Bambara groundnut: the future crop for Botswana

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Presentation outline

- **Introduction**
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  - Aim of the study
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  - Research questions and hypothesis
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Introduction

Farming systems of Botswana

- Botswana is a landlocked country in Southern Africa with an area 582000km
- Climate is semi- arid to arid
- Average rainfall ranges from 250mm (south west) to 650 mm (North west) with a whole country annual of 475mm
- Rain falls in summer between October and April
- Mostly starts to rain too late, with some prolonged droughts
- Temp in Dec – Jan are high and 40^{o}C is common
- The rains are localised
- End of rainy season night temperatures are low
- Botswana soils are shallow, consists of coarse grained sands, sandy loam, with poor water holding capacity, form crusts after heavy rains
- Deficient in phosphorus, low levels of mineral N and low organic matter contents

Introduction

- The conditions described shows that Botswana's agriculture is poor especially arable farming
- Arable land is limited to less than 1% of cultivated total area of the country
- Majority of the 46% of population in rural areas rely on agriculture
- Crop production is mainly sorghum, maize, millet, cowpeas and bambara groundnuts
- Yield are usually low per hectare average (250 – 300 kg)
- Annual output for cereal: fluctuates around 18 000 tonnes which is less than 10% of the 200 000 tonnes annual requirements
- Well adapted crop genotypes in that environment such as bambara groundnut could increase food production and have the potential to contribute to food security

Introduction

Importance of bambara groundnut

Seeds

Unshelled pods

The crop

- It is an important food legume crop (high protein content)
- It is grown by small scale farmers especially women
- It is a high value crop, it fetches more money than most crops
- More profit, poverty eradication and improves livelihood
- Bambara groundnut fixes N into the soil this can reduce fertilizer costs
- Processing of harvest in the field can recycle nutrients/organic matter which improve physical and chemical properties of soil.

Statement of research problem

- Influence of sowing date on yield

  -Early planting: prolonged drought and heat stress. Late sowing exposure to low temp and frost bite

- Low moisture, pests and diseases

  -Low yields of approximately 200kg/ha recorded

- Crop management practices

  -Labour costs of earthing up, sowing methods

- Antinutritional factors in bambara groundnut

  -Especially in dark coloured seeds, farmers prefer cream coloured seeds

- Mating systems

  -Difficult to undertake hybridisation

Opportunities in bambara groundnut crop

- The cultivation of bambara groundnut is widespread in Botswana
- Seed multiplication unit (DAR)
  - -Opportunity to give out bambara seeds
  - -supply maximum 5 ha per farmer
- Government assistance/inputs
  - - Farm service centres for row planters (resolve the problem of broadcasting)
  - -Fertilizer input
  - -Field ploughing
- Bambara groundnut potential for use in weaning ration

Main aim of the study

- Evaluation of bambara groundnut (*Vigna subterranea*) for yield and yield stability in Botswana environment.

Objectives of the study

- To identify high yielding bambara groundnut
- To identify new sources of germplasm for bambara groundnut improvement
- To determine agronomic variation among bambara groundnut lines due to environment, cultivar and CXE
- To determine the yield stability of bambara groundnut in Botswana
- Determine the genetic diversity of Botswana landraces
- To determine the effect of fertilizer and Rhizobium application on bambara groundnut
- To assess the nutritional quality of selected bambara groundnut
- To provide an overview of bambara cultivation

