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Ethnobotanical study and agro-morphological evaluation of Kersting's groundnut (*Macrotyloma geocarpum* Harms) in Benin

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OVERVIEW

- **Introduction**
- **Methodology**
- **Results and discussion**
- **Conclusion**
- **Perspectives**

INTRODUCTION

- ❑ Kersting's groundnut (*Macrotyloma geocarpum* Harms) is the subterranean legume (Fabaceae) which produces pods under ground
- ❑ Origin: West Africa particularly Nigeria, Mali, Burkina Faso, Niger, Togo and Benin (Ogbosi and Agbatse, 2003)
- ❑ High nutritional value (**25% of protein ; 42% of essential amino acids ; 60 to 70% of carbohydrate**) widely consumed in Benin. It is also a good source of mineral salt (**iron, phosphorus, calcium, magnesium**, etc.) and energy (Chikwendu, 2007 ; Ajayi and Oyetayo, 2009)
- ❑ *M. geocarpum* can be used in complementary food formulation for children (Chikwendu, 2007) and helps to combat malnutrition (Dansu *et al.*, 2012)



INTRODUCTION

- ❑ Veritable source of incomes : 1,000 to 3,000 FCFA per kg
- ❑ Despite its importance, Kersting's groundnut is cultivated on a small scale in West Africa. It is one of the lesser known and underutilized indigenous legume in Benin (Dansi *et al.*, 2012)
- ❑ Gradually disappearing from traditional food production (Aderanti, 2001)
- ❑ Benin (MAEP, 2011): production decreased from 2358 tonnes (2005) to 1050 tonnes (2010)
- ❑ No scientific study has been done: Cultivation zones, diversity, constraints of production and traditional practices are not yet known for promotion and valorization of this crop

OBJECTIVES OF OUR STUDY

- To identify the production areas and importance of *M. geocarpum* in southern and central Benin ;
- To explore indigenous knowledge related of production, diversity and use of this NUS ;
- To investigate major constraints to production of the plant ;
- To undertake participatory evaluation of local varieties for agronomic traits ;
- To assess morphological variations in Kersting's groundnut landraces from southern and central Benin for research and development programs

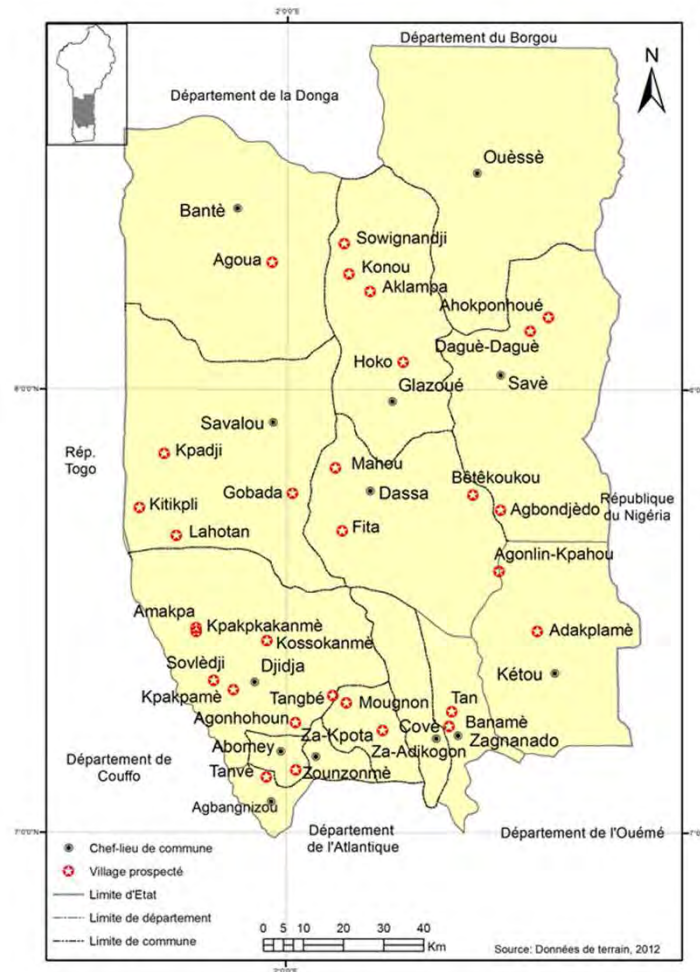
METHODOLOGY

❖ *Selection of surveyed villages*

Study area:

- humid agro-ecological zone ;
- temperature (26°C - 28°C) ;
- rainfall (1100 - 1400 mm)

➤ 30 villages surveyed



➤ Selection approaches :

- Exploratory study in agricultural research institutions ;
- Local and urban market visits ;
- Discussion with farmers' association and sellers
- Agricultural extension services (CARDER)

Figure 1: map showing geographical localization of villages

METHODOLOGY

❖ *Data collection*

Individual interviews

- Average of 12 households per village: in total 374 interviewees
- Information collected included:
 - socio demographic characteristics (*ethnic group, age, cultivated areas, etc*) ;
 - farmers' perception on its cultivation;
 - production constraints ;
 - cultural practices;
 - seed management ;
 - gender role on crop production ; etc.

METHODOLOGY



Agro morphological characterization

- 32 accessions collected and planted
- **Experimental design:** complete random blocks with 3 replications
- **Planting date :** 09 July 2012
- **Harvest date:** 07 December 2012
- Spacing: **0.30 m** (inter-rows)
and **0.30 m** (intra-rows)(Bampuori, 2007 and producers)



Picture 1: Partial view of experimental field

METHODOLOGY

Table 1: Morphological characters recorded in 32 accessions of Kersting's groundnut diversity study

Quantitative traits (15)	Code	Qualitative traits (05)	Code
Days from sowing to 50% lifting (d)	DTL	Pilosity of stem	PIS
Days from sowing to 50 % flowering (d)	DTF	Petiole colour	PEC
Plant height (cm)	PHT	Flowers colour	FLC
Petiole length (cm)	PEL	Pods colour	POC
Diameter of plant (cm)	DIP	Seed colour	SEC
Leaflets length (cm)	LEL		
Leaflets width (cm)	LEW		
Days from sowing to first fructification (d)	DFF		
Days from sowing to maturity (d)	DTM		
Number of pods per plant	NPP		
Seeds length (mm)	SEL		
Seeds width (mm)	SEW		
Yield per plant (g)	YPP		
100 seed weight (g)	HSW		
Grain yield (kg/ha)	GRY		

Statistical analysis

- Survey information : descriptive statistics (frequencies, means, etc.)
- Agro-morphological data : multivariate analysis (ANOVA, SNK, PCA) using appropriate softwares

