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Farmer preference for selected finger millet (*Eleusine coracana*) varieties in Rift Valley, Kenya

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Lack of awareness and information on the traits of orphan crops such as finger millet is a major constraint to finger millet production. Farmer participatory and varietal selection (FVPS) is an efficient method of achieving productivity through enhancing adoption of improved high yielding varieties. A study was conducted in two major growing areas in central Rift Valley, Agri-ecological zone III (ATC-Nakuru and Bomet), to assess the level of awareness and farmer preference of twenty-five finger millet varieties. Farmer participatory variety selection was conducted at physiological maturity of the finger millets. One hundred farmers assessed and scored their preferred traits and varieties in each site. The scores were ranked on a scale of 1-5 in Focused Group Discussions (FDGs) and analyzed using Kruskal Wallis H-test of non-parametric data using Statistical Package for Social Science (SPSS) while scores collected on variety traits were used to construct a Pair-wise ranking table to find the best traits selected by farmers. The results showed that farmers preferred high yielding varieties with qualities such as uniformity, drought tolerance, tillering ability, big fingers, lodging and folded or straight fingers. They appreciated the snapping varieties for the ease of harvesting using fingers instead of traditional cutting using a knife. Kal 2 Pader (3.9), P-224 (3.9), KatFM1×U151.6.6.3.1.1 (3.9), GBK 027189A (2.8), Snapping green early (3.7) and KatFM1xU151.7.8.2.1 (3.7) were the most preferred varieties while in AEZ III, Bomet ATC KatFM1 (4.3), KNE 741 (4.3), KNE629 (4.2), KatFM1×U151.6.6.3.1 (4.1), Gulu E (3.9), GBK 027189A (3.8) and Kal 2 pader (3.8) were the most preferred varieties in ATC Nakuru. In both sites KatFM1×U151.6.6.3.1.1 (4.0), Kal 2 pader (3.85) and GBK 027189A (3.8), Gulu E (3.75) and P-224 (3.75), were ranked the best. The farmers expressed their interest in accessing the seeds of these improved varieties. FPVS provides a platform for identification of the most preferred traits of finger millet and knowledge dissemination of improved varieties to farmers.

Key words: Finger millet, farmer participatory variety selection (FVPS), farmers preferred traits and varieties.

INTRODUCTION

Finger millet (*Eleusine coracana*) is highly nutritious cereal food for the weak and people with low immunity (Takan et al., 2012). It contains nutritional elements which are easy to digest thus a major source of food for pregnant women, the sick, lactating mothers, children and diabetics (Singh and Raghuvanshi, 2012). *E.*

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coracana is the most important small millet grown for subsistence in Eastern Africa and Asia. In East Africa, it is majorly used for food in form of thin porridge, malting and brewing (Mitaru et al., 1993). In Kenya, finger millet also commonly called '*wimbi*' is used for making porridge, thick porridge '*ugali*' and for brewing. Finger millet production has declined over the years from 99000 tons in 2015 to 54000 tons in 2016 and 2017. It is commonly planted in Western Kenya, around Lake Victoria and in Eastern Kenya. Western Kenya has 77,000 ha (29%), Nyanza 57,000 ha (15%) and Rift Valley 65,000 ha (13%) under finger millet production (FAO, 2012).

However, in recent years, finger millet has witnessed an expansion in the last 5 year to >200,000 ha (Upadhyaya et al., 2016) due to combined research and promotion efforts that have provided new varieties, improved agronomy, and growing of the crop as an alternative to Maize Lethal Necrosis Disease (MLND) in many areas including Bomet (Mgonja et al., 2007).

Finger millet production is still low due to continuous use of poor unimproved landraces that are mostly susceptible to blast and low yielding, insufficient information on improved varieties, poor dissemination of seeds, post-harvest handling of finger millet and poor attitude linked to the crop (Degu et al., 2009; Molla et al., 2020). This has been a major challenge for adoption of finger millet to farmers in Kenya. High yielding varieties have been developed and released for general cultivation through breeding of exotic and indigenous lines by researchers but adoption is still a challenge (Singh et al., 2016). FPVS has resulted in positive impact with adoption of technology and improvement of livelihood to both farmers and researchers (Witcombe et al., 2005). It has been successfully done in many crops including rice (Paris, 2011; Panwar et al., 2019; Orlando et al., 2020), beans (Tamene, 2016; Yadavendra et al., 2017), barley (Ferede and Demsie, 2020), wheat (Van Frank et al., 2020), sorghum (Sissoko et al., 2019; Vom et al., 2020), Bambara nuts in Malawi (Pungulani et al., 2012) and finger millet (Ojulong et al., 2017; Tarekegne et al., 2019). Various varieties of finger millet have been up-scaled, released, adopted and disseminated to farmers in countries such as Tadesse, Wama, Degu and ACC#213572 for Delgi and Chilga in Ethiopia (Fentie, 2012), and U-15 and P-224 in Tanzania (Ojulong et al., 2017) through Farmer Participatory Varietal Selection (FVPS). Different environmental conditions, traits of interest, cultural and religious beliefs, gender, marketability and value addition among others influence the choice made by farmers during evaluation (Cleveland et al., 2000). Recent research incorporates farmers for improved uptake, knowledge dissemination and promotion of innovations which can easily be found during FVPS. This study aimed at identifying the most preferred traits and varieties of finger millet identified in AEZ III, ATC Nakuru and Bomet for future breeding, up-scaling and release of the farmer-chosen varieties.

