THE NEXT GREEN REVOLUTION WILL BE BASED ON AGROECOLOGY

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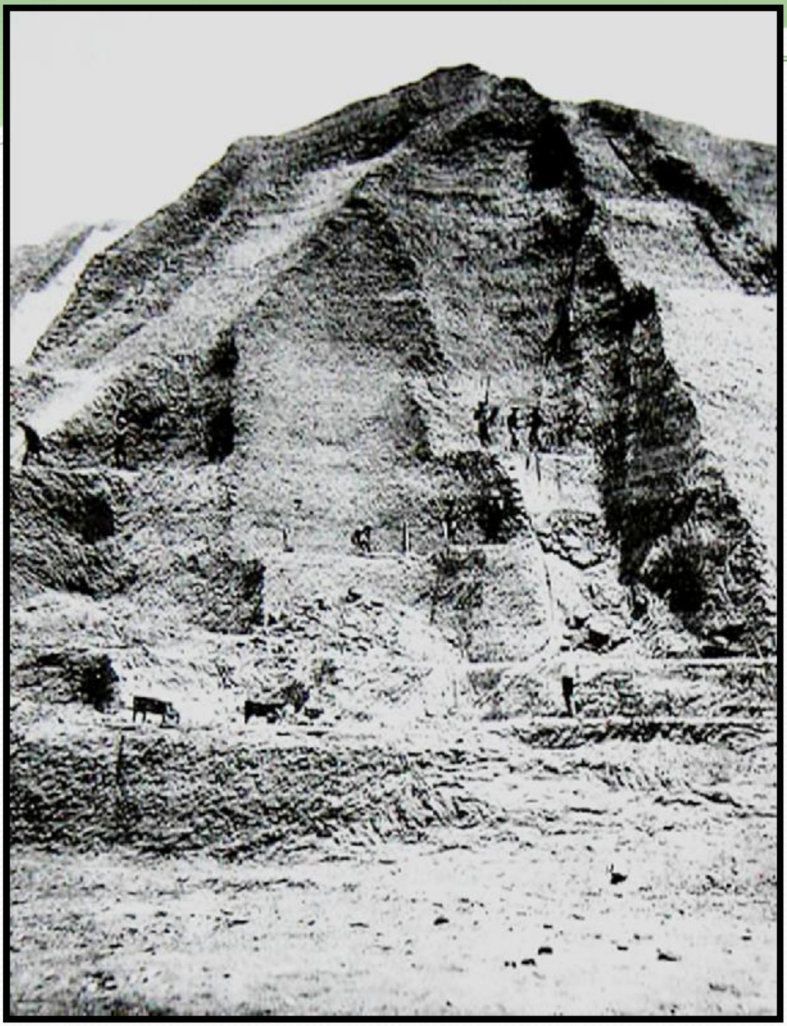
A&L is integrated throughout the agriculture industry from the farm gate to the dinner plate

We provide our customers with interpretation of the analytical information

Key Areas Of Service

- Soil, Water and Plant Analysis
- Fertilizer Analysis
- Compost Analysis
- Feed Analysis
- Manure Analysis
- Greenhouse Analysis
- Pesticide Analysis/Good Laboratory Practices
- Nematode Analysis
- Precision Technology/Aerial monitoring via drones coming
- Geo Processing Centre and Data Management
- Microbiology/Pest Diagnostics
- PCR (Polymerase Chain Reaction)/Microbial Identification
- Environmental Analysis/ Research on Agroecology

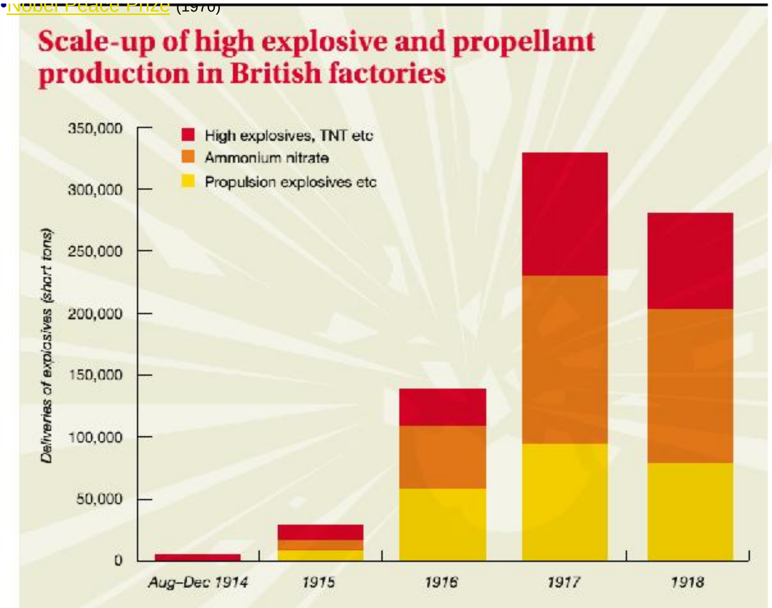


Mining guano in the Chincha Islands off the central coast of Peru. 1860.

The First Green Revolution

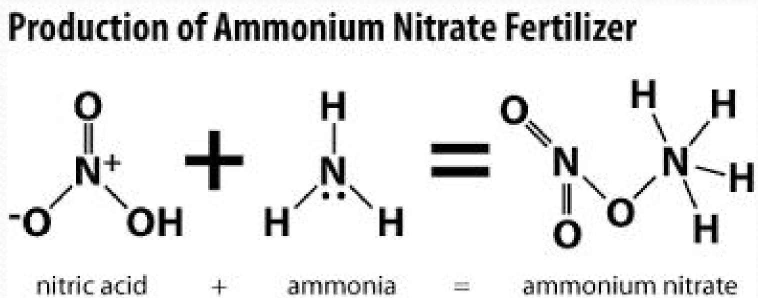
- **Millions of fish eating birds + dry conditions off the islands of Peru provided ideal guano fertilizer**
- **Between 1840 - 1880, the Peruvians excavated over 20 million tons of guano for export = $2 billion in profits.**
- **By 1910 the reserves had become depleted and harvest became regulated**

• Nobel Peace Prize (1970)

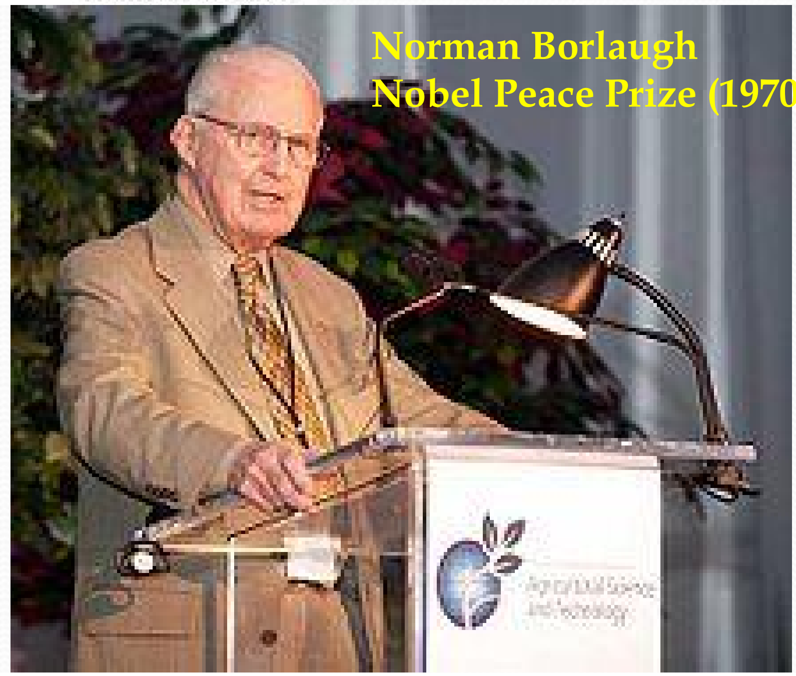


The Second Green Revolution

Greatly based on the Haber–Bosch nitrogen patents



Negro farmer hauling bags of dry fertilizer onto his truck, San Augustine, Texas, 1939. FSA.



We have destroyed a third of Earth's farmland in 40 years

- Soil is being destroyed 100 X faster than it can form
- to avert disaster, farmers must adopt sustainable agricultural practices based on ecological principles.

http://news.sciencemag.org/sifter
USDA NRCS SOUTH DAKOTA/FLICKR (CC BY-SA 2.0)

HOME SEARCH

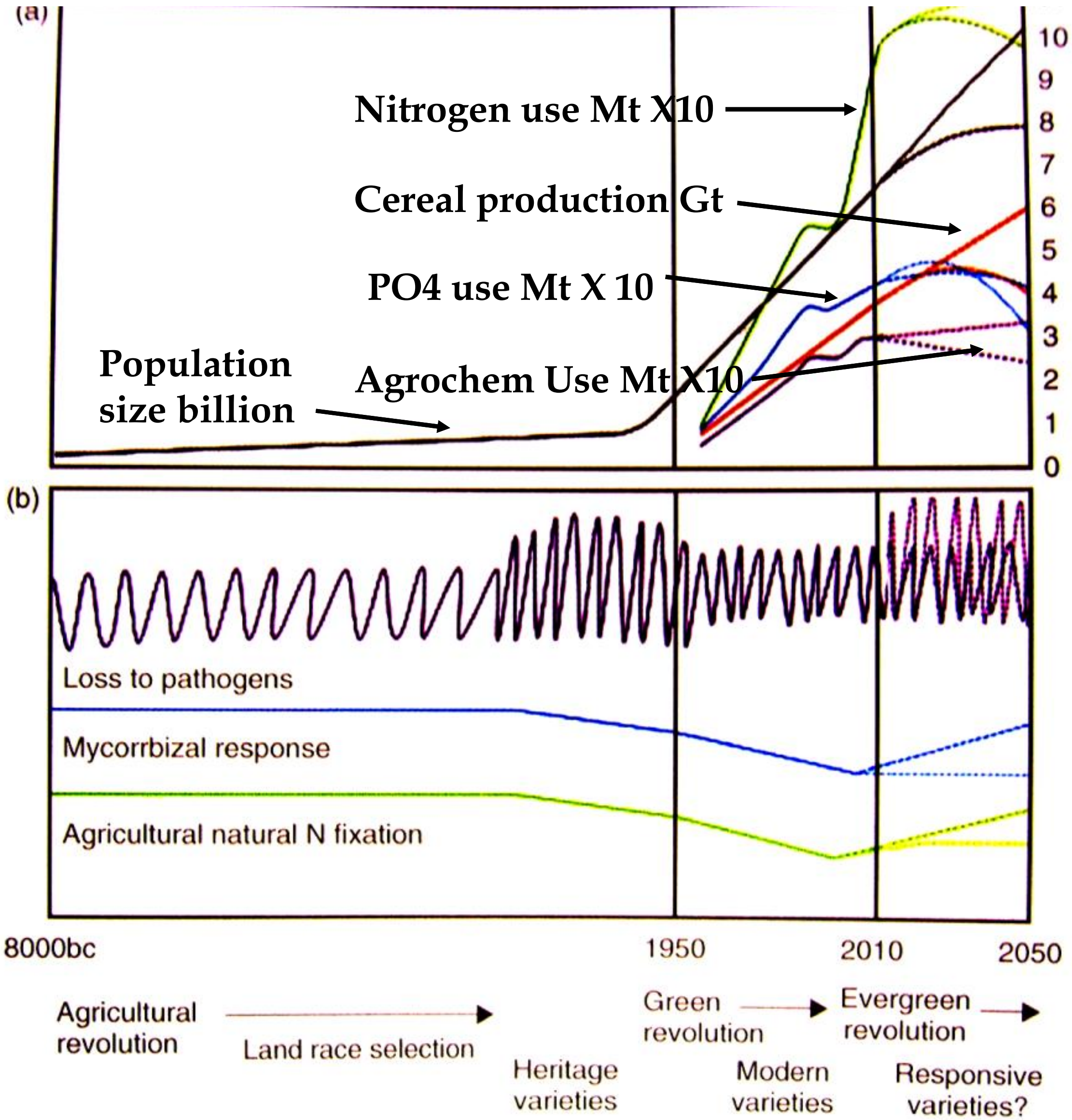
The New York Times

The Opinion Pages | OP-ED CONTRIBUTORS

We Need a New Green Revolution

By PHILLIP A. SHARP and ALAN LESHNER JAN. 4, 2016

JANUARY 4, 2016



THE EVERGREEN REVOLUTION

A.E. Bennett et al. 2013
Molecular Microbial Ecology of the Rhizosphere

Agriculture based on ecology

Ecological agriculture

Practices that require greater reliance on natural soil processes, native microorganisms, and the interactions between plants, animals, and humans.

In order to **increase** plant productivity we aim to:

- improve root structure and health
- improve soil structure
- improve beneficial soil microbiology
- utilize plant-microbial associations

All aspects lower cost of production and reduce the environmental footprint of agriculture

All plants and animals (humans) are super organisms composed of many microorganisms

- 2 kg of our weight is bacteria
- Our DNA codes for about 25,000 proteins - bacteria code for >8 million
- They help digest our food, synthesize vitamins, metabolize drugs, detoxify carcinogens, stimulate cell renewal, activate and support our immune system, etc.
- The bacteria we carry now differs from those of our grandparents – antibiotics, water, etc.