Research questions and hypothesis

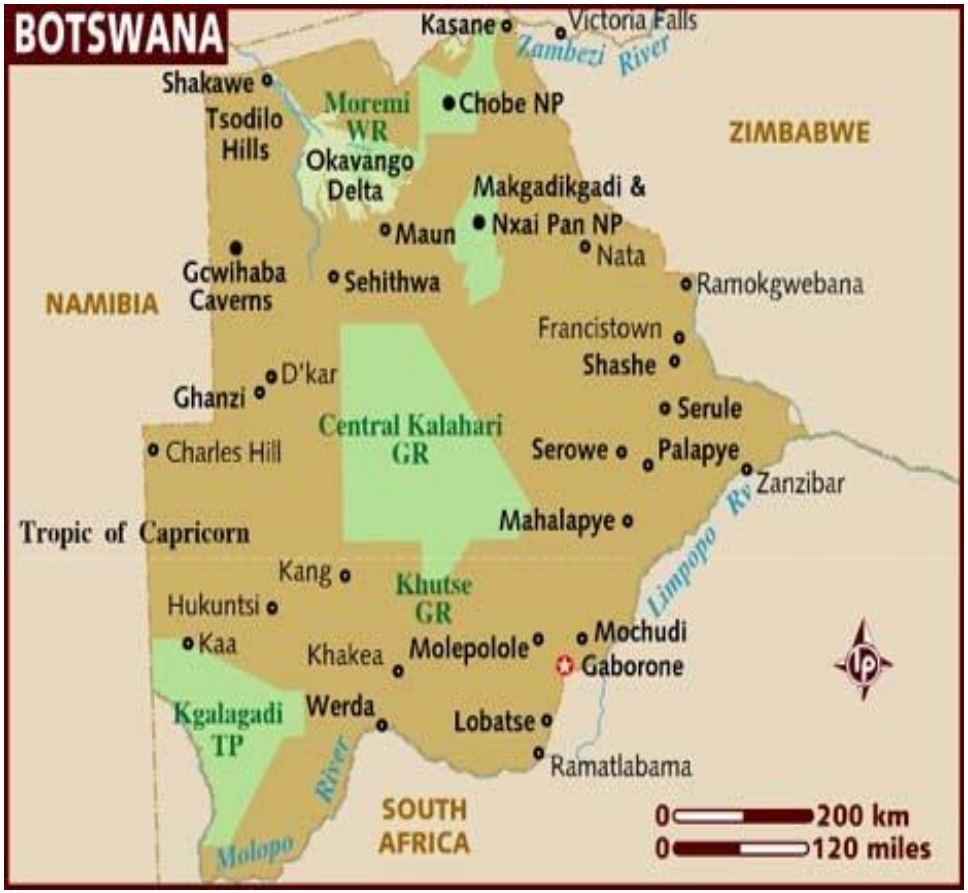
- Which bambara lines are high yielding and stable among Botswana agro-ecological zones ?
- Which bambara groundnut lines are more nutritious and good to be selected ?
- Which are the best rate recommended for fertiliser use and the impact/effect of Rhizobium on bambara ?
- What is the farmers's perception of bambara groundnut as a crop

Significance of the study

- Farmers rely on using landraces which are low yielding and non-stable. High yielding and stable lines will be developed
- Recommended fertilizer rate will be given to farmers and best Rhizobium identified (yield improved)
- Highly nutritious lines identified and could be used in weaning foods in Botswana.

Description of the study area

- The research will be conducted in Sebele Agricultural Research station, in the first season.
- The following season, it will cover Kang, Maun, Francistown, Mahalapye and Sebele.
- Temperature and Rainfall
- Soils



Scope of the study

- The study will depend on seeds availability to cover areas mentioned. This basically covers all the major research stations and regions of the country.

