

# Sustainable solutions to elevate local protein-rich crops from subsistence to high-tec innovative products

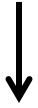


# SusTec

## Challenges of climate change

Target region:

Low rainfall

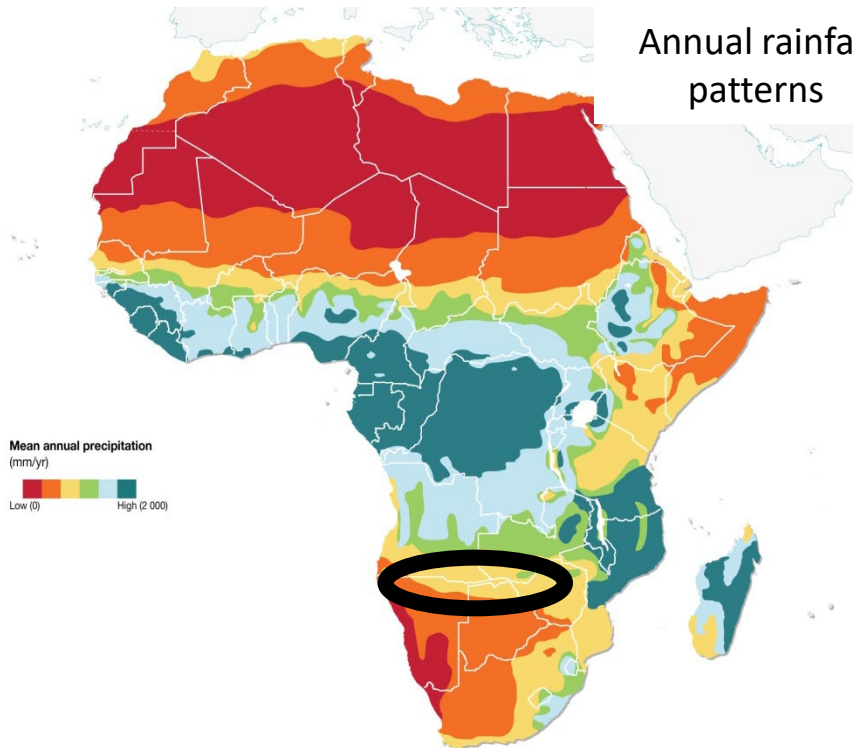


High temperatures

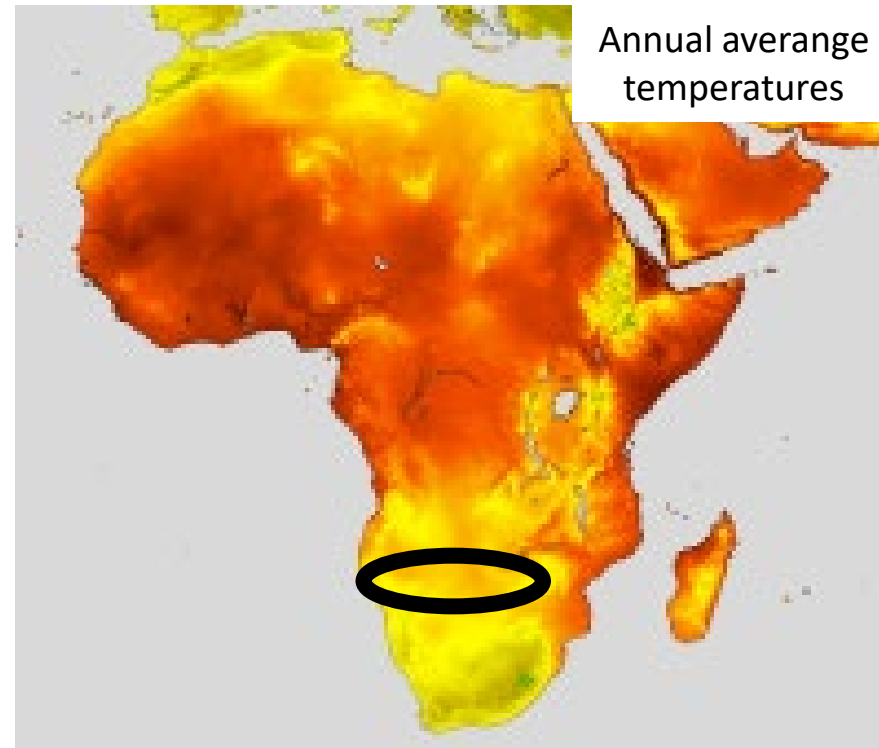


Conditions projected to exacerbate

Annual rainfall patterns



Annual average temperatures



## Challenges climate change

Dominating: rural community with rain-fed smallholder farming



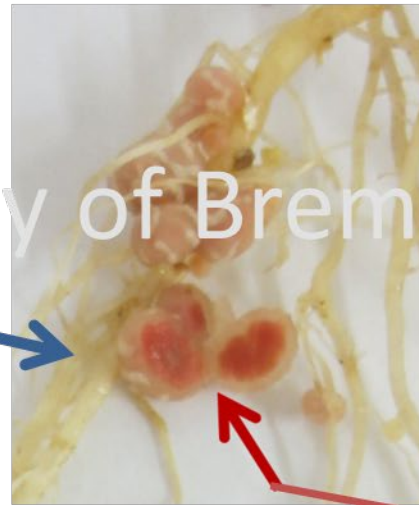
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# Beans for nitrogen input in smallholder farms

