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Soybean: An Assessment of Varieties Grown, Seed Sources and Farm-saved Seed Management Practices in Meru South Sub-County, Kenya

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ABSTRACT

Information on soybean varieties grown and seed sources is scanty. Since soybean seed deteriorates rapidly in the tropics; seed management is key to provision of planting material for the subsequent season. The study assessed soybean commonly grown varieties, seed sources and farm-saved-seed management practices in Meru South Sub-county, Kenya. Data was obtained from 308 purposively sampled soybean growing households using a pre-tested questionnaire in February 2013. Data was analyzed using SPSS. The study revealed that; the most commonly grown soybean varieties were Gazelle (82.2%), SB19 (14%), SB3 (1.9%) and SB 13 (1.9%). Due to lack of certified seed, farmers relied mostly on the Ministry of Agriculture (46%), farm saved seeds (25%) and seed exchange (15%). Seed management was poor as it was exposed to field weathering due to late harvesting (76%); mechanical damage by beating with sticks (94%); sun drying (100%); moisture damage by storage mostly in gunny bags (91%) for prolonged periods of up to 9 months before planting and lack of seed treatment (88%) leading to poor seed viability(43%). Therefore limited use of improved varieties, lack of certified seed, poor farm-saved-seed management practices hence poor viability were identified as constraints to soybean cultivation in the study area.

Introduction

Soybean (*Glycine Max* (L.) Merrill) is one of the world's leading sources of vegetable oil and plant protein suitable for human consumption. In the Kenyan market, production (1,000 to 5,000 Metric Tons) has outstripped demand (50,000 to 100,000 MT) hence the reliance on imports. The government aims to achieve self-sufficiency in vegetable oil and protein meal and is encouraging local production of oil seeds. Soybean is one of the principle seeds under consideration but its expansion has been met with various challenges (MOA, 2012). One major constraint to soybean cultivation in the tropics is the rapid loss of seed viability and vigor during storage under ambient conditions (Nkang and Umho 1996). Moreover, soybean seed germination has been found to vary among soybean cultivars, type of seed storage materials used as well as on the environmental conditions of storage (Sajo and Tame, 2013, Chirchir *et al*, 2016). Due to these, farmers in Kenya experience poor retention of soybean farm-saved-seed viability between harvest and the next planting season (Tinsley, 2009). Consequently, seed management is key to provision of planting material for the subsequent planting season. However, in spite of the availability of high yielding, drought tolerant, early maturing and adaptable varieties for the short day tropical conditions, (Myaka *et al*., 2005; Mathu *et al*., 2010), farmers in Kenya have continued to use mixed varieties sourced from markets that result in low yields (MOA, 2009). In spite of these challenges, much of the information on varieties grown, the seed sources, seed management practices as well as seed viability in Kenya is not based on experimental data evaluation. There was therefore need to adequately characterize the existing soybean seed system in order to design appropriate seed management strategies for enhanced soybean production to meet the high market demand. On this basis, this study was initiated in Meru South Sub-county of Kenya

Methodology

Study Area

A farm-household survey was conducted in soybean growing areas of Chuka, Mugumoni and Igambang'ombe wards in Meru South Sub-county, Tharaka Nithi County of Kenya from 19th -26th February 2013. The area is situated between Longitudes 37^{0}18'37"and 37^0 28'33"East and Latitude 00^0 07'23" and 00^0 26'19" South (NEMA, 2007). The altitude ranges from 500 m and 5,199 m above sea level, resulting in a wide range of climatic conditions and Agro-ecological zones (MOA, 2013). The area is densely populated with high agricultural potential, having complex farming systems with perennial cash crops, food crops, trees and livestock. The farmers practice small-scale rain-fed, mostly non-mechanized agriculture on smallholdings ranging from 0.1 to 2 ha with an average of 1.2 ha per household (MOA, 2013).

