, we find many instances where the line between public and private is difficult to trace. For instance, there are a number of public agricultural employees who produce or market seed, and many of these have an inside track to resources and contacts. In addition, some seed producers (both small-scale and companies) have connections that allow them to take better advantage of government or donor programs that buy seed for their activities. Access to source seed from public institutes has also often been expedited by friendship or past connections. Whether these types of linkages are viewed as creative facilitation or unwarranted cronyism, they are some distance from the private sector usually envisioned in policy documents. The way these relations adjust and evolve in the coming years will help determine the structure of Ghana's domestic seed industry. An additional concern is the possibility that a shift of attention away from public sector management may lead to jealousies and impediments. Despite general government support for privatization, public researchers, regulators, and others may protect their turf and be resentful of private entrepreneurial activity that is seen to generate significant profits within a domain formerly within public sector control.

Another unknown in assessing the future of Ghana's seed industry is the production of foundation seed. In a system that depends largely on public plant breeding and private seed production, foundation seed represents the hand-off from the public to the private side. It is not only a key stage in the seed chain but decisions about who takes responsibility for its production can make a significant difference to the structure of the industry. Because of the relatively small quantities of foundation seed that are required and the exceptional care needed in its production, it does not offer any significant profit-making opportunities. The new law allows anyone to produce foundation seed, and there are several possibilities. NARIs could produce foundation seed, but producing large quantities of seed is not within their mandate nor is it a good use of their resources. At the other extreme, companies can use breeder seed they acquire from NARIs, and produce the foundation seed they require. This is the strategy that is being tested by some of the companies for maize hybrids, and, in the case of a high value product such as this, it is quite possible that the companies will be willing to adopt this approach. For lower value (non-hybrid) seed, however, it is an open question as to whether the companies will be willing to invest time and resources in producing a product they do not sell but rather use as an input the following year. In India, the public research system provides breeder seed of crops such as rice and wheat to private (and public) seed companies, and they take responsibility for producing their own foundation seed. Another possibility is an intermediate, not-for-profit organization that produces foundation seed and provides it to the commercial seed producers. In the US and Canada, for instance, intermediary organizations produce and distribute (at cost recovery) foundation seed of crops like wheat or field peas, which the small seed companies do not want to produce (Tripp, 2006).

The idea of an intermediary sounds like the current situation with GLDB, but this is not the case. Almost everyone in the seed sector has been dissatisfied with the performance of GLDB in producing and delivering foundation seed. An efficient intermediary for foundation seed requires shared governance from the seed industry, the public breeding organizations, and the regulatory bodies. The inexperience of Ghana's current seed industry and questions about the incentives of public research and regulation make such an intermediary unlikely at the present time. Reliance on government entities (whether GLDB or the NARIs) to produce foundation seed raises important concerns about efficiency, responsiveness and quality. Thus, who will take responsibility for foundation seed in Ghana remains an open question, with the danger that it may become a missing link in the seed production chain – a key step that no one wishes to perform. This could limit access to seed, particularly of crops or varieties that are less commercially attractive.

Another factor that will help determine the course of private sector seed development in Ghana is the conduct of donor support. There are significant requirements for capacity building in the seed sector that donors can help address. The scale of current donor interest in developing the private seed sector is growing rapidly and may mean that potential entrepreneurs will be able to take advantage of various programs, loans and grants without necessarily facing the immediate realities of the seed market. Some rationalization and coordination of future donor seed efforts may be called for.

Competition from imported seed products (hybrid maize and a few others) may also affect domestic seed industry development. This will largely depend on the types of varieties that foreign companies bring to Ghana. Earlier we discussed the importance of ensuring that local seed companies can offer varieties with superior performance. It should be possible for

domestic (public or private) plant breeding to develop varieties that are more appropriate for Ghana's production environments than those offered by foreign companies or MNCs, unless the latter target their own breeding programs more precisely at Ghana. That kind of investment would require clear evidence of demand and a substantial market, which does not currently exist. Nevertheless, we have little information on the relative performance of Ghana's current small number of maize hybrids versus that of hybrids from some of the major MNCs with long experience in maize for the tropics.