## Nitrogen input by bacteria: rhizobia-bean symbiosis



Root nodules as sites for nitrogen fixation by bacteria (*Bradyrhizobium*, *Rhizobium*)



# Beans for nitrogen input in smallholder farms

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## Nitrogen input by bacteria: rhizobia-bean symbiosis

Local protein-rich pulses with potential to improve soil fertility and yields are available

Cowpea



*Vigna unguiculata*

Bambara groundnut



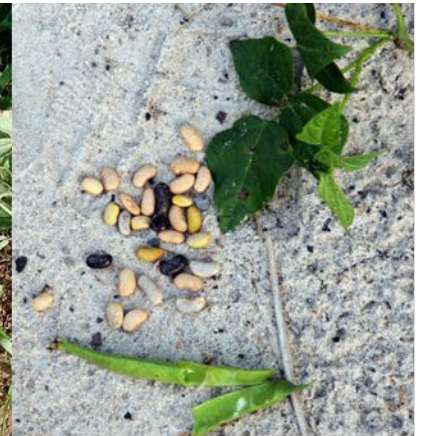
*Vigna subterranea*

Peanut



*Arachis hypogea*

Garden bean



*Phaseolus vulgaris*



## Beans for nitrogen input in smallholder farms

**Nitrogen input by bacteria: rhizobia-bean symbiosis**  
**Local protein-rich pulses with potential to improve soil fertility and yields are available**

