

Participatory analysis of groundnut (*Arachis hypogaea* L) cropping system and production constraints in Burkina Faso

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Abstract

Background: Groundnut (*Arachis hypogaea L*) is one of the major legume crop grown as food and cash crops across the agro ecological zone in Burkina Faso. It is ranked 2nd legume crop in the country, in term of importance, for household food, nutrition and income generation for both rural and urban zone, contributing significantly to food supply and the country economy. However, groundnut was downgrade long ago, forsaken and the groundnut sector is still struggling, with a low productivity, disorganized groundnut sector and a weak breeding program, due to several constraints. Assessing and describing the present groundnut cropping system and production constraint will eventually serve as a basis to guide efficiently the groundnut breeding activities.

Methods: A Participatory Rural Appraisal (PRA) study was conducted in three groundnuts production areas (Central-Eastern, Central-Northern and Central- Western). A total of 124 farmers were involved in the study to collect data on socio-demographics, farming system, cropping practices and identified production constraints. Analysis was carried out for qualitative and quantitative variables using STATA 14. Mean variance were determined across regions and gender, and pairwise ranking were used to assess the level of agreement for variables ranking among the three regions using Kendall's W. Pearson's correlation was carried out to assess the relationship between variables.

Results: The study revealed a cropping system of groundnut in an environment largely affected by climate change, and in a subsistence and extensive agriculture. There is a variance in groundnut cropping system across the regions with similarities in the cropping practices. Gender plays a key role in the production of the groundnut and 48.39% of women are engaged in groundnut cropping with less access to land and production resources. A yield gap between men and women has been observed denoting a huge inefficiency between men and women. Production constraints, although similar, are perceived and appreciated differently across the region. The lack of improved varieties, Absence of agricultural credit, lack of materials, high price of seeds, high price of fertilizer, drought and disease are some of the important constraints compromising the crop.

Conclusion: This study provides a recent view of groundnut cropping, allowing good understanding of farmer's situation. The result, will contribute to an efficient refining of breeding priorities and guide further activities in groundnut breeding in Burkina Faso.

Introduction

Burkina Faso is a landlocked country with an economy largely based on agriculture. Crop production is largely based on rainfall farming systems and remains vulnerable to climate hazards (1,2). It is in this context that over 13 million (3) people owe their food to a subsistence agriculture strongly dominated by cereals, leguminous, tubers and some minor crops (4). In west Africa, groundnut plays a primary role as food crop for household consumption and also as a cash crop, source of employment and important incomes for smallholders in rural zone (5).

Groundnut (*Arachis hypogaea L*) is one of the important leguminous crops grown largely in Burkina Faso, thanks to its wide adaptability and dual purpose human use and animal feed (6). It was the number one cash crop until it was overtaken by cotton in 1980 (7). The groundnut production has since experienced a regression following a long drought, poor soil fertility, climate change, lack of support and lack of promotion of the crop (8). The country is under a highly variable spatial and temporal distribution of rainfall which is sometimes uncertain and erratic(2). Consequently, groundnut production has been decreasing over the years and pod yields remained low. The groundnut breeding program remained less organized to develop improved varieties that mitigate the constraints. The rare increases of groundnut production observed are largely attributed to an extensive cropping system and not due to the performance of varieties(8–10)0 The breeding program had little success in improving and disseminating new varieties based on high yield potential . The efforts made in groundnut production were more focus on land extension instead of improved varieties development. Consequently, groundnut production is still characterized by low productivity and highly dependent on local and inadequate materials, coupled to a precarious environment condition. The availability of improved varieties seeds and support remained however among the difficulties and activities are limited to the varietal tests of released material from international institutes International Crops Research Institute for the Semi-Arid Tropics (ICRISAT). The National groundnut breeding program still have little information on farmers' constraints and preferences to guide efficiently the breeding activities. Given the situation described above, there was a need to involve farmers in all breeding process. Participatory Rural Appraisal (PRA) is well known as approach and method involving farmers and other key actors in research activities (11).

In breeding, this approach allows rural people to design, to share information, to analyze their knowledge of life and conditions(12), take responsibility and give orientation to the development of the new technologies. PRA are nowadays acknowledged as a strong tool in plant breeding ensuring an efficient identification of farmer's constraints, preferences and also a large uptake of varieties and technologies. In Togo, (13) have conducted a PRA study as a pre-breeding activity to identify farmer's constraints and preferences in groundnut production. (14) used Participatory variety development as best approach to enhance sorghum germplasm and preserve local agrobiodiversity of this crop in Burkina Faso. The PRA approach is becoming increasingly a crucial step in breeding by matching scientist criteria and farmers' ones for better adoption of improved varieties. This study aims to describe groundnut farming system in Burkina Faso which is still not well known and to identify the different constraints in groundnut production. The results from this study will contribute to an efficiently refining of breeding priorities and guide further activities in groundnut breeding in Burkina Faso.

Materials And Methods

Description of the study area.

The study was conducted by a multi-disciplinary team composed of breeders and sociologists with a good knowledge of the groundnut production areas. Local Agricultural Extension Agents (LAEA) and the Leaders of Farmers Association (LFA) were involved in this study. Questionnaire survey and Focus Group Discussion (FGD) were used to gather information on groundnut farming system. Three main groundnut production regions (i.e. Central-Northern, Central-Eastern and Central-Western regions) were the target areas of the study (Fig.1). The Central-Northern region located in the South-Saharan zone is characterized by annual rainfall between 500mm to 700mm and mostly sandy clay soil texture. The Central-Eastern region, located into the North-Sudanian agro-ecological zone has an annual rainfall range of 700 to 900 mm while the Central-Western region which belongs to the South-Soudanian agro-ecological zone has annual rainfall varying from 900mm to 1100 mm (15,16).

Questionnaire design, sampling procedure and data collection

A semi-structured survey questionnaire generated using computer package Sphinx V [19] and Focus Group Discussion (FGD) were used to collect information in the selected areas using multistage sampling approach. The first stage was a purposive selection of the three regions based on the importance of groundnut production reported by the Direction of National Agricultural Statistics (17). Four (4) villages were selected in each region based on the dynamic of groundnut farmers and platforms established by the groundnut breeding program in these regions. Groundnut farmers were then randomly sampled in the selected villages to give 124 farmers interviewed using the semi structured questionnaire (Table 1). Data collected from the FGD were used to support and validate the information obtained from the questionnaires. One FGD was conducted in each region involving 12 to 15 farmers. Each FGD gathered 3 farmers from each selected village in the region. The three selected farmer was made up of one producer, one processor and one trader. The group was constituted of both women and men in one hand and also by young and old persons, to assess the perceptions from each social component. To establish an easy communication, participants were divided in men group and women group. Using the questionnaire, socio-demographic information was gathered such as sex, matrimonial status, farmers age and education level.