METHODOLOGY

Site description

The experiment was conducted during the long rain season 2019, January-June and short rain season of June-December, in ATC-Bomet and ATC-Nakuru, respectively. ATC-Bomet, the experiment was done at longitude 35°20'29.62" E and latitude of 0° 46'52.64" N. It is a medium altitude zone with an evenly distributed rain throughout the year and a mean rainfall of 1000-1400 mm. The mean monthly temperature is 17.2°C. Soils are *Humic Nitisols*. ATC-Nakuru, lies at a longitude of 36°04'0.01" E and a latitude of 0°16'59.99" N with a mean annual rainfall of 1012 to 1800 mm, well distributed and temperature ranging from 15 to 20°C. Soils are *Mollic Andosols*, well drained dark reddish brown for ATC-Nakuru (Jaetzold and Schmist, 2012).

Experimental layout and management operations

The experiment was laid out in Alpha lattice design with 5 blocks and 3 replications. Each experimental plot was 2 m long by 2 m wide therefore having a gross area of 4 m^2. Each block had four rows, each 2 m long. Planting was done by hand drilling both the seeds and the fertilizer at the rate of 20 kg/ha. Fertilizer was applied during planting at a rate of 40 kg/ha N of DAP sourced from Spring fertilizer. 48 kg/ha P_2O_5 applied during topdressing as CAN during topdressing at tillering stage. Due to differences in maturity which affected tillering stages among the varieties, an interval of two weeks was considered during application to the late maturing varieties.

Data was collected from center two rows to reduce the border effect. All management practices such as thinning and gapping, weeding, and topdressing were performed as required.

All data collected was subjected to Statistical Analysis Software (SAS) and SPSS. Pair-wise comparison, mean tables were then constructed to give the best varieties and traits in both sites. SAS was used to compute univariate procedure to give standard error of the means.

Plant genotypes

Twenty-five finger millet genotypes were planted in Agri-Ecological Zone (AEZ) III in both ATC Nakuru and ATC Bomet. The 25 genotypes were sourced from ICRISAT, Egerton Seed Unit, KALRO, Genebank of Kenya and local varieties. Of the 25 selected varieties, eight are commercial varieties, twelve are advanced breeding lines and five are local varieties (Table 1).

Farmer participatory variety selection

Target population and sampling procedure

The target group of study was smallholder millet farmers in Nakuru and Bomet counties. This group was composed of people of varying gender and age, income groups, lifestyles and education levels. The area had a high concentration of people whose project targets and deliverables were directly impacted on their livelihoods. A sample size was generated using Yamane formula (Yamane, 1973):

$n = N / (1 + Ne^2)$

Where n= corrected sample size, N= population size, e= $(0.08)^2$ the margin of error 30= 300/1+300$(0.08)^2$=102 farmers.

Table 1. List of Finger millet genotypes evaluated.

No.	Genotype	Source	Description
1	P-224	Kenya Seed	Commercial variety
2	U-15	KALRO	Commercial variety
3	NKRFM1	Egerton	Commercial variety
4	KATFM1×U15 1.7.8.2.1	KALRO	Advanced breeding line
5	IE 615	ICRISAT	Advanced breeding line
6	KNE1034	ICRISAT	Advanced breeding line
7	GBK027189A	Gene Bank	Advanced breeding line
8	IE 2183	ICRISAT	Advanced breeding line
9	IE 2872	ICRISAT	Advanced breeding line
10	Kal Dokolo	Local	Local land race
11	Otiyo brown	Local	Local land race
12	Kal 2 Pader	Local	Local land race
13	KNE 628	ICRISAT	Advanced breeding line
14	Kal pader	Local	Local land race
15	Snapping purple	Egerton	Commercial variety
16	KAT FM1	KALRO	Commercial variety
17	KNE 741	Egerton	Commercial variety
18	Ikhulule	Local	Local landrace
19	Gulu E	ICRISAT	Commercial variety
20	SMDF 1702	Egerton	Advanced breeding line
21	KNE 629	ICRISAT	Commercial variety
22	Snapping green early	Egerton	Advanced breeding line
23	KATFM1×U15 1.6.3.3.1	KALRO	Advanced breeding line
24	KNE 1124×KNE 796	ICRISAT	Advanced breeding line
25	KATFM1×U15 1.6.6.3.1.1.	KALRO	Advanced breeding line

Farmers' ranking on traits of finger millet

Ranking and selection of best performing varieties and varietal differences was conducted when the crop was at physiological maturity. At this stage, farmers were able to note the agronomic differences of finger millet such as flower type (folded or straight), number of tillers, grain color, uniformity among other traits scored by farmers. Farmers were grouped into Focused Group Discussion (FGD) consisting of 10 farmers and one extension officer assigned to each group. They were then provided with scoring templates that contained the variety numbers (1-25) arranged vertically on the left of the sheet and the scoring traits arranged horizontally. Each of the varieties was scored on a scale of 1 to 5 (very poor to excellent respectively) (ICRISAT, 2011) (Table 2). The scores were then utilized for identification of most preferred traits and varieties. Traits included high yielding-based on agronomic traits of the plant, size of the fingers, high tillering ability, resistance to bird infestation and lodging among others. Early maturity-based on early days to heading, anthesis and physiological maturity. Marketability-based on the color of the grain and ability to be availed to the market on time depending on maturity. Drought tolerance, the ability to mature early and escape drought and high number of tillers. Blast tolerance-ability to resist and tolerate blast disease both on finger and leaf. Big fingers- based on the finger length and finger number. Lodging was based on ability to resist lodging by having strong stems and medium height. Grain color-based on red, black brown and white. Tillering-based on the number of tillers per plant and uniformity-the ability to have a uniform height and mature uniformly. Varieties were ranked based on the scores received per trait and afterwards the scoring sheet collected and separated according to gender. Both qualitative and quantitative data was then used as an indication of final scoring and selection of traits and varieties chosen by farmers. This data did not only give the best traits and varieties chosen by farmers in both regions but also the overall comments and opinions of farmers on finger millet in both regions. Survey data collected (Table 5) was subjected to Kruskal-Wallis test of non-parametric data and the highest means and ranking was used to obtain the best varieties selected by farmers using Statistical Package for Social Sciences version 20. A pairwise ranking matrix was also done to obtain the best traits selected by farmers. Statistical Analysis Software (SAS) was used in univariate analysis to find the standard error of the means and to check the normality of the data.

