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11 **ABSTRACT**

Conclusion: Farmers in the humid forest zone of Cameroon are aware of the soil fertility decline on their farms. Respondents lack knowledge on importance of legumes in cropping system and grow and prefer white coated cowpea with erect growth habit. The farmers are however, ready to cultivate grain legumes for soil fertility restoration purpose if this could be demonstrated on-farm.

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16 1. INTRODUCTION

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18 In west and central Africa, cowpea is the second most important grain legume after
19 groundnuts [*Arachis hypogaea*; 1]. In Cameroon, cowpea is the third most important food
20 legume after groundnuts and common beans (*Phaseolus vulgaris*) and it is frequently
21 intercropped with cereals [2]. Besides its use as food and feed, an important beneficial
22 attribute of this legume is its contribution to the soil nitrogen status through symbiotic
23 nitrogen fixation, thereby enhancing soil fertility. Hence it reduces the need for N-fertilizer
24 application [3]. The importance of grain legumes as green manure in enhancing soil fertility
25 has been demonstrated, but these practices and adoption are still limited in sub-Saharan
26 Africa [4]. However, grain-legume cereal rotation are more attractive to the farmers both for
27 food and cash [5]. In the case of the HFZ of Cameroon, cowpea and soybean are
28 increasingly being used in cropping systems [6]. Soil fertility in the HFZ of Cameroon is low
29 due to the old nature of the landscape.

30 Even though the decline in soil fertility is a major concern for most farmers [7], their adoption
31 of improved techniques has been limited [8]. This poor adoption may be due to inadequacies
32 in the agricultural extension system, but an important factor may be the different ways that
33 farmers, extension workers and researchers all perceive and assess soil fertility, leading to
34 differences in the problems perceived and solutions required. With an increase in the use of
35 participatory research approaches, it is becoming clear that farmers have a well-developed
36 ability to perceive differences in the level of fertility on their farms. Thus, there is a strong
37 need to compare the indicators used by farmers with those used by researchers.

38 Farmers have developed various techniques that can be used to detect the decline in soil
39 fertility, through their long experience of agricultural practices. The soil fertility decline
40 indicators used by farmers includes: change in weed biomass and species; changes in soil
41 color, and thickness; reduced growth and color changes of crops and low crop yields in
42 climatically good seasons [9].

43 Participatory rural appraisal (PRA) techniques have been employed widely to assess
44 farmer's perception on soil quality, soil fertility problems and indigenous soil fertility
45 management practices [10; 9; 11]. Despite the importance of farmers' perception on soil
46 fertility improvement, no such study has been conducted in the HFZ of Cameroon on the role
47 of legumes in improving soil fertility. Thus, recent and adequate information is lacking on
48 farmers' perception on the role of grain legumes in improving soil fertility in cropping
49 systems, and the farmer preferred cowpea traits. This study was carried out to identify
50 farmers' preferred cowpea traits in the HFZ of Cameroon and also assess their knowledge
51 on the role of grain legume in improving soil fertility in their cropping systems.

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53 2. METHODOLOGY

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55 2.1 Study site description

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57 The study was conducted at five sites (Asso'oseng, Nkoemvone, Nkolofoulou, Nkoemetou II
58 and Nkoemetou III) in the HFZ of Cameroon. Nkolofoulou (3°56'N, 11°35'E, Nkoemetou II (4°
59 08'N, 11° 55'E) and Nkoemetou III (3°62'N, 11°15'E) are villages in the Center region while
60 Nkoemvone (2°90'N 11°20 'E) and Asso'oseng (02°49'N, 11°08'E) are in the South region
61 of Cameroon (Fig 1). The five villages were selected by the convenience sampling method
62 as representative of cowpea growing areas of the HFZ of Cameroon, and also
63 representative of soils with contrasting physicochemical properties. The climate of the sites
64 is subtropical, with a bimodal rainfall distribution. The humid seasons are September –
65 November (heaviest rainfall) and April - May, and the dryer seasons are December - March
66 and June – August. Rainfall ranges from 1500 to 1800mm annually [12] in this zone and this

117 and household size. Respondents were also asked about their major and subsidiary income
118 sources.