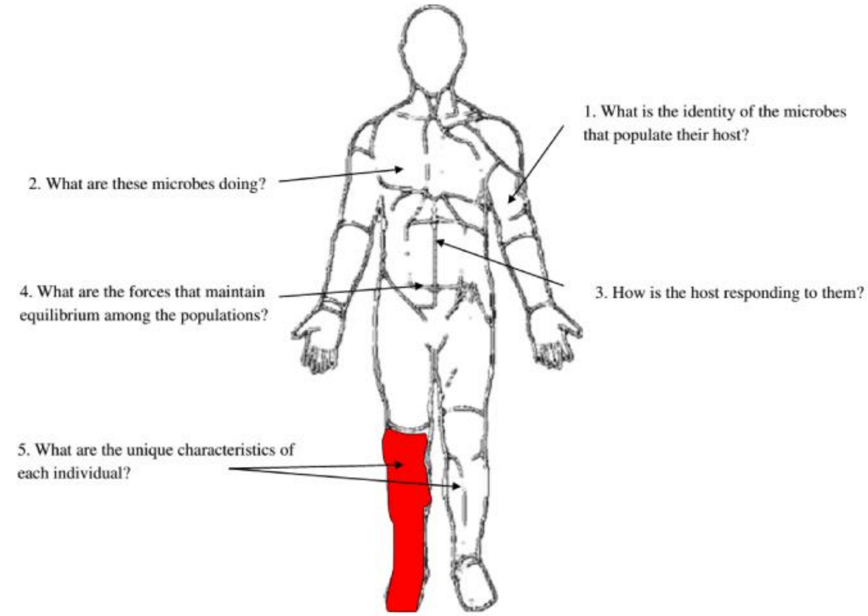
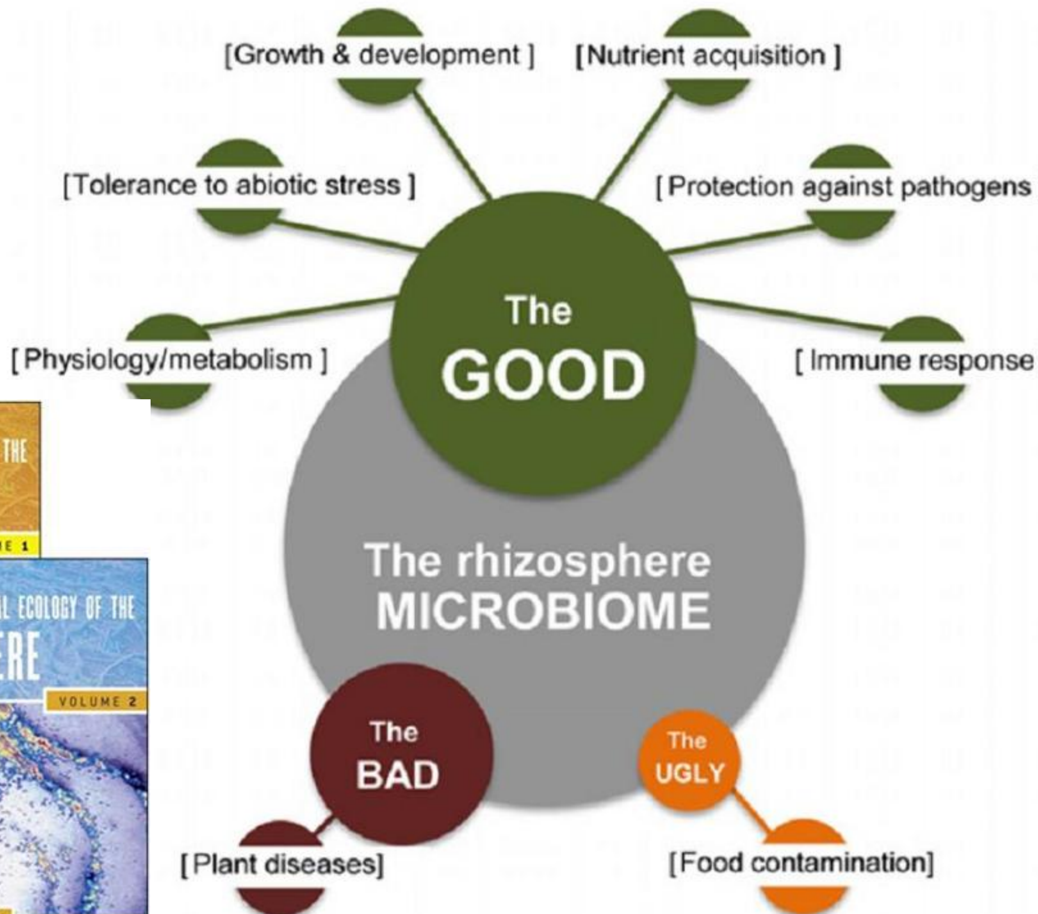
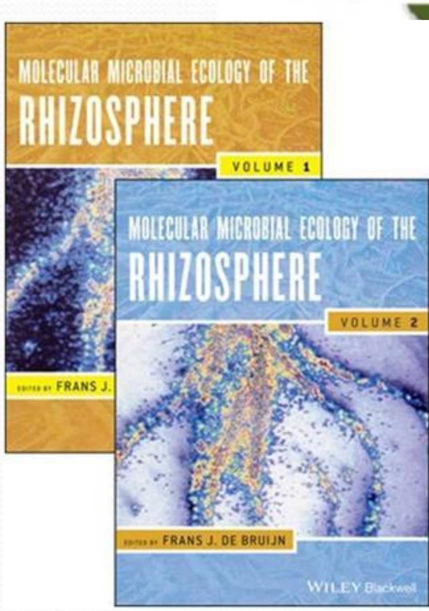


Fig. 1. Five fundamental biological questions that underlie the Human Microbiome Project. Initially, answers are phenomenologic but ultimately must be understood in the context of evolutionary processes. Along the way, myriad applications will be discovered. The red leg represents about 1/10 of the human body, symbolizing 10^{13} human cells in a host with 10^{14} microbial cells (10).

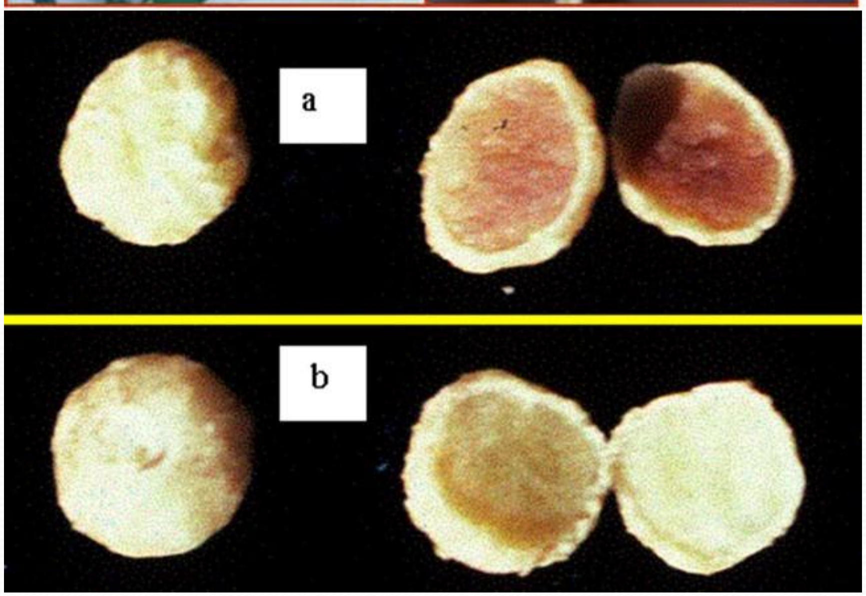
MJ Blaser PNAS | April 6, 2010 | vol. 107 | no. 14 | 6125–6126

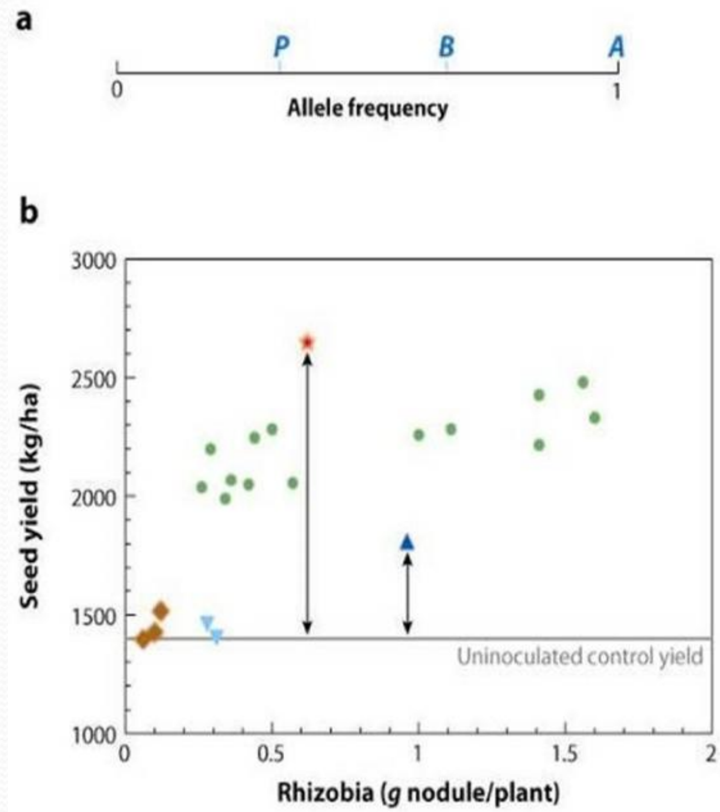




FEMS Microbiol Rev37(2013) 634–663

ARE ALL RHIZOBIUM INTERACTIONS BENEFICIAL?





Kiers ET, Denison RF. 2008.
Annu. Rev. Ecol. Evol. Syst. 39:215–36

Plant Soil (2010) 336:129–142
DOI 10.1007/s11104-010-0454-7

REGULAR ARTICLE

Enhancement of rice production using endophytic strains of *Rhizobium leguminosarum* bv. trifolii in extensive field inoculation trials within the Egypt Nile delta

Youssef G. Yanni · Frank B. Dazzo

Large-scale field experiments evaluated 5 varieties X 7 endophytic Rhizobia strains over 5 seasons, including **sites ranked as the world's highest in rice production**.

Inoculation increased yield in 19 of the 24 trials.

Increased yields were up to 47% in farmers' fields; average 19.5%.

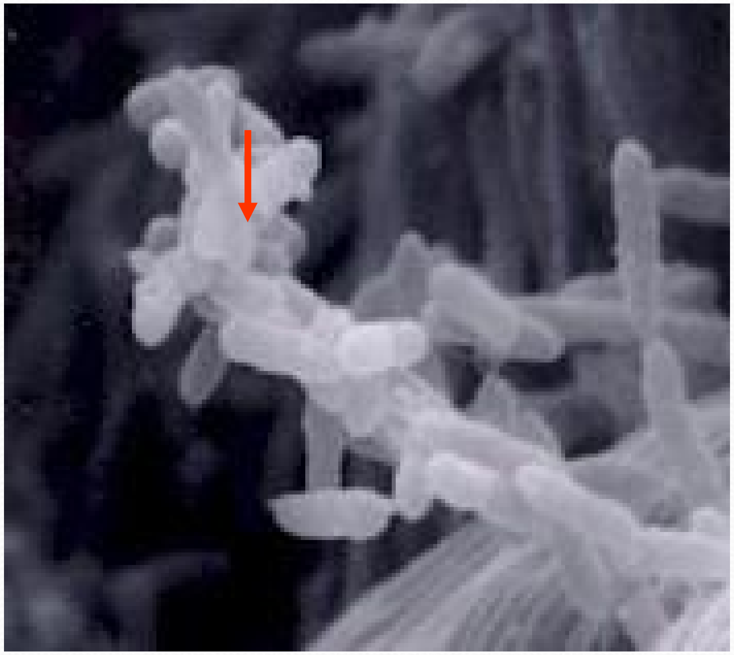
BUCKS = Potential is billions in increased rice yields at reduced cost

Sugar cane endophytes were shown to be an integral component of production

Table 3. Nitrogen fertilizer levels applied to sugarcane plants grown in different countries
Source: IFA (1999)

Country	Nitrogen fertilizer (kg ha^{-1})
Argentina	100
Australia	150–250
Brazil	50
India	100–300
Mexico	120–200
Philippines	120–200
South Africa	80–120
USA — Hawaii	300–400

Gluconacetobacter diazotrophicus, *Herbaspirillum spp.*, *Azospirillum* spp. and *Burkholderia* spp.



Disease Suppressive Soils: Pathogen is present but no disease occurs.

Eur J Plant Pathol
DOI 10.1007/s10658-007-9201-1

FULL RESEARCH PAPER

Management of resident plant growth-promoting rhizobacteria with the cropping system: a review of experience in the US Pacific Northwest

R. James Cook

Fig. 1 Views of the same area within a 1-ha experimental plot cropped to continuous monoculture wheat starting in 1967/68 crop year. *Left*, 1974, the 7th year of monoculture facing north, showing the response to chloropicrin fumigation. *Right*, 1982, the 15th year of monoculture wheat, facing south but otherwise the same area within the 1-ha plot, with the man standing on the border separating a subplot fumigated from an adjacent subplot not fumigated. Yield of wheat in the non-fumigated plots was roughly 50% of the yield in fumigated plots in the 7th year of monoculture and 95% of the yield in fumigated plots in the 15th year of monoculture

