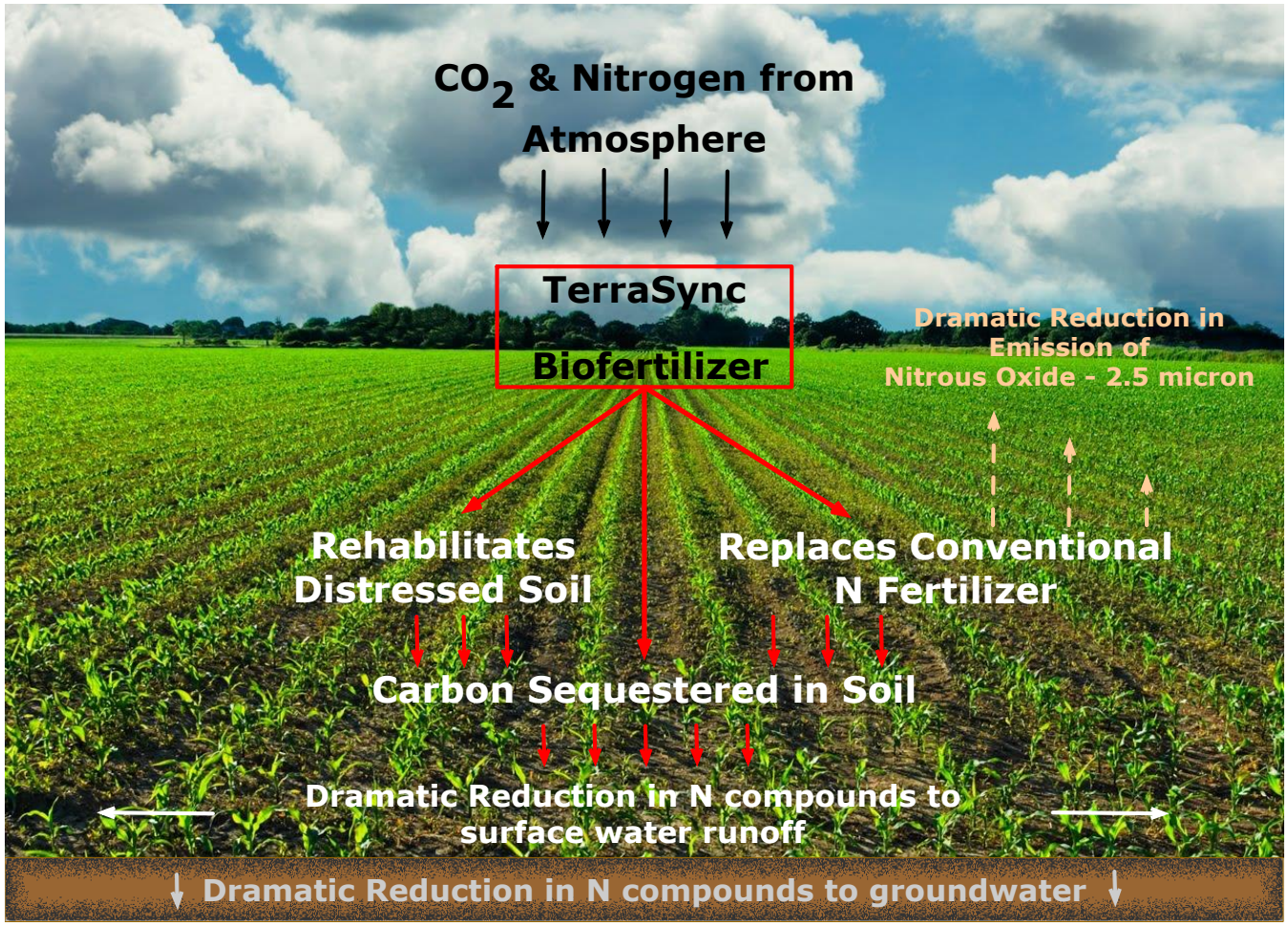
Carbon Farming with Algae



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VP Integrated Carbon Solutions
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July 2018

TerraSync Biofertilizer – **Synthetic N Replacement**

Anthropogenic Process CO_2

1 ton of carbon captured

Algae Production

Atmospheric CO_2 and N_2

TerraSync™ Biofertilizer

(Autotrophic Photosynthetic Nitrogen Fixation)

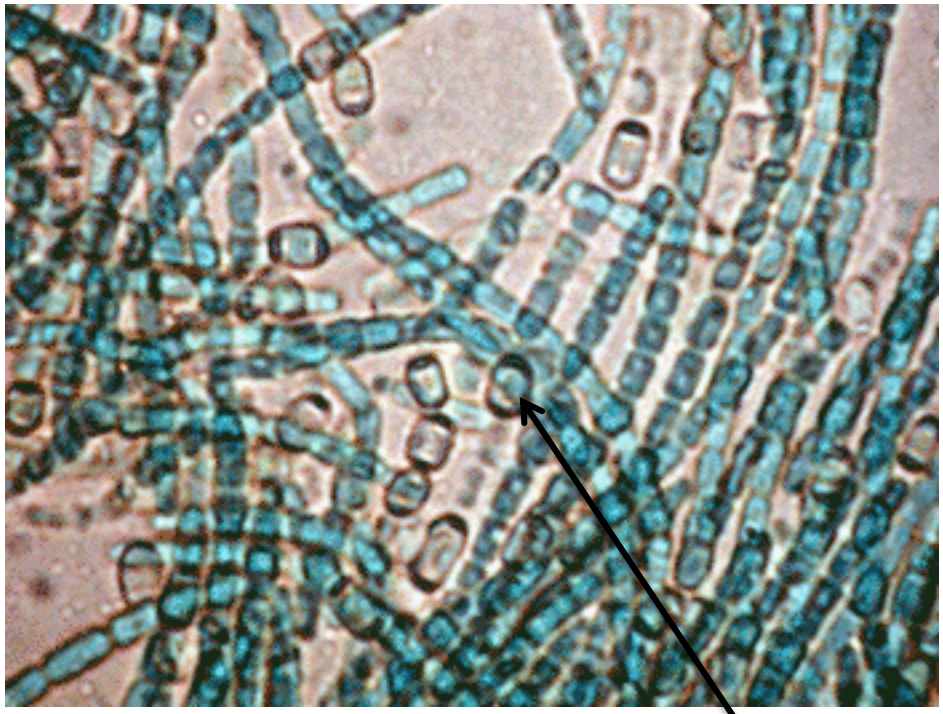
Agricultural Production and Consumption Nutrient Capture and Recycle