Cowpea



Bambara groundnut



Peanut



Garden bean



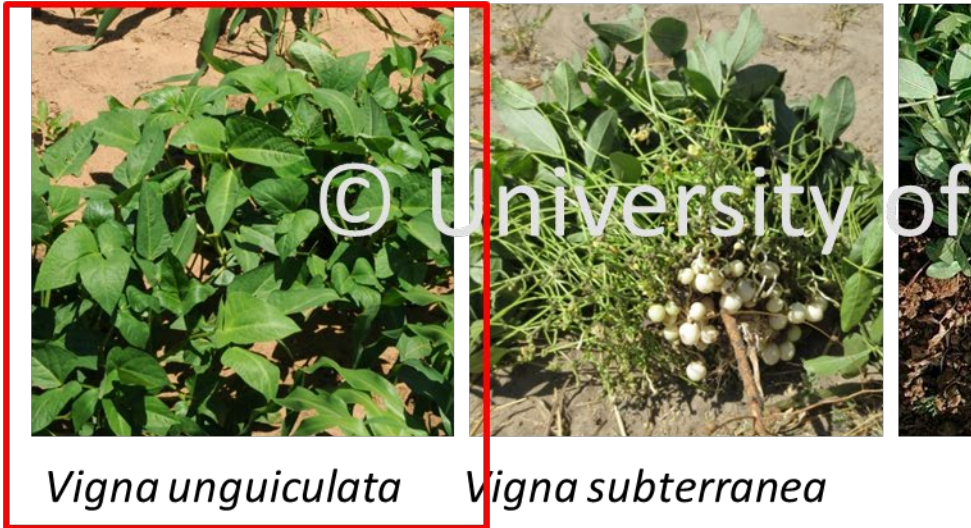
*Phaseolus vulgaris*

# Beans for nitrogen input in smallholder farms

**Nitrogen input by bacteria: rhizobia-bean symbiosis**

**Local protein-rich pulses with potential to improve soil fertility**

**But often badly nodulated**



# Beans for nitrogen input in smallholder farms

## Nitrogen input by bacteria: rhizobia-bean symbiosis

Local protein-rich pulses with potential to improve soil fertility

But often

Problem survival in soil?

High temperatures in soils  
(37-50°C)

Long dry season



*Vigna unguiculata*



*Vigna subterranea*





# Beans for nitrogen input in smallholder farms

## Nitrogen input by bacteria: rhizobia-bean symbiosis

Local protein-rich pulses with potential to improve soil fertility

But often

Problem survival in soil?

High temperatures in soils  
(37-50°C)

Long dry season

**Inoculation to increase numbers of  
adapted rhizobia**

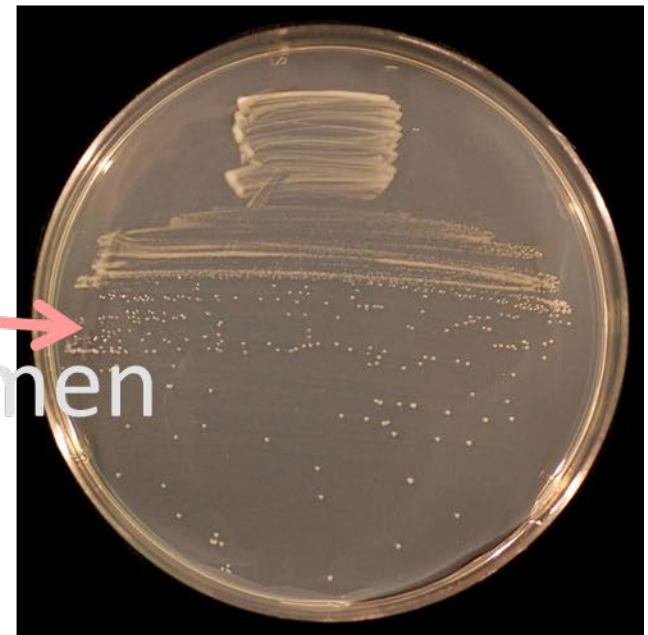
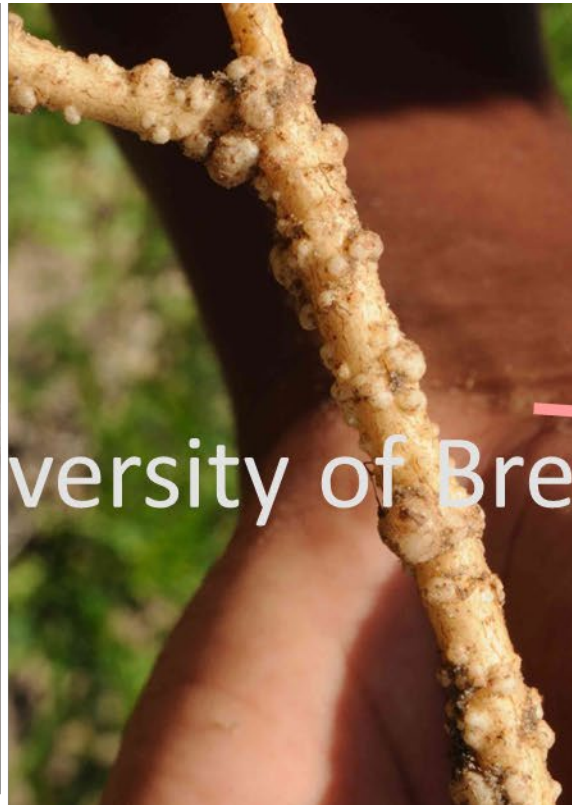


