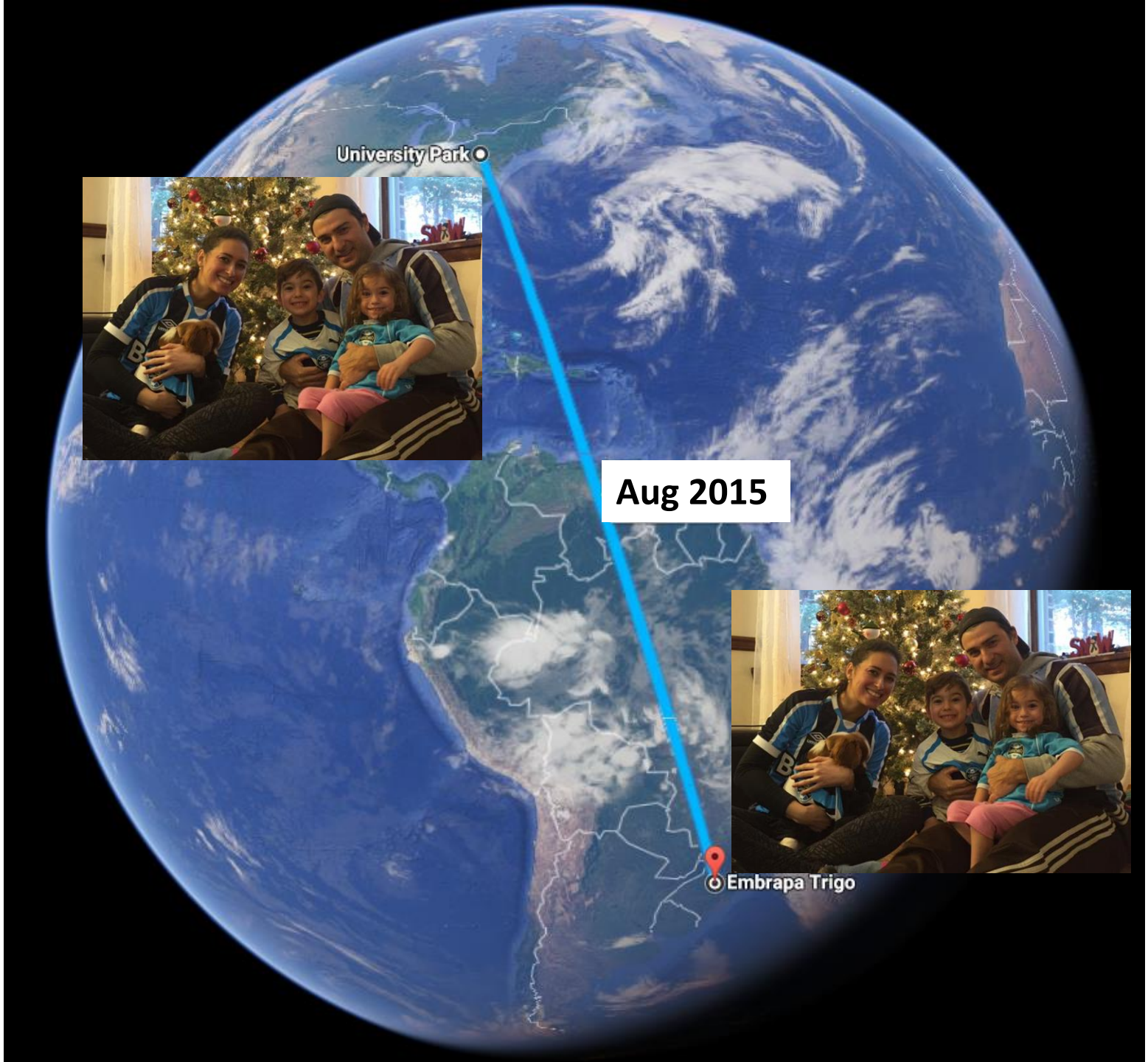
Factors that Influence Soybean Yield
“Ground Truthing Data”

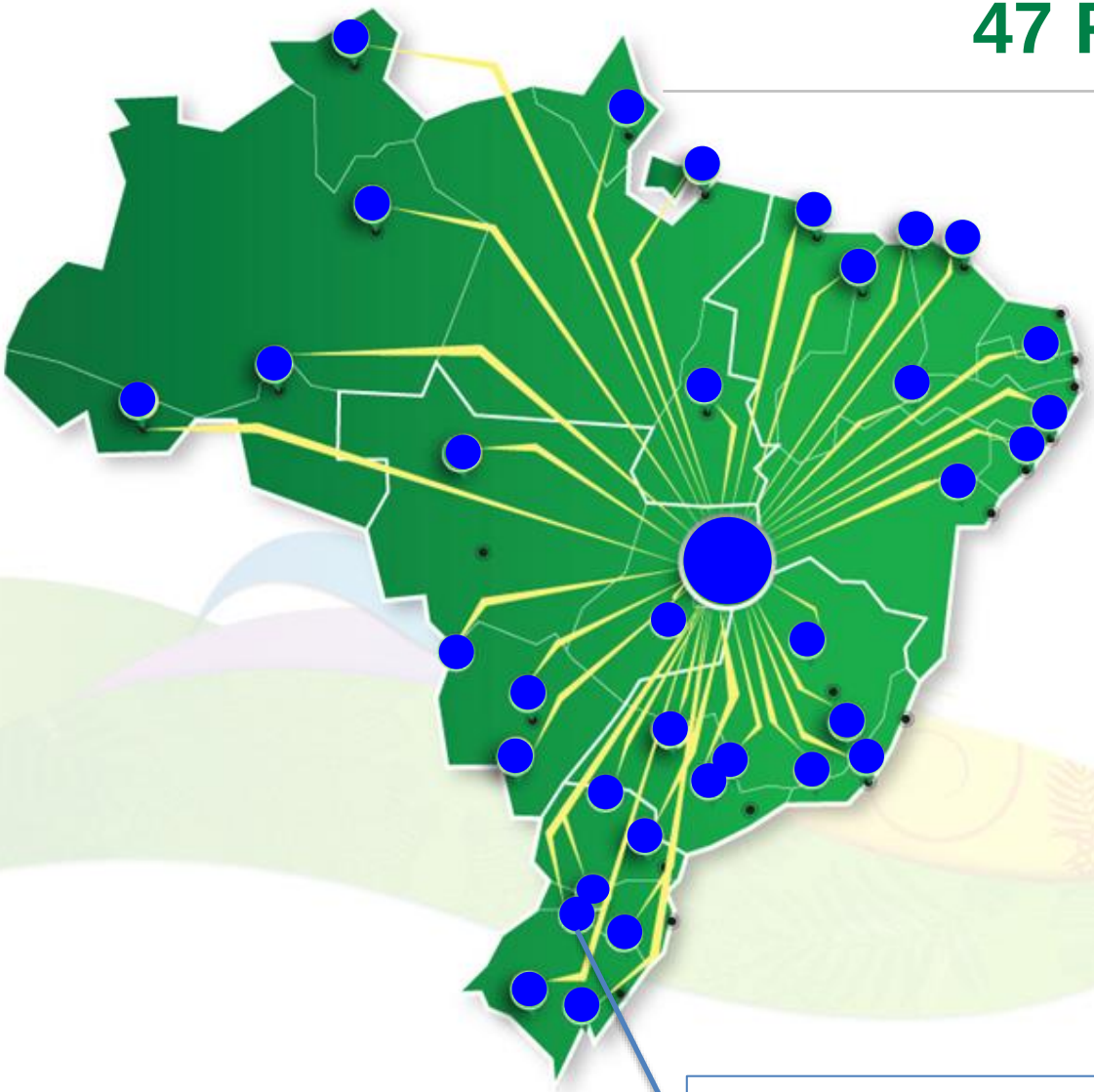
Giovani Stefani Faé

Armen Kemanian
Charlie White
Del Voight
Greg Roth
Jack Watson

Oct 23rd 2018


University Park
Aug 2015
Embrapa Trigo

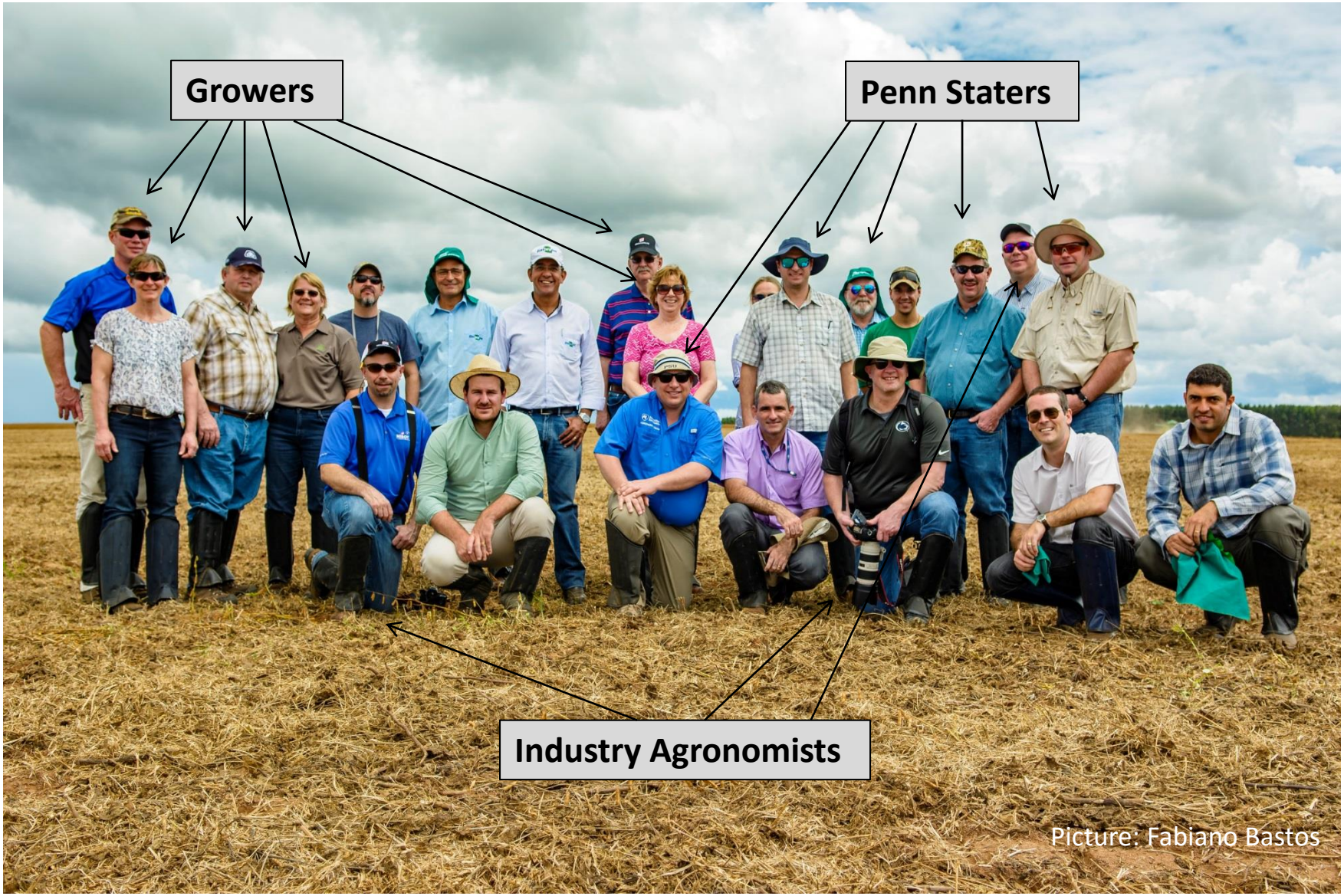
47 Research Stations



Embrapa Wheat (28°15’ S, 52°24’W)

