M-trophs for Sustainable Agriculture

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NewLeaf Symbiotics

Saint Louis, Missouri, USA

- Where Mississippi and Missouri Rivers meet
- Named after King Louis IX of France
- Settled by French Explorers
- Sold to U.S. in 1803 in the Louisiana Purchase
- Middle of U.S. farmland

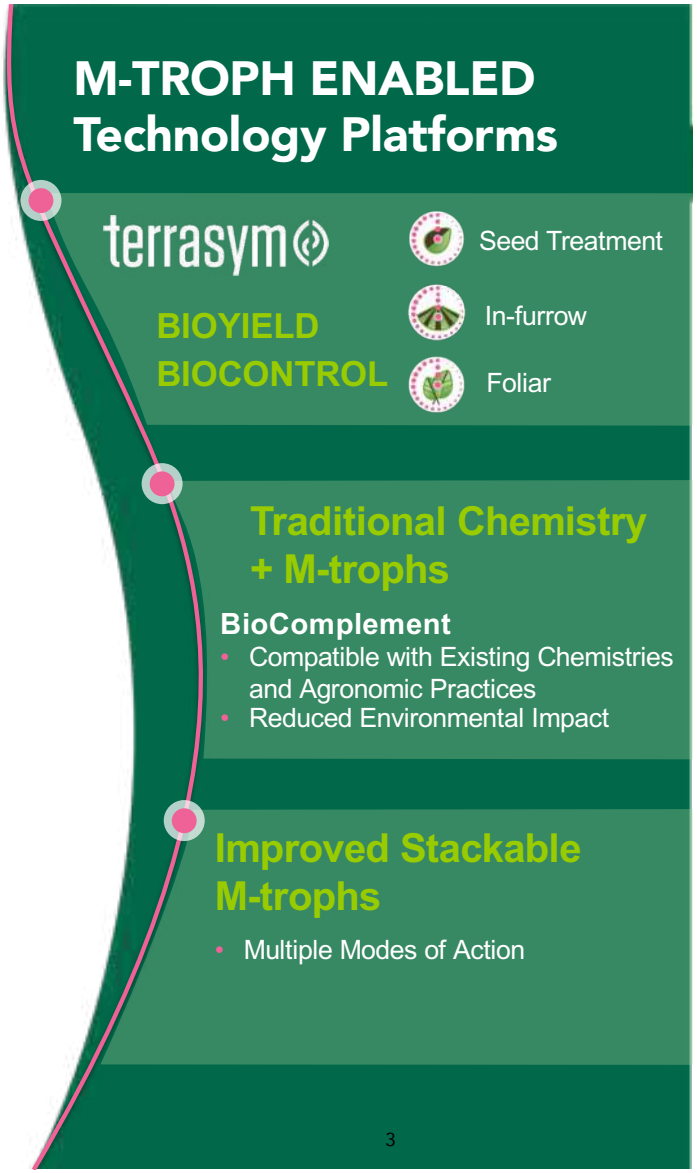
United States Department of Agriculture - Cropscape

NewLeaf symbiotics

- Focus on *Methylobacterium* genus (M-trophs)
- Founded 2013
- ~40 employees, 12 PhD scientists with a strong genomics & bioinformatics focus
- 80+ filed or granted patents, 17 patent families
- 15 products in pipeline
- First products launched in 2018