Table 1
Study area and distribution of farmers in interview and FGD

Region	Village	Geographical Location		Number of Farmers	
		N	W	Interview	FG
Central-Eastern	Daltenga	11.95	-0.483333	12	12
	Boussouma	11.730646	-0.66152	7	
	Lergo	11.63352	-0.719828	12	
	Pagou	11.79	-0.72	6	
Total	4			37	12
Central-Northern	Iryastenga	13.2329	-1.1335	10	12
	Kalambaongo	13.211802	-1.039553	6	
	Nessemtenaga	13.010959	-1.145495	11	
	Pissila	13.21	-0.73	10	
Total	4			37	12
Central-Western	Léo	11.1	-2.17	13	12
	Mouna	11.15	-2.124262	12	
	Wan	11.184317	-2.0713	12	
	Zoro	11.003337	-2.084641	13	
Total	4			50	12
Total	12			124	36

Data analysis

Data collected were coded, descriptive and comparative statistical analysis were performed using STATA 14 software. Analysis of variance and means were determined across regions and gender. Pearson's correlation was carried out to assess the relationship between variables. For the FGD, farmers were asked in each region to list the production constraints which have been ranked. The rank of the constraint in each region were used to assess the level of agreement for the ranking of the constraint among the three regions using Kendall's W coefficient of concordance.

$$W = \frac{12 S}{m^2(n^3 - n) - nT} ; \quad S = \sum_{i=1}^n (R_i - \bar{R})^2$$

where n is the number of constraint and m is the number of region. S is a sum-of-squares statistic over the row sums of ranks R_i , and \bar{R} is the mean of the R values (18,19).

Results

Demographic characteristics of groundnut farmers

The gender distribution, matrimonial situation, literacy and age dynamics of the groundnut farmers is given in Table 2. Among the 124 farmers interviewed, 29.84 % were from the Central-Eastern, 29.84 % from the Central-Northern and 40.32% from the Central-Western. About 48.4% were women and 51.61% were men, suggesting a gender balance of the groundnut farmers. However, at the region level, the study revealed a big gap for the gender participation in the survey. In the Central-Eastern region, 67.57% of participants were women and 59.46% of participants in the Central-Northern regions were women. In each region both men and women produce groundnut as a cash crop. Women are largely involved in groundnut value chain which become a main activity for incomes in off season specially in the Central-Northern region. Majority of participants were married (96.77%) and the few non married were from the Central-western region (3.23%). Majority of farmers (65.32 %) were between the age of 35 and 60 years. Thirty-six percent of farmers were under 35 years while only 5.65% of respondents were more than 60 years old. More than twenty-nine (29.3%) young people were engaged in groundnut farming activities with age varying from 15 to 34 . The mean age of the participants was 41 years. There is no significant difference of age across the region and similar proportions of each group were observed in each region. Unlike the age of farmers across region, there is a high significant difference of age between men and women ($P < 0.0001$). Women farmers appear to be younger with mean age of 37 ages than men farmers (mean age of 45 ages). Majority of the respondents (58.6%) were illiterate and didn't attend school at all. The remaining farmers (41.4%) are able to read and write in either other languages and/or official language. Only 11.29% of the respondents attended primary school, 6.45% attended secondary school and 24.19% of the participants attended local basic literacy training. Unlike the men farmers, women farmers show a higher proportion of secondary education and low proportion of primary school education (Fig. 2). The Central-Northern region presents the lowest level of secondary school educated farmers while in the Central-Western region, proportion of primary and secondary school educated is almost the same (Fig. 2).

Table 2

Table: Socio demographic profile of farmers in the study areas

Region		Central-Eastern		Central-Northern		Central-Western		Total				
Variable	Category	Num	Perc	Num	Perc	Num	Perc	Num	Perc	Df	Chi-square	Pvalue
Gender	Women	25	67.57	22	59.46	13	26	60	48.39	2	17.3009	0.0000
	Men	12	32.43	15	40.54	37	74	64	51.61			
	Total	37	29.84	37	29.84	50	40.32	124				
Matrimonial	Single	0	0	0	0	4	8	4	3.23	2	6.1173	0.047
	Married	37	100	37	100	46	92	120	96.77			
Age-group	< -35	9	7.26	12	9.68	15	12.1	36	29.03	4	2.69	0.61
	35-60	25	20.16	22	17.74	34	27.42	81	65.32			
	>60	3	2.42	3	2.42	1	0.81	7	5.65			
Education level	Illiterate	21	56.76	21	56.76	30	60	72	58.06	6	3.8501	0.697
	Basic Literacy	8	21.62	11	29.73	11	22	30	24.19			
	Primary School	6	16.22	4	10.81	4	8	14	11.29			
	Secondary School	2	5.41	1	2.7	5	10	8	6.45			

Groundnut cropping system and practices

The cropping systems and cultural practices in the study area are summarized in Table 3. The main soil types in the study areas are sandy soil, clay soil, clay-sandy soil. In the Central-Northern region 94.6% farmers produce groundnut on sandy soil while in the Central-Western region 88% farmers grown groundnut on sandy clay soil. In the Central-Eastern region 56.7% of interviewed farmers grow groundnut in clay or clay sandy soil. Diverse crops are grown in the study area where on average 4 crops are grown by a producer with a range of minimum one crop and a Maximum of 7 crops. On average groundnut ranked second important crop in terms of area and importance among the crops produced. The average ranking of groundnut between the regions was not significant. However, the average ranking of the crop by gender shows a significant difference between women and men ($P < 0.0000$). Groundnut is more important for women compared to men. It was mostly ranked first crop produced for most of the women, especially in the Central-Eastern region, while for men the crop was ranked up to 5th. About 45% of women and only 12.5% of men ranked groundnut as their first crop among the crops produced while half of the men and 38.33% of women ranked groundnut as a second crop among crops produced.

Early June appeared to be the most appropriate sowing period for groundnut according to 46.77% of farmers (Table 3). The mid-June and the end of June are both considered as suitable periods in 11.29% of producer's opinions. Considering the appropriate sowing period within each region, the Central-Western and the Central-Eastern respectively 60.0% and 59.5% of farmers reported the early June as a suitable period for groundnut sowing while in the Central-Northern the appropriate sowing period seems to be early July (32.4%) and the end of June (27.02%). Farmers generally practice groundnut weeding twice, the first, 2 weeks after sowing and the second, 30 to 45 days after sowing generally or at flowering stage.

More than half (65.32%) of the interviewed farmers mentioned the end of September as a suitable period harvesting groundnut, 16.13% of farmers mentioned the early October and 10.48% of farmers reported the Middle-October.

In the Central-Eastern around 59.4% as well as in the Central-Western around 88% of farmers harvest groundnut at the end of September. On the other hand, in the Central-Northern region 40.53% of farmers harvest at the end of September and 32.43% of farmers at mid-October.

