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Participatory Selection of Cowpea Varieties in Kilifi County of Kenya

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To identify farmer preferred cowpea varieties in coastal lowland Kenya.
Study Design: The experiment was laid out in a randomized complete blocks design with three replications.
Place and Study Duration: Tezo location, Bahari division, Kilifi County, Kenya during July – October 2011/2012 cropping seasons.
Methodology: Thirty nine farmers (30 female and 9 male) from three farmer groups in Tezo location, Kilifi County participated in the establishment and evaluation of 11 cowpea varieties using their own selection criteria. The varieties were evaluated at flowering, podding, maturity and post harvest stages. Farmers' cowpea selection criteria before flowering and at podding were high grain yield, drought tolerance, early maturity, ease of harvesting and leafiness.
Results: Kutambaa, KVU 27-1 and Nyeupe were rated top varieties at these stages. Farmers' selection criteria at maturity and after harvest included grain yield, color, taste and cooking duration. KVU 419, Kaima koko and Nyeupe were rated top varieties at these stages. Grain yield varied from 3.3 t ha^{-1} (KVU 419) to 0.48 t ha^{-1} (Kaima koko).

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Conclusion: The results of this study have demonstrated the need for plant breeders to integrate grain color, taste and cooking duration traits in cowpea improvement programmes. Integration of KVU 419, Nyeupe, KVU 27-1 and Kutambaa cowpea varieties into the maize-based system is likely to improve cowpea productivity in Kilifi County, Kenya.

Keywords: Grain yield; maize-based; Nyeupe; drought; leafiness; color.

1. INTRODUCTION

Plant breeding and agricultural promotion programs continue to be patterned after those in western industrialized countries, emphasizing the use of modern innovations that practice the development of high yielding varieties that perform well in environments that are stabilized through the use of irrigation, fertilizers, pesticides and other inputs [1]. Perhaps the most significant realization at the beginning of the 21st century is the fact that the areas in the developing world, characterized by traditional/subsistence agriculture, remain poorly served by the top-down transfer-of-technology approach, due to its bias in favor of modern scientific knowledge and its neglect of local participation and traditional knowledge [2]. Single genotypes have been widely promoted, to be grown in pure stands regardless of the system in which the crop is currently being grown or the availability of risk reducing inputs [1]. This could be the reason why many promising crop varieties coming out of national agricultural research institutes and universities are often not taken up by farmers. For example, despite the availability of improved maize varieties farmers still grow coastal maize landraces in coastal lowland Kenya [3]. According to [4], the disconnect that has been there between the crop varieties which have been released by plant breeders for a particular region and what the farmers in that region grow raised two major challenges. First new varieties can be disappointing to farmers in case undesirable traits go undetected during the breeding process. Second, breeders discard many crosses and varieties during the selection process because of traits considered undesirable. However, these traits may actually be of interest to farmers, thus indicating the communication gap between breeders and farmers [5].

The top-down transfer-of-technology approach as a strategy in promoting agricultural programs has not produced the desired results of sustainable and increased crop yields. It has also failed to make use of the significant agricultural biodiversity available and its potential to address food security concerns and issues in the region [1]. The most effective way to ensure adoption of improved cultivars is involving farmers in the process of development. Participatory varietal selection (PVS) is a simple way for breeders and agronomists to learn which varieties perform well on-station and on-farm and to obtain feedback from the potential end users in the early phases of the breeding cycle. It is a means for social scientists to identify the varieties that most men and women farmers prefer, including the reasons for their preference and constraints to adoption [6]. It has shown success in identifying an increased number of preferred varieties by farmers in a shorter time than the conventional system, in accelerating their dissemination and increasing cultivar diversity [7].

[8] reported that complex farming systems, adapted to the local conditions, have helped small scale farmers to sustainably manage harsh environments and to meet their subsistence needs, without depending on mechanization, chemical fertilizers, pesticides or other technologies of modern agricultural science. According to [1] a small farmer deals with a variable environment and has multiple production objectives that will affect his or her choice of crops and selection of genotypes. Next to yield, which in formal breeding programmes is by far the most important objective, yield stability, adaptation to production techniques and conditions, and various consumption purposes are selected for. This range of objectives often results in the use of a large number of varieties by individual farmers and the use of genetically heterogeneous varieties. Farmers need adaptation to the local and variable water and soil conditions in combination with a variety of characteristics related to labour and food availability, intercropping and weed competition [9]. Consumption objectives include culinary and cultural preferences regarding taste, color, consistence, size, cooking time, processing quality and suitability for preparation of traditional dishes or drinks. Consumption criteria also include secondary uses, such as leaves of sweet potato, cowpea and cassava as vegetable or animal feed [9]. Cowpea is the most important grain legume in coastal Kenya, mainly grown as an intercrop with maize [10,11]. There are many

cowpea varieties with potential for high yields tolerance to drought and resistance to insects in the region but have not been evaluated by farmers. The current study was carried out to identify cowpea varieties most preferred by coastal farmers through participatory variety selection.