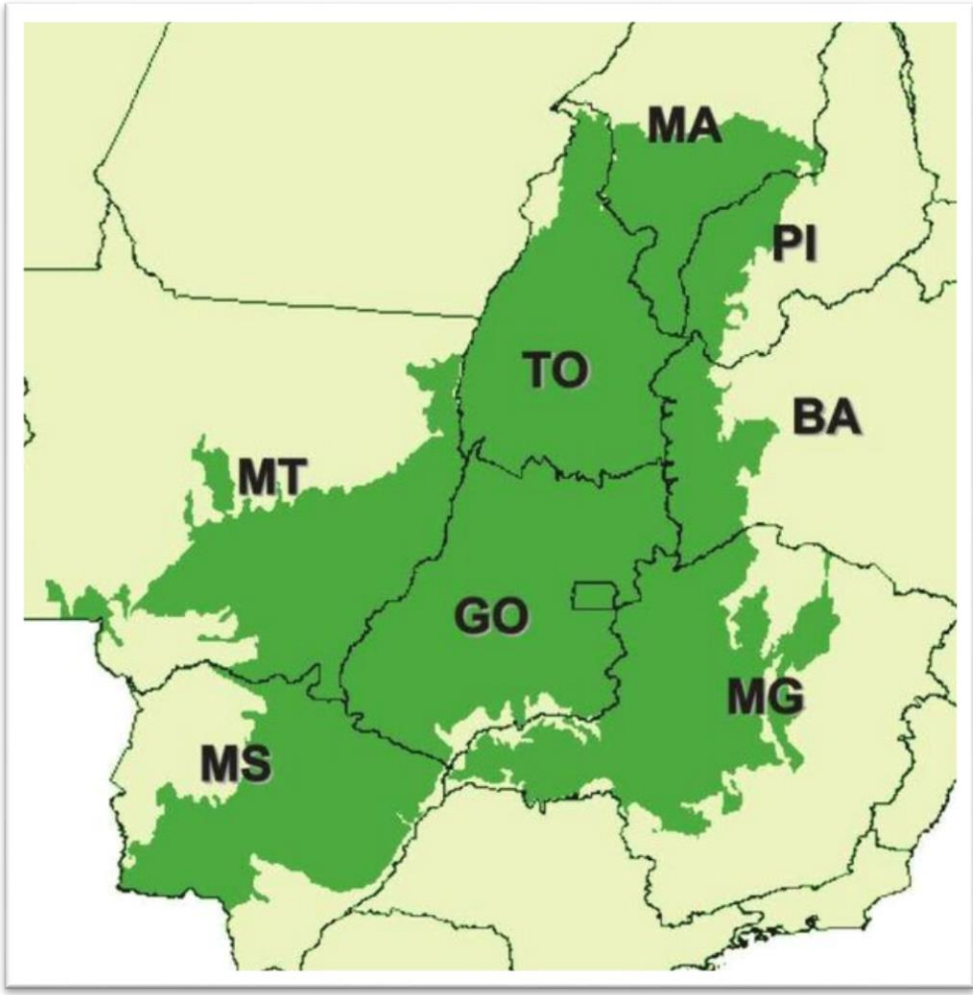
VITRINE TECNOLÓGICA
Embrapa
BRASIL

Brazil 2018 Soybean Production Tour



Brazil

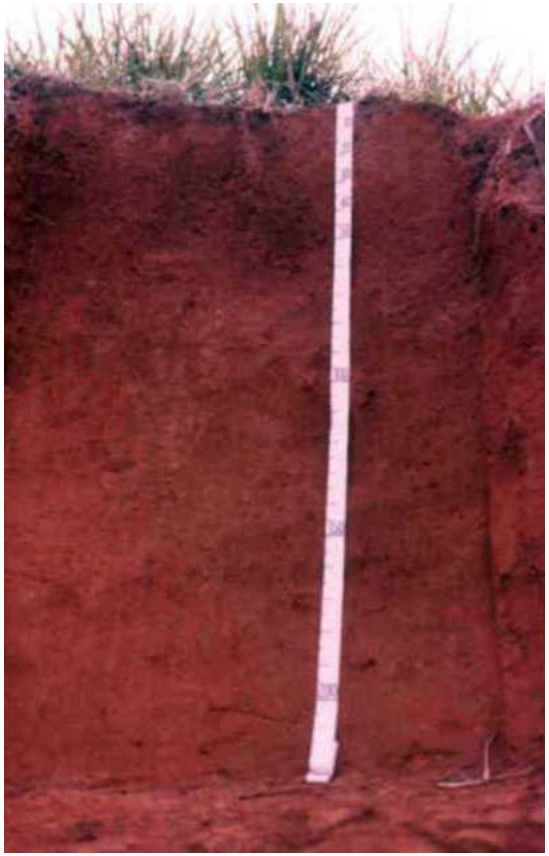
2018 Soybean Production Tour

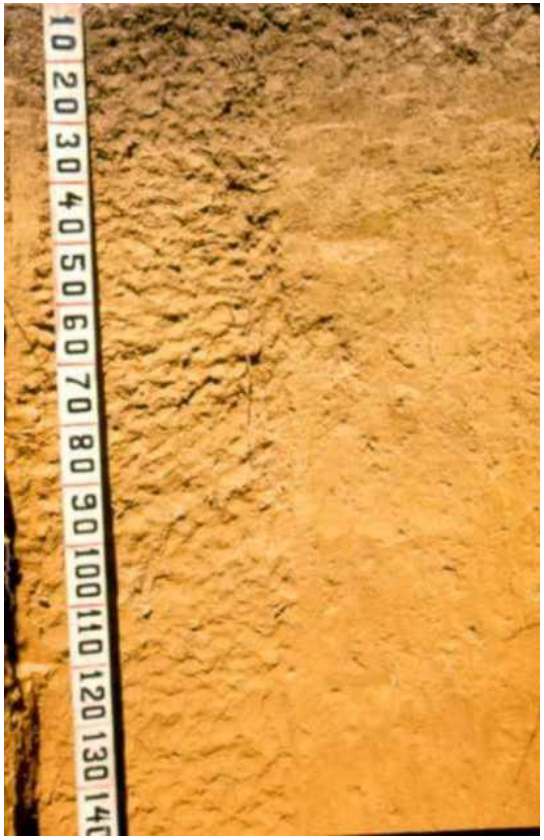


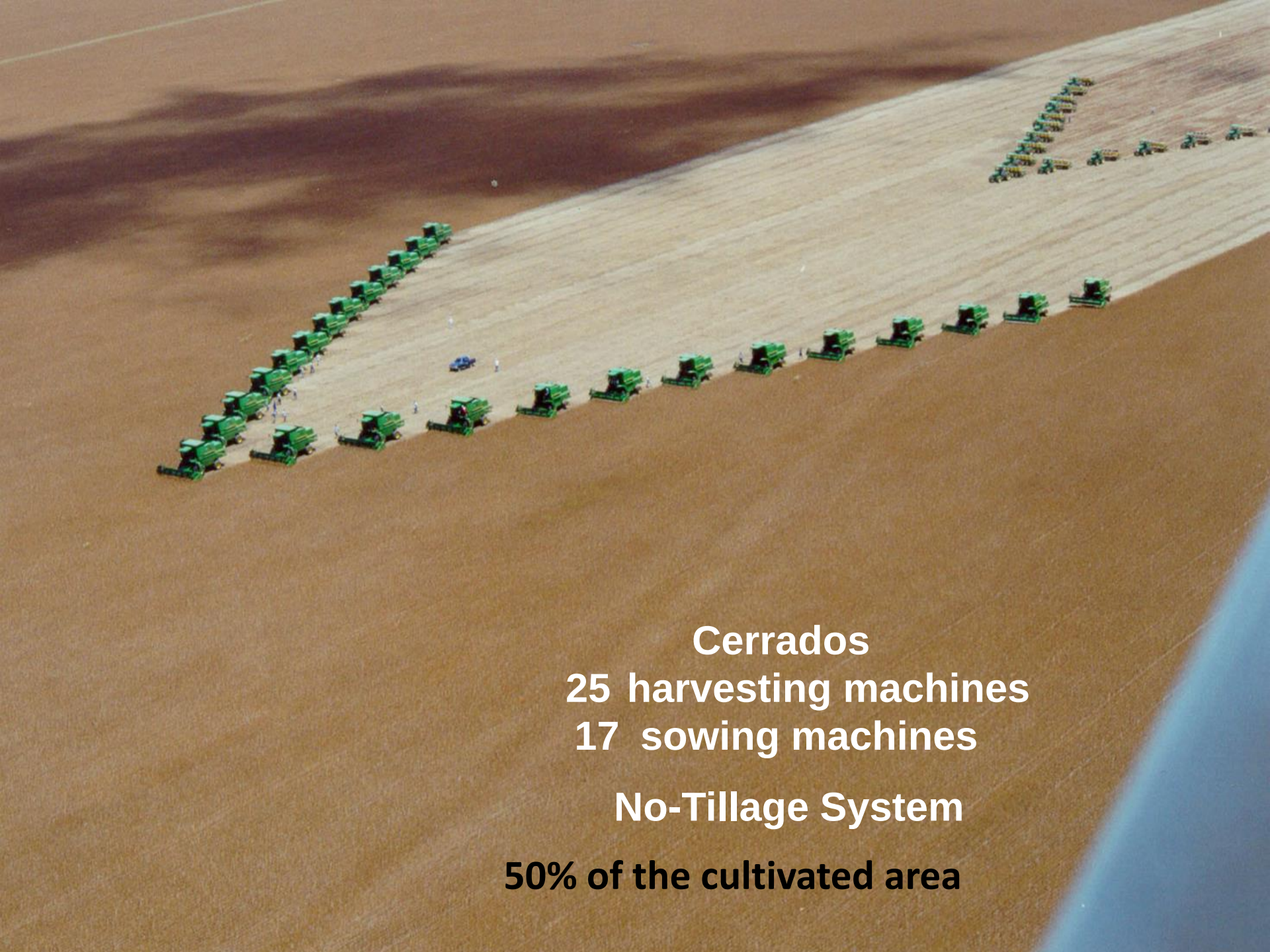
Soils

Highly weathered, acid soils:

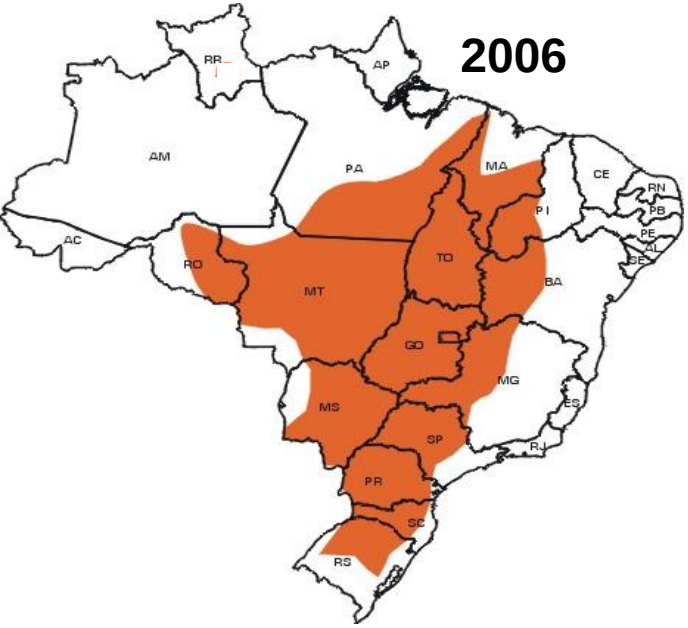
- **Low pH**
- **High Al content (toxic for plants)**
- **Low fertility: P, Ca, K, Mg, Zn ....**





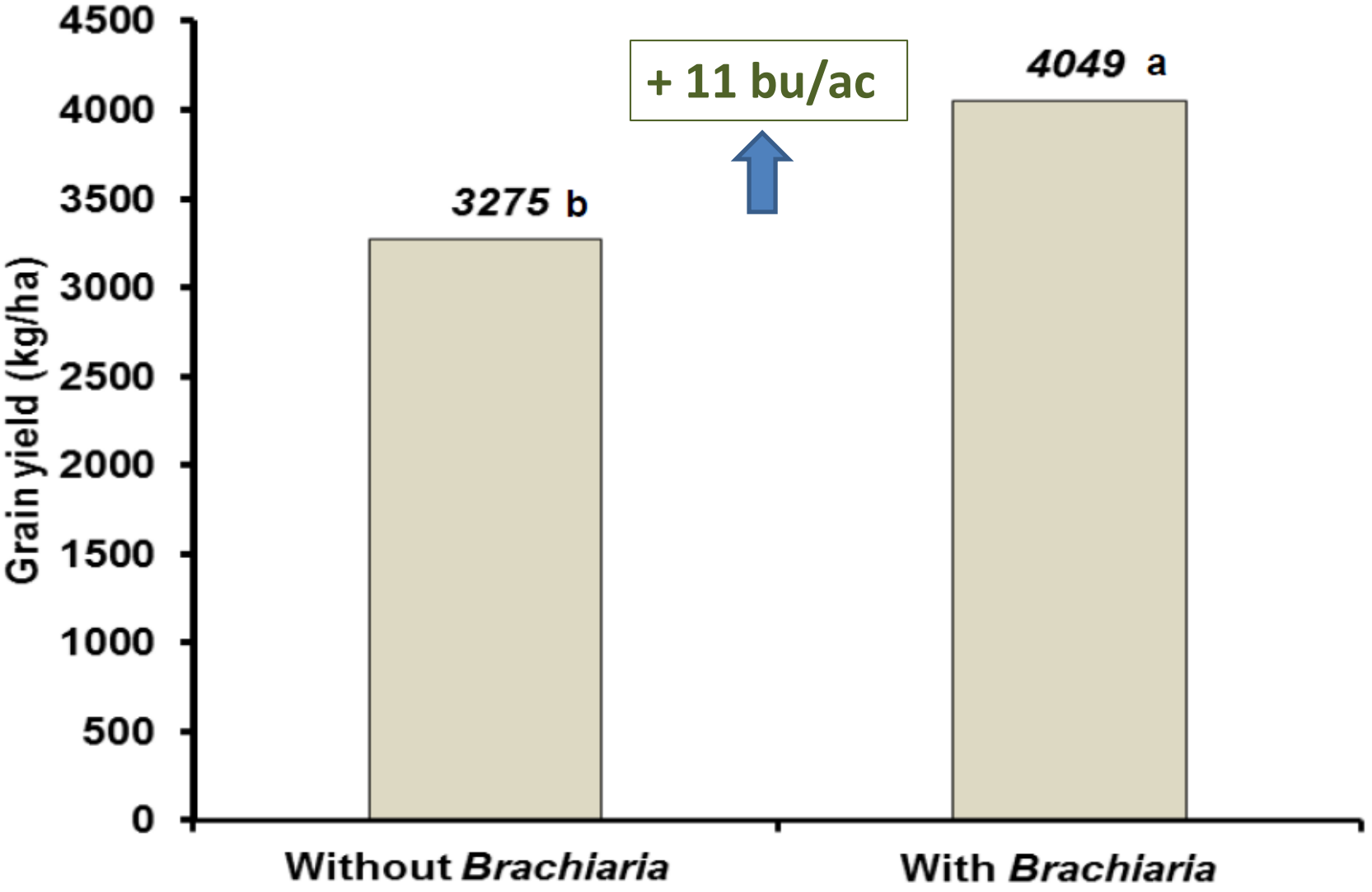

Cerrados
25 harvesting machines
17 sowing machines
No-Tillage System
50% of the cultivated area

Soybean in Brazil



Area (1000 ha)	Yield (kg/ha)
906	1.166
23.500	2.916

Breeding program + soil management + pests and diseases control + BNF



Effect of straw of Brachiaria grasses intercropped with corn (B. ruziziensis and B. brizantha cv. Piatã) on soybean yield cv. M-SOY 8866. Triunfo, Formosa do Rio Preto, BA. Means followed by different letters differ from each other by the Tukey test ($P < 0.05$). Source: Vilela et al. (2017)

Santa Brígida Farms

July 2010

Source: Luis Adriano M. Cordeiro

Brachiaria Roots

Horita Farms, West of Bahia

Conheça a competência de seus colegas
não subestime sua competência!.