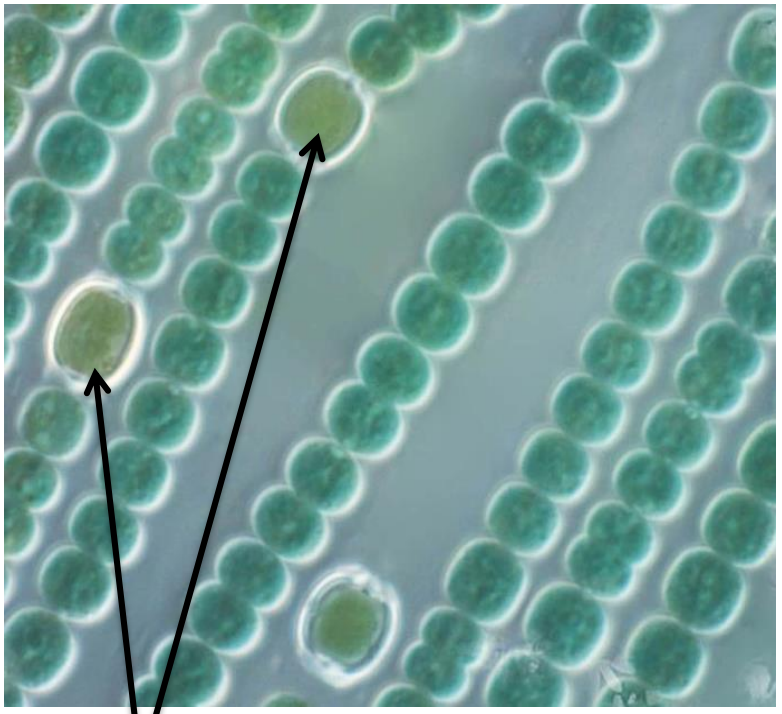
Terrestrial Carbon Sequestration

10 to 50 tons of carbon stored

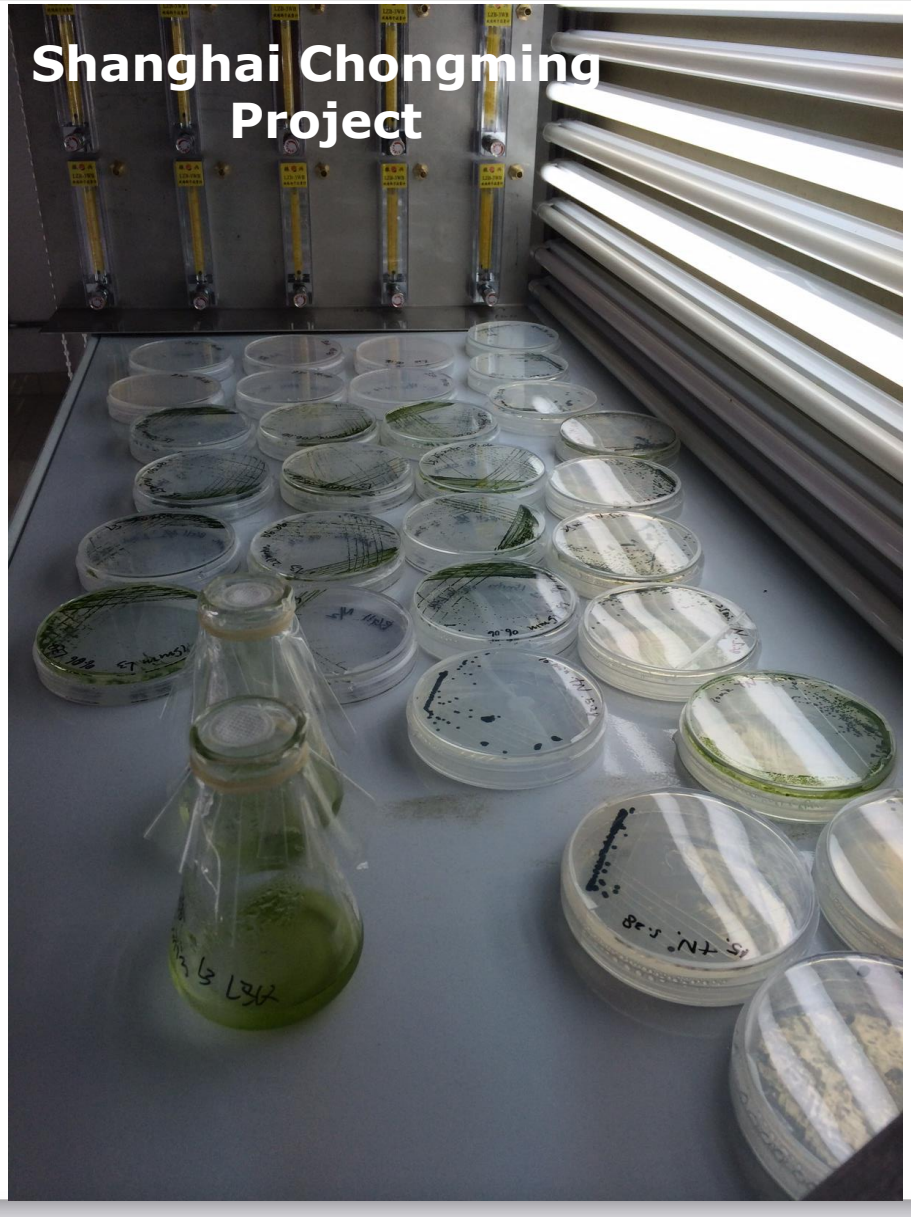
Cyanobacteria (Blue Green Algae) – as old as dirt