2. MATERIALS AND METHODS

2.1 Experimental Site

The participatory varietal selection study was carried out on-farm at Majaoni in Tezo location, Kilifi County which is 68 km north of Mombasa. It lies between latitudes 3º S and 4º S and longitudes 39º E and 40º E. The region receives an average annual rainfall of 600–1100 mm that comes in two seasons [12]. The long rains are received in March/April through August while the short rains are received in October, November and December. The long rains season is the most important cropping season and 75% of the annual rainfall is usually received during this time [13]. Mean monthly minimum and maximum temperatures are about 22ºC and 30ºC, respectively, and the mean relative humidity is 80% [14]. According to [12] the soils in coastal lowland Kenya are mostly ferralsols. These soils have low organic matter content, are deficient in essential plant nutrients (especially nitrogen), are prone to leaching, and have a pH ranging between 5 and 7 [15].

2.2 Experimental Design, Treatments and Crop Husbandry

Needs of farmers were assessed using the participatory rural appraisal technique to set goals and identify farmer's preferences and perceptions on ideotype cowpea cultivar [16]. Farmers who participated and evaluated the cowpea varieties were representative of the area. The participant farmers were selected based on their indigenous knowledge [1] and from the most active farmer groups growing maize and cowpea in the region. The farmer groups were identified through the County Director of Agriculture's office in Kilifi. Participants in the participatory varietal selection were drawn from Lamukani, Dziuzeni and Sife moyo farmer groups, all in Bahari Division, Kilifi County. The farmer groups were briefed by the researcher on what was involved in varietal selection exercise. Only farmers from each group who accepted to take part in the study were involved in participatory variety selection. Traits preferred by farmers were identified and prioritized for both men and women. Cowpea varieties were established and evaluated in one of the farmer group's field in Tezo location based on yield performance and farmers' selection criteria, according to [1]. The test varieties included the most popular local varieties and improved varieties which are recommended for the region. Cowpea varieties were laid out in a randomized complete block design (RCBD) and replicated three times.

The cowpea varieties evaluated were (plate 1 - 11): (i). KVU 419 (improved variety from KALRO Katumani); (ii). Khaki (local variety); (iii). K80 (improved variety for the coastal region); (iv). Macho (local variety); (v). Kaima-koko (local variety); (vi). Nyeupe (local variety); (vii). KVU 27-1 (improved variety from Katumani); (viii). Nyekundu (local variety); (ix). M 66 (improved variety from Katumani); (x). Kutambaa (local variety); and (xi). Mwandato (local variety). Each variety was grown in a 5 m x 5 m plot size. The plant spacing was 60 cm by 30 cm with two seeds per hill. Land was ploughed using a tractor and the farmers participated in the leveling and planting. There were two weedings: Three and seven weeks after planting, respectively. Insect pests were controlled by spraying with a pesticide cypermethrin 100/1 EC (pestox ® 100 EC) two weeks after planting then fortnightly up to podding stage. Pestox insecticide, whose active ingredient is cypermethrin, is a synthetic pyrethroid that belongs to a group of insecticides used widely as industrial and agricultural pesticides [17].

Thirteen (13) farmers (10 female and 3 male) from each farmer group participated in the exercise. The farmers participated in land preparation, crop establishment, weeding, pest control and harvesting. Evaluation was done before flowering and at podding, maturity and post-harvest stages. The female and male farmers were assisted to develop selection criteria independently and then jointly. At every evaluation time all farmers were given voting cards. Males were given red cards while the females were given green cards. All the farmers were given a voting card to pick the variety which was best for a certain trait, before choosing the second best and so on. After harvest, all the varieties were cooked in pots before the organoleptic test. During cooking, the water boiled in the pot first before the cowpeas were placed in. The time taken from when the cowpeas were put in the boiling water to when

they were ready for eating was recorded. Farmers were later allowed to taste all the varieties and rank them in order of decreasing palatability. Cooked cowpea samples were scored by semi-trained sensory panel using a modified version of quantitative descriptive analysis (QDA) since standards were not provided [18]. The sensory panel, which consisted of ten (10) panelists, was conducted at one of the farmer's homes near the farmer group field where the evaluation was conducted [19]. The languages used during the sensory testing were Kiswahili (national language) and Giriama (local language). The panelists had been screened for familiarity with the cowpea dish and ability to determine differences between cowpea dishes from different cowpea varieties. Sensory attributes evaluated were color and taste.