terrasym 401 for soybean BIOYIELD

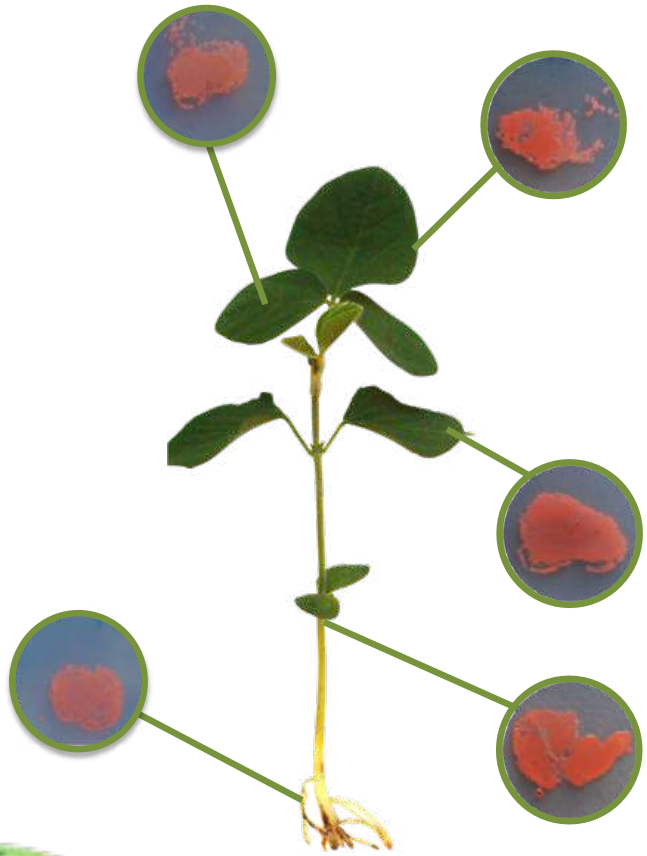
terrasym 402 for peanut BIOYIELD

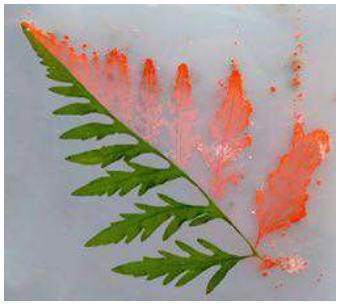


Biologicals in the Future of Agriculture

- Beneficial microbes or derivatives as active ingredient
- Global acceptance in mainstream agriculture
- New traits and crop protection chemistries
  - cost $150 - 250 MM
  - take 10 - 12 years to get to market
- Biologicals have an accelerated path-to-market

NewLeaf symbiotics





Why M-troph Focus?

- Robust and ubiquitous colonizers of plants
- No energy cost to plants
- Rich in plant enhancing "traits"
- Highly productizable with our proprietary methods