Data Collection Methods

Purposive sampling of soybean growing households was done and data collected by administration of structured questionnaires. The number of households interviewed was

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calculated using the formula adopted from Fischer *et al*., (1998).

$$N = \frac{z^2 pq}{d^2} = \frac{1.96^2 0.5(1-0.5)}{0.05^2} = 384 \quad \text{(Eq. 1)}$$

Where: N is the required sample size;
z is normal deviation (1.96) which corresponds to 95% confidence interval;
p is proportion in the population growing soybean estimated at 50% since it is not known.
q is 1-p
d is degree of accuracy (0.05)

Trained enumerators recruited from the local community conducted the interviews. Pretesting of the questionnaire was done in Keringani and Kiangondu villages using the local language (Meru) on a sample of 10 farmers and then revised accordingly. A total of 308 respondents were interviewed during the survey with the household head being the targeted respondent but with a spouse or close family member being interviewed in their absence. Data was collected soybean varieties grown, source of seed, seed handling, storage and perceived viability under farm conditions in soybean growing areas of Meru South Sub-county. The aim of the survey was to characterize farmer preferences for soybean varieties; document on-farm soybean seed management scenario - seed sources, storage and viability for designing future seed management strategies for enhanced development of soybean industry.

Data Analysis

Information from the survey questionnaire was coded on a numerical scale and entered into a spreadsheet. The responses were summarized and similar responses combined, coded and analyzed using IBM® SPSS Version 20. The analysis involved data summary by frequencies and pie charts. Missing data was excluded on a case by case basis.

Results and Discussion

Soybean varieties grown and preference

Surveyed households identified the soybean varieties that they grew; their variety preferences and the reasons thereof (Table 1).

The results showed that five soybean cultivars had been grown by farmers in Meru South: Gazelle (66%), SB 19 (26.3%), SB3 (4%), SB13 (2.6%) and Nyala (1.1%). However, during the last cropping season of year 2012/13, the most commonly grown soybean variety was Gazelle (82.2%), with the remainder of households growing SB19 (14%), SB3 (1.9%), SB 13(1.9%) but with none growing Nyala. These findings revealed that farmers have very limited number of varieties available to them. Goldsmith (2015) similarly reported that soybean farmers in Africa have access to only few low-yielding varieties of seed from their country's national breeder when compared to farmers in North and South America. However the superior IITA developed Glycine cross (TGx) soybean genotypes for Africa, which nodulate with *Bradyrhizobium* spp populations indigenous to African soils (Pulver *et. al*., 1985) were available to farmers in the study area. Such varieties have high grain yields and produce large amounts of biomass, making them useful as a soil-building rotation crop and as fodder for livestock (Adelodun, 2011).

Of the available varieties however, the most preferred variety was Gazelle (80.6%) a grain variety, liked by farmers because of large grains, high yields and early maturity hence easily escaping drought.

Table 1. Soybean varieties grown and farmer preferences

Soybean Variety	Varieties ever grown	Variety grown in Last Crop	Variety preference	Reasons for preference
	Frequency (% total responses)	Frequency (% of N)	Frequency (% of N)	
Gazelle	231 (66)	212 (82.2)	175 (80.6)	Early maturing, good yields and large grains
SB 19 (TGx 1740-2F)	92 (26.3)	36 (14)	34 (15.7)	Late maturing, high yielding with adequate rains
SB3 (TGx 1835-10E)	14(4.0)	5 (1.9)	5 (2.3)	Early maturing, high yields when rains are adequate.
SB 13	9 (2.6)	5 (1.9)	3 (1.4)	Early maturing, reasonable yields, drought tolerance
SB23 (Nyala)	4(1.1)	0 (0)	0(0)	Not preferred
Total	**350(100)**	**258(100)**	**217(100)**	

