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Diagnostic Assessments of Farmer-preferred Traits and Production Constraints of Cowpea in Zambia

N. Nkhoma[1], H. Shimelis[2], M. Laing[2], I. Mathew[2], A. Shayanawako[2]

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ABSTRACT

Background: Cowpea [*Vigna unguiculata* (L.) Walp.] in Zambia is a valuable source of cheap protein, complement to the food systems and value chains in rural and urban areas despite the low productivity. This study aimed to document the present level of cowpea production, identify constraints affecting cowpea production among smallholder farmers and prioritize trait preferences in a cowpea variety as a guide to pre-breeding programs in Zambia.

Methods: Participatory rural appraisal (PRA) was used to collect data from cowpea production areas in Zambia's Eastern, Southern and Northern provinces. The PRA was conducted during the 2017/18 cropping season. Information was solicited from 187 farmers using interview questionnaires with a further focused group discussions with 7 groups.

Result: Cowpea is perceived to be 'a woman's crop' in rural areas of Zambia but the present data showed that the frequency of female farmers who were directly involved in cowpea production in the study areas was relatively low at 44.00 per cent. About 93.60 per cent, the respondents were cultivating unimproved, local cowpea landraces, while the remainder (6.40 per cent) cultivated a few introduced varieties. The most important constraints of cowpea production in the study areas were identified by the respondents as poor varieties with low yield potential (45.10 per cent), pests and diseases (18.10 per cent) and the lack of modern production inputs (14.80 per cent). The farmers indicated that high yield potential, insect pest and disease resistance and good eating quality were the most important traits in a variety.

Key words: Cowpea breeding, Farmer perceptions, Participatory rural appraisal, Production constraints.

INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] is a multipurpose grain legume widely cultivated in the tropical and subtropical regions of the world. Cereals, especially maize and sorghum, are the main staple food crops in Zambia, like many other sub-Saharan Africa (SSA) countries.

However, cereals provide comparatively less protein than legumes, present imbalances in critical amino acids and essential micronutrients Morris *et al.* (2020), which exposes many people to malnutrition because of heavy dependence on cereal-based diets. Legumes, including cowpea, contain relatively high concentrations of protein, balanced amino acid complements and high levels of micronutrients such as iron (53.20 mg/kg), zinc (38.10 mg/kg), calcium (826.00 mg/kg) and magnesium (1915.00 mg/kg), all of which are essential in the food and feed industry Boukar *et al.* (2019). Production of cowpea complements cereal production in enhancing food and nutritional security in SSA region.

There are only seven official cowpea cultivars in Zambia, Official Variety Register Zambia (2021) and their adoption rates have been low. These cultivars were developed to fulfil breeders' objectives without the participation of farmers, which resulted in a lack of farmer-preferred traits and low adoption rates by farmers. Studies have shown that engaging farmers during the initial phases of breeding is important to identify key production constraints, target traits and attributes that are required by farmers and clients Persley and Anthony (2017). A breeding model incorporating farmers' preferred traits during product development helps to bridge the gap between plant breeders and product users. Such a breeding model would generate crop varieties that address farmers' challenges, satisfying their needs and requirements in terms of quantity and quality. Consequently, adoption rates should increase where improved cultivars are released that possess relevant attributes and withstanding prevailing production constraints.

In Zambia, cowpea is a valuable crop complementing food systems and value chains in rural and urban areas. However, its production and productivity is affected by biotic, abiotic and socio-economic constraints. Zambia lacks recent documentation of constraints affecting cowpea production and preferred varietal attributes. Much of the cowpea breeding in Zambia was conducted without consultation with farmers, creating a gap between breeders' and farmers'

[1]Seed Control and Certification Institute, P.O. Box 350199, Chilanga, Lusaka, Zambia.
[2]Africa Centre for Crop Improvement, University of KwaZulu Natal, P/Bag X01, Scottville, Pietermaritzburg 3209, South Africa.

