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Farmers perception on production constraints, trait preference and variety selection of chickpea (*Cicer arietinum* L.) in Kenya

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Abstract

Chickpea (*Cicer arietinum* L.) production in Kenya is mainly practiced on a small scale and productivity per hectare is lower compared with the world average, despite its promotion in different regions. The chickpea adoption rate is also relatively slow, despite its benefits. This study investigated farmers' production constraints, preferred traits, and selection criteria for specific varieties to generate information that can assist in the development of new varieties, which can be more readily adopted by farmers. A participatory Rural Appraisal (PRA) through Focus Group Discussions (FGD) was conducted in Bomet and Embu counties of Kenya. The direct ranking was used to identify farmers' constraints to chickpea production, preferred traits, and specific chickpea varieties based on preference. The collected data was analysed using Statistical Package for the Social Sciences (SPSS) software. Farmers' responses indicated that the major production constraints were pests and disease infestations, drought, lack of early-maturing varieties, lack of market, and lack of information on chickpea production and utilization. The farmers reported that they preferred ICCV 97105, ICCV 92944, and ICCV 00108 due to high yielding, drought tolerant, early maturing, and pest and disease resistance. Farmers in both counties also had a higher preference for *Desi* than *Kabuli* chickpea types because of tolerance to drought and disease resistance and that its testa does not peel off when cooked. This study revealed farmer-preferred traits in varieties they would want to grow. Breeders should aim at developing varieties with multiple traits for increased chickpea adoption and production in Kenya.

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Introduction

Chickpea (*Cicer arietinum* L.) production is ranked third among pulse crops grown accounting for approximately 14.2M tons, produced in over 50 countries, India being the main producer in terms of area (9.5M ha) and yield production (9.9M tons) (FAOSTAT, 2019) while Ethiopia is predominantly the main producer in Africa (Snapp *et al.*, 2018, FAOSTAT, 2019). In Kenya, chickpea is relatively new and efforts to introduce the crop in dry highlands and lowlands showed a significant yield increase of up to 1.8 tons/ha in arid and semi-arid lands (ASALs) and 3.2 tons/ha in dry highlands.

The crop is estimated to produce between 45,000-48,000 tons annually (MOA, 2017). With its recent introduction in dry highlands as a relay crop in Bomet, Nakuru, Koibatek regions among other parts of Kenya, chickpea will serve as a bonus crop in such areas since after harvesting the main crop, e.g. maize (*Zea mays* L.) or wheat (*Triticum aestivum* L.), the land is normally left fallow before the next cropping season. Chickpea grain is utilized in Kenya as a source of protein after boiling in a mixture with other grains, such as maize. Research shows that 40% of its weight is protein and with potential health benefits such as reducing cardiovascular, diabetic, and cancer risks (Meger and Haji, 2019). Its grain flour is used in making cakes, *chapatti,* and *Ugali.* Further, its flour can be used as a substitute for wheat in pasta production (Saget *et al.*, 2020). Additionally, the grain is used as livestock feed especially for poultry and the straw is fed to cattle and shoats. Its green leaves and immature pods are utilized as a vegetable. However, despite the tremendous improvement in yield, its cultivation, adoption, and utilization are quite limited across the country.

There are two types of chickpea grown worldwide: *Desi* and *Kabuli* (Upadhyaya *et al.*, 2008; Gaur *et al.*, 2009). The *Desi* type is characterized by small seeds (100-200mg), angular shape, with a rough surface, colored seeds of various shades of brown, yellow, green, and black, with a high percentage of fiber. The flowers are generally pink and the plants show various degrees of anthocyanin pigmentation, although some *Desi* types have white flowers and no anthocyanin pigmentation on the stem. On the other hand, Kabuli types are large-seeded (200-680mg), ram-head shape, and have beige-colored seeds, thin seed coat, smooth seed surface, with a low percentage of fiber but high sucrose, white flowers, and no anthocyanin pigmentation on the stem. Both types are grown in Kenya, with most being introductions from the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), India, and are selected for adaptability studies. However, there is only scanty information on these introductions of chickpea variety-specific traits that influence adoption.

