Using Crop Models to Understand and Maximize Soybean Yields

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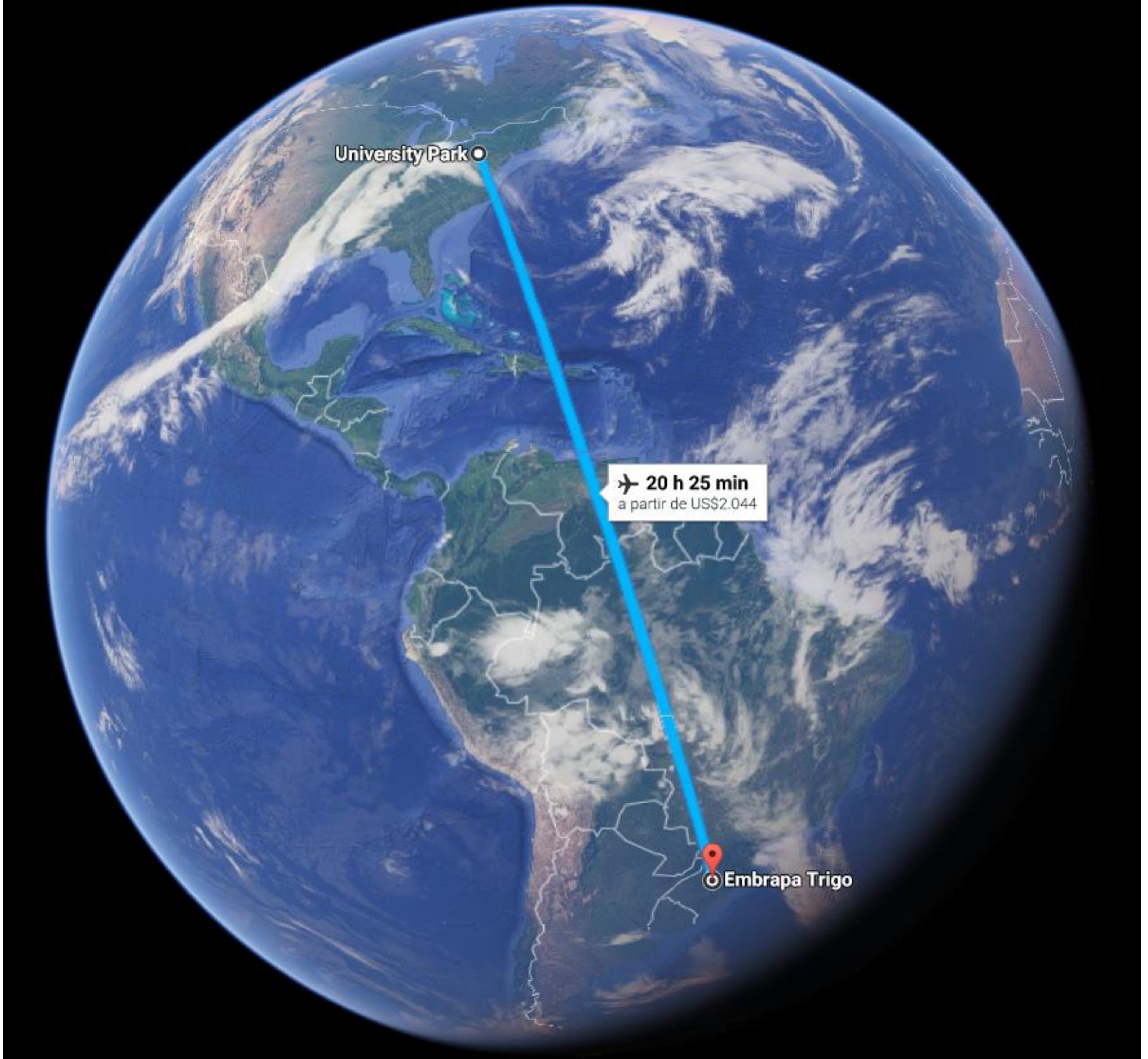