Corresponding Author: N. Nkhoma, Seed Control and Certification Institute, P.O. Box 350199, Chilanga, Lusaka, Zambia.
Email: nellyphiri47@gmail.com

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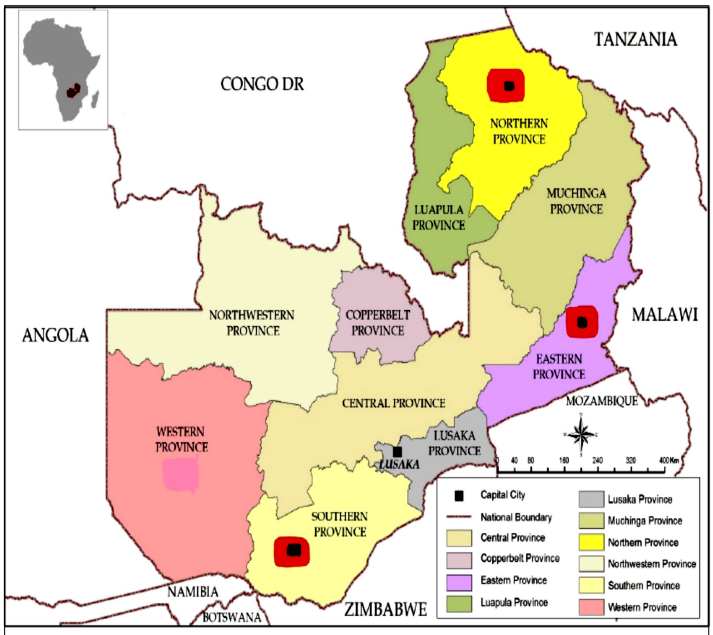
objectives. There was a need for a well-structured survey using the participatory rural appraisal (PRA) approach to identify the major production constraints affecting the production of cowpea and to determine a suite of target traits for cowpea improvement to guide cowpea pre-breeding and breeding, in order to meet farmers' aspirations. Therefore, this study was conducted to document the present level of cowpea production, identify constraints affecting cowpea production among smallholder farmers and prioritize trait preferences in a cowpea variety as a guide to pre-breeding programs in Zambia.

MATERIALS AND METHODS

The PRA was conducted in the Southern, Eastern and Northern provinces of Zambia (Fig 1) in 2018. These provinces are representative of all the three agro-ecological regions of Zambia. The Southern Province is located in Region I, while the eastern and northern provinces falls in Regions II and III, respectively (Table 1). The study used a multi-stage, purposive sampling procedure to identify cowpea-producing farmers. Sampling followed the hierarchy of the agricultural administration system in Zambia that starts at the provincial level and moves down to the district, block and camp levels (Table 1). An agricultural camp comprised of three to five villages. The major cowpea producing districts and target camps in each province were identified with the help of agricultural extension officers based on their accessibility. Finally, cowpea-producing farmers were selected randomly from each camp to reduce bias. The number of villages sampled from each agricultural camp varied from two to five villages.

In total, 187 farmers were randomly selected from the sampled villages. Agricultural officers and civic leaders were the contact personnel for the survey. Officers helped to how farmers acquired their production inputs and the indigenous agricultural methods used in the areas. Traditional leaders gave permission for the respondent interviews and were present in all group discussions, ensuring that protocols were adhered to. They were also useful in explaining how traditional land was apportioned for crop production in their areas. Different cowpea grain varieties and potted plants were used in the discussions.

Data were collected using semi-structured questionnaires for individuals, focus group discussions (FGDs) and transect walks. The semi-structured questionnaire collected quantitative and qualitative data on demographics, production practices, the significance of cowpea in the study areas, important pests and diseases of cowpea, production constraints and trait preferences of respondents. A questionnaire pre-test was conducted on five respondents to reduce bias. Interviews were conducted with assistance from trained enumerators. The questionnaire was in English but was administered in local languages including Tonga, Chewa and Bemba in the southern, eastern and northern province by the enumerators, to foster comprehension by the respondents. The FGDs involved different categories of farmers to discuss various topics on cowpea. Two to three farmers were selected from each agricultural camp and 5 to 7 farmers participated in each focus group with two groups each from Eastern and Northern Provinces, while Southern Province had 3 groups. In total, seven FGDs were conducted for this study. The research team, agricultural officers and farmers participated in the transect walks to augment data collected during the FGDs and interviews.