Engaging farmers in understanding chickpea production constraints and their preferred traits would help in breeding varieties that are adaptable to the farmers' needs and environmental conditions. Farmers can be involved in the development of variety programs through various approaches including; Farmer's Breeding Approach (FAB) that involved farmers in the breeding process, which was successful compared to Formal Breeding (FOB) as reported in Ethiopia (Mekbib, 2008a). Another approach is Participatory Plant Breeding (PPB) (Chiffoleau and Desclaux, 2006; FAO, 2009; Kiiza *et al.*, 2012) was used in the development of cultivars suitable for organic farming (Shelton and Tracy, 2016). Combining PPB and Participatory Variety Selection (PVS) helped to reduce the possibility of farmers being given unacceptable varieties (Kiiza *et al.*, 2012). Chickpea farmers in Naivasha and Bomet districts (currently sub-counties) in Kenya, participated in selecting chickpea varieties by utilizing the PVS approach (Thagana *et al.*, 2009). In another study farmers in Mbeere sub-county, evaluated chickpea as an adaptation to agricultural systems in Kenya through a survey (Kaloki, 2010). A recently developed AgroDuos technique that utilizes gamification, involved the pairwise ranking of variety traits (Steinke and Van Etten, 2017). This will enhance the understanding of farmer preferred variety traits. A Participatory Rural Appraisal (PRA) technique has been successful in engaging farmers in identifying and analyzing their data and coming up with possible solutions based on their challenges

(Cornwall and Pratt, 2011). This approach has been applied in several crops to understand farmers' constraints and varietal trait preferences. According to Mekbib, (2008b) selection efficiency of socio-ecotype differentiation and the varietal mixture was achieved in Ethiopia through farmer participation.

In Zimbabwe, a study on maize adaptation to drought showed that farmers had varying opinions on the ranking of traits they take into account during the selection of varieties for drought-prone environments (Mhike *et al.*, 2012). Similarly, in Nigeria, farmers were able to select specific preferred traits and high pro-vitamin A varieties of cassava (Njogu *et al.*, 2014) and sweet potato farmers indicated their preferences and production constraints in Tanzania (Kagimbo *et al.*, 2018). Farmers in Northern Ghana were able to identify production constraints of groundnuts (Oppong-Sekyere *et al.*, 2015) while farmers participated in identifying reasons for crop establishment in maize, chickpea and upland rice in India and Zimbabwe (Harrisa *et al.*, 2001). In Kenya, research in common beans showed that the major constraints were drought and pest infestations (Ojwang, 2010). On the other hand drought and lack of know-how were the major concerns and farmers preferred drought tolerant lines in addition to high yielding lines, ability to recover after a dry spell, and stay green traits in maize (Leley, 2007).

Farmers selected preferred traits in cassava and finger millet production systems in Kenya (Oduori, 2009; Were, 2011). The above studies show that knowledge on criteria that farmers use to evaluate new crop varieties will enable breeders to set priorities that target diverse breeding approaches that meet farmers' needs.

Farmers' participation through various approaches is useful in understanding their needs during the development of new varieties. This information on farmers' constraints and preference for specific varieties of chickpea in Kenya are scanty. It is for this reason that this study was conducted with the following three objectives a) identify the major constraints in chickpea production b) identify preferred traits influencing varietal selection and c) identify specific preferred chickpea varieties by farmers in the selected growing regions.

Materials and methods

Study area

The study area covered three chickpea growing areas namely: Bomet, Chepalungu, and Mbeere South sub-counties, formerly districts. Bomet and Chepalungu are located in Bomet County. The altitude in the county ranges from 1,689m to 2,328m above sea level (asl) and represents dry highlands, while rainfall ranges between 1,000mm and 1,400mm per annum. The county receives bimodal rainfall with the long rains occurring from March to May and the short rains from August to October. Temperatures are in the range of 10ºC to 27ºC, with a mean monthly temperature of 18ºC (NEMA, 2009a). These areas represented the dry highlands of Kenya where chickpea production was being promoted to increase production. Further, farmers in these areas leave the land fallow after harvesting the main crop hence promoting chickpea that can survive under residing moisture will enhance the production.