One advantage of some of the MNCs is their experience in seed production, quality control, packaging and marketing. If there were only modest differences between domestic and imported hybrids in terms of yield performance, the presentation and delivery of the imported varieties could tip the balance. This emphasizes the importance of ensuring that domestic companies develop excellent seed production and distribution practices. It must be said that there does not appear to be much concentrated attention from the MNCs on Ghana's hybrid maize seed market, but if local hybrids started to catch on, this might change.

The idea of supporting small and medium domestic seed companies is an attractive one. There are not large economies of scale in conventional seed production and the world is full of examples of viable small seed enterprises, even in the age of Monsanto. In much of sub-Saharan Africa, the strategy of starting the process with emphasis on hybrid maize makes sense, but there are a limited number of examples to date that allow an examination of the viability of small enterprises in the face of large-scale competitors. In countries that have a long history of hybrid maize and where a single public seed enterprise has been dominant (e.g. Kenya) or where the former public seed company has been privatized (e.g. Zambia, Malawi), it appears that the large firms so far maintain the major market share (Smale and Olwande, 2011; Hamukwala et al, 2010; Chinsinga, 2011). In Uganda, on the other hand, where maize's area, relative contribution to the diet, and role as a cash crop are roughly similar to those of Ghana, and where no large seed firm existed previously, hybrid seed is becoming increasingly common. Over 2,000 MT of hybrid maize seed was marketed as early as 2006/07 (Langyintuo et al, 2008) and several local seed companies producing public maize hybrids have the majority of that market, despite competition from MNCs (G. Bigirwa, pers. comm.).

An additional note on seed industry development is in order. The preceding discussion has outlined a difficult but hopefully positive trajectory for the emergence of a viable commercial seed sector in Ghana. Even in the best of cases, it will be many years before a wide portfolio of commercial seed crops is on the market. In the meantime, there will be a continuing need to ensure that seed of new varieties of a range of crops, including those of less interest to the commercial seed industry, is available to farmers. Ensuring such availability will require additional strategies, including programs for local seed multiplication or efforts to distribute or perhaps subsidize seed of particular varieties of so-called 'orphan crops' (see section 5.6 for further discussion of subsidies). However, to the extent that these involve donor- or government-funded efforts, it is important that they explore possibilities of going through the nascent commercial seed companies rather than the common practice of establishing ad hoc project seed production schemes that lack either financial viability or disciplined management. Public resources would often be better used in contracting local commercial seed companies for this purpose.

5. POLICY DECISION POINTS

Regardless of the direction of seed system development determined by the agronomic and economic considerations discussed above, there are several important issues that policymakers need to address if Ghana's commercial seed sector is to progress. Three of these are related to the implementation and enforcement of regulations (for variety release, seed certification, and consumer protection) and come under the responsibility of the National Seed Council. Other issues concern the management of CSIR's agricultural research institutes (breeder seed supply and information provision), and a final issue is seed price.

5.1. Variety Release

The new seed law establishes both a Technical and Variety Release Committee (TVRC) and a National Variety Release and Registration Committee (NVRRC); there is considerable overlap in membership and duties of the two bodies. Such committees are standard features in most countries, but the real challenges involve the organization of variety testing, the financing of such testing, and the criteria that are used for approval. In many countries, what appear to be straightforward procedures turn into unclear and drawn-out processes that seriously delay the seed production of new varieties (Tripp and Louwaars, 1997).

