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PARTICIPATORY RURAL APPRAISAL OF THE IMPACT OF DROUGHT AND FARMERS' PREFERENCES FOR COWPEA [*Vigna unguiculata* (L.) WALP] IN KANO STATE, NIGERIA

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ABSTRACT
Drought is the most important constraint threatening food security in the world because change in temperature and rainfall has drastic effect on agricultural productivity. A more sustainable approach to improving farmers' adoption of new crop varieties and new technologies is to include farmers in the developmental processes. This study aimed at analyzing the impact of drought on cowpea production, control strategies and to identify farmers' preferred traits of breeding priorities of cowpea. A participatory rural appraisal (PRA) was conducted in cowpea growing regions of four local government areas of Kano State, Nigeria with total of 150 individuals for semi-structured survey and 80 individuals for focus group discussion (FGD). Results of this study indicate that 80% of cowpea farmers interviewed had experienced drought stress during growing season and that about 75% of the grain yield were lost whenever drought stress occurred during the growing season. About 55% of the respondents use irrigation as a control strategy, 93% manipulate planting and harvesting times and 95% planted improved cowpea varieties. Grain yield reduction between 51% and 75% was recorded by the farmers in the event of drought corresponding to reduction in the realizable income. Drought, pests and diseases and non-availability of drought tolerant varieties were major constraints to production. Quality traits such as large seeds and short cooking time were equally preferred as drought and pest tolerance when choosing cowpea varieties. These findings are relevant in breeding for drought tolerant varieties which combine farmers' preferences for choosing new varieties.

Keywords: Cowpea production, drought tolerance, preferred traits, PRA, and sustainability

Introduction

Cowpea has the potential to make a significant contribution to food and nutritional security and poverty reduction in Sub-Saharan Africa (SSA) as it provides nutritious grain and a less expensive source of protein for both the rural poor and urban consumers (Coulibaly and Lowenberg-Deboer, 2002). In addition to food for humans, it is a valuable source of livestock fodder (Singh et al., 2003) making it very attractive to farmers. As a leguminous crop, cowpea improves soil fertility through its ability to fix atmospheric nitrogen (Sanginga et al., 2000). Although the production trend of cowpea shows a significant increase of 410% in production, this has resulted mainly from 440% increase in land area planted (Oritz, 1998). The challenges of meeting the rapidly growing food needs of SSA cannot be successfully overcome without due consideration of the capacity and limitations of the natural environment which include land tenure system and increasing evidence of climate change (Abaje et al., 2014). Kano State in Nigeria is located in the Sudano-Sahelian Ecological Zone (SSEZ) and it is a major cowpea producing zone in Nigeria. This zone suffers from seasonal and inter-annual climatic variability.

Effects of drought on cowpea include impaired germination and poor plant establishment (Harris et al., 2002; Kaya et al., 2006) if it occurs at the seedling stage, reduced flowers (Kawakami et al., 2006), small seed size (Samarah, 2005) and poor pod filling (Ogbonnaya et al., 2003) if mid-season or terminal droughts are experienced. Since rain has become less reliable and growing seasons shorter, development and release of cowpea varieties that tolerate drought that can occur at any period within the growing season is inevitable. However, it is important that these improved varieties meet farmers' preferences in order to facilitate adoption. This therefore means that

farmers' preferences must be included in the drought tolerant varieties.

By responding closely to farmers' concerns and conditions, researchers can develop technologies that are adopted more widely and that respond to important social issues such as equity and sustainability (Bellon, 2001; Chambers, 1994). Their participation in breeding can be achieved in various ways namely: farmer field schools (FFS), participatory plant breeding (PPB), participatory varietal development (PVD), farmer participatory varietal selection (FPVS), participatory research and extension (PRE) and participatory rural appraisal (PRA) among others. PRA in plant breeding is designed to bridge the gap between breeders and farmers (Banziger and de Meyer, 2000) and also ensure that new varieties satisfy farmers' preferences and suit their socioeconomic situation (Abedi and Vahidi, 2011; Kiiza et al., 2012). Hence a PRA exercise was conducted to identify impact of drought stress on cowpea production and farmers' income (ii) production constraints and preferred traits for inclusion in breeding for improved varieties.