Mbeere South sub-county is located in Embu County with an altitude ranging from 500m-1200m asl. The extensive altitude range of the sub-county influences the temperature, which ranges from 20ºC to 32ºC. August being the coldest month with an average monthly minimum temperature of 15ºC, while March is the warmest month with an average monthly maximum temperature rising to 30ºC.

The sub-county has two rainy seasons, the long rains that fall between March and June, while the short rains coming on from October to December. The rainfall however is not very reliable and range between 640 – 1100mm per year. Despite this, most parts of the sub-county receive less than 500mm of rainfall per year, giving the area a marginal status (NEMA, 2009b). Mbeere region represented the dry lowlands where chickpea production is grown. Most farmers in these areas plant chickpea mainly during the short rain season.

Sampling procedure

Bomet and Mbeere South Counties are in dry highlands and lowlands respectively and farmers in these regions grow chickpea. Three villages in Bomet Sub County; Kiplabotwa, Cheboror, Olbobo, and two villages in Chepalungu sub-county; Bing'wa and Chemeng'wa, were sampled while in Mbeere South sub-county four villages (Ndia-Ndasa, Gategi, Maviani-Wovosyo, and Maviani-Rurii) were sampled for the study. The villages in Bomet Sub-County were randomly sampled while in Mbeere South sub-county, purposive sampling, guided by black cotton soils type which could support chickpea growth for a longer period, given that most parts of the sub-county are hot and dry, was used. The identification of these villages was guided by agricultural extension officers. The total number of farmers involved in the study was 235 comprising 103 males and 132 females (Table 1).

Table 1. Sites and number of farmers involved in the PRA study conducted in Bomet and Chepalungu Sub-Counties.

Sub-County	Village	Number of farmers by gender		Total
		Female	Male	
Bomet	Kiplabotwa	9	6	15
	Cheboror	8	7	15
	Olbobo	10	9	19
Sub-total		27	22	49
Chepalungu	Bingwa	10	7	17
	Chemengwa	21	11	32
Sub-total		31	18	49
Mbeere South	NdiaNdasa	5	7	12
	Gategi	18	13	31
	Maviani–Wovosyo	41	34	75
	Maviani – Rurii	11	9	20
Sun-total		55	43	95
Total		132	103	235

Data collection and analysis

Data was collected using Focus Group Discussions (FGD) comprising of 235 farmers (103 males and 132 females) as shown in Table 1. A semi-structured questionnaire was used to lead the discussions. Data was collected on chickpea production constraints, preferred chickpea traits, and specific varieties traits where direct ranking was used. The study was organized with the help of extension officers from the Ministry of Agriculture Livestock Fisheries and Cooperatives, farmer groups, and chickpea informants. Farmers listed the responses and were ranked based on their importance by the majority. The total was obtained by adding the number of respondents, to the same suggested ranking, and dividing by the total number of farmers. The farmer's constraints, preferences, and criteria for variety selection were analyzed using Statistical Package for the Social Sciences (SPSS) version 17, and results were summarized in tables.