- Free living autotrophic photosynthetic nitrogen fixing
- Photosynthesis splits water into oxygen and hydrogen
- Hydrogen and an enzyme split carbon dioxide into oxygen and carbon
- Heterocyst's **fix elemental nitrogen to ammonia nitrogen**

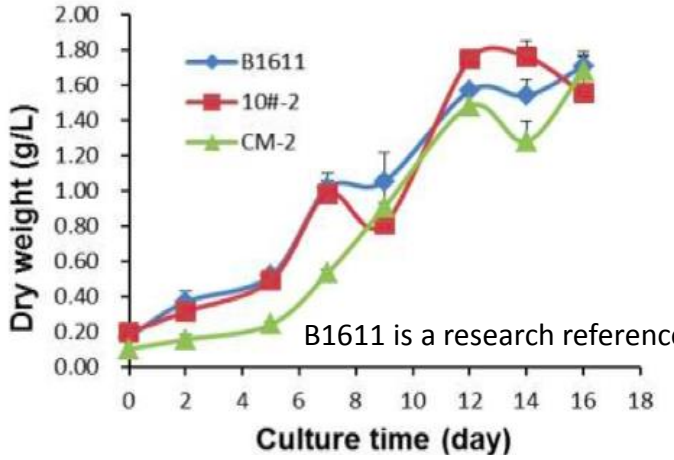




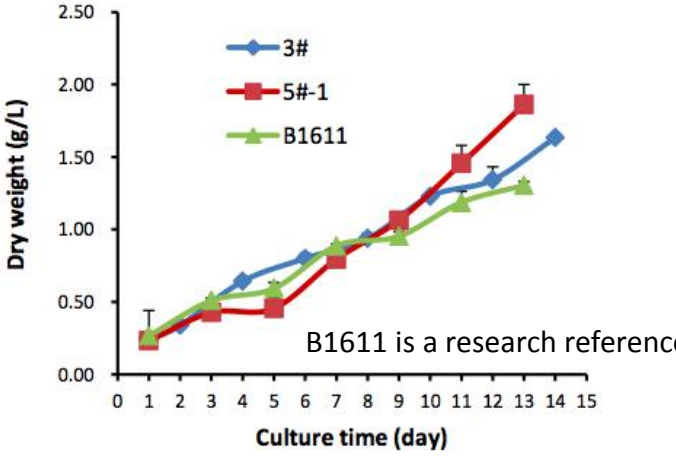
Heterocyst



27 local strains isolated for consideration



B1611 is a research reference strain



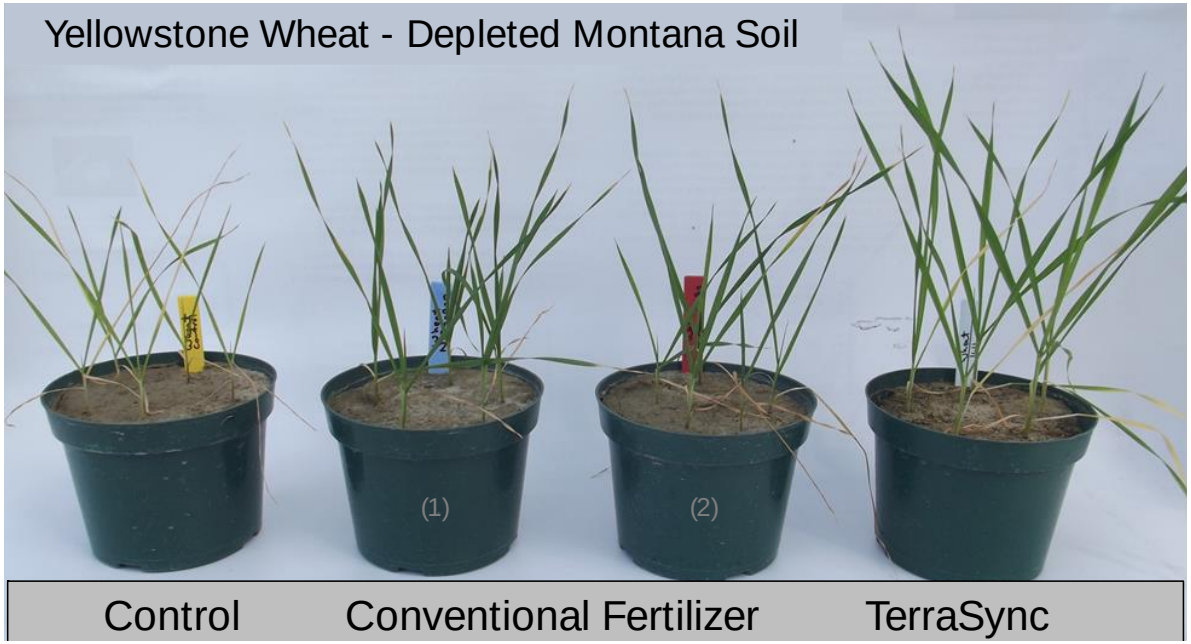
B1611 is a research reference strain

Kubuqi Desert Restoration – Inner Mongolia

Staged inoculation, over several days, of PBR with four indigenous strains of nitrogen fixing cyanobacteria.