Materials and Method

Survey area

Participatory rural appraisal (PRA) was conducted in fifteen cowpea growing communities sampled from four Local Government Areas (LGA) of Kano State (Gwarzo, Tofa, Bichi and Garko). Kano State lies approximately between latitudes 10º 33'N and 12º 23'N and longitudes 7º 45'E and 9º 29'E and 473 metres above sea level (masl). Kano has a sub-tropical low-latitude semi-arid hot climate with an annual mean rainfall of 600mm.

Data collection and analyses

Primary data was collected from total of 150 farmers with the aid of a semi-structured questionnaire and 80 individuals for focus group discussion. Local language was used to interact with farmers in order to facilitate effective communication and correct responses. Data were collected on farmers' perception of drought, mitigation measures and its impact on cowpea production. Data on production constraints as well as criteria for preference for cowpea traits were collected. Data collected from interviews were recorded, coded and analyzed using SPSS version 9.2. Frequency table of the responses with their percentages and means was used for a descriptive analysis of the variables. Derived scores were calculated for the different criteria by assigning the criterion/rank a value that was inversely proportional to the rank i.e. a rank of 1 received a score of 5, 2 received 4, 3 received 3, 4 received 2 and 5 and above received 1. Mean Derived Scores (MDS) were then calculated from the derived scores (De Groote et al., 2002).

Results and Discussion

Basic information on cowpea production

The result in Table 1 revealed that majority of farmers cultivating cowpea in the surveyed communities were male (90%), farming was their primary occupation and their average age was 47years. The result also revealed that smallholder farmers pre-dominated cowpea production in these communities with about 87% cultivating between 0.5ha to 2ha. This study revealed young adults that still possess strong mental and physical strength needed for the work are engaged in cowpea production in these communities. These findings agree with Awotide et al. (2015), Maza et al. (2012) and Musa et al (2013) who reported that young adults are involved in farming activities. Most farmers held small fields (87%) cultivating average farm size of 1.5 ha for cowpea. Almost all farmers practiced mixed-cropping in order to improve resilience and their level of food security (Lin, 2011). This study revealed that there is high level of land fragmentation to accommodate cultivation of other crops for security reasons which hinders full mechanization that could boost cowpea productivity. This result reflected the general trend common to other crops like sorghum, rice, maize in the sub-Saharan Africa (Fermont et al., 2009, Traore et al., 2015). . Almost all the interviewed farmers (83%) practiced mixed cropping with crops such as maize, groundnut and millet. About 63% of the farmers cultivated cowpea once a year under rain-fed condition, 34% of the respondents who cultivated twice a year has access to irrigation Although, Hussain et al. (2004) reported that using furrow irrigation increased grain yield of cowpea majority of the farmers interviewed in this study could not use irrigation because of associated problems which include high cost, shortage of irrigation water, reduction in pumping pressure and sudden shutting-down of irrigation by authorities without prior notice.

Cowpea production is affected by climatic changes. Farmers revealed in this survey that erratic pattern of rainfall during the cowpea production period significantly limit its production (Figure 1). About 88% of the farmers had experienced severe damage as a result of drought occurring at the sensitive growth period of the cowpea plant which is the pod-filling stage (Table 2). This result agrees with the result of Ajetomoni and Abiodun, (2012) who reported that the occurrence of drought at the pod-filling stages of cowpea is negative to cowpea productivity. Farmers observed reduction in leaf production, abscission, stunted growth and wilting when drought occurred at the vegetative stage. This result agrees with the report of Akyeampong, (1986) and Mustapha et al., (2014).

Farmers reported increased flower abortion, poor pod filling leading to reduction in grain yield when drought occurred at flowering towards the pod-filling stage. Similar findings were reported by Sakamoto et al. (2012) and Daneshnia et al. (2013). Although 95% responded to be growing improved cowpea varieties that were introduced to them by extension workers, these varieties were not exclusively bred for tolerance to drought, hence they still perform poorly under drought stress (Table 2).