2.3 Data Collection

Data were collected before flowering, at podding, maturity and post harvest stages. Before flowering and at podding the farmers evaluated the varieties on the basis of grain yield (pod load), drought tolerance (based on leaf phenoology such as leaf senescence) [20], time to maturity, and ease of harvesting (plants with large pods were considered easy to harvest). At maturity and post harvest stages the farmers evaluated the varieties based on grain color, grain yield (in terms of kg per plot), taste (organoleptic test after cooking) and cooking time (time taken to cook in boiling water). Each criterion was scored on a scale of 1 to 5 (1 = very poor, 2 = poor, 3 = average, 4 = good and 5 = very good) for each variety [4].

Plate 1. KVU 419 cowpea variety

Plate 2. Nyeupe cowpea variety

Plate 3. Macho cowpea variety

Plate 4. Kaima koko cowpea variety

Plate 5. Khaki cowpea variety

Plate 6. K80 cowpea variety

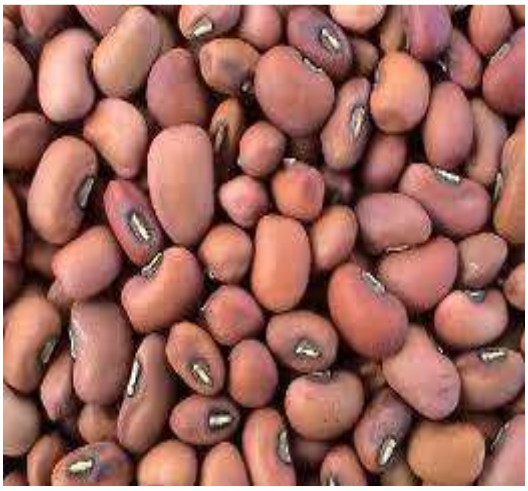

Plate 7. Kuhambala cowpea variety

Plate 8. M66 cowpea variety

Plate 9. Mwandato cowpea variety

Plate 10. KVU 27-1 cowpea variety

Plate 11. Nyekundu cowpea variety

2.4 Data Analysis

Collected data were analyzed by the general linear model (GLM) procedure for analysis of variance using SAS statistical package (SAS Institute, 1993). Where the F values were significant, means were compared using the least significant difference (LSD) test, at p = 0.05.

3. RESULTS

3.1 Farmers' Rating of Cowpea Varieties before Flowering and at Podding Stages

The male farmers' selection criteria in order of decreasing preference were early maturity, high grain yield, drought tolerance, ease of harvesting and leafiness (Table 1). The female farmers' selection criteria in order of decreasing preference were high grain yield, drought tolerance, pest and disease resistance, ease of harvesting and leafiness. Both men and women ranked leafiness fifth. Early maturity was a top priority for the men but it did not feature in the women's criteria, while pest and disease resistance featured in the women criteria as a priority but not in the men selection criteria. Farmers' collective selection criteria knocked out the female farmers' criteria of pest and disease resistance and reorganized the male farmers' criteria by considering the female farmers' priority criteria of high grain yield and drought tolerance. Most of the traits in the farmers' selection criteria, such as high grain yield, drought tolerance and early maturity, were similar with the traits considered by plant breeders. The farmers' selection criteria differed from those of plant breeders in that the former included traits such as ease of harvesting and leafiness (Table 1).

In Table 2, male farmers rated M66 to be earliest maturing cowpea variety followed by KVU 27-1 and Kutambaa. The female farmers rated KVU 27-1 and Kutambaa the best for that trait followed by Nyekundu. Kutambaa was rated the highest yielder by both male and female farmers, but male farmers also ranked Kaima koko as the highest yielder.

The female farmers rated KVU 27-1 as drought tolerant while male farmers rated Kutambaa as drought tolerant. Khaki variety was rated the best in terms of ease of harvesting by male farmers while female farmers ranked Nyeupe as the best in this attribute. The mean scores in Table 2 indicate that the best varieties were Kutambaa, KVU 27-1 and Nyeupe with mean scores of 1.9, 2.3 and 3.0, respectively.

