Research Journal of
Seed Science

ISSN 1819-3552

Academic
Journals Inc.

www.academicjournals.com

Research Journal of Seed Science 6 (2): 29-39, 2013
ISSN 1819-3552 / DOI: 10.3923/rjss.2013.29.39

Influence of Current Seed Programme of Ghana on Maize (*Zea mays*) Seed Security

I. Sugri, R.A.L. Kanton, F. Kusi, S.K. Nutsugah, S.S.J. Buah and M. Zakaria
CSIR-Savanna Agricultural Research Institute, Manga Agriculture Station, P.O. Box 46, Bawku, UER, Ghana

Corresponding Author: I. Sugri, CSIR-Savanna Agricultural Research Institute, Manga Agriculture Station, P.O. Box 46, Bawku, UER, Ghana Tel: +233 243 850292

ABSTRACT

Though several maize (*Zea mays*) varieties and hybrids have been developed over the last three decades in Ghana, farmers still face challenges of access to quality seed. This study examined the influence of current seed programme of maize and suggests interventions to ameliorate the constraints of farmers in relation to seed security. The research tools employed were a field survey, key informant interviews and seed quality analysis. A structured questionnaire was employed to capture information from 90 respondents consisting of farmers, agro-input dealers and seed growers from 6 districts in the Upper-East Region. Seed samples of 100-500 g were obtained from the respondents for some quality analysis. Overall access to seed was influenced by distance, price and information about the improved varieties. Majority of respondents (75%) utilized certified seed as initial planting, however up to 60, 33.3, 2.2 and 4.4% of actors recycled seed for 1-2, 3-5, 6-10 and 11-25 years, respectively. Average germination across sources of seed was 78.1-86.8%. Considering the minimum range (47-71%) improvements in seed processing and conditioning is still required. Most preferred traits were early maturing (48%), high yielding (25%) and drought escape (23.2%). Over 90% of respondents did not know the "release name" of the variety, nor the specific qualities they possessed. Achieving seed security will require adopting innovative seed multiplication and distribution approaches, such as the community seed concept in rural communities. The capacity of Ghana Seed Inspection Division should be strengthened to conduct field inspection and seed processing services at regional and district levels.

Key words: Maize varieties, seed access, distribution, seed policy, community seed

INTRODUCTION

Seed security (availability, access and quality) is essential to farmers' livelihoods and household food security in agricultural communities (MacRobert, 2009; Louwaars and de Boef, 2012). According to the Food and Agriculture Organization (FAO, 1998), farm families are seed secure when they have access to quality seed in adequate quantity at the time for planting. In general, increased yield and productivity as well as farmer's income are directly related to the availability and adoption of improved crop varieties (Wiredu *et al*., 2010; Buah *et al*., 2011). It is well documented that initial seed quality determines the success of crops in terms of yield and yield stability, product quality and subsequent contribution to food security as well as market potential (Buah *et al*., 2011; Sugri *et al*., 2011; Sathish *et al*., 2012; Louwaars and de Boef, 2012). Though Africa has witnessed a 4-5 fold increase in the number of Seed Companies marketing various types

of improved varieties in recent times, more than half of maize area (6.7 ha^{-1}) is still planted to traditional low yielding varieties (Langyintuo *et al*., 2008). According to MacRobert (2009), many of these are small seed companies producing a little around 500 t of seed per annum which satisfies the seed requirement of minority of farmers. However, wide variations exist in different parts of Africa in terms of access and utilization of certified seed. For instance, over 70% of growers in South Africa, Kenya, Zimbabwe and Zambia utilize certified seed for planting compared to less than 30% of growers in most parts of West-Africa (Langyintuo *et al*., 2008). In some instances, Donor Agencies and Non-Governmental Organizations (NGOs) purchase certified seed from Seed Companies and supply to farmers at subsidized price or as seed donation (MacRobert, 2009; ISSD, 2012).