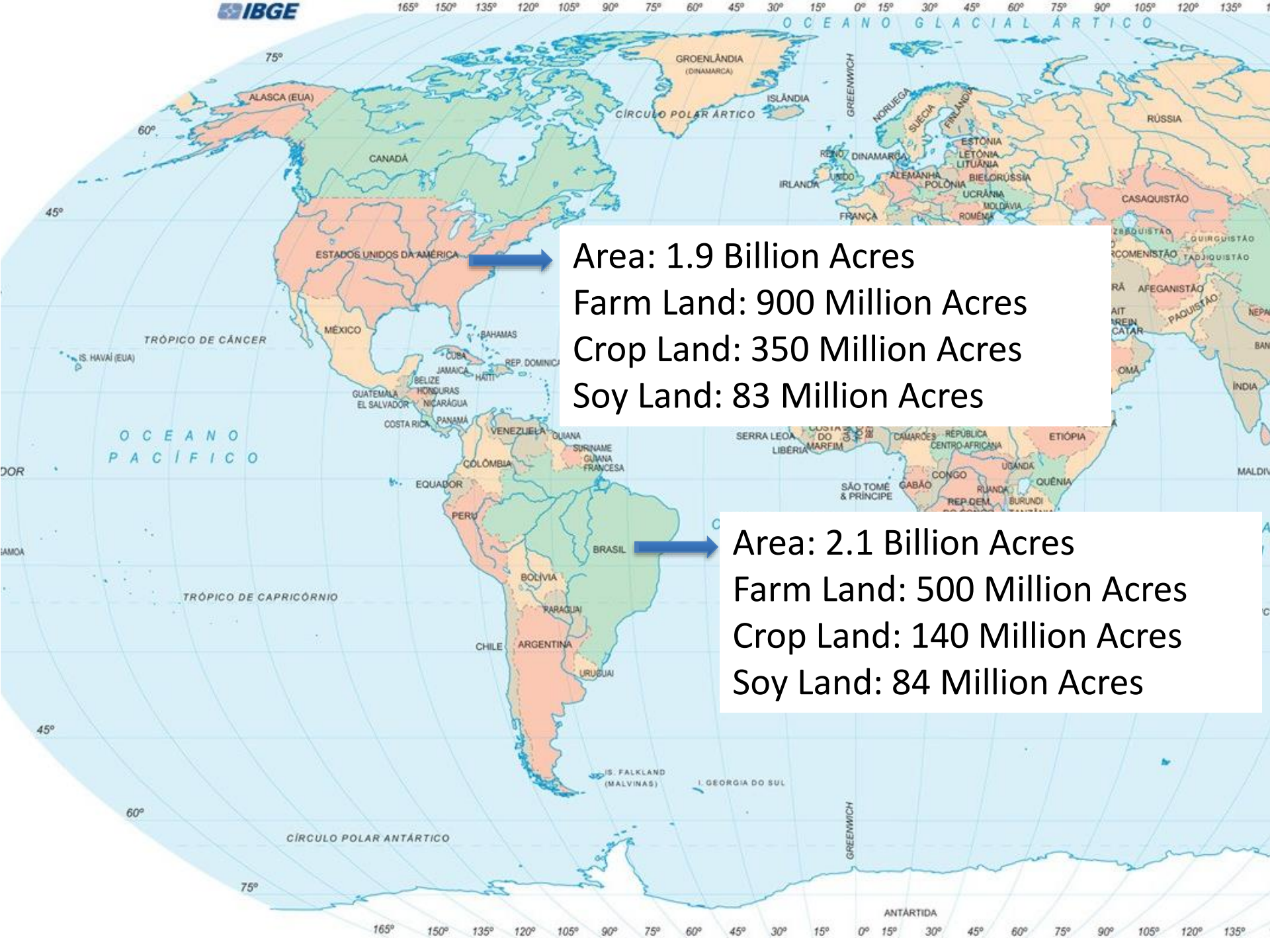
USA. 1972.
3.500Kg

Brasil 1972.
2.200Kg

USA. 2011
5000 Kg

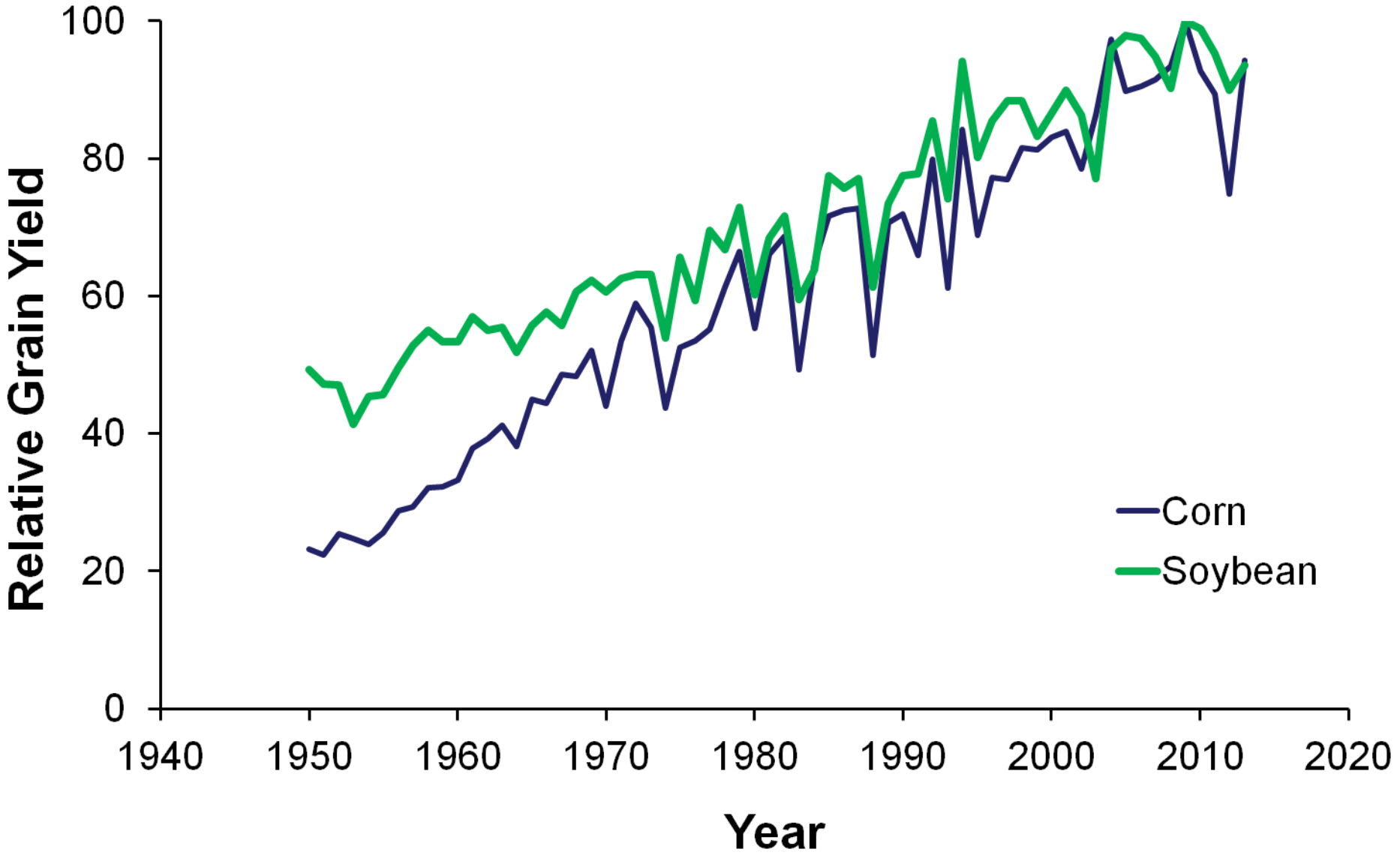
Brasil. 2013
5.000Kg

"E temos ainda a cultura de inverno!"


IBGE
OCEANO GLACIAL ÁRTICO
GROENLÂNDIA (DINAMARCA)
ALASCA (EUA)
CÍRCULO POLAR ÁRTICO
ISLÂNDIA
GREENWICH
NORUEGA
SUÉCIA
FINLÂNDIA
RÚSSIA
ESTÔNIA
LETÔNIA
LITUÂNIA
DINAMARCA
REINO UNIDO
IRLANDA
ALEMANHA
POLÔNIA
BIELORRÚSSIA
UCRÂNIA
MOLDÁVIA
ROMÊNIA
FRANÇA
CANADÁ
ESTADOS UNIDOS DA AMÉRICA
CASAQUISTÃO
QUIRGUISTÃO
TADJIQUISTÃO
AFEGANISTÃO
PAQUISTÃO
ÍNDIA
TRÓPICO DE CÂNCER
MÉXICO
IS. HAVAÍ (EUA)
BAHAMAS
CUBA
JAMAICA
HAITI
REP. DOMINICANA
BELIZE
GUATEMALA
HONDURAS
EL SALVADOR
NICARÁGUA
COSTA RICA
PANAMÁ
OCEANO PACÍFICO
VENEZUELA
GUIANA
SURINAME
GUIANA FRANCESA
COLÔMBIA
EQUADOR
PERU
BRASIL
BOLÍVIA
PARAGUAI
CHILE
ARGENTINA
URUGUAI
TRÓPICO DE CAPRICÓRNIO
SERRA LEOA
LIBÉRIA
CAMARÕES
REPÚBLICA CENTRO-AFRICANA
ETIÓPIA
UGANDA
CONGO
GABÃO
RUANDA
QUÊNIA
SÃO TOMÉ & PRÍNCIPE
REP. DEM.
BURUNDI
IS. FALKLAND (MALVINAS)
I. GEORGIA DO SUL
CÍRCULO POLAR ANTÁRTICO
ANTÁRTIDA
Area: 1.9 Billion Acres
Farm Land: 900 Million Acres
Crop Land: 350 Million Acres
Soy Land: 83 Million Acres
Area: 2.1 Billion Acres
Farm Land: 500 Million Acres
Crop Land: 140 Million Acres
Soy Land: 84 Million Acres

US yields

Yield relative to maximum



Physiological Mechanisms associated with gains in Soy Yields

Historical gains in Soy yields (1923 to 2007):

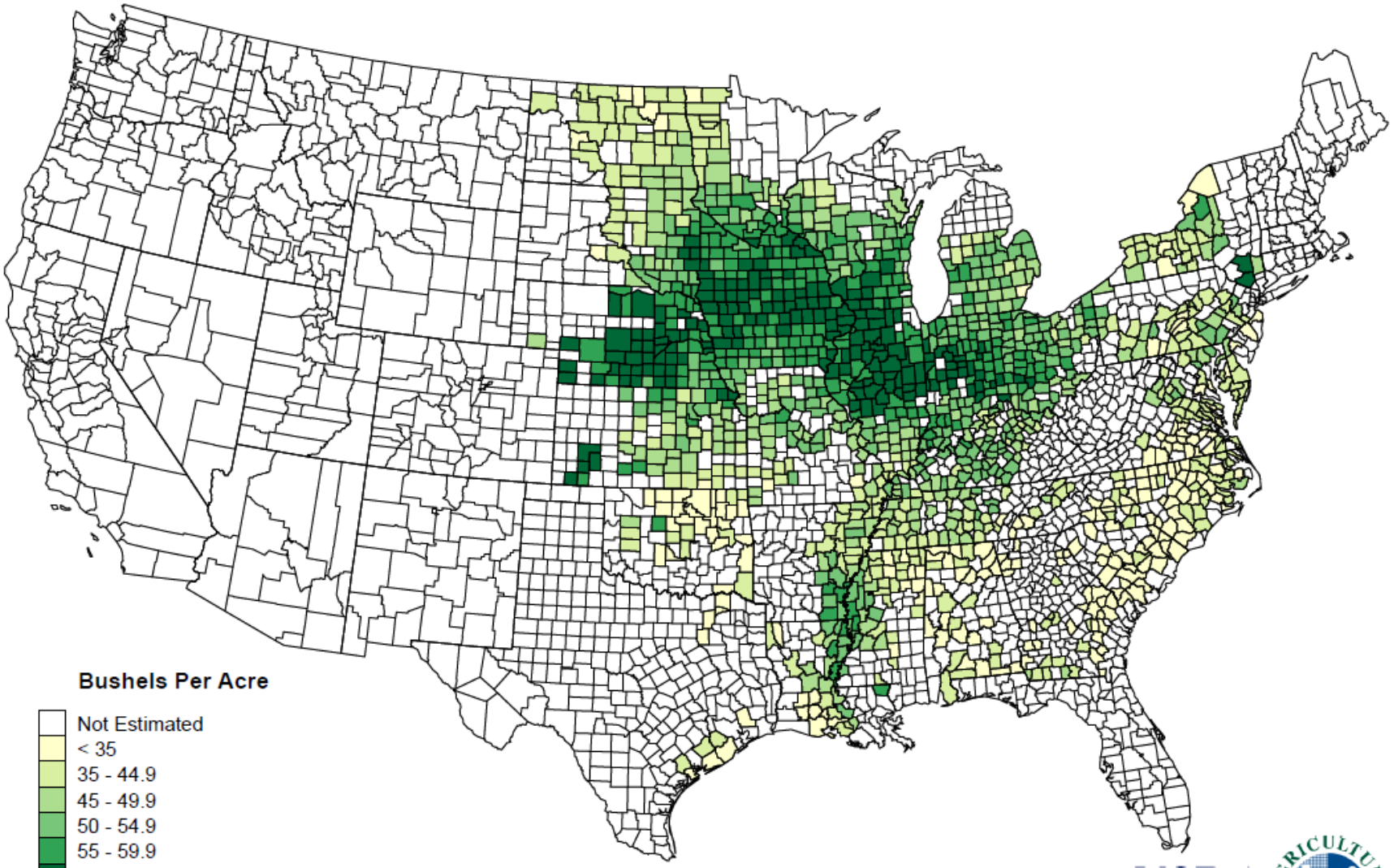
- **PAR Interception**: canopy light interception
- **Energy Conversion (RUE)**: light energy into Biomass
- **Partioning Efficiencies (HI):** biomass into seed

Koester et al. (2014)

Yield Potential = PAR Intercept x RUE x HI

Monteith (1977)

