

Comparative Analysis of Farmers' Selection Criteria for Cowpea (*Vigna unguiculata*) Varieties in Niger and Burkina Faso

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Abstract

A comparative analysis of farmers' preferences on improved cowpea varieties was carried out based on the data obtained from farmers' participatory varietal selection and questionnaire survey undertaken in south-eastern Niger and north-central Burkina Faso. The grain yield was consistently the most important and common selection criterion for farmers in both countries, with a significant influence of other traits, including balance between grain and fodder yields, earliness, seed characteristics, and resistance to *Striga gesnerioides* in their variety selection process. In other words, if the variety had enough yield, the farmers' selection of the variety was separated from the second criterion reflecting farmers' demand specific to their social and environmental conditions, such as tradition, marketing, assets, rainfall, and biotic and abiotic stresses in the region. Key criteria for farmers' variety selection were obtained as well as an understanding of the potential of participatory activities to improve strategies in cowpea breeding and dissemination targeting these regions.

Discipline: Plant breeding

Additional key words: cash crop, dissemination, improved variety, participatory varietal selection, questionnaire

Introduction

Cowpea (*Vigna unguiculata* L. Walp.) is an important crop for promoting food security, livelihoods, and income of farmers, particularly in the dry savannah areas of sub-Saharan Africa. The crop is grown as a cash crop in Burkina Faso, Ghana, Nigeria, Mali, Mauritania, Niger, and Senegal, and is a primary source of protein in diets, compensating for the lack of animal proteins due to inaccessibility, poverty, or dietary preferences in the region (Mortimore et al. 1997, Kormawa et al. 2002, Muranaka et al. 2015). The crop's nutrition-rich green pods and leaves, as well as grains of existing extra-early

maturing varieties, also greatly contribute to the food security of the farmers in the region as emergency food source during hungry periods, just before the main harvests of cereal crops (Gómez, 2004). Based on the crop's importance and efforts of international and national cowpea breeding programs, reasonable adoption rates of improved cowpea varieties have been reported in several sub-Saharan African countries (Olufowote & Barnes-McConnell 2002).

However, the reports on farmers' selection criteria and acceptability of improved cowpea varieties are limited (Sanders et al. 1994, Lowenberg-DeBoer 1994, Kitch et al. 1998). As Kamara reported (2009), the

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discrepancies between the available improved varieties and the actual farmers' preferences for cowpea varieties suggest the lack of researchers' understanding on a wide range of criteria and local preferences in the production and utilization of cowpea. Furthermore, the farmers' needs and preferences for cowpea varieties vary by region depending on the natural and social environment and reflect deep-rooted cultural traditions (Coulibaly & Lowenberg-DeBoer 2002, Faye et al. 2004). Better understanding of farmers' preferences in the target region is critical for an effective breeding strategy and further acceptance of developed cowpea varieties.

Niger and Burkina Faso are the second and third largest producers of cowpea in the world, respectively (FAO 2017), and both countries export cowpea extensively to surrounding West African countries, such as Nigeria, Ghana and Côte d'Ivoire. However, based on the breeders' understanding, it is suggested that the farmers' preference for their cowpea varieties are not always aligned with the market preferences reported by Mishili (2007), and those are quite different between two countries (personal communications). There is no evidence-based information comparing actual preferences of the farmers for their selection of cowpea variety in both countries, though it should be important information which alters the acceptability of the introduced variety.

Thus, in this study, we aimed to conduct a comparative analysis on the farmers' preferences for cowpea varieties and key criteria for selection using farmers' participatory varietal selection (FPVS), a rapid and cost-effective approach to grasp the farmers' preference using existing cowpea genotypes and also improve the farmers' understanding of the benefit of those (Sperling et al. 1993, Witcomber et al. 1996, Ashby & Lija 2005). The objectives of this study were to 1) understand the key traits that foster the difference of farmers' preference for cowpea among two countries and 2) provide the information on the farmers' preference for cowpea breeders to promote effective breeding activity to develop more acceptable cowpea varieties.