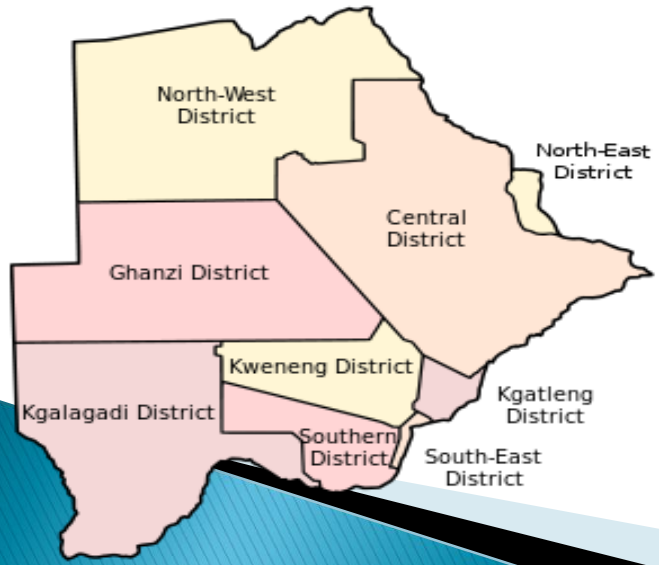
Literature review

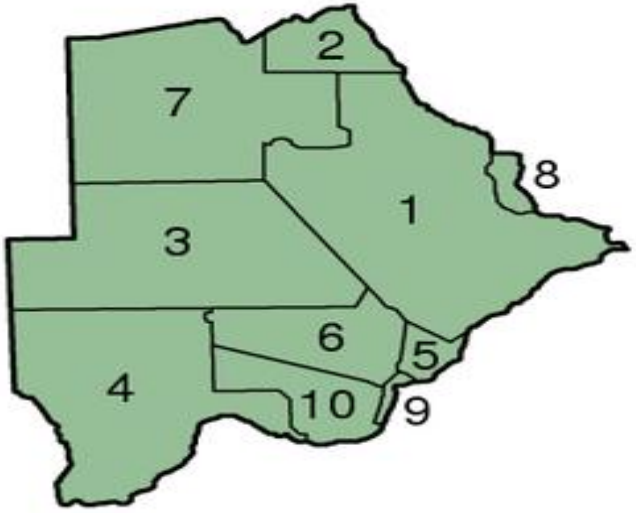
Brief history of bambara groundnut research in Botswana.

- Yield trials in the 1950s on seven landraces.
- The experiments/trials continued in the 1960s.
- Botswana was also involved in the 1st , 2nd and 3rd EU bambara projects (1992 to 2010).

Literature review : Genetic resources

- Department of Agricultural Research houses the accessions
- The genebank conserved 424 accessions
- The accessions are sourced from Central and NorthEast a few are from Southern, Kweneng, Ngamiland/Okavango district





Literature review: Past projects at Department of Research

- A coordinated research was initiated from 1994/95 to 1998/99 (Chui *et al.,* 2003)
- Work consisted of germplasm selected from only one i.e Northeast district
- Landraces N100 (Mokgalo) and MA-15A (Keledi) were selected.
- In the 2005/06 season: Two lines were evaluated under on-farm
- Determination of two lines to levels of phosphorus
- Effect of soil types on the performance of the two

Mokgalo (N100) and MA-15A (Keledi)

- Purplish / Reddish colour
- Flowers, pod earlier
- Matures in 120 days
- Yield potential 2.0 t/ha

- Cream white seeds, with butterfly shaped eye colour
- Flowers, pod later
- Matures in 130 – 150 days
- Yield potential is 1.5 t/ha

Field crops handbook

Mean and range of the genetic distances values for three different selection cycles of bambara groundnut from single seed descent estimated based on 12 microsatellites markers using Popgene version1.31 (Yeh and Boyle, 1997).

	Genetic distance estimates										
	First cycle selection			Seecond cycle selection				Third cycle selection			
Selected lines	N	Mean	Ho-He	Range	N	Mean	Ho-He	Range	N	Mean	Ho-He	Range
81-Acc385TZA	3	0.751	0.000-0.356	0.287-1.049	7	0.000	0.000	0.000	6	0.000	0.000	0.000
84-Acc696ZMB	3	0.314	0.000-0.222	0.206-0.403	4	0.000	0.000	0.000	6	0.000	0.000	0.000
88-AHM753NAM	3	0.222	0.000-0.267	0.198-0.248	7	0.000	0.000	0.000	6	0.000	0.000	0.000
90-S19-3NAM	3	0.347	0.000-0.311	0.305-0.405	7	0.000	0.000	0.000	6	0.000	0.000	0.000
109-BWA1-BWA	3	0.389	0.000-0.311	0.331-0.431	7	0.000	0.000	0.000	6	0.000	0.000	0.000