Peculiar to most parts of Africa, national seed programmes of Ghana are still challenged by inefficient seed production, high cost, distribution and poor quality assurance systems (Lyon and Afikorah-Danquah, 1998; MacRobert, 2009; Louwaars and de Boef, 2012; Etwire *et al*., 2013). The general adoption rate for most crop varieties by farmers is below optimum (Wiredu *et al*., 2010; Buah *et al*., 2011; Asante *et al*., 2011). In an earlier study, Lyon and Afikorah-Danquah (1998), noticed that only 13% of maize farmers and 22% of cowpea farmers in Ghana obtained fresh seed of a variety they are already growing. They further reported that the average age of farmer's seed stocks was 3.7 and 2.9 years for maize and cowpea, respectively. Another study on the exposure and adoption of New Rice for Africa (NERICAs) among Ghanaian rice farmers showed only 6% adoption rate (Asuming-Brempong *et al*., 2011). Apparently, most smallholder farmers are ignorant of the potential benefits of improved seed and still recycle grain as seed (Buah *et al*., 2011). For instance, during the recent Emergency Rice Programme in Ghana from 2009 to 2011, the use of quality rice seed doubled the yield and income of participating farmers and led to about 33% increase in total household income (Buah *et al*., 2011). In another study, Wiredu *et al*., 2010 reported that yields of improved maize varieties were higher (0.92 t ha^{-1}) compared to local varieties (0.02 t ha^{-1}). Currently, less than 1% of the total area cropped to cowpea and sorghum were under certified seed production. Only 23 and 14% of total area cropped to rice and soybean, respectively were under certified seed production in Ghana (Etwire *et al*., 2013). A recent Bulletin of Tropical Legumes estimates that cowpea in particular has up to 25% seed demand shortfall in Ghana (TL II, 2012). Even when improved crop varieties exist, there appears to be low publicity about their availability in rural areas (Etwire *et al*., 2013).

Somehow, a critical review of current information reveals that seed sector development in many parts of Africa has attracted the attention of governments, donors and other civil society organizations (MacRobert, 2009; ISSD, 2012; Louwaars and de Boef, 2012). A rapid appraisal shows that the formal seed sector has achieved considerable success in the supply of maize and rice and other high-value legumes (cowpea, soybean and peanut) in Ghana (Wiredu *et al*., 2010; Buah *et al*., 2011; Etwire *et al*., 2013). However, myriads of small grains such as millet and sorghum and indigenous vegetables cultivated by smallholder farmers are quite neglected (Sugri *et al*., 2011). Maize variety development in Ghana albeit, was concentrated on open-pollinated varieties (OPVs) because of socio-economic reasons (Asiedu *et al*., 2001). It is now common knowledge that hybrid maize can be more productive than the OPVs. This has led to the development and release of some maize hybrids to farmers (Sallah *et al*., 1997; Asiedu *et al*., 2001). In general, the development of improved crop varieties should be supported by sustainable systems to make the seed available to farmers. This study assessed the influence of current seed programme of maize and suggests approaches to ameliorate the current constraints of farmers in relation to seed security.

MATERIALS AND METHODS

Description of study area: The Upper East Region (UER) of Ghana lies between longitude 1°15'W to 0°5'E and stretches from latitude 10°30'N to 11°8'N. The region lies in the Sudan Savanna agro-ecology which forms the semi-arid part of Ghana. It has alternating wet and dry seasons with the wet season occurring between May and October during which about 95% of rainfall occurs. Maximum rainfall occurs in August and severe dry conditions exist between November and April each year. During this period the northeasterly winds which stream from the Sahara desert bring masses of dust. There is wide fluctuation in relative humidity with as low values as 30% in dry season and above 75% in the wet season. Post-harvest storage of grain and seed is conducted during this dry period.

Scope of study: The study was carried out from June to September (2012), coinciding with the main cropping season of maize. The research tools employed were field survey, farm visits, key informant interviews and seed quality test. A structured questionnaire was used to capture information from 90 respondents, agro-input dealers and seed growers from 6 districts in the Upper East Region. The districts were: Bawku-East, Bawku-West, Talensi-Nabdam, Bongo, Kassena-East and Kassena-West. The questionnaire captured information on name of variety, source of seed and reasons for selecting a variety. The current constraints and areas requiring research and training were also identified. To improve upon the reliability of data, unannounced visits were made to farmer's field on days of planting. Seed samples of 100-500 g were obtained from respondents on the field for seed quality analysis. Twelve sachets of packaged seed, 4 random samples each from Tamale, Bolgatanga and Bawku urban markets, were obtained as standard check.

Seed quality test: All sources of seed (100-500 g) from respondents were subjected seed quality analysis such as grain moisture content (wb and db%), seed purity and 100 seed weight. Field germination test was conducted using 4 replicates of 100 seeds of 90 samples. The seeds were thinly drilled on 1 m rows on raised seed beds and germination counts were made on 5 and 8 days after nursing. The germination rate was expressed simply as a percentage of the number of normal seedlings that emerged to the total seeds cultured.