Results

Constraints in chickpea production

The ten constraints faced by chickpea farmers are displayed in Tables 2 and 3. The farmers in the Bomet had varied responses on constraints, Kiplabotwa and Olbobo ranked insect pests (86.67% and 94.74%, respectively) while Cheboror ranked drought (86.67%) as the major production constraints. Overall, farmers in Bomet sub-county reported insect damages (87.13%) and drought (83.16%) as the main constraints. Other constraints were damage by birds (76.96%) and unavailability of seeds (68.66%) especially of varieties that were early maturing (53.57%). In Chepalungu sub-county, Bing'wa reported that the maturity period (88.24%), followed by drought (82.35%) were a major threat while Chepmeng'wa farmers indicated insect pests (78.13%) and drought (75.00%) as major factors. The results from the two villages showed that drought (78.68%) and insect pests (77.30%) were major hindrances to production. Overall insects (82.22%), drought (80.93%) and birds damage (72.44%) were major tthreath in Bomet county. Unlike the two sub-counties, Mbeere South had a slightly different ranking where lack of market for the chickpea was the main challenge as reported in Ndia-Ndaasa (91.67%), Maviani-Rurii (62.00%), and Mariani-Wavosyo (82.67%) while in Gategi, drought (93.55%) was a major factor. Overall, 84.91% and 77.72% of farmers felt that lack of market and drought respectively were the major factors to chickpea production in Mbeere South (Table 3). However, these farmers had no challenge with bird damage, seed availability, and the duration the varieties take in the field unlike in Bomet, but they reported a lack of dehusking machine and poor timing of planting.

Table 2. Constraints to chickpea production in three areas in Bomet and two in Chepalungu and their combined percentages in the two Sub-Counties.

	Bomet sub-county				Chepalungu sub-county			Overall combined constraints (%)
	Kiplabotwa (%)	Cheboror (%)	Olbobo (%)	Overall percetage	Bingwa (%)	Chepmengwa (%)	Overall percentage	
Insect	86.67	80.00	94.74	87.13	76.47	78.13	77.30	82.22
Drought	73.33	86.67	89.47	83.16	82.35	75.00	78.68	80.92
Birds's damage	80.00	66.67	84.21	76.96	76.47	59.38	67.92	72.44
Lack of seeds	73.33	80.00	52.63	68.65	35.29	15.63	25.46	47.06
Maturity period	46.67	66.67	47.37	53.57	88.24	56.25	72.24	62.90
Available market	60.00	53.33	36.84	50.06	35.29	53.13	44.21	47.13
Diseases infestation	33.33	40.00	47.37	40.23	58.82	68.75	63.79	52.01
Water logging	60.00	26.67	10.53	32.40	41.18	18.75	29.96	31.18
Threshing ability	20.00	13.33	0.00	11.11	11.76	31.25	21.51	16.31
Lack of training	0.00	26.67	10.53	12.40	11.76	87.50	49.63	31.02

Note: The total percentage can add up to more than 100 since the ranking was by a majority of farmers.

Table 3. Constraints to chickpea production in the four areas and combined percentage in Mbeere South Sub-Counties.

	Ndia-Ndasa (%)	Gategi (%)	Maviani – Rurii (%)	Maviani – Wavosyo (%)	Overall combined constraints (%)
Lack of Markets	91.67	90.32	62.00	82.67	84.91
Drought	75.00	93.55	58.00	77.33	77.72
Pest infestation	66.67	87.10	55.00	73.33	74.27
Diseases (Blight)	75.00	80.65	50.00	66.67	69.33
Threshability	25.00	77.42	30.00	40.00	46.85
Lack of dehusking machine	16.67	67.74	32.00	42.67	35.52
Water logging	58.33	61.29	10.00	13.33	38.24
Poor timing at planting	16.67	16.13	15.00	20.00	20.70

Note: The total percentage can add up to more than 100 since the ranking was by a majority of farmers.

Chickpea preferred traits

Farmers in Kiplabotwa, Cheboror, and Olbobo preferred chickpeas that are high yielding; 86.67%, 93.33%, and 89.47% respectively, while drought tolerance; 73.33%, 86.67%, and 78.95% in that order respectively came second. Other highly-rated traits by the three areas were earliness, pest resistance, and good taste (Table 4). Similarly, in Bing'wa and Chepmeng'wa high yielding varieties were preferred, 88.24% and 90.63% respectively, while drought (74.47%) in Bingw'a and earliness (74.36) in Chepmeng'wa came second. The results obtained showed that in both Bomet and Chebalungu farmers regarded high yield (89.63%), drought tolerance (76.91%), and early maturing varieties (72.79%) as the most important traits they would choose in a variety. Although farmers in Mbeere South considered all these traits as important, their ranking differed slightly with high yield (81.66%) being ranked first, followed by drought tolerance (67.23%), pest resistance (56.40%), and early maturity (47.56%) (Table 5).

