In situ: MYA
Domestication: 10-12,000 years ago

Secondary diversification: 
~6,000 years ago

Secondary diversification: 
~3,000 years ago

Secondary diversification: 
~3,000 years ago

Recent introduction: Within last century

Microbial nitrogen fixation imbues chickpea with high nitrogen content

A key source of humankind’s protein nitrogen
Collections of chickpea’s wild microbes offer solutions for agriculture

Nitrogen fixation
~1,500 genomes

The microbiome
>1,000 communities

Unweighted Unifrac

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Massive diversity on a global scale

- >20 symbiont species.
- 90% of genome is highly diverse.
- 10% of genome is highly conserved.

What is the significance of this diversity in agricultural systems?

Can we improve inoculant technology and crop yields?
Hand-off discoveries and accelerate outcomes

UC Davis → National programs → Industry partners → In-country value chain

Each 200 ml package can treat 40 kg of seed, or approximately 100,000 seed.

This gives agricultural-scale capacity to test strains in a country-wide effort, and ultimately to deliver improved strains as high quality formulations.
What makes an efficient symbiosis?

- Bacterial genome background?
- Individual strain idiosyncrasies?
- Host genotype?
- Local environments? (HGT strain displacement)

Are we looking for 1 superior strain?
OR
Multiple strains, each superior on a particular host genotype of environmental condition?

ICCV96029 response under different N sources

![Image showing plant responses to different N sources]

Phenomenon of strain displacement

Fast: HGT
Survive local soil factors

Slow: co-evolution
Maximize host benefit

Perhaps long-standing global diversity can address this issue?
**Cicer spp.**

Peptide hormones

Metabolite hormones

**Mesorhizobium**

Nod factor

Systemic signaling

NCR peptides

Type III Secretion
Parallel Planning Sessions

(1) Integrating genomics, phenotyping and genetics: knowledge-driven breeding.

(2) Harnessing chickpea’s microbes, nitrogen fixation and plant growth promoting rhizobacteria.

(3) Designing and developing chickpea ideotypes for harsh climatic conditions.

(4) Making genomic, genetic and phenotypic data accessible to breeders and other chickpea colleagues: analyzed data, databases, web access and views.

(5) Designing and developing disease and pest resistant chickpea cultivars.
30 minutes, Brief panel statements

2 hrs, Open discussion

30 minutes, Wrap up and development of summary points

Identify and prioritize desired practical outcomes for chickpea, especially new cultivars and biological inoculants, and to enumerate the ingredients (research, breeding, partnerships, etc) necessary to achieve those outcomes.

We request that the discussions focus on activities and outcomes divided into three time horizons: 2 years, 5 years and 10 years.