



#### AGRICULTURAL SOLUTIONS

### **Agricultural "Probiotics":**

- ✓ Increased Crop Productivity
- ✓ Accelerated Soil Carbon Sequestration
- ✓ Increased On-Farm Profits

#### June 2018 Special Issue of *Industrial Biotechnology* Dedicated to "Agricultural Probiotics"



Cover shot: Florida Strawberry Field

Editors: Larry Walker and Paul Zorner

Great papers and commentary on multiple topics contributed by many companies operating in this sector

Released at the July. 2018 World Congress of Industrial Biotechnology in Philadelphia

### **Productive Agriculture Starts With Healthy Soil**

- Rhizosphere microbiome serves the same immune, nutrition and health function for plants as the "gut" microbiome does for humans.
- Enriching and supporting this ecologically important population allows crops to naturally flourish
  - -Just like probiotics are beneficial for humans, they are also beneficial for plants

Microbial Solutions for Top Agricultural Challenges

Agricultural productivity and the communities in which we grow our food are experiencing serious challenges from:

- Soil degradation
- Pest resistance to chemicals
- Consumer concerns over GMOs
- Grower profits

- Chemical residues on food
- Movement of inorganic nutrients and chemicals to sensitive environments
- Climate change

### New 2000 Year Old Insight

"One thing is sure: the Earth is more cultivated and developed now than ever before; there is more farming but fewer forests, swamps are drying up and cities springing up on an unprecedented scale. We have become a burden to our planet. Resources are becoming scarce and soon Nature will no longer be able to satisfy our needs."

-Quintus Septimius Tertullianus

- (Roman politician) 200 BC



How have we avoided disaster?

- Opening new lands
- Technology/Innovation
- Agriculture a climate "hero"

## Crop Productivity Depends on Microbes



The rhizoplane as described in L. Philippot et al. Nature Rev Microbiol 11: 789-799, 2013







Improved Soil Health and Carbon Sequestration "sugars" secreted from roots and feed microbes which then deposit carbon in soil

# 🚺 Locus Ag Soil Probiotic



### RHIZOLIZER®

A customized, non-GMO and organic-certified soil amendment comprised of two microbes:



✓ Low Use Rate ✓ Low Cost ✓ Easy Application

### Improved Productivity in Trees Impacted By Citrus Greening





57% Decrease

in annual revenues since early 2000's



While the industry is slowly rebuilding, it needs effective solutions...

# **Treated Groves:**

#### Increased Vigor

- ✓ Root mass
- ✓ Tree architecture
- ✓ Young tree growth

#### Higher Yields

- $\checkmark$  Pound solids
- ✓ Box weight

#### Improved Fruit Quality

- ✓ Weight
- ✓ Diameter
- ✓ Brix

### Improved Root Growth





Valencia Applied bi-monthly; two total treatments Hamlin Applied bi-monthly; two total treatments









# Improved Fruit Quality







3 total treatments Differences are statistically significant



3 total treatments Differences are statistically significant



3 total treatments Differences are statistically significant





### Marvest Yield

#### Florida Field Trials



4 total treatments Differences are statistically significant

### Positive Results Across More Than A Dozen Crops

### Improved crop productivity via multiple mechanisms of action.



Available in 41 states OMRI certified

✓ Used commercially on > 40k acres

\*Varies by crop

Increases in yield up to:



## Metagenomic functionality

### ✓ Quorum Sensing









Improved Soil Health and Carbon Sequestration "sugars" secreted from roots and feed microbes which then deposit carbon in soil



Data is approximated based on 4.38 metric tons CO2 equivalent/acre/year from soil carbon sequestration. Does not include soil GHG reduction results.

# Locus Ag – SoilCQuest Partnership



- Locus Ag and SoilCQuest collaborating on deployment of soil carbon sequestration technology
- SCQ microbe deposits carbon at levels similar to Locus Ag Rhizolizer<sup>®</sup> at 4+ metric tons C02e/year/acre soil carbon deposition.
- SCQ microbes provide a great visual example of microbes using secreted plant sugars to fix atmospheric carbon in soil.



# **BEAM Results**

Using <u>BEAM approaches</u> for the previous 4.5 years on beginning soils (0.43% C increase/year) ISAR has averaged soil C increases of <u>10.71 tons C ha<sup>-1</sup> yr<sup>-1</sup></u>

This rate is from <u>20 to 50 times</u> soil C capture rates observed by other agriculture management methods.



New Mexico State University



#### April 10, 2019

Carbon Removal – A New American Agricultural Product: How Carbon Farming and Building Soil Health Will Fight Climate Change

Our best shot at cooling the planet might be right under our feet

Jason Hickel at The Gaurdian

Science News Climate Change Goes Underground Soil Science Society of America

# Stanford

#### OCTOBER 5, 2017

Soil holds potential to slow global warming, Stanford researchers find The land under our feet and the plant matter it contains could offset a significant amount of carbon emissions if managed properly. More research is needed to unlock soil's potential to mitigate global warming, improve crop yields and increase resilience to extreme weather. Amplified Soil Carbon Deposition From Crop-Microbe Synergy Crops become more active carbon "pumps"

#### How we sequester carbon has a BIG impact.

Third-Party Validated Measurements <sup>3</sup>	Increases in CO <sub>2</sub> e Sequestration Annually
Almond California	6.2 tons per acre <sup>1</sup>
Citrus Florida	<b>4.4</b> tons per acre <sup>1</sup>
Grapes California	<b>3.5</b> tons per acre <sup>1</sup>
Cherries California	<b>3.3</b> tons per acre <sup>1</sup> Within three months
<b>Turfgrass</b> Arizona	<b>3.2</b> tons per acre <sup>1</sup>

Sequestration in just these five crops alone can reduce annual greenhouse gas emissions in the U.S. by Larger root volume

More crop canopy and chlorophyll density Increased fungal biomass

Applying Soil "Probiotics" to Just 1 Acre of Citrus Trees, 4x Per Year Can <u>Offset the GHGs</u>



Data is approximated based on 4.7 metric tons CO<sub>2</sub> equivalents per passenger vehicle annually, according to the EPA. Does not include soil GHG reduction results.

#### Soil carbon credits are now a reality, with the first transaction already completed in Australia

#### Potential Buyers Are Expanding

- Airlines will be required to offset carbon by 2021
- Public companies are increasingly under pressure from shareholders
- Regulatory barriers are being erected to reduce the carbon footprint of companies expanding their facilities

#### Carbon Credit Market Increasing In Size And Sophistication

- Voluntary credits at \$3-\$10 per metric ton
- FUTURE Act credits at as much as \$35 per metric ton
- Increasing likelihood of "carbon taxes" being levied world-wide
- Growing involvement from major financial firms (Goldman Sachs, JP Morgan, Morgan Stanley)

# "Problems cannot be solved by the same level of thinking that created them"

Albert Einstein





### We are at the forefront of simple,

### clean solutions to the world's largest challenges

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