The draft regulations specify that the NVRRC is the authority that oversees crop variety release. The breeder of a variety must provide sufficient seed to the NVRRC and it will arrange for field-testing and inspection. The nature of the testing is not specified in the draft regulations, which only indicate that the seed samples will be given to a 'competent independent body for testing'. Until recently, the only varieties considered for release were the products of the NARIs, who took responsibility for carrying out their own multi-location tests and on-farm trials. The release committee visited trial sites and reviewed the data. With the possibility of domestic and foreign (private and public) varieties seeking release, these procedures need to be reviewed. It is not clear what 'independent body' will be used to manage performance trials for new varieties.

The few recent examples of testing foreign varieties seem to have been ad-hoc in their organization and funding. It appears that a donor-funded NGO paid CRI to begin testing several of the imported maize hybrids; the foreign seed companies themselves paid for further tests, and the results have been discussed by the variety release committee that was in force before the new law (given that the new regulations have not been finalized). Such unclear procedures are not satisfactory. Their needs to be a single, clearly marked doorway through which all applications (domestic and foreign) pass, and the entity in charge of trial management needs to be clearly designated and acceptable to all parties. Such variety testing requires funds for trial establishment and management and there needs to be a clear understanding of what the charges are for this testing. It is likely that large, foreign seed companies will be willing to pay such charges, as will many donor-funded plant breeding projects, but a funding mechanism needs to be identified that does not restrict the testing of varieties only to those that have wealthy sponsors.

It is not clear what standards will be used to allow new varieties to be registered. This has often been a thorny issue in seed regulation (Tripp and Louwaars, 1997). Performance is sometimes compared to a 'check variety', but there are questions about how such checks are chosen. Of equal importance are the conditions under which the trials are performed. Ghana's current variety testing protocols require data from both multi-location trials (with management levels at those of an experiment station) and on-farm trials (with more representative, but unspecified, management), but the draft regulations provide no specific guidance on types of trial. These trials often give results that are not perfectly straightforward and require interpretation and judgment. The draft regulations only indicate that for a variety to be approved it must be 'superior in performance…in one or more characteristics important for that type of crop…'. It is important that the variety release process provides as wide a range of choice for farmers as possible. The National Seed Council needs to ensure that the variety release authority is not a complacent gatekeeper but is dedicated, instead, to bringing the best varieties to farmers.

The issue of foreign varieties is particularly important. Several public officials have expressed the opinion that varieties such as private (foreign) maize hybrids should only be approved if their seed is produced in Ghana. This would make such seed much more expensive and would preclude the possibility of bringing almost any imported hybrid variety to market. The location of seed production should not be an element in regulatory decisions about variety release. If a foreign company found that there was sufficient demand for its seed in Ghana, then it might well consider investing in the facilities that would allow in-country production. However, that will not happen until Ghanaian farmers are able to first grow these varieties and make up their own minds.

An ECOWAS initiative for regional seed regulatory harmonization includes a regional variety catalogue that would include all varieties released in member states. Such catalogues are often used in regional harmonization initiatives to ensure that a variety released in one member state does not have to be fully tested in another in order to be approved for seed production. However, the ECOWAS regulation provides no specific guidance. With or without such guidance, it makes sense for Ghana's variety release process to take account of evidence from neighboring countries and to facilitate the testing process for varieties in the regional catalogue.

Another issue related to variety release is plant variety protection (PVP) legislation. Ghana will soon have a PVP law (to comply with WTO requirements for intellectual property protection of plant varieties). It is not clear who will be in charge of the testing for PVP certificates (which involves recording the botanical descriptors for a new variety and is distinct from the performance testing under the NVRRC), who will pay for that process, or what impact it might have on the management of relations between the NARIs and the seed companies.

This paper is not the place to explore the precise rules and organization appropriate for variety release in Ghana. As discussed above there are a number of important and difficult decisions to be taken about test procedures, organization, and standards. At this point, the most important priority is to recognize that the draft regulations leave a great deal undefined. It is imperative that a clear set of procedures must be established (drawing in part on experiences in other countries); that these

procedures must be administered in an absolutely transparent manner and in a way that supports farmers' access to the widest possible range of appropriate varieties; and that the costs and funding of the procedures must be clearly understood and managed.