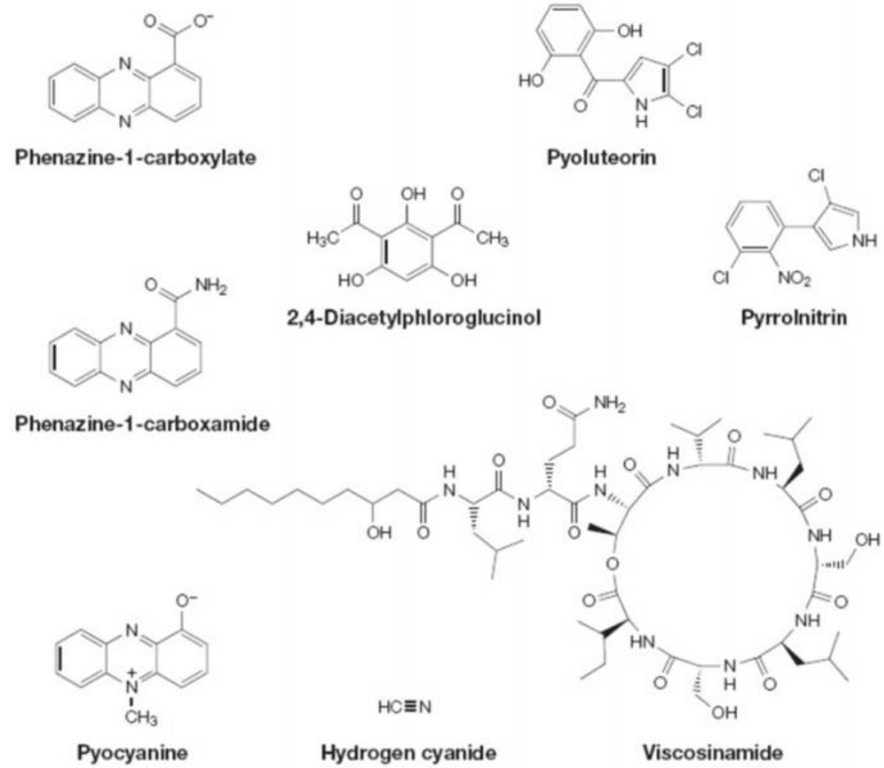
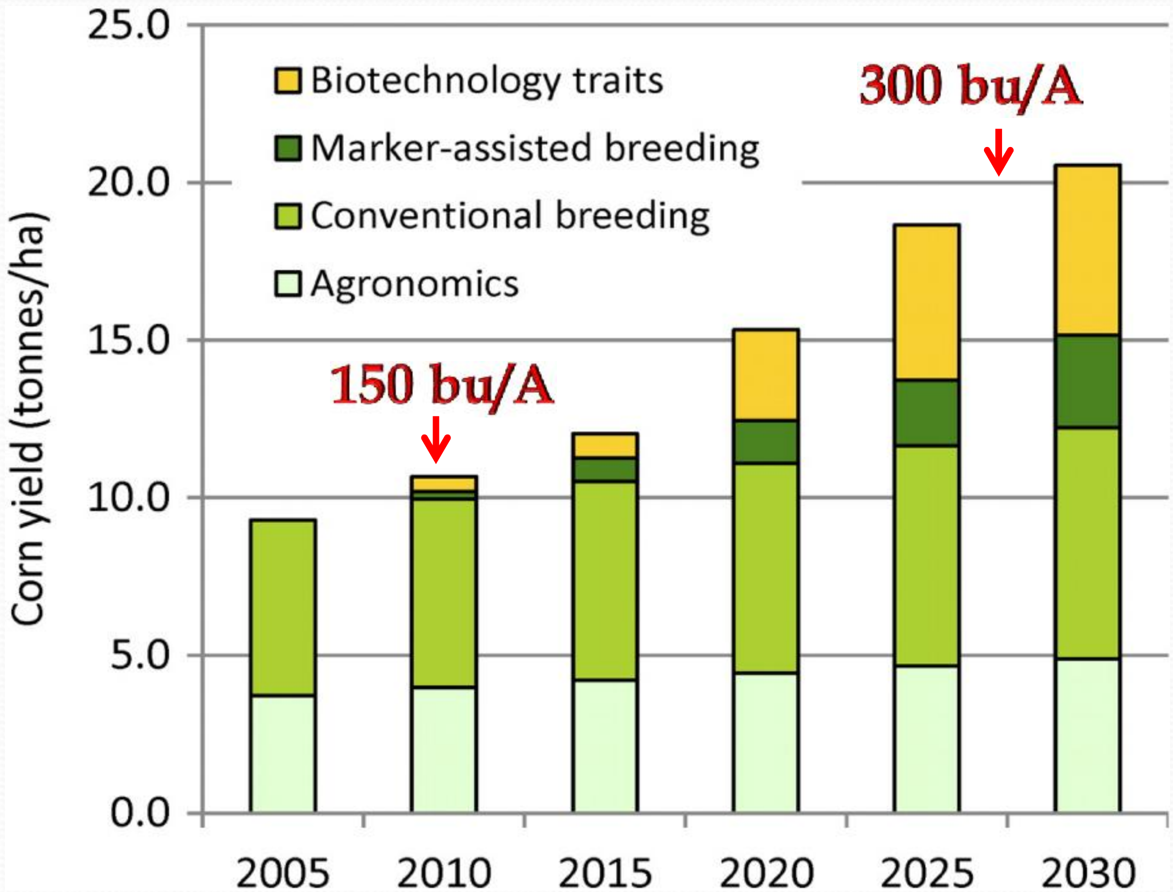


Figure 2 | **The antibiotic compounds produced by fluorescent pseudomonads that are relevant for biocontrol.** The phenazines, phloroglucinols, pyoluteorin, pyrrolnitrin and cyclic lipopeptides are all diffusible, whereas hydrogen cyanide is volatile.

Anticipated impact of improvements in agronomics, breeding, and biotechnology on average corn yields in the United States.



Edgerton M D Plant Physiol. 2009;149:7-13

Fence Row Farming – Improving Soil Processes

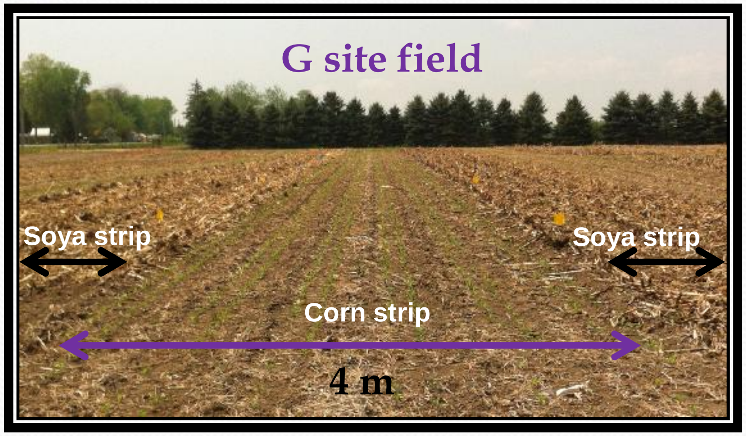
Mr. and Mrs. Dean Glenney, Dunnville, Ontario

Average Corn Yield at 301 bu/acre for corn and 62bu/acre soybeans; yields 2X times that of the county average

Identification of physical, chemical and biological factors involved in corn productivity

High yielding G site corn production field

No-till strip row farming practice

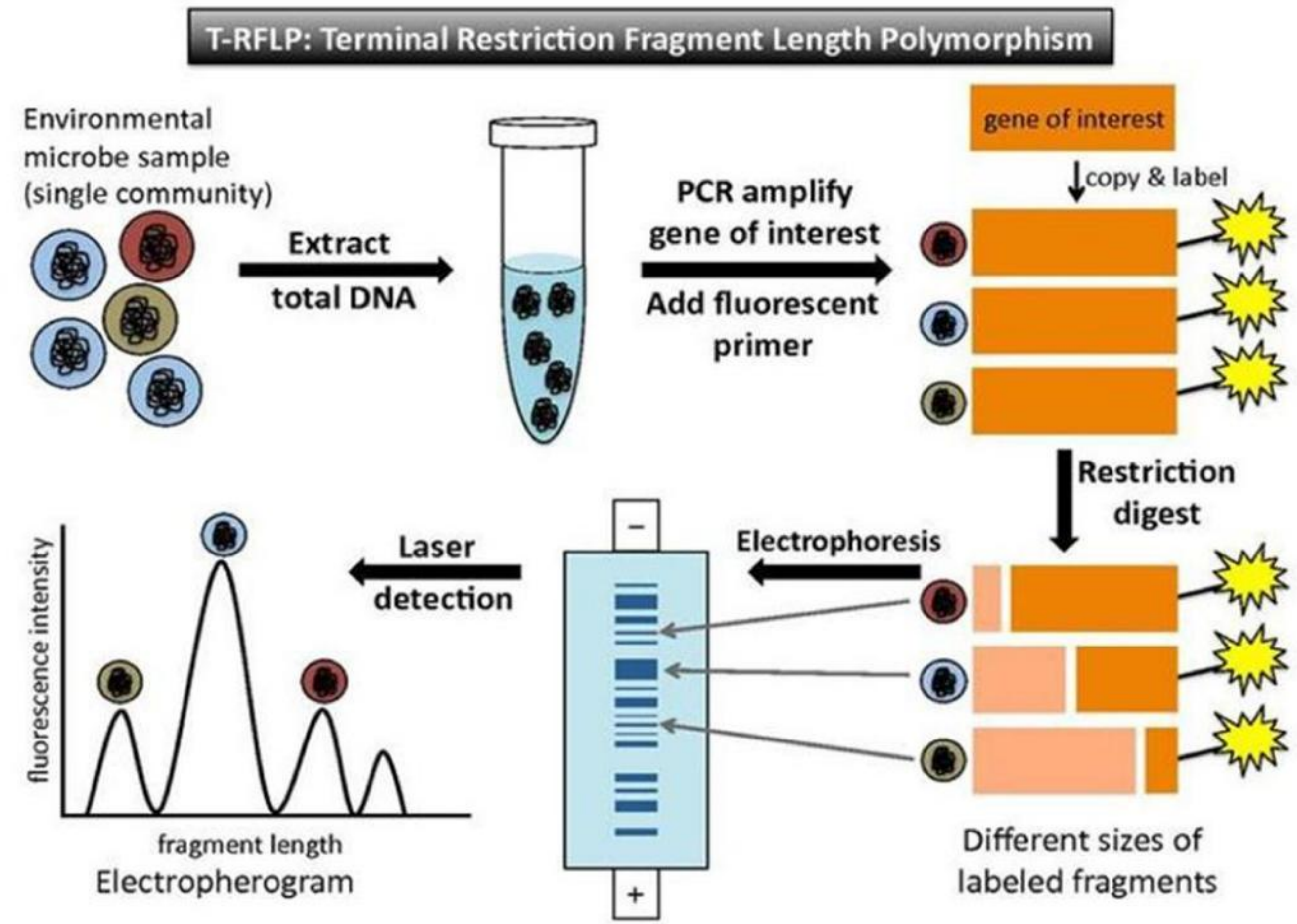


Conventional field (H site)

Harvested corn ears from G and H sites

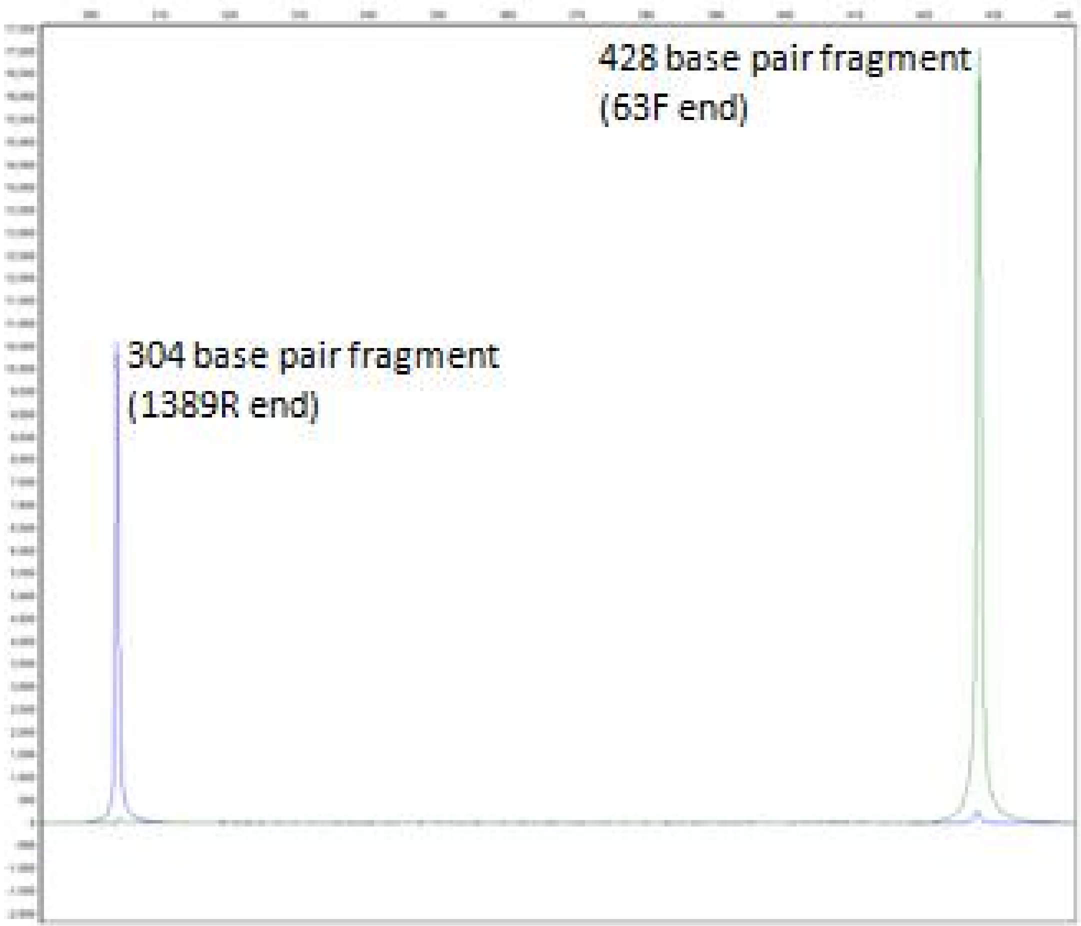
G site ear

H site ear

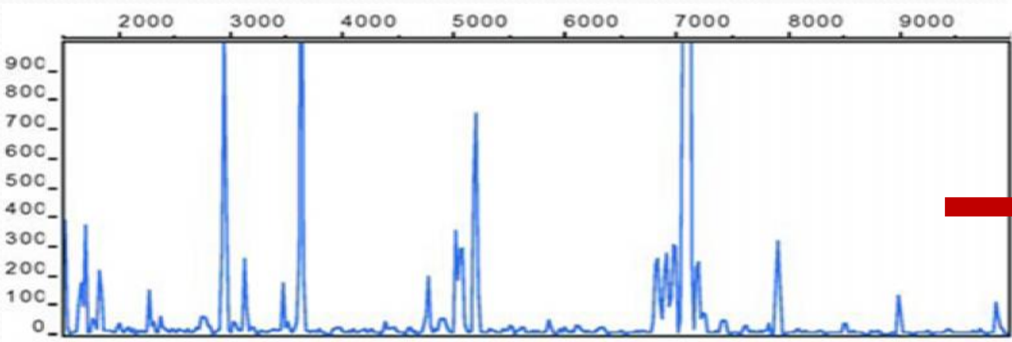

T-RFLP: Terminal Restriction Fragment Length Polymorphism
Environmental microbe sample (single community)
Extract
total DNA
PCR amplify gene of interest
Add fluorescent primer
gene of interest
copy & label
Restriction digest
Electrophoresis
Laser detection
fluorescence intensity
fragment length
Electropherogram
Different sizes of labeled fragments