Data analysis: Descriptive statistics involving frequencies, pie charts, central tendency and flow charts were used in data analysis and reporting. A rapid appraisal of secondary information on current seed programmes was conducted at the Savanna Agriculture Research Institute (SARI) and the Ministry of Food and Agriculture (MoFA) to identify knowledge gaps for future interventions and research.

RESULTS

Seed systems of Ghana: Figure 1 illustrates a generalized structure and the role of actors along the chain of formal seed systems of Ghana. Currently, the Plants and Fertilizer Act (Act 803, 2010) of Ghana deals with seed production, import, export, sale, distribution and inspection in Ghana. Three Councils namely: The Plant Protection Advisory Council, the National Seed Council and the National Fertilizer Council, provide advisory services to government on plant protection, handling of seed and fertilizers and related matters for the purpose of safeguarding public health, agriculture and the environment. The National Seed Council formulates policies on the development, production, inspection, sampling, analysis, conditioning and marketing of seeds. The Ghana Seed Inspection Division (GSID) is responsible for seed certification and provides advisory services to

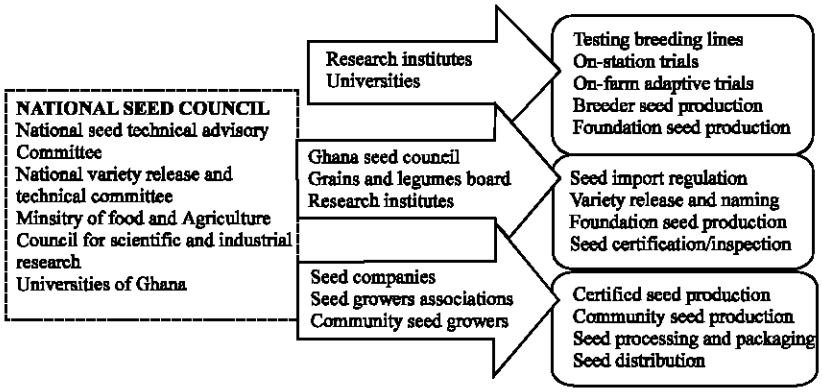

Fig. 1: A flow chart of the structure of formal seed system of Ghana

seed growers, seed dealers, seed importers and seed exporters. The GSID houses the National Seed Testing Laboratory (NSTL) which conducts seed sampling and laboratory seed quality analysis. The National Seed Service under the Ministry of Food and Agriculture (MoFA) and National Seed Technical Advisory Committee advise the government on seed issues. The Variety Release and Technical Committee is responsible for recommending varieties for release and cataloguing, whereas the Ghana Seed Inspection Division ensures that varieties produced are true to type through rigorous field inspection. The Research Institutes and Universities produce and maintain breeding lines and breeder seed. Foundation seed is produced by registered individuals, private seed growers, companies and cooperatives. The Seed Producers Association of Ghana (SEEDPAG) is responsible for the production, distribution and marketing of certified seed. Seed trade and distribution is conducted by agro-input traders who have sale outlets or agents mostly at urban and district capitals.

Crop improvement in maize: A rapid appraisal of information on current seed programmes in Ghana revealed that the Council for Scientific and Industrial Research (CSIR) and other development partners have developed and released several maize varieties and hybrids to farmers during the last 3 decades (Table 1). The varieties have specific qualities which are suited to different agro-ecologies of Ghana. Some of these qualities include high yielding, early maturing, drought tolerance, disease and pest resistance, *Striga* resistance and additional nutritional qualities (Table 1). However, functional national seed programmes (Fig. 1) to ensure adequate supply of quality seeds to farmers are constrained by myriad of challenges. It appears that the capacity of seed companies and seed growers to produce adequate certified seed of these varieties is limited.

The development, release and adoption of improved varieties require complex interrelationships and linkages from research, policy and agriculture extension to farmers (Fig. 2). The objectives of any crop improvement programme will vary; they directly relate to the agro-ecology, environment, food quality and socio-economic needs of the target beneficiaries. The breeder may have a couple of objectives to achieve, however the target farmers usually have an array of expectations (Fig. 2). Several policy, legislations and institutional networks are integrated into the chain to ensure the delivery of quality materials to end-users. These linkages sort to regulate, supervise and monitor the operational efficiencies of each actor along the seed value chain. However, weak institutional linkages and capacities turn to adversely influence the performance of functional seed systems in most parts of Africa.