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120 **2.3 Statistical analysis**

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122 Data collected was analyzed using Statistical Package for Social Scientist (SPSS) version
123 17.0 (SPSS, Inc., Chicago IL). Participatory rural appraisal (PRA) techniques such as mean,
124 rank and frequency, were used to analyze the data.

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127 **3. RESULTS AND DISCUSSION**

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129 **3.1 RESULTS**

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131 **3.1.1 Social and economic characteristics of the respondents**

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133 Following the FGD a total of 165 questionnaires were assigned to farmers in the five
134 villages. Forty four (44) respondents came from Asso'oseng, 35 from Nkoemvone, 17 from
135 Nkolfoulou II, 38 from Nkometou II and 31 from Nkometou III (Table 1).

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137 **Table 1. Distribution of respondents in the five study sites**

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Location	Frequency	Percent
Asso'oseng	44	26.7
Nkoemvone	35	21.2
Nkolfoulou II	17	10.3
Nkometou II	38	23
Nkometou III	31	18.8
Total	165	100

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141 The age of the respondents ranged from 18 to 70 years with the majority falling between 36-
142 45 years, representing 58% of the respondents (Table 2). Seventy six percent of the
143 respondents were females while 24% were males. The major activities carried out by the
144 respondents included: hunting, driving, trading, civil service and farming. Farming was the
145 main occupation involving 87% of the respondents (Fig. 2).

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147 **Table 2. Age distribution of respondents**

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Age range	Frequency	Percent
[18-25]	11	6.7
[26-35]	29	17.6
[36-45]	58	35.2
[46-55]	36	21.8
[56-65]	22	13.3
[65+]	9	5.5

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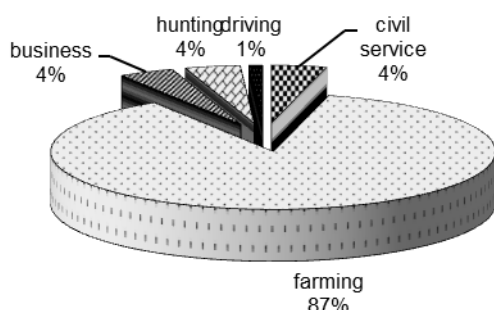


Fig. 2. Principal occupation of the respondents

3.1.2 Farmer preferred cowpea traits

Generally the farmers grew four varieties of cowpea: brown, black, speckled and white. White was the dominant (75%) and preferred variety. They also grew and preferred mostly the erect and early maturing cowpea type (94%). In two of the locations in the survey area, the local name for cowpea varies. Cowpea is generally called “koki” in Asso’oseng, Nkoemvone, and Nkometou II, while known as Ekoki and wak in Nkometou II and Nkolfoulou II, respectively (Table 4). The seeds cultivated also came from various sources including the market, other farmers and research institutions like the Institute of Agricultural Research for Development (IRAD) and the International Institute of Tropical Agriculture (IITA) as indicated in Table 4.

Table 4. Local names, types of cowpea cultivated and source of seeds.

Location	Local name for cowpea		Cowpea cultivated		Source of cowpea seeds	
	Name	Percentage of respondents	Variety	Characteristics	Source	Percentage of respondents
Asso’oseng	Koki	56.8 (25) ^a	Lori-niebe	White seeds	Market	63.6 (28)
Nkoemvone	Koki	85.7(30)	Lori-Nebe	White seeds	IRAD	62.9 (22)
Nkolfoulou II	Wak	58.8 (10)	Dsch MMBr	Brown,	Market	70.6 (12)
			Dsch MMBI	Black		
Nkometou II	Koki	92.1(35)	MTA 22	Variegated	Other farmers	76.3 (29)
Nkometou III	Ekoki	74.2(23)	MTA 22, Lori-Nebe	Variegated, White seeds	IITA	96.8 (30)

^a Numbers in brackets represent the number of respondents .

3.1.3 Cowpea cropping system and production constraints

Cowpea was mostly intercropped (69%) with cereals and other crops while a minor proportion of the farmers practised sole cropping (29%) and rotation or shifting cultivation (2%). In cultivating cowpea, these respondents faced production constraints including, poor soils, low yields, pest and diseases, weeds that compete with their crops, harvest difficulty, lack of seeds and lack of fertilizer (Fig. 4). Among these constraints, poor soils (30%) was the most important, followed by low yields (29%) and pests and diseases (23%).

