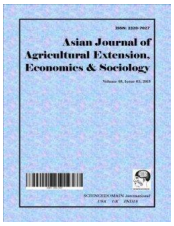

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Assessing Farmers' Knowledge on the Role of Cowpea in Improving Soil Fertility in Cropping Systems in Southern Cameroon

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Authors' contributions

This work was carried out in collaboration between both authors. Author MFA designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Author NAN managed the analyses of the study and the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

A study was carried out to identify farmers' preferred cowpea traits and assess their knowledge on the role of grain legume in improving soil fertility in cropping systems in the humid forest zone (HFZ) of Cameroon. This study was conducted at five sites (Asso'oseng, Nkoemnvone, Nkolfoulou, Nkoemetou II and Nkometou III) in the HFZ of Cameroon, between December 2012 and March 2013. A two stage stratified sampling procedure was applied. In the first stage, each study site formed a sampling stratum. In each site, two focus groups were constructed. The groups included both women and men of various ages. Focus group discussions with 6 -10 farmers per group were carried out during periods when the farmers are less busy in their farms (December and January). In the second stage semi-structured questionnaires were administered (January – March 2013) after the focus group discussion (FGD) to a total of 165 farmers. A total of 44 respondents were interviewed in Asso'oseng, 35 in Nkoemvone, 17 in Nkolfoulou II, 38 in Nkometou II, and 31 in Nkometou III making a total of 165 respondents. Demographic questions included personal details such as gender, age, level of education, position in the house hold, and household size.

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The results indicated that the age of the respondents ranged from 18 to 70 years with the majority falling between 36-45 years, representing 58% of the respondents. Seventy six percent of the respondents were females. 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%). 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%). The farmers identified poor soils as the main cowpea production constraints. On average, less that 30% of the respondents were aware of the role legumes play in soil fertility restoration except in Nkometou III where 50% of the farmers surveyed did have some knowledge. To 90% of the farmers, root nodules represented organs that harbor disease agents, which they referred to as soil "cysts".
From the study, it can be concluded that 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.

Keywords: Grain legume; soil fertility; farmer perception; Southern Cameroon.

1. INTRODUCTION

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

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

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

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

2. METHODOLOGY

2.1 Study Site Description

The study was conducted at five sites (Asso'oseng, Nkoemnvone, Nkolfoulou,

Nkoemetou II and Nkometou III) in the HFZ of Cameroon. Nkolfoulou (3°56'N, 11°35'E, Nkometou II (4° 08'N, 11° 55'E) and Nkometou III (3°62'N, 11°15'E) are villages in the Center region while Nkoemvone (2°90'N 11°20 'E) and Asso'oseng (02°49'N, 11°08'E) are in the South region of Cameroon (Fig. 1). The five villages were selected by the convenience sampling method as representative of cowpea growing areas of the HFZ of Cameroon, and also representative of soils with contrasting physicochemical properties. The climate of the sites is subtropical, with a bimodal rainfall distribution. The humid seasons are September – November (heaviest rainfall) and April - May, and the dryer seasons are December - March and June – August. Rainfall ranges from 1500 to 1800 mm annually [12] in this zone and this high precipitation is responsible for leaching of soil nutrients especially nitrogen. The mean annual temperature is 25°C. The climate gradually changes with elevation. The vegetation of the study site is a humid tropical forest. The population density is less than 10 inhabitants km^{-2} [13]. The major ethnic groups are Ntoumou, Mvae, Beti (Ewondo, etone) and Bulu. Agriculture is the main activity of the population while hunting and fishing is also practiced. The major land uses in the traditional farming system of the study sites are the essep, banana farm, afup owondo, and cocoa or coffee plantation [13].

2.2 Questionnaire Description and Data Collection

This study was conducted with the aid of agricultural extension workers, a socio-economist and village heads. Sampling was designed to maximize on spatial coverage in order to capture variability in socio-economic and agro-ecological circumstances that span the study site. A two stage stratified sampling procedure was applied. In the first stage, each study site formed a sampling stratum. In each site, two focus groups were constructed. The groups included both women and men of various ages. Focus group discussions with 6-10 farmers per group were carried out during periods when the farmers are less busy in their farms (December and January).