Fully inoculated PBR ready for harvest, multi-strain culture of nitrogen fixing cyanobacteria will be applied to desert soil for plant cultivation.

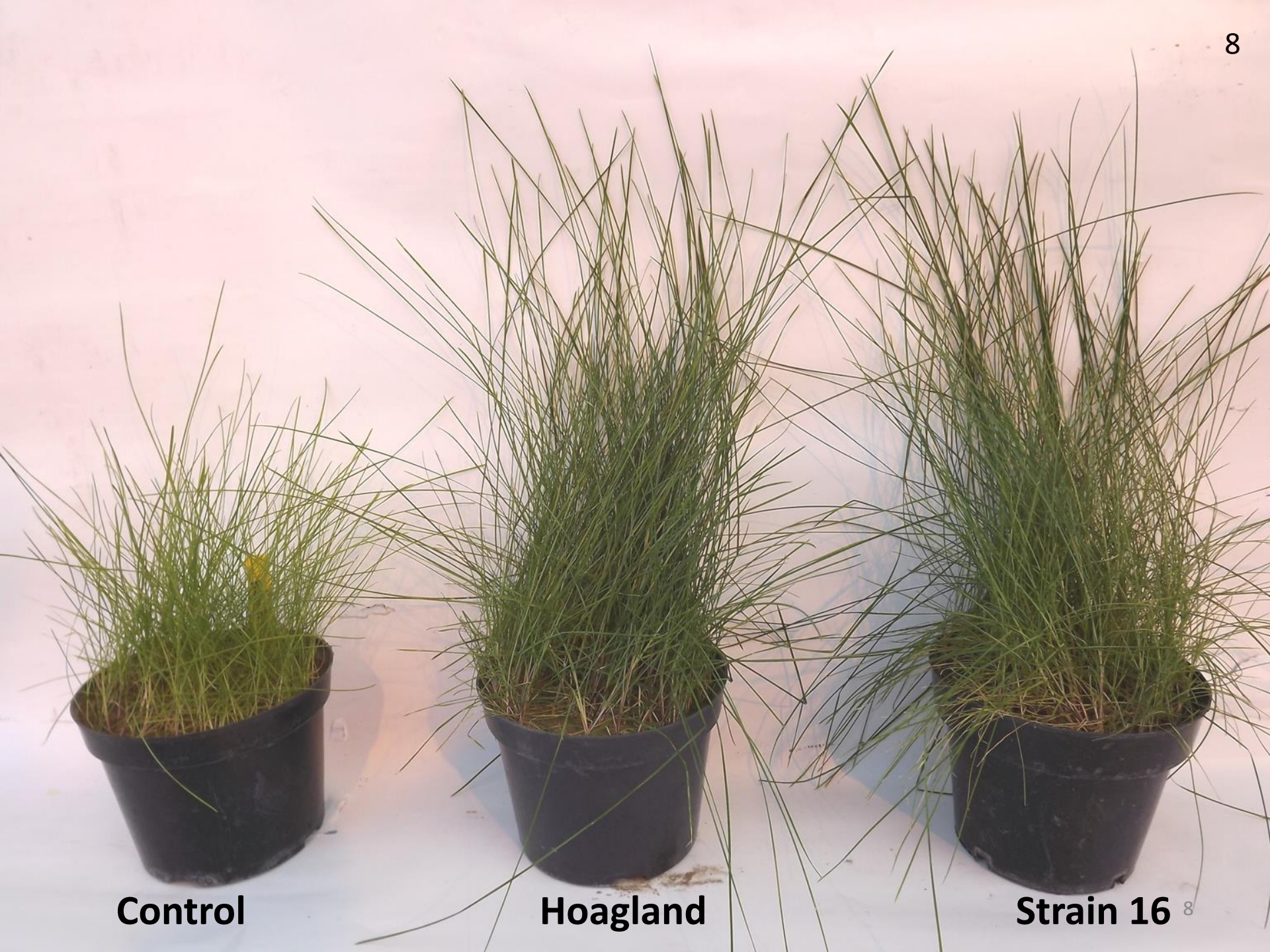
TerraSync™ BioFertilizer Development – DOE NETL Funded



- Control – no NPK fertilizer
- (1) - 35-0-0 – standard application of Nitrogen fertilizer
- (2) - Hoagland's - all macro & micro nutrients
- TerraSync Algae Strain B1611 – ONLY nitrogen fixing cyanobacteria (blue-green algae) at eqv. standard nitrogen application rate
- No macro or micro nutrients were applied with Strain 16

Root development, (control on left – TerraSync Strain 16 biofertilizer on right) is indicative of overall healthy plant development