*Vigna unguiculata*



# Inoculant development

## Screening for climate-, soil- and crop-adapted symbionts



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# Inoculant development

## Building up a culture collection from Southern African legumes

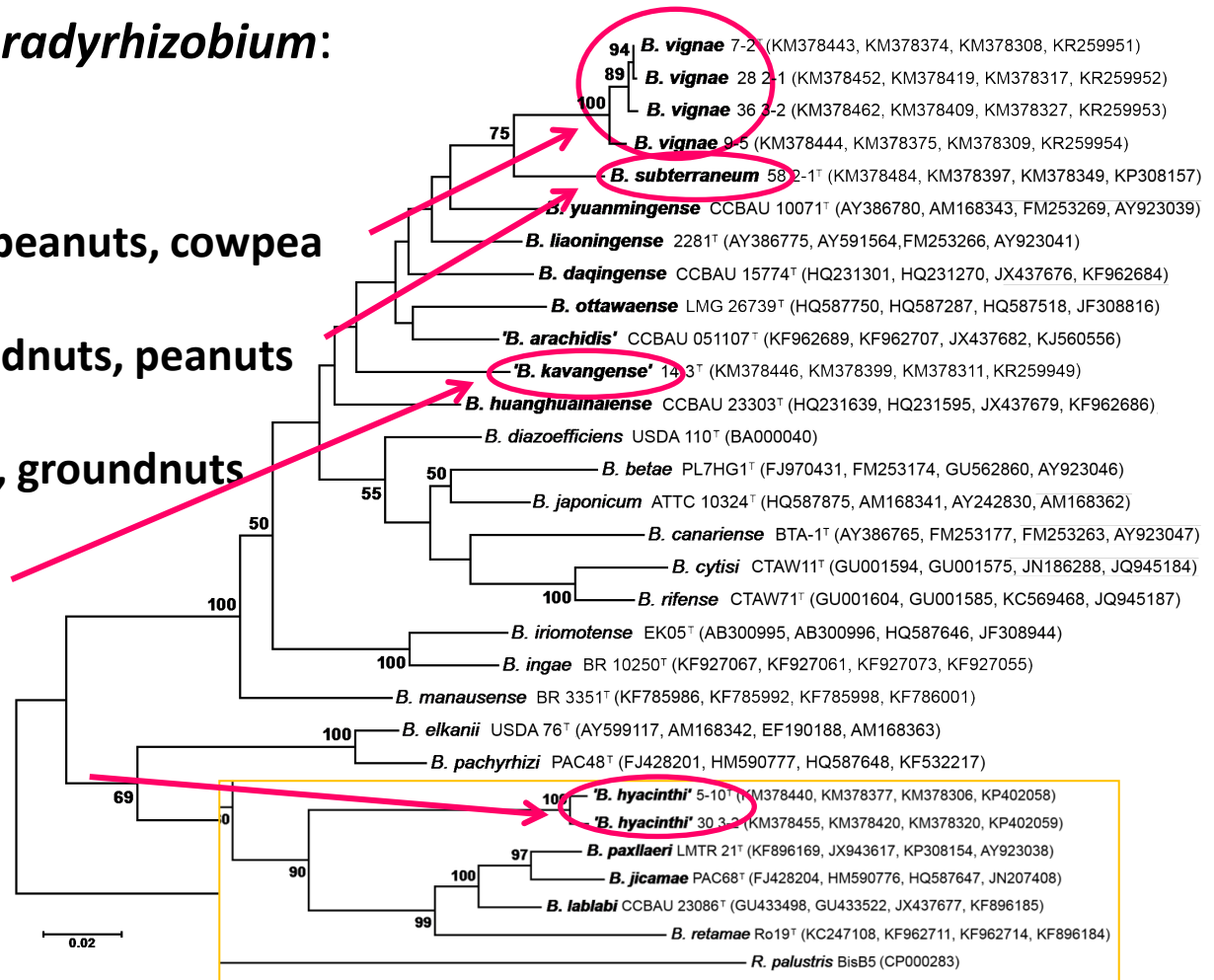
Many novel species of *Bradyrhizobium*:

*B. vignae* von groundnuts, peanuts, cowpea

*B. subterraneum* von groundnuts, peanuts

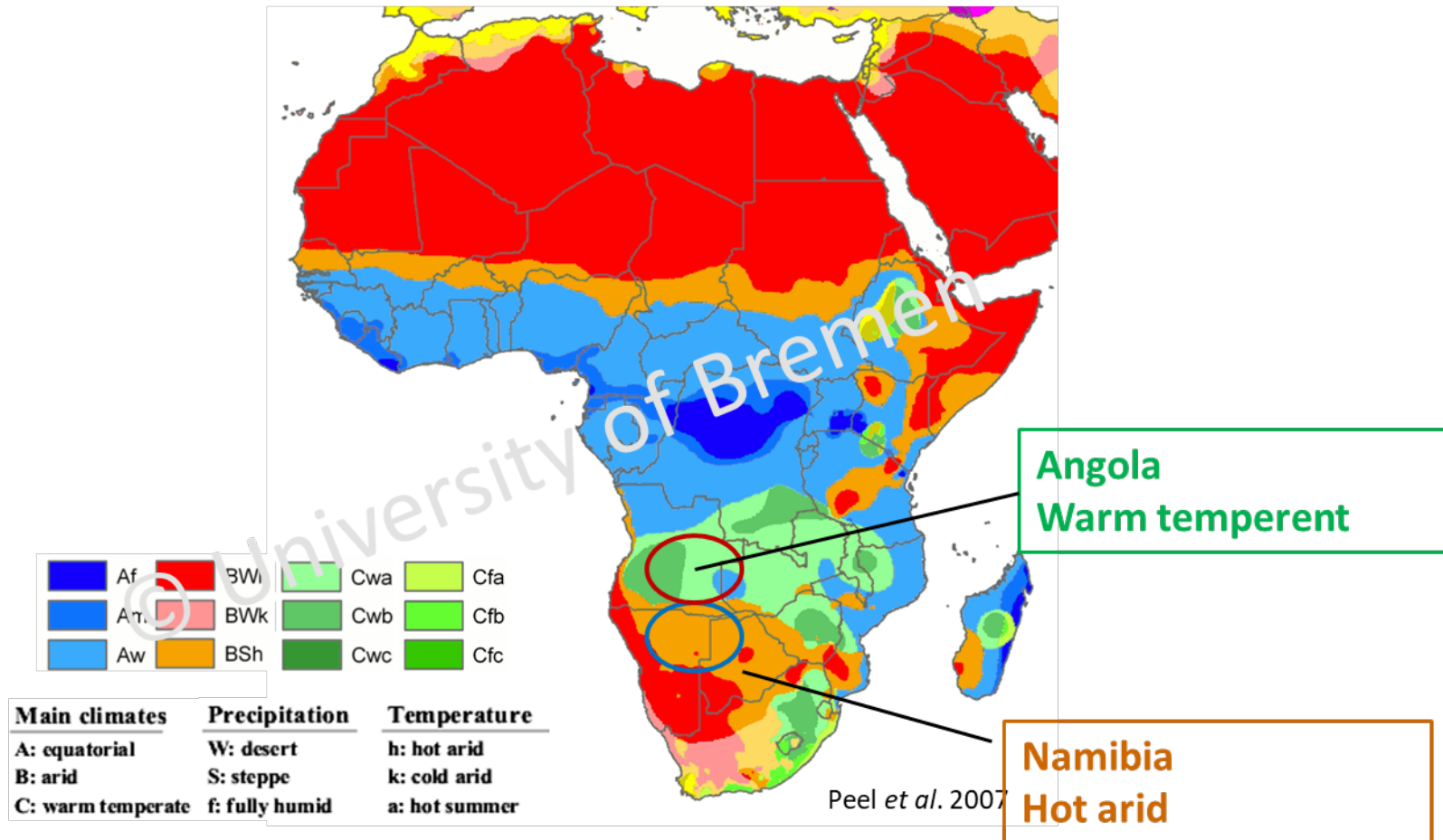
*B. kavangense* von cowpea, groundnuts

*B. namibiense* von Lablab



# Inoculant development

## Different climate zones



# Inoculant development

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## Screening for climate-, soil- and crop-adapted symbionts

Many climate-smart *Bradyrhizobium* strains

e.g.