Soybeans 2016
Yield Per Harvested Acre by County
for Selected States



U.S. Department of Agriculture, National Agricultural Statistics Service

Landisville 2015

MESON
NYLON CLAD
N479

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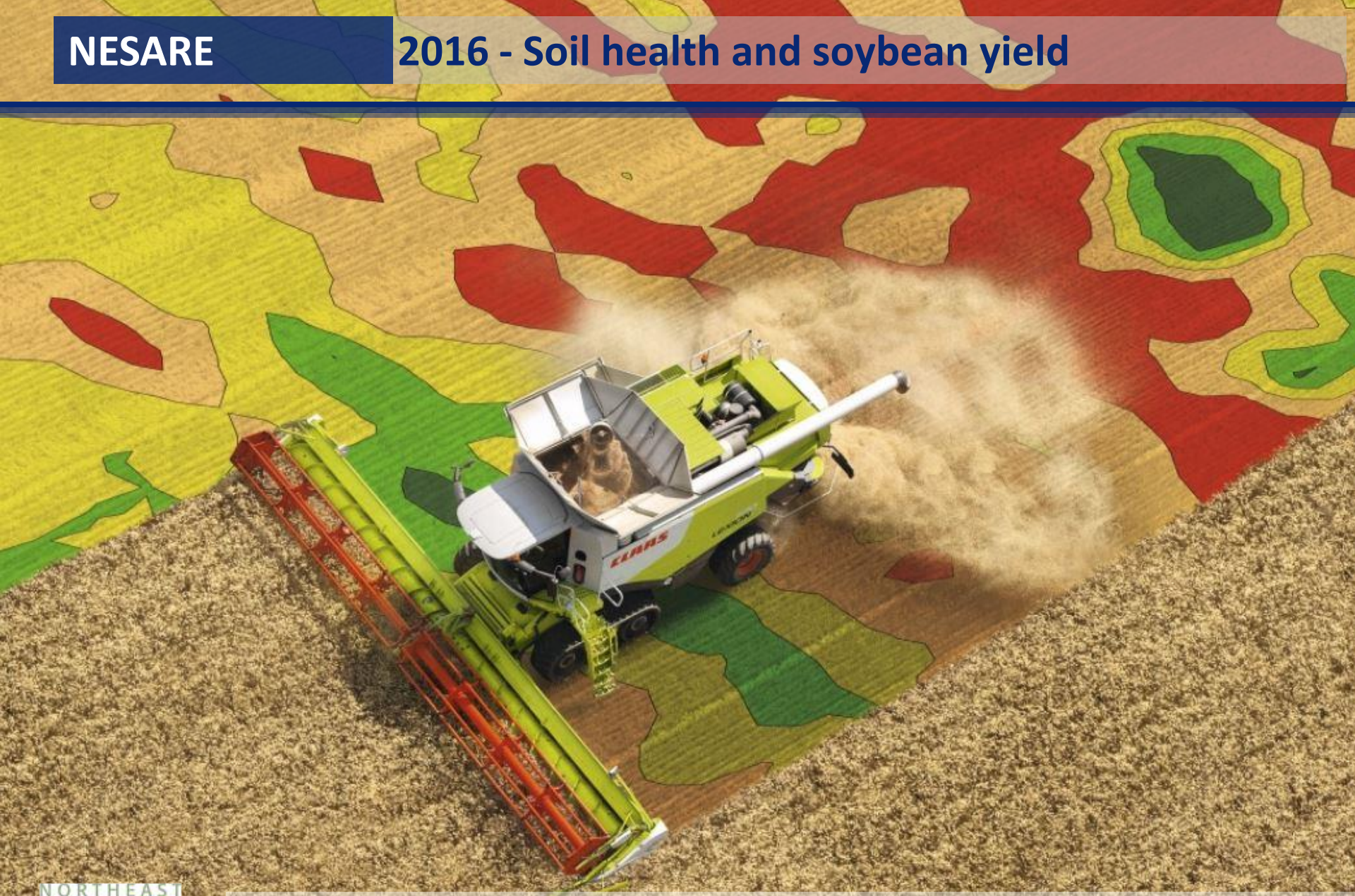
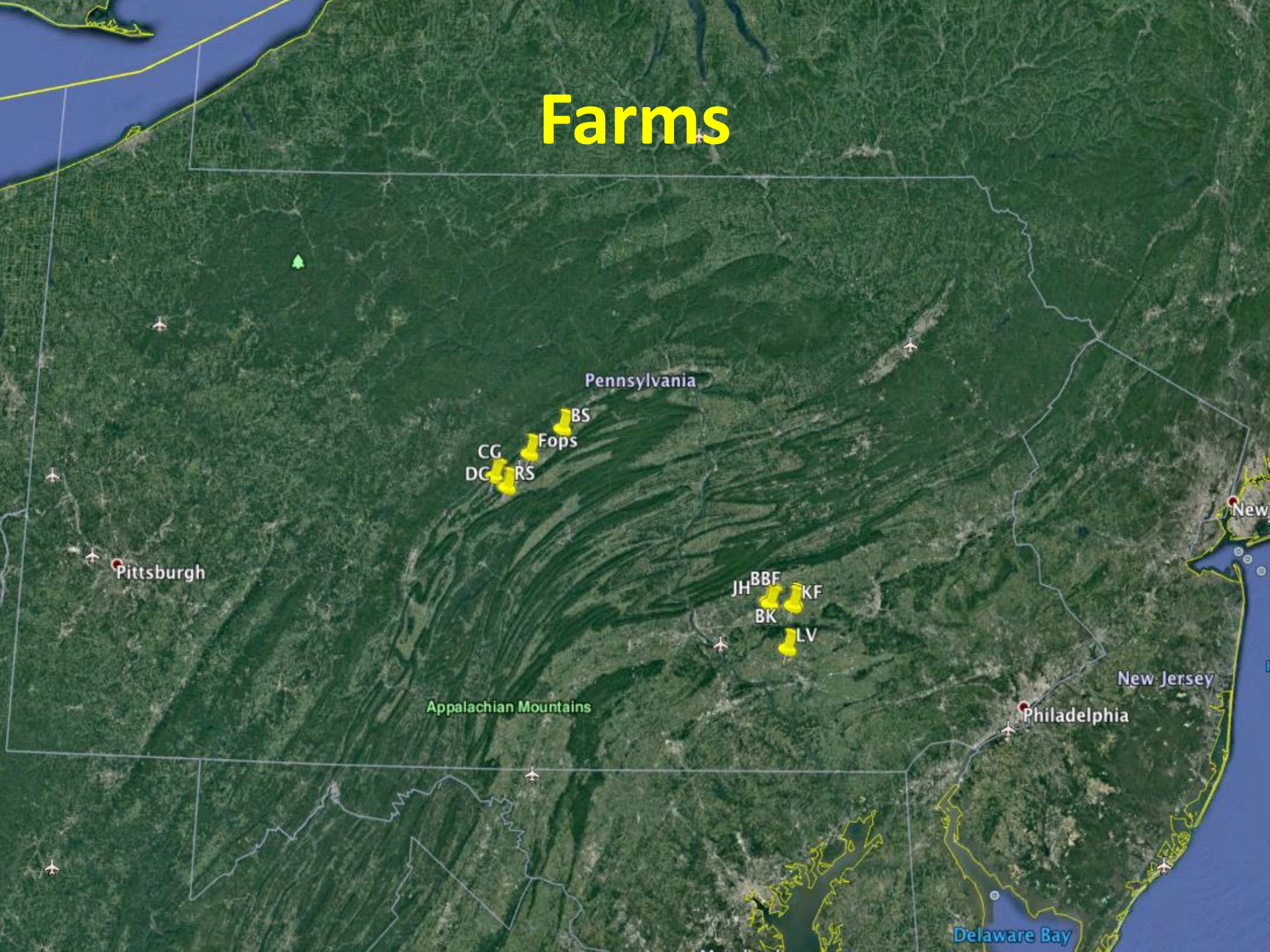
2016 - Soil health and soybean yield

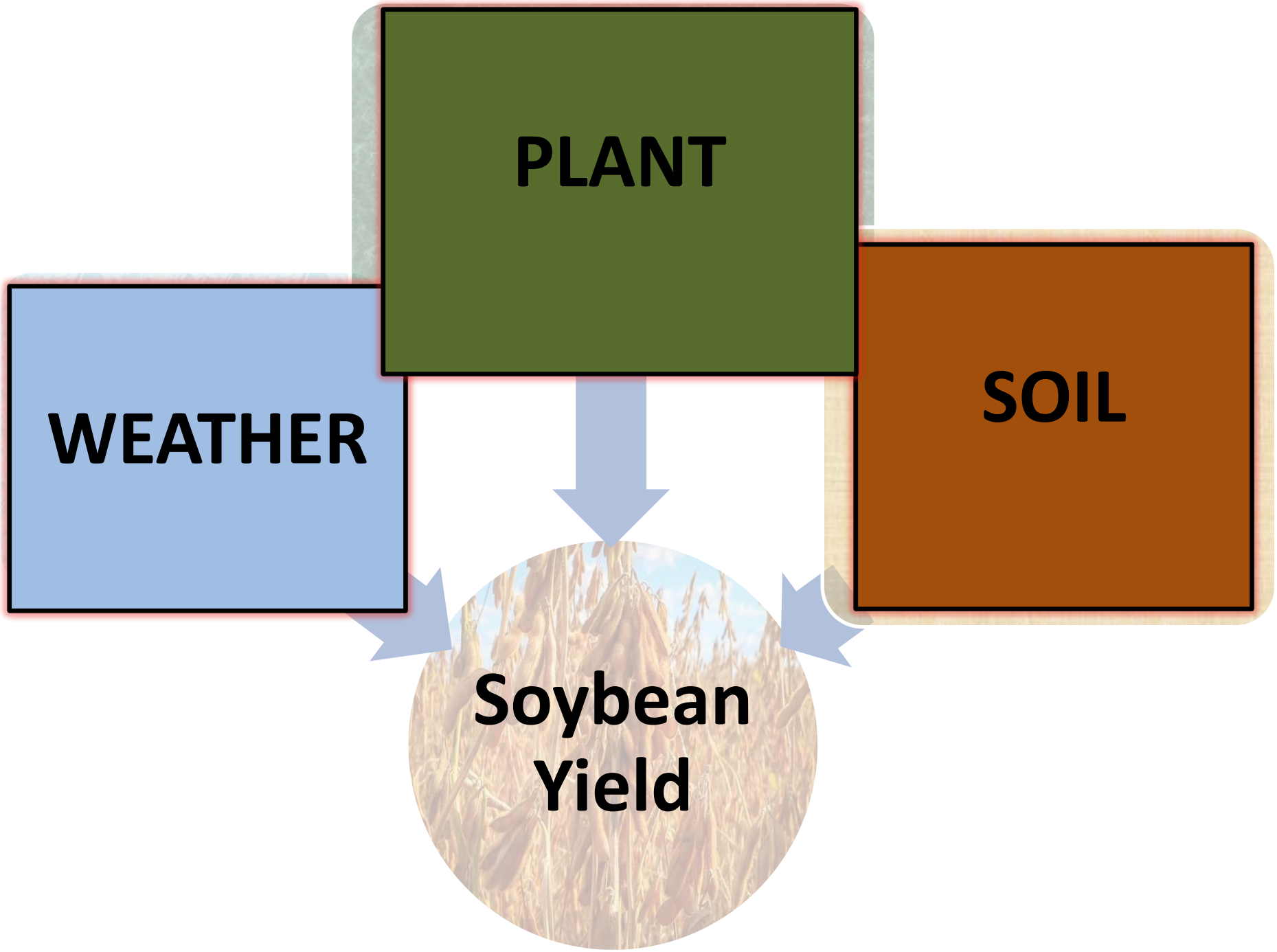


Targeting sustainable soil management practices using crop modeling in soybean systems

NORTHEAST SARE Sustainable Agriculture Research & Education

Farms


Pennsylvania
BS
Fops
CG
DC
RS
JH
BBF
KF
BK
LV
Pittsburgh
Appalachian Mountains
New Jersey
Philadelphia
Delaware Bay