Source: geology.com (2018).

Fig 1: Map of Zambia showing the survey areas.

RESULTS AND DISCUSSION

Demographic description

The demographic profiles of participants are presented in Table 2. The frequencies of male and female participants were significantly different among the different provinces (X= 13.06, p<0.001). Overall, the frequency of male participants across all the provinces was slightly higher at 56 per cent than the female participants (44 per cent). Despite this ratio, cowpea is considered a woman's in Zambia and other SSA countries Ouédraogo *et al.* (2018). However, when the value of a crop becomes lucrative, males suddenly dominate the value chains of crops previously considered to be "women's crops" Gondwe *et al.* (2017). The relatively higher frequency of male farmers could also have resulted from government-led program to promote the production of "underutilised" crops, including cowpea Malik and Chaudhary (2019). The government's promotion of cowpea raised awareness of its potential, which most likely increased the number of male participants beyond that previously reported.

The farmers' ages did not vary significantly (X= 12.06, p<0.60) across the provinces, with the dominant group of cowpea farmers being between 35 and 49 years of age (Table 2). Expectedly, this demographic group was most active in local and household economies. Hence, its dominance in land ownership, household decision-making and management of financial resources, the key determinants of agricultural participation in smallholder farming systems. This generation of farmers possesses experience and confidence to embrace new technologies, which substantiates reports by Koutsou *et al.* (2014), who suggested that middle-aged farmers' involvement could facilitate the adoption of new innovation that improves productivity. Thus, it is likely that such a progressive, dominant group of farmers would adopt new and improved varieties if they conferred production advantages over the currently cultivated varieties.

Importance of cowpea for food security and income generation

The two major uses of cowpea were identified as income generation (48.00 per cent) and food (37.00 per cent) (Table 3). The people living in low rainfall environments, where other crops such as maize often fail to attain reasonable yields, cowpea provides food for subsistence and income for household needs. Marginalized communities that often lack protein-rich diets benefited greatly from cowpea production, which is among the cheapest protein sources for children and pregnant women in SSA Jimenez-Lopez and Clemente (2019). Thus, cowpea provides food and nutritional security contributing to farmers' livelihoods (da Silva 2018). Improving cowpea production and productivity in SSA will have multiple benefits, especially food security. New varieties that can withstand production constraints also minimize production costs, increase yield potential and ultimately contribute to higher profit margins for farmers.

Table 1: Description of the study sites in three agro-ecological regions of Zambia.

Province	Districts	Blocks	Camps	AER	Alt (m)	GPS	Rainfall (mm)	Temp (°C)	Dominant soils
Eastern	Chipata	Chiparamba	Kalichero	2	900-1300	-14.367, 31.682	800-1000	32	Highly leached red to brown clay and shallow to gravel soils
			Chawa	2	900-1300	-13.610, 32.469	800-1000	32	
	Mambwe	Masumba	Masumba	2	900-1300	-13.258, 31.931	800-1000	32	
			Ncheka	2	900-1300	-10.803, 24.277	800-1000	32	
Northern	Mpika	Mpika central	Chishibeso	3	<1300	-11.837, 31.441	<1000	28	Clay to loamy soils, slightly leached clay soils and Kalahari soils
	Kasama	Kasama central	Kasonde	3	<1300	-10.283, 31.051	<1000	28	
Southern	Mazabuka	Ngwezi	Ngwezi	1	300- 900	-17.527, 24.277	>800	38	Loamy and clay soils with coarse to fine loam top soils and reddish coarse sandy soils
		Magoye	Maunga	1	300- 900	-18.185, 23.887	>800	38	
			Magoye	1	300- 900	-18.185, 23.887	>800	38	
		Dumba	Munjile	1	300- 900	-15.381, 28.322	>800	38	
	Gwembe	Gwembe	Gwembe central	1	300- 900	-16.625, 27.655	>800	38	
	Chirundu	Lusitu	Lusitu	1	300- 900	-15.433, 28.290	>800	38	

AER- Agro-ecological region, GPS- Global positioning system, Alt (m)- Altitude (metres), Temperature (°C).