terrasym

M-trophs Powered by Prescriptive Biologics Knowledgebase®

PBK

SOURCED FROM NATURE

TECHNOLOGY PLATFORMS

Terrasym®

Traditional Chemistries + M-trophs

Improved Stackable M-trophs

PBK-guided vignettes: from lab to product

Associating genotypes to phenotypes

Finding and utilizing natural variation

Optimizing our ability to make products

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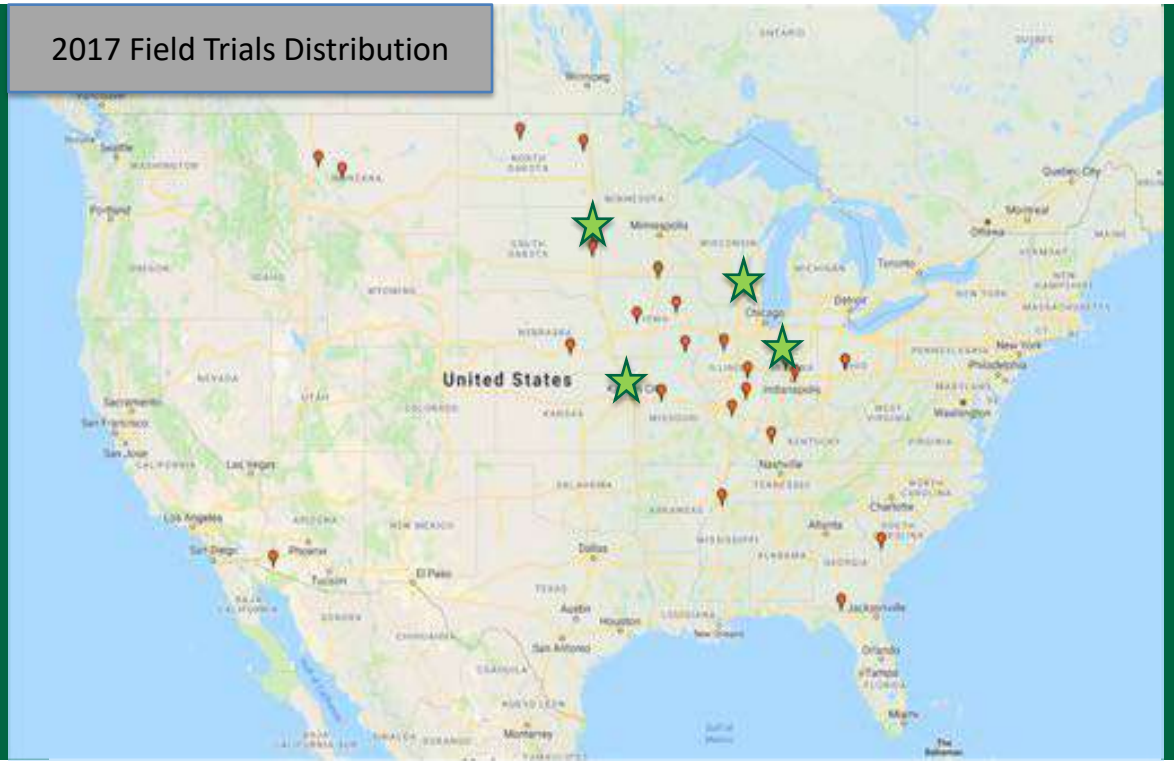
Associating Genotypes to Phenotypes

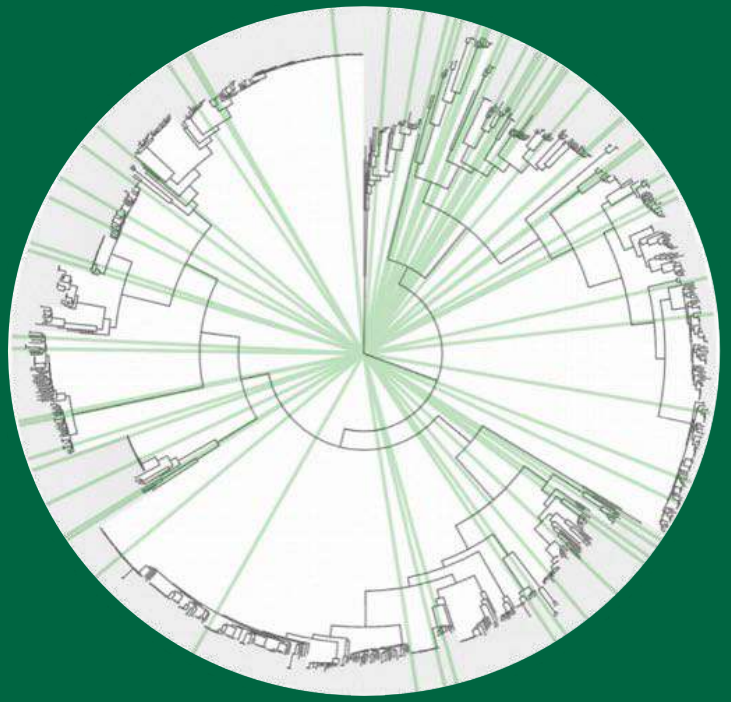
- Yield is ultimate phenotype
- 4 locations
- Elite soybean seed varieties
- M-trophs coapplied on seed with standard chemistries
  - Seed applied insecticides &
  - Seed applied fungicides
- No additional Rhizobium application on seed