5.2. Seed Quality Control and Certification

The GSID is the body responsible for seed certification. It was given a prominent place in the SG2000 program that established the small-scale seed producer system, not only providing inspection services but also playing a role in producer training and the provision of the standard packaging materials in which all seed is sold. GSID has continued in its seed inspection role, and the new seed law decrees that all field crop seed offered for sale must be certified. This obliges government inspectors to visit each seed production field several times during the cropping season, to be present when the seed bags are filled and sealed, and to draw samples for testing.

There is apparently a significant gap between the resources available to GSID and the actual cost of performing the duties required by the past or new regulations. Dispatching trained field inspectors from regional offices to make multiple inspections of dispersed seed production fields and arranging for the laboratory testing of seed samples requires more resources than are available to GSID. No one is able to offer an estimate of what the process actually costs, but almost all of the activities are paid from the budget allocated to GSID from MOFA. Until now the process has been offered almost free of charge, although there is a small charge for the testing of seed samples. GSID inspectors may try to requisition transport from the local extension office, but in practice seed producers often need to provide transport to the inspectors to visit fields (which obviously compromises the independence of the inspection service). Reports from both the regulators and the seed producers indicate that it is not always possible to complete all the duties required by the regulations. An inadequate certification service can lead to what we might call Type I or Type II errors. In Type I, good seed is rejected either because of faulty inspection procedures or because lack of resources simply precludes inspection and approval is therefore denied; it would seem that this is not common in Ghana – even if all inspections have not been made, seed is allowed on the market. Type II errors, where sub-standard seed is accepted because of inadequate inspection, would seem to be more common. If an under-resourced certification service attempts to clamp down on Type II errors by insisting that all inspections 'go by the book', it may simply increase the Type I errors, rejecting perfectly good seed and frustrating the ambitions of legitimate and competent seed producers. A satisfactory answer can only be achieved by matching regulatory ambitions with regulatory resources, which probably means adjusting both sides of the equation.

On the resource side of the equation, PPRSD has put forward proposals to MOFA that establish modest charges for the certification services. But there is no certainty they will be approved and, in any case, they do not appear likely to bridge the resource gap. In addition to the recurrent costs of certification and quality control, GSID would need funding to upgrade transportation and laboratory facilities and probably to hire or train personnel. Someone needs to document the costs of supporting and maintaining a certification service (one that actually does all of the things listed in a set of regulations) and decide who pays for it. Does it remain fully funded by government; are nominal charges levied; or is it to be managed at full cost recovery by levying the requisite charges? The future structure of the seed industry will have some bearing on the costs of certification. For instance, an increasing number of small-scale seed producers would add to travel costs for inspectors, while seed companies with their own (larger) fields or clustered contract growers will lower the regulatory costs per hectare. Similarly, an increasing number of seed conditioning facilities may also imply increased costs because inspectors need to be present to draw samples. On the other hand, the new conditioning facilities to replace the antiquated equipment currently in use will surely improve seed quality, with or without inspection. Dispersed companies producing their own foundation seed could also increase total regulatory costs. An efficient certification system should not add more than a few percent to seed cost (Tripp and van der Berg, 1997). There is an urgent need to understand how such a service can be provided.

The resource challenges of establishing a competent and comprehensive certification service appear considerable. Hence, it is important to also consider the other side of the equation, regulatory ambitions. For the short term, the new law seems to lock Ghana into mandatory certification for all field crops, even as the country moves toward more conventional private sector activity where companies themselves have significant incentives to pay attention to quality control to defend their reputations and market share. The establishment of recognized seed brands can make an important contribution to seed quality management. The law contemplates the possibility of accrediting seed companies to do much of their own quality control. This would seem to be a situation that would develop well in the future, but it is certainly worth beginning to investigate how some responsibilities may be shared. Although new regulations are still in draft form, it is already worth

contemplating how they might be modified or interpreted to put more responsibility on the private seed sector and to identify the areas that deserve priority attention from a certification agency.