*B. vignae* and relatives from Namibia

Exceptionally heat tolerant



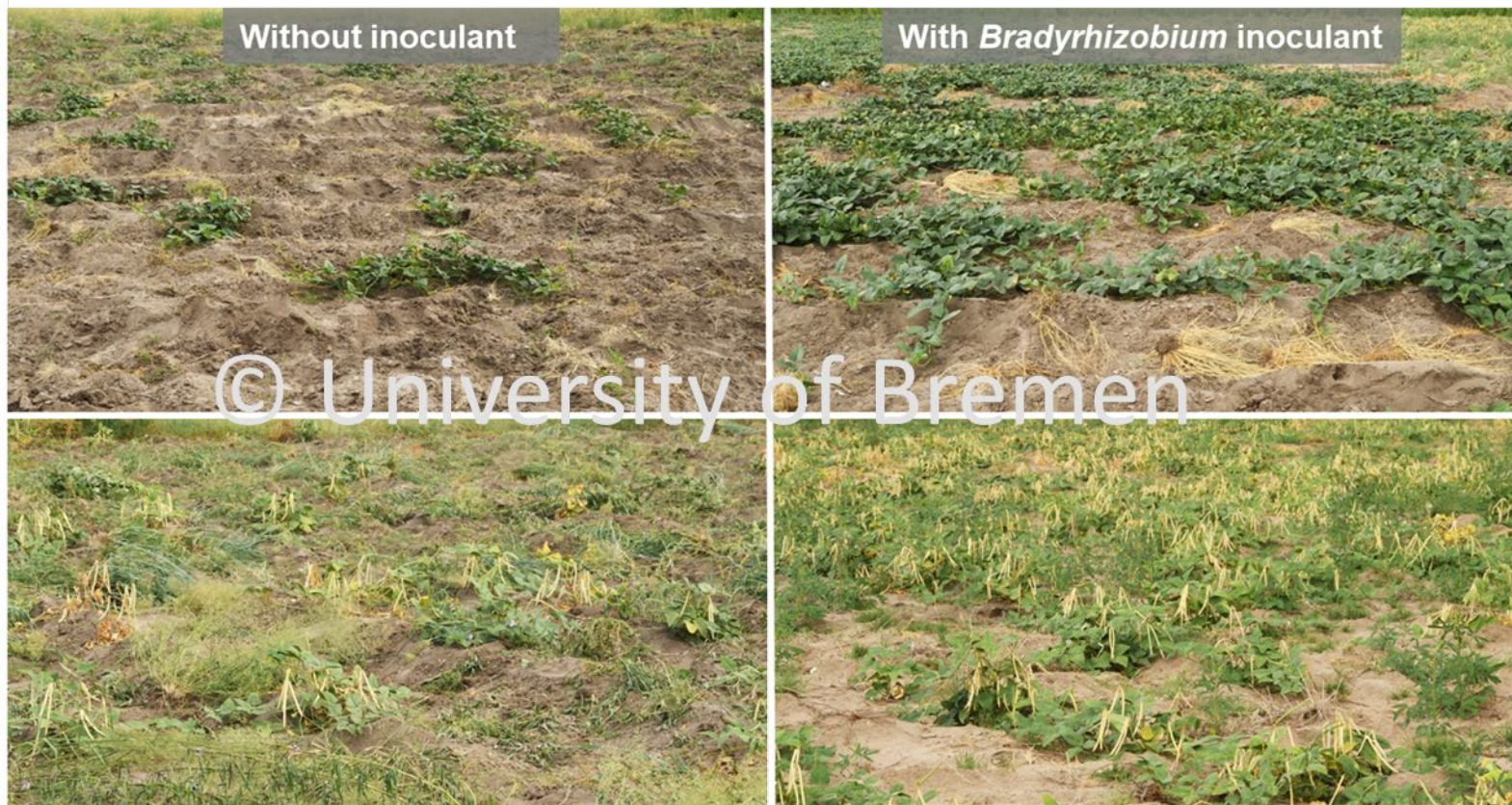
40 – 41 °C instead of 28°C e.g. for strains from Angola