SB19 (TGx 1740-2F) a promiscuous variety that nodulates freely with local rhizobia (Mahasi *et al*., 2011) was preferred by 17% of respondents due to high yields. However, farmers reported that this variety was disadvantaged by late maturity hence requiring more rain and may not escape mid-season droughts which are a common feature in the study area. The 2.3% that preferred SB3 said that it was early maturing and produced high yields when rains were adequate. The 1.4% respondents that preferred SB13 cited early maturity, reasonable yields and drought tolerance as its advantages. Hence farmers preferred high yielding, early maturing soybean varieties that escape drought. Mahasi *et al*., (2011) reported similar findings under western Kenyan conditions, that farmers preferred early maturing varieties that escape off-season dry spells and ensure food security. This analysis further recommended cultivar TGx 1740- 2F across locations but that breeding for earliness was necessary. In Malawi however, TGx 1740 2F was the most preferred variety due to high yields, early maturity, better lodging resistance and good performance under poor and erratic rainfall (IITA 2011). The current study therefore suggests production of TGX 1740-2F (SB 19) in areas with adequate rainfall so that farmers can reap its potential benefits of high yields, large biomass and soil fertility improvement through Biological Nitrogen Fixation.

Soybean seed sources

Soybean producing farm households reported on their sources of soybean seed (Figure 1). Results revealed that there was no established source of certified soybean seed in Meru South Sub-county. Farmers sourced their soybean seed mainly from the Ministry of Agriculture Soya and climbing bean (SOCO) project (46 %); own farm-saved seed (25%), seed exchange with other farmers (15 %), local markets (3%), Kenya Agricultural Research Institute (KARI) - 1%, Tropical Soil Biology and Fertility (TSBF) Programme - 5%, Catholic Diocese - 3%; Kenyatta University (KU) - 1%. Other seed sources which comprised 1% were International Centre for Insect Physiology and Ecology (ICIPE), and Kenya Tea Development Agency (KTDA).

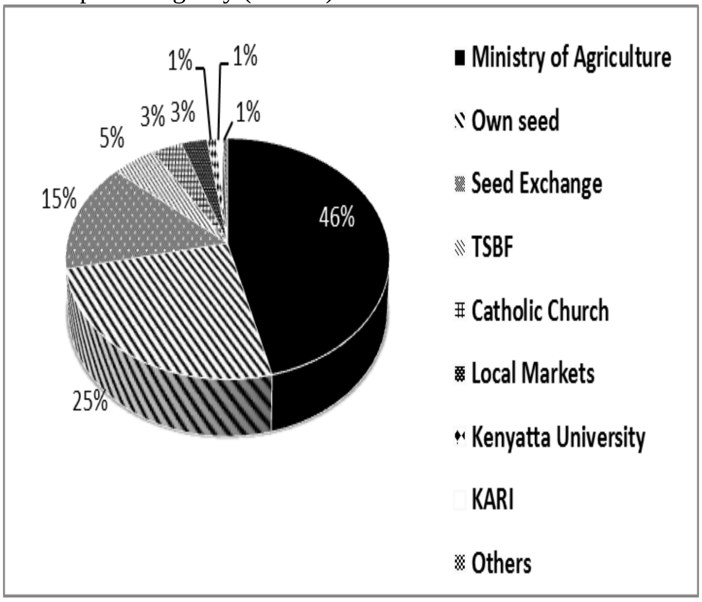

Figure 1. Sources of soybean Seed in Meru South Sub-county

The study therefore revealed that for soybean seed, farmers in Meru South largely relied on short term institutional soybean promotion projects, farm saved seed, seed sourced from markets and seed exchange of uncertified seeds, which may lead to low germination and consequently reduced yields. These results agree with the findings of Monyo, (2013) who reported that more than 60% of soybean seed in Mozambique is farmers' own-saved seed mainly because seed companies don't show interest in producing self-pollinated crops such as soybean. There is therefore need to establish a source of quality soybean seed in the study area for increased productivity.

Soybean seed management practices

Respondents reported on how they managed their soybean seed from field to storage (Table 2).