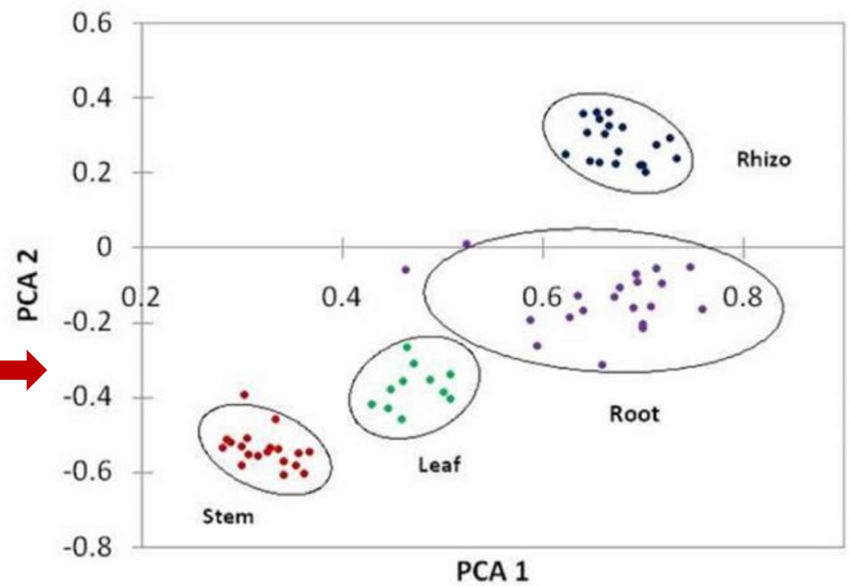
BAR CODE

TRFLP Chromatogram of *Streptomyces scabies* amplified with 63F and 1389R then cut with HhaI



Bacterial diversity analysis using TRFLP technique

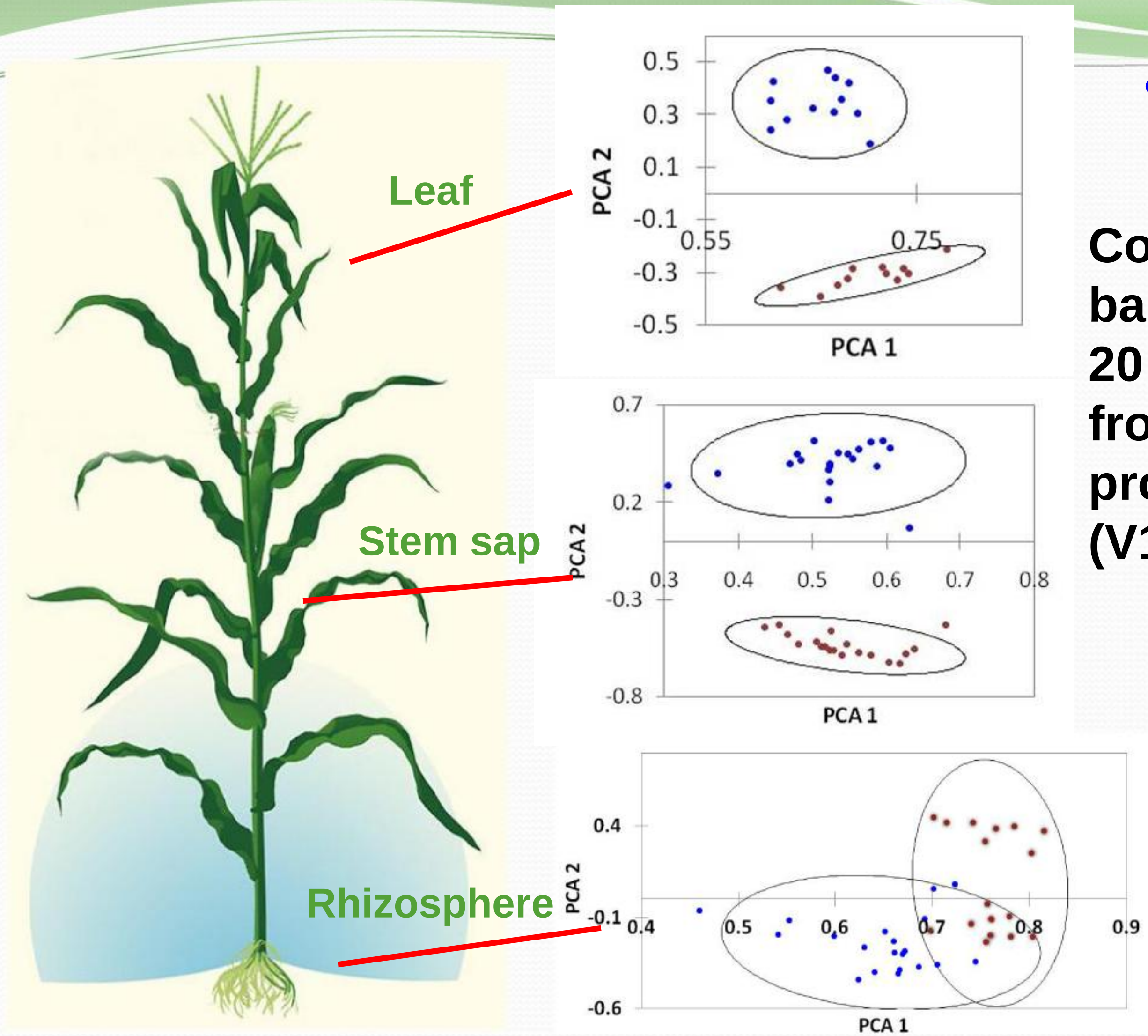




Chromatogram of TRFLP data

Principal component analysis (PCI)

TRFLP of bacteria populations in various corn tissues of 20 plants sampled from a high yielding soil at 60 days (V10) after planting.

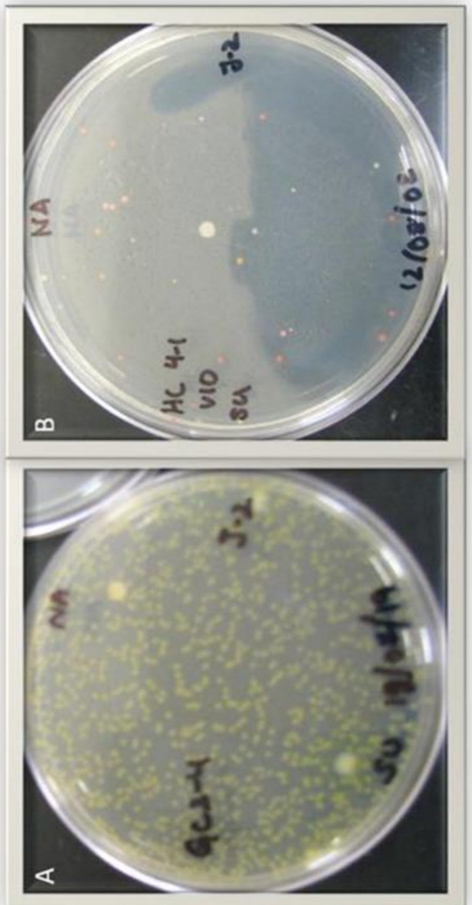


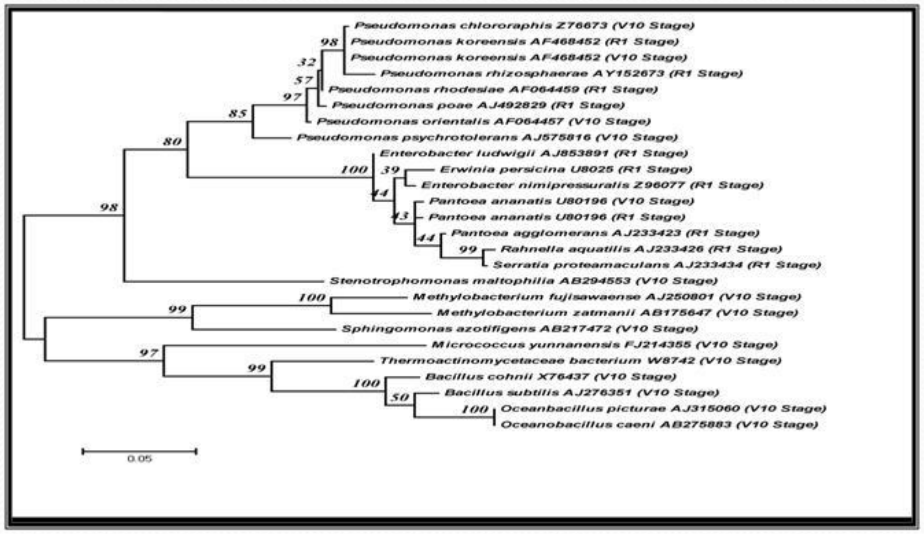
● = 150 Bu/A

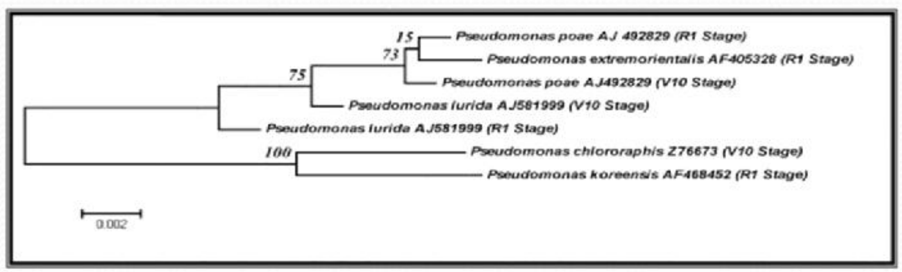
● = 300 Bu/A

Comparison of bacterial TRFLP profiles of 20 corn plants harvested from a high and average production site at 60 days (V10) after planting

Bacteria isolated from stem sap of corn plants from G and H sites at V10 growth stage.