It has been observed that groundnut is mainly cultivated in mono-cropping system in the three regions. Intercropping is practiced in the study area and mostly in the Central-western region with cereals such as sorghum, millet; maize and in some rare cases with legumes. In this study area 11.29% of respondents rotated groundnut with others crop. About 54.3% of the respondents practice row planting of groundnut with diverse spacings used between rows and hills. The study showed 65.32% of the farmers used chemical products for the seed treatment. Although farmers use several products, the main ones are Caiman, Pacha, Thiorol, and Calthio which is the most utilized product across the three regions. Fertilizer use for groundnut production is limited in the study area. These people believed that there is no need to apply fertilizer for groundnut while for some of

them, the reason is the lack of money. However, some farmers apply either chemical fertilizer (41.94%) or organic fertilizer (40.32%) in the three regions due to the drought, low soil fertility and also to increase yield. The Central-Eastern and Central-Northern regions are where chemical fertilizer are highly used with respectively 62.16 % and 64.86% (Table 3) according to the producers. Only 10% of respondent from the Central-Western region used chemical fertilizer. The similar trend was observed for the use of organic fertilizer in the three regions

Gender implication and farm characteristics

The groundnut farm size ranged from 0.25 ha to 10 ha with an average of 1.072 ha (Table 4). The average production is 584.47 Kg while the average yield is 681,23 Kg/ha. In general, analysis of variance showed a significant difference only for the farm size across regions ($p < 0.0029$) and for the yield across the regions ($P < 0.0363$). The Central-Eastern region which presented the largest average of groundnut farm size (1.57 ha) has the lowest average yield of 591,07Kg/ha. The Central-Western region, although presenting the smallest average farm size, differs from other regions with the highest yield of 767.15Kg/ha. All the three regions possess the equal minimal farm size (0.25 ha) but the largest one is located in the Central-Eastern (10 ha).

Table 3

Cropping systems and cultural practices in groundnut cropping in the study area.

	Central-Eastern	Central-Northern	Central-Western	Total	DF	Chi 2	P-values
	Percent	Percent	Percent	Percent			
Sowing period							
Early of June	59.46	16.22	60	46.77	8	61.18	0.000
Midle of June	0	5.41	24	11.29			
End of June	32.43	27.03	16	24.19			
Early of July	8.11	32.43	0	12.10			
Midle of July	0	18.92	0	5.65			
Harvest period							
End of September	59.46	40.54	88	65.32	6	46.29	0.0000
Early of October	16.22	21.62	12	16.13			
Midle of October	2.7	32.43	0	10.48			
End of October	21.62	5.41	0	8.07			
Soil type							
Gravelly soil	8.11	0	0	2.42	14	66.21	0.0000
Loose soil	10.81	0	0	3.23			
Sandy soil	16.22	37.84	26	26.61			
Sandy-clay soil	8.11	56.76	62	44.35			
Clay soil	16.22	2.7	6	8.06			
Sandy clay soil	40.54	2.7	4	14.52			
Lateritic soil	0	0	2	0.81			
weeding							
Once	35.14	13.51	32	41.94	3	26.92	0.0000
Twice	64.86	86.49	68	58.06			
Chemical fertilizer							
Yes	37.84	35.14	90	41.94	3	35.14	0.0000
No	62.16	64.86	10	58.06			
Organic fertilizer							
Yes	51.35	48.65	74	40.32	3	7.19	0.027
No	48.65	51.35	26	59.68			

Table 4

Groundnut farm characteristics, production and yield in the study area

Region	Village	Groundnut farm size range			Groundnut Production range			Groundnut yield range		
		Min	Mean	Max	Min	Mean	Max	Min	Mean	Max
Central-Eastern	Boussouma	0.25	1.17	2	500	820	1500	500	756.66	933.33
	Daltenga	0.5	2.43	10	200	610	1000	200	648.48	1133.33
	Lergo	0.25	1.291	3	200	611.11	1200	100	408.33	1050
	Pagou	0.5	0.875	2	700	750	800	750	775	800
	Total	0.25	1.57_b	10	200	661.53_a	1500	100	591.07_a	1133.3
Central-Northern	Iryastenga	0.25	0.675	1	266.66	652	1433.33	666.66	673.33	680
	Kalambaongo	0.5	1.58	3	216.66	944.44	2266.66	433.33	634.88	850
	Nessemtega	0.25	0.613	1	200	365.75	733.33	400	587.77	933.33
	Pissila	0.25	0.525	1	150	234.07	366.66	100	703.33	973.33
	Total	0.25	0.76_a	3	150	508.79_a	2266.66	100	643.24_{ab}	973.33
Central-Western	Léo	0.5	0.98	1.5	216.66	769.25	1233.33	216.66	875.51	1492.06
	Mouna	0.25	0.708	1.5	143.33	425.55	123.33	433.33	751.38	1233.33
	Wan	0.5	1.125	4	236.66	557.58	983.33	473.33	1049.9	1600
	Zooro	0.5	0.903	2	216.66	593.58	1500	383.33	589.6	1000
	Total	0.25	0.93_{ab}	4	143.33	602.5_a	1566.66	216.66	767.15_{abc}	1600
Total		0.25	1.07	10	143.33	584.47	2266.66	100	681.23	1600

Means within a column followed by the same letter(s) are not significantly different

*Means within a column with different letter(s) are significantly different

The study indicates a significant difference within regions although there was no significant difference at study area for the farm size by sex. The ANOVA of the average farm size by sex presents no significant difference. The smallest farm usually belongs to the women while the largest farms are owned by men. Only the Central-Western region showed gender balanced for the average groundnut farm size. The analysis of variance of the average yield by gender was significant ($p < 0.0252$). Men' average yield was higher than the average yield of the women (Table 5). A similar observation was made for the average production ($p < 0.0000$) With men production almost twice the women average production.

Table 5

ANOVA of groundnut farm size, production and yield by gender

Region	Sex	Groundnut farm size		Groundnut Production		Groundnut yield	
		Mean	P-value	Mean	P-value	Mean	P-value
Central-Eastern	Women	1.07 _a	0.0086	572.54 _a	0.0344	502.77 _a	0.0245
	Men	2.625 _b		829.62 _b		750 _b	
Central-Northern	Women	0.6 _c	0.345	297.46 _c	0.0006	624.5 _c	0.52
	Men	1 _c		804.66 _d		688.73 _c	
Central-Western	Women	1.01 _d	0.5355	426.38 _e	0.0536	769.44 _d	0.97
	Men	0.89 _d		645.061 _e		766.17 _d	
Total	Women	0.88 _e	0.0715	421.93 _f	0.0000	614.89 _e	0.0252
	Men	1.24 _e		724.575 _g		750.53 _f	

*Means within a column followed by the same letter(s) are not significantly different

*Means within a column with different letter(s) are significantly different

The table 6 shows some significant correlations between farmers' characteristics and farming system variables: A negative and significant correlation were observed for farmers age and the technical assistance, age and use of improved variety. A high positive and significant correlation has observed for sex and Production, Sex and Yield and also Sex and the rank of groundnut. Groundnut production is positively correlated to Field superficities, Yield and Sowing period with high significance

Table 6

Correlation among farm characteristics and farming system variables

	Age	Sex	T.A	U.I.S	E.L	F.S	Prod	Yield	Exp.	RAC	ASP	AHP
Age	1											
Sex	0.3454**	1										
T.A	-0.1851*	0.0344	1									
U.I.S	-0.1912*	0.0231	0.6368**	1								
E.L	-0.2484**	-0.041	-0.0769	-0.0415	1							
F.S	0.1422	0.1624	-0.0434	-0.1382	-0.0515	1						
Prod	0.2556**	0.4111**	-0.0602	-0.1208	0.009	0.3137**	1					
Yield	0.0536	0.2334*	-0.0831	-0.1509	0.1873	0.1119	0.4065**	1				
Exp.	0.2625**	-0.0172	-0.0037	-0.0878	-0.0316	0.1231	-0.0089	0.102	1			
RAC	0.1079	0.3662**	-0.1953*	-0.0658	0.1308	-0.1568	-0.0625	0.0588	0.0008	1		
ASP	-0.1256	-0.2483**	-0.2098*	0.0632	0.1761	-0.2175*	-0.2773**	-0.1928	0.0242	0.1976*	1	
AHP	0.1404	0.1348	-0.2455**	-0.171	0.081	0.138	0.1902	-0.0135	-0.0299	0.1039	0.3962**	1

Signification code : **=0.01 ; * = 0.05

T.A.= Technical Assistance; U.I.S.= Use of Improved Seed; E.L.= Education Level; F. S.= Field Superficities; Prod= Production; Exp= Experience; RAC= Groundnut rank among crops produced; ASP= Appropriate Sowing Period; AHP= Appropriate Harvested Period.