Results revealed that most farmers (99%) did not manage soybean seed crop differently from grain crop. The 3 % that indicated some difference in management did so only by selecting vigorous healthy plants for seed. Soybean was mostly harvested when totally dry (76 %) but with 24 % being harvested when leaves were yellow and dropping. Threshing was done mainly by beating with sticks (94%) followed by sun drying (100%). In addition, most farmers (88%) did not seed-dress before storage, but 10% treated with commercial chemicals while 3% used traditional methods such as ash and herbs (mostly Neem leaves).

These findings suggest that the failure of farmers to separate grain crop from seed crop meant that maintenance of seed quality by seed field cleaning was not done.

Moreover, deterioration of seed due to high temperature and relative humidity prior to harvest (during maturation) in the field known as field weathering (TeKrony *et al.*, 1980), is likely to have occurred due to delayed harvesting leading to loss in seed quality.

Table 2. Farmer's soybean seed management practices

Parameter	Frequency	% of total N
Is seed crop managed separately from grain crop? (N=308)		
yes	3	1.0
No	305	99.0
Harvesting stage (N=295)		
At maturity (yellow leaves, leaf drop)	70	23.7
When totally dry	225	76.3
Threshing methods (N=297)		
Beating with sticks	279	93.8
Manually by hand shelling	18	6.1
Mechanical threshing	0	0.0
Seed drying after threshing (N=296)		
Yes	201	67.9
No	95	32.1
Drying methods (N=201)		
Sun drying	201	100
Mechanical drying	0	0.0
Use of seed dressing (N=300)		
None	265	88.3
Commercial seed treatment	29	9.7
Ash	5	1.7
Herbs	1	0.3

In addition, because the structure of a soybean seed makes it susceptible to splitting and breakage during mechanical handling (Acklin 1998), the practice of threshing by beating with sticks in the study area may have led to further loss in seed quality. Further, the common practice of sun-drying as opposed to drying under shade of soybean seed after harvest may have induced seed ageing (Babiker *et al*. 2010). In general, the soybean farm saved seed management practices in the study area was poor which may have predisposed seed to rapid ageing.

Seed storage methods

Table 3 shows the soybean seed storage methods in Meru south Sub-county.

Table 3. Soybean seed storage methods

Parameter	Frequency	% of total N
Seed storage (N=292)		
Within the house	253	86.6
Granary	39	13.4
Type of storage containers (N=248)		
Gunny bags	225	90.7
Gourds	8	3.2
Plastic cans	6	2.4
Khaki paper bags	5	2.0
Earthen pots	2	0.8
Polythene bags	2	0.8
Type of gunny bags used (N=275)		
Synthetic	270	98.2
Sisal	5	1.8
Sealing of plastic container (N=13)		
Unsealed	10	76.9
Sealed	3	23.1

The majority of farmers (87%) stored their soybeans within their houses as opposed to 13% that stored in granaries; mainly due to security related issues. Synthetic gunny bags (91%) was the most commonly used storage material, with the others being gourds (3.2%), plastic cans (2.4%), khaki bags (2.0%), earthen pots (0.8%) and polythene bags (0.8%). Increase in seed moisture has been reported to reduce the longevity of seeds (Harrington, 1972). Seeds with low moisture content and stored in any air tight containers have been found to retain viability for a longer time. Rahman *et al*.,

(2010) found that sealed plastic pots and polythene bags were more effective storage containers than cloth bag or jute bag and earthen pot for storage of soybean seeds. Ali *et al*., (2014) also found that soybean seeds stored in polyethylene bags which had lower seed moisture stored better than seed stored in cloth bags which gained more moisture.

Hence the farmers' soybean seed storage methods in non-air-tight containers, exposed seed to storage pests and increases in moisture content, which probably may have reduced soybean seed longevity in the study area.

Soybean seed storage period and viability

The farm saved soybean seed storage period before next planting (table 4) and perceived levels of seed viability (table 5) was assessed in the study area.