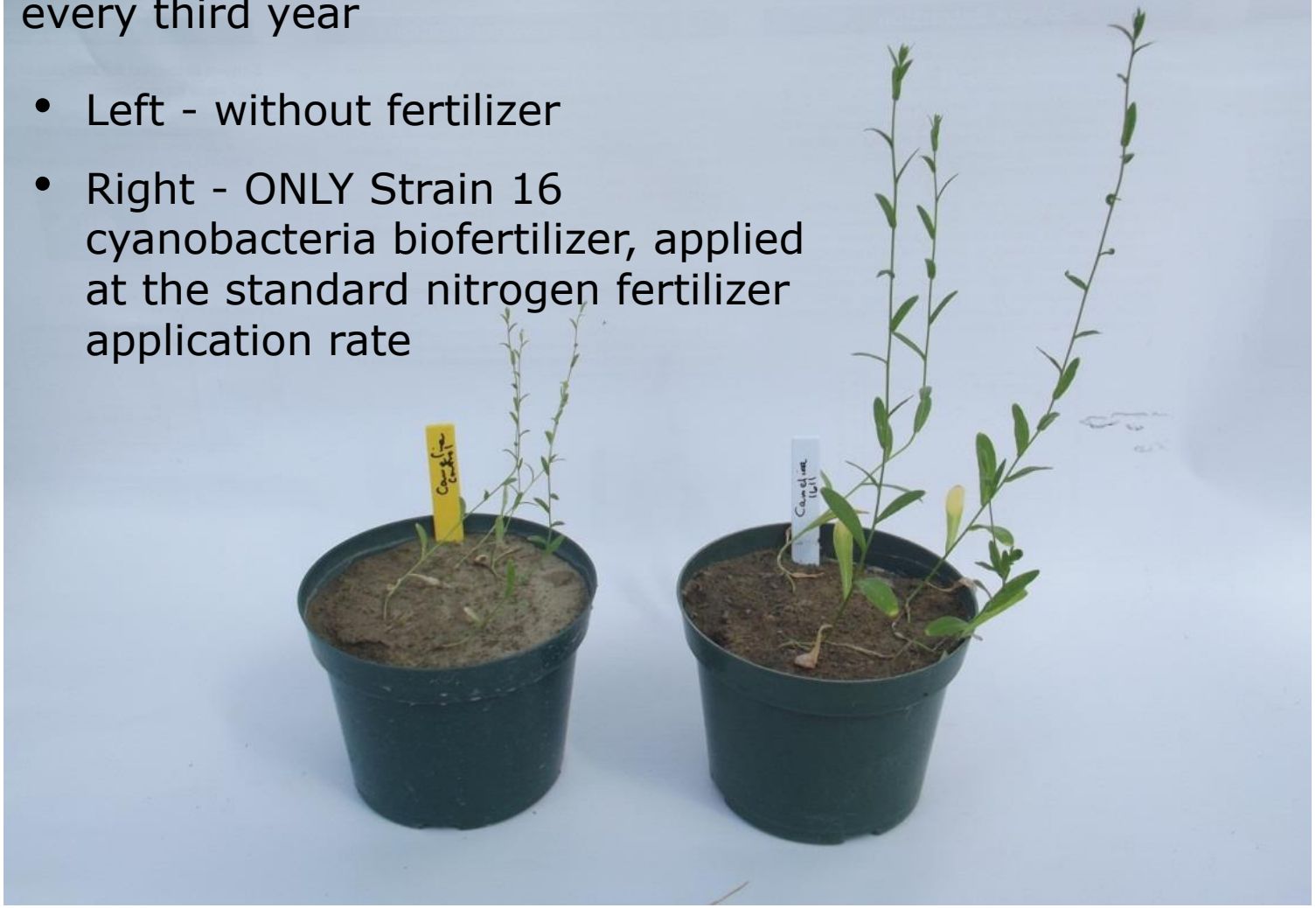

Control
Hoagland
Strain 16


Control
Hoagland
Strain 16

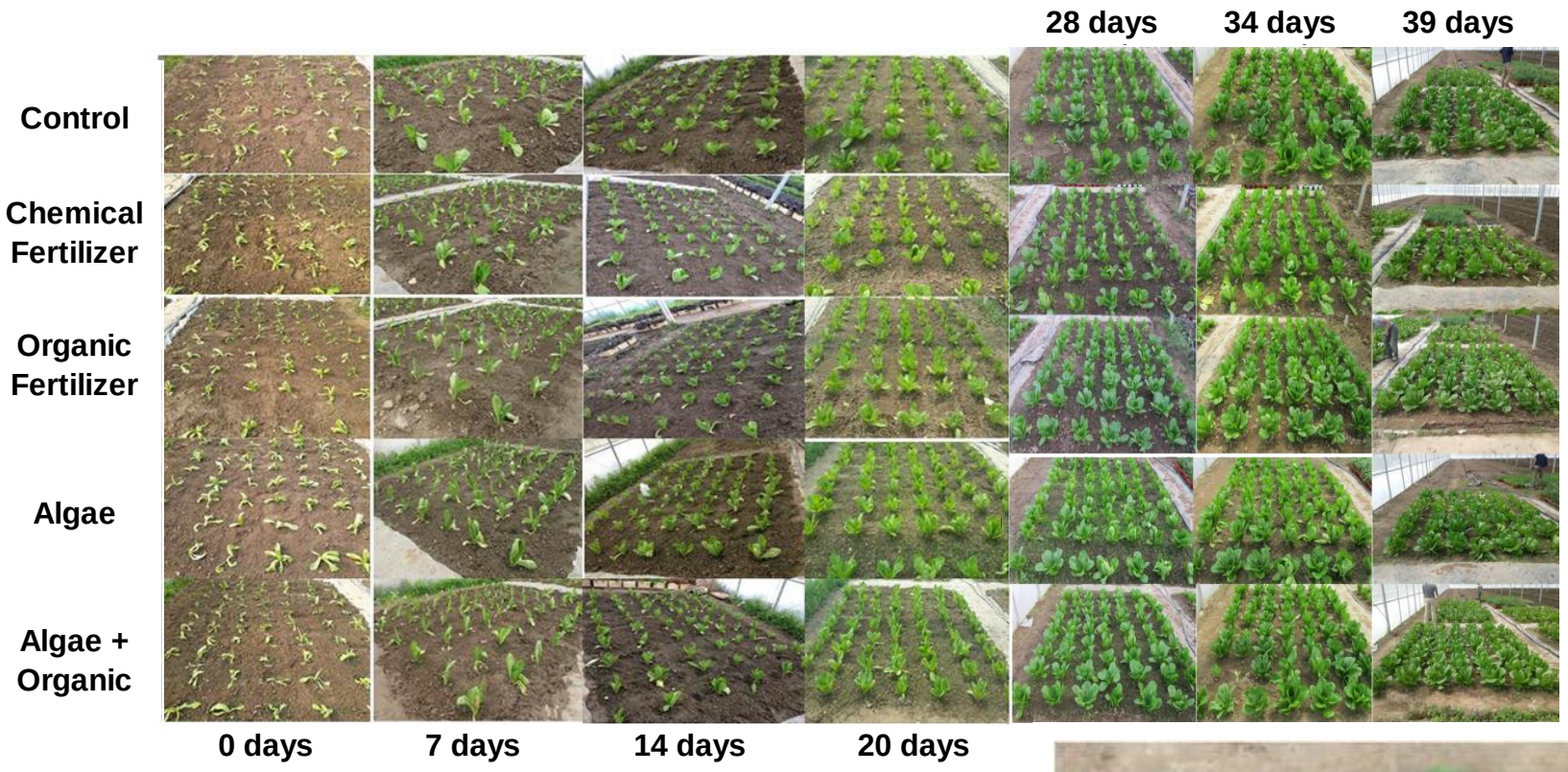
TerraSync BioFertilizer – Camelina Seed Oil Energy Crop

Camelina seed oil crop is used in crop rotation with wheat every third year

- Left - without fertilizer