3.2 Farmers' Rating of Cowpea Varieties at Maturity and Post Harvest Stages

The variety selection criteria used by farmers at maturity and post harvest stages were grain color, taste, grain yield and cooking time (Table 3).

Unlike most plant breeding programmes, farmers considered taste and cooking time as key criteria in cowpea variety selection. Male and female farmers had the same scores for each of the varieties evaluated. Farmers identified Nyeupe

as having the best color, KVU 419 as the highest grain yielder, Macho as tastiest and Khaki as the fastest cooking (Table 3). Across the selection criteria, the most preferred cowpea varieties were KVU 419, Macho and Nyeupe with mean scores of 2.5, 2.8 and 3.3, respectively.

Table 1. Male and female farmers' criteria for selecting cowpea varieties and the most preferred traits

	Criteria		
Ranking	**Men**	**Women**	**Men and women**
1	Early maturity	High grain yield	High grain yield
2	High grain yield	Drought tolerance	Drought tolerance
3	Drought tolerance	Pest and disease resistance	Early maturity
4	Ease of harvesting	Ease of harvesting	Ease of harvesting
5	Leafiness	Leafiness	Leafiness

Note: pest and disease resistance was based on pest and disease damage scores on leaves, pods and grains

Table 2. Farmers' rating of cowpea varieties before flowering and at podding stages

Cowpea variety	Early maturity		High yield		Drought tolerance		Ease of harvesting		Mean score
	Men	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	
KVU - 419	4	4	2	5	3	5	3	3	3.6
Khaki	3	5	2	5	2	5	1	5	3.5
K80	4	5	2	5	4	3	3	5	3.9
Macho	5	5	2	5	5	5	5	5	4.6
Kaima- koko	5	4	1	3	3	3	3	5	3.4
Nyeupe	4	5	4	2	2	3	3	1	3.0
KVU 27-1	2	1	2	4	3	1	2	3	2.3
Nyekundu	5	2	5	2	5	4	5	3	3.9
M 66	1	4	4	5	3	3	5	5	3.8
Kutambaa	2	1	1	1	1	3	3	3	1.9
Mwandato	5	3	5	2	5	2	5	2	3.6

**Overall Scores: (1 – 5) Scales; 1 = Very good, 2 = Good, 3 = Average, 4 = Below average and 5 = Poor*

Table 3. Farmers' rating of cowpea varieties at post harvest stage

Cowpea variety	Colour (score)	Grain yield (score)	Taste (score)	Cooking duration (minutes)	Cooking (score)	Mean score	Actual grain yield (t/ha)
KVU - 419	2	1	5	39	2	2.5	3.30
Khaki	5	5	5	29	1	4.0	1.40
K80	5	5	5	40	3	4.5	0.90
Macho	3	2	1	63	5	2.8	2.66
Kaima- koko	5	5	3	55	5	4.5	0.48
Nyeupe	1	5	2	52	5	3.3	1.04
KVU 27-1	4	4	5	55	5	4.5	1.70
Nyekundu	5	5	2	57	5	4.3	1.68
M 66	5	3	5	47	4	4.3	1.80
Kutambaa	5	5	4	55	5	4.8	1.20
Mwandato	5	5	5	82	5	5.0	1.06

**Scores scales: (1 – 5); 1 = Very good, 2 = Good, 3 = Average, 4 = Below average and 5 = Poor; cooking duration was the time the cowpea variety took to be ready for eating while cooking score was the score based on the time taken to be ready for eating*

Table 4. Farmers' overall rating of the cowpea varieties

Cowpea variety	Mean scores		Mean scores
	Flowering and podding stages	Maturity and post harvest stages	
KVU - 419	3.6	2.5	3.1
Khaki	3.5	4.0	3.8
K80	3.9	4.5	4.2
Macho	4.6	2.8	3.7
Kaima- koko	3.4	4.5	4.0
Nyeupe	3.0	3.3	3.2
KVU 27-1	2.3	4.5	3.4
Nyekundu	3.9	4.3	4.1
M 66	3.8	4.3	4.1
Kutambaa	1.9	4.8	3.4
Mwandato	3.6	5.0	4.3

**Scores scales: (1 – 5): 1 = Very good, 2 = Good, 3 = Average, 4 = Below average and 5 = Poor; Note: ranking dependent on the stage of evaluation*

3.3 Overall Ranking of the Cowpea Varieties

Farmers' overall evaluation before flowering, at podding, maturity and after harvest ranked KVU 419, Nyeupe, KVU 27-1 and Kutambaa as the most preferred varieties with mean scores of 3.1, 3.2, 3.4 and 3.4 respectively (Table 4). Improved varieties K80, M66 and local varieties Nyekundu, and Kaima koko were ranked below average.