Table 1: Characteristics of some maize varieties and hybrids developed over the last few decades of research in Ghana

Release varieties	Year of release	Seed coat colour and texture	Maturity period (Days)	Yield potential (ton ha^{-1})	Special quality attributes
Golden crystal	1972	Yellow, Flint/dent	110	5.0	OPV
Safita 2	1984	White, dent	95		OPV, EM
Kawanzie	1984	Yellow, flint	95	4.0	OPV, EM
Dobidi	1984	White, dent	120		OPV
Laposta					OPV
Aburotia	1984	White, dent	105		OPV, Intermediate
Okomasa	1988	White, dent	115-120	6.0	OPV, SR, Pop 43-SR
Abeleehi	1990	White, dent	105	5.0	OPV, Pop 49-SR
Obaatanpa	1992	White, dent	110	5.5	OPV, QPM, Pop 63-SR
Dorke	1992	White, dent	90-95	5.0	OPV, Pop 16-SR
Mamaba	1997	White, flint	110	7.5	3-way hybrid, QPM
Dadaba	1997	White, flint/dent	110	6.8	3-way hybrid, QPM
CIDA-ba	1997	White, dent	110	6.3	3-way hybrid, QPM
Dodzi		White, dent	75-80		OPV, EEM, QPM
CSIR-Golden Jubilee	2007	Yellow, flint/dent	110	5.0	OPV, QPM, DT
CSIR-Aziga	2007	Yellow	110	5.0	QPM
CSIR-Etuto-Pibi	2007	White, flint	110	5.5-6.5	Hybrid, QPM, DTM
CSIR-Apkasoe	2007	White, flint/dent	75-80	3.5	OPV, QPM, DT, EEM
CSIR Omankwa	2010	White, flint/dent	90	5	OPV, QPM, DT, STR, EM
CSIR-Aburohemaa	2010	White, flint/dent	90	5	OPV, QPM, DT, ST, EM
CSIR-Abontem	2010	Yellow, lint/dent	75-80	4.7	OPV, QPM, DT, STR, EEM
CSIR-Enii-Pibi	2010	White, flint	110	5.5	3-way hybrid, QPM, DT
CSIR-Sanzal-Sima	2012	White, flint/dent	110	5.4	OPV,QPM, DT
CSIR-Ewul-Boyu	2012	White, flint/dent	110	5.4	OPV, QPM, DT
CSIR-Bihilifa	2012	Yellow, flint/dent	90	4.6	OPV, QPM, DT, STR, EM
CSIR-Tigli	2012	Yellow, flint/dent	115	5.2	OPV, QPM, DT, SR
CSIR-Wang-Dataa	2012	White, flint/dent	90	4.7	OPV, STR, DT, EM
Pannar 53, ProSeed	Imported	White, flint/dent	High yielding hybrids, Wienco		

NB: Information in Table 1 is obtained from different secondary sources, with varying degree of absolute accuracy, CSIR: Council for Scientific and Industrial Research, OPV: Open Pollinated Variety, DT: Dronght Tolerance, STR: *Striga hermonthica* Resistance, SR: Streak Resistance, QPM: Quality Protein Maize, EM: Early Maturing, EEM: Extra Early Maturing

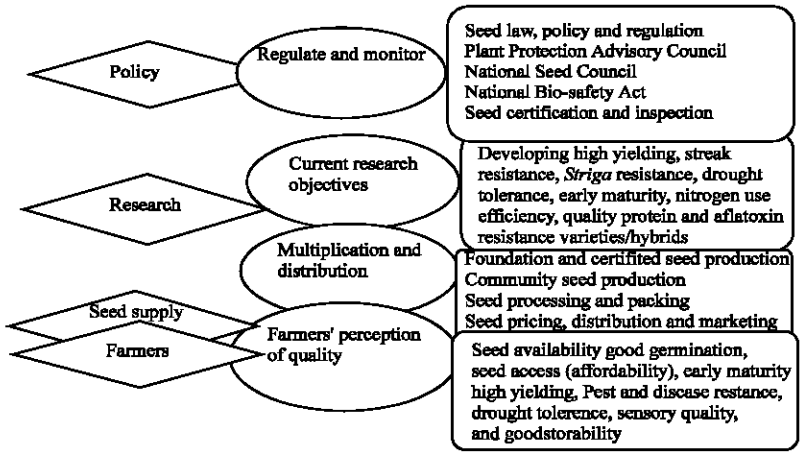

Fig. 2: A flow chart showing the functions and expectations of actors in the seed value chain

Table 2: Seed age and recycling behaviour of different actors in the seed supply chain