RESULTS AND DISCUSSION

Farmer preference of finger millet traits

Results of the study (Table 3) showed farmers had high preference to varieties with higher uniformity (3.98), drought tolerance (3.80), snapping ability (3.79), tillering ability (3.69), big fingers (3.55) and high yielding (3.54) and resistance to lodging (3.51) in both sites. In Nakuru county, farmers recognized good taste (2.72),

Table 2. Scoring template for the 25 varieties.

Score	Description	Remarks
1	Very low vigor, very low number of tillers, not uniform, very small fingers, high lodging, very low tolerance to pest and diseases	Very poor
2	Low vigor, less tiller numbers, small fingers, lodging, low tolerance to pests and diseases	Poor
3	Average vigor, average number of tillers, medium sized fingers, averagely tolerant to pest and diseases	Fair
4	Vigorous, highly tillering, big fingers, tolerant to pest and diseases, less lodging	Good
5	High plant vigor, highly tillering, long and big fingers, resistant to pest and diseases and not lodging	Excellent

Table 3. Results of Focused Group Discussions (FDG) on preferred finger millet traits done in both sites Nakuru and Bomet.

Finger millet trait	Scores per site		
	Nakuru	Bomet	Mean
Uniformity	59	4.23	3.91
Folded or straight fingers	96	3.65	3.81
Snapping ability	71	3.88	3.79
Drought tolerance	36	4.15	3.76
Tillering	61	3.71	3.66
Lodging	68	3.33	3.51
High yielding	3.63	3.37	3.50
Bird resistance	3.37	-	3.37
Marketability	3.53	3.13	3.33
Early maturity	3.32	3.03	3.18
Resistance to diseases	3.42	2.38	2.90
Good taste	2.76	-	2.76

*Blanks indicate that the parameters bird resistance and good taste were not assessed in Bomet.

grain color (2.46) and folded or straight fingers (1.73) as least important while in Bomet marketability (3.32), early maturity (3.19) and resistance to diseases (2.19) received the lowest score (Table 2). A pair-wise comparison (Table 4) was done to determine the most preferred trait of finger millet as scored by farmers and the best traits selected and ranked (Table 4). For the presence of various varieties ranging from commercial varieties, advanced breeding lines and local varieties, there were different opinions of varieties basing on their performance. Selection was based on yield and yield component traits including uniformity, drought tolerance, tillering ability, big finger, lodging and folded or straight fingers; resistance to challenges such as bird infestation and resistance to diseases; and good marketing ability such as good taste, grain color. Farmers selected the best traits of finger millet based on the yield traits and yield performance of the varieties including high yielding, tolerance to diseases and birds, high tillering ability, plant height and early maturity. The farmers evaluated and ranked the

Table 4. Finger millet trait ranking based on focused group discussion (FDGs) at Agricultural Training Centre in Nakuru and Bomet.

Trait	Bird infestation	Early maturity	Tillering	Big finger	High yielding	Lodging resistance	Uniformity	Points	Rank
Bird resistance		Bird resistance	Tillering	Big finger	High yielding	Lodging	Uniformity	6	7
Early maturity			Tillering	Big finger	High yielding	Lodging	Uniformity	5	8
Tillering ability				Tillering	Tillering	Tillering	Uniformity	10	2
Big finger					Big fingers	Big finger	Uniformity	9	4
High yielding						High yielding	Uniformity	8	5
Lodging							Uniformity	7	6
Uniformity								12	1
Snapping ability								6	7
Marketability								5	9
Drought tolerance								10	2
Resistance to diseases								3	10
Good taste								2	11
Good color								1	12
F/S finger								0	13

Trait	Marketability	Drought tolerance	Resistance to diseases	Good taste	Grain color	Folded/Straight finger		
Bird resistance	Bird resistance	Drought tolerance	Bird resistance	Bird resistance	Bird resistance	Bird resistance	6	7
Early maturity	Marketability	Early maturity	Early maturity	Early maturity	Early maturity	Early maturity	5	8
Tillering ability	Tillering	Drought tolerance	Tillering	Tillering	Tillering	Tillering	10	2
Big finger	Big finger	Drought tolerance	Big finger	Big finger	Big finger	Big finger	9	4
High yielding	High yielding	Drought tolerance	High yielding	High yielding	High yielding	High yielding	8	5
Lodging	Lodging	Drought tolerance	Lodging	Lodging	Lodging	Lodging	7	6
Uniformity	Uniformity	Uniformity	Uniformity	Uniformity	Uniformity	Uniformity	12	1
Snapping ability	Snapping ability	Snapping ability	Snapping ability	Snapping ability	Snapping ability	Snapping ability	6	7
Marketability		Drought tolerance	Marketability	Marketabilit y	Marketab ility	Marketability	5	9
Drought tolerance			Drought tolerance	Drought tolerance	Drought tolerance	Drought tolerance	10	2
Resistance to diseases				Resistance to diseases	Resistance to diseases	Resistance to diseases	3	10
Good taste					Good taste	Good taste	2	11
Good color						Grain color	1	12
F/S finger							0	13

best chosen traits of finger millet through Focused Group Discussions (FDG) and using a pairwise ranking matrix (Table 3), the best trait were selected for future breeding purposes. Pair-wise ranking and farmers' preference linked to high yielding, high tillering, resistance to diseases, grain color and good threshability (Owere et al., 2014; Watson, 2019; Sibiya et al., 2013).