4. DISCUSSION

From the study the farmers' most preferred trait was grain yield. Similar observations were made by [21] and [22] who reported that high grain yield was ranked top because all the farmers who participated in the evaluation used cowpea mostly for grain production. The different patterns in the gender division of labour and final forms of consumption of cowpea influence men's and women's varietal selection criteria [2]. Women were also concerned about storage quality and this is reflected in the fact that they considered resistance to diseases and insect pests as very important criteria. This is because women have more knowledge of cooking, food processing, preservation and storage [1]. Although most of the variety selection criteria for men and women were similar, the slight variation is an indication that male and female farmers have particular preferences for certain traits. They have different preferences because they are related to the food chain in different ways, and often at different times and places. According to [2] men have more selection criteria for production performance and storage while women have more criteria related to processing and food preparation, where final forms of consumption are also considered. [23] argued that men and women play different roles and responsibilities within the household, in farming, and in society, yet the operational implications are often obscured, by gender bias and ignorance on the part of plant breeders.

Farmers differed from researchers by considering grain color, ease of harvesting, taste and cooking time as key variety selection criteria. According to [24] farmer's selection criteria are based on ecological needs, livelihood uses, and gender, social and economic needs. This shows the significance of involving farmers in varietal selection to complement plant breeders' selection processes; thereby enhancing adoption and diffusion of any recommended variety [21]. At podding stage the farmers selected the high yielding varieties based on pod load. The number of pods per plant has been reported to be the main yield component with direct effects on cowpea grain yield [25].

The low broad sense heritability for pod load implies that the trait is influenced by environmental effects [26]. The varieties which both male and female farmers selected at podding stage were not the ones they selected at maturity and post harvest stages. The overall rating identified four cowpea varieties namely KVU 419, Nyeupe, KVU 27-1 and Kutambaa based on the farmers' most preferred traits of early maturity, pod load, drought tolerance, ease of harvesting, grain color, grain yield, taste and cooking time. From the findings of this study farmers may be inclined to integrate KVU 419, Nyeupe, KVU 27-1 and Kutambaa cowpea

varieties in their maize-cowpea intercropping system because they participated in the selection process. The recommended cowpea varieties in the region K80 and M66 were rated below average and this could partly explain why many farmers have not fully adopted these varieties. This study reinforces the suggestions of [16] that farmer's participation in varietal selection improves crop development and adoption [6].

5. CONCLUSION

The farmers' most preferred cowpea traits were early maturity, pod load, drought tolerance, ease of harvesting, grain color, grain yield, taste and cooking time. The four most preferred cowpea varieties were KVU 419, Nyeupe, KVU 27-1 and Kutambaa. The farmers' most preferred cowpea traits differed with those of plant breeders in that farmers' considered traits such as colour, taste, cooking duration and ease of harvesting. Therefore, plant breeders could consider these traits in their cowpea breeding programmes.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Nkongolo KK, Chinthu KKL, Malusi M, Vokhiwa Z. Participatory variety selection and characterization of sorghum (*Sorghum bicolor* (L.) Moench) elite accessions from Malawian gene pool using farmer and breeder knowledge. African Journal of Agricultural Research. 2008;3(4):273-283.
2. Miguel AA. Agroecology: The science of natural resource management for poor farmers in marginal environments. Agriculture, Ecosystem and Environment. 2002;93:1–24.
3. Ndiso JB, Kibe AM, Mugo S, Pathaka RS. Influence of drought stress on growth, yield and yield components of selected maize genotypes in coastal lowland Kenya. International Journal of Agricultural Sciences. 2012;2(6):178–185.
4. Girma A, Teshale A, Hussein H, Tewodrose M, Abdel Rehman MA. Participatory selection of drought tolerant maize varieties using mother and baby methodology: A case in the semi arid zones of the central Rift Valley of Ethiopia. World Journal of Agricultural Sciences. 2005;1(1):22–27.
5. Kamara A, Defoer T, De Groote H. Selection of new varieties through participatory research, use of corn in South Mali. Tropicultura. 1996;14:100–105.
6. Paris TR, Manzanilla D, Tatlonghari G, Labios R, Cueno A, Villanueva D. Guide to participatory varietal selection for submergence- tolerant rice. International Rice Research Institute. 2011;1–111.
7. Weltzien E, Smith ME, Meitzien LS, Sperling L. Technical and institutional issues in participatory plant breeding – Farm the perspective of farmer plant breeding. A global analysis of issues, results and current experience. PPB Monograph No. 1. Cali: PRGA; 2003.
8. Denevan WM. Prehistoric agricultural methods as models for sustainability. Advanced Plant Pathology. 1995;11: 21–43.
9. Almekinders CJM, Louwaars NP, De Bruijn GH. Local seed systems and their importance for an improved seed supply in developing countries. Euphytica. 1994;78: 207-216.
10. Njunie MN, Saha HM, Muli BM, Lewa KK. Soil and water management to enhance food security in coastal Kenya: End of project technical report (2002–2006). Technical report No. 5. KARI Mtwapa; 2007.
11. Ministry of Agriculture (MOA); 2010. Kenya. Annual Food and Crop Situation Report; 2009.
12. Sombroek WG, Braun HMH, Van Der Pouw BJ. Exploratory soil survey report no. E1, Kenya Soil Survey, Nairobi; 1982.
13. Saha HM. Improving resource use under maize – green legume systems in coastal lowland Kenya. Ph. D Thesis. Jomo Kenyatta University of Agriculture and Technology; 2007.
14. Jaetzold R, Schmidt H, Hornetz B, Shisanya C. Farm Management handbook of Kenya. Vol. II/ Part C, Sub-Part C2, coast province. Ministry of Agriculture, Kenya, in corporation with the German Agency of International Cooperation (GIZ); 2012.