Production constraints of cowpea

The cowpea production constraints identified by the farmers are presented in Table 4. The most important constraints across the provinces were the lack of improved varieties, insect pests and diseases and limited access to inputs, as reported by 45.10 per cent, 18.10 per cent and 14.80 per cent of the respondents, respectively. Cowpea production in SSA and other parts of the world, is still dominated by landraces and traditional varieties. Landraces and traditional varieties became adapted to local conditions during the long period of cultivation in these agro-ecologies, but they tend to have low yield potential. Farmers' awareness that better

Table 2: Gender and age representation of farmers interviewed in the survey areas.

Variable	Class	Province (%)			Total (%)	*df*	Chi-square	*P*-value
		Eastern	Southern	Northern				
Gender	Male	13 (8.80)	28 (38.50)	16 (8.80)	57 (56.00)	2	13.06	0.00
	Female	9 (10.40)	27 (18.70)	7 (18.70)	43 (44.00)			
Age (years)	15 - 19	1 (1.90)	5 (9.10)	0 (0.00)	6 (11.00)			
	20 - 34	6 (17.77)	19 (26.35)	3(8.88)	28 (53.00)			
	35 - 49	12 (15.57)	33 (57.12)	20 (48.31)	65 (121.00)	6	12.06	0.60
	> 50	0 (0.00)	1(0.55)	0 (0.00)	1 (0.55)			

df= Degrees of freedom; *P*-value= Probability value. Values outside and inside the bracket indicate the frequency and proportion in percentage, respectively.

Table 3: Uses and significance of cowpea in the surveyed areas.

Uses	Province						df Total	Chi Overall ranking	*P*-	-square	value
	Eastern		Southern		Northern						
	Proportion (%)	Rank	Proportion (%)	Rank	Proportion (%)	Rank					
Cash income	7.70	2	25.40	1	14.9	1	48.1	1			
Human food	9.90	1	24.90	2	2.20	2	37.0	2			
Soil fertility	1.10	3	3.30	3	1.20	5	5.60	3			
Manure	0.60	4	1.10	5	1.10	6	2.80	4	14	48.30	0.00
Seed	0.00	6	0.00	8	2.20	3	2.20	5			
Food supplement	0.00	5	0.00	7	2.20	4	2.20	6			
Livestock feed	0.00	7	1.70	4	0.00	7	1.70	7			
Dowry	0.00	8	0.60	6	0.00	8	0.60	8			

df= Degrees of freedom; *P*-value = Probability value.

Table 4: Major constraints to cowpea production in the surveyed areas.

Constraint	Province								df	Chi -square	*P* -value
	Eastern		Southern		Northern		Overall				
	Proportion (%)	Rank	Proportion (%)	Rank	Proportion (%)	Rank	Proportion (%)	Rank			
Lack of improved seed	12.10	1	29.7	1	3.30	4	45.10	1			
Pests and diseases	3.30	2	11.5	2	3.30	3	18.10	2			
Limited access to inputs	0.50	5	5.50	4	8.80	1	14.80	3			
Lack of labour	1.60	3	6.00	3	1.60	5	9.30	4			
Lack of knowledge on cowpea agronomy	1.10	4	0.00	9	3.80	2	4.90	5	16	59.48	0.00
Limited access to credit	0.00	9	2.20	5	1.10	7	3.30	6			
Weed pressure	0.00	8	1.10	6	1.10	6	2.20	7			
Poor seed germination	0.00	10	0.50	8	0.50	8	1.10	8			
Lack of extension services	0.50	6	0.00	10	0.00	9	0.50	9			
High labour costs	0.00	7	0.50	7	0.00	10	0.50	10			

df = Degrees of freedom; *P*- value = Probability value.

Table 5: Desirable of cowpea reported by interviewed farmers across the surveyed areas.