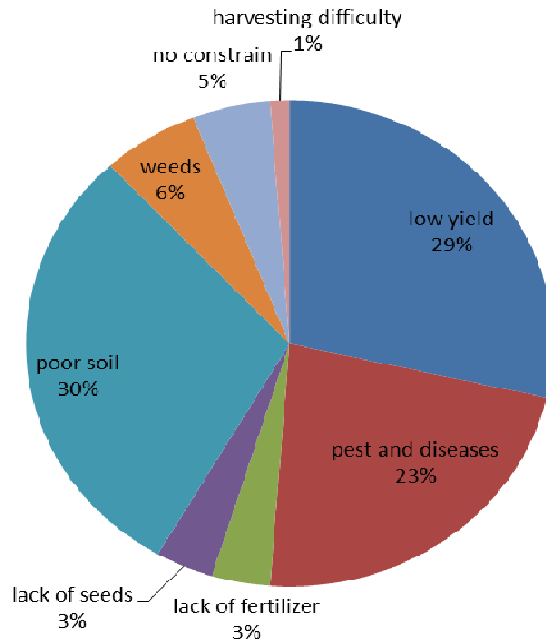


Figure 1. Cowpea production constraints in the study sites

3.1.4 Fertilizer application and awareness on role of legumes in soil fertility improvement.

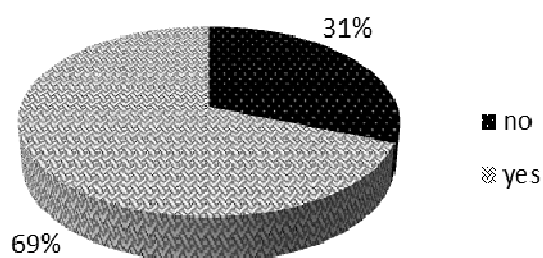
The farmers identified poor soils as the main cowpea production constraints. Since they could not distinguish between soil physical properties like texture, it was considered that poor soils referred to infertile soils. To redress the problem of soil infertility, only 4.5% of the respondents in Nkoemvone did apply some kind of fertilizers. The maximum percentage (19.2%) of fertilizer users were registered in Nkometou II (Table 5). Some of the farmer respondents were aware of the role of legumes in soil fertility improvement. On average, less than 30% of the respondents were aware except in Nkometou III where 50% of the farmers surveyed did have some knowledge on the role legumes play in soil fertility restoration (Table 5). Interestingly, all the farmers were ready to cultivate grain legumes for soil fertility restoration purposes if this can be demonstrated on-farm. Most of the farmers (69%) respondents had observed root nodules on their crops, especially ground nuts and soybean (Fig.5) but very few (6%) knew the role these nodules play in soil fertility improvement (Fig.6). To most of the farmers (90%), the nodules represented organs that harbor disease agents, which they referred to as soil “cysts” and help to render the soil poor. They could not also distinguish between root knots caused by nematodes on tomatoes and root nodules of legumes.

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Table 5. Fertilizer use and role of legumes in restoring soil fertility

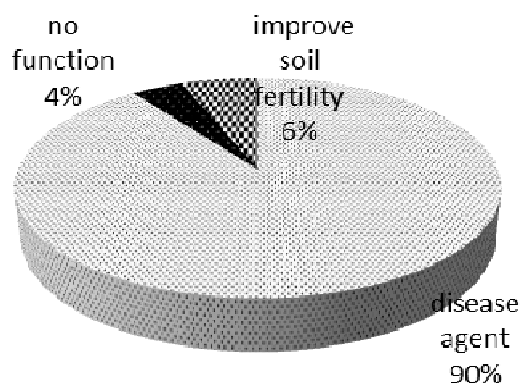
Location	Fertilizer application (% farmers)		awareness on role of legume in soil fertility restoration(% farmers)	
	Yes	No	Yes	No
Asso'oseng	14.8	81.5	11.1	77.8
Nkoemvone	4.5	86.4	22.7	77.3
Nkolfoulou II	15	85	27.5	72.5
Nkometou II	19.2	76.9	15.4	65.4
Nkometou III	12.5	81.3	50	50

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Figure 5: observation of nodules on plant roots