- Right - ONLY Strain 16 cyanobacteria biofertilizer, applied at the standard nitrogen fertilizer application rate



TerraSync BioFertilizer – Lettuce Field Trials



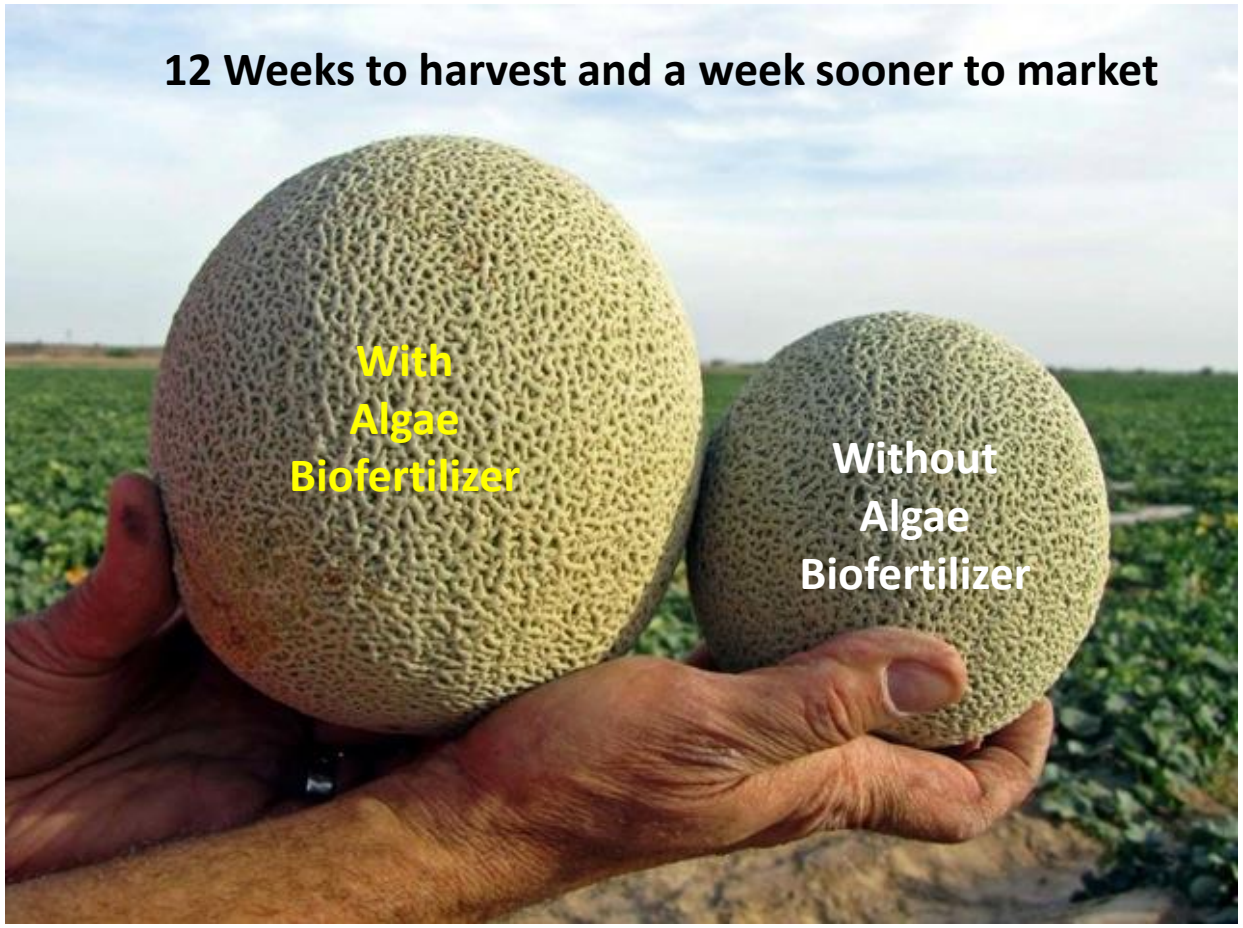
- Algae fertilizer yields 28% more plant weight over chemical fertilizer
- Algae raises vitamin C by 20%
- 13% greater plant available N in soil
- 70% greater total organic carbon in soil