Materials and methods

1. Target villages and plant materials

The activities were conducted during 2008-2011 across 12 villages: seven in Niger and five in Burkina Faso in the Sudan savannah and Sahel agroecological zones (Table 1). The target villages were selected from potential villages in the cowpea-producing area of both countries, based on 1) the size of the village (more than 10 households), 2) lesser experience of the intervention by research institutes or cooperative agencies on cowpea,

3) accessibility to the village, especially during the rainy season, and 4) level of cooperativeness of the village head and farmers to the work. A total of 32 cowpea genotypes used in these trials are listed in Table 2 along with their characteristics. Of the 32 genotypes, 24 were evaluated in Niger and 15 in Burkina Faso, with seven genotypes commonly used in both countries (Table 2). Demonstration fields were established in all target villages, and in each demonstration field, plots were arranged in a randomized block design with three replicates. Planting was conducted at the beginning of the rainy season of each village. In Niger, plants were arranged with 20 cm and 80 cm spacing between plants and rows, respectively, for all genotypes. In Burkina Faso, following the standard procedure of the Institut de l'Environnement et de Recherches Agricoles, the plants were arranged with 40 cm spacing between them, and 60 cm spacing between rows for six genotypes (IT98K-205-8, IT99K-573-2-1, Melakh, IT98K-901-5, IT93K-452-1, and IT98K503-1) with smaller plant size, and 80 cm for nine other genotypes. Additional cultivation practices such as fertilizer (NPK = 15:15:15) application as top dressing at 100 kg/ha, 2-3 rounds of weed control, and spraying for disease and insect control according to the conditions of each village were made accordingly.

2. Farmers' participatory variety selection

In each target village, FPVS was conducted during the maturity period of the early maturing genotypes with the farmers invited to the demonstration field. Invitations were given to all farmers of the target and surrounding villages regardless of their social status, age, and sex, excluding minors under the age of 12, and all farmers who could attend the FPVS and questionnaire survey were treated without distinction. For FPVS, the farmers were guided to the demonstration field by a group of 5-10 farmers and requested to select their three most preferred cowpea genotypes per replication, based on the plant and seed characteristics, using plants growing and a seed sample placed in each plot. Each group was formed by farmers of similar age and of the same sex, and the participants were instructed in advance to select the preferred genotypes irrespective of the selection of other farmers in the same group, which can reduce the mutual effects among farmers, especially the influence of the elder on the young, and between male and female. To avoid any bias caused by the name of a genotype, unique ID numbers given to each plot were used for the farmers' selection. In Niger, FPVS was conducted for two years in Radi, Danja, Toumnia, and Magaria, and once in Tessaua, Sarkin Housa, and Tchadoua, while FPVS was conducted for two years in all target villages of Burkina Faso (Table 1).

3. Questionnaire Survey

After the first year of FPVS in each village, a questionnaire survey was conducted to all the farmers that participated in the FPVS practice by the trained local facilitators. To obtain unbiased information free from peer pressure, interviews were conducted individually without interaction between farmers. Through the interview, the information on 1) the individual attributes (age, sex, education level, and number of livestock owned), 2) the major reasons for the selection made in FPVS, 3) the preference based on the agronomic and seed quality traits (grain and fodder yield, maturity, plant shape, peduncle position, texture, seed color, fodder, grain, maturity, grain size, resistances to biotic and abiotic stresses), and 4) the cowpea production situation (constraints, cropping system, use of insecticide and fertilizer) were obtained.

Results

1. Farmers' choice in FPVS

In Niger, a total of 403 farmers participated during the two years of FPVS activities (135 farmers from four villages in 2008 and 268 from seven villages in 2009), while in Burkina Faso a total of 910 farmers (406 in 2010 and 504 in 2011) participated from six villages. Since the number of women participants was very low (2.7%) due to the fasting period and cultural circumstances in Niger, the gender of the respondents was not considered for the analysis in both countries, and this should be noted as a

limitation of the analysis conducted.

The grain yield of the cowpea genotypes used in this study ranged from 27.1 to 929.3 kg/ha in Niger and from 437.7 to 1,044 kg/ha in Burkina Faso, while the seven genotypes commonly used in both countries showed a similar grain yield level ranging from 592.5 to 929.3 kg/ha in Niger and from 437.7 to 929.3 kg/ha in Burkina Faso (Table 2). The greater variation observed in Niger was due to the inclusion of some varieties with very late maturity, such as IT99K-241-2 and IT03K-338-1, which did not mature before the end of the rainy season in some villages.