# Inoculant development



## Example for simple peat-based inoculant for cowpea

### Smallholder farm during drought



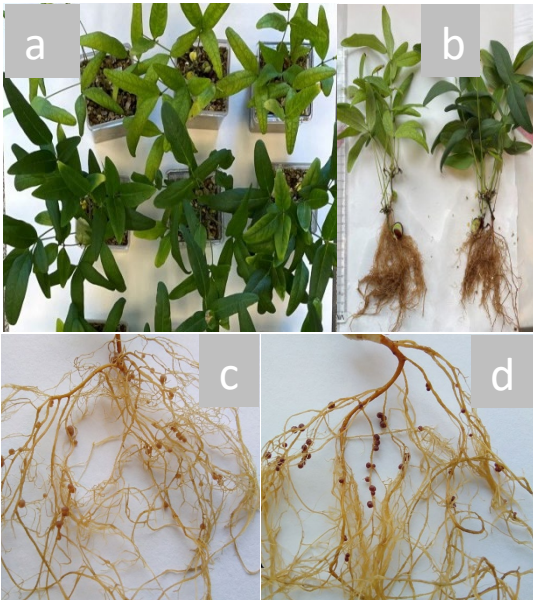
# Inoculant development

## Bambara groundnut: 3 Namibian varieties

red

brown

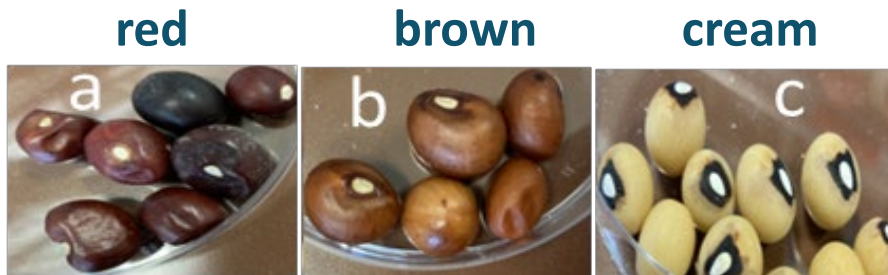
cream



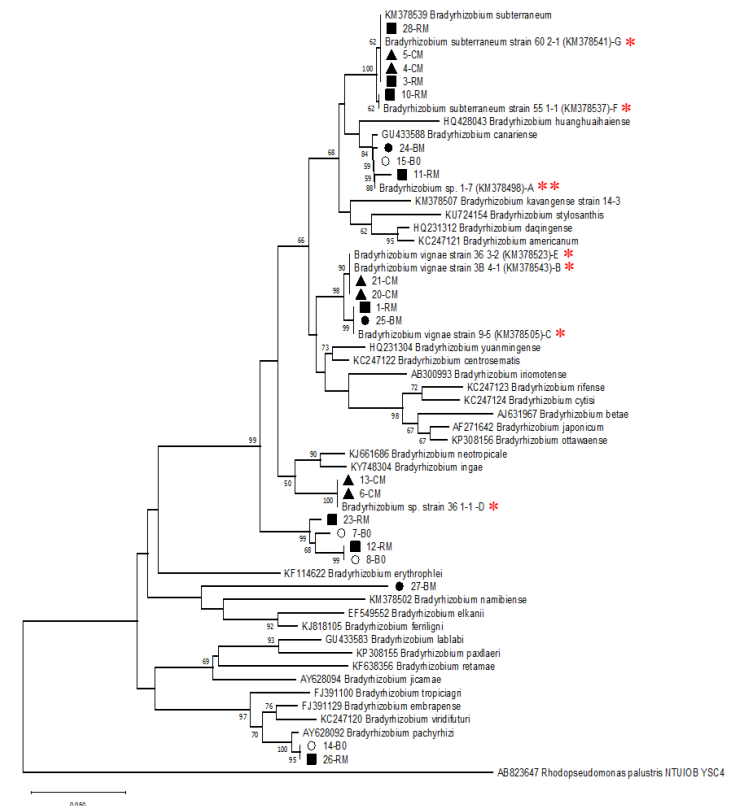
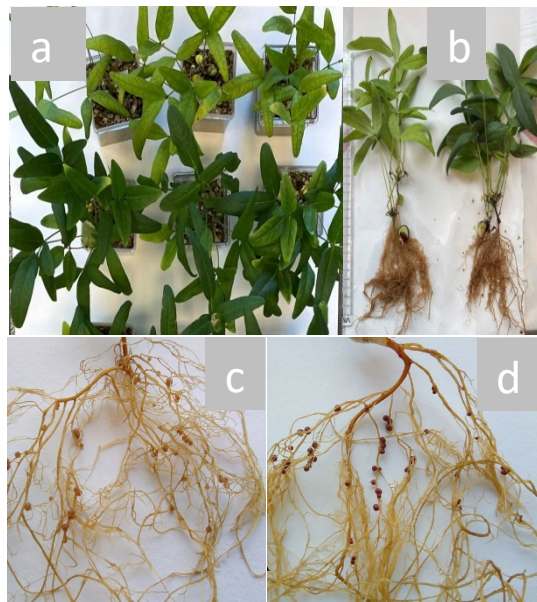
aseptic pot experiments in phytotron