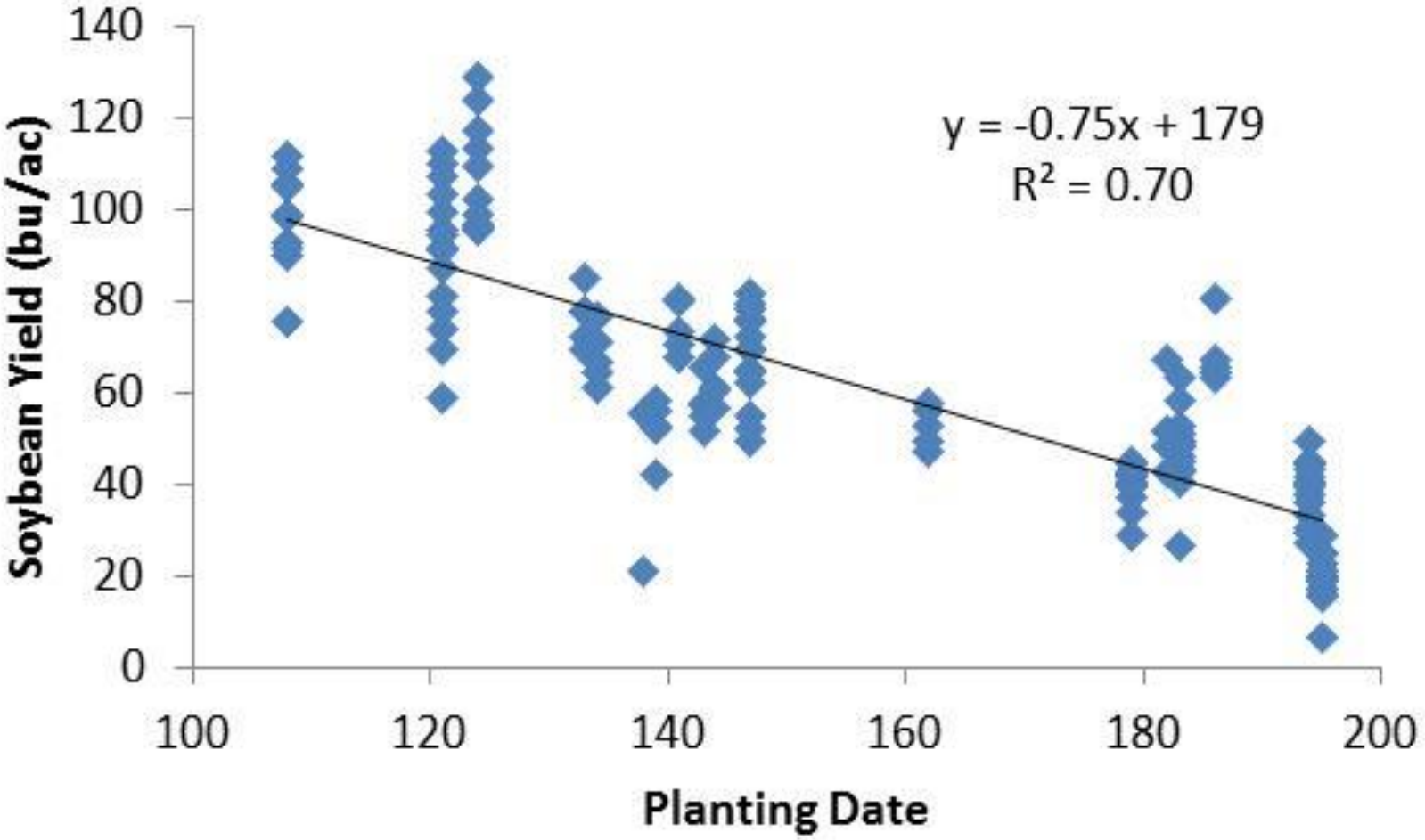

PLANT
WEATHER
SOIL
Soybean
Yield

GIDDINGS

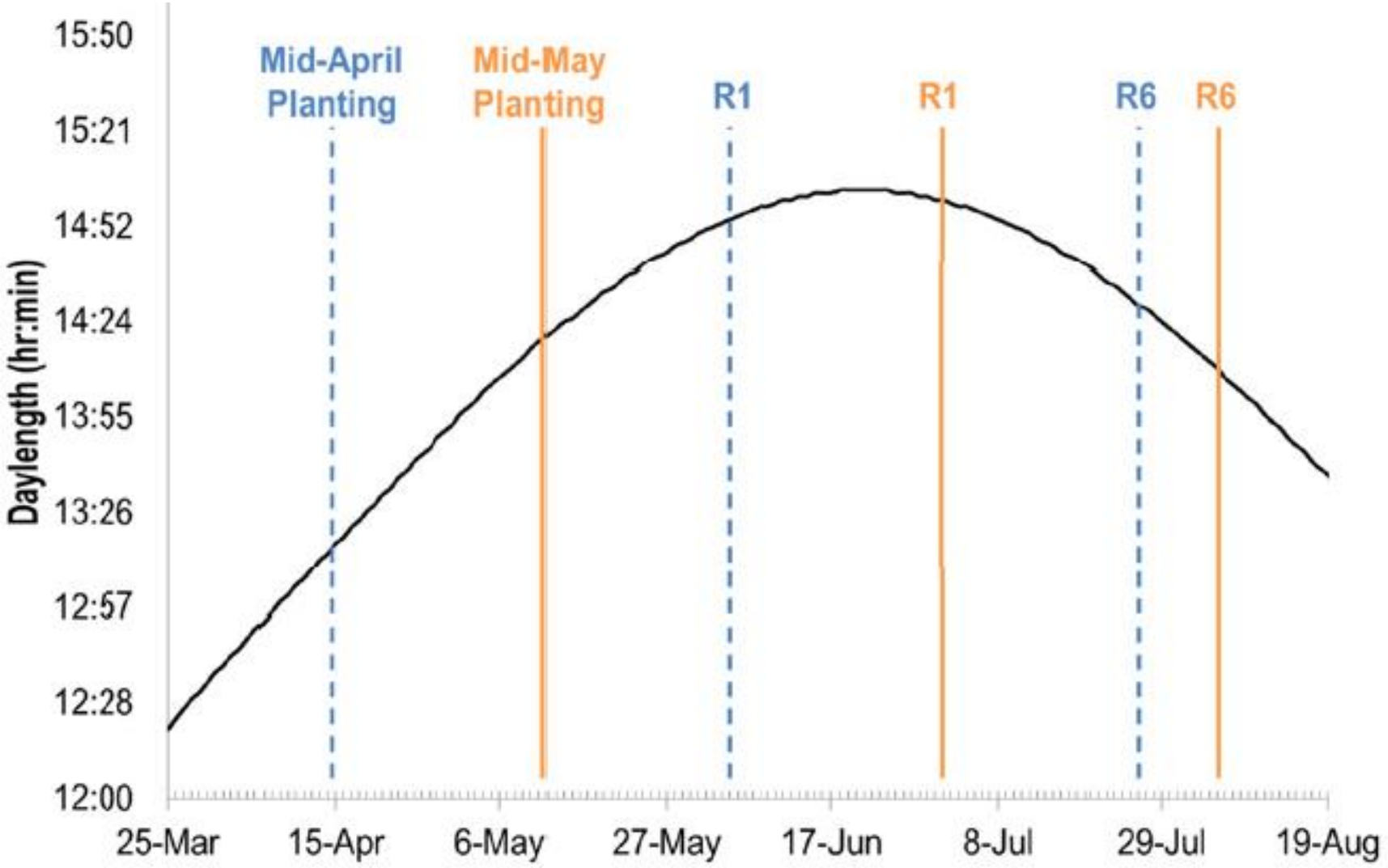
What is the most important soybean yield predictor?

Planting Date x Yield

(21 Fields, 18 Planting Dates, 2016 and 2017)

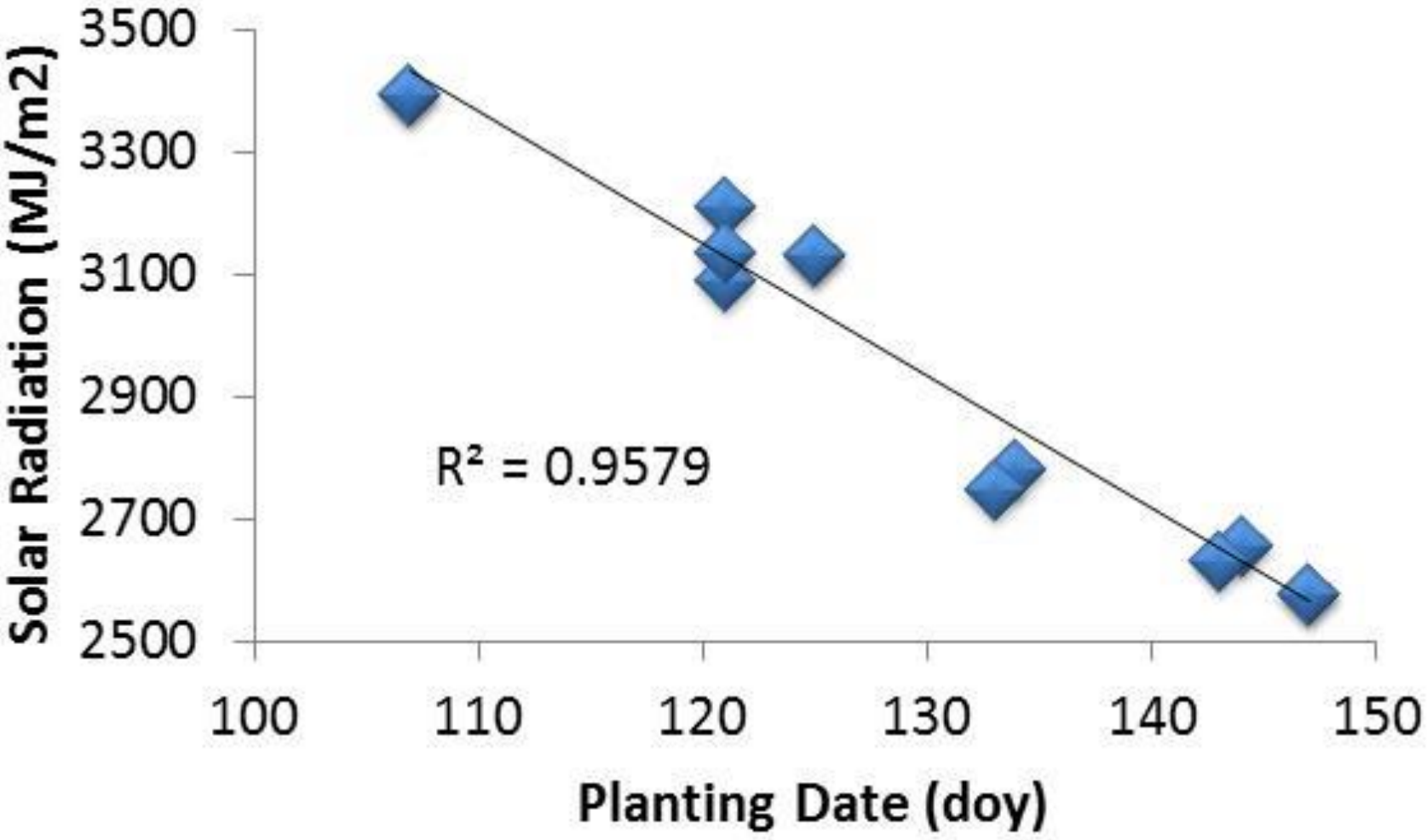


Understanding and Increasing Soybean Yields



R.V. Roekel & L. Purcell / Crop Insights Vol. 26 Nº 7 (2016) Dupont Pioneer

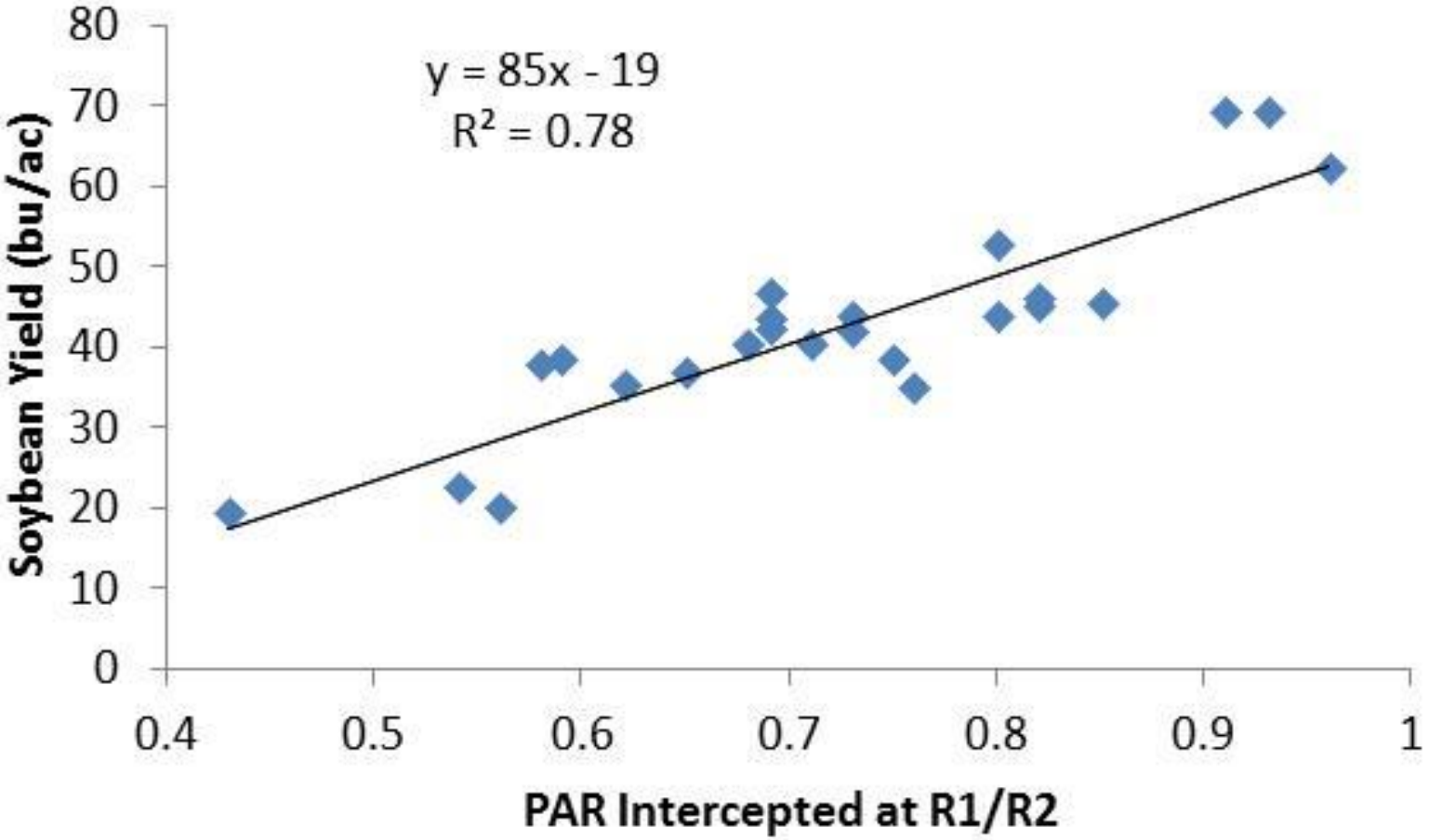
Sunlight


Solar Radiation (MJ/m2)
3500
3300
3100
2900
2700
2500
R² = 0.9579
100
110
120
130
140
150
Planting Date (doy)