Table 5. Mean scores and ranking of varieties on various traits of finger millet in ATC-Nakuru.

Variety	High Y	Market	Early M	DRT T	RTD	Taste	F/S fingers	Lodging	Tillering	Uniformity	Bird I	Means	Rank
Kal 2 Pader	4.51	4.29	3.53	3.73	4.12	3.08	4.02	3.98	4.18	4.04	3.8	3.93	1
P-224	4.29	3.92	3.43	3.75	4.14	3.29	4.02	3.71	4.1	4.06	3.94	3.88	2
KATFM1 × U15 1.6.6.3.1.1	4.12	3.65	3.63	3.88	3.94	3.02	4	4.1	4.1	4.14	3.96	3.87	3
GBK 027189A	4.27	4.16	3.69	3.45	3.88	2.88	3.96	4.16	3.82	3.94	3.96	3.83	4
Snapping Green Early	3.8	3.78	3.29	3.59	3.86	3.06	3.88	4.04	3.63	3.98	4	3.72	5
KATFM1 × U15 1.7.8.2.1	4	3.78	3.51	3.82	3.55	2.96	3.94	3.76	3.69	3.73	3.59	3.67	6
KNE 1034	4	3.78	3.37	3.53	3.73	3.24	3.96	3.47	3.63	3.59	3.8	3.65	7
GULU E	3.86	3.76	3.49	3.41	3.59	3.04	3.96	3.94	3.82	3.53	3.59	3.64	8
Snapping Purple Variety	3.88	4	3.33	3.53	3.84	2.73	3.96	4.06	3.67	3.53	3.41	3.63	9
Ikhulule	4.04	3.78	3.49	3.27	3.61	3.12	3.98	3.82	3.73	3.51	3.2	3.6	10
Kal Dokolo	3.92	3.86	3.43	4.24	3.2	2.78	3.92	3.76	3.75	3.78	2.9	3.6	11
Kal Pader	3.78	3.39	3.22	3.35	3.61	2.86	3.92	3.78	3.51	3.75	3.59	3.52	12
KATFM1 × U15 1.6.3.3.1	3.59	3.45	3.55	3.82	3.41	2.82	3.9	3.63	3.57	3.45	3.47	3.52	13
SDMF 1702	3.61	4.55	3.25	3.53	3.49	2.9	3.94	3	3.45	3.25	3.69	3.52	14
IE 2872	4.02	3.31	3.45	3.41	3.37	2.57	3.94	3.67	3.55	3.76	3.1	3.47	15
U-15	3.57	3.57	3.31	3.43	3.22	2.49	3.96	3.82	3.55	3.63	3.1	3.42	16
KNE 1124 × KNE 796	3.67	3.43	3.08	3	3.2	3.04	4.02	3.39	3.65	3.61	3.37	3.4	17
NKR FM1	3.24	2.9	3.65	3.1	3.04	2.76	4	3.73	3.67	3.9	3.04	3.37	18
KNE 628	3.33	3.24	3.45	3.18	3.45	2.24	3.88	3.65	3.59	3.35	3.12	3.32	19
KNE 629	3.06	3.18	3.02	2.94	2.98	2.82	4.02	3.76	3.37	3.2	3.35	3.25	20
Etiyo Brown	3.39	3.27	3.24	3.22	3.2	2.43	3.9	3.33	3.29	3.12	3.12	3.23	21
KAT FM1	2.9	2.75	3.24	2.67	2.88	2.22	4	3.82	3.45	3.33	2.55	3.07	22
IE 615	2.8	2.84	2.63	2.75	2.73	1.96	3.92	3.24	3.2	3.51	3.33	2.99	23
IE 2183	2.84	2.71	2.98	2.76	2.73	2.25	3.88	3.14	3.24	3.25	3	2.98	24
KNE 741	2.33	2.9	2.86	2.65	2.78	2.39	3.98	3.33	3.16	2.76	2.27	2.86	25
Mean	3.63	3.53	3.32	3.36	3.42	2.76	3.96	3.68	3.61	3.59	3.37	3.48	-
Standard error of mean	0.1070	0.0977	0.0512	0.0823	0.0843	0.0703	0.0093	0.0613	0.0529	0.0667	0.0887	0.23	-

*High Y=High yielding, Market=Marketability, Early M=Early Maturity, DRT T=Drought Tolerance, RTD=Resistance to diseases, F/S finger=Folded/Straight finger, Bird I=Resistant to bird infestation.

The farmers had a high preference for uniformity of finger millet (3.91). The response was that non uniform varieties have difficulties in management causing increased labor. Uniformity provides an ease of management activities such as ease of harvesting, weeding and spraying for the control of weeds. Farmers also had a high preference to drought tolerant varieties (3.75) especially in Bomet as reported by Owere et al. (2016) who stipulated that height of 1±0.2 m, high tillering ability and drought tolerant varieties are most preferred by farmers. Tillering ability and big fingers (3.69 and 3.55, respectively) of the variety were directly linked to high yielding qualities si. The higher the number of tillers the