Cultivated groundnut varieties

The analysis of the type of varieties grown in the last three years (2015-2017) shows large proportion of the local varieties in each year and in each region (Fig.3). The relative frequencies for the local varieties grown was 87.9%, 90.63% and 75% for 2015, 2016 and 2017 respectively, against 12.1%, 9.37 and 25% of improved varieties for the same periods. Most of the respondents reported the unavailability of the improved varieties. In addition, most of the varieties used in the study area are characterized by small kernel size (Fig.3). Indeed, 72% of the utilized varieties in 2015 were characterized by small kernel and 28% for large kernel. The proportions were 65.59 % for the small kernel and 34.41% for the large kernel in 2016 and 58.51% for the small kernel with 41.49% for the large kernel in 2017. According to the farmers, the small kernel varieties are widely spread and easily accessible.

The study revealed multipurpose use of groundnut in the study areas including food, cash source, animal feed and ecological services.

Groundnut is an extremely versatile crops being used in wide range of food products(20,21) in Burkina Faso. It is used increasingly as roasted with salt commonly called (marba-tigue) which is sold and eaten almost everywhere in publics, celebrations and community festival (22). Boiled groundnut and fresh one, are also eaten daily, and its raw products are included in varying food preparation. It is even prepared mixed with burnt sugar called (nangour-siido) in local language or caramel which are highly appreciated and sold everywhere in the country. The crop is crushed after being roast to produce groundnut butter which is used as a main ingredient in several foods. The butter is used in basic food preparation with cereals, Tuber, leguminous. It is also used in the preparation a local food which is made up of a mixture of sorrel leaves, Cowpea leaves, and millet or sorghum grains commonly called (Baag-benda, Zind-zangsenga...) in local language. Groundnut cakes, rich food in nutrition, used as common snacks(21) is produce, especially in the Central-northern region, after oil extraction. The cake is also crushed and mixt with spices in meat roasting. Although the groundnut trading flows remain unknown due to the unorganized situation of the sector, it is estimated that more than 60% of the production is marketed (10). A large part of the production is sold in the country through an organized network, from collectors to wholesalers who supplied the retailers and export the crop. These traders handle large volume of the transactions of groundnut across urban and regional centers. The sector is organized in a circuit involving different social strata, and constitutes an important source of employments and income generation for a large part of the people, especially the rural dwellers. It has been reported that groundnut provide 16% of farm cash income (10) in the country.

In urban centers, the sale of groundnuts constitutes an activity practiced through large markets (Pouytenga, Sankar yaaré...) and especially by housewives and young girls. It is potential source, generating activity for small farmer(21), providing cash income for many young girl's, schoolchildren in rural and urban zone, during holidays period. In regional centers, groundnut is processed and sold individually or collectively through women's groups, villages group or regional cooperatives. Wholesalers export groundnuts to neighboring countries, with a low export rate representing 2% of production (8). The higher income of groundnut generated has been observed in 2008 with only 2billions francs CFA on income generated. Groundnut and it derived products through artisanal processing, provide per annum around 1.45% of the GDP (Gross Domestic Product). The marketing of groundnut and it derived products in Burkina Faso actively contributes to the well-being of many households, access to health and above all, the education of children. In animal feed, groundnut constitute a rich fodder appreciated by livestock and the haulm is used to feed animal either fresh or dry. Rarely used in manure, after harvest, haulms are always dried and can be well sold for cattle, goats nutrition and in few case for sheep. Additionally groundnut is used in mixt cropping system to restore soil fertility thanks to its ability of N₂ fixation and nutrient uptake (23,24). In Burkina, Faso, groundnut is among the most suitable crops for rotation purpose with Cereals(25). An important improvement of soil fertility and increase of millet biomasses of 20% have been reported in rotation cropping (26). In the semi-arid climatic conditions, without mineral fertilization, groundnut improve soil fertility hence in rural zone the crop is mostly grow in marginal soil by small farmer.

Groundnut production constraints

In the FGD, farmers identified constraints and make ranking of these constraints (table 7). The constraints listed and ranked by farmers in FG were similar from one region to another region. Despite their similarity, there was no concordance of the ranking of the constraints across the regions. Each constraint was perceived with different rank from one region to another region. In the FGD, farmers in the Central-Eastern region identified soil pest, short period of rainfall, lack of short maturity varieties, diseases and lack of improved varieties as the most important constraints

Table 7

Groundnut constraint rank in each region and across the region

<i>Groundnut production constraint</i>	<i>Constraint rank</i>			
	Central-Eastern	Central-Northern	Central-Western	Mean
<i>Lack of improved seed</i>	4	4	2	4.5
<i>Lack of short maturity varieties</i>	3	3	5	4.5
<i>Short period of rainfall</i>	2	1	3	2.17
<i>High price of improved seed</i>	6	6	11	4.67
<i>Diseases</i>	4	5	4	5.5
<i>Drought</i>	3	1	8	7.67
<i>Pest</i>	1	8	10	7.67
<i>Lack of training</i>	5	2	12	7.83
<i>Problem of land ownership</i>	8	9	1	8.33
<i>Lack materials</i>	9	3	6	8.33
<i>Soil poverty</i>	7	7	7	9
<i>Lack of reliable market</i>	6	8	5	9.5
<i>Problem of conservation</i>	10	8	9	11.33
<i>Kendall's W</i>	0.431			
<i>Chi-square</i>	15.51			
<i>F distribution p value</i>	0.214			

Production constraints faced by farmers in the study area and their frequencies are presented in Fig. 4. The main constraints included lack of improved varieties, lack of materials, high price of seed, low yielding varieties, pest attacks, diseases and drought. However, the analysis of the constraints in each region reveals that each constraint is perceived differently from one region to another (Fig. 5).

In the central-northern region, drought, short period of rainfall, lack of training, lack of improved seed, lack of short maturity varieties, and diseases are the most appreciated constraints while in the central-western region, land ownership, diseases, lack of improved seed, short period of rainfall, lack of short maturity varieties were ranked ahead as important constraints. However, in general the lack of improved varieties, the lack of materials, the high price of the seed, the low yielding varieties and pest attack appear to be more important with respectively 13.79%, 11.23%, 10.21%, 9.57% 6.38% of interview people rank of the constraints.