RESULTS AND DISCUSSION

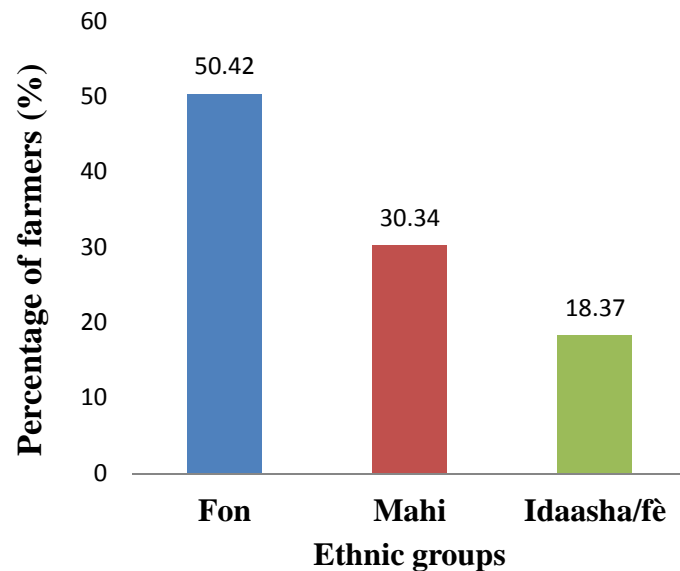
✚ Socio-demographic characteristics

- 81% male and 19% female

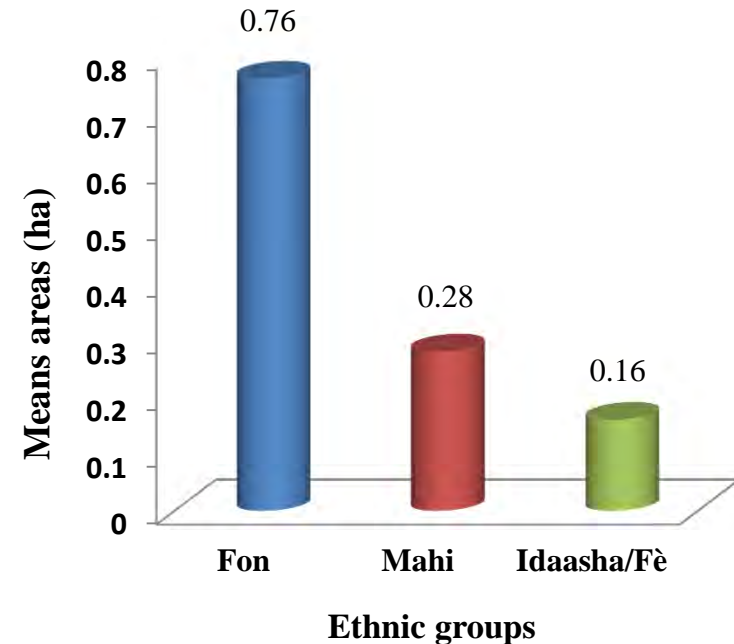


❖ **Most of the farmers are men**

- Production area : low (100 m² to 4 ha)
an average 0.48 ha per household



Graph 2 : Interviewees ethnic groups



Graph 3 : Area under cultivation per ethnic group

❖ **Fon ethnic group : high producers of Kerstings' groundnut of this zone**

RESULTS AND DISCUSSION

- **Farmers' age:** 20 to 64 years old (average of 40 years)

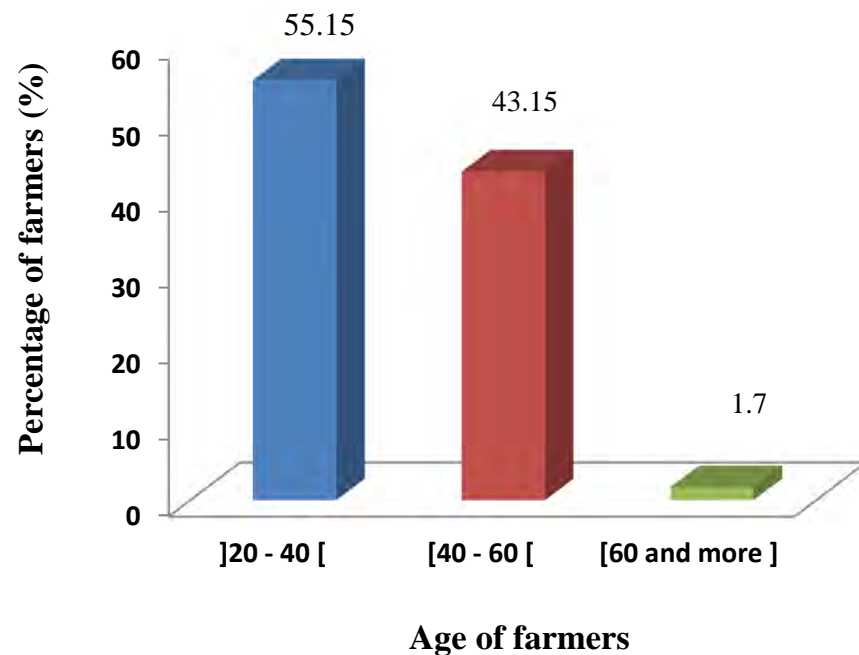
Interpretation :

☐ Cultivation of the plant is often ensured by young producers



- Production requires high physical investment
- Commercialization generates high incomes and contributes to improved actors' livelihoods