Table 4. Soybean seed storage period before next planting season in Meru South Sub-county (N=304)

Seed storage period (months)	With only Short rains (SR) planting	With only Long rains (LR) planting	With both SR+ LR planting (Two seasons per year)	
	Frequency (% of total responses)	Frequency (% of total responses)	SR	LR
1	0(0)	0(0)	3 (0.98)	66(21.71)
2	0(0)	0(0)	32(10.53)	28(9.21)
3	0(0)	0(0)	28(9.21)	1(0.32)
4	0(0)	0(0)	33(10.85)	1(0.32)
5	0(0)	0(0)	0(0)	0(0)
6	0(0)	0(0)	0(0)	0(0)
7	5 (1.6)	6 (1.97)	0(0)	0(0)
8	95 (31.3)	25 (8.22)	0(0)	0(0)
9	63 (20.7)	14 (4.61)	0(0)	0(0)
Total	163 (53.6)	45 (14.8)	96 (31.6)	96 (31.6)

Numbers in parenthesis are % of total responses

Results showed that seed storage period varied with the number seasons soybean was grown in a year, whether for short rains (SR) planting (October) or long rains (LR) planting (March) or for both seasons. Out of the 304 respondents, 31.6% that grew soybean in both seasons (LR+SR) stored their farm saved seed for shorter periods of 1 to 4 months. However, the sampled farmers that grew soybean only in one season, that is SR (53.6%) or LR (14.8%) stored their seed for longer periods of between 7 to 9 months. Field storage conditions of high humidity and temperature have been known to synergistically accelerate physiological deterioration and pathological damage of soybean seed leading to loss in seed viability and vigor (Dornbos *et al*., 1989).Consequently, the longer the seed storage period under ambient conditions, the greater risk of loss in seed viability.

The soybean growing households reported their perceived level of field germination of soybean (Table 5).

Table 5. Level of field germination of soybean reported by survey households

Field germination (N=300)	Frequency (%)
0-50% (Poor)	14 (4.7)
51-70% (Average)	115 (38.3)
71-100% (Good)	171(57)
Total	**300 (100)**

Numbers in parenthesis are % of N

The results revealed great variability in the level of germination of soybean seed reported by farmers. Most (57%) reported good germination, 38% - average germination with only about 5% experiencing poor germination. The wide range of climatic conditions present in Meru South Sub-County (MOA, 2013), may be the likely reason for the variability in germination. Moreover, the changes in environmental conditions of temperature and relative humidity as well as differences in seed management practices may have led to the great variability in perceived seed viability in the study area (Chirchir *et al* 2016).

The results of the current study suggests that growing soybeans in the two seasons in a year would reduce seed storage duration under ambient conditions and in addition to proper farm-saved-seed management would likely reduce the problem of loss in seed viability.

Conclusion

The results identified limited use of improved varieties, lack of certified seed and poor farm-saved-seed management practices as constraints to soybean cultivation in the study area. Since there was no established source of certified seed, farmers relied on farm saved seed and seed exchange with other farmers. Such seed was exposed to field weathering, mechanical damage during threshing, heat damage with sun drying and exposure to moisture and pests during storage in synthetic gunny bags; predisposing seed to ageing.

The study recommends streamlining of the soybean seed system and establishment of a credible source of certified seed in order to increase soybean production to meet the high market demand. In order to improve farm-saved seed quality, training programs on proper seed management practices should be offered to farmers. Such interventions would ensure sustainable soybean enterprise and seed system in Meru South Sub-county and in other similarly suited areas.

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References

Acklin T., Soybean handling and storage. In World-Grain.com., 1998

Adelodun K., Soybean: Africa's Potential Cinderella Food Crop, Soybean - Biochemistry, Chemistry and Physiology, Prof. Tzi-Bun Ng (Ed.), I SBN, 2011; 978-953-307-219-7, InTech, Available from: http chemistry-and-physiology/soybean-africa-s-potential-cinderella-food-crop.

Ali M. R., Rahman M. M., Hammad K. U. A., Effect of relative humidity, initial seed moisture content and storage container on soybean (*Glycine Max*.Merill.) Seed Quality ISSN 0258 7122 Bangladesh J. Agric. Res. 2014; 3 9(3): 461-469.