# Inoculant development

## Bambara groundnut: 3 Namibian varieties



## 7 divergent \* *Bradyrhizobium* strains



aseptic pot experiments in phytotron



# Inoculant development

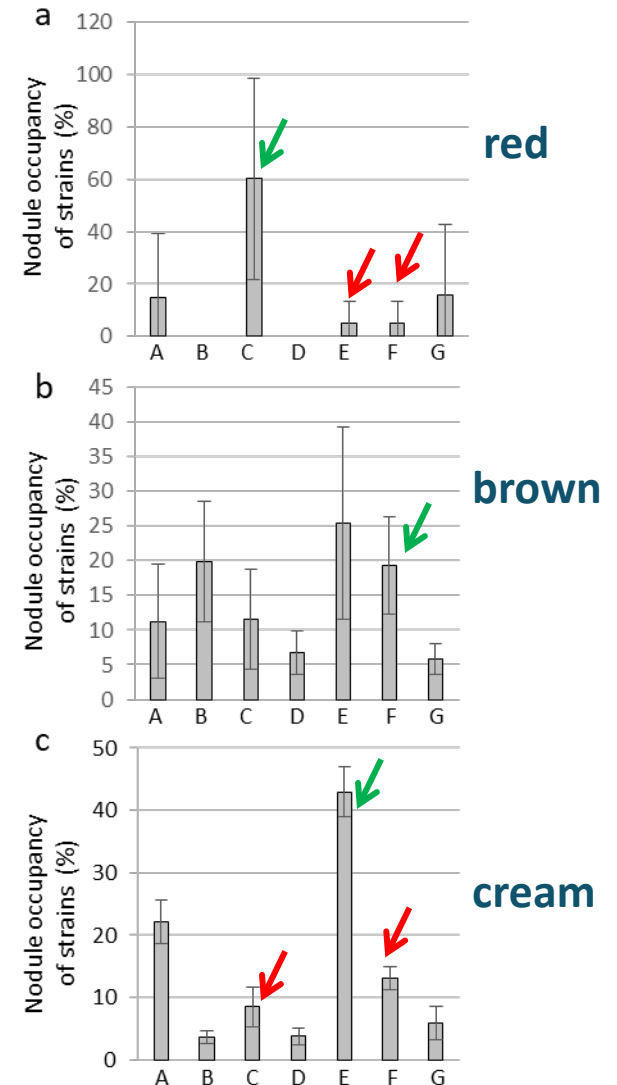
**Strong effect of plant genotype – symbiont genotype interaction!**

**Mixed inoculum**

**Nodule occupancy indicates competitiveness**

**Field experiments ongoing**

Sarkar et al. (2023) *Front. Plant Sci.*  
DOI 10.3389/fpls.2023.1270356

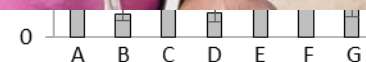
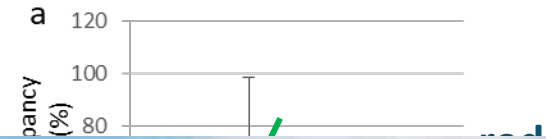


# Inoculant development

**Strong effect of plant genotype – symbiont genotype interaction!**

**Mixed inoculum**

**Field experiments ongoing**



Thank you!

## Bambara groundnut inoculant development complex!