		How long seed is reused by actors (% responding)					
Age of seed (years)	Farmer seed	Community seed growers	Certified seed growers	Research institute (CSIR-SARI)	Ministry of Food and Agriculture	Total frequency	Overall response (%)
1-2	10.5	90	74.1	68.2	76.9	54	60.0
3-5	68.4	10	25.9	31.8	23.1	30	33.3
6-10	5.3	-	-	-	-	2	2.2
11-25	15.8	-	-	-	-	4	4.4
	100.0	100	100	100	100	90	100.0

CSIR-SARI: Council for Scientific and Industrial Research-Savanna Agriculture Research Institute

Table 3: Most utilized maize varieties by farmers and reasons for selecting the varieties

Most utilized maize varieties	Frequency	Responding (%)	Reason for selecting the variety
CSIR-Abontem	3	3.3	Earliness, drought escape, yellow maize
CSIR-Aburohemaa	2	2.2	Earliness, *Striga* resistance, drought escape
Dorke	4	4.4	Earliness, high yielding, drought escape
Obaatanpa	15	16.7	Earliness , high yielding, drought tolerance, quality protein
CSIR-Omankwa	7	7.8	Earliness, high yielding, drought tolerance
Safita 2	1	1.1	Earliness, resistance to lodging
Unknown (white)	45	50.0	Earliness, high yielding, drought escape
Unknown (yellow)	3	3.3	Earliness, high yielding, less fertilizer requirement
Pannar 53 (hybrid)	3	3.3	Earliness, high yielding
Breeding lines	7	7.7	Earliness, high yielding, drought tolerance

Unknown variety: Respondents did not know the exact name of variety, seed coat colour (white or yellow) was the basis of identification

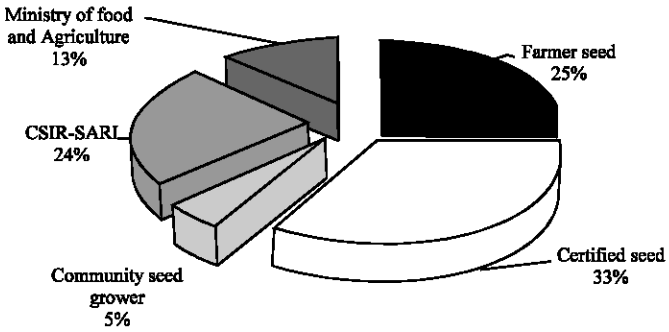

Fig. 3: Sources of maize seed for planting

Access to quality seed: Table 2 shows the seed age and recycling behaviour of different actors in the seed value chain. The overall response showed that 60, 33.3, 2.2 and 4.4% of actors recycle seed for 1-2, 3-5, 6-10 and 11-25 years, respectively. Only 10% of responding farmers recycled seed for 1-2 years, a large majority (68.4%) recycled seed for 3-5 years (Table 2). Majority of respondents utilized certified seed as initial planting material (Fig. 3). The main sources of seed included seed dealers (33%), CSIR-SARI (24%), Ministry of Agriculture (13%), community seed growers (5%) and farmer seed (25%) (Fig. 3). Decisions on seed acquisition were influenced by price, perceived quality and overall availability. The most utilized varieties were CSIR-Abontem (3.4%), CSIR-Aburohemaa (2.2%), Dorke (4.4%), Obaatanpa (16.7%), CSIR-Omankwa (7.8%), Safita 2 (1.1%) and Pannar 53 (3.3%) (Table 3). Though these varieties were developed for specific qualities, over 90% of farmers responding did not know the "release name" of the variety, nor the specific qualities they possessed.

Seed coat colour (white or yellow) was the basis of identification for most responding farmers. This poses great limitation if a farmer desires to change his variety due to poor performance.

Sources of seed: Farmers obtained seed from 11 recurrent sources which can be classified as informal, formal and semi-formal. Brief description of these sources is provided below:

- **On-farm adaptive trials:** These are seed of non-released genotypes. The seed is provided by Research Institutes only to farmers who participate in collaborative on-farm adaptive trials. The participating farmers may share the seed with other farmers
- **Research institutes and MoFA:** These organizations are a vital source of seed to farmers. They provide seed to lead farmers through government or donor funded projects, sometimes small quantity of seed is provided and farmers multiply to share with others
- **Government, Non-Governmental Organizations (NGOs) and donor seed aid:** In some instances, seed is provided by these agencies either as seed aid or at subsidized price. For instance, Pannar 53 and ProSeed hybrid maize are currently supplied by government for the block farmers
- **Imported seed:** High performing varieties or hybrids are supplied as seed aid or by seed companies to agro-input dealers
- **Certified seed:** This is provided by certified seed growers. The seed is produced under supervised field conditions. Seed is packaged and supplied through agro-input dealers in both urban and rural distribution outlets
- **Non-certified seed:** Such seed is produced by non-certified but trained seed growers; they usually consist of current and retired government workers who observe seed production safety standards. The seed may be packaged and supplied through agro-input dealers
- **Community seed:** This is an innovative approach to widen the availability and access to quality seed. Here, selected farmers are trained and pre-financed with agro-inputs to multiply specific varieties. Part of the harvested seed is used to defray the initial cost and the seed can be sold to other farmers in subsequent seasons
- **Informal sources:** These include the use of farmer varieties, recycled seed of improved varieties, non-packaged seed in open market and seed sharing from friends, relations and other farmers