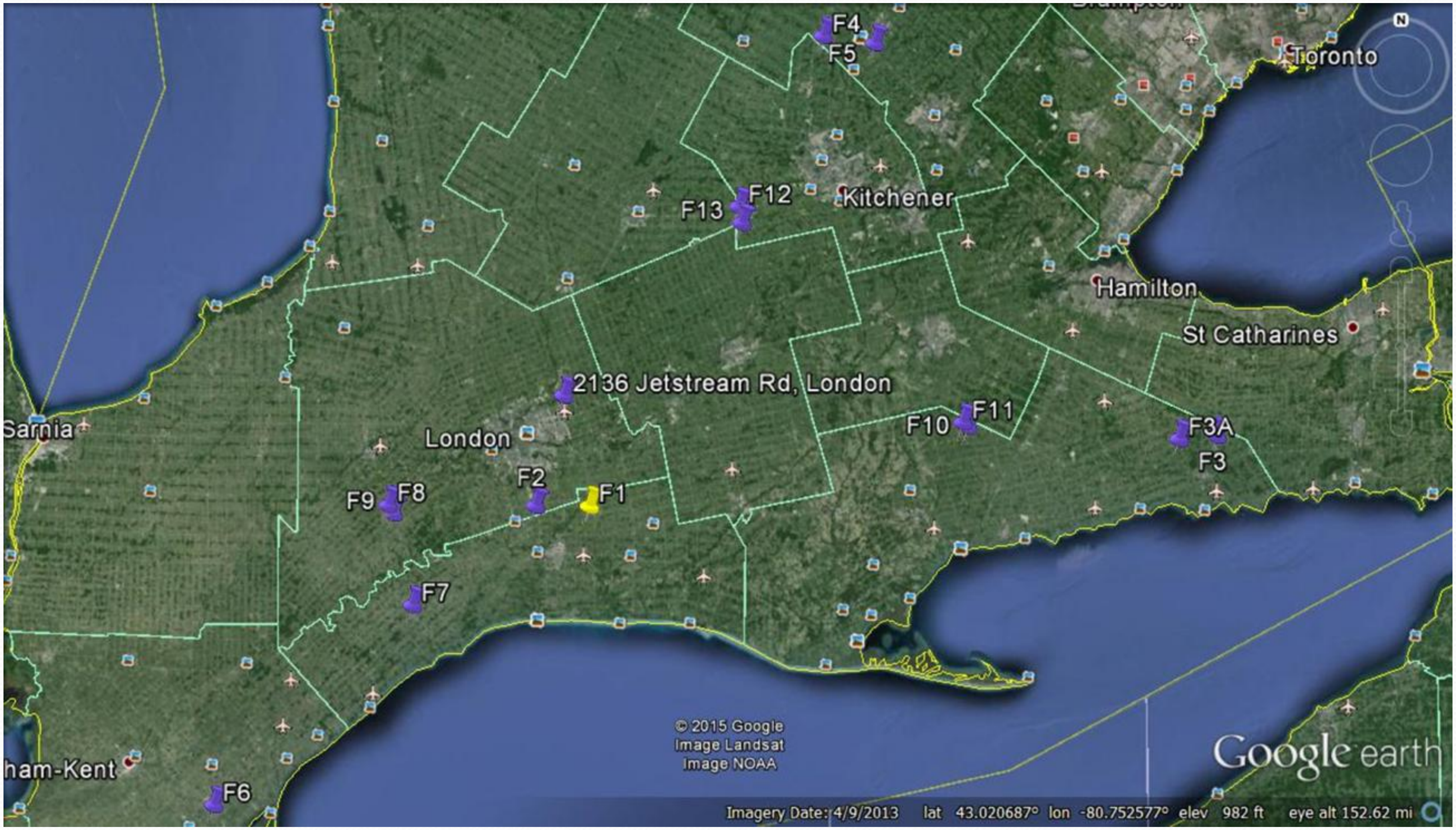







A+L
Biologicals

SAMPLING LOCATIONS IN ONTARIO



FIELD SAMPLING



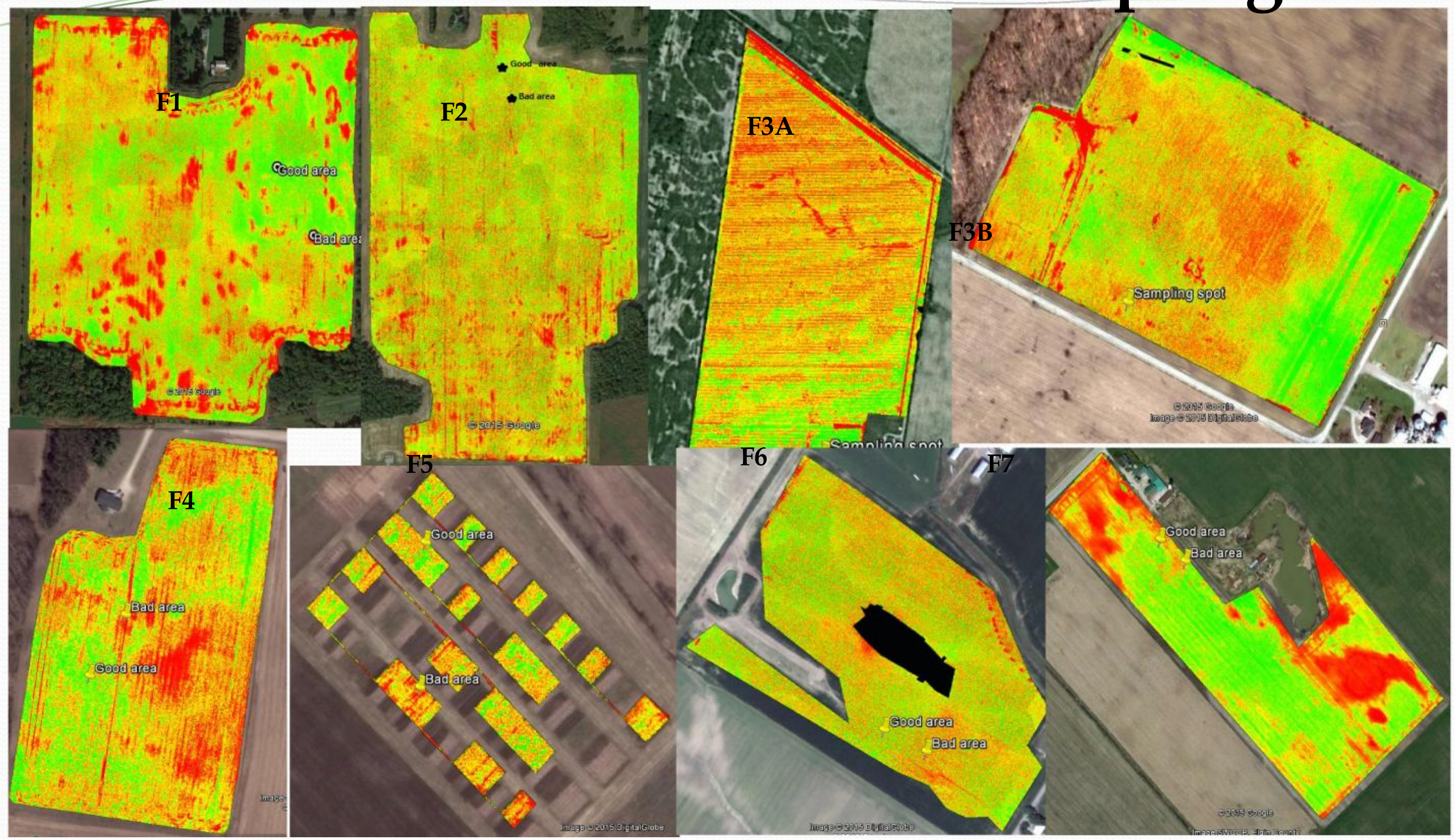




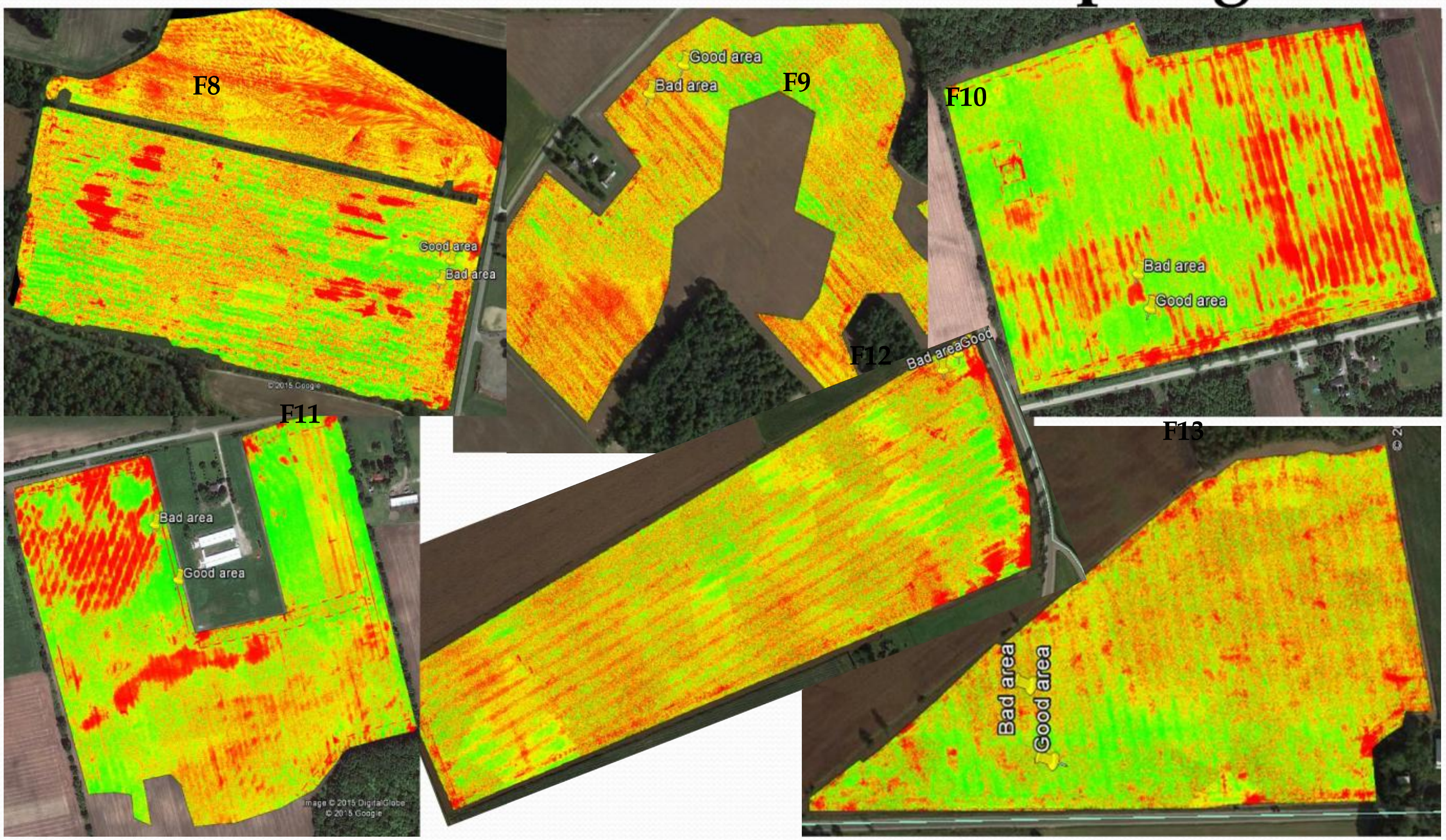


© 2015 Google
Image © 2015 DigitalGlobe
NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI)
Google earth
2003
Imagery Date: 5/31/2010 42°57'56.02" N 80°11'42.36" W elev 748 ft eye alt 2207 ft

NDVI's of farms with marked sampling sites



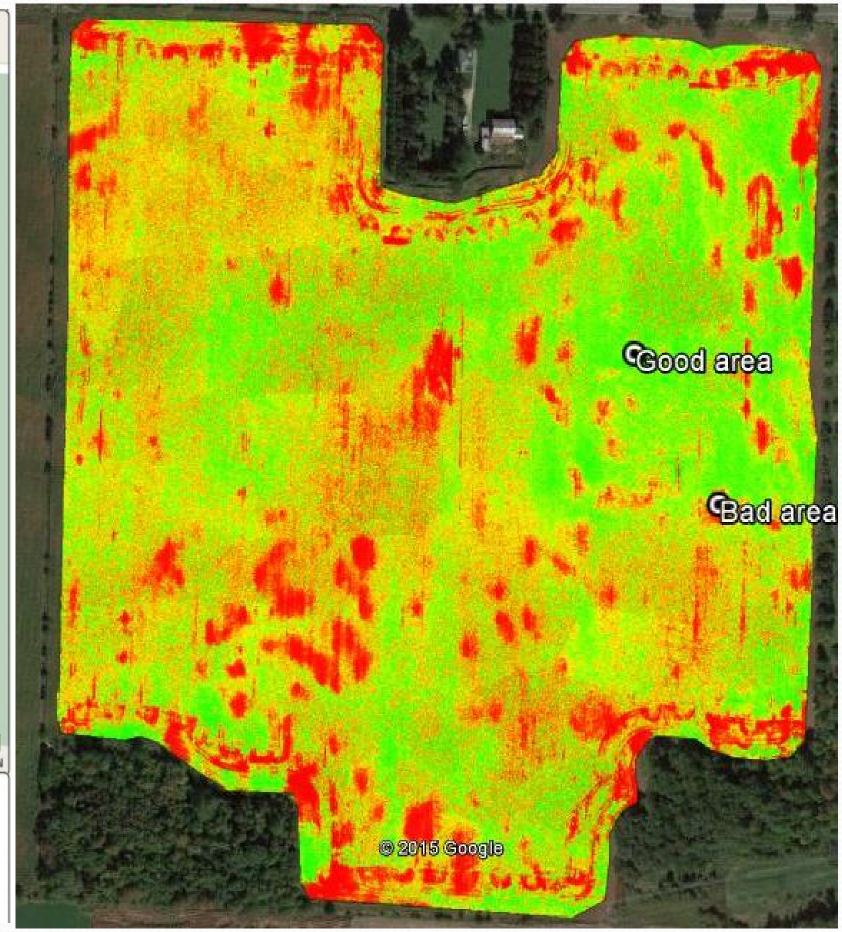
NDVI's of farms with marked sampling sites



EVEN SMALL PLOTS HAVE ENORMOUS VARIABILITY AMONG THE PLANTS (UofG long term rotations)

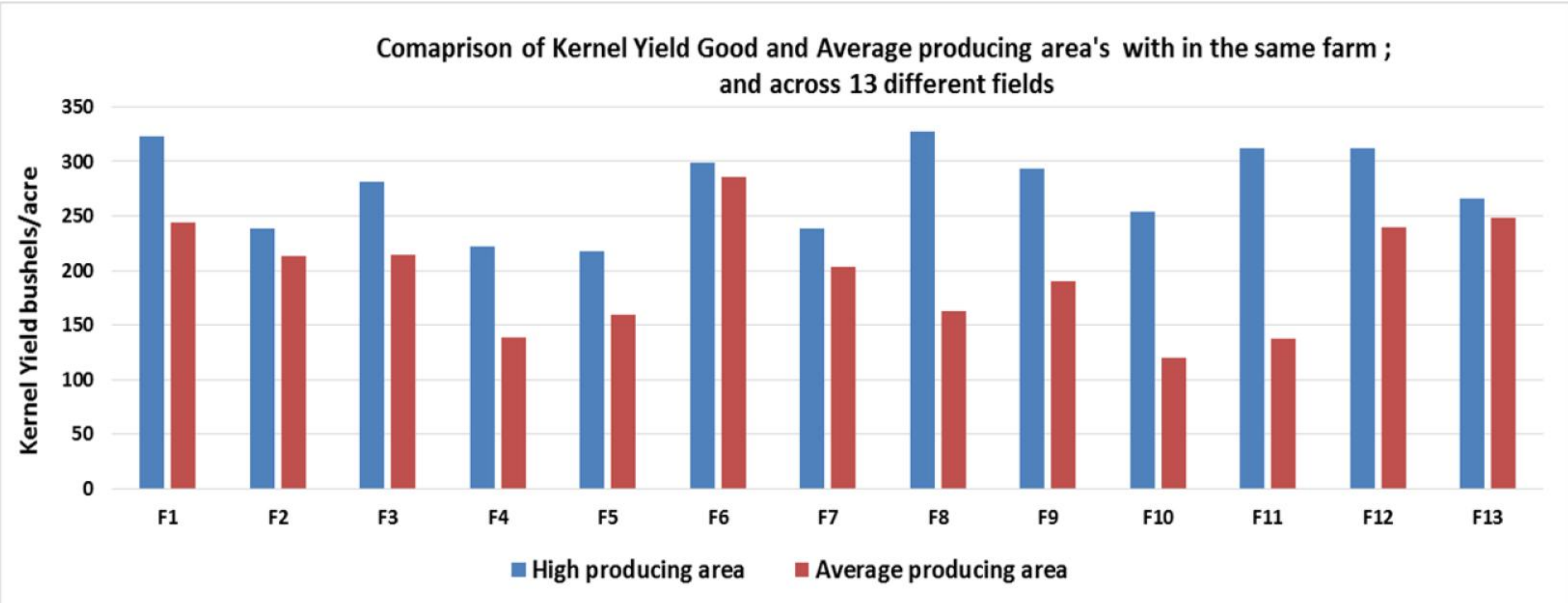
Normalized difference vegetation index map (NDVI) and the combine yield harvested across the field

Dataset	Area ac	Est. Volume (Dry) bu	Avg. Yield (Dry) bu/ac	Date Logged
L0:Ferguson Bros.-	0.00	0.00	184.15	1/18/2016