Three of these priorities are the certification of foundation seed, hybrid seed production, and consumer protection. It is obviously crucial that foundation seed be of the highest standard – this is a major determinant of commercial seed quality, and there have been complaints in the past of the quality of foundation seed from GLDB. It appears that foundation seed production will now be more dispersed and, thus, will require even more attention. In addition, if hybrid maize becomes a major seed product, its foundation seed production will require close scrutiny. In any case, the production of commercial hybrid seed is much more demanding than that of non-hybrid seed and so deserves more regulatory oversight. But in both cases, regulatory authorities need to take advantage of the fact that commercial firms have strong incentives to pay attention to their own quality control. The third priority, consumer protection, is discussed in the next section (5.3).

An additional issue regarding the management of seed certification and quality control is an ECOWAS regulatory harmonization effort that attempts to standardize seed certification throughout the region. The ECOWAS regulation (2008) makes no mention of how countries are expected to pay for the enforcement of the rules it describes. It would appear highly unlikely that any type of ECOWAS authority in regional seed marketing would take shape in the near future, so addressing such conflicts is not a high priority. The purpose of the ECOWAS regulation is to encourage regional seed trade, although such apparently arbitrary standardization may be counterproductive. It is important to recognize that Ghana can establish useful seed trade relations with other countries in the region (or beyond) without waiting for a full-blown ECOWAS authority to take shape.

As in the case of variety release, seed quality control and certification procedures in Ghana require much more attention than implied in the draft regulations. Perhaps most important is the large resource gap between regulatory requirements and available funding. The size of that gap and measures to deal with it deserve immediate attention; otherwise, seed certification will merely be 'on paper'. In many countries, seed certification and quality control duties are increasingly shared between state regulators and the private seed sector. As private seed enterprise develops in Ghana, there will be increasing opportunities for such a division of responsibilities, but that depends on the direction and composition of Ghana's seed sector. At this point, in the face of a considerable resource gap and evolving seed enterprises, it is imperative that priorities for seed certification and the means of funding them be clearly identified.

5.3. Consumer Protection and Education

In most developing countries, instances of poor quality or fraudulent commercial seed are much less likely to be caused by legitimate seed producers and more likely to come from activities that take place beyond their gates. That is, although the errors or shoddiness of seed enterprises may sometimes lead to poor quality seed, the majority of these problems are usually the result of either bad seed management by transporters or seed dealers, or deliberate fraud where, for instance, grain is used to fill bags labeled as seed. Nevertheless, the vast majority of seed regulatory resources in developing countries are spent monitoring commercial seed production rather than carrying out point-of-sale inspections.

Despite the very modest level of Ghana's current seed industry (and the low prices of its products), there are enough reports of 'fake seed' to conclude that there is some fraudulent activity, mostly the sale of market grain as seed. The standard plastic seed bags that have been provided (indeed mandated) by GSID are easy enough to imitate, and reports say that a number of people, including some 'insiders', have profited from selling grain as packaged seed. At current volumes and prices, this may not be enough to worry about, but as Ghana moves to higher value seed products, the threat becomes more substantial. Unchecked activity could make farmers reluctant to buy more expensive new seed.

The new law provides penalties for fraud, which were previously insubstantial. But how do you identify the culprits? There are currently very few regulatory resources devoted to point-of-sale inspection. This needs to change. Massive sampling and testing exercises are out of the question, but there seems to be general knowledge about the type and location of merchants who are likely to offer fraudulent seed (e.g. the Kejetia market in Kumasi is almost universally cited) and some focused enforcement activities could go a long way to eliminate the major offenders. On the other side, farmers need to be more aware of the problem and its remedies. There have been examples of complaints lodged by farmers, sometime with GSID and sometimes with district MOFA offices, but there needs to be a clear-cut complaints procedure. The extension service could also develop consumer education activities to support a growing seed market. Farmers need to be familiar with various seed products and companies, to know to only buy from recognized input dealers, and to be familiar with procedures for reporting cases where there is suspicion of fraudulent or poor quality seed.