☐ In opposite to Ghana where *M. geocarpum* is cultivated by farmers older than 50 years (Bampuori, 2007)



Graph 4: Age distribution of interviewees

RESULTS AND DISCUSSION

✚ Farmers' perception on its cultivation

- Increased (15.38%)
- Decreased (55,13%)

- In total **10 reasons** explain the decrease of production

Varieties adapted to local conditions must be created or introduced

Table 2: Reasons of decreasing of *M. geocarpum*

Categories	Reasons	Percentage of responses (%)
Economic (55.98%)	High production costs	40.74
	Very high labour required	10.77
	Lack of good market for seed supply	2.69
	High costs of seeds	1.68
Agronomic (29.28%)	Susceptibility to high soil moisture	25.58
	Inadaptability to all types of soil	2.69
	Difficult post harvest storage	1.01
Technological (14.47%)	Difficulty of harvest	8.08
	Difficult of seeds hulling	6.39
Cultural (0.37%)	Traditional consideration (myth, taboo)	0.37

RESULTS AND DISCUSSION

✚ Varietal diversity of Kersting's groundnut

- 3 local varieties :



Most cultivated and consumed

- Black and red seed varieties are disappearing from traditional agriculture and must be preserved
- Local diversity very low contrary to other pulses such as cowpea (Baco et al., 2008 ; Gbaguidi et al., 2013) and bambara groundnut (Bonny and Dje, 2011; Olukolu and al., 2011)

RESULTS AND DISCUSSION

Table 3: Utilization of this crop

Reasons	Importance of responses (%)
Commercialization	72.64
Home consumption	22.65
Medicinal values	4.71

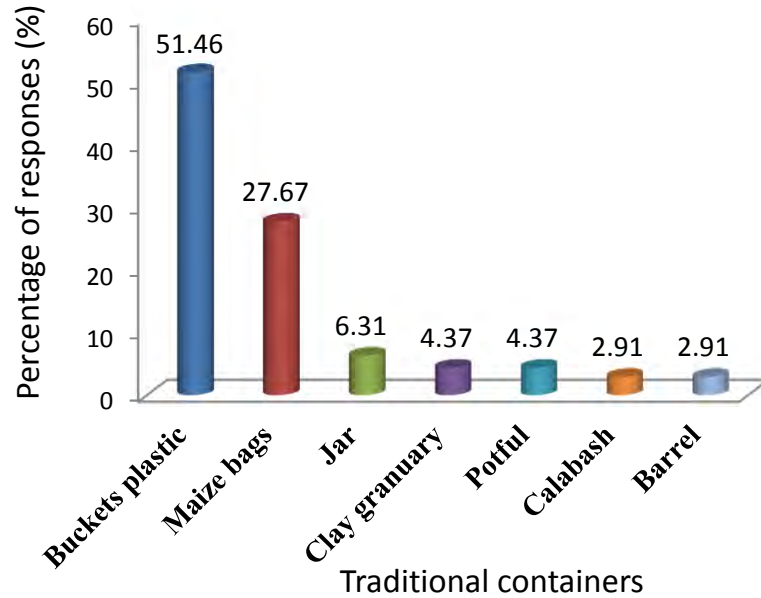
Black seeds variety :
diarrhea, stomachache,
ulcer, cough

RESULTS AND DISCUSSION

Seed management

- Seed system : auto production (78.85% of responses) or purchase (21.15% of responses)