Information gotten from the farmers that were interviewed revealed that there could be a grain yield loss between 51 and 75% in the event of drought (Table 3). During the focus group discussion, farmers were worked through simple arithmetic to be able to determine the average grain yield under optimum condition and under drought stress in order to be able to deduce the income that a farmer could generate per hectare under both conditions and to analyze the impact of drought stress on production and their livelihood. Farmers from Kogon Kura gave the highest grain yield of 1,027Kgha^{-1} under optimum condition and 475Kgha^{-1} under drought stress. A bag of cowpea is packaged in 100Kg, this suggested that farmers from this community could realize $1,016 and $470 during optimum and drought stress conditions respectively (Table 3). Farmers revealed that drought stress is very significant to them because the income they generated from cowpea is ploughed into the production of other crops like maize that need higher inputs.

Drought and incidence of insect pests were ranked equal by farmers as major constraints followed by diseases and lack of improved varieties for drought tolerance (Table 4). Constraints such as high cost of land preparation and farm management, flood, soil fertility were ranked as moderately important. Other constraints such as gender, educational level, land ownership and high cost of land rent were referred to be less important when it comes to cowpea production. Farmers ranked quality traits such as market acceptability, large seeds and short cooking time as equally important as tolerance to drought, insect pests and high yield with regards to traits of preference across all surveyed communities (Table 5).

Farmers ranked both drought and insect pests as major constraints to cowpea production (Table 4). Because cowpea is predominantly grown towards the end of the rainy season which is characterized by erratic pattern of rainfall and high temperatures, its grain yield is being reduced under terminal drought and high temperature (Ahmed et al., 1992; Suliman. 2007). The result of this study revealed that drought tied in ranking with increased insect pest infestation followed by diseases. This agrees with the finding of Hall (2012) that the lesser corn stalk borer (*Elasmopalpus lignosellus)* and the ashy stemblight disease caused by *Macrophomina phaseolina* increased and destroyed cowpea seedlings under hot and dry soil conditions. Increase incidence of Striga gesnerioides was also reported by Muranaka et al. (2011) and Ishiyaku and Aliyu (2013) under drought stress. Quality traits that such as short cooking time, large seeds are related to consumer acceptability which in turn drives market were equally ranked as important as drought and pest resistance (Table 5). Farmers revealed that since they sell about two-third of their yield in the market, consumer preferences drive their adoption of any improved variety for cultivation as this commands a premium price in the market. They added that they may likely not adopt varieties that are high yielding and tolerant to some of the mentioned stresses if they do not combine the consumer-based traits because they may not get good returns on their investment. This result is consistent with the findings of Langyintuo et al. (2004), Mishili et al. (2007) and Egbadzor et al. (2013).

Conclusion

Farmers are aware of the negative impact of drought stress on cowpea productivity but they are incapacitated by the addition that irrigation does to cost of production. Hence, availability of improved drought tolerant varieties will satisfactorily be adopted by farmers which will enhance sustainable production. It is evident from this study that other traits which breeders may not be interested in contribute greatly to farmers' adoption of improved varieties or technologies, Inclusion of important consumer-based quality traits like large seeds and short cooking time greatly influence adoption. It is therefore important to be in constant communication with farmers and other stakeholders along the crop value chain so as to be able to determine traits for inclusion in breeding programs.

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Table 1: Socio-economic characteristics of interviewed farmers

Characteristics	Frequency (N=150)	Percentage (%)
Age Range		
20 - 40	58	38.7
41 - 50	42	28
51 - 60	30	20
61 and above	20	13.3
Mean age = 47years		
Gender		
Male	135	90
Female	15	10
‡**Primary occupation of respondents**		
Farming	89	59
Trading	67	45
Civil service	18	12
Artisan	17	11
‡**Land ownership type**		
Owned through inheritance	135	90
Rent	24	16
Owned through purchase	70	47
Area of farmland cultivated with cowpea		
< 0.5ha	4	2.7
0.5 - 2ha	128	87.1
> 2ha	15	10.2
Mean land area = 1.5ha		
Cropping system		
Mono-cropping	24	16
Mixed cropping	125	83.33
No response	1	0.67
Frequency of cultivation/year		
Once	95	63.33
Twice	51	34.00
Thrice	2	1.33
No response	2	1.33