Discussion

The present study revealed a subsistence groundnut farming system dominated by smallholder farmers in Burkina Faso. The cropping is characterized by extensive and low external input with big diversity across regions(9), largely depending on the rainfall which follow a north-south gradient, soil types and socio-economic conditions (2,27). The maturity cycle of groundnut varieties and cultural practices varied from one region to another region depending on rainfall distribution and soil typology (28). The early sowing period of groundnut observed in the Central-western and Central-Eastern regions compared to the Central-Northern region is relates to the onset of effective rainfall in June, giving farmers 4 to 5 months growing period (29). In these regions, the early sowing in a long duration season allow farmers to cope with drought issues. This practice is coupled with the use of short duration groundnut varieties for the purpose of early harvest. A strategy for farmers specially in the Central-Western region to plant a second crop such as yam, maize cowpea, okra sorrel enabling them to produce two crops in one season and thereby increasing income. In the Central-northern region the large spread of the sowing period might be associated to the experience intermittent start of rain with often dry spells after first rain (30), facing by farmers which is reported as characteristic in this region. This situation often forces farmers to wait in order to avoid crops failure. In Burkina Faso, groundnut is produced in the field with rudimentary farming practices and techniques (10). The current study also revealed poor cultural practices where production is mainly carried out in monoculture associated with a relative low use of organic and chemical fertilizers due to limited availability of the fertilizer and the finance to acquire it (9). In some areas, for example, in the Central-Northern and Central-Eastern regions, fertilizer is used with improved varieties coupled with soil and water conservation techniques to cope with soil poverty. Such

practices has been reported as an effective method to restore soil fertility and increase productivity (31,32). Gender, age and education level have significant implication in groundnut farming in Burkina Faso. The high number of women compared to men involved in groundnut production, especially in the Central-Northern and Central-Eastern regions, may be explained by their importance at each level of the groundnut value chain. Across the regions, women play an important role in groundnut production trading and processing (33,34). Groundnut processing represents a primary cash crop for women which seems to be one of the principal activity of women in off season, especially in the Central-Northern region, justifying the larger number of women involved in groundnut production. The groundnut average farm size differs between regions ($P < 0.0029$) with the Central-Eastern region having the largest farm size. The ANOVA for the average yield was significant across the regions ($P < 0.0363$) and the Central-Western regions present the high average yield. It's has been reported that this Central-Eastern region accounts for the largest area under groundnut cropping in Burkina Faso(8,20). Yet, this region seems to have the lower average yield. The higher average yield was observed in the Central-Western region. It was observed that, although women are in numerical importance among groundnut farmers in the Central-Eastern and Central-Northern regions, they are those farmers possessing small farm size, almost 50% smaller than men farm size. Women access to land and production resources such as labor remain one of the highlighted characteristic of agriculture in West Africa, especially in Burkina Faso (35,36). Many women in groundnut production have smaller size and marginal land as production resources. These women in rural zone are facing routinely the challenge in accessing agricultural inputs such as fertilizer, and even have less access to agriculture extension services such as training and information (37–39) (38,39). The lack of financial means, labor and especially the women right and access to land are some of the reasons justifying the differences in farm size between men and women. In addition, land accessibility to women is limited in those regions because socio-cultural factors and traditional common property systems impact women empowerment. Indeed, in Burkina Faso, land ownership and access, access to natural resources such as soil and water are largely governed by men and land ownership is exclusively inherited through family lineage from father to son (40). Yet in the Central-Western region some women groundnut farm sizes are as big as men farm sizes. These women are mostly groundnut traders who grow groundnut for sale. The proximity of the zone with Ghana offers more interesting market for the sale of groundnut (8,10). So, these women do not hesitate to invest and often rent or buy land for groundnut production. The access to land may also be explained by the social structure in this region which is more flexible and open, giving more access to land by women. Unlike the difference in groundnut farms size between regions, there is no difference of average production across the regions, which is characterized by low productivity. However, there is a significant difference in average production and average yield between men and women with men achieving higher average yield. This result reflects the gender implication in groundnut production in Burkina Faso. Recent research testing the weak implication of household models (hold by men or by women) on agriculture production in Burkina Faso reported similar observations (35).

The significant and positive correlation between the sex and the yield and also the production and the farm size, not only confirm the gender effect on groundnut production but also underline the dependence of groundnut production to the farm size in general, a manifestation of an extensive cropping system. This extensive farming system has been highlighted by (41). The finding that there is a large gender difference in farm size and yield, therefore does not imply that neither women are less efficient in groundnut cropping than men, nor more access to land of women will increase the production or the yield. But it is obvious that this yield gap between man and women is imputable to several constraints such as access to inputs, training, finance, marginal land...which are tidily associated to women farmers condition in west Africa (37). In general, there is limited use of improved varieties in the study area with the lowest use in the Central-Western region. According to most respondents, the reasons are the lack of the improved varieties, the inaccessibility of the improved varieties and the lack of money to acquire it. Some farmers do not even know where and how to have the improved varieties. However, it should be noted that the study did not have a reliable identification system of the varieties used by the farmers. As a result, a producer could have used an improved variety that he/she has considered as a local variety. Some farmers restrict themselves for buying the improved seed in the belief that the improved seed must come from the technical assistant or NGOs or groundnut platforms members. Indeed, the strong positive and significant correlation of the technical assistance and the use of improved varieties confirm that most of the users of improved varieties may get it from the technical assistance either by the Local Agriculture Extension Agent (LAEA) or NGO. This fact could have explained the high proportion of improved varieties use in the Central-Eastern and Central-Northern region where the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has reported an increase of groundnut improved seed community in 2018 under the project Tropical legumes project TL 3 (42). Young farmers are the most users of improved seed which is confirmed by the significant negative correlation of age of farmer and the use of improved varieties. This could be due to the fact that the young farmers are more educated compared to the elders which gives them better access to information and makes them more open to new technologies. Groundnut producer are less educated and only few have education and most are the youth. The low level of education observed in the study areas suggests the need to use local languages for dissemination of new improved varieties of groundnut. This will facilitate awareness creation and the uptake of the new varieties for their rapid adoption. The educated farmers can serve as communicators about the potential of new varieties or other technologies: Those farmers with primary and secondary level may be useful in gathering information regarding to groundnut farming. They can also serve as facilitators when introducing new technologies in groundnut farming communities in the study areas. However, the important proportion of local literature tuition farmers could be helpful to seed companies for the promotion of new varieties if the groundnut seed system was well operating. Another noticeable fact revealed by this study was the higher proportion of the small kernel groundnut used in the area. The Central-Western and Central-Northern are those regions presenting high proportion of small kernel groundnut used. For the interviewed peoples, the reason is the fact that these small seed of groundnut are widely spread and they are used because, farmers have limited choice for large seed. Farmers reported that the limited choice in terms of varieties, forces them to rely on the local varieties and the small kernel varieties which are less productive and even not preferred. Formerly considered as a cash crop because of oil extraction, varieties with small seed were promoted because of their high oil content and are then the most available groundnut varieties disseminated in Burkina. The low productivity of groundnut observed in the study area is attributed to diverse