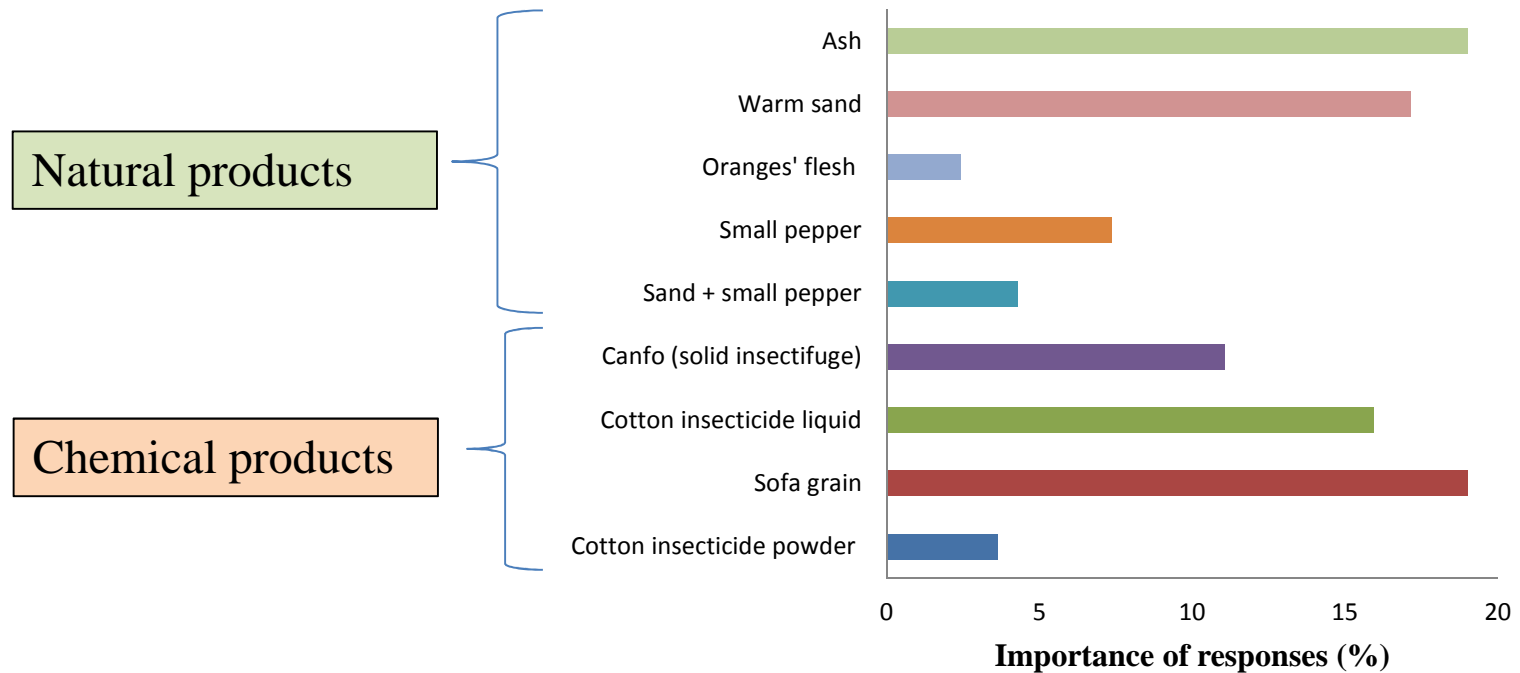
- Seeds storage



Graph 5: Seeds conservation methods

RESULTATS ET DISCUSSIONS

Kerstings' groundnut seeds very susceptible to storage insects



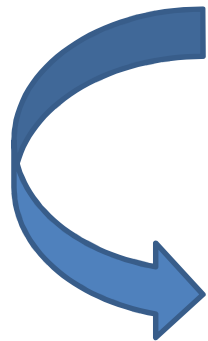
Graph 6: Products used for seeds conservation