Light Interception

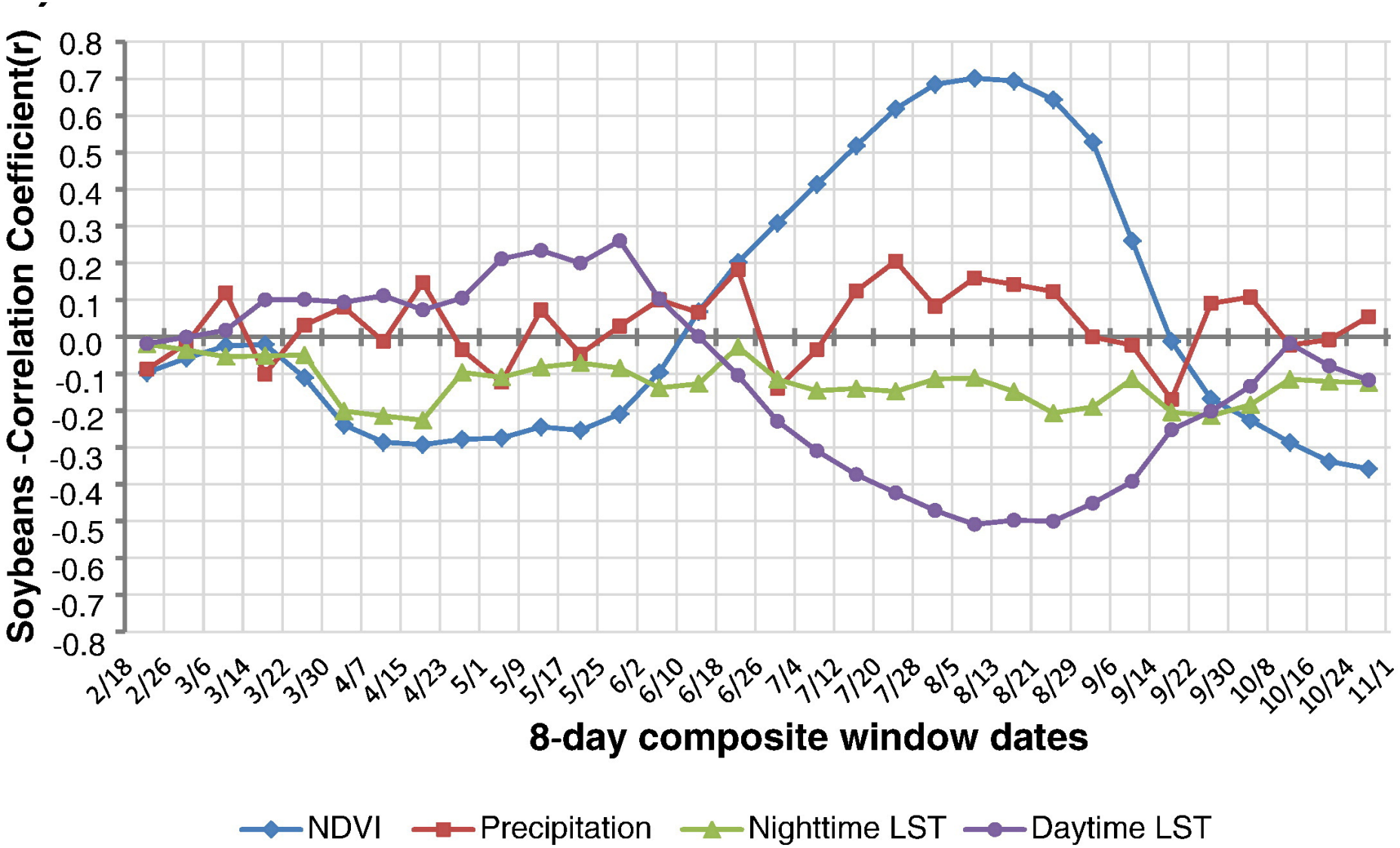
PAR Interception x Yield

(SEAREC and Rock Springs, 2016)



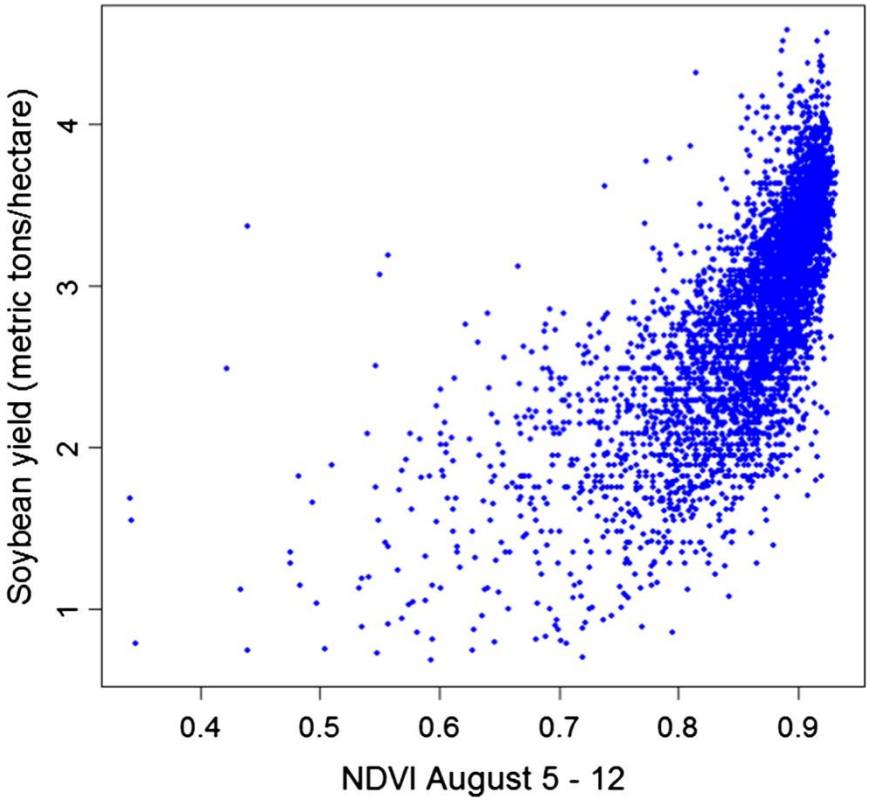
8-year average (36 – 96% range) in Rock Springs: 10% change in light interception at flowering represents an impact of *4.4 bu/ac in soybean yield*!

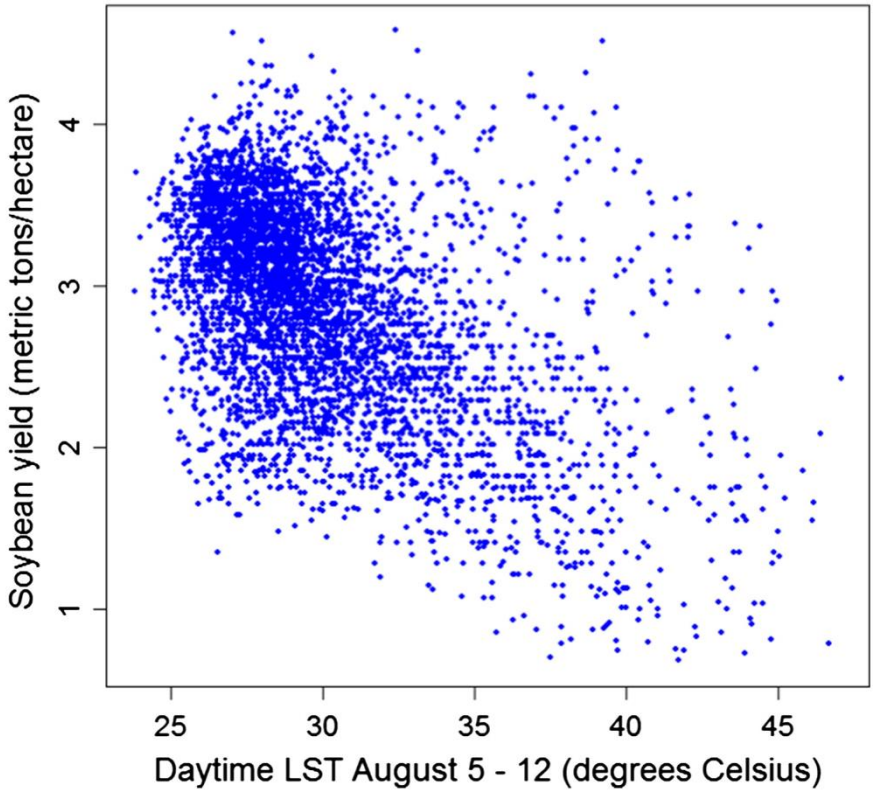
Soybeans Remotely Sensed Variables Correlation by Date
Corn Belt – 2006 to 2011



D.M. Johnson / Remote Sensing of Environment 141 (2014) 116–128

Relationship between NDVI and Surface Temperature to Yield

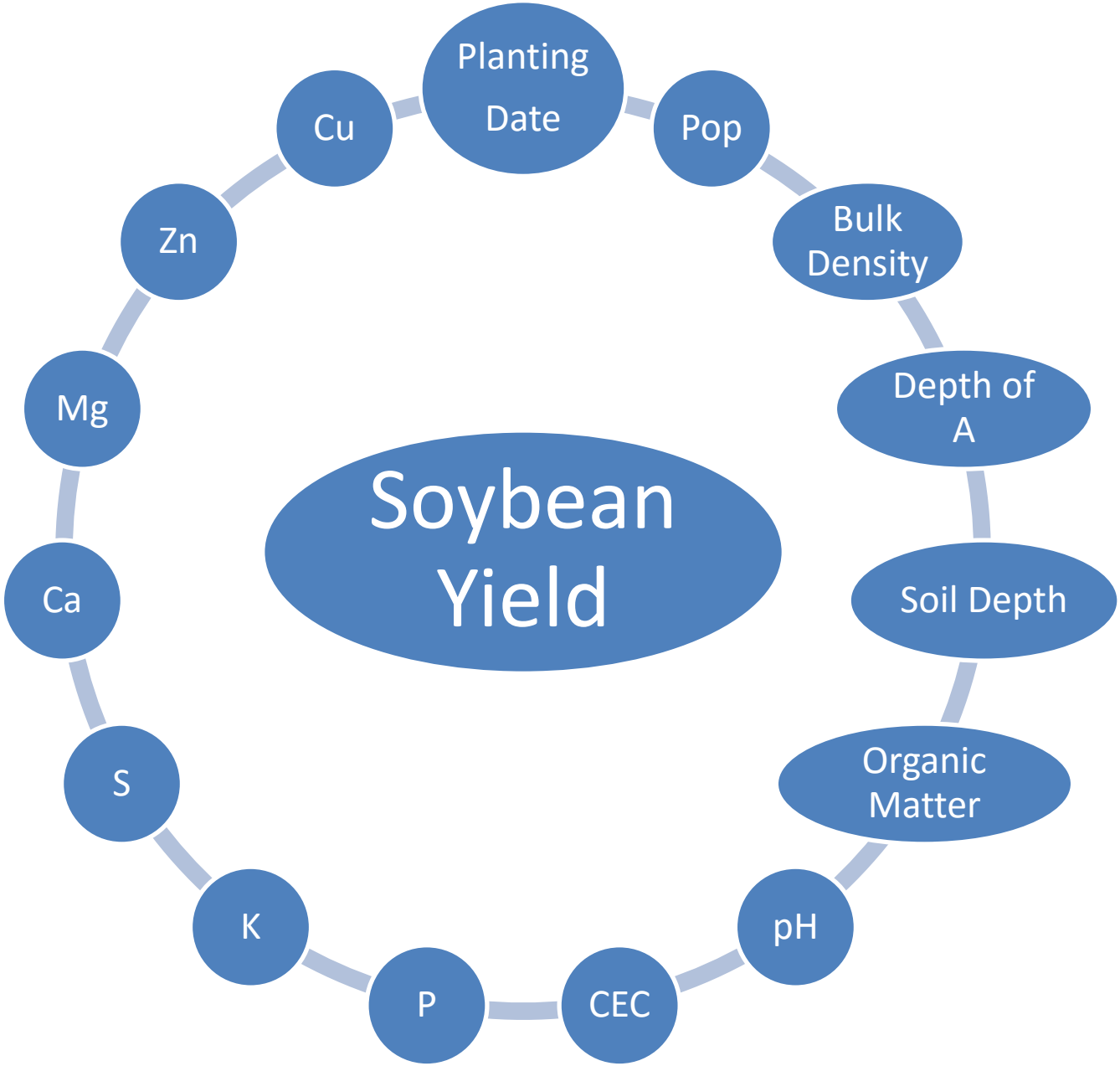




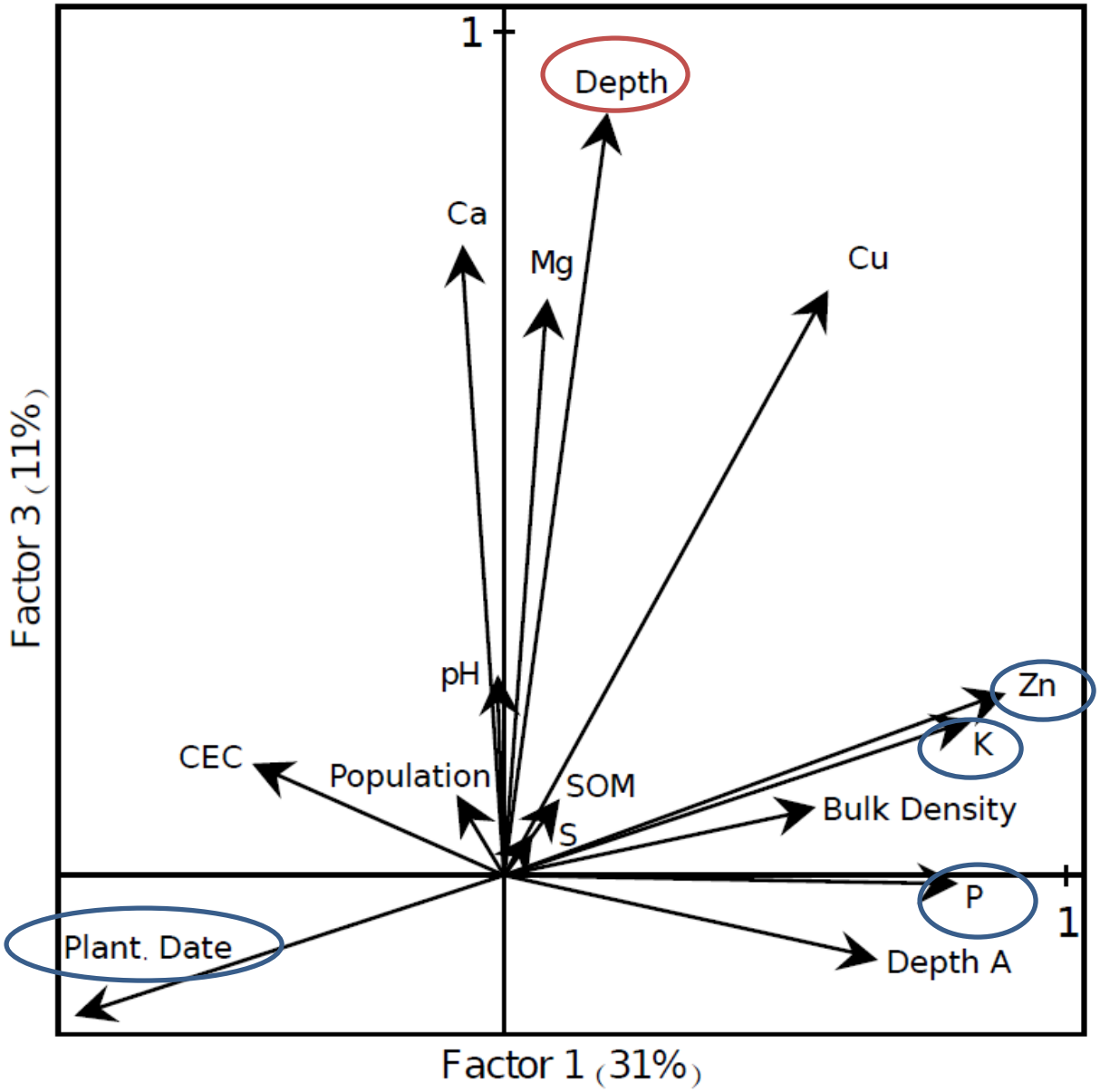
D.M. Johnson / Remote Sensing of Environment 141 (2014) 116–128

How about the soil variables?