production constraints (9,43). Although similar these constraints are ranked differently from one region to another. The Central-Eastern region and specially the Central-Northern region have growing season known to be shorter (44) and farmers reported increasingly the unpredictable and unreliable rainfall distributions which can justify the rank of drought, short period of rainfall, lack of short maturity varieties ahead in these regions. To mitigate the constraints, some short duration (90 days) varieties (TE3, TS-32-1, CN 94, etc.) have been introduced and promoted (45) by the National Institute of environment and Research in Agriculture (INERA). Although farmers remained unsatisfied for yield potential, their complaining for the inaccessibility of these varieties may be a proof of good appreciation. That may have justified why in these region farmers perceived the lack of training and information as reason of the low used of improved varieties. Involving farmers in breeding activities to choose their preferred varieties and reinforce their capacities on seed production could help to make available and accessible the new varieties. Some respondents mentioned the lack of groundnut seed production companies. The abandonment of the groundnut sector for the benefit of other cash crops (cotton, sesame) by authorities (10) and the limited support from policies in groundnut breeding may be the causes of the disorganization of groundnut seed production system (46,47). In the Central-Western regions the high level of humidity thanks to a good annual rainfall exceeding 1000 mm (29), diseases were reported with predominant occurrence causing important loss of production (13,43,48). The high fertility of soil increased soil value which became out of reach for small farmer specially women. Additionally, farmers mentioned foliar diseases such as rosette disease, and rust including the post-harvest loss due to storage pest. Farmers reported that groundnut fetches a better price when it is sold fresh in pods. Yet a large proportion of the harvest is often sold at low price to avoid the problem of storage loss. Another noticeable issue is that farmers, sometimes may leave groundnut in the field after harvest and/or the harvest is postponed due to the other farm activities with other stable crops such as sorghum and millet. This practice causes a lot of damages and losses due to termite damage or pod loss from peg breakage due to the drying of soil at harvest time. In general, the lack of improved varieties, Absence of agricultural credit, lack of materials, high price of seeds, high price of fertilizer, drought and disease are some of major yield limiting factors (49) compromising groundnut production in Burkina Faso. Finding a way to overcome with these constraints constitute a primary step to alleviate groundnut farmer conditions and enhance groundnut production in Burkina Faso.

Conclusion

The study provided a recent information on groundnut production in Burkina, which is characterized by an extensive cropping system in an environment largely dominated by cereals and in a subsistence agriculture system. It was evident that women are highly involved in groundnut production but with limited and unequitable access to production resources. The crop is found to be constrained by several abiotic and biotic factors which impacted its production and constitute a bottleneck for groundnut sector. This situation is worsened by an unstructured and unorganized groundnut sector. a weak breeding program and seed production and distribution system. Groundnut yields are low where lack of improved varieties, particularly lack of large kernel varieties persistent exacerbated by the weakness of groundnut breeding program and seed production and distribution system. Therefore, there is the need for new technologies and strategies to tackle and enhance groundnut production in Burkina Faso. These include strengthening breeding program, seed production companies and extension services for enhanced generation and dissemination of technologies. Breeding of new varieties must take into account the specific farmers preference and market needs of target areas for better adoption of these varieties.

Abbreviations

ELS: Early Leaf Spot

FG: Focus Group

FGD: Focus Group Discussion

ICRISAT: International Crops Research Institute for the Semi-Arid Tropics

INERA: Institute National of environment and Research in Agriculture

LAEA: Local agricultural Extension Agent

LFA: Leaders of Farmers Association

PRA: Participatory Rural Appraisal

Declarations

Ethics approval and consent to participate

“Not applicable” in this section.

Consent for publication

"Not applicable" in this section.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

All data generated or analyzed during this study are included in this published article [and its supplementary information files].

Competing interests:

The authors declare that they have no competing interests" in this section

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Authors' contributions

BS, designed the study, the questionnaire, carried out the survey, analyzed and interpreted the results. He drafted the first manuscript.

BN was a major contributor in writing the manuscript.

AT, AM and BZ participated in the study design, the questionnaire design, the Data collection and the manuscript correction

JE, and OK are the academic supervisors of the study and they have corrected and revised the manuscript.

HD and RT are Supervisors of the whole study and contributor in writing the manuscript participated in the manuscript correction.

All Authors have agreed to be personally accountable for the author's own contributions and to the accuracy or integrity of the work.

study design and was a major contributor in writing the manuscript.

All authors read and approved the final manuscript.

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Figures

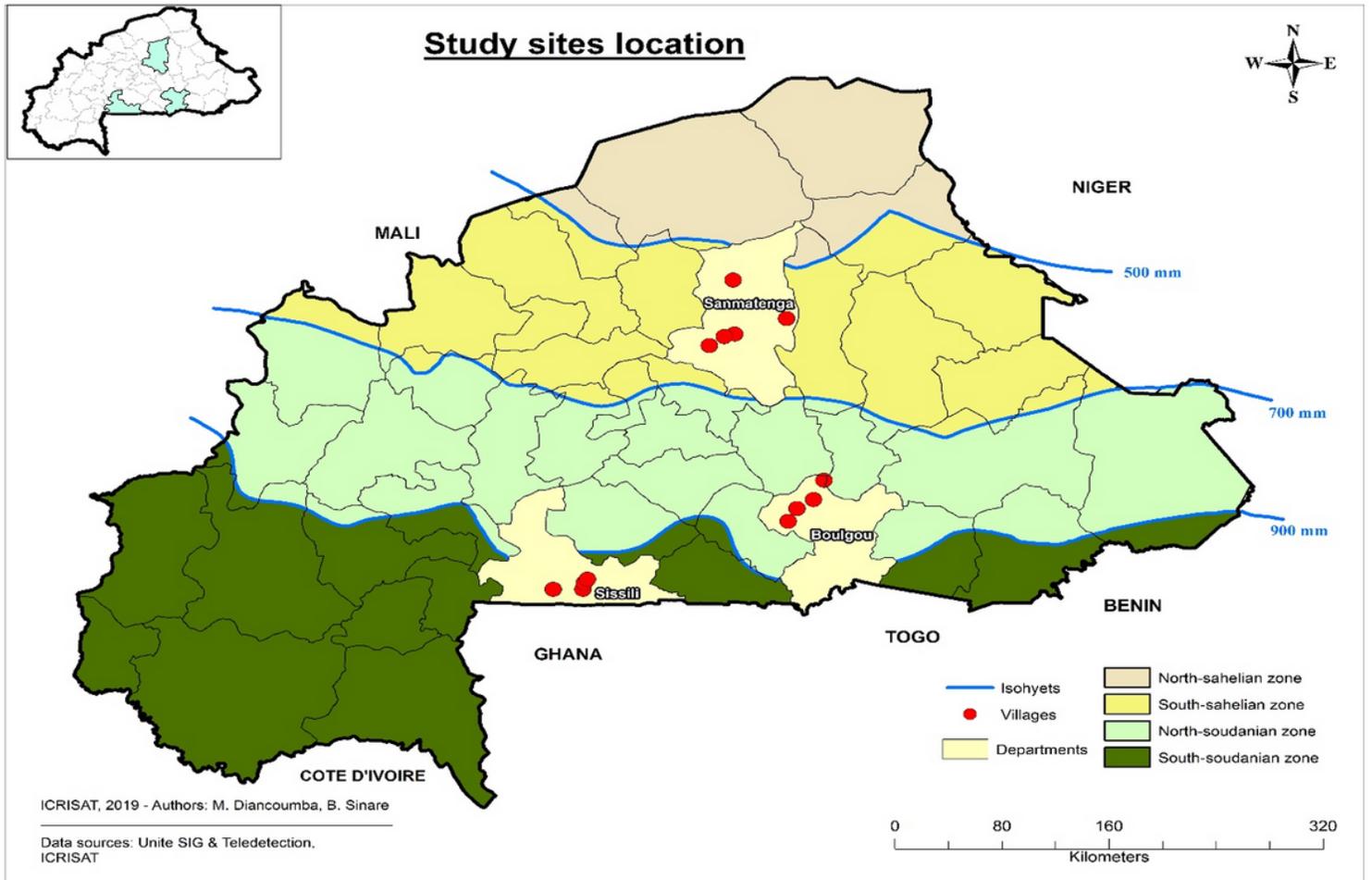
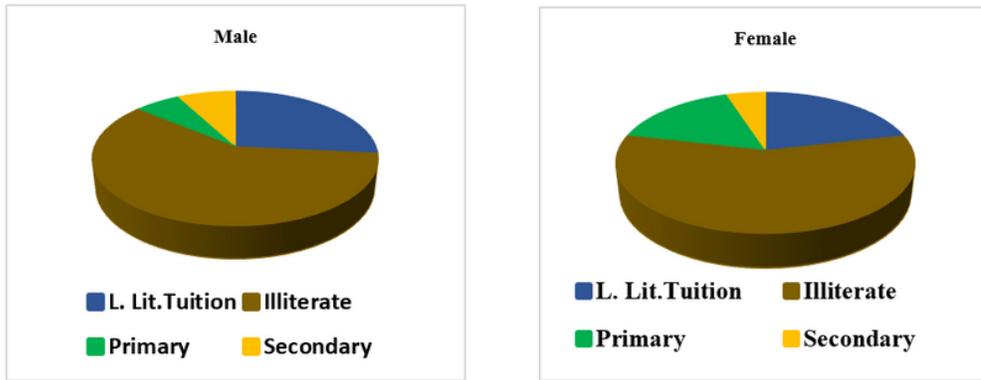
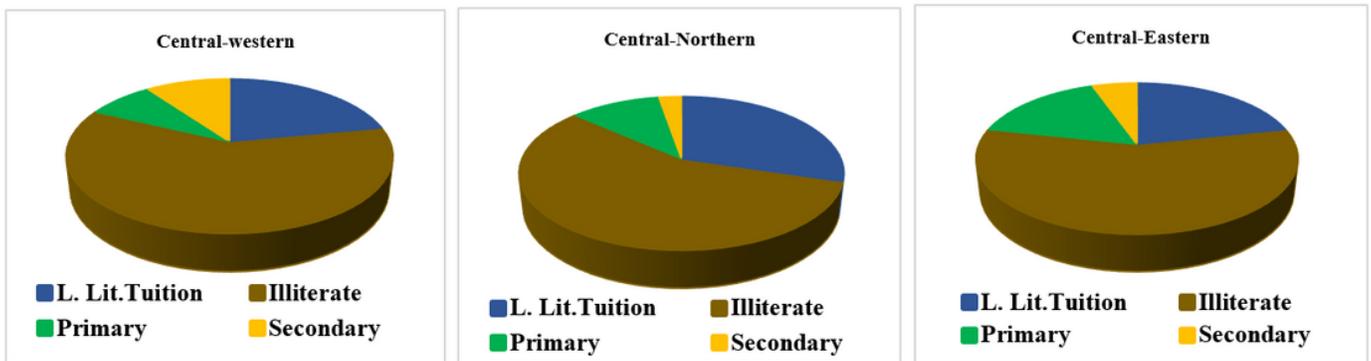