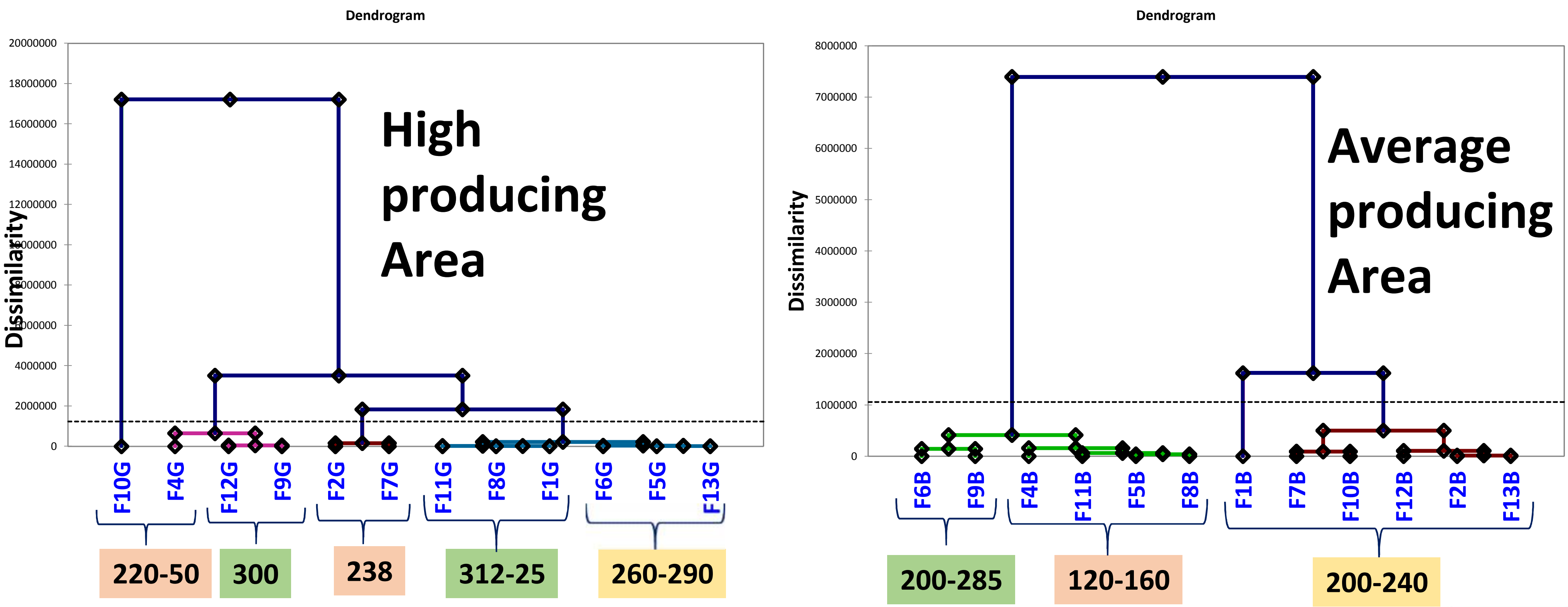


YIELDS BY LOCATION IN ONE PASS

CORN YIELDS FORM 13 FIELDS

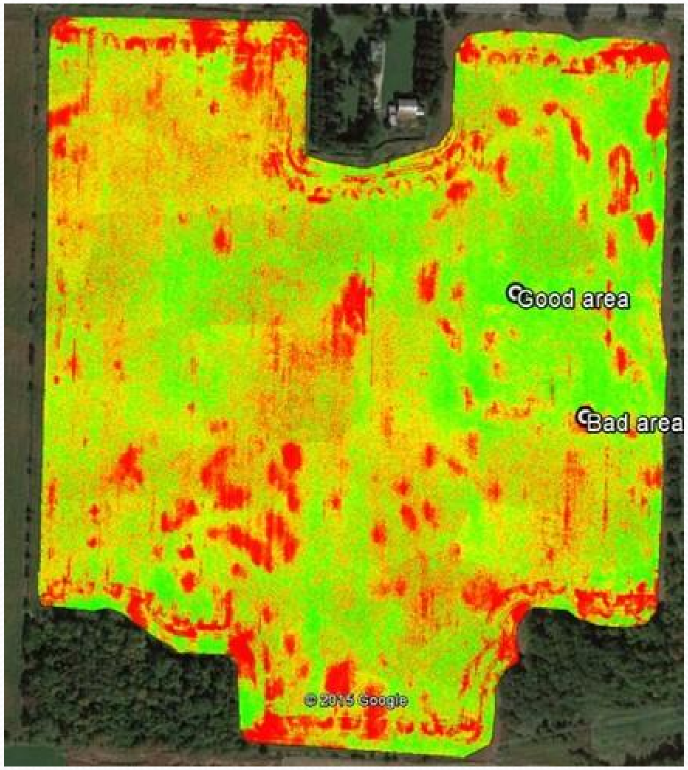


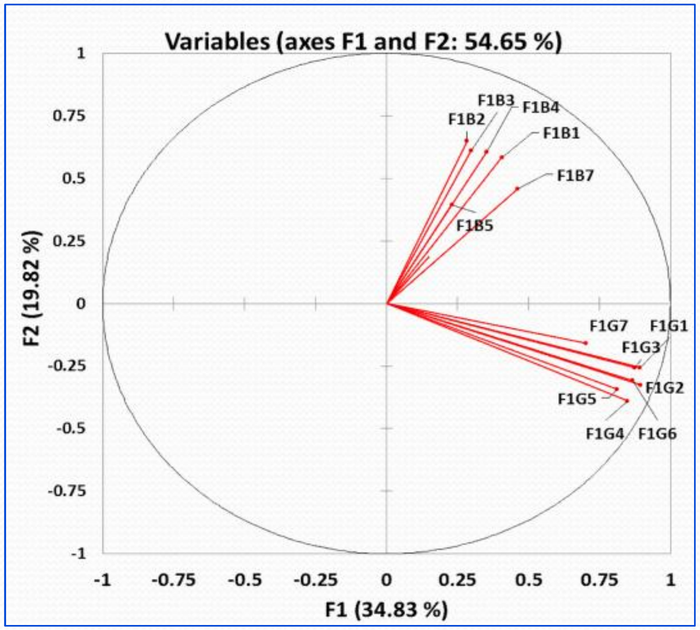
Hierarchical clustering generated based on soil analysis data for high and low sites and compared with the yield data

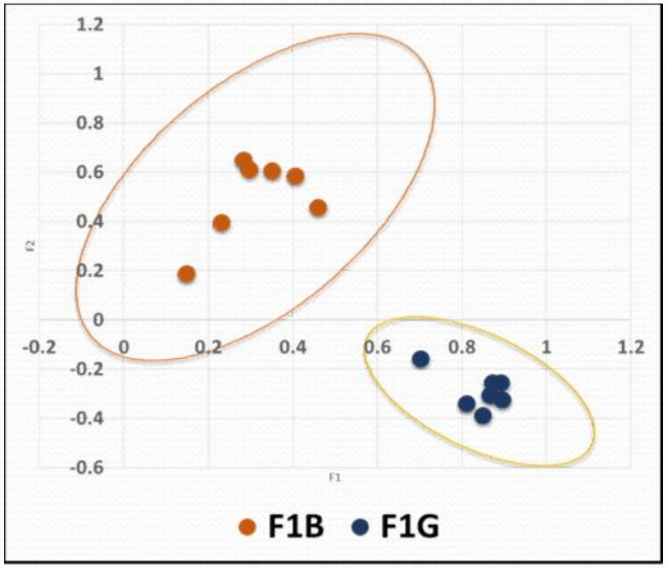


Yield Bu/ac

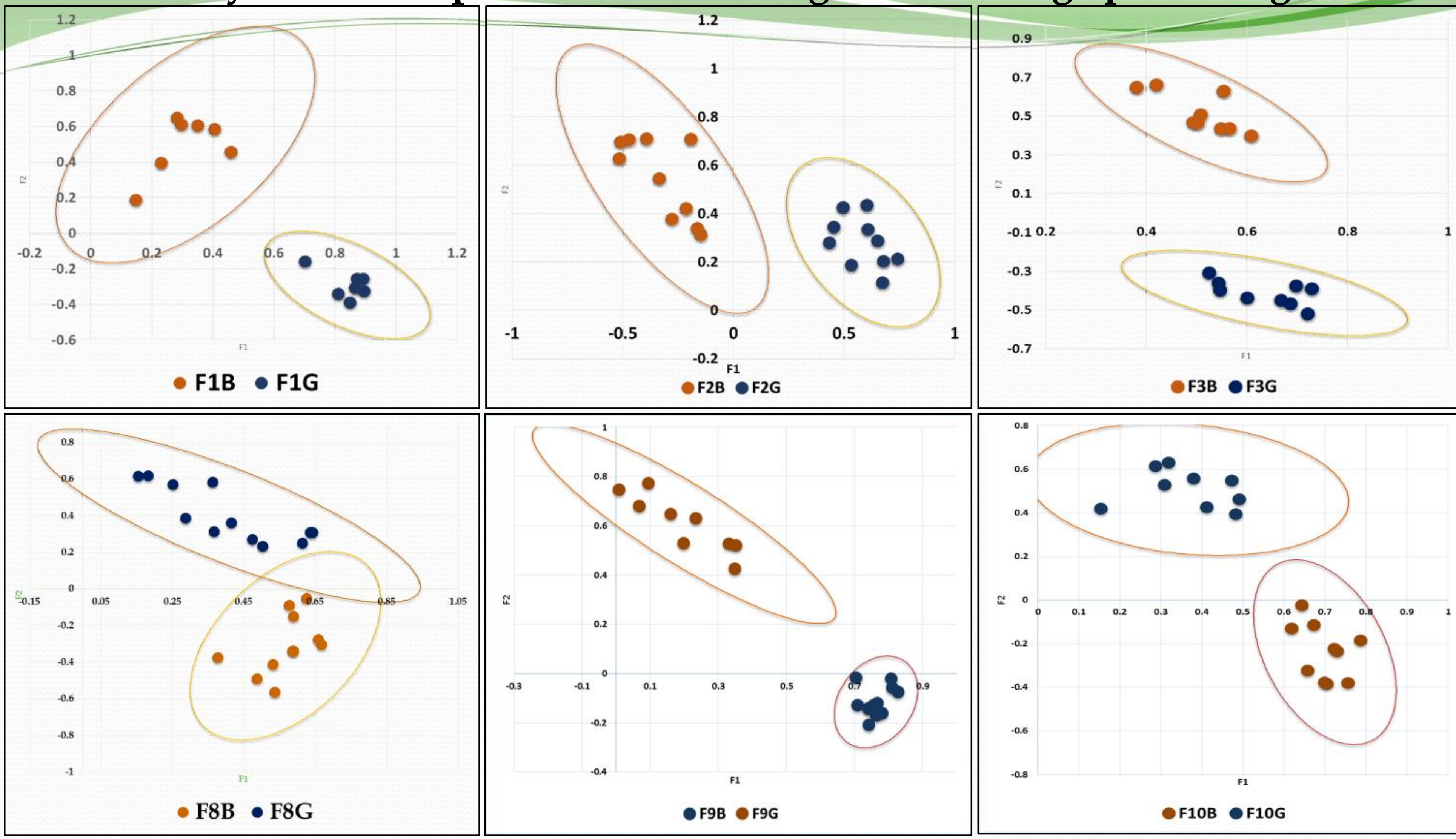
Diversity of Microbial community from the corn Sap collected from High and low producing Sites with in the same field-F1G and F1B



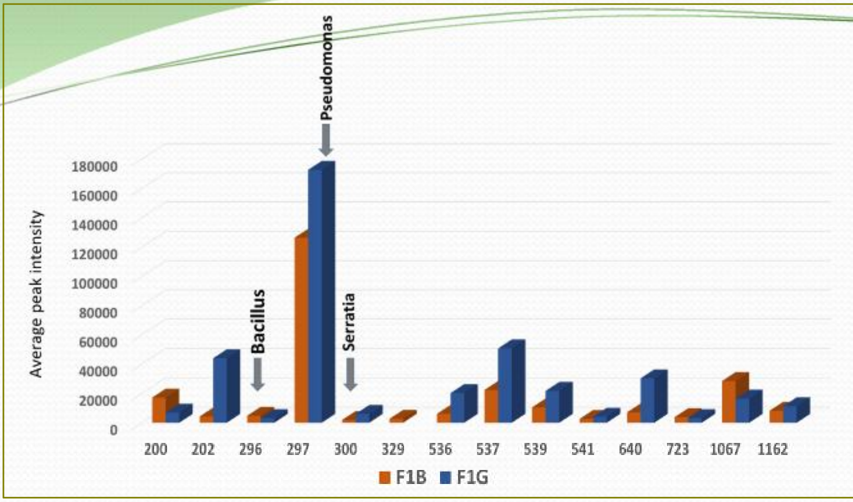


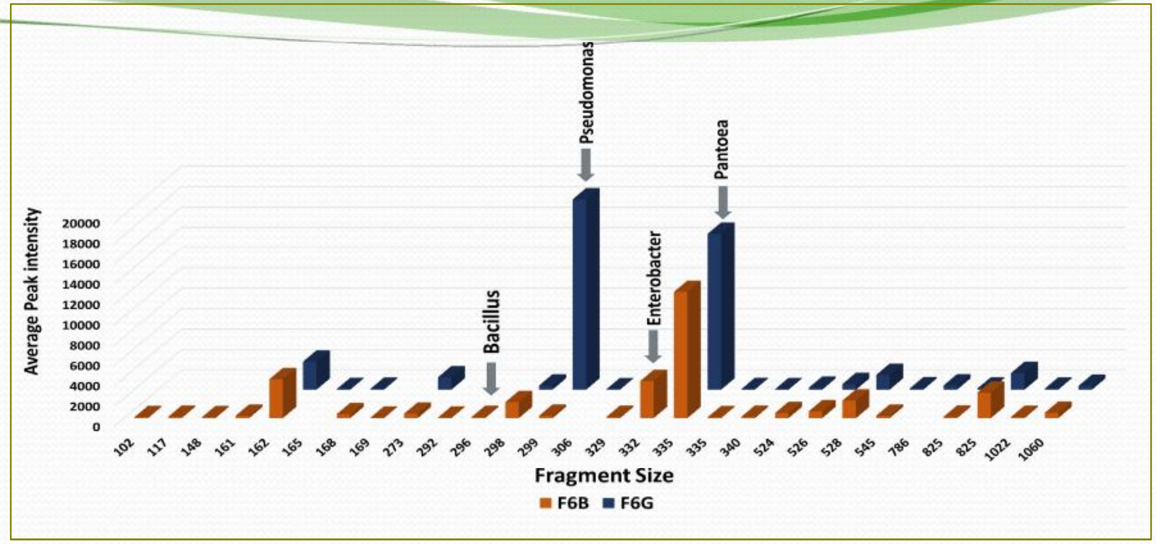


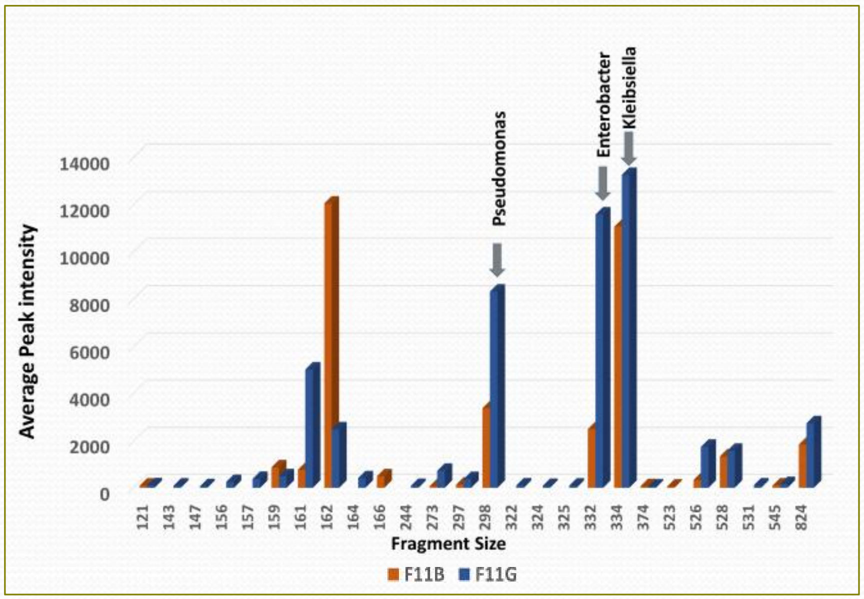
Diversity of Corn Sap microbiome in High and Average producing Sites