Traits	Characters	Province (%)				df	Chi- square	*P*- value
		Eastern	Southern	Northern	Total			
Desirable	High yielding	12.20	33.30	1.10	46.70			
	Big leaf size	0.60	0.00	0.00	0.60			
	Early maturity	1.10	0.00	0.00	1.10			
	Drought tolerance	1.10	12.80	3.90	17.80			
	Resistance to pests and diseases	1.10	8.30	5.60	15.00			
	Good leaf taste	0.60	1.10	3.30	5.00			
	White seed coat colour	1.10	0.60	1.10	2.80	24	93.30	0.00
	Medium seed size	0.00	0.00	0.60	0.60			
	Smooth texture	0.60	1.70	1.70	3.90			
	Easiness to harvest	0.60	0.00	0.00	0.60			
	Good pod taste	0.00	0.00	2.20	2.20			
	Long shelf life	0.00	0.00	1.10	1.10			
	Good grain taste	0.60	0.00	2.20	2.80			

df = Degrees of freedom; *P*- value = Probability value.

varieties might be available opens opportunities for breeders to develop and deploy suitably adapted and high yielding varieties. Ficiciyan *et al*. (2018) reported that modern varieties were desirable due to their high yields, tolerance to pests and disease resistance. Pests and diseases of cowpea include aphids (*Aphis craccivora* Koch) and bruchids (*Callosobruchus maculatus* Fabricius) and cowpea aphid-borne mosaic virus (CABMV). Mweke *et al.* (2020) reported that aphids were the most important constraint of cowpea production in southern Africa. Farmers reported that cowpea was susceptible to various pests in the field and in storage. Pests cause severe grain damage and decimate stored grain if it is not treated with agro-chemicals. Tiroesele *et al.* (2015) also noted that the cowpea weevil was a serious storage pest, ranked as a major post-harvest pest in the tropics because it caused substantial quantitative and qualitative losses, as well as reductions in weight, market value and germination ability of seeds.

Farmers' trait preferences in cowpea varieties

Farmers preferred varieties with high yield potential, drought tolerance, pest and disease resistance, as indicated by 46.70, 17.80 and 15.00 per cent of the respondents, respectively (Table 5). High yield was the most important determinant influencing cultivar selection. Similarly, Abudulai *et al.* (2016) found that farmers in Ghana preferred high-yielding cowpea varieties. Thus, it would be imperative to develop high-yielding cowpea varieties to increase farmers' prospects in the target environments. However, it is also imperative to identify complementary traits required by farmers in addition to yield. Traits such as drought tolerance, pests and disease resistance are important because they directly contribute to the attainment of high yields in stressful environments. Other qualitative attributes including taste, cooking time and seed colour have been reported among the farmer-preferred traits in legumes. Farmers in Malawi preferred pigeon pea varieties with good cooking quality and cream-coloured seed Nyirenda *et al.* (2020). These findings suggest that these traits need to be integrated into cowpea germplasm with high yield, drought tolerance and pests and disease resistance genetic backgrounds to develop suitable varieties for farmers. Persley and Anthony (2017) concluded that breeders needed to be aware of the target traits desired by farmers and their markets to develop suitable cultivars for rapid acceptance and adoption by clients within the local value chain.

CONCLUSION

The study demonstrated that farmers should be considered active stakeholders in cowpea pre-breeding to develop suitable varieties for improved food and nutritional security in SSA. Both male and female farmers participate in cowpea production in Zambia. Farmers identified insect pests notably aphids and bruchids, diseases such as cowpea aphid-borne mosaic virus and the use of unimproved cultivars as the most important constraints affecting cowpea production. Priority traits preferred by farmers were high grain yield, drought tolerance, insect pest and disease resistance and good taste for leafy vegetable types. Therefore, the identified characteristics should be included in cowpea breeding programs to enhance cultivar adoption by farmers across the country. Successful pre-breeding of novel cowpea varieties will require the selection of high-yielding genotypes bred from both landraces and exotic varieties for introgression of farmer-preferred traits.

Conflict of interest: None.