Figure 1

Map of Burkina Faso, showing the study site, the agro-ecological zones, rainfall quantity and Isohyets



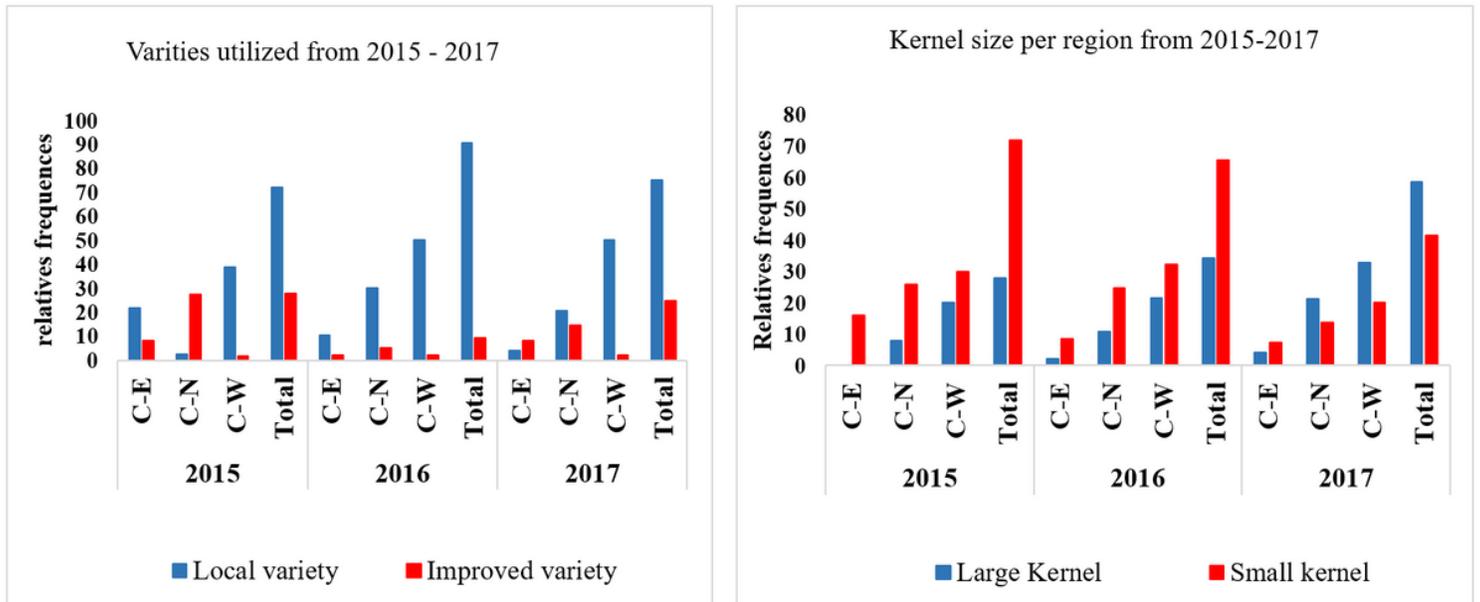
A. Education level in the study area by gender



B. Education level in each region

Figure 2

Education level in the study area and in each region



A: Varieties Utilized from 2015-2017

B: Kernel size per region from 2015-2017

Figure 3

Types of varieties and characteristics of their kernel size in the study areas from 2015-2017: A: Varieties Utilized from 2015-2017; B: Kernel size per region from 2015-2017. C-E: Central-Eastern, C-N: Central-Northern, C-W: Central-Western