‡multiple responses

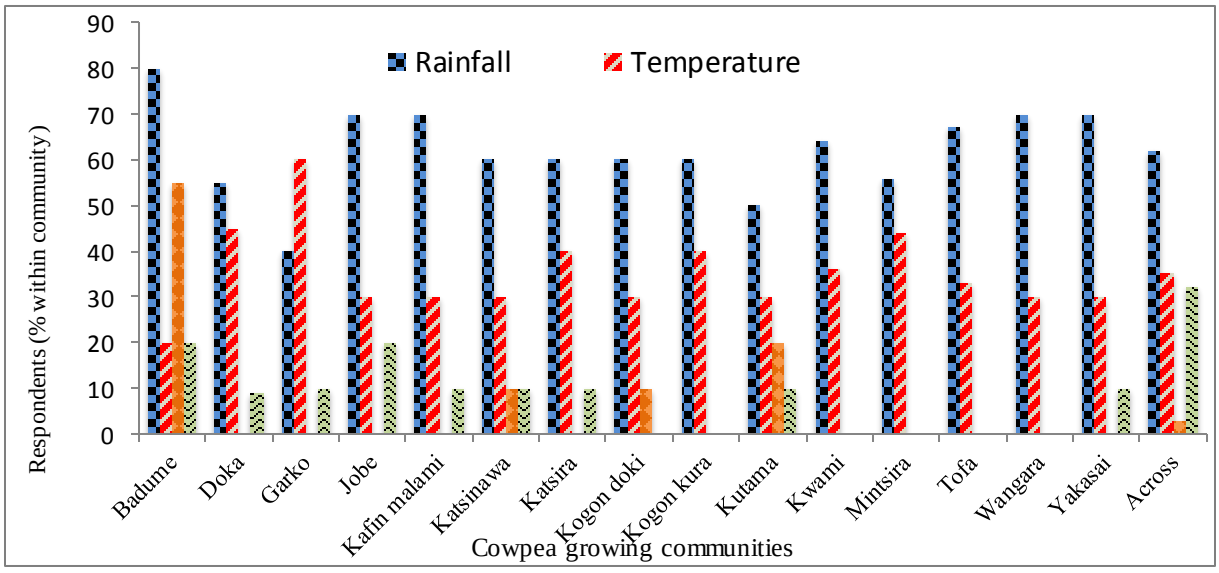

Figure 1: Response of Farmers to erratic pattern of rainfall during the cowpea production period

Table 2: Drought incidence, impact on cowpea production and mitigation measures employed by farmers in the 15 surveyed communities of Kano State

Questions	Response	Frequency	Percentage (%)
Experienced drought during cowpea growing season	No	18	12.0
	Yes	132	88.0
		N=150	
Effect of the drought experienced on grain & fodder yield	Very severe	97	74.62
	Moderately severe	29	22.31
	Not severe	4	3.08
		N=130	
Crop growth stages susceptible to drought devastation	Vegetative stage	47	31.76
	Flowering & grain-filling stage	86	58.11
	All growth stages	15	10.14
		N=148	
Drought mitigation measures			
Irrigation	No	80	54.79
	Yes	66	45.21
		N=146	
Planting improved varieties	No	8	5.33
	Yes	142	94.67
		N=150	
Manipulation of planting and harvesting times	No	8	5.33
	Yes	140	93.33
		N=150	
Other measures	No	8	72.73
	Yes	3	27.27
		N=11	