5.4. Breeder Seed

As long as Ghana's seed industry depends on public crop varieties, the assurance of adequate quantities of good quality breeder seed is a crucial requirement. Until now, breeder seed production by the NARIs has been hit or miss. Inadequate management and financing of breeder seed production by public agencies in sub-Saharan Africa is a perennial problem (Tripp and Rohrbach, 2001). In Ghana, breeder seed may be available from the NARI for a few of the major varieties, but for many crops and varieties, breeder seed production is a function of donor project support. When breeder seed is produced, the previous arrangement was to sell it (at low cost) to GLDB, when requested, as well as to occasionally provide it to various other individuals and entities without any clear policy for allocation. Breeder seed production requires significant resources; it must be supervised by trained plant breeders; the yields are generally low because of rigorous selection of acceptable plants ('roguing'); and the seed must be stored under carefully controlled conditions. Excess production is wasteful, but insufficient supply effectively shuts down the seed production chain.

Presently there is no system of setting deadlines for requests for breeder seed or requiring a deposit. Requests for breeder seed are currently addressed to the NARI director, but these are then passed on to individual breeding programs which may or may not have the resources or interest to act upon them. The NARIs need to establish an absolutely transparent system where foundation seed producers make advance requests for breeder seed. The arrangement should be contractual and the NARI should have a designated manager of this activity, across crops. The seed should be sold at cost recovery or alternative arrangements should be in place to cover the costs where it is deemed to be in the public interest. To do this, someone needs to establish the actual costs of breeder seed production. Any thought of making a profit on breeder seed (or charging royalties for varieties) in order to help meet CSIR goals for income generation by NARIs must be suspended until a robust breeder seed delivery system is in place.

Foundation seed producers who do not take delivery of breeder seed should lose their deposits and/or their place in line the following year. NARIs that are unable to meet their obligations should be penalized. If most foundation seed is produced by seed enterprises that go on to use it for their own production, they will be able to gauge their needs and make the appropriate requests. To the extent that an intermediary such as GLDB continues to produce foundation seed (e.g. in support of the small-scale seed producers), they must ask that those producers provide estimates of their needs in advance, probably through SEEDPAG.

Considering that breeder seed is the first, crucial step in delivering the products of public agricultural research, there is no reason for CSIR to tolerate anything but excellent performance from its institutes on this issue. Performance to date has been inadequate in terms of both quantity and quality. AGRA is providing training to the staff of several seed companies on breeder seed maintenance for maize hybrids to prepare for the possibility that the NARIs simply will not be able to fulfill their responsibility.

5.5. Seed Promotion and Information

The average Ghanaian farmer knows very little about what varieties are potentially on offer in the formal seed system. Everyone seems to have an excuse for this situation. The NARIs say that promotion is not their mandate. The extension service says it has inadequate resources and often inadequate information from the NARIs. Seed producers or seed companies are wary of investing in the promotion of a product sold by their competitors. Input merchants are provided with little information on which to base any kind of promotion. The result is that large amounts of government and donor money invested in plant breeding are wasted, with very little uptake of new technology. The scenario is not uniformly dismal –there are instances where individual NARI breeding programs have taken the initiative to promote their varieties to farmers or seed producers. But the total investment in this type of activity is wholly inadequate.

Some changes can be expected. Certainly if imported seed products are brought to the market they will be supported with considerable promotion. The emerging domestic seed companies are trying to differentiate their products and some have aspirations of developing the plant breeding capacity to produce their own varieties.