2017 Field Trials Distribution



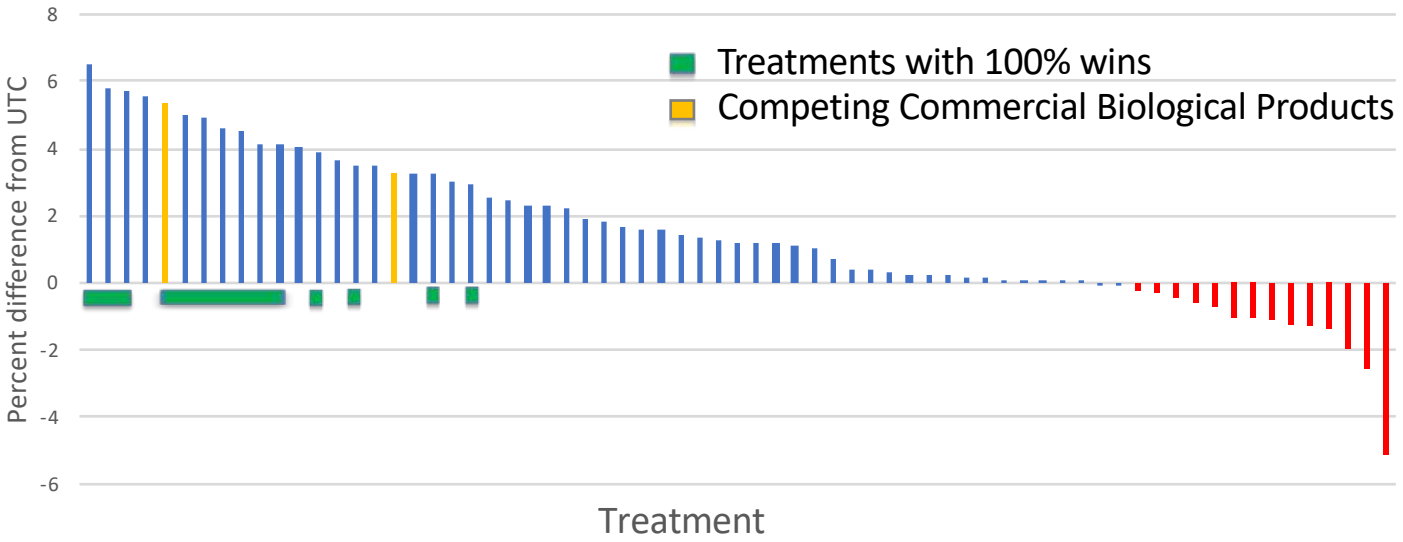
M-trophs Were Selected to Maximize Diversity

- Phylogeny from 37 single-copy genes (Darling *et al.*, 2014)
- Isolates not pre-screened for potential efficacy in the field
- 67 isolates, 6 UTC, 2 commercial biological products
- Treated, planted, and grown to yield



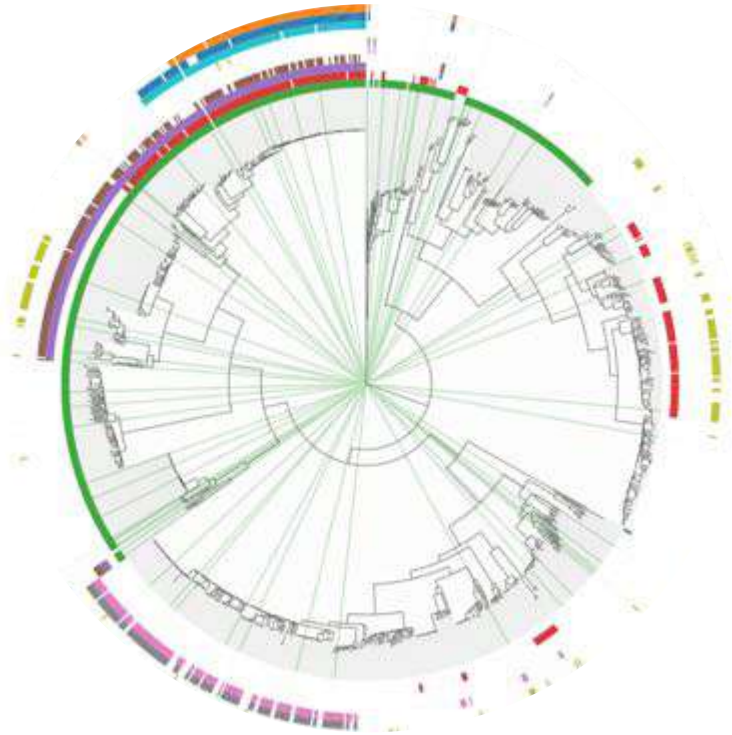
Yield Increases Across All Locations

- We have clear winners including several which outperformed competing commercial biologicals
- Skew towards increased yield indicates general beneficial nature of M-trophs