Chickpea variety ranking

Specific varieties grown by farmers were ranked based on the six most preferred traits (Table 6). However, this was done only in Bomet (Kiplabotwa) and Chepalungu (Bing'wa and Chemeng'wa) sub-counties since the farmers knew the specific varieties by name unlike in other villages in Bomet and Mbeere South. The results indicated that variety ICCV 97105 (Desi), released as *Chania Desi I* was the most preferred variety because it was considered high yielding, drought tolerant, early maturing, pest and disease resistant but it was reported to have small seeds. The other three important varieties were ICCV 92944 (Desi), released as *Chania Desi II* and ICCV 00108 (Desi), released as *LDT 068,* and ICCV 95423 (Kabuli) released as *Saina K1* based on traits as shown in Table 6. The farmers interviewed in Mbeere South distinguished varieties based on types either as Desi (brown seeds) or Kabuli (cream seeds) with more preference to Desi than Kabuli.

Table 4. Chickpea preferred traits ranked by farmers in three areas in Bomet and two in Chepalungu Sub-Counties and their combined responses.

	Bomet Sub-County				Chepalungu Sub-County			Overall combined preference (%)
Traits	Kiplabotwa (%)	Cheboror (%)	Olbobo (%)	Overall percentage	Bing'wa (%)	Chemeg'wa (%)	Overall percentage	
High yield	86.67	93.33	89.47	89.82	88.24	90.63	89.43	89.63
Drought tolerance	73.33	86.67	78.95	79.65	76.47	71.88	74.17	76.91
Earliness	66.67	73.33	73.68	71.23	70.59	78.13	74.36	72.79
Pest resistance	93.33	53.33	47.37	64.68	64.71	6.25	35.48	50.08
Disease resistance	80.00	60.00	31.58	57.19	70.59	65.63	68.11	62.65
Threshing ability	6.67	66.67	0.00	24.44	47.06	6.25	26.65	25.55
Good taste	40.00	86.67	63.16	63.27	52.94	59.38	56.16	59.72
Germination	6.67	66.67	52.63	41.99	58.82	65.63	62.22	52.11
Heavy seeds	6.67	6.67	36.84	16.73	5.88	50.00	27.94	22.33
Colour	0.00	6.67	31.58	12.75	5.88	28.13	17.00	14.88
Tolerant to waterlogging	6.67	6.67	26.32	13.22	5.88	6.25	6.07	9.64
Stability	6.67	6.67	42.11	18.48	5.88	6.25	6.07	12.27

Note: The total percentage can add up to more than 100 since the ranking was by a majority of farmers.

Table 5. Chickpea preferred traits ranked by farmers in four areas visited in Mbeere South Sub-County.

Trait Preference	Ndia-Ndasa (%)	Gategi (%)	Maviani - Ririi (%)	Maviani - Wavosyo (%)	Overall preference (%)
High yielding	83.33	90.32	85.00	68.00	81.66
Drought tolerance	52.94	80.65	70.00	65.33	67.23
Early maturity	47.06	74.19	5.00	64.00	47.56
Pest resistance to both field and storage pests	41.18	67.74	50.00	66.67	56.40
Tolerance to water logging	41.18	54.84	5.00	46.67	36.92
Easy to thresh and Winnow	5.88	3.23	60.00	48.00	29.28
Adaptability to intercropping	5.88	3.23	40.00	2.67	12.94
Resistance to diseases	35.29	61.29	20.00	45.33	40.48
Good taste	23.53	41.94	55.00	37.33	39.45
Colour	29.41	0.00	15.00	20.00	16.10
Soft testa	35.29	32.26	5.00	1.33	18.47

Note: The total percentage can add up to more than 100 since the ranking was by a majority of farmers.