As long as most seed is based on varieties from the NARIs, there is an urgent need to provide better information. The responsibility for doing so will logically fall mostly 'upstream', with research and extension. Just as CSIR must insist that a viable system for breeder seed is established in the NARIs, it must also insist that the NARIs take a more proactive stance in promoting their varieties. This needs to be complemented by a much clearer extension strategy, linked in part to the consumer education activities discussed above. Seed producers and input dealers will surely be willing to do their part, but

without a competent strategy from research and extension, the demand for seed will be limited. In addition, any hopes that farmers will move towards hybrid maize requires a concerted effort to educate farmers on the nature of hybrid seed and its management.

It is unrealistic to propose large-scale public research and extension field activities in variety promotion; the public budget simply does not allow for that sort of effort. Nevertheless, there are some basic things that should be done for any new variety. For instance, for each new variety the NARI should, at a minimum, provide basic documentary resources (text and perhaps appropriate diagrams or photos, available on-line and in hard-copy) describing the characteristics and management of the variety. Those who will promote the variety (extension service, projects, NGOs, seed producers, merchants) can use these resources to develop their own educational materials and activities (field days, posters, pamphlets, websites, etc.).

5.6. Seed Price and Subsidy

The price of seed in Ghana is low. Although there is no mandatory price, SEEDPAG has participated in setting a standard price for seed each year. In most cases, the seed price is barely twice the price of market grain, which is about as low as can be expected. Expressing the price of seed in relation to that of grain makes particular sense for non-hybrid seed, because an important part of the seed price is usually field production. The final seed price will take account of the 'grain' price (plus a premium to the seed producer), conditioning, storage, and transportation, as well as the markup from the seed dealer. In cases where these costs are low and seed production is straightforward and managed by a public entity at cost recovery, seed price may not exceed twice grain price. This is more or less what public seed companies in India (and their private competitors) get for seed of rice and wheat. Crops that are more difficult to produce as seed will have higher prices. There is now little public OPV maize seed in India, but in the 1990s it sold for an average of 3.4 times grain price (Singh et al, 1995).

Hybrid seed pricing is more difficult to calculate, partly because there may be two production stages (e.g. initially crossing two inbreds to obtain one of the parents for a three-way cross, the type of hybrid currently available in Ghana), and the seed yield from inbreds and hybrid production fields may be quite low. Nevertheless, a seed-to-grain price ratio is at least useful for gauging farmers' decisions on investment in seed. The little public hybrid maize currently on the market in Ghana sells for 4-5 times the grain price, which is quite low by international standards. Hybrids are planted on the majority of Kenya's maize fields and the seed price tends to be approximately 10-11 times grain price (Smale and Olwande, 2011). Surveys across many developing countries in the 1990s showed a range of maize seed prices, but the medium range for hybrids from public companies was equivalent to a 7.8:1 seed-to-grain price ratio, while the corresponding figure for hybrids from private firms was about 12:1 (Krull et al, 1998). Private companies will expect to earn a return on their investment. Private seed prices will also be higher if they include in-house plant breeding instead of relying on publicly funded research.

In spite of Ghana's low seed prices, the government has recently announced a subsidy on seed of maize (initially OPVs), rice, and soybean. The subsidy will reduce the price of maize and soybean seed by about 50 percent and rice seed by about 10 percent. If this is applied to the quantities of seed of these crops that have been produced (but not necessarily all sold) in recent years, the seed subsidy could cost the government more than US$1 million annually. The discussion in the earlier parts of this section describes activities that are more deserving of this money. However, most of those activities are 'behind the scenes' and do not provide visibility, while a subsidy allows MOFA and the government to point to something they are doing directly for farmers.

The problem is that it is not clear that the seed subsidy accomplishes anything useful for farmers, or for anyone else. The majority of it, at least initially, will be spent on lowering the price of OPV maize seed to close to grain price and the vast majority of this will be spent on the most common variety in the seed system, Obatanpa, which is 20 years old and already the most common single variety in Ghana's maize fields. Depending on grain price fluctuations over the year, it is conceivable that maize seed at planting time could be priced lower than maize grain in the market. Several countries in eastern and southern Africa have embarked on major efforts at seed subsidies, with mixed results (e.g. Mason and Ricker-Gilbert, 2012).