No observed or expected heterozygosity in the 2nd or 3rd round of selection

This data strongly suggest genotypes are essentially pure lines or effectively varieties

Methodology

- Survey research
- Experimentation research

  -Field experiment

    Yield and Stability analysis

  - Field and lab experiment

    Genetic diversity of bambara groundnut

    Soil fertility and nitrogen fixation analysis

    Nutritional analysis

Methodology …

- Survey research
  - Direct field survey and questionnaire
  - Last farmers's survey was done in 1995 covered only three districts
  - This survey to include three districts close to the city (Kweneng, Kgatleng and South east)
  - Later Kgalagadi and Ghanzi

Methodology …

Yield and stability analysis

- Thirty seven lines were selected for use in this study
  - 11 lines are originally from DAR
  - 15 are sourced from IITA
  - 11 were sourced from UoN but have been planted before in Botswana environment

Methodology

Examples of selected material

DAR

- Ma 15
- Vs-2-B
- Mark-1-B
- E34

IITA

- Those which produce more than 100 seeds per plant

UoN

- OM6
- ZimRed
- GabC
- NTRS
- Goo93
- JacB

Methodology …

The Duncan multiple range test and selection index of bambara groundnut based on the vegetative and yield characters in a field experiment in Botswana (2009)

Lines	Leaf area	DMRT	Shoot	DMRT	Seeds no.	DMRT	Pod no.	DMRT	SX	Rank
90-S19-3 Nambia	4019	Defgh	48.3	Ghij	66	B	68	C	7.33	1
84-Acc696 Zambia	4343	Fghi	50.8	Ij	33	A	36	B	3.12	2
88-AHM753 Namibia	3879	Defgh	47.2	Fghij	31	A	35	Ab	2.68	3
85-Acc754 Zambia	4098	Efgh	72.3	Kl	20	A	17	Ab	1.33	4
109-Botswana	3982	Defgh	69.9	Kl	18	A	19	Ab	1.25	5

Methodology …

- Soil fertility, and Nitrogen fixation ability of bambara groundnut

  - Soils
  - Field screening of bambara groundnut
  - Isolation of rhizobium strains from bambara groundnut nodules
  - Screen rhizobial strains

(Gueye M , 1986)

Methodology …

- Genetic diversity analysis
  - Preliminary evaluation of approximately 100 accessions based on morphological markers (NPGRC)
  - The accessions are to be analysed based on SSR markers

Methodology continues

- Nutrition analysis

  - Protein
  - Starch
  - Reducing sugars
  - Tannin and Trypsin inhibitors contents

Poulter N.H (1980)

Conclusions

- Despite the abundant genetic material of bambara in Botswana only a few were selected from a narrow genetic base
- From the selected germplasm, there are some promising lines that can be fully developed into varieties
- Yield and yield stability analysis for bambara (Little attention)
- Little work has been conducted on the genetic diversity analysis both (morphological and genetic markers)
- Compound fertilizer 2:3:2 resulted in better performance compared to single and double superphosphates (more work to be done to identify best combinations)
- A need for a breeding strategy for bambara groundnut

Research scientists working on BG

- Mrs Mapena Ramokapane (MoA/DAR)
- Mrs Seipati Seketeme (MoA/DAR)
- Mr Chiyapo Gwafila (MoA/DAR)
- Dr Thebeetsile S. Moroke (MoA/DAR)
- Mr Ugele Majaule (MoA/DAR)
- Dr Elias Peloewetse (UB)
- Dr Sunuguko W. Mpoloka (UB)
- Mr Selalelo Mpotokwane (Naftec)

Thank you…