Table 3: Impact of drought stress on grain yield and farmers' income

Community	§Grain yield (Kg/ha)			*Realized income (per ha)			
	Optimum condition	Drought stress	Percentage yield reduction	Optimum condition		Drought stress	
Badume	587	199	66.1	105660	(581)	35820	(197)
Doka	638	271	57.5	114840	(631)	48780	(268)
Garko	727	288	60.4	130860	(719)	51840	(285)
Jobe	967	459	52.5	174060	(956)	82620	(454)
Kafin malla mai	639	336	47.4	115020	(631)	60480	(332)
Katsinawa	803	364	54.7	144540	(794)	65520	(360)
Katsira	826	367	55.6	148680	(817)	66060	(363)
Kogon doki	594	192	67.7	106920	(588)	34560	(190)
Kogon kura	1027	475	53.7	184860	(1016)	85500	(470)
Kutama	726	325	55.2	130680	(718)	58500	(321)
Kwami	730	274	62.5	131400	(722)	49320	(271)
Muntsira	792	397	49.9	142560	(783)	71460	(393)
Tofa	515	256	50.3	92700	(509)	46080	(253)
Wangara	678	167	75.4	122040	(671)	30060	(165)
Yakasai	592	270	54.4	106560	(586)	48600	(267)

§1bag of cowpea = 100Kg

*Realized income in Naira (top line); realized income in dollars (below line).

$1= N182 at survey period.

Table 4: Production constraints in 15 communities surveyed nested within each Local Government Area

	Bichi LGA		Garko LGA		Gwarzo LGA		Tofa LGA			
Constraints	**‡Responses**	**Rank**	**Responses**	**Rank**	**Responses**	**Rank**	**Responses**	**Rank**	***MDS**	**Overall rank**
Lack of improved varieties	84.6	2	90.0	3	92.5	4	95.0	3	3.0	3
Drought	100.0	1	100.0	1	100.0	1	100.0	1	5.0	1
Diseases	100.0	1	100.0	1	97.3	3	99.0	2	4.3	2
Insect pests	100.0	1	100.0	1	100.0	1	100.0	1	5.0	1
Poor soil fertility	64.1	5	70.0	5	92.5	4	61.5	7	1.3	6
Educational level	20.5	8	30.0	8	25.0	7	29.3	9	1.0	7
Gender and land ownership	10.2	9	13.4	9	17.5	8	19.5	10	1.0	7
High cost of land rent	27.0	7	33.3	7	25.0	7	53.6	8	1.0	7
Flood	78.9	3	60.0	6	87.5	5	90.2	4	1.8	5
High cost of land preparation and maintenance	74.4	4	89.9	4	97.5	2	75.6	6	2.3	4
Inadequate marketing channels	61.6	6	90.1	2	85.0	6	82.9	5	1.8	5

‡Percentage respondents within LGA. *MDS= mean derived scores of ranks obtained across LGAs. A rank of 1 received a score of 5, 2 received 4, 3 received 3, 4 received 2 and 5 and above received a score of 1.

Table 5: Preferred traits cowpea varieties as ranked by farmers in the 15 surveyed communities of Kano State

	Local Government Areas									
	Bichi		Garko		Gwarzo		Tofa		Across	
Criteria	**‡MDS**	**Rank**	**MDS**	**Rank**	**MDS**	**Rank**	**MDS**	**Rank**	**MDS**	**Rank**
High yield	1.27	5	1.64	3	1.18	6	1.64	3	1.82	2
Pest and disease resistance	1.36	4	1.45	4	1.45	3	1.73	2	1.91	1
High palatability	1.36	4	1.45	4	0.64	8	1.27	5	1.46	3
Early maturing	1.73	2	1.73	2	1.64	1	1.82	1	1.82	2
High storability	0.72	6	0.54	8	0.72	7	1.46	4	1.82	2
Large seeds	1.73	2	1.36	5	1.36	4	1.27	5	1.91	1
Drought tolerance	1.73	2	1.73	2	1.27	5	0.91	6	1.91	1
Dual-purpose	1.45	3	0.91	6	1.18	6	1.82	1	1.91	1
Short cooking time	1.27	5	1.64	3	1.55	2	1.82	1	1.91	1
High market acceptability	1.81	1	1.81	1	1.64	1	1.73	2	1.91	1
Late maturing	0.18	7	0.64	7	0.27	9	0.55	7	1.18	4

‡MDS=Mean Derived Score; Every time a criterion is ranked first it receives a score of 5, each second ranking scores 4, each third ranking scores 3, each fourth ranking scores 2, and each other ranking scores 1.0=no response.