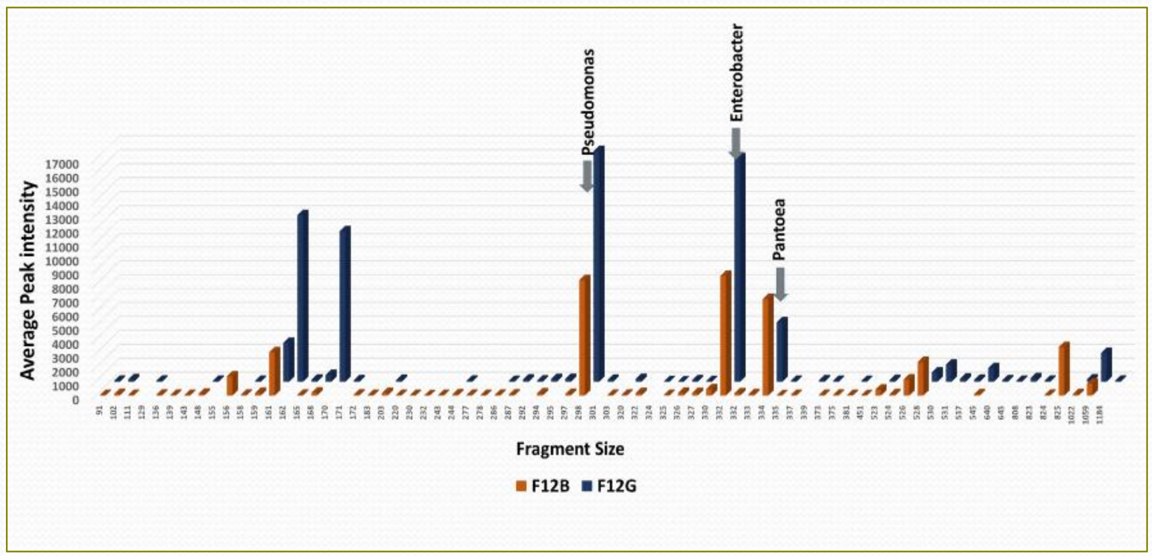


Abundance and Diversity of Corn Sap microbiome in High and Average producing Sites









List of Factors showed significant direct correlation to the yield

Fields with high total CFU

GFI (B & R)	0.678
% K	0.774
Nitrate Nitrogen	0.488
Boron	0.615
Ca/B	-0.672
P- Bray-P1 & Bicarb	0.751
K/Mg Ratio	0.836

High *Pseudomonas*

GFI (B &R soil)	0.950
Calcium (Ca)	-0.986
% K	0.909
Saturation (%) P	0.775
pH	-0.822
CEC meq/100g	-0.856

All Fields with high *Rhizobium*

GFI(B & R)	0.686
% K	0.641
Nitrate Nitrogen (B&R)	0.767
pH	-0.629
Soluble salts ms/cm	0.705
K/Mg Ratio	0.623

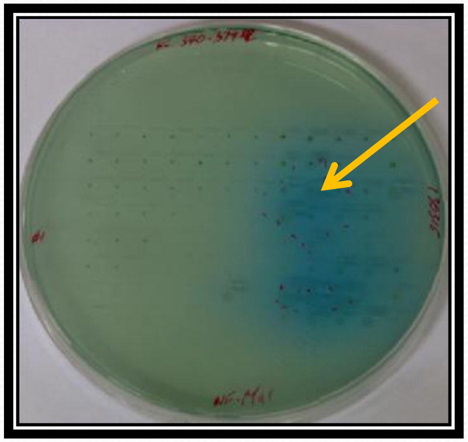
High gram positives population

GFI Rhizosphere	0.698
Nitrate Nitrogen	0.631
% K	0.704
K/Mg Ratio	0.567

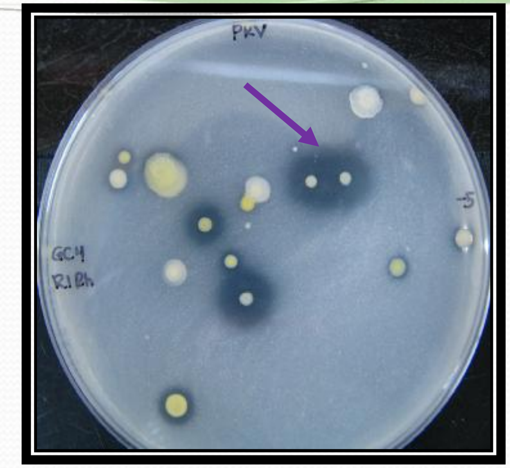
Summary: Soil factors significantly influenced in balancing the microbial population and thereby yield

Rank	Factors
1	GFI
2	% K
3	K/Mg Ratio
4	Nitrate Nitrogen
5	pH
6	CEC meq/100g
7	Saturation (%) P
8	Soluble salts ms/cm
9	Calcium (Ca)

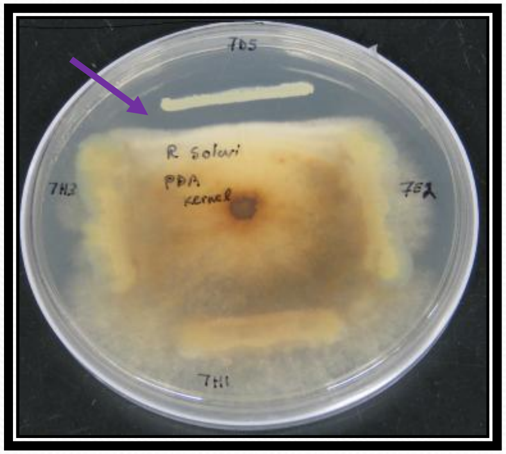
WHAT ARE THESE HEALTHY FUNCTIONS



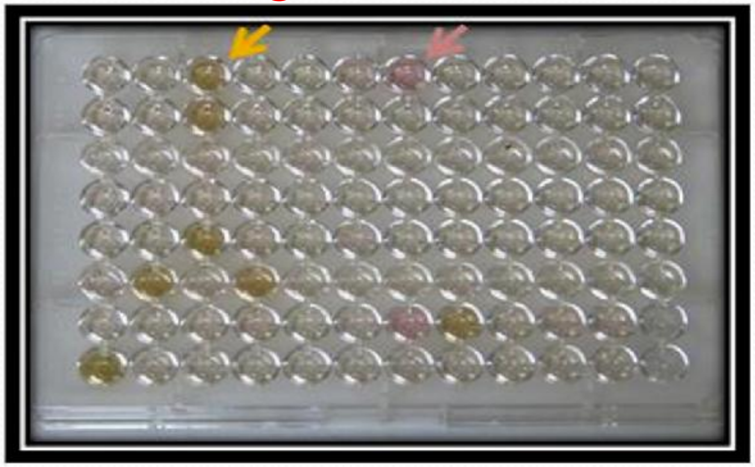
N fixing activity



P:K:Mg solubilization



Antifungal activity



Hormone (IAA) production

Plant biostimulants: Definition, concept, main categories and regulation.

P. du Jardin (2015). Sci. Hortic. http://dx.doi.org/10.1016/j.scienta. 2015.09.021

- promote plant growth but not as fertilizers or pesticides
- Include bacteria and fungi
- May increase nutrient use efficiency or provide new routes of nutrient uptake: mycorrhizal fungi, bacteria and PGPR
- Biostimulants that enhance growth by unidentified modes of action

Induced root formation of Brachypodium by volatile compounds emitted by *Bacillus pumilus*

Sterile potato plants inoculated with the bacterium *Burkholderia phytofirmans.*

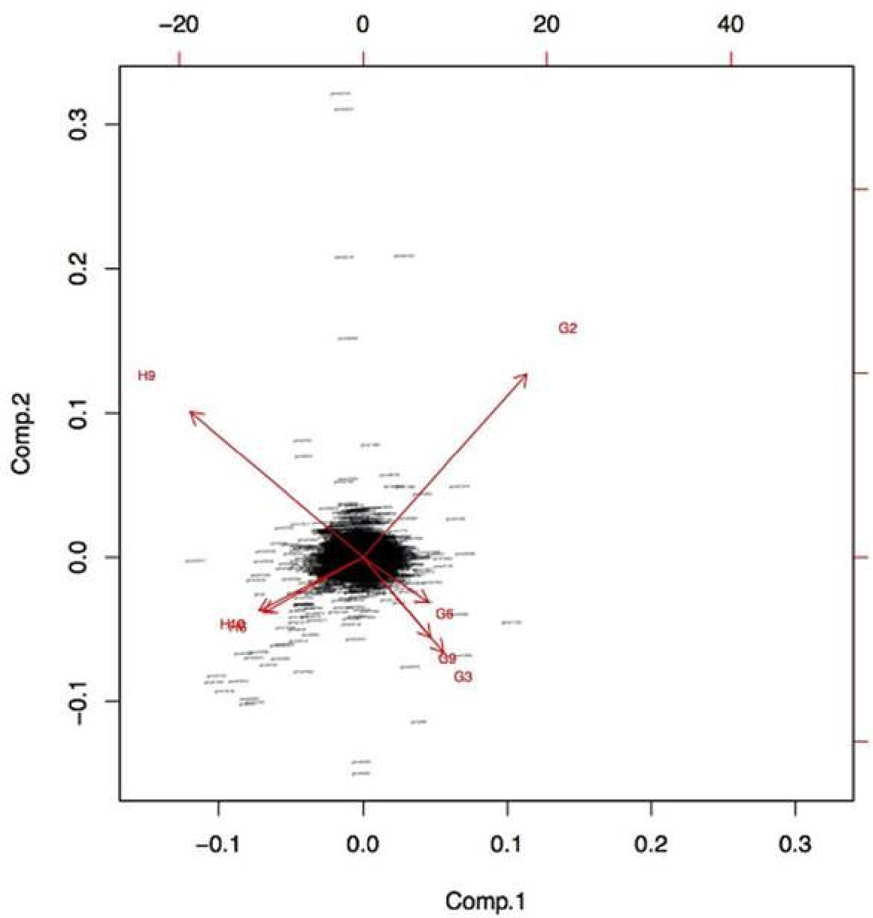
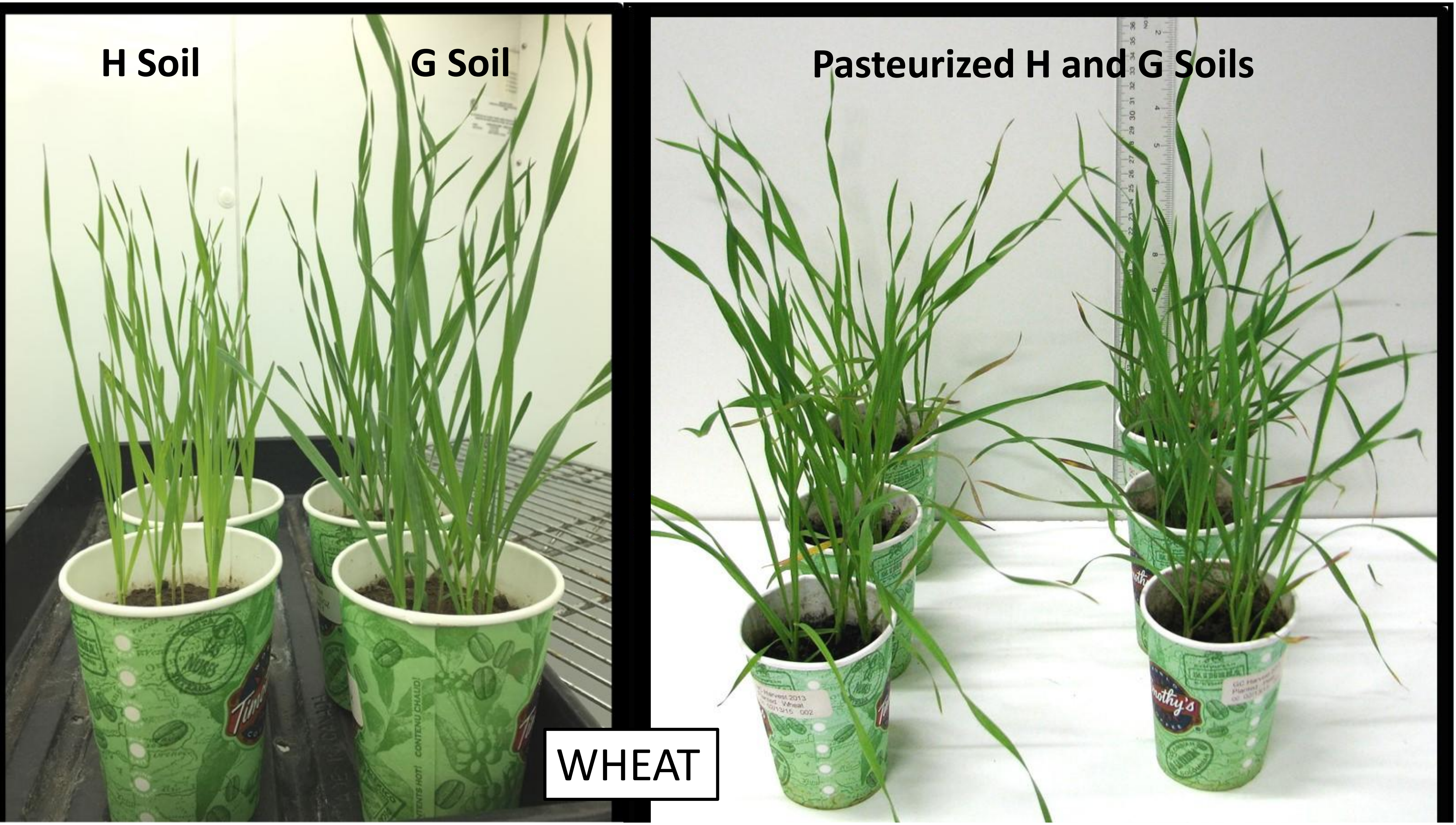


Figure 2. Compositional PCA Biplot comparing G and H samples. The first component (38% of the variance) separates G and H samples into their respective groups. Component 2 represents a further 32% of the variance. Sample H1 was removed as it was an outlier (Figure 1).