In both countries, individual farmer selection across three replications in each year was highly consistent (data not shown), though the selection changed over the years (Table 3). The method used for the farmers' selection in this study was without ranking among their three most preferred genotypes. The obtained result suggests the method was effective to indicate the farmers' preference stably with less burden and time to the participated farmers, though the precision accuracy might be deteriorated. In Niger, across the seven villages the high grain-yielding genotypes IT00K-1148, IT99K-573-2-1, and IT90K-372-1-2 were consistently nominated by farmers as their preferred genotypes, though two extra-early maturing genotypes, IT99K-573-2-1 and IT98K-205-8, gained popularity in the drought-prone 2009. In Burkina Faso, across the five villages, high-grain yielding, white- and large-seeded cowpea genotypes such as KVx442-3-25, IT99K-573-2-1, and

Table 1. Location of villages and years of FPVS and questionnaire surveys conducted in Niger and Burkina Faso

Country	Region	Village	Location		Year of		Effective rainfall* (mm)
			Latitude	Longitude	FPVS	Questionnaire	
Niger							
	Maradi	Radi	13°26'N	7°08'E	2008-2009	2008	237-305
	Maradi	Danja	13°23'N	7°11'E	2008-2009	2008	131-318
	Zinder	Toumnia	13°58'N	9°01'E	2008-2009	2008	217-431
	Zinder	Magaria	12°58'N	8°55'E	2008-2009	2008	211-363
	Maradi	Tessaoua	13°32'N	7°26'E	2009	2009	179
	Maradi	Sarkin Housa	13°50'N	7°35'E	2009	2009	145
	Maradi	Tchadoua	13°45'N	7°59'E	2009	2009	213
Burkina Faso							
	Nord	Sofe	13°52'N	2°07'W	2010-2011	2010	309-483
	Nord	Pathiri	12°94'N	2°08'W	2010-2011	2010	391-510
	Centre-Nord	Samboaga	12°45'N	0°54'E	2010-2011	2010	347-483
	Plateau Central	Loango	12°31'N	1°16'W	2010-2011	2010	429-520
	Centre-Ouest	Pouni	11°57'N	2°32'W	2010-2011	2010	512-752

*Effective rainfall means total amount of rainfall observed from 2 days before planting till maturity of all tested genotypes.

KVx775-33-2 were nominated as their preferred genotypes. Notably, the farmers in Niger showed a certain acceptance for the brown-seeded high-yielding variety IT00K-1148, while in Burkina Faso, none of the brown-seeded cowpea genotypes were popular, despite their high-grain yield and/or large seed size (Table 2).

2. Key criteria for farmers' choice of cowpea variety

A total of 215 farmers (126 in 2008 and 89 in 2009) in Niger and 406 (in 2010) in Burkina Faso participated in the questionnaire survey after the first year of FPVS. Based on the data obtained, a high-grain yield was considered the most important criterion for farmers'

Table 2. Agronomic and seed characteristics of genotypes used for FPVS activities in Niger and Burkina Faso