Table 6. Direct ranking of specific chickpea varieties against highly ranked traits in Kiplabotwa in Bomet Sub-County, Bing'wa and Chemeng'wa both in Chepalungu sub-Counties.

Variety/type	High yield	Drought tolerance	Early Maturity	Pest resistance	Disease resistance	Large seeds
	Kiplabotwa					
ICCV 97105 (Desi)	1 (60)	1 (47)	1 (47)	2 (27)	2 (33)	4 (7)
ICCV 92944 (Desi)	2 (20)	2 (27)	2 (27)	3 (13)	1(40)	2 (27)
ICCV 00108 (Desi)	4 (7)	4 (20)	3 (20)	1 (53)	3 (20)	3 (13)
ICCV 95423 (Kabuli)	3 (12)	3 (7)	4 (7)	4 (7)	4 ()	1 (60)
ICCV 96329 (Kabuli)	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)
	Bing'wa					
ICCV 97105 (Desi)	1(35)	1 (41)	1 (35)	1 (41)	1 (35)	5 (9)
ICCV 95423 (Kabuli)	2 (6)	2 (12)	5 (6)	4 (12)	2 (29)	2 (24)
ICCV 00108 (Desi)	3 (29)	3 (24)	2 (29))	2 (24)	3 (26)	4 (12)
ICCV 00305 (Desi)	5 (12)	4 18)	4 (12)	3 (18)	5 (9)	1 (41)
ICCV 96329 (Kabuli)	4 (18)	5 (9)	3 (18)	5 (9)	5 (9)	3 (18)
Variety/type	Chemeng'wa					
ICCV 97105 (Desi)	1 (34)	1 (38)	1 (41)	1 (38)	1 (31)	4 (9)
ICCV 92944 (Desi)	2 (31)	2 (31)	2 (25)	2 (31)	3 (22)	3 (22)
ICCV 95423 (Kabuli)	4 (22)	3 (13)	3 (22)	5 (13)	2 (28)	2 (25)
ICCV 96329 (Kabuli)	3 (13)	4 (19)	4 (13)	3 (19)	4 (19)	1 (44)
ICCV 00108 (Desi)	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)	5 (0)

Key: Varieties ranked 1 had highly preferred trait and 5 was ranked lowest; Fig.s in parenthesis represent farmers preferred trait in percentage (%); Note: The total percentage can add up to more than 100 since the ranking was by a majority of farmers.

Discussion

Chickpea production Constraints

Chickpea in Kenya is produced purely under rain-fed conditions where a majority of farmers plant during the short rains, once the main crop is harvested and on a small scale. Farmers in Chepalungu and Bomet sub-counties reported that pest infestations, drought, and lack of early maturing varieties were the major constraints while farmers in Mbeere South farmers ranked lack of market as a major constraint followed by drought and pest infestation. This difference in the ranking was due to different farming systems, needs, and purposes in addition to farming practices in differing localities. Lack of market for example was a major issue in Mbeere South because most of the communities in the region planted chickpea for commercial purposes just like crops such as maize and rice. Availability of the market strongly determines when and what to plant. In other reports, market demand strongly influenced farmers' crop selection criteria (Witcombe *et al.*, 2006).