Perception of seed quality: Selection and preference for a variety were influenced by a combination of factors. First choice preference traits were early maturing (48%), high yielding (25%) and drought escape (23.2%) (Table 4). For 3.1% of respondents, the local yellow maize was often the first to be cultivated, because it is adapted to poor soil conditions and providing security against huge yield losses resulting from unfavorable weather conditions. Overall preference traits were early maturing (41.8%), high yielding (23%), drought escape (24.5%), *Striga* resistance (1.01%), less fertilizer requirement (2.04%), resistance to lodging (1.01%), yellow maize (3.1%) and quality protein maize (2.04%) (Table 4). All sources of seed showed germination potential within optimum range (78.1-86.8%) (Table 5). Also, seed moisture content of seed was generally close to optimum range (8.5±1-10.2±1.3% db). However, the minimum germination range of 47 to 71% across all sources of seed is indicative that improvements in seed processing and conditioning such as drying, cleaning and packaging is still required. Farmers did not used any seed dresser but seed priming by soaking in water for 3-6 h was done by few farmers.

Table 4: Most recurring reasons for selecting a particular maize variety for planting

Reasons for selecting a variety	1st selection criteria		2nd selection criteria		Overall selection
	Frequency	Responding (%)	Frequency	Responding (%)	Responding (%)
Early maturing	27	48.2	14	33.3	41.8
High yielding	14	25.0	9	21.4	23.5
Drought escape	13	23.2	11	26.2	24.5
Striga resistance	1	1.8	-	-	1.01
Less fertilizer use	1	1.8	2	4.8	2.04
Resistance to lodging	-	-	1	2.4	1.01
Yellow maize	-	-	3	7.1	3.1
Quality protein maize	-	-	2	4.8	2.04

Table 5: Effect of source of seed on some physical qualities of maize

Source of seed	Sample weight (g)	100-seed weight (g)	Moisture content (% wb)	Moisture content (% db)	Germination potential (%)		
					Minimum	Average	Maximum
Farmer seed	145.4±87.4	26±4.4	12±3.7	10.2±1.3	47	82±11.3	97
Certified seed	127.7±16	29±3.8	11±1.6	9.9±1.4	79	85.9±4.7	91
Community seed	137.3±14.2	25.1±0.4	11.3±1.3	10.1±1.1	45	78.1±8.5	96
CSIR-SARI/MoFA	156.7±35.3	32.3±6.4	11.1±0.8	9.9±0.6	79	86.8±4.9	93
Donor/government	156.7±35.7	32.3±6.4	11.1±0.7	10±0.6	65	78.1±3.5	90
Open market	232.6±24.5	28.6±2.2	9.3±1.2	8.5±1	71	82.4±7.6	91

CSIR-SARI: Council for Scientific and Industrial Research-Savanna Agriculture Research Institute, MoFA: Ministry of Food and Agriculture