Genotype	Maturity	Average grain yield (kg/ha)*		Resistance to <i>Striga</i> **		Seed characteristics			Remarks
		Niger	Burkina Faso	Niger	Burkina Faso	Color	Coat texture	Size***	
IT00K-1217	EE	569.2	-	R	-	White	Rough	Small	Breeding line (IITA)
B301	E	781.9	-	R	-	Brown	Smooth	Small	Germplasm (Botswana)
IT98K-409-4	E	782.0	-	R	-	White	Rough	Small	Breeding line (IITA)
KVx30-309-6G	M	904.9	-	S	-	White	Rough	Large	Breeding line (INERA)
IT97K-499-35	M	795.0	-	R	-	White	Rough	Medium	Breeding line (IITA)
Aloka	M	653.8	-	S	-	Spekle	Rough	Medium	Germplasm (Niger)
IT89KD-374-57	M	574.8	-	S	-	White	Rough	Medium	Breeding line (IITA)
IT00K-1263	M	571.8	-	S	-	Brown	Smooth	Medium	Breeding line (IITA)
TN256-87	M	507.9	-	S	-	White	Rough	Medium	Breeding line (INRAN)
IT88D-867-11	M	455.2	-	S	-	Brown	Rough	Medium	Breeding line (IITA)
IT99K-377-1	M	437.7	-	S	-	White	Smooth	Small	Breeding line (IITA)
IT98K-238-3	M	386.0	-	S	-	Black	Smooth	Medium	Breeding line (IITA)
IT99K-216-44	L	578.9	-	S	-	White	Rough	Medium	Breeding line (IITA)
Danila	L	761.2	-	S	-	White	Rough	Medium	Germplasm (Nigeria)
IT81D-994	L	500.5	-	S	-	White	Rough	Large	Breeding line (IITA)
IT03K-338-1	L	110.8	-	R	-	Brown	Rough	Large	Breeding line (IITA)
IT99K-241-2	L	27.1	-	S	-	White	Rough	Large	Breeding line (IITA)
IT99K-573-2-1	EE	876.4	907.6	R	R	White	Rough	Large	Breeding line (IITA)
IT98K-205-8	EE	723.8	854.3	R	S	White	Rough	Medium	Breeding line (IITA)
IT00K-1148	E	929.3	929.3	S	S	Brown	Rough	Medium	Breeding line (IITA)
IT90K-372-1-2	E	907.6	904.9	S	R	White	Rough	Medium	Breeding line (IITA)
IT99K-494-6	E	854.3	723.8	R	R	Brown	Rough	Small	Breeding line (IITA)
IT98K-503-1	E	592.5	437.7	R	S	White	Rough	Medium	Breeding line (IITA)
IT98K-1093-1	M	642.8	929.3	R	S	Black	Smooth	Small	Breeding line (IITA)
IT00K-901-5	EE	-	957.5	-	S	White	Rough	Medium	Breeding line (IITA)
IT93K-452-1	EE	-	921.9	-	S	White	Rough	Medium	Breeding line (IITA)
Melakh	EE	-	936	-	S	White	Rough	Medium	Germplasm (Senegal)
KVx 775-33-2	E	-	1044.7	-	S	White	Rough	Large	Breeding line (INERA)
KVx396-4-5-2D	E	-	952	-	S	White	Rough	Medium	Breeding line (INERA)
KVx442-3-25	E	-	1006.6	-	S	White	Rough	Large	Breeding line (INERA)
KVx771-10	E	-	760.9	-	R	White	Rough	Large	Breeding line (INERA)
KVx421-3J	M	-	853.8	-	S	Brown	Rough	Large	Breeding line (INERA)

* The grain yield indicated is the average value of the grain yield observed in all demonstration fields with three replications for one or two year(s) in each country.

** Resistant (R) means no *S. gesnerioides* attachment observed on all plants in the demonstration fields in each country.

*** Categorized using average 100-seed weight (g/100 seeds) of all demonstration trials as small: less than 13; medium: from 13 to less than 17, and large: above 17.

cowpea variety selection in both countries (Table 4). On the other hand, resistance to drought and pest were commonly considered less important criteria.

In general, maturity was nominated as one of the key criteria for farmers' cowpea variety selection in both countries. However, while early maturing was commonly important for the farmers in Burkina Faso, the level of importance of this criterion varied among the villages in Niger. Especially, among the three villages that

experienced severe drought in the year of trial (145-213 mm effective rainfall), significantly high interest in earlier maturity was observed in Tessaoua and Sarkin Housa, while the farmers of Tchadoua showed a unique preference for late-maturing cowpea (Tables 1, 3, and 4).

In Niger, following grain yield, high-fodder yield and resistance to the root parasitic weed *Striga gesnerioides* were nominated as important criteria (Table 3). There was no relationship between the average

Table 3. Percent of farmers selected cowpea genotypes in FPVS conducted in Niger and Burkina Faso

Genotype	Percent of farmers selected					
	Niger			Burkina Faso		
	2008	2009	Average	2010	2011	Average
IT00K-1217	8.5	5.7	7.1			
IT98K-409-4	9.9	8.3	9.1			
B301	2.2	2.6	2.4			
KVx30-309-6G	22.8**	10.4	16.6			
IT97K-499-35	13.2	12.6	12.9			
Aloka	13.7	13.2	13.5			
IT89KD-374-57	4.9	9.8	7.4			
IT00K-1263	15.0	10.7	12.9			
TN256-87	16.5	14.5	15.5			
IT88D-867-11	13.7*	5.8	9.8			
IT99K-377-1	14.7*	7.7	11.2			
IT98K-238-3	5.2	3.6	4.4			
Danila	4.3	12.1	8.2			
IT99K-216-44	7.5	7.5	7.5			
IT81D-994	5.5	8.6	7.1			
IT03K-338-1	3.5	6.6**	5.1			
IT99K-241-2	10.4	11.3	10.9			
IT99K-573-2-1	20.0	32.3*	26.2	26.6	40.2*	33.4
IT98K-205-8	15.2	28.0**	21.6	29.6**	15.0	22.3
IT00K-1148	32.9	39.0	35.9	10.3**	2.3	6.3
IT90K-372-1-2	26.8	23.5	25.2	23.1	15.0	19.1
IT99K-494-6	16.8	11.8	14.3	15.1	3.1	9.1
IT98K-503-1	15.2	12.2	13.7	6.9	12.2	9.6
IT98K-1093-1	1.5	2.1	1.8	4.3	5.1	4.7
IT00K-901-5				7.0	18.2	12.6
IT93K-452-1				31.5**	9.9	20.7
Melakh				14.7	24.8*	19.8
KVx771-10				11.9	29.6**	20.7
KVx396-4-5-2D				13.0	19.5	16.3
KVx442-3-25				55.6	43.2	49.4
KVx775-33-2				25.3	44.9***	35.1
KVx421-3J				6.7	4.9	5.8