ITS ALL ABOUT FUNCTION

- RNA analysis will tell us what functions are impacting plant performance
- 2.5 billion amplicons identified from corn sap differentiated plants grown in soils with high and average yields


H Soil
G Soil
Pasteurized H and G Soils
WHEAT

Formulation and site specific delivery of liquid plant growth stimulating products

THE MOST O REA
FOR FUTUR FITS

Fig. 1 Hydrophobic- and hydrophilic-nitrification inhibitors (BNIs) released from sorghum roots and its significance to BNI function

Subbarao et al Plant & Soil 2012

Billions of horticultural plants are now grafted to take advantage of more resilient root systems

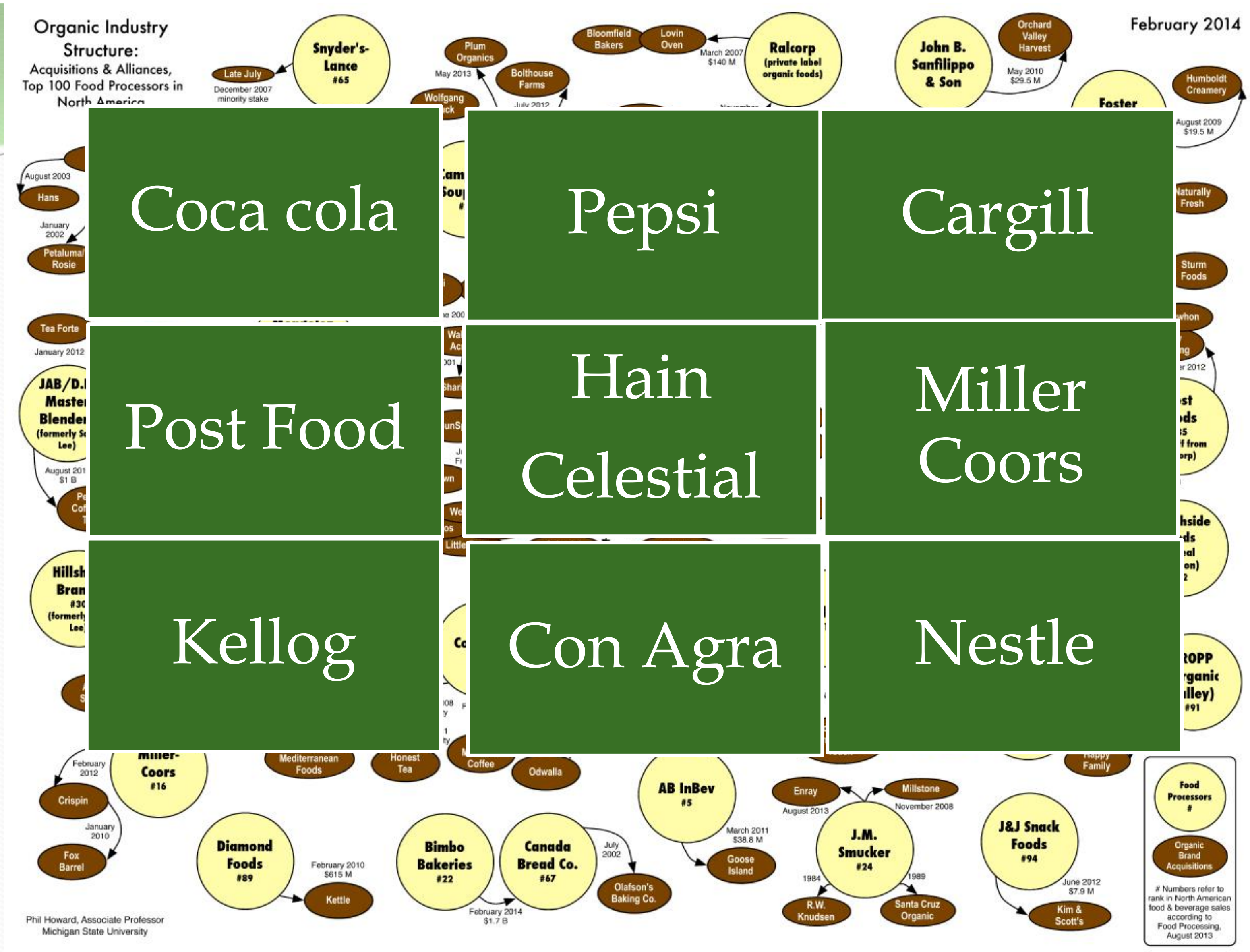
YIELD RESPONSES OF GRAFTED TOMATO PLANTS

Rootstock	Yield 2011- 2012 Tons per acre	Percent Increase Vs control
Control	31.9	
Beaufort	53.7	68.3
Bruce	46.2	44.8
RST-04-105-T	55.8	**74.9**
Survivor	38.5	20.7
P279	46.6	46.1
Q183	44.0	38.0

IF WE CAN GET BETTER ROOTS TO OUR PLANTS WITHOUT GRAFTING

> $2000 per A

Steve Loewen - U of G, Amy Turnbull – Fanshawe College



Coca cola

Pepsi

Cargill

Post Food

Hain Celestial

Miller Coors

Kellog

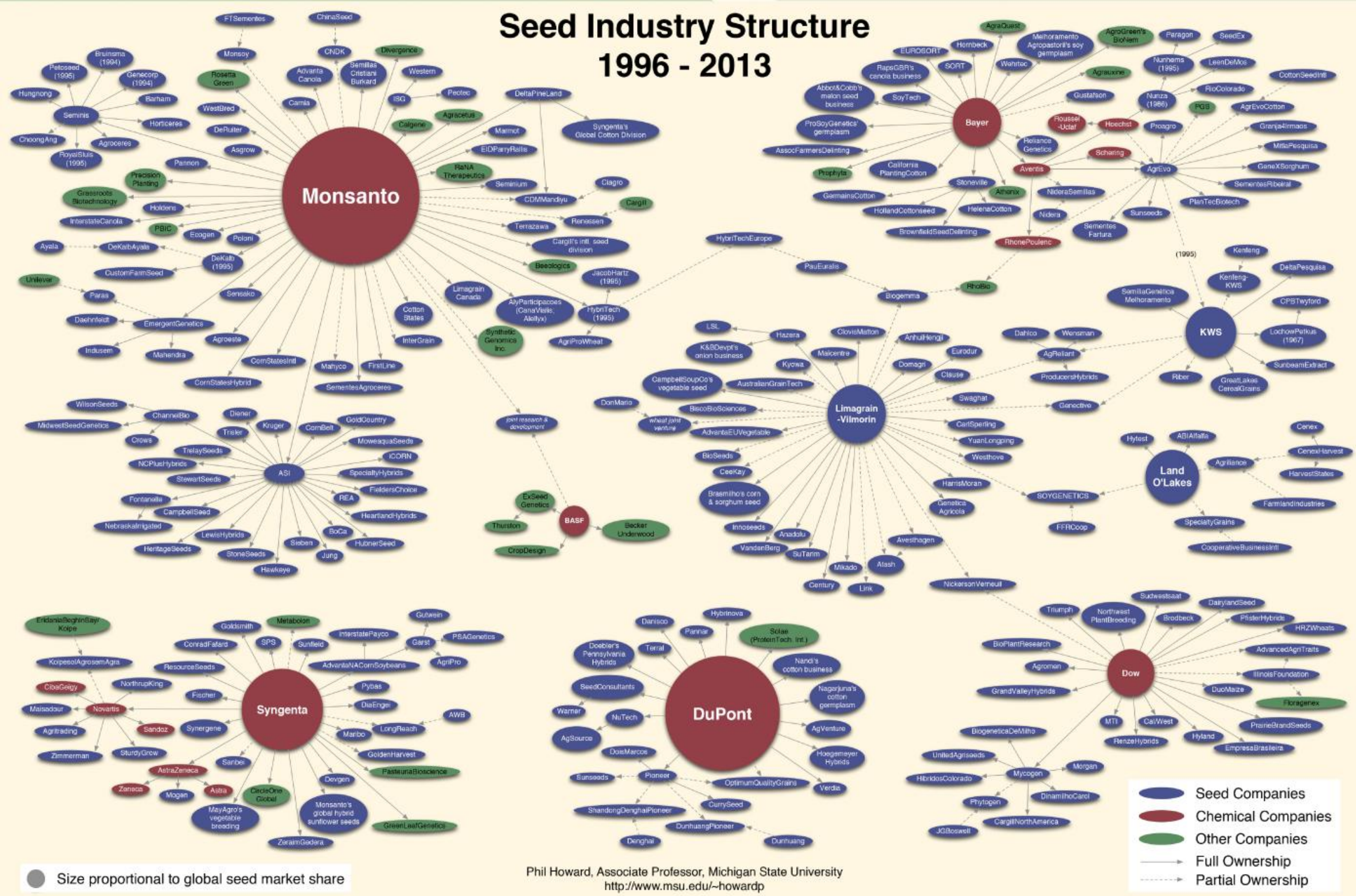
Con Agra

Nestle

In 1995 there were 81 independent organic processing companies in the USA. By 2005, Big Food had gobbled up all but 15.

http://www.cornucopia.org/who-owns-organic/

Philip H. Howard



Monsanto, DuPont and Syngenta now control over half the global market of seed and biotech companies

Dr. Phil Howard
http://www.cornucopia.org/seed-industry-structure-dr-phil-howard/

WHAT WE LEARNED ABOUT AGRICULTRUAL PRODUCTION SITES

- There is a high correlation between yield and aerial monitoring
- Most if not all fields have areas of high, average and poor yield potentials
- By focusing on high versus low yield sites we will be able to identify drivers for crop yield
- Microbes play a major role in soil and crop health

The new Green Revolution will combine biotechnology with smarter agricultural practices and equipment as a means to bring about better crop yields in the face of declining land available for farming.

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Growing Forward 2

AAC agricultural adaptation council

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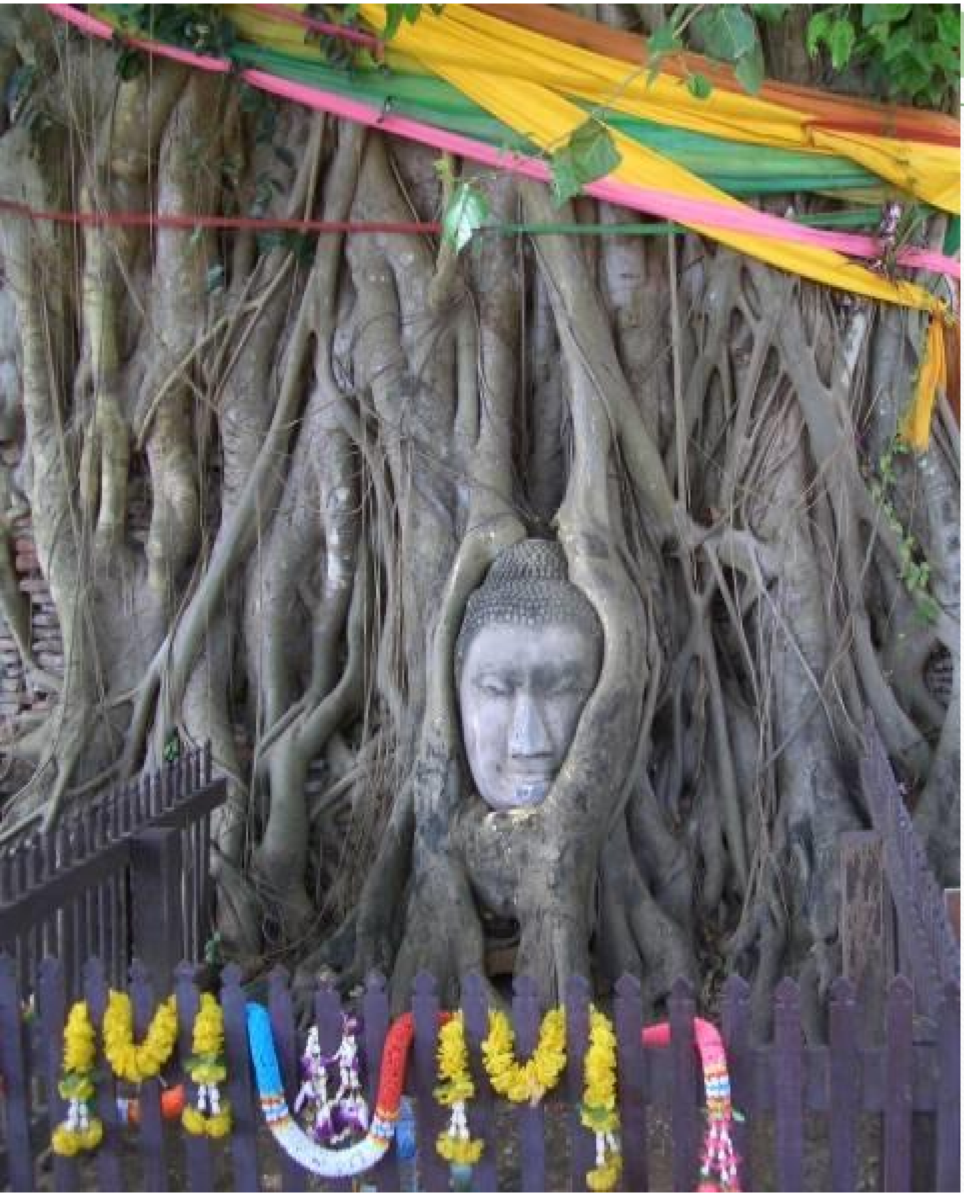

The Next Green Revolution will Emerge from Underground