PBK Analyses Identify Genes Associated with Yield

- 40+ associated genes – showing top 10
- Refine associations in 2018 field trials
  - 65 isolates including top and bottom performers in 2017
- Single genus simplifies comparative genomics



PBK-guided vignettes: from lab to product

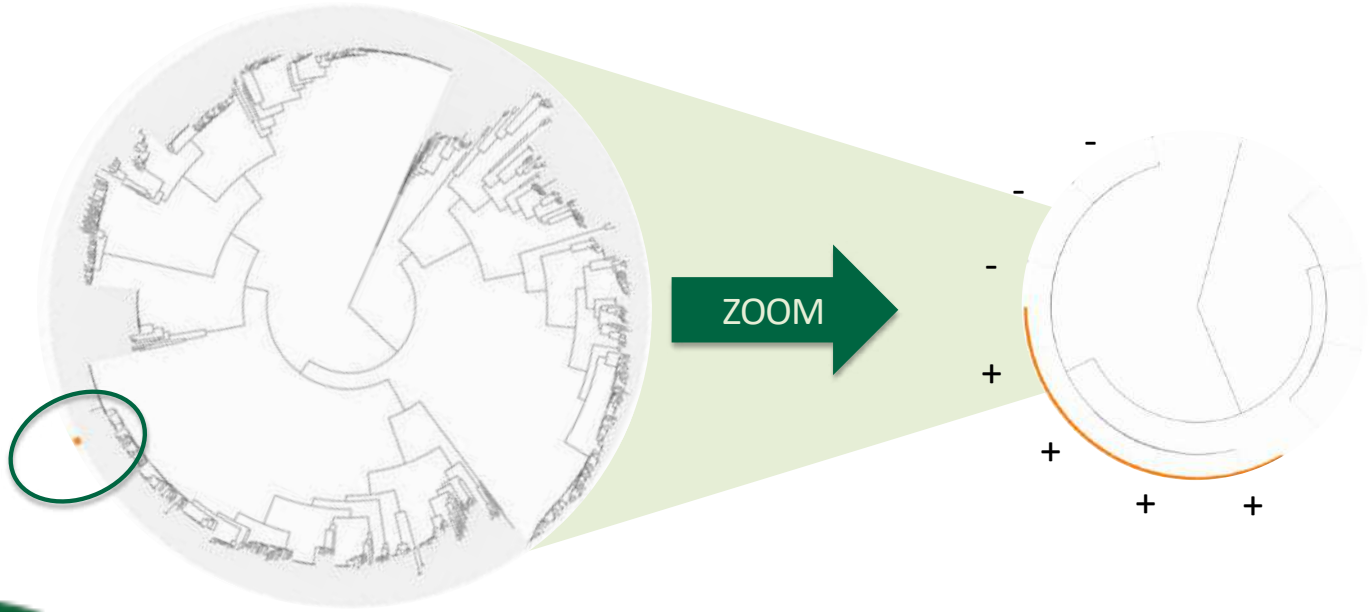
Associating genotypes to phenotypes