Asterisks represent significant independence of the farmers' selection among the years according to chi-squared analysis, *** $p = 0.001$, ** $p = 0.01$, * $p = 0.05$.

numbers of livestock held and the preference for fodder in both countries (data not shown). In Burkina Faso, the seed size and color were considered more influential for farmers' selection. The seed size preferred by most Niger farmers (75.5%) was medium (13-17 g/100 seeds), while 54% of the farmers in Burkina Faso preferred a large seed size (≥ 17 g/100 seeds) (data not shown). For the seed color, in both countries, white was supported by the majority of the farmers (85.5% in Niger and 86.7% in Burkina Faso) (data not shown).

3. Farmers' constraints to cowpea production

Insect damage was commonly suggested as a serious constraint for cowpea production among farmers in both countries, followed by *S. gesnerioides* and lack of chemicals, as shown in Table 5. Farmers in Niger consistently nominated *S. gesnerioides* as a major problem across all villages, which may be connected to the higher severity of the *S. gesnerioides* infestation (averagely 0.55 and 0.06 *S. gesnerioides* plants/susceptible cowpea plant in Niger and Burkina Faso, respectively [data not shown]). The farmers in Burkina Faso

consistently nominated the lack of chemicals as a major constraint, though little interest among farmers was observed in Niger. In Tessaoua, Sarkin Housa, and Tchadoua, where the survey was conducted in a severe drought year, drought was nominated as a major constraint. Other constraints, such as disease, weed, cowpea marketing, and seed supply, were not seen as major constraints for the farmers in either country in this survey.

Discussion

Throughout the two-year FPVS activity, individual farmer's selection was highly consistent across three replications, despite the name of the genotypes having been hidden from the farmers that participated. This indicates that the farmers are selecting their preferred genotypes through the combination of various traits based on their consistent preferences. The "consistency" of the farmers' choice has also been reported by Kitch et al. (1998) and Sperling et al. (1993). The fact indicates that individual farmer's selection was made based on his/

Table 4. Farmers' key criteria for the selection of cowpea variety in Niger and Burkina Faso

Country	Village	Percent of farmers selected							
		Grain yield	Maturity	Fodder yield	Resistance to <i>Striga</i>	Seed size	Seed color	Resistance to drought	Resistance to pest
Niger									
	Radi	80.0	12.0	88.0***	64.0	32.0***	12.0	8.0	0.0
	Danja	94.4	16.7	72.2*	61.1	5.6	22.2**	16.7	5.6
	Toumnia	95.2	20.6	38.1	52.4	25.4**	0.0	25.4*	17.5***
	Magaria	93.1	20.7	41.4	69.0*	34.5***	6.9	31.0**	3.4
	Tessaoua	96.7***	60.0***	23.3	20.0	0.0	13.3	16.7	0.0
	Sarkin Housa	84.0	60.0***	52.0	40.0	4.0	16.0	20.0	4.0
	Tchadoua	97.1	32.4	58.8	58.8	8.8	5.9	0.0	0.0
Burkina Faso									
	Sofe	95.4	66.2	30.8***	1.5	18.5	3.2	13.8	20.0***
	Pathiri	87.7	51.8	23.7	7.9	26.3	36.0	18.4**	4.4
	Samboaga	94.0*	74.0	16.3	2.0	22.0	18.0	8.0	2.0
	Loango	95.7	89.9*	7.2	13.0	31.9	44.9*	2.9	2.9
	Pouni	70.4	65.7	11.1	22.2***	25.0	52.8***	8.3	18.5**
Average									
	Villages in Niger	91.5	31.8	53.4###	52.2###	15.8	10.9	16.8	4.4
	Villages in Burkina Faso	88.6	69.5###	17.8	9.3	24.7	31.0###	10.3	9.6
	Villages in two countries	90.3	47.5	38.6	34.3	19.5	19.3	14.1	6.5

Asterisks represent significant independence of selected criteria in the each village according to chi-squared analysis, *** $p = 0.001$, ** $p = 0.01$, * $p = 0.05$.