A seed subsidy requires more careful consideration. State governments in India sometimes offer a small subsidy on seed of newly released varieties, to encourage famers to switch. Where there is urgent need of seed (for instance, to promote a new variety that addresses a plant disease threat) this might be offered at a subsidized rate. Alternatively, one might imagine some kind of promotion program for hybrid maize where education about hybrids was combined with an introductory offer of lower-priced hybrid seed. But to spend scarce public resources on reducing the price of seed products

that are already cheap, are relatively well known to farmers, and are only in modest demand anyway, requires a second look.

6. CONCLUSIONS

One of the problems in considering any national seed policy is that the challenges tend to be overwhelmingly framed in terms of supply rather than demand. The policy decision points in Section 5, for instance, are mostly concerned with types of action that will facilitate the growth of a commercial seed sector and the delivery of its products. These interventions may be necessary, but they are far from sufficient to ensure that Ghana's agricultural sector becomes more productive. In the words of a comprehensive guide to seed industry development in Africa, 'seed alone is not the silver key that will unlock farmers' productivity or national economies...' (MacRobert, 2009: 19).

It is for this reason that Section 4 preceded the policy recommendations with an outline of some of the issues regarding the competence of public agricultural research, the business environment, and the strength of agricultural output markets, all of which help determine the demand that must be present to elicit commercial seed supply. It is important to understand that good seed supply is a means of improving agricultural productivity and is not an end in itself. Thus, any aspirations of increasing the use of certified seed or raising the seed replacement rate need to be backed by good evidence of productivity gains. The role of new varieties and better quality seed must be assessed along with all of the other factors of crop management that contribute to farm productivity. While it is important to examine the seed supply side, the demand side of the equation is crucial, and often overlooked. So Ghana's agricultural progress should not be measured by the rate of seed sale but rather by evidence of the use of better crop varieties, the production of more and better quality output, and increases in farming efficiency.

This paper has only considered the role of the commercial seed sector. Although there is general agreement that further privatization is the way forward to meet any increased seed demand, this path will require a fairly radical shift in behavior and attitude. The current 'privatized' system is characterized by complacency, comfortable relationships, and very modest output. The distinction between public and private players needs to be more obvious, and each side needs adequate incentives to perform its roles.

The new law and regulations move Ghana only a few small steps toward an adequate seed system. Some of the most urgent tasks are related to implementation and enforcement, and much of this responsibility apparently falls on the shoulders of the new National Seed Council. Establishing a transparent variety release system, deciding how to match seed certification aspirations with resources, and ensuring consumer education and protection are three of their most important tasks. The Council has a huge task in front of it.

As long as the seed system is based mostly on public varieties, CSIR should see that its agricultural research institutes experience a radical change in attitude and incentives. The actual uptake of varieties should be one of the primary measures for assessing an institute's performance. To achieve such uptake, the NARIs need to rethink their breeder seed production and to devote more attention to ensuring that adequate information about varieties is available for seed growers and farmers.

External donor support may provide needed capacities to meet some of these objectives, but the major responsibility is with national policymakers. Ghana needs to get out of depending on donor projects, lurching from one scheme to the next. While there are several efforts underway that seek to develop a sustainable commercial seed system, the highest priority contribution to viable seed enterprises will not be money but rather the establishment of a supportive enabling environment and the development of healthy agricultural markets.

Supporting the development of a national seed sector will involve some unpopular decisions that break established privileges and complacency, resisting easy answers such as seed subsidies, and providing adequate incentives to the public and private actors in the seed system. Whether Ghana's seed policy implementation is up to this challenge remains to be seen.

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