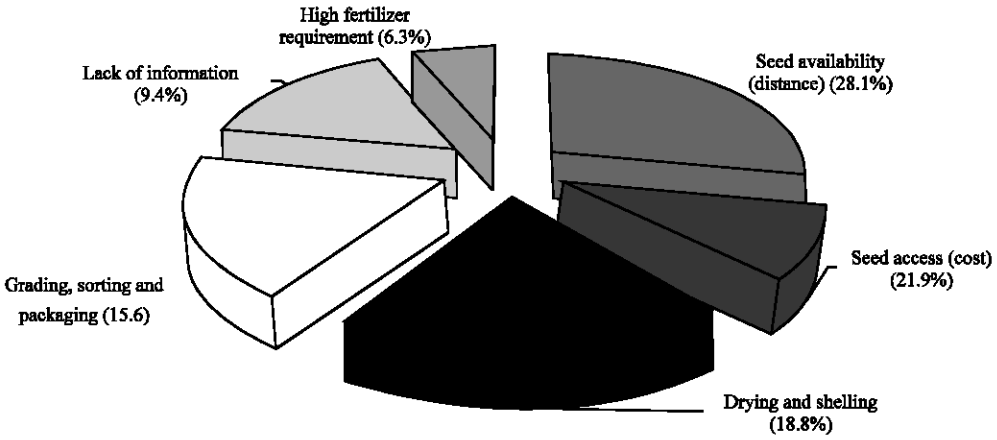

Fig. 4: Critical constraints of the seed industry in Ghana

Critical constraints: Figure 4 summarizes the critical constraints facing the seed industry in Ghana. The prominent constraints were seed availability (28.1%), seed access (21.9), drying and shelling equipment (18.8%), grading, sorting and packaging (15.6%), lack of information (9.4%) and high fertilizer requirement (6.3%). Key informant interviews showed that each actor had different perceptions of these challenges. For instance, most seed producers complained about low patronage of certified seed, long distances to regional seed processing centres and lack/outmoded of shelling, grading and packaging equipment. Due to pressure on arable land, access to isolation fields has become a threat to producers. Improper labeling was another issue requiring immediate attention; sometimes even name of variety was not found on seed label.

DISCUSSION

The study revealed that achieving seed security will require the concerted efforts of stakeholders in the maize seed value chain. This should include coordination of interventions, enabling policies and innovative approaches to increase seed multiplication and distribution. Proximity and information about improved varieties require further marketing innovation to increase access to seed in distant rural communities in Ghana. Farmers' inertia to scout for certified seed requires further attention by the Unified Extension Service of Ministry of Food Agriculture (MoFA). Some farmers recycled improved varieties for several years (2-25 years); such varieties may contaminate, degenerate or segregate. This beheviour poses great threat with the introduction of hybrid seed which must be replaced each year. Hybrid seed could bear pictorial warning symbols to indicate 'Do Not Re-plant' seed in subsequent years. Retail weights of 1, 5, 25 and 50 kg should be considered to meet the requirements of different growers. Label content of certified seed should include: Name of variety and seed producer, maturity period, yield potential, germination percentage and special quality traits. Though all sources of seed showed optimum germination range (78.1-86.8%), improvements in seed processing and conditioning such as drying, cleaning and packaging are still required. The use of appropriate seed dressers and seed priming techniques should be promoted among farmers to improve on seed vigour. Several recommendations exist on the role of seed dressers and seed priming techniques in enhancing moisture imbibition and reducing vagaries of adverse weather and soil conditions (Rahman *et al*., 2011; Rani and Devanand, 2011; Sathish *et al*., 2012).

Several other recommendations have been put forward to strengthen the seed systems in Ghana. Policy needs to consider the social and economic factors underpinning the seed industry (Lyon and Afikorah-Danquah, 1998). Etwire *et al*. (2013) suggest the need for education in local languages about the importance of using certified seed and hybrid seed in particular through field days, demonstrations and mass media programmes. For instance, Asante *et al*. (2011) identified age, farm size, yield, farm income, formal education and visit to a demonstration field to greatly influence the adoption of vine multiplication technique in seed yam production. Access to formal education and promotional activities increased farmers' willingness to adopt the improved maize varieties (Wiredu *et al*., 2010). In addition, general infrastructure such as cold rooms, warehouses and seed cleaning and packaging equipment at regional, district and zonal levels should be considered (Etwire *et al*., 2013). Government could provide these services at a fee or provide seed companies with grants to acquire such facilities. Currently, several other Donor-funded projects are implemented to complement existing interventions to increase access to quality seed for smallholder farmers in Ghana (ISSD, 2012). For instance, the Association of Church-based Development Projects (ACDEP) and partner NGOs, Programme for African Seed Systems (PASS) and the Alliance for a Green Revolution in Africa (AGRA) are promoting the community seed concept in which communities are supported to produce maize seed.

CONCLUSION

The study provides some precursors to accelerate access to maize seed in Ghana. The recommendations are relevant to improving seed programmes of other staple crops which are equally challenged by similar constraints. Overall, seed production, distribution and general information about improved varieties and hybrids require some improvement. Seed security is severely constrained in communities far away from urban and district markets. The recent Plants and Fertilizer Act (2010) (Act 803) of Ghana which appears more liberal should provide impetus

for Research Institutes, MoFA, Private Seed Companies and Seed Growers to increase current seed production levels. Up-scaling the community seed concept to cover many rural communities should be considered by government; this is currently championed by NGOs and Donor funded projects. Other marketing strategies such as seed fairs and seed vouchers can be considered. Finally, the capacity of Ghana Seed Inspection Division of MoFA should be strengthened to conduct field inspection and provide seed processing services at regional, district and zonal levels.