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Figure 6: knowledge on role of nodules

3.2 DISCUSSION

Some of the farmers in Nkoemvone and Nkometou III have been exposed to some training and knowledge on soil fertility management from researchers and extension workers from IRAD and IITA working in these benchmark villages. This exposure made it easier to work with and understand these farmers compared with those from Asso'oseng, Nkolfoulou II and Nkometou II who were very reserved at the beginning of the focus group discussion but later got interested. However, the peculiarity of Asso'oseng and Nkometou II was that the women have formed common initiative groups that worked towards a common goal. This makes it easier for them to adopt a new technology like the use of grain legume in soil fertility management improvement that was being introduced to them.

The results of the survey revealed that the farmers preferred erect and early maturing cowpea varieties that they could harvest just once comparable to how they harvest ground nuts and soybean.

The seeds also came from diverse sources including the market, other farmers and research institutions like the Institute of Agricultural Research for Development (IRAD) and the International Institute of Tropical Agriculture (IITA). This makes it difficult for the farmers to have good quality seeds since IITA had stopped working in these villages. The problem of lack of quality seeds was serious especially in the benchmark villages.

Cowpea was mostly intercropped (69%) with cereals and other crops. The farmers explained that they were bound to include a variety of crops on their field for security reasons such that if some failed, the remaining crops would be used to feed their families. In cultivating cowpea, the respondents faced production constraints including poor soils, low yields, pest and diseases, weeds that compete with their crops, harvesting difficulties, lack of seeds and fertilizer. Among these constraints, poor soil (30%) was the most important, followed by low yields (29%) and pests and diseases (23%). Low yields can be the consequences of poor soil as well as pest and disease manifestation. Therefore emphasis was laid on poor soils. With regards to the yields, low yields referred to cases where the farmer cannot harvest three buckets of cowpea from a field of about 200m². The measuring buckets are usually 15 litres.

Participatory rural appraisal (PRA) techniques have previously been employed to assess farmers' perception on soil quality, soil fertility problems and indigenous soil fertility management practices [9;11]. The farmers identified poor soils as the main cowpea production constraint but very few did apply fertilizers. In some cases only 4.5% of the respondents did applied some kind of fertilizers. Some of the farmer respondents were aware of the role of legumes in soil fertility improvement. On the average, less than 30% of the respondents were aware except in Nkometou III where 50% of the farmers surveyed did have some knowledge on the role legumes play in soil fertility restoration. Nkometou III being one of the benchmark villages of IITA, the farmers were well educated on soil fertility management.

Most respondents 69% had observed root nodules on their crops, especially ground nuts and soybean but very few (6%) knew the role these nodules play in soil fertility improvement. To most of the farmers (90%), the nodules represent organs that harbor disease agents, which they called soil "cysts" and help to render the soil poor. The farmers could not also distinguish between root knots (caused by nematodes) and root nodules and this could explain why some thought nodules did harbor disease causing agents leading to soil infertility. However, after observing fresh nodules on roots of the grain legumes they cultivated and comparing with root knots on tomato roots, the farmers were convinced nodules have different functions and are ready to adopt high N₂-fixing cowpeas if the residual effect is demonstrated on their farms.

4. CONCLUSION

Farmers in the humid forest zone of Cameroon are aware of the soil fertility decline on their farms. They have indicators of poor and fertile soils. These farmers do not apply fertilizers but have other soil amendments strategies. Some respondents lacked knowledge on importance of legumes in cropping system and grew and preferred white coated cowpea with erect growth habit. The farmers were ready to cultivate grain legumes for soil fertility restoration purpose if this could be demonstrated on-farm. Farmers need to increase the use of other alternative soil fertility management practices, such as crop rotation with legumes involved in biological nitrogen fixation. They should be encouraged and supported to use such alternative soil fertility management practices by training, research and development programs. Farmers should be encouraged to grow grain legumes especially cowpea through on-farm research in all the villages to demonstrate the beneficial residual effects of these legumes to other crops like maize.

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COMPETING INTERESTS

No competing interest.

All authors read and approved the final manuscript

CONSENT (WHERE EVER APPLICABLE)

Not applicable

ETHICAL APPROVAL (WHERE EVER APPLICABLE)

Not applicable

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