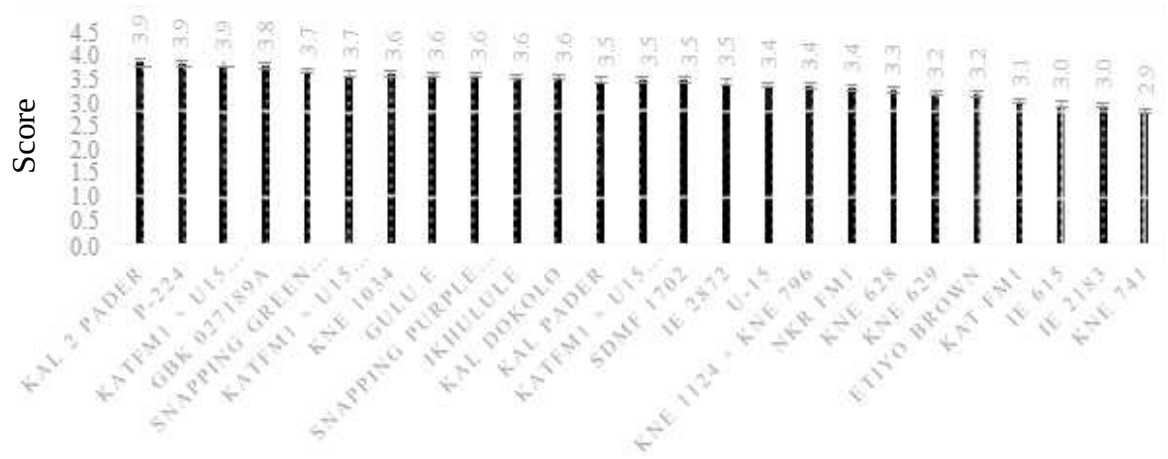

Figure 1. Mean variety scores on a scale of 1-5 of 25 varieties in ATC Nakuru county.

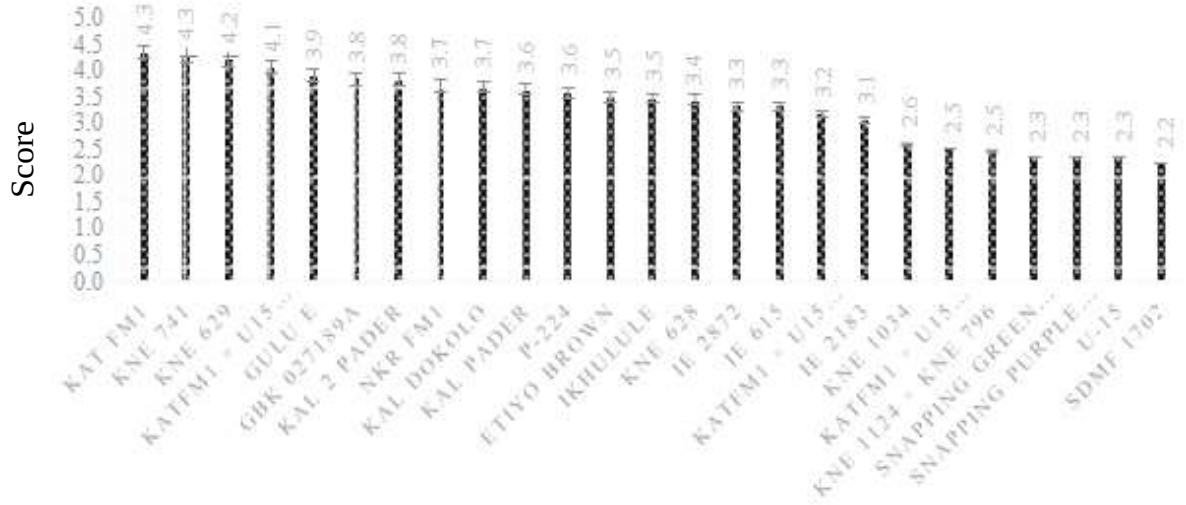

Figure 2. Mean variety scores on a scale of 1-5 of 25 varieties in ATC, Bomet county.

higher the plant will produce and the bigger the finger length and number the higher the number of seeds a panicle could carry. Sadreddine (2016) and Hadjichristodoulou (1985) reported that in order to select the high yielding varieties for breeding purposes in multi-environments, one should consider tillering as an important trait. The farmers had major interest on big fingers as compared on folded or straight fingers. They observed that the bigger the fingers whether they have a straight or folded type, could yield more seeds. Therefore, they preferred big-fingered varieties. The folded varieties also had an advantage over the straight varieties. They pointed out that the folded-finger variety could easily escape disease and bird attack as compared to the straight type of varieties. This however did not seem to directly affect the traits that led to high yield therefore scoring less compared to other traits.

The farmers assessed the grain color of the varieties and used it to determine the marketability of the varieties. The color of the grain was either reddish brown, brown or white seeded. The scores were then used to calculate the percentages and presented in Figures 1 and 2. The most preferred traits of finger millet were the reddish brown color in Bomet while in Nakuru farmers also preferred the red and brown seeded varieties. It was most preferred because it fetches high prices in the market. The farmers were able to point the fact that it could blend well with other flours such as cassava and sorghum, which is similar to the results by Oduori and Kanyenji (2007). The second best preference for farmers was the brown grain seeded varieties

which had similar comments only that it fetched slightly lower prices as compared to the reddish brown. These two varieties were also said to be resistant to blast disease and also they were not preferred by birds because of the bitter taste they contained. The white grained was said to be sweeter and more suitable for brewing. Ravikumar and Jeetharam (1993) reported that the white seeded had higher content of proteins and lower phenols and tannins. This is the reason for birds and blast susceptibility to the variety.

Farmers experienced difficulties in identification of blast disease in the varieties and the only way they could score is by checking the mature heads. Most farmers had not known that it was a disease and had suspects of birds or other pest such as shoot fly. Farmers also had minimal knowledge on differentiating an attack by shoot fly and the blast disease. Also the compact headed varieties were found to be resistant to blast disease as compared to the open and straight finger types. Farmer's knowledge on blast disease was minimal. The farmers could not differentiate the disease when it was on the leaf. On the head attack the compact fingers projected a higher preference as compared to the straight fingers. These results show similarity with Takan (2004). There was a serious lack of awareness concerning the disease.