15. Mureithi JG, Tayler RS, Thorpe W. Productivity of alley farming with leucaena (*Leucaena leucocephala* Lam. de Wit) and Napier grass (*Pennisetum purpureum* K. Schum) in coastal lowland Kenya. Agroforestry Systems. 1995;31:59-78.
16. Adu Dapaah HK, Asibuo JY, Danquah OA, Asumadu H, Haleegoah J, Asafo Adjei B. Farmer participation in groundnut varietal selection. African Crop Science Conference Proceedings. 2007;8:1435–1439.
17. Chibuike SU, Parker EJ. Comparative effect of “pestox” powdered insecticide on both serum aspartate aminotransferase and alanine aminotransferase of male and female albino rats. Research Journal of Pharmacology and Pharmacodynamics. 2010;2(4):309–313.
18. Tomlins KI, Manful JT, Larwer P, Hammond L. Urban consumer acceptability and sensory evaluation of locally produced and imported parboiled and raw rice in West Africa. Food Quality Preference. 2005;16:79–89.
19. Tomlins K, Ndunguru G, Stambul K, Joshua N, Ngendello T, Rwiza E, Amour R, Ramadhani B, Kapande A, Westby A. Sensory Evaluation and consumer acceptability of pale-fleshed and orange-fleshed sweet potato by school children and mothers with preschool children. Journal of Science, Food and Agriculture. 2007;87(13):2436-2446.
20. Bolanos J, Edmeades GO. The importance of the anthesis-silking interval in breeding for drought tolerance in tropical maize. Field Crops Research. 1996;48:65-80.
21. Adu Dapaah HK, Asibuo JY, Danquah OA, Asumadu H, Haleegoah J, Asafo Adjei B. Farmer participation in groundnut rosette resistant varietal selection in Ghana. In: Fisher, et al. (Eds). New direction for a diverse planet: Proceedings for the 4th International Crop Science Congress, Brisbane, Australia; 2004.
22. Truong TNC, Phan VL, Thelma P. Farmers’ participation in rice variety selection. Omonrice. 2007;15:159–163.
23. Franworth CR, Jiggins J. Participatory plant breeding and gender analysis. CGIAR system wide program on participatory research and gender analysis (PRGA Program), Cali, Colombia. 2003;116. (PPB Monograph No. 4).
24. Halleegoah J, Adu Dapaah HK, Danquah OA. Farmers preferences for bambara groundnut ideo type in two districts in the forest savannah transition zone of Ghana. Ghana Journal of Horticulture. 2005;4: 82–92.
25. Almeida WS, Fernandes FRB, Teofilo EM, Bertini CHCM. Correlation and path analysis in components of grain yield of cowpea genotypes. Revista Ciencia Agronomica. 2014;45(2):726–736.
26. Singh P, Narayanna SG. Biometrical techniques in plant breeding. Kalyani Publishers. New Delhi, India. 2000;74–84.

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