Pound signs represent significant independence of selected criteria in each country according to chi-squared analysis, ### $p = 0.001$, ## $p = 0.01$, # $p = 0.05$.

her specific preference on the characteristics of the plants and seed samples, and the results obtained from the activities could reliably suggest the key criteria for the farmers' selection of cowpea variety in both countries.

Through the FPVS, promising lines such as IT00K-1148, IT99K-573-2-1, and IT90K-372-1-2 for Niger, and KVx442-3-25, IT99K-573-2-1, IT98K-205-8, and KVx775-33-2 for Burkina Faso were nominated, and many of those were released as registered varieties in Nigeria and Burkina Faso (Ishikawa et al. 2017, Boukar et al. 2018). The farmers that participated in the FPVS were categorized into three groups based on the major purposes of their cowpea production as follows: 1) mainly sell as cash crop, 2) mainly use for self-consumption, and 3) use as both cash and food crops (data not shown). In Niger, 44% of the farmers on average produce cowpea mainly as cash crop; contrastingly, in Burkina Faso, 97% of farmers on average use cowpea for self-consumption. However, in both countries, there is no relationship between the purpose of cowpea production and the selection of the farmers' preferable cowpea genotypes.

It has been reported that grain yield is the sole criterion that impacts agronomic performance, consumer preference, and socioeconomic conditions (Sperling et al. 1993, Dorp & Rulkens 1993). Our result agrees with grain yield being the most important trait commonly used by farmers in both Niger and Burkina Faso as a key criterion for their variety selection. However, the significant impact of other agronomic and seed quality traits on the farmers' choice were also suggested, which aligned with the report by Kitch et al. (1998) in Cameroon.

Interestingly, on the several key criteria nominated by farmers in addition to grain yield, differences in the farmers' preferences were observed between the countries as well as among villages. In Niger, farmers consider high-fodder yield and resistance to *S. gesnerioides* as key criteria for their variety selection, which may reflect the demand for animal fodder especially during the dry season and severe *S. gesnerioides* infestation in their fields (Tables 4 and 5). In Niger, several farmers who do not have livestock indicated that harvested fodder is used as a gift or cash

Table 5. Major constraints on farmers' cowpea cultivation in Niger and Burkina Faso

Country	Village	Percent of farmers selected							
		Insect	<i>Striga</i>	Lack of chemicals	Low soil fertility	Drought	Weed	Disease	Other
Niger									
	Radi	92.0	96.0	56.0	40.0***	0.0	4.0	0.0	4.0
	Danja	83.3	100.0	72.2***	16.7	0.0	11.1	11.1	0.0
	Toumnia	85.7	87.3	58.7	31.7**	0.0	20.6***	30.2***	7.9*
	Magaria	89.7	89.7	72.4***	20.7	0.0	10.3	17.2	10.3***
	Tessaoua	93.3	93.3	20.0	3.3	83.3***	0.0	0.0	0.0
	Sarkin Housa	96.0	92.0	24.0	4.0	64.0***	0.0	16.0	0.0
	Tchadoua	100.0	100.0	32.4	8.8	52.9***	0.0	0.0	0.0
Burkina Faso									
	Sofe	92.6	3.1	90.8	90.8***	12.3	72.3***	0.0	1.5
	Pathiri	95.6**	63.2***	72.8	0.0	0.0	25.4	8.8	0.0
	Samboaga	94.0**	38.0	74.0	0.0	32.0***	20.0	0.0	0.0
	Loango	94.2	47.8	94.2	94.2***	0.0	5.8	4.3	0.0
	Pouni	74.1	63.9***	84.3	0.0	35.2***	29.6	14.8***	0.0
Average									
	Villages in Niger	91.4	94.0###	48.0	17.9	28.6	6.6	10.6	3.2
	Villages in Burkina Faso	90.1	43.2	83.2##	37.0	15.9	30.6##	5.6	0.3
	Villages in two countries	90.9	72.9	62.7	25.9	23.3	16.6	8.5	2.0

Asterisks represents a significant independence of selected constraints in the each village according to chi-squared analysis, *** $p = 0.001$, ** $p = 0.01$, * $p = 0.05$.