Farmer preference on the varieties

The findings of the study showed that there was variation in the scoring of the varieties in both sites. In Nakuru ATC, majority of farmers participated in the evaluation process leading to a higher scoring compared to ATC-Bomet. The varieties had different characteristics due to genotype by environment interaction which was evident in the performance and traits of the finger millet (Kebede et al., 2019). Scores ranged from a mean of 3.9 to 2.9 and 4.3 to 2.2 highest to lowest in Nakuru and Bomet, respectively (Table 4). In Nakuru-ATC, Kal 2 Pader (3.9), P-224 (3.93), KatFM1×U151.6.6.3.1.1 (3.9), GBK 027189A (2.8), Snapping green early (3.7) and KatFM1×U151.7.8.2.1 (3.7) were the most preferred varieties (Table 4) while in Bomet-ATC, KatFM1 (4.3), KNE 741 (4.3), KNE629 (4.2), KatFM1×U151.6.6.3.1 (4.1), Gulu E (3.9), GBK 027189A (3.8) and Kal 2 pader (3.8) were the most preferred varieties (Table 6). In both sites KatFM1×U151.6.6.3.1.1 (4.0), Kal 2 pader (3.85), GBK 027189A (3.8), Gulu E (3.75) and P-224 (3.75) ranked the best (Figure 1). On the selection of varieties, the best selected varieties in both areas had a high yielding, high tillering ability, resistance to diseases and pest, high number of tillers and uniformity (Tables 4 and 5).

Kal 2 pader a local variety stood out to be best in both ATCs; this is a local variety. Local varieties such as Kal 2 Pader, Ikhulule and Otiyo Brown are well adapted to the local environments of farmers. The farmers pointed out that the variety can easily survive extreme temperature and rainfall patterns and therefore receiving better preferences. Kal 2 Pader however was the best as it was high yielding, matured early and had resistance to birds. GRAIN and the Alliance for Food Sovereignty in Africa (AFSA, 2018) supports this after an experiment was done in Uganda. Farmers' preferred local varieties because of their resilience, taste and local preferences such as cultural and spiritual significance. GBK 027189A is a released variety in Kenya mostly for rift valley regions. It performed highly in both regions because it is modified to adapt to these regions (Manyasa, 2013). They were depicted by its ability to have high yields of 1300 and 900 kg ha^{-1} in Nakuru and Bomet, respectively. Gulu E and P-2224 are commercial varieties with ability to resist birds and other pests and the agronomic traits. Other varieties that caught the attention of farmers were SMDF 1702, Snapping Green early and snapping purple variety.

In ATC-Nakuru, variety SMDF 1702 an advanced breeding line, had short height, takes long to mature and has a spreading nature with high number of tillers. It had high preference to farmers who kept livestock, they marveled at its ability to produce more feed to cattle. They therefore recommended that the variety was suitable for livestock feed and should be improved as a fodder crop. KNE 741, a commercial variety was among the best varieties selected in ATC- Bomet, because of its high yielding ability and early maturity. Maturing early is considered as an ability to escape drought. The medium height of this variety also makes it to escape lodging a characteristic that is important to farmers from Bomet. In Nakuru however this was entirely opposite of what was expected. This is because the variety had an earlier maturity of 80.5 days (Table 6) which made it more susceptible to birds and blast disease. Farmers evaluated the variety based on what they see and since most of them saw the damage due to disease and birds, hence the least score in Nakuru. In Bomet, the same variety scored among the best. This is because, the plot was carefully guided against birds using a scarecrow and physically chasing them away. KatFM1×U151.6.6.3.1.1 was high yielding and had high number of tillers, early maturing, highly uniform and with good grain qualities. Such was desirable to farmers in both ATCs. Snapping Purple variety had high preference in both ATCs. This is not only because of its highly snapping ability during harvesting but also it is resistant to pests including birds and diseases such as blast. The variety is also high yielding with 800 and 900 kg ha^{-1} in Nakuru and Bomet-ATCs, respectively. Snapping green early has an ability to snap very early, high yielding with 900 kg ha^{-1} in both sites. The variety also has numerous tillers, a contributing factor to the high yield. Farmer based selection was dependent on the attributes of each variety most importantly the high

Table 6. Mean scores and ranking of varieties on various traits of finger millet in ATC-Bomet.