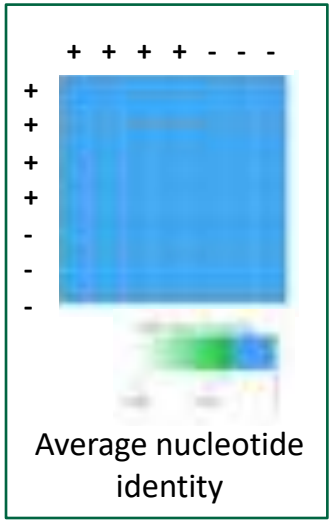
Finding and utilizing natural variation

Optimizing our ability to make products

Finding and Utilizing Natural Variation in our Collection

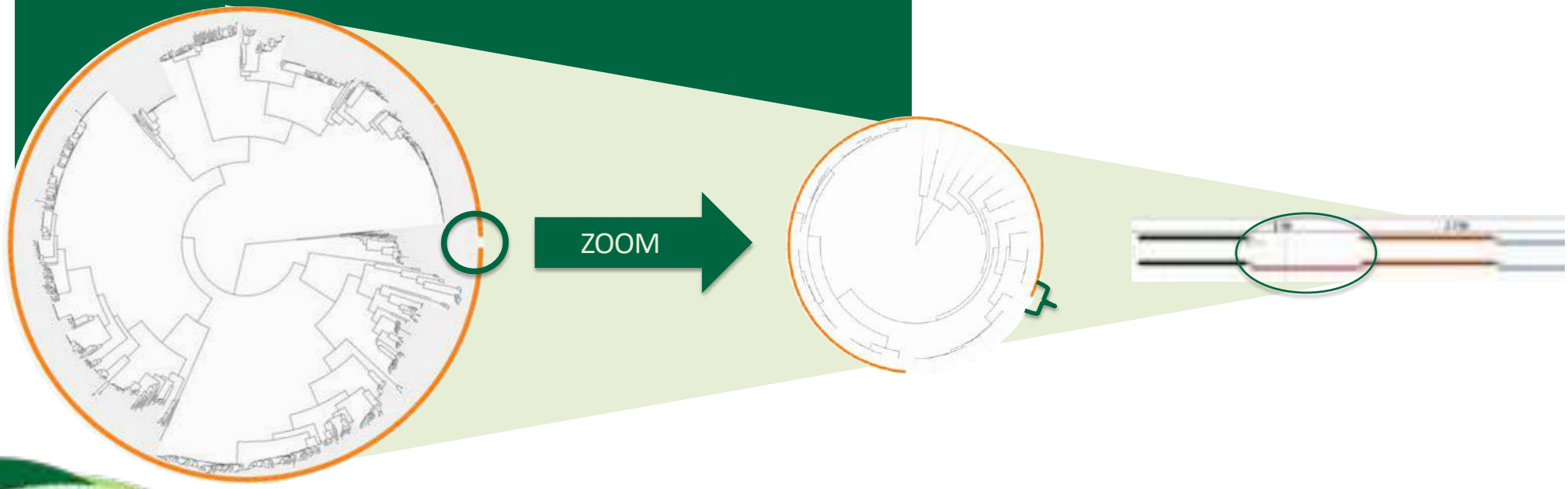
- Hypothesis: Gene A causes Activity X found in a certain isolate
- Can test nearly identical isolates with & without Gene A