22 Fields – Centre and Lebanon



Factor x Yield – PCA Analysis



Take Home Message

- Lebanon Factor
  - Planting Early
  - Manure (P, K, Zn)
- Soil Depth

$R^2 = 0.79$

I thought he would talk about soil health…

Comprehensive Assessment of Soil Health

From the Cornell Soil Health Laboratory, Department of Soil and Crop Sciences, School of Integrative Plant Science, Cornell University, Ithaca, NY 14853. http://soilhealth.cals.cornell.edu

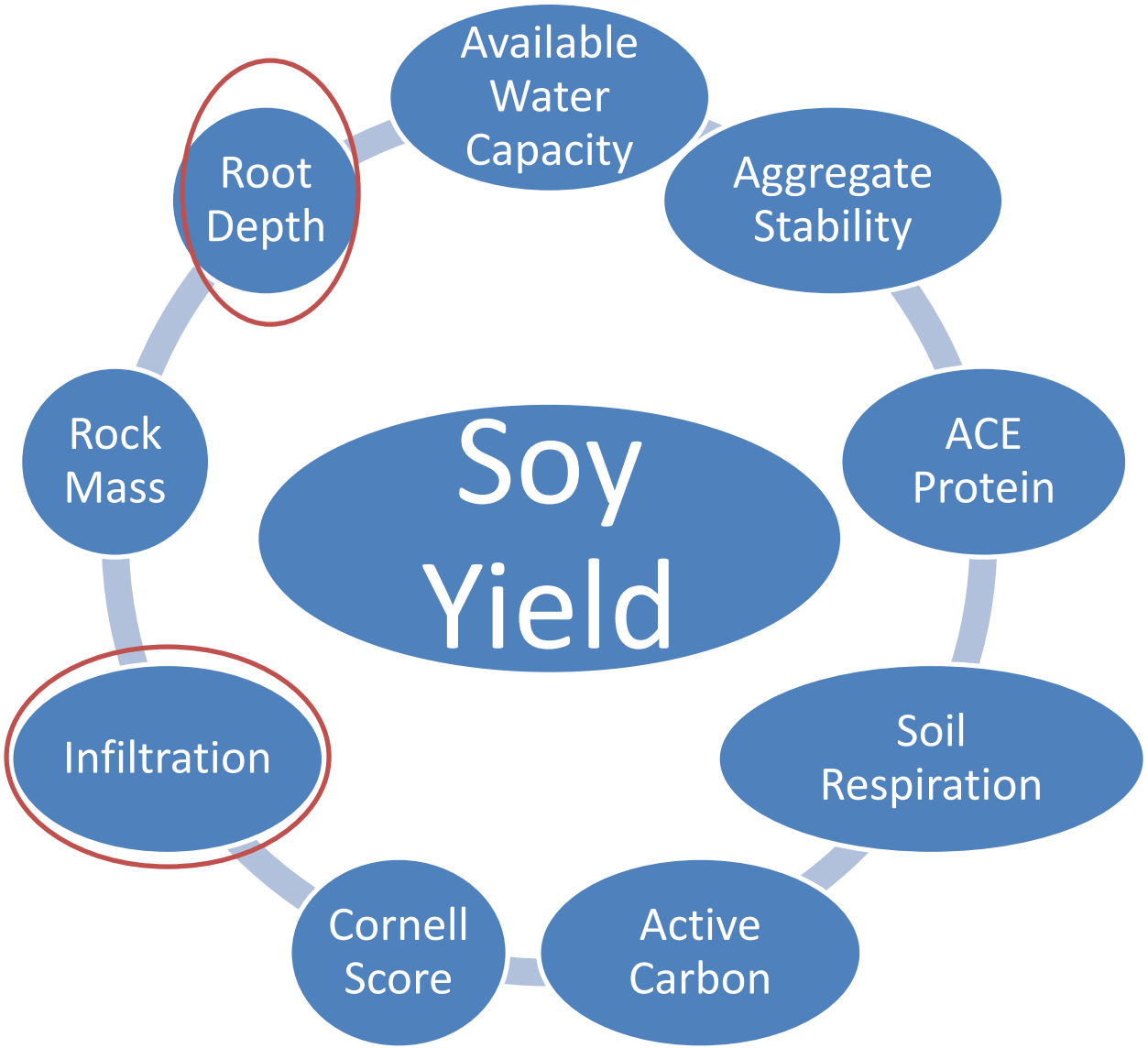
Measured Soil Textural Class: **silt loam**

Sand: **28%** - Silt: **50%** - Clay: **21%**

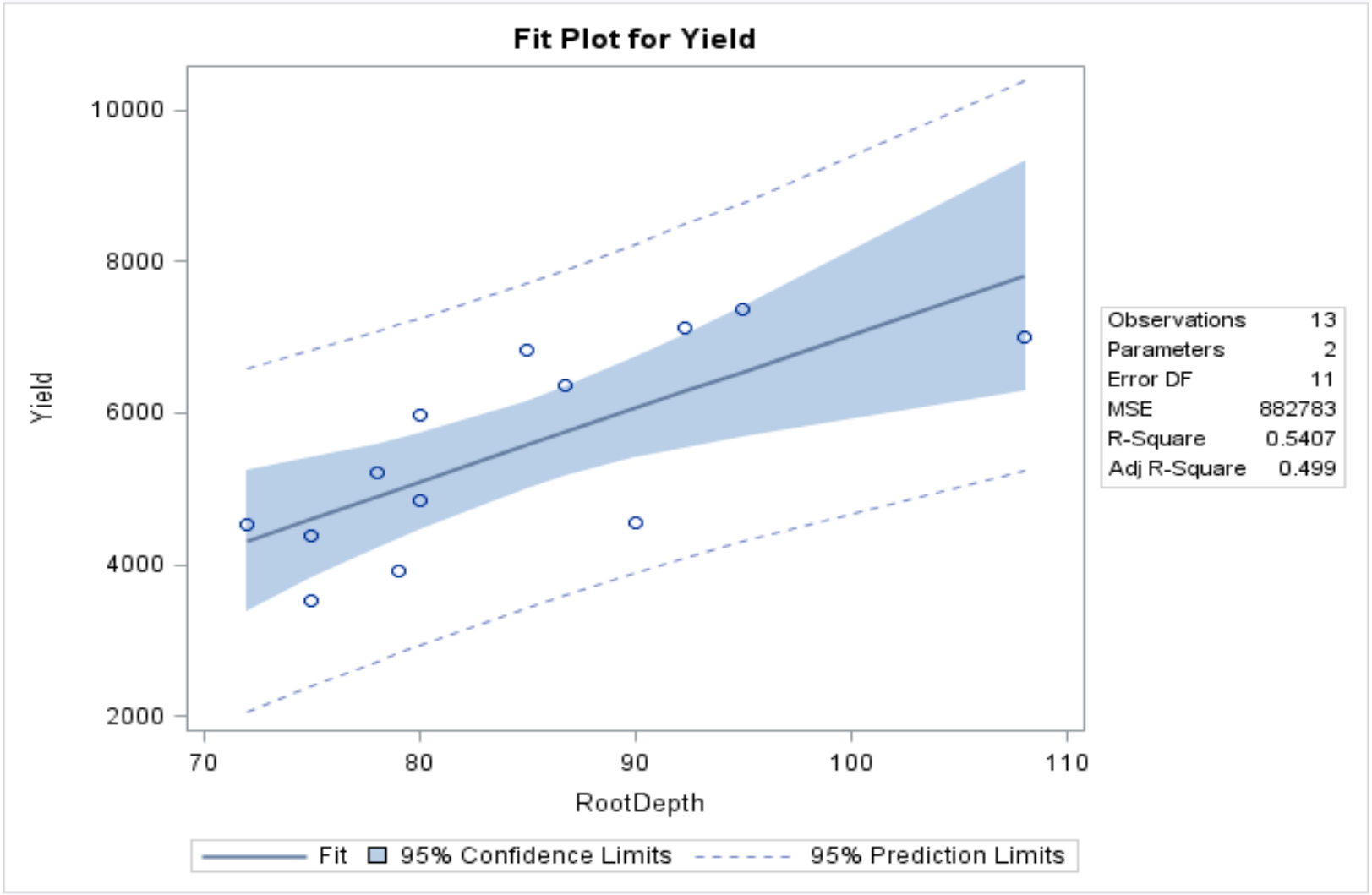
Group	Indicator	Value	Rating	Constraints
physical	Available Water Capacity	**0.21**	**77**	
physical	Surface Hardness			Not rated: No Field Penetrometer Readings Submitted
physical	Subsurface Hardness			Not rated: No Field Penetrometer Readings Submitted
physical	Aggregate Stability	**16.2**	**20**	
biological	Organic Matter	**3.1**	**53**	
biological	ACE Soil Protein Index	**5.0**	**32**	
biological	Soil Respiration	**0.4**	**21**	
biological	Active Carbon	**408**	**31**	
chemical	Soil pH	**5.8**	**41**	
chemical	Extractable Phosphorus	**6.6**	**100**	
chemical	Extractable Potassium	**133.2**	**100**	
chemical	Minor Elements Mg: 31.1 / Fe: 2.5 / Mn: 14.5 / Zn: 0.9		**56**	

Overall Quality Score: **53** / Medium

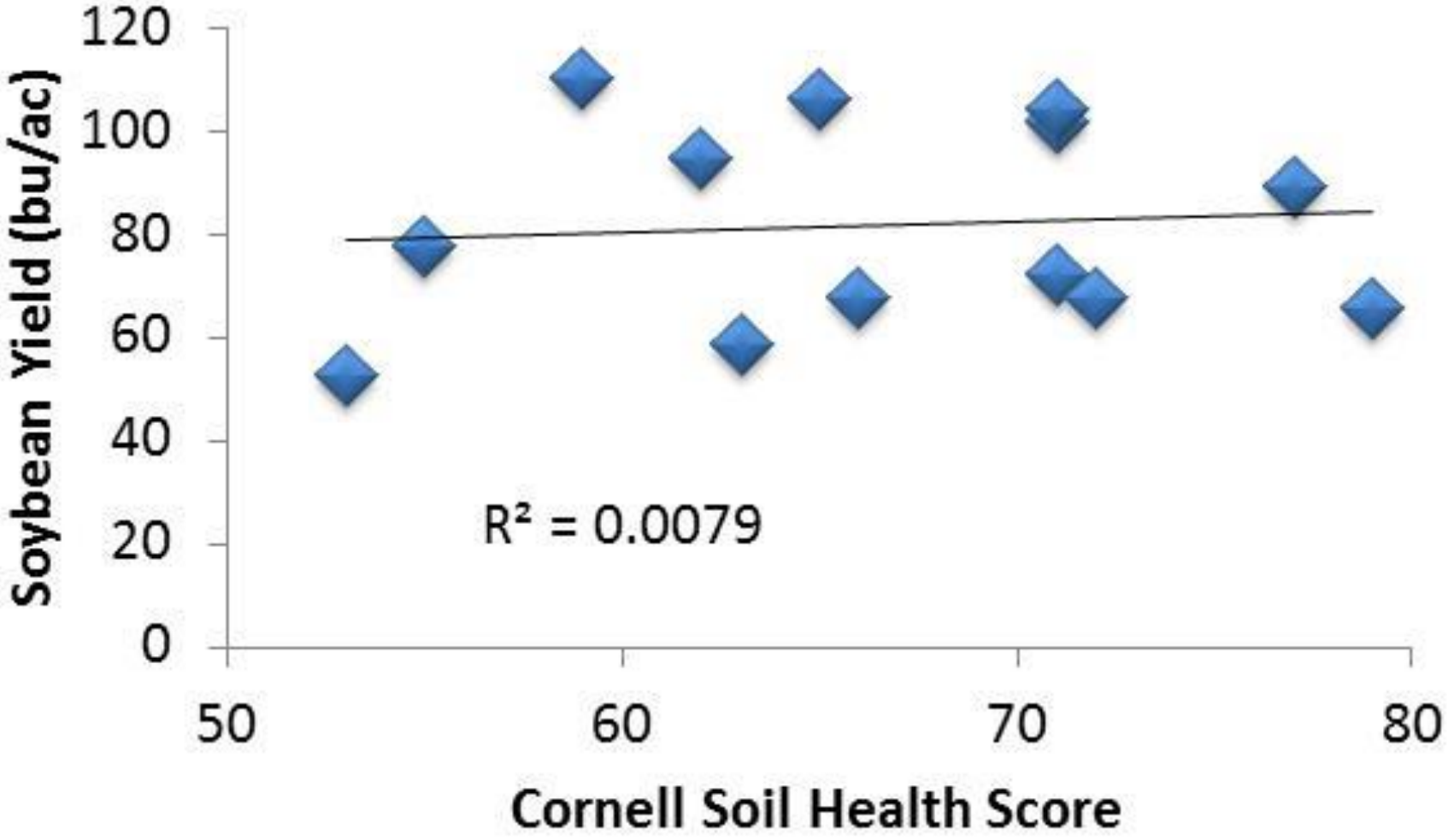
PCA (Soil Health) – 0 to 6 inches



Multiple Regression (Soil Health)