TerraSync BioFertilizer - Organic Rice Production in China

- Local strain of blue-green algae
- Increased Yields of 15+% Per Acre
- High Quality Organic Rice for Premium Market
- Now Evaluating Single vs Multiple TerraSync Applications for Long Term Benefits
- Reduced CO2 emissions from conventional N fertilizer production and reduced NO3 emission from field

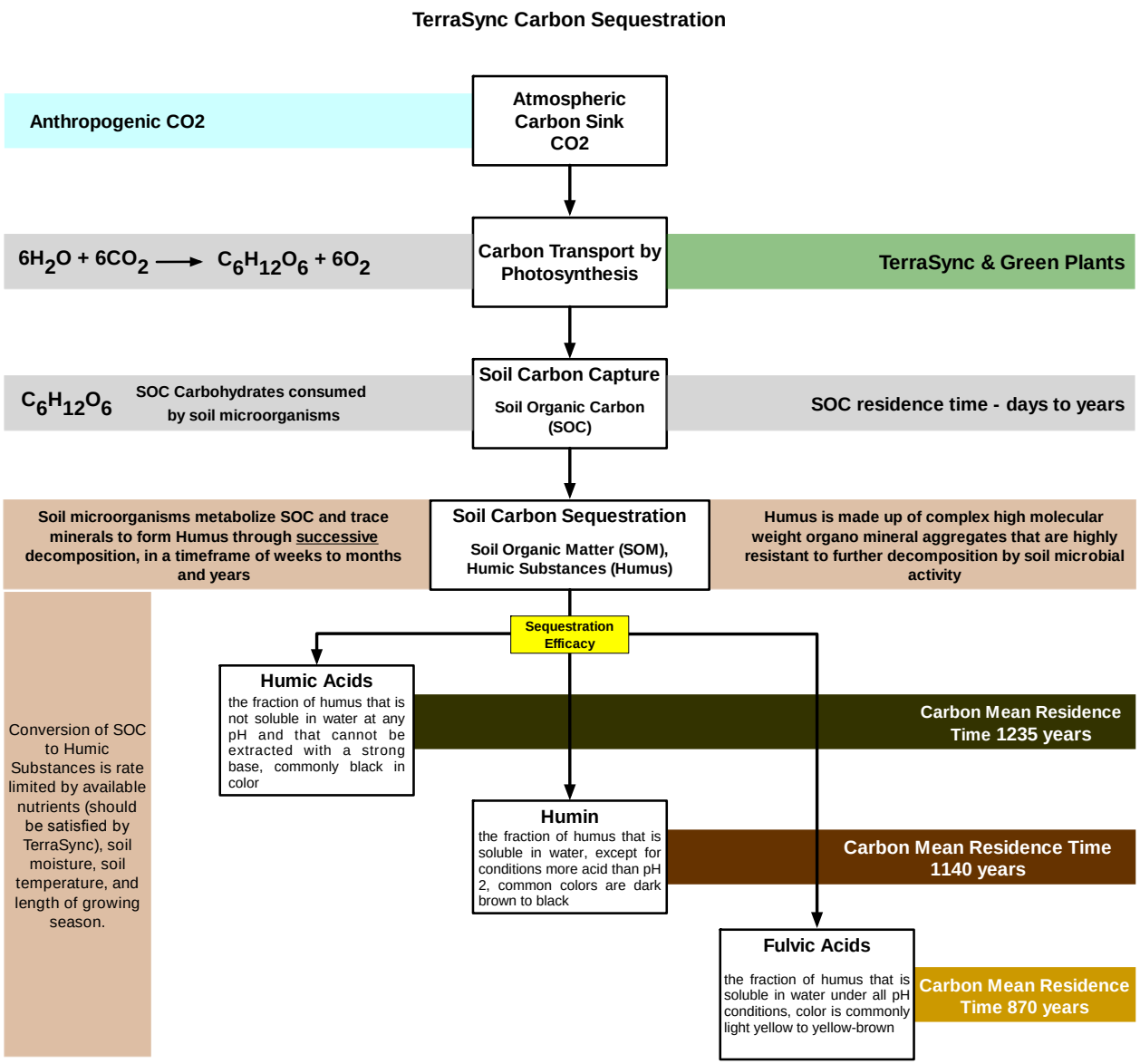
200 Acre Algae Biofertilizer Demonstration – Arizona Farm

- Algae applied to previously abandoned farm land
- Algae distributed through drip irrigation system



Yosemite Melons	
Germination	2X
Early Growth	2.5X
Plant Size & Density	3X
Early Melon Maturity	2X
Mature Melon Size	1.4X
Mature Melon Weight	1.5X
Taste (blind panel test)	14:1