Pest infestations were major constraints that cut across the three sub-counties. Pod borers were reported to be the major pest. Losses in chickpea due to *Helicoverpa armigera* (Hüb,) alone were reported to range between 20 – 40% (Sharma *et al.*, 2005). Chickpea was planted during the short rains under rain-fed conditions, as a relay crop in Bomet and Chepalungu and as a sole crop in Mbeere South. These seasons are characterized by unreliable and unpredicted rainfall patterns and changes in temperature due to the dry period. This probably increases the pest population mainly pod borers. When there is high rainfall, it was predicted to contribute to washing the noctuid eggs of *H. armigera* (Hüb.) lowering the population (Mulwa *et al.*, 2010). Additionally, it was reported that an abrupt rise in temperature by 5°C at the podding stage of chickpea caused the maximum prevalence of *H. armigera* larvae in India (Singh *et al.*, 2015). A similar observation was reported in common beans during drought and late-planted seasons where temperature affected bean fly populations (Sariah and Makundi, 2007; Kosgei, *et al.*, 2013). This showed that pest infestation correlates with weather conditions hence the need for continuous pest monitoring. Birds' damage was also reported as a problem in Bomet and Chepalungu during the podding stage. Birds become serious during podding when pods are tender and easy to peck, and generally, chickpea is sweet-tasting at this stage. Also during this season, chickpea is probably the only crop in the field, since it is planted after harvesting the main crop. This gives birds no other alternative food, hence serious damage is experienced when few farmers having a crop in the field. Some farmers indicated that they intercropped chickpea and sorghum, as a trap crop since sorghum is preferred by birds. This has been reported to work in managing pests such as stem borers in other crops (Wright *et al.*, 2020). Encouraging many farmers to plant chickpea as a relay crop in an intercrop will probably reduce bird's damage.

Drought has become a frequent occurrence in several parts of the country. Although chickpea is known for its drought tolerance compared to other commonly grown legumes, terminal drought reduces yield and can lead to total crop failure. In general, drought has been reported to cause 40 - 50% average yield loss in chickpea (Varshney *et al.*, 2009) while terminal drought caused seed yield reduction of between 58-95% in comparison to yield under irrigation (Leport *et al.*, 2006). Terminal drought imposed on early podding chickpea affected yield-related traits which ultimately affected yield (Pang *et al.*, 2017). According to Lalitha *et al.*, (2015) further losses due to climate change will lead to increased incidence and severity of drought resulting in reduced food production. In a survey done in Mbeere, farmers indicated that food shortage period occurs from December to February (Mergeai *et al.*, 2001). During this time, these areas are receiving short rains and also indicated as a time of planting chickpea hence exposing it to terminal drought. Lack of early maturing variety was another constraint that caused yield reduction in Bomet and Chepalungu sub-counties. When varieties take longer to mature, the crop will be at the podding stage during the dry period of the short rains, hence they will not escape drought. During the short rains season, rainfall may either delay or stop early.

This exposes the crop to both early stress and late drought (terminal) or one of these constraints. Reports on chickpea in Naivasha, planted towards the end of the rainy season, had significantly decreased shoot biomass and number of pods (Onyari *et al.*, 2010) while early maturing varieties escaped drought (Upadhyaya *et al.*, 2007). Significant advancement in the maturity date of chickpea in Canada was achieved by incorporating early flowering, double podding, and other favorable alleles into the desirable genetic backgrounds (Anbessa *et al.*, 2007).

International Center for Agricultural Research in the Dry Areas (ICARDA) considered traits such as early seedling establishment, early plant growth vigor and canopy development, early flower development, and maturity as potential traits through which useful lines were identified (Mazid *et al.*, 2013). Such traits are important in managing drought conditions, especially during short rains.

Disease infestation was also reported as an important constraint. The major disease reported to attack chickpea was Ascochyta blight [*Ascochyta rabiei* L. (Pass.)] and cases of Fusarium wilt (*Fusarium oxysporum*) (Gan *et al.*, 2006; Pande *et al.*, 2011; Kimurto *et al.*, 2013; Pande *et al.*, 2013). This was mainly a problem in the dry highlands due to cooler temperatures during the early months of chickpea production. Chickpea losses due to Ascochyta blight were reported to cause up to 100% crop loss especially in dry highlands (Kimurto *et al.*, 2013). Besides, black cotton soils could retain water longer, and if excess rainfall occurred at a later stage of crop growth it could result in root rots and blights.