REFERENCES

Asante, B.O., E. Otoo, A.N. Wiredu, P. Acheampong, J. Osei-Adu and B. Nsiah-Frimpong, 2011. Willingness to adopt the vine multiplication technique in seed yam production in the forest Savanna transition agro-ecological zone, Ghana. J. Dev. Agric. Econ., 3: 710-719.

Asiedu, E.A. P.Y.K. Sallah S. Twumasi-Afriyie, K. Obeng-Antwi, K. Ahenkora and P. Adusei-Akowuah, 2001. Agronomic and post-harvest characterization of three quality protein maize (QPM) hybrids developed in Ghana. Ghana J. Agric. Sci., 34: 57-62.

Asuming-Brempong, S., K.O. Gyasi, K.A. Marfo, A. Diagne and A.N. Wiredu *et al*., 2011. The exposure and adoption of New Rice for Africa (NERICAs) among Ghanaian rice farmers: What is the evidence? Afr. J. Agric. Res., 6: 5911-5917.

Buah, S.S.J., S.K. Nutsugah, R.A.L. Kanton, I.D.K. Atokple and W. Dogbe *et al*., 2011. Enhancing farmer's access to technology for increased rice productivity in Ghana. Afr. J. Agric. Res., 6: 4455-4466.

Etwire, P.M., I.D.K. Atokple, S.S.J. Buah, A.L. Abdulai, A.S. Karikari and P. Asungre, 2013. Analysis of the seed system in Ghana. Int. J. Adv. Agric. Res., 1: 7-13.

FAO, 1998. Towards seed security. Proceedings of the International Workshop on Seed Security for Food Security, November 30-December 1, 1997, Florence italy.

ISSD, 2012. Ghana seed sector assessment: Briefing note. Integrated Seed Sector Development, September 2012, Ghana, pp: 1-5.

Langyintuo, A.S., W. Nwangi, A.O. Diallo, J.F. MacRobert, J. Dixion and M. Banziger, 2008. An Analysis of the Bottlenecks Affecting the Production and Development of Maize Seed in Eastern and Southern Africa. CIMMYT, Harere, Zimbabwe.

Louwaars, N.P. and W.S. de Boef, 2012. Integrated seed sector development in Africa: A conceptual framework for creating coherence between practices, programs and policies. J. Crop Improv., 26: 39-59.

Lyon, F. and S. Afikorah-Danquah, 1998. Small-scale seed provision in ghana: Social relations, contracts and institutions for micro-enterprise development. Agricultural Research and Extension Network (AgREN) Papers No 84, pp: 1-10. http://www.odi.org.uk/publications/4246-small-scale-agriculture-seed-ghana

MacRobert, J., 2009. Seed Business Management in Africa. CIMMYT, Harare, Zimbabwe, pp: 1-23.

Rahman, M.M., K.U. Ahammad and M.M. Alam, 2011. Effect of soaking condition and temperature on imbibition rate of maize and chickpea seeds. Res. J. Seed Sci., 4: 117-124.

Rani, P.U. and P. Devanand, 2011. Efficiency of different plant foliar extracts on grain protection and seed germination in maize. Res. J. Seed Sci., 4: 1-14.

Sallah, P.Y.K., S. Twumasi-Afriyie and C.N. Kasei, 1997. Optimum planting dates for four maturity groups of maize varieties grown in the Guinea Savanna zone. Ghana J. Agric. Sci., 30: 63-70.

Sathish, S., S. Sundareswaran, N. Senthil and K.N. Ganesan, 2012. Biochemical changes due to seed priming in maize hybrid $COH(M)_5$. Res. J. Seed Sci., 5: 71-83.

Sugri, I., S.K. Nutsugah and J. Yirzagla, 2011. Effect of some seed physical characteristics on viability of pearl millet (*Pennisetum glaucum* (L.) R. brown). Res. J. Seed Sci., 4: 181-191.

TL II, 2012. Bulletin of tropical legumes, 2012: A monthly publication of the Tropical Legumes II (TL II) project. Tropical Legumes II, January 13, 2012. http://www.icrisat.org/tropicallegumesII/pdfs/BTL13-20120131.pdf

Wiredu, N.A., K.O. Gyasi, T. Abdoulaye, D. Sanogo and A. Langyintuo, 2010. Characterization of maize producing households in the northern region of Ghana. Country Report Ghana CSIR/SARI-IITA, Ibadan, Nigeria.