Babiker, A. Z., Dulloo, M. E., Mustafa, M. A., Balla, E. and Ibrahim, E. T., Effects of low cost drying methods on seed quality of Sorghum bicolor (L.) Monech. *African Journal of Plant Science*, 2010; 4(9):339-345.

Better soybean varieties offer African farmers new opportunities. International Institute of Tropical Agriculture publication. 2011; pp 1.

Brief on soyabean production in Meru South Sub-county. Ministry of Agriculture. 2013; Unpublished: 1-6

Chirchir J. G, Mwangi M, Nyamongo D O, Gweyi-Onyango J.P., Soybean farm-saved seed viability and vigor as Influenced by agroecological conditions of Meru South Sub-county, Kenya. *Journal of Applied Biosciences.* 2016; 101: 9634-1942.

Dornbos D.L., Mullen R.E. and Shibles R.M. Drought stress effects during seed fill on soybean seed germination and vigor.

Crop Science. 1989; 29:476–480

Fischer A.A; Liang J. E; Stoeckel J.E. and Townsend J.W., Handbook for Family Planning Operations Research Design. 2nd Edition. Population Council, New York, USA 1998; (77).

Goldsmith P., Help for soybean industry in Africa starts with the source. College of Agricultural, Consumer and Environmental Sciences, ACES-News@illinois.edu. 2015; 217-333-5131

Harrington, J. F., Seed storage and longevity. *In*: Seed Biology. Ed. T. T. Koslowski. Academic Press, N. Y. 1972; 3:145-245.

Kenya District Environmental Action Plan 2006-2011. Meru South District. NEMA, 2007; pp. 31-38.

Mahasi J.M., Mukalama J... Mursoy R.C,. Mbehero P and Vanlauwe B., A sustainable approach to increased soybean production in western Kenya. African Crop Science Conference Proceedings, 2011; 10:115 – 120.

Mathu R.W., Nandokha, T., Riungu, T. C., Matere, S. and Bendera, N. K, The potential of soybean to increase agricultural productivity in dry areas of Central Kenya. Agricultural research Institute publ. 2010; pp 156-161

Monyo E.S., Bulletin of the Tropical Legumes. http://www.icrisat.org/TropicallegumesII/Bulletin-of-Tropical-Legumes.htm, 2013; 18:4-5

Myaka F.A, Kirenga G. and Malema B. (Eds), Proceedings of the First National Soybean Stakeholders Workshop, 10–11 November 2005; Morogoro, Tanzania.

Nkang A. and Umho E..A., Six month storability of five soybean cultivars as influenced by stage of harvest, storage temperature and relative humidity. Seed Science and Technol. 1996; 25: 93-99.

Pulver E.L.; Kueneman E.A., Ranga-Rao, V., Identification of promiscuous nodulating soybean efficient in N2 fixation.*Crop Science*, 1985; 25:1065-1070

Rahman, M.M. Hagidok B, Masood M. M and Islam M.N., Effect of storage container and relative humidity on the quality of wheat seed. *Bangladesh J. Seed Sci. Technol*. 2010; 14 (1&2): 89-94.

Resource Management Guidelines for Meru South District. Ministry of Agriculture District Agricultural Office, Meru South 2009; pp 1-95.

Sajo, A.A. and Tame, V.T., Effects of storage materials and environmental conditions on time of germination of soybean (glycine max l. Merril) seed in Yola, Nigeria . Acta Hortic. 2013; 1012, 71-76,

Strategy for Soybean Production and Marketing in Kenya. Ministry of Agriculture. 2012; Unpublished: 1-20.

TeKrony D.M., Egli D.B. and Phillips A.D, Effect of field weathering on the viability and vigor of soybean seed. *Agron. J*. 1980; 72: 749-755.

Tinsley R. L, Assessing the Soybean Value Chain Analysis in Kenya., CNFA, 2009; pp 1-44.