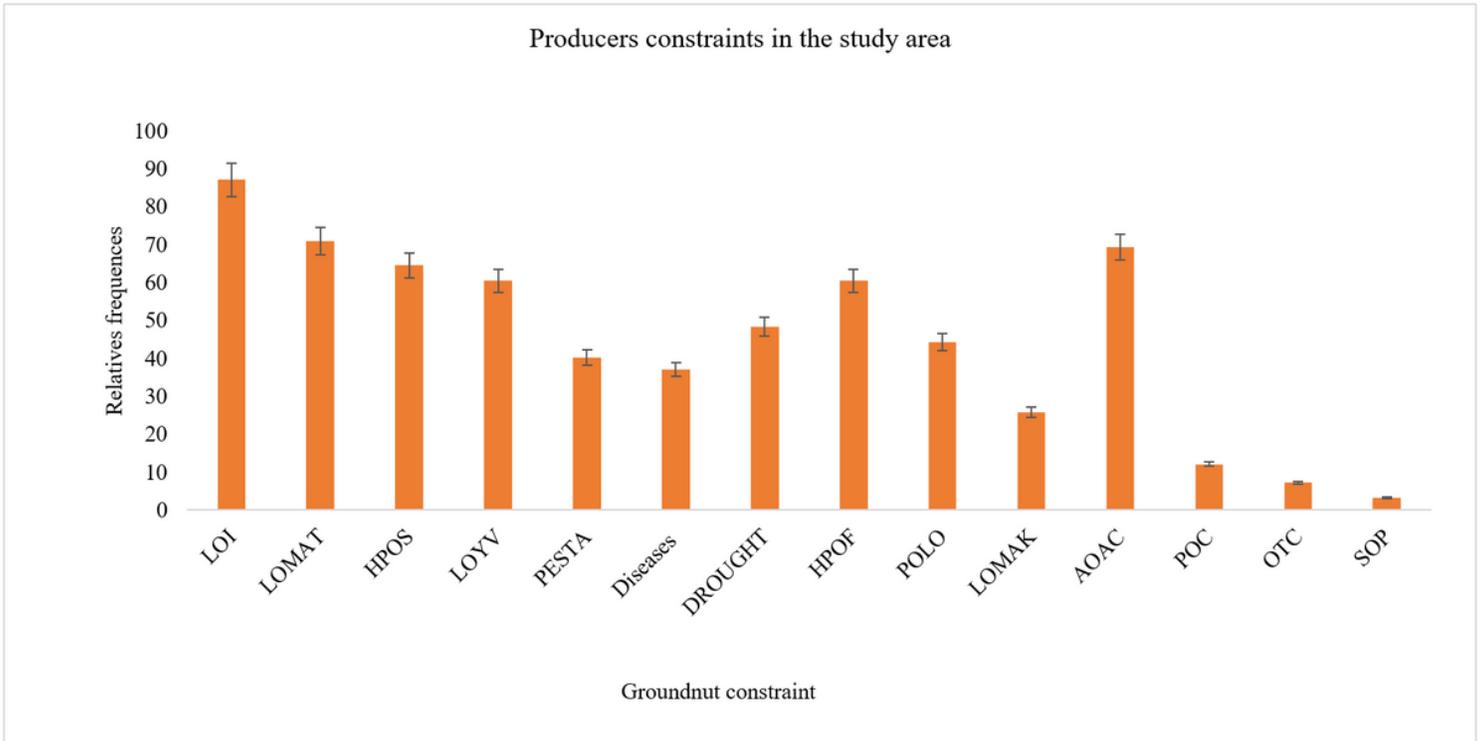


Figure 4

Groundnut Production constraints in the study area: LOI= Lack of improved varieties; LOMAT= Lack of materials; HOPS= High price of seeds; LOYV= Low yielding varieties; PESTA= Pest attack; Diseases; Drought; HPOF= High price of fertilizer; POLO= Problem of land ownership; LOMAK= Lack of market; AOAC= Absence of agricultural credit; POC= Problem of conservation; OTC= Others constraints; SOP= Soil poverty

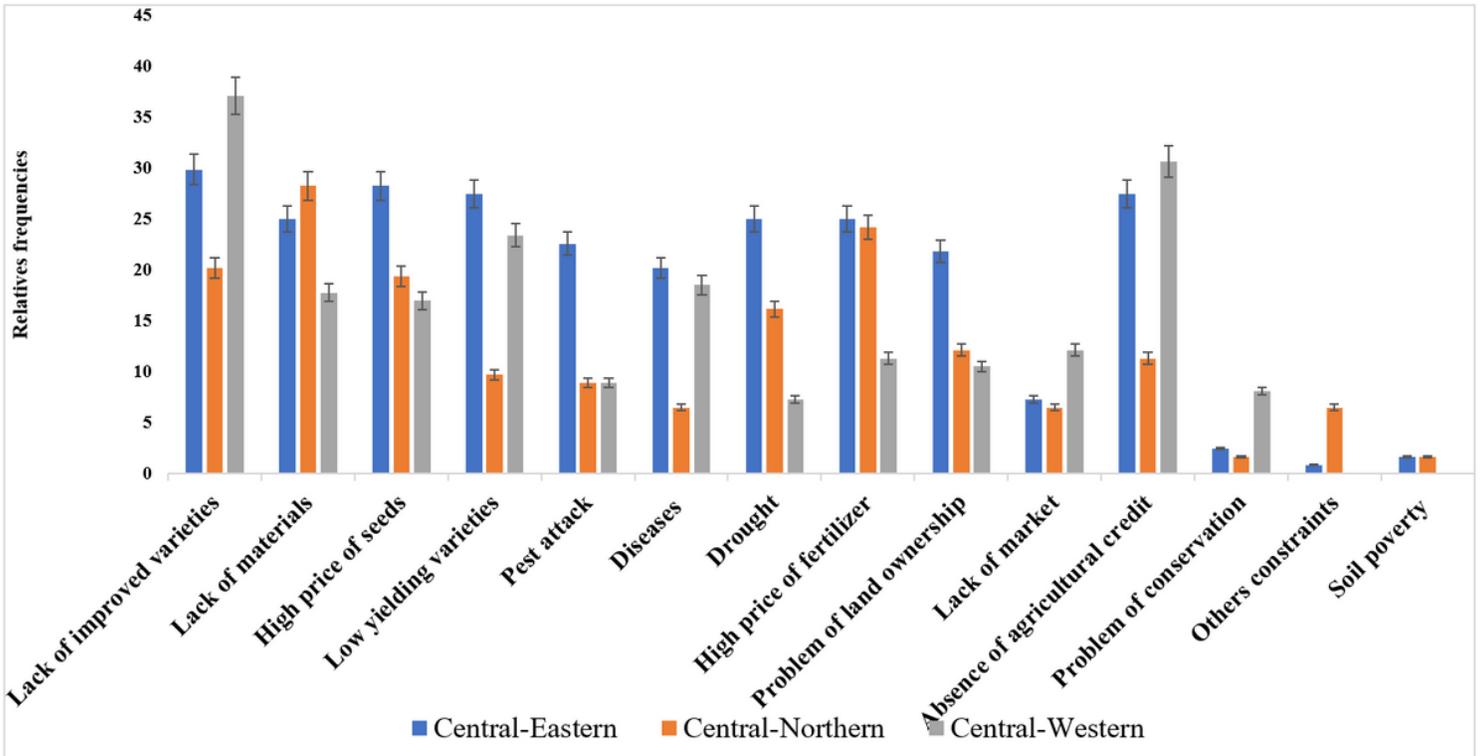


Figure 5

Groundnut production constraints in each region

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [FGDDataProductionconstraints.xlsx](#)
- [DataProducer.xlsx](#)