TerraSync™ Carbon Farming – Terrestrial Sequestration



Anthropogenic CO_2 Captured to Grow TerraSync

↓

Atmospheric CO_2 Captured in use of TerraSync as Biofertilizer

↓

Live TerraSync Bioertilizer Secretes Carbon into Soil Increasing Net Soil Organic Carbon (SOC)

↓

~ 50% of SOC converts to Soil Organic Matter (SOM) that is Sequestered on average 1080 years

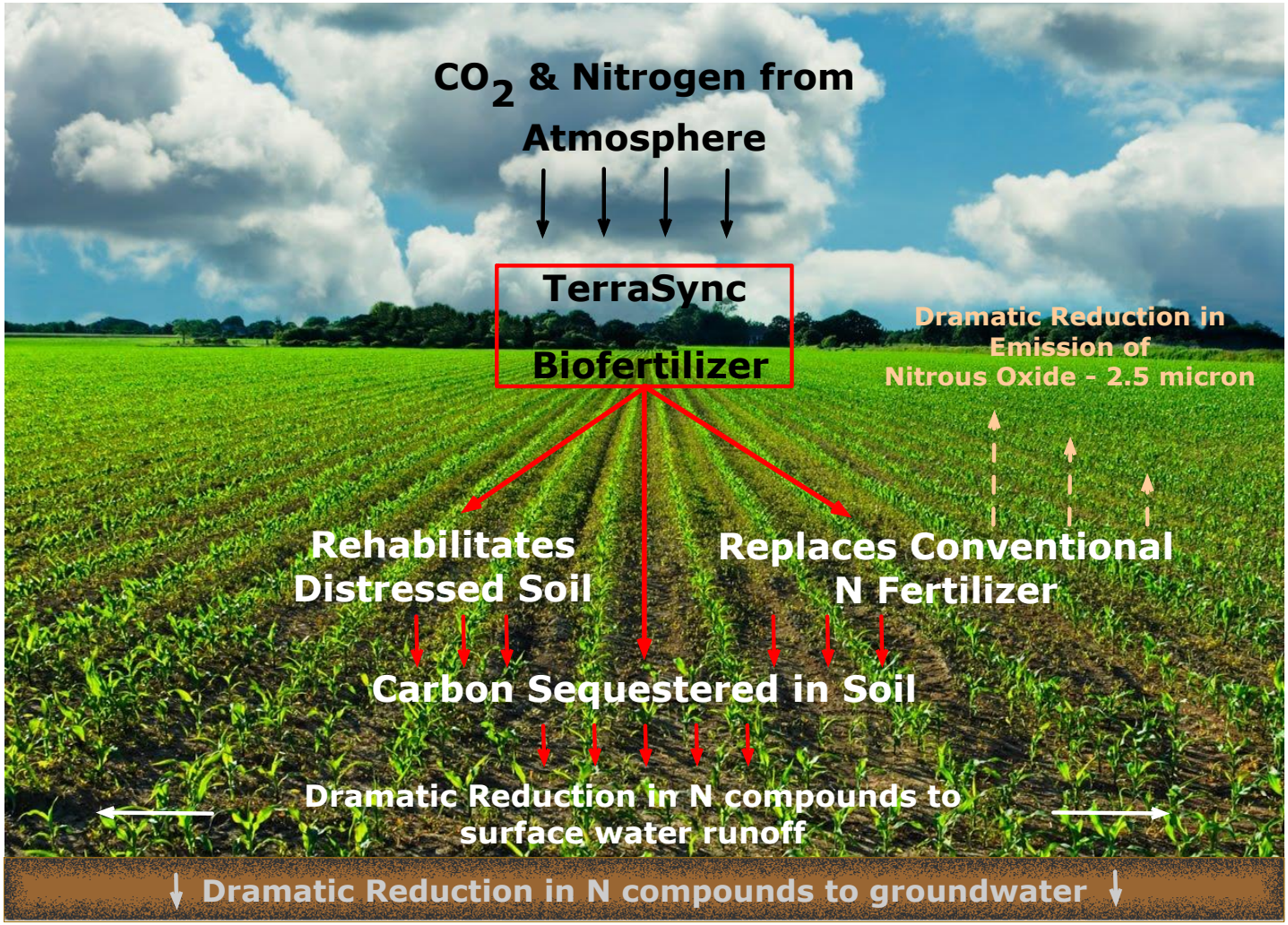
TerraSync™ Accelerates Nature - Wide Range Of Benefits Including Beneficial Use of CO_2 and GHG Mitigation

Addition Of Carbon To The Soil Improves:

- Crop yield and quality
- Water retention
- Soil permeability
- Nutrient controlled release capability

Can Replace Nitrogen Fertilizers Dramatic Reduction Of:

- NO_X P2.5 Off Gassing
- Nitrogen Compounds in Run Off
- Nitrogen Compounds in Ground Water



Monetizing CO_2 with TerraSync BioFertilizer - KEY POINTS

- CO_2 Emissions can be used to grow algae
- Algae Biofertilizer can be used to grow crops
- Algae Biofertilizer can replace conventional nitrogen fertilizer
- Each ton of CO_2 used to grow algae biofertilizer off-sets 2 to 4 tons of $CO_{2\text{-}e}$ from the production of conventional nitrogen fertilizer
- Additional $CO_{2\text{-}e}$ off-set comes from substantially reduced nitrous oxide off gas from farming
- Live algae pump atmospheric carbon (simple sugars) into the soil
- Over time, on a net basis, 10 to 50 times the carbon emission consumed to initially grow the algae is stored in the soil long term
- On many areas of the planet agricultural and other soils have been severely depleted of carbon – a large carbon sink is available
- <u>CO_2 emissions can be utilized today to make money</u>