Variety	High Y	Early M	Drought T	RTD	Marketability	F/S finger	Lodging	Tillering	Uniformity	Mean	Rank
KATFM1 × U15 1.6.6.3.1.1	5	4.83	4.83	2.33	4.83	4.83	3.33	4.17	4.83	4.33	1
KNE 1034	4.83	3.83	4.83	2.5	4	4.83	3.33	4.83	4.83	4.2	2
KNE 741	4.83	4.67	4.83	2.17	4.67	4	4.67	3.83	4.83	4.28	3
GULU E	3.5	3.17	3.83	2.5	4.33	3.67	4.67	4.5	4.83	3.89	4
KATFM1 × U15 1.7.8.2.1	4.67	3.5	4.83	2.17	4.83	4.83	3.33	3.5	4.83	4.06	5
GBK 027189A	4.5	2.17	4.5	2	4.5	4.17	3.33	4.5	4.83	3.83	6
Kal 2 Pader	4.33	2.33	4.67	2.33	3.67	4.67	3.33	4.33	4.67	3.81	7
Kal Pader	3.33	2	4.67	3.33	3.67	3.67	3.33	3.83	4.83	3.63	8
KNE 629	2.33	1.67	4.17	2.33	2.67	4.67	4.67	3.83	4.67	3.44	9
U-15	3.83	3.5	4.83	2.17	3.67	3.83	3.33	4.17	4.83	3.8	10
Snapping Purple Variety	4.67	4.17	4.5	2	4.67	4.67	1.67	4.17	4.67	3.91	11
NKR FM1	3.33	3.33	4.67	2	3.5	3	4.67	4	4.83	3.7	12
Kal Dokolo	3.5	3.33	4.67	3.5	3.33	3.67	3.33	3.33	4.5	3.69	13
P-224	3.5	3.67	3.17	3.33	3	4.67	3.33	4	3.33	3.56	14
Etiyo Brown	2.83	3.17	4.5	2.17	3.33	3.33	3.33	4	4.83	3.5	15
IE 615	2.83	3.33	4.5	2.33	2.33	2.67	3.33	4	4.5	3.31	16
Ikhulule	3.67	3.67	4.83	2.17	3.33	3.67	2.33	2.67	4.83	3.46	17
KATFM1 × U15 1.6.3.3.1	3	2.83	4.17	3	2.33	2.33	3	3.67	4.17	3.17	18
IE 2872	3.5	3.83	4.83	2.17	3.33	3.5	1.33	3.83	3.5	3.31	19
IE 2183	3.17	3.17	4.17	2.17	2.33	3	2	3.33	4.17	3.06	20
KNE 1124 × KNE 796	2	3.17	1.83	2.17	2	3.67	3.5	2.5	2.5	2.59	21
KNE 628	2	1	3	2	1.33	1.33	4.67	3.5	3.33	2.46	22
Snapping Green Early	1.67	1.5	2.67	3	1	2.67	3.33	2.67	2.5	2.33	23
KAT FM1	2	2.5	3.17	2	1.33	3	3	2.33	3.17	2.5	24
SDMF 1702	1.5	1.5	3	1.67	0.33	3	3	3.17	2.83	2.22	25
Mean	3.37	3.03	4.15	2.38	3.13	3.65	3.33	3.71	4.23	3.44	-
Standard error of mean	0.5411	0.5733	0.5898	0.5715	0.3801	0.3469	0.4004	0.3991	0.5547	-	-

*High Y=High yielding, Market=Marketability, Early M=Early Maturity, DRT T=Drought Tolerance, RTD=Resistance to diseases, F/S finger=Folded/Straight finger, Bird I=Resistant to bird infestation.

yielding traits. Snapping green early also has an ability to escape drought by maturing early.

The study provided a need for extension services in the value addition of finger millet, processing and market information. There were also other socio-economic challenges expressed by farmers such as labor intensive farming practices that includes weeding, post-harvest handling of finger millet, insufficient information of improved genotypes, insufficient supportive agencies among others which were pointed out by Gurung et al. (2016) and Pudasaini et al. (2016). For promotion and utilization of finger millet, capacity building is necessary for farmers and agricultural extension workers (Mgonja et al.,

Table 7. Means of height, maturity and yield t/ha in comparison with the scores and ranking of finger millet varieties scored at ATC-Nakuru.

Variety	Height	Maturity	Yield t/ha	Scores	Rank
Kal 2 Pader	110.9 ±17.2	96.5 ± 9.2	1.2 ± 0.22	3.9	1
KATFM1 × U15 1.6.6.3.1.1	84.3 ± 9.7	86.0 ± 9.7	1.0 ± 0.10	3.9	1
P-224	81.5 ± 7.3	95 ± 6.1	1.5 ± 0.15	3.9	1
GBK 027189A	95.8 ± 20.1	90.7 ± 6.1	1.3 ± 0. 17	3.8	2
KATFM1 × U15 1.7.8.2.1	88.4 ± 8.4	108.3 ± 17.4	1.5 ± 0.24	3.7	3
Snapping Green Early	81.3 ± 3.8	92.0 ± 6.4	0.9 ± 0.07	3.7	3
GULU E	82.7 ± 5.6	111.3 ± 1.2	0.9 ± 0.06	3.6	4
Ikhulule	67.5 ± 3.6	96.7 ± 9.0	1.3 ± 0.42	3.6	4
Kal Dokolo	86.3 ± 7.9	92 ± 2.5	1.4 ± 0.14	3.6	4
KNE 1034	77.7 ± 4.1	106.7 ± 7.5	1.73 ± 0.20	3.6	4
Snapping Purple Variety	88.3 ± 16.9	99.1 ± 7.6	0.8 ± 0.17	3.6	4
IE 2872	68.3 ± 12.5	111 ± 1.2	1.9 ± 0.11	3.5	5
Kal Pader	98.8 ± 19.2	86.3 ± 8.0	1.2 ± 0.21	3.5	5
KATFM1 × U15 1.6.3.3.1	82.5 ± 9.7	103 ± 7.0	1.2 ± 0.03	3.5	5
SDMF 1702	63.2 ± 5.1	107.3 ± 5.8	0.37 ± 0.17	3.5	5
KNE 1124 × KNE 796	86.9 ± 2.1	105.0 ± 2.1	1.2 ± 0.03	3.4	6
NKR FM1	89.1 ± 20.2	114.3 ± 2.4	1.2 ± 0.01	3.4	6
U-15	89.2 ± 3.6	99.3 ± 7.5	1.2 ± 0.08	3.4	6
KNE 628	98.1 ± 13.5	81.0 ± 2.1	1.5 ± 0.13	3.3	7
Etiyo Brown	94.2 ± 11.8	93.7 ± 5.8	1.4 ± 0.21	3.2	8
KNE 629	91.3 ± 2.3	104 ± 4.7	2.1 ± 0.05	3.2	8
KAT FM1	76.1 ± 13.1	89.7 ± 3.5	1.8 ± 0.29	3.1	9
IE 2183	68.5 ± 10.2	101.6 ± 5.2	1.3 ± 0.34	3	10
IE 615	107.5 ± 4.9	93.3 ± 4.8	1.5 ± 0.09	3	10
KNE 741	82.7 ± 4.2	96.2 ± 16.4	0.7 ± 0.11	2.9	11
Means	85.1 ± 2.18	97.2 ± 1.82	1.3 ± 0.08	3.5 ± 0.06	5.28

*Means of varieties ± standard error of the mean.