Soil Health

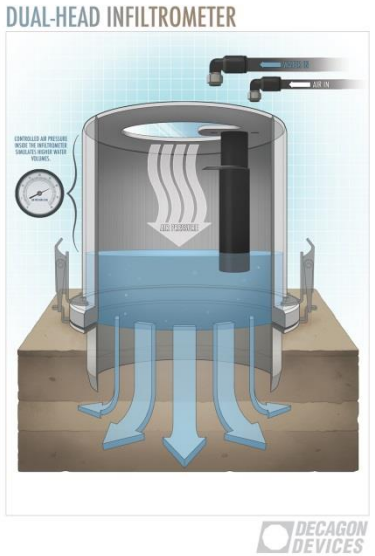

Soybean Yield (bu/ac)
120
100
80
60
40
20
0
50
60
70
80
Cornell Soil Health Score
R² = 0.0079

Take Home Message

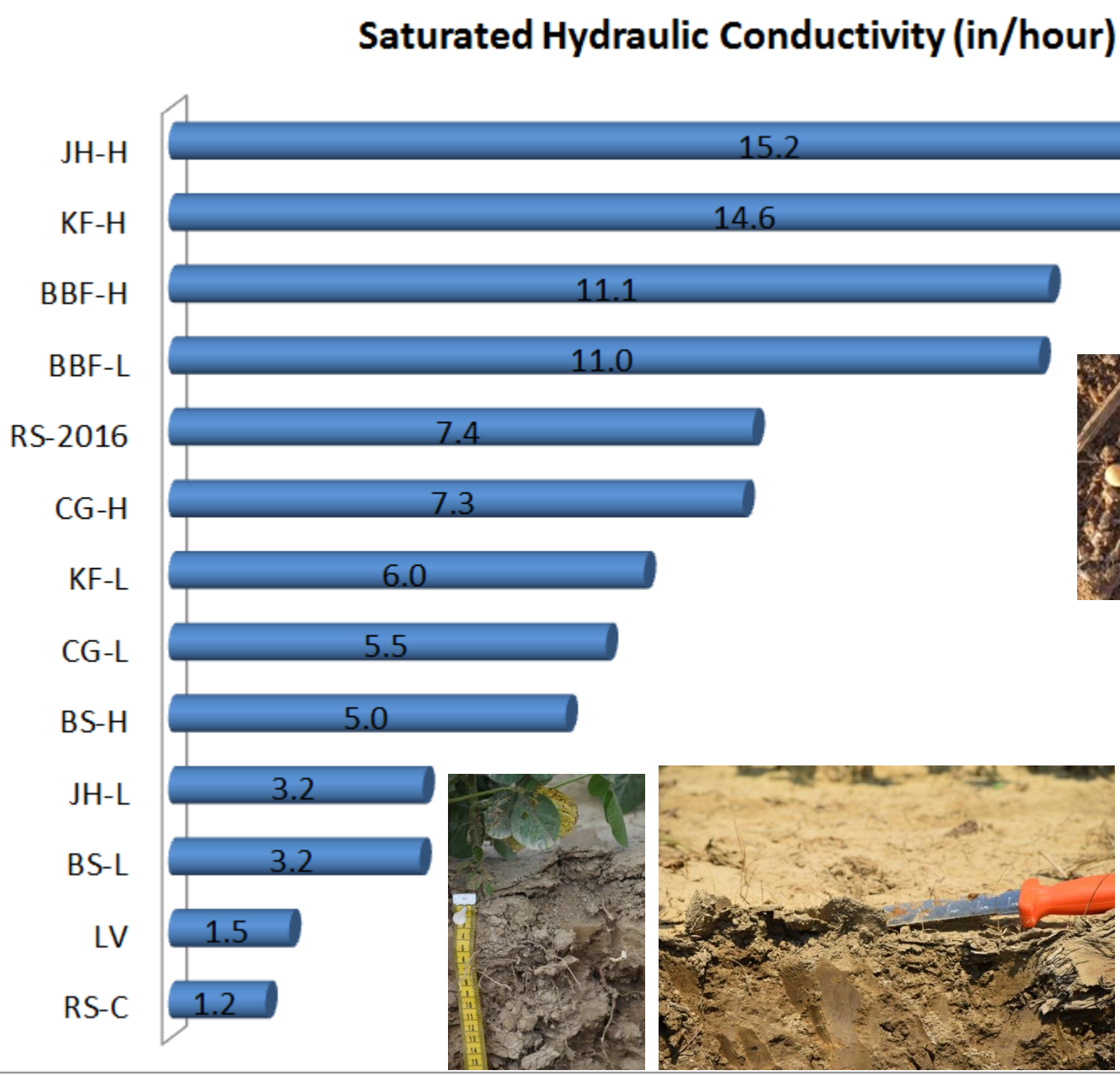
- Infiltration (ksat) and root depth are the main yield predictors, and they are related to each other;
- Root depth alone explains 54% of the soybean yield variation;
- The other soil health indicators were not good yield predictors.

NESARE

Dual Head Infiltrometer

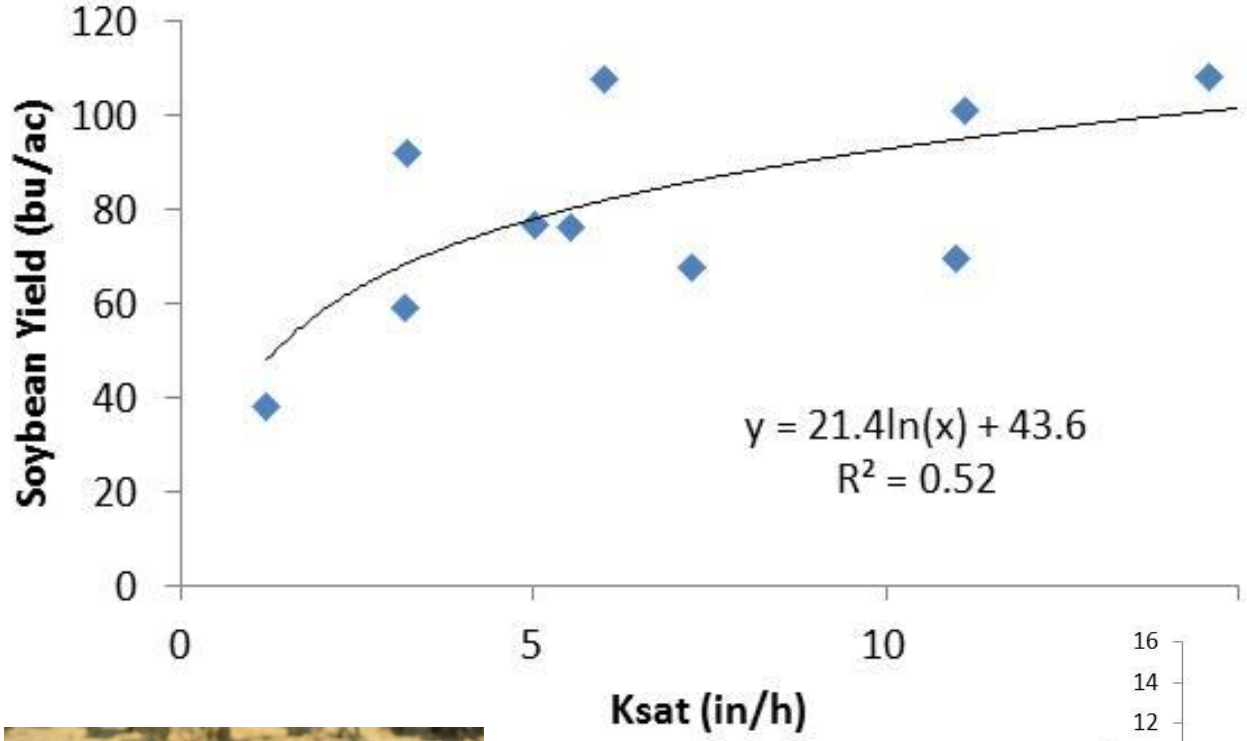


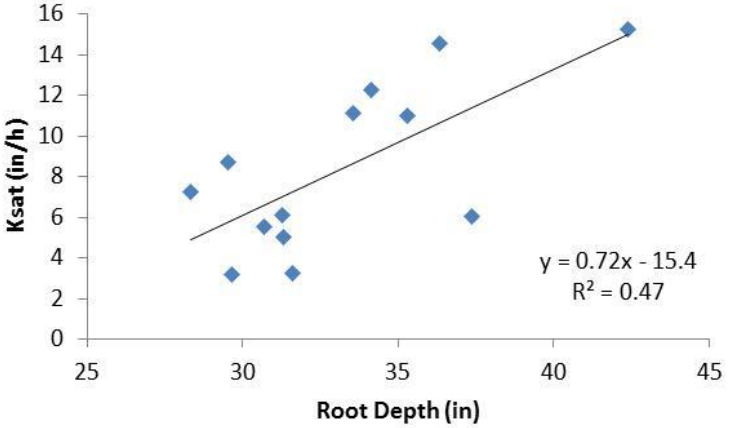
Dual Head Infiltrometer

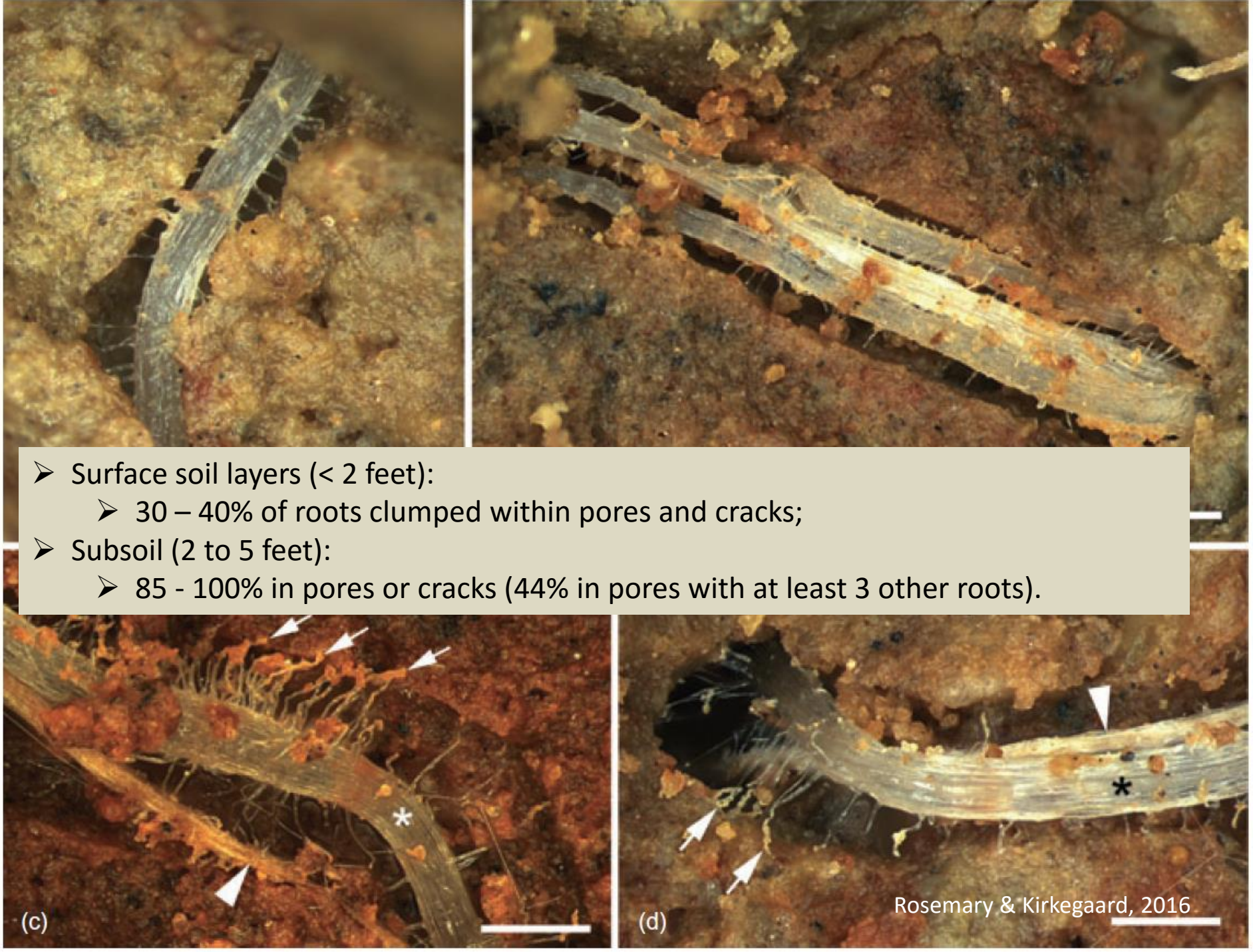


Infiltration

(Lebanon and Centre, 2017)







- Surface soil layers (< 2 feet):
  - 30 – 40% of roots clumped within pores and cracks;
- Subsoil (2 to 5 feet):
  - 85 - 100% in pores or cracks (44% in pores with at least 3 other roots).

Rosemary & Kirkegaard, 2016

Final Comments

- **Plant as early as possible** – Every day matters!
- **Focus on Light Interception at R1** - Manage population and row spacing based on your environment.
- After raising soil macro and micro to optimum levels, **focus on raising your soil infiltration levels.**
- Genotype x Soil x Climate interactions – **Understand you varieties**.

Thank You!

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gbs5118@psu.edu