Seed storage period depends on product used

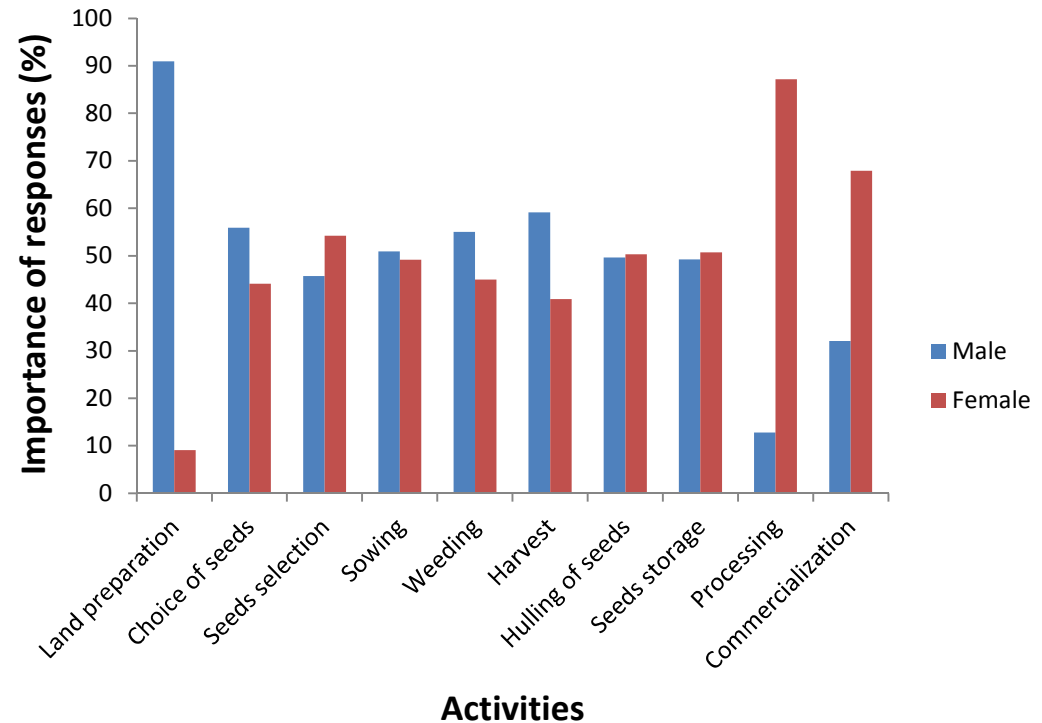
RESULTS AND DISCUSSION

Gender roles in *M. geocarpum* production and management

Both men and women are involved on crop production and management



Women are significantly involved in the use and management of this crop in Benin as noted (Dansi *et al.*, 2012)



Graph 7 : Gender role in the crop production

RESULTS AND DISCUSSION

✚ Agro-morphological variability of Kerstings' groundnut accessions



Picture 2 : Diversity of *M. geocarpum* based on qualitative traits

RESULTS AND DISCUSSION

Table 4: Analysis of 15 quantitative variables measured between accessions collected

N°	Characters	Minimum	Maximum	Means	SD	CV (%)
1	Plant height (cm)	31.30	40.33	35.22	2.06	5,86
2	Leaflets length (cm)	6.23	7.38	6.79	0.28	4,25
3	Leaflets width (cm)	4.31	5.39	4.80	0.23	4,97
4	Petiole length (cm)	14.16	26.36	20.27	3.32	16,38
5	Diameter of plant (cm)	23.40	86.00	67.57	13.39	19,82
6	Number of pods per plant	49.00	342.00	131.71	61.64	46,80
7	Seeds length (mm)	3.50	6.67	4.78	0.71	14,97
8	Seeds width (mm)	1.62	3.15	2.53	0.40	15,83
9	Yield per plant (g)	617	3840	1583	7.04	44,52
10	100 seed weight (g)	10.70	14.71	13.05	1.03	7,90
11	Grain yield (kg/ha)	617.00	3840.00	1588.46	699.86	44,06
12	Days to 50% lifting (d)	5.00	6.66	5.46	0.49	9,00
13	Days to 50 % flowering (d)	61.00	64.00	62.71	0.88	1,42
14	Days to first fructification (d)	112.00	120.00	117.53	2.03	1,73
15	Days to maturity (d)	144.00	150.00	148.68	2.36	1,59

RESULTS AND DISCUSSION

Structuring of diversity within accessions of *M. geocarpum* with 15 quantitative traits

Table 5: Comparison of the means of the different groups of Kerstings' groundnut Performances are indicated in bold