REFERENCES

Abudulai, M., Seini, S.S., Haruna, M., Mohammed, A.M and Asante, S.K. (2016). Farmer participatory pest management evaluations and variety selection in diagnostic farmer field Fora in cowpea in Ghana. African Journal of Agricultural Research. 11: 1765-1771.

Boukar, O., Belko, N., Chamarthi, S., Togola, A., Batieno, J., Owusu, E.O., Haruna, M., Diallo, S., Umar, M.L., Olufajo, O. and Fatokun, C. (2019). Cowpea [*Vigna unguiculata* (L.) Walp.]: genetics, genomics and breeding. Plant Breeding. 138: 415- 424.

Coulibaly, O. and Lowenberg-DeBoer, J. (2002). The Economics o f Cowpea in West Africa. Proceedings of the Third World Cowpea Conference: Challenges and Opportunities for Enhancing Sustainable Cowpea Production. C.A. Fatokun, S.A. Tarawali, B.B. Singh, P.M. Kormawa and M. Tamò (Eds). Ibadan: IITA.

Da Silva, A., da Costas Santos, D., Teixeira, D.L., da Silva, P.B., dos Santos, R.C. and Siviero, A. (2018). Cowpea: A strategic legume species for food security and health. In: Legume Seed Nutraceutical Research. [J.C. Jimenez-Lopez and A. Clemente (Eds)]. IntechOpen Publishers. DOI: 10.5772/interchopen.79006.

Ficiciyan, A., Loos, J., Sievers-Glotzbach, S. and Tscharntke, T. (2018). More than yield: Ecosystem services of traditional versus modern crop varieties revisited. Sustainability. 10: 2834.

Gondwe, T., Tegbaru, A., Oladeji, A.E., Khonje,M., Manda, J. and Gaya, H. (2017). Correlates and consequences of women's participation in the cowpea value chain in Eastern Zambia. Agrekon. 56: 263-273.

Jimenez-Lopez, J.C. and Clemente A. (2019). Legume seed nutraceutical research. National Spanish Research Council. 10: 5158-5172.

Koutsou, S., Partalidou, M. and Ragkos, A. (2014). Young farmers' social capital in Greece: Trust levels and collective actions. Journal of Rural Studies. 34: 204-211.

Malik, A.A. and Chaudhary, G. (2019). Global Food Security: A Truncated Yield of Underutilised and Orphan Crops. Switzerland: Springer Nature. DOI: 10.1007/978-3-319-92399-4_11.

Morris, J.B., Tonnis, B.D. and Wang, M.L. (2020). Protein content and seed trait analysis in a subset of the USDA, ARS, PGRCU cowpea [*Vigna unguiculata* (L.) Walp] core collection. Legume Research: An International Journal. 43: 495-500.

Mweke, A., Akutse K.S.., Ulrichs C., Fiaboe K.K.M., Maniania N.K. and Ekesi, S. (2020). Integrated management of *Aphis craccivora* in cowpea using intercropping and entomopathogenic fungi under field conditions. Journal of Fungi. 6: 60.1-16

Nyirenda Yohane, E., Shimelis, H., Laing, M., Mathew, I. and Shayanowako, A. (2020). Phenotypic divergence analysis in pigeonpea [*Cajanus cajan* (L.) Millspaugh] germplasm accessions. Agronomy. 10(11): 1682: 1-18.

Official Variety Register. (2021). Seed Control and Certification Institute, Secretariat. Zambia.

Ouédraogo, M., Barry, S., Zougmoré, R., Partey, S., Somé, L. and Baki, G. (2018). Farmers' willingness to pay for climate information services: evidence from cowpea and sesame producers in Northern Burkina Faso. Sustainability. 10: 611.1-16.

Persley, G.J. and Anthony, V.M. (2017). The business of plant breeding: Market-led approaches to new variety design in Africa. CABI Direct. DOI. 10.107079/9781786393814.0000.

Tiroesele, B., Thomas, K. and Seketeme, S. (2015). Control of cowpea weevil, *Callosobruchus maculatus* (F.) (Coleoptera: Bruchidae), using natural plant products. Insects. 6: 77-84.