Fig. 1. Map of Cameroon showing the study sites

In the second stage semi-structured questionnaires were administered (January – March 2013) after the focus group discussion (FGD) to a total of 165 farmers. The questionnaires were administered by two agricultural extension workers, two technicians and a village head with good knowledge of the local language and English. Respondents were purposefully selected on basis of having cultivated cowpea or a grain legume in the past or presently cultivating cowpea. Each respondent represented household heads, or in their absence, household members responsible for the farm management. A total of 44 respondents were interviewed in Asso'oseng, 35 in Nkoemvone, 17 in Nkolfoulou II, 38 in Nkometou II, and 31 in Nkometou III making a total of 165 respondents. The main questions focused on were: source of cowpea seeds; number of cowpea varieties cultivated; utilization of cowpea grown; preferred varieties; criteria for selecting variety; cropping system practiced; cowpea production constraints; soil fertility diagnosis method; indicators of declining soil fertility; soil fertility amendments strategies; role of legumes in cropping systems; perceptions on legume nodulation; seasons and soils with enhanced plant nodulation. Demographic questions included personal details such as gender, age, level of education, position in the house hold, and household size. Respondents were also asked about their major and subsidiary income sources.

2.3 Statistical Analysis

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

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Social and economic characteristics of the respondents

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

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

Table 1. Distribution of respondents in the five study sites

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

Table 2. Age distribution of respondents

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

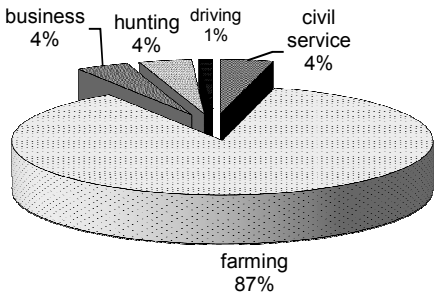

Fig. 2. Principal occupation of the respondents

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 3). 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 3.

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. 3). Among these constraints, poor soils (30%) was the most important, followed by low yields (29%) and pests and diseases (23%).

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 4). Some of the farmer respondents were aware of the role of legumes in soil fertility improvement. On average, less that 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 4). 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. 4) but very few (6%) knew the role these nodules play in soil fertility improvement (Fig. 5). 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.

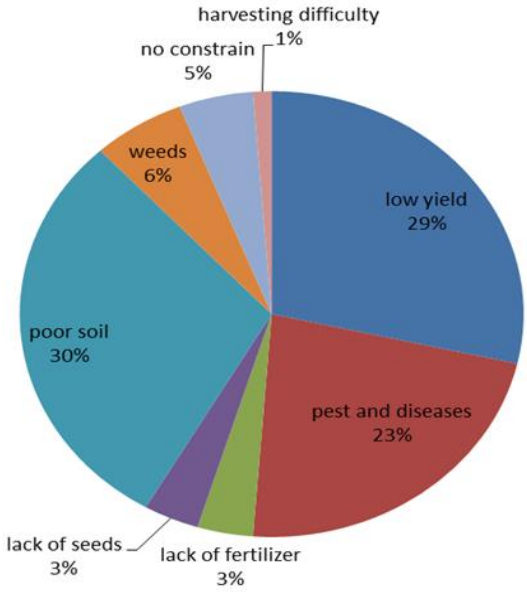

Fig. 3. Cowpea production constraints in the study sites

Table 3. 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 Dsch MMBl	Brown, Black	Market	70.6 (12)
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*

Table 4. 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

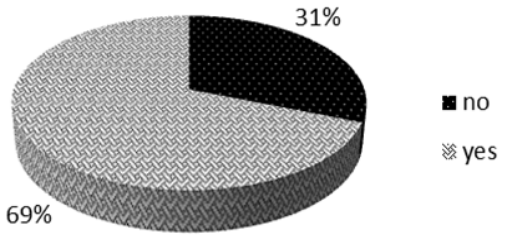

Fig. 4. Observation of nodules on plant roots

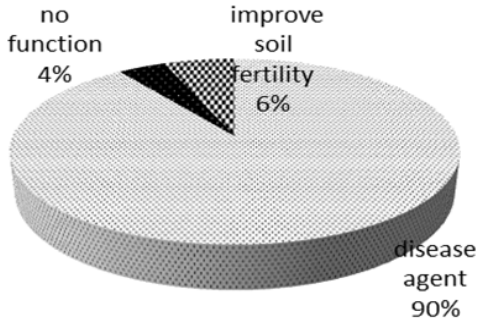

Fig. 5. Knowledge on role of nodules

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 benckmark 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 200 m2. 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 that 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 cultivateed and comparing with root knots on tomato roots, the farmers were convinced nodules have different functions and are ready to adopt high N_2-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 expecially 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

Authors have declared that no competing interests exist.

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