Traits	Group 1	Group 2	Group 3	F
PHT	35.27±1.70	33.50±1.76	34.45±2.33	1.834 ns
LEL	6.78±0.32	6.88±0.16	6.61±0.26	2.018 ns
LEW	4.86±0.24b	4.72±0.17ab	4.60±0.16a	5.320*
PEL	19.00±3.20	22.00±3.46	19.64±2.80	1.998 ns
DIP	64.67±16.03	74.67±9.43	67.18±10.49	1.210 ns
NPP	127.4±28.59b	224.17±64.36c	87.18±35.02a	23.951***
SEL	4.70±0.67	4.65±0.33	4.92±0.92	0.393 ns
SEW	2.49±0.35	2.68±0.27	2.46±0.52	0.611 ns
YPP	15.53±2.56b	26.66±6.25c	9.46±2.86a	45.157 ***
HSW	12.33±1.23	13.17±0.75	12.45±0.93	1.355 ns
GRY	1610.8±231.42a	2693.33±626.95ab	390.09±323.52b	4.506 *
DTL	5.44±0.41	5.21±0.40	5.59±0.59	1.170 ns
DTF	62.67±0.82ab	62.00±0.63a	63.18±0.87b	4.203 *
DFE	117.67±1.49	116.17±2.40	118.09±2.30	1.910 ns
DTM	149.33±1.79	149.00±2.44	147.63±2.80	1.790 ns