Pound signs represents a significant independence of selected constraints in each country according to chi-squared analysis, ### $p = 0.001$, ## $p = 0.01$, # $p = 0.05$.

crop in the questionnaire. It is known that farmers in West Africa utilize cowpea fodder as feed for livestock, especially during the dry season, and/or as a commodity for sale in the market to generate extra income (Sambo & Odion 2016). The preference for fodder yield may be also affected by their use of cowpea leaves for human consumption, which was observed in both countries (data not shown).

In contrast, the farmers in Burkina Faso generally showed more interest in the criteria related to grain quality as well as early maturation than those in Niger (Table 4). High farmer preference for a large seed size and a specific seed color reflecting local tradition and market demands have been reported in Cameroon (Kitch et al. 1998) and northern Nigeria (Kamara et al. 2009). Especially for Burkina Faso, which exports tons of cowpea to Ghana, the strong preference for large and white-seeded cowpea varieties in Northern Ghana reported by Langyintuo et al. (2003) may also influence the preference of the farmers. Early maturing cowpea varieties are a good source of income for farmers due to their higher market value compared with late-maturing varieties (Bediako et al. 2009). The higher preference for early maturity may reflect the importance of cowpea as a cash crop in Burkina Faso since the farmers in Burkina Faso do not consider drought a major constraint.

As Langyintuo et al. (2003) reported, consumers place value on a large seed size and specific seed color in cowpea markets of some West African countries. However, farmers in Niger were less strict regarding the seed size and color, that are considered as key criteria alternate market price (Tables 3 and 4), while more than 44% of the farmers produce cowpea mainly to obtain cash income (data not shown). The farmers' comments obtained in the survey indicated that no premium was given for larger seed size at the farm gate, and their preference for a medium seed size is reflected in their experiences on the low trade-off with grain yield. A certain acceptance by the Niger farmers for the brown-seed variety (IT00K-1148) if they had other preferable key traits such as high-grain yield, also illustrates the difference between the countries.

The result of this study also illustrates that the farmers' selection of cowpea varieties varies, reflecting specific environmental, historical, and cultural factors. For example, the additional information obtained in the questionnaire survey suggests that the unique selection by farmers in Tchadoua for late-maturing varieties was influenced by severe *S. gesnerioides* infestation and their historical experience with their local late-maturing variety with *S. gesnerioides* resistance, which could only produce large amounts of fodder constantly and

occasionally grains in the village. On the other hand, the farmers in Tessaoua and Sarkin Housa, who also experienced severe drought in the same year, showed significantly more interest in early maturation, which can allow avoiding the adverse effects of drought.

Conclusion

The data obtained in the FPVS practice and the questionnaire survey provided important suggestions for the development of cowpea breeding/dissemination strategies for better improved cowpea varieties targeting those regions. We confirmed that there is a significant influence of other key traits on the farmers' choice in the variety selection process and that those key traits vary between the two countries, while grain yield was consistently the most important and common selection criterion. In other words, if the varieties had enough grain yield, it is important to grasp those subordinate key traits which reflects the farmers' demands specific to the target region to improve the acceptability of the introduced variety.

Reflecting the importance of cowpea as a cash crop in the target regions, farmers' preferences may be influenced by local market demands and the pricing system. Both Niger and Burkina Faso export tons of cowpea to other West African countries, so it is necessary to capture the demands in the surrounding local markets and further connected regional markets to improve the adoption of the selected genotypes in the target regions.

The study demonstrates the potential of participatory activity to effectively illustrate the farmers' requirements on their preferred cowpea variety, including the significant influence of surrounding environments and traditional knowledge. It was expected that the breeding strategy will be reviewed with those country specific information to enhance the adoption of improved varieties, and the positive influence of participatory approaches will also support enhanced awareness of the performance of the available improved varieties (Ashby & Lilja, 2005). Further study with integrated activity on the development of sufficient seed sector should be designed to evaluate the influence of participatory activities on the adoption rate of selected cowpea.

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