Chickpea farmers preference

Farmers in the three sub-counties ranked high yield, tolerance to drought, and early maturity as the main reasons for the choice of varieties to plant. Other traits of importance were tolerance to pests and diseases. As indicated, during the short rains season, chickpea is normally exposed to harsh conditions such as drought reducing the yields (Thudi *et al.*, 2014). Varieties that could tolerate these conditions or mature early before the terminal drought sets in were preferred (Gaur *et al.*, 2009).

Such varieties would also have less infestation by pests due to a short cycle when pest population pressure was still low. Results from a survey in Embu, indicated that farmers were also interested in chickpeas that are bold seeded, easy to thresh (adaptable to mechanization), heat tolerant, easy to cook, and have a better taste (Kaloki, 2010).

In PVS conducted in Naivasha and Bomet sub-counties, farmers preferred chickpea that was disease-resistant, early maturing, high plant vigor, tasty, and high seed yield (Thagana *et al.* 2009). Seed size and uniformity were noted as important in determining market price especially for the Kabuli type (Davies *et al.*, 1999). Lack of improved varieties and mechanization challenges in chickpea were indicated as reasons that hinder the development of the chickpea seed industry (Van Gastel *et al.*, 2018). Lack of availability of seed also hinders farmer adoption.

Chickpea requires 152.4-254.0mm of rainfall a season or irrigation during its growth and development and hence well suited to semi-arid lands or under limited-irrigation production areas, however, its exposure to terminal drought is one of the major constraints to increasing productivity (Kanouni *et al.*, 2012). In research conducted in Zimbabwe on maize adaptation to drought, farmers indicated that they preferred maize that was high-yielding, early maturing, and drought-tolerant (Mhike *et al.*, 2012). Farmers' interest in high-yielding and drought-tolerant varieties could be attributed to the current temperature increase due to global warming. Rising temperatures, droughts, floods, desertification, and weather extremes will severely affect agriculture, especially in the developing world (IPCC, 2009).

Reports indicated that negative impacts of climate change on crop yields than positive impacts have been more common (IPCC, 2014). Farmers, therefore, have rich knowledge and experience in the selection of varieties over several years hence enhancing agricultural production.

Chickpea variety selection

The choice of specific preferred varieties differed among the farmers in the regions but three varieties namely; ICCV 97105, ICCV 92944, ICCV 00108, all being Desi types, were common across the three locations and given more preference. One variety ICCV 95423 which is Kabuli type was given some preference. Similar differences in the choice of varieties across localities have been reported (Ojwang, 2010; Were, 2011; Kiiza *et al.*, 2012). Farmers reported that the Desi type had many uses compared to Kabuli in addition to less infestation by pod borers and disease. It also cooked well without testa peeling off, just like beans, pigeon peas, green grams, and green peas, compared to Kabuli types. Thus, it was possible to cook in a mixture with maize just like beans. However, they indicated that it takes slightly longer to cook. Further, the Desi type of varieties was shown to be more drought tolerant than the Kabuli type (Purushothaman *et al.*, 2013). Involving farmers in understanding their constraints and preferences of traits of interest and choice of specific varieties are key factors in the development of varieties that target and meet their needs, under different environmental conditions.

Conclusion

Results from this research show that farmers have constraints that hinder chickpea production and utilization and preferred traits for specific varieties that could influence adoption rate. Farmers in chickpea growing areas indicated that drought, pest infestations, and lack of market were the most important constraints, followed by lack of training and good quality seeds. Farmers preferred chickpea varieties with the following traits: high yielding, drought tolerant, early maturing, resistant to pests/diseases, and tolerant to waterlogging. Farmers also reported preference to certain varieties over others, with more preference to Desi than Kabuli types, given that it cooks without peeling off its testa hence possible to cook well with maize. To develop high-yielding chickpea with qualities that address farmers' constraints and preferences, their involvement is crucial from the beginning of the breeding process i.e. before developing a variety, to ensure their major constraint(s) and preferred traits are considered. This will increase the chances of adoption of varieties released, hence increased chickpea productivity in Kenya.

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Conflict of interest

The authors have no conflict of interes to declare.

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