Finding and Utilizing Natural Variation in our Collection

- We need an isolate lacking Gene B



PBK-guided vignettes: from lab to product

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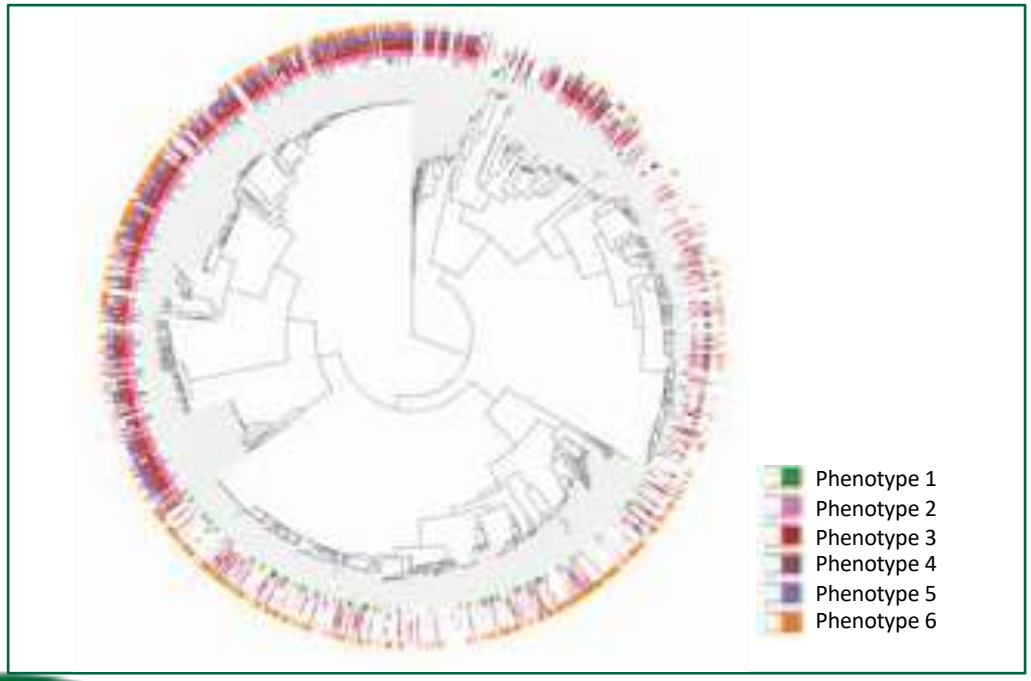
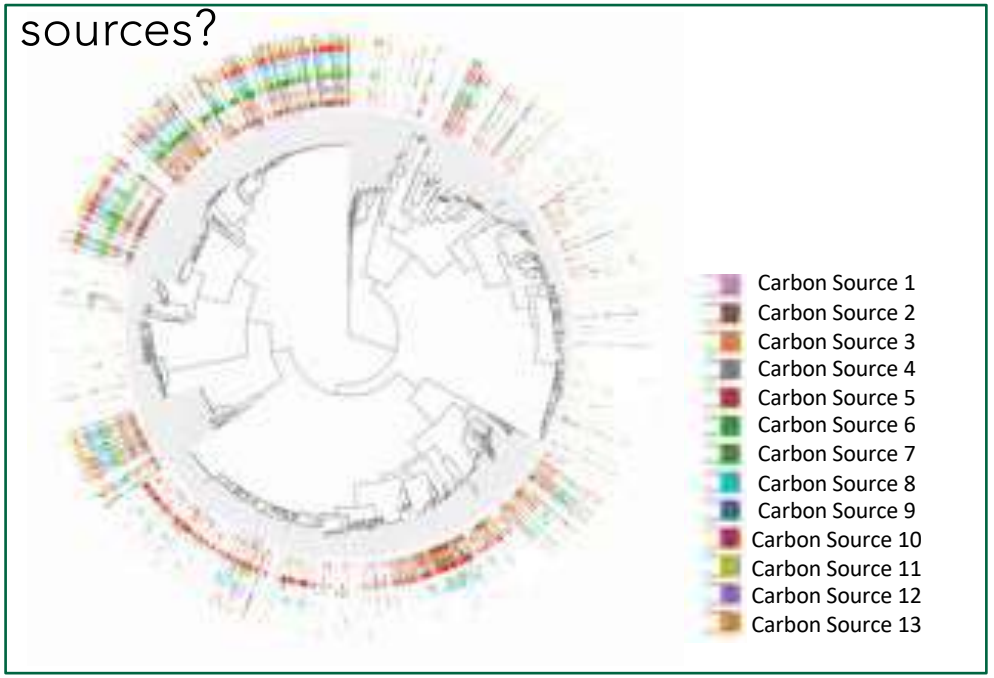
Which isolates are easier to formulate?



Which isolates use specific carbon sources?



Take Home Message

- Our M-troph-based Terrasym products are part of the future for sustainable agriculture
- We developed our Prescriptive Biologics Knowledgebase to leverage our
  - Sizable collection of M-trophs
  - Extensive genomic information and annotations
  - Large collection of phenotypic data from *in vitro* and *in planta* assays
  - Years of field trial results
- We are maximizing our ability to predict and prescribe M-trophs that will perform in the field

The Applied Innovation of…

terrasym

PHYTOBIOMES ALLIANCE

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