* P < 0.05; ** P < 0.01; *** P < 0.001; ns = not significant

RESULTS AND DISCUSSION

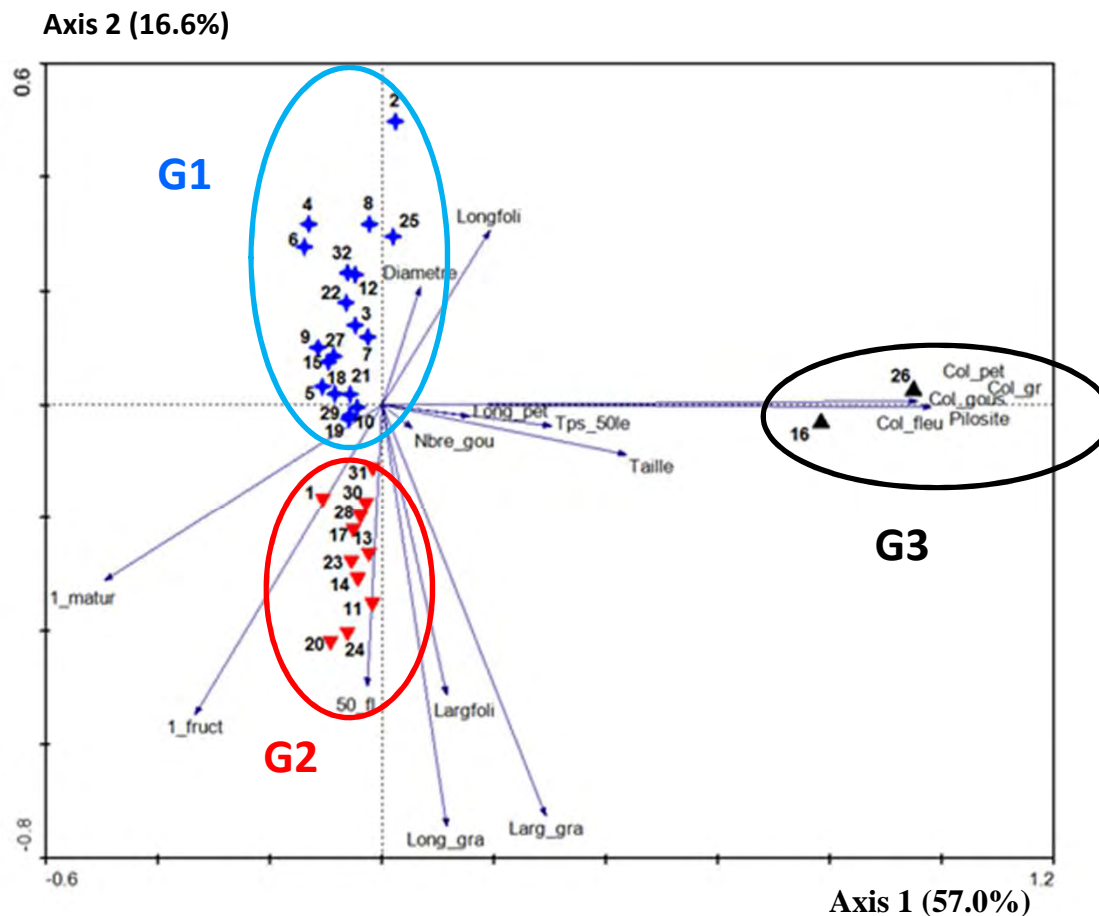
Agro morphological variability

3 morphotypes



Low morphological variability

Similar result with Bayorbor et al. (2010) in Ghana



Graph 8: Phenotypical diversity grouping following the axis 1-2

RESULTS AND DISCUSSION

Table 6: Correlations between quantitative agro-morphological characters for *M. geocarpum*

	PHT	LEL	LEW	PEL	DIP	NPP	SEL	SEW	YPP	HSW	GRY	DTL	DTF	DFF	DTM
PHT	1														
LEL	0,50*	1													
LEW	0,39*	0,75*	1												
PEL	-0,26	-0,14	-0,11	1											
DIP	0,27	0,31	0,22	0,04	1										
NPP	-0,15	0,26	0,14	0,31	0,23	1									
SEL	0,12	-0,03	0,05	-0,05	-0,05	0,03	1								
SEW	0,09	0,11	0,27	0,17	0,03	0,27	0,72*	1							
YPP	-0,12	0,32	0,25	0,37*	0,26	0,94*	-0,09	0,21	1						
HSW	0,08	0,26	0,14	0,12	0,09	0,15	0,19	0,27	0,28	1					
GRY	-0,12	0,31	0,25	0,42*	0,27	0,90*	-0,15	0,15	0,97*	0,26	1				
DTL	0,05	0,18	0,22	-0,02	0,28	-0,18	-0,09	-0,01	-0,24	-0,1	-0,19	1			
DTF	-0,09	-0,22	-0,13	-0,3	0,12	-0,45*	0,02	-0,23	-0,4*	0,26	-0,39*	0,24	1		
DFF	0,13	-0,04	-0,01	-0,05	0,12	-0,17	0,25	-0,02	-0,13	-0,02	-0,20	-0,10	0,17	1	
DTM	-0,24	0,09	0,06	0,06	-0,02	0,27	0,29	0,12	0,31	0,08	0,28	-0,06	-0,09	0,38*	1

Negative correlation between date of 50% flowering and yield parameters



Early maturity accessions have given high yield

RESULTS AND DISCUSSION

Yield variability among the accessions and local varieties

- Yield of accessions : 617 to 3840 kg/ha, with mean of 1588 kg/ha
- Significant variation ($p = 0.015$) between 3 local varieties :
 - White seeds varieties ($p = 0.001$; Mean: 1062 ± 93 kg/ha)
 - Red seeds varieties (Mean: 1197 ± 77 kg/ha)
 - Black seeds varieties (Mean: 1548 ± 102 kg/ha)



High agronomical diversity

CONCLUSION

- Ethnobotanical research indicated that Kerstings' groundnut production is decreasing in Benin
- Main reasons for the decline were: high cost of production, susceptibility to high soil moisture and high labor requirement
- This crop contributes to women empowerment (especially the rural young)
- Only 3 local varieties but two of them (red and black seeds varieties) were less consumed and were disappearing for traditional production
- There are difference between yield among local cultivars and among white seeds accessions

PERSPECTIVES

- Extend the survey to the northern regions of Benin for better assessment of diversity of this NUS
- Conduct a biochemical study (nutritional value and toxicity analysis) on different local cultivars for food promotion
- Conduct molecular characterization of the accessions to better understand the genetic structure of the species
- Define the best strategies to conserve rare varieties
- Create and/or introduce improved varieties adapted to local climate conditions to strengthen the diversity of *M. geocaprum*



THANK YOU

- IFS for financial support