2017).In general, Nakuru had the highest means in plant height, number of days to maturity and yield in t/ha as compared to ATC-Bomet. Varieties in Nakuru ATC had the highest mean height (0.85 m) with a longer maturity period (97.2 days) and high yield of 1300 kg ha^{-1} compared to Bomet ATC which had medium height of 0.57 m, lower maturity days of 95.7 days and 0.9 t/ha yield. The best performing varieties in ATC-Nakuru are Kal 2 Pader, P-224, KatFM1×U151.6.6.3.1.1 and GBK 027189A and Snapping green early with higher yield ranging from 1.18 ± 0.0757 to 1.29 ± 0.0757 t/ha, respectively (Table 7) while in Bomet- ATC they are KatFM1, KNE 741, KNE629, KatFM1×U151.6.6.3.1 and Gulu E, GBK 027189A and Kal 2 pader with yield ranging from 0.5 ± 0.0506 to 1.02 ± 0.0506 t/ha, respectively (Table 8). KNE 629 and IE 2872 had the highest yield in both sites with 2.13 and 1.49 t/ha. IE 2872 was the highest in ATC-Bomet with 1.57 t/ha. The yield could be affected by weather. In Bomet, the yield was quite low 900 kg ha^{-1} due to high rainfall that settled in the finger millet plots. This interfered with the performance of the varieties leading to low yields. In Nakuru, high yield was observed despite the high infestation of birds in the region. This is because of the favorable conditions of the short season period favored by cool and humid climate.

Conclusion

Farmers preferred uniform varieties with high tillering ability, drought tolerant, and varieties with big fingers. KatFM1×U151.6.6.3.1.1, Kal 2 pader, Ikhulule, P-224, Gulu-E, Snapping green early and GBK 027189A were the preferred varieties by farmers from Nakuru while KatFM1, KNE 741, KNE629, KatFM1×U151.6.6.3.1, U-15 and Kal Dokolo were the most preferred varieties for Bomet. The farmers also expressed the lack of awareness on blast disease and pests affecting finger millet. The lack of information on improved varieties was also a major factor that discouraged farmers from growing millets. Further research should be done on Farmer Participatory and Varietal Selection of finger millet in various regions of Kenya in order to increase

Table 8. Agronomic traits of finger millet varieties scored at ATC-Bomet and the ranking.

Variety	Height	Maturity	Yield t/ha	Scores	Rank
KAT FM1	62.7 ± 4.09	89.3 ± 11.3	0.5 ± 0.09	4.3	1
KNE 741	57.2 ± 1.74	63.3 ± 4.70	1.0 ± 0.09	4.3	1
KNE 629	51.0 ± 0.68	104.3 ± 2.96	1.5 ± 0.17	4.2	2
KATFM1 × U15 1.6.6.3.1.1	46.3 ± 2.40	102.3 ± 4.48	0.8 ± 0.18	4.1	3
GULU E	55.3 ± 2.90	83.3 ± 12.17	0.7 ± 0.09	3.9	4
GBK 027189A	62.3 ± 5.04	104.7 ± 6.33	0.9 ± 0.09	3.8	5
Kal 2 Pader	72.8 ± 1.92	105.7 ± 5.69	1.0 ± 0.10	3.8	5
Kal Dokolo	52.8 ± 5.08	85.7 ± 10.20	0.9 ± 0.21	3.7	6
NKR FM1	64.3 ± 4.66	77.3 ± 4.37	0.8 ± 0.11	3.7	6
Kal Pader	65.0 ± 7.63	105.3 ± 2.96	0.8 ± 0.11	3.6	7
P-224	49.3 ± 4.09	99.3 ± 1.66	0.9 ± 0.44	3.6	7
Etiyo Brown	58.0 ± 7.21	100.3 ± 0.67	0.8 ± 0.14	3.5	8
Ikhulule	66.3 ± 3.52	103.3 ± 1.76	0.9 ± 0.02	3.5	8
KNE 628	43.0 ± 1.80	108.0 ± 3.51	0.9 ± 0.13	3.4	9
IE 2872	67.0 ± 3.51	83.0 ± 5.13	1.6 ± 0.07	3.3	10
IE 615	46.7 ± 2.40	98.3 ± 3.92	1.3 ± 0.02	3.3	10
KATFM1 × U15 1.6.3.3.1	49.5 ± 7.05	104.0 ± 3	1.2 ± 0.13	3.2	10
IE 2183	46.0 ± 2.00	92.7 ± 7.26	0.7 ± 0.04	3.1	12
KNE 1034	63.3 ± 7.31	97.0 ± 1.00	0.9 ± 0.11	2.6	13
KATFM1 × U15 1.7.8.2.1	59.7 ± 2.60	110.0 ± 9.50	0.8 ± 0.18	2.5	14
KNE 1124 × KNE 796	49.5 ± 7.05	78.7 ± 4.48	1.0 ± 0.13	2.5	14
Snapping Green Early	65.3 ± 2.60	103.7 ± 6.35	0.9 ± 0.18	2.3	15
Snapping Purple Variety	54.7 ± 0.33	100.3 ± 2.33	0.9 ± 0.03	2.3	15
U-15	59.0 ± 5.50	89.7 ± 10.20	0.9 ± 0.04	2.3	15
SDMF 1702	47.3 ± 3.38	104.3 ± 1.67	0.6 ± 0.10	2.2	16
Means	56.9 ± 1.6	95.8 ± 2.3	0.9 ± 0.1	3.3 ± 0.1	-

*Means of the 25 varieties±standard error of means.

awareness of improved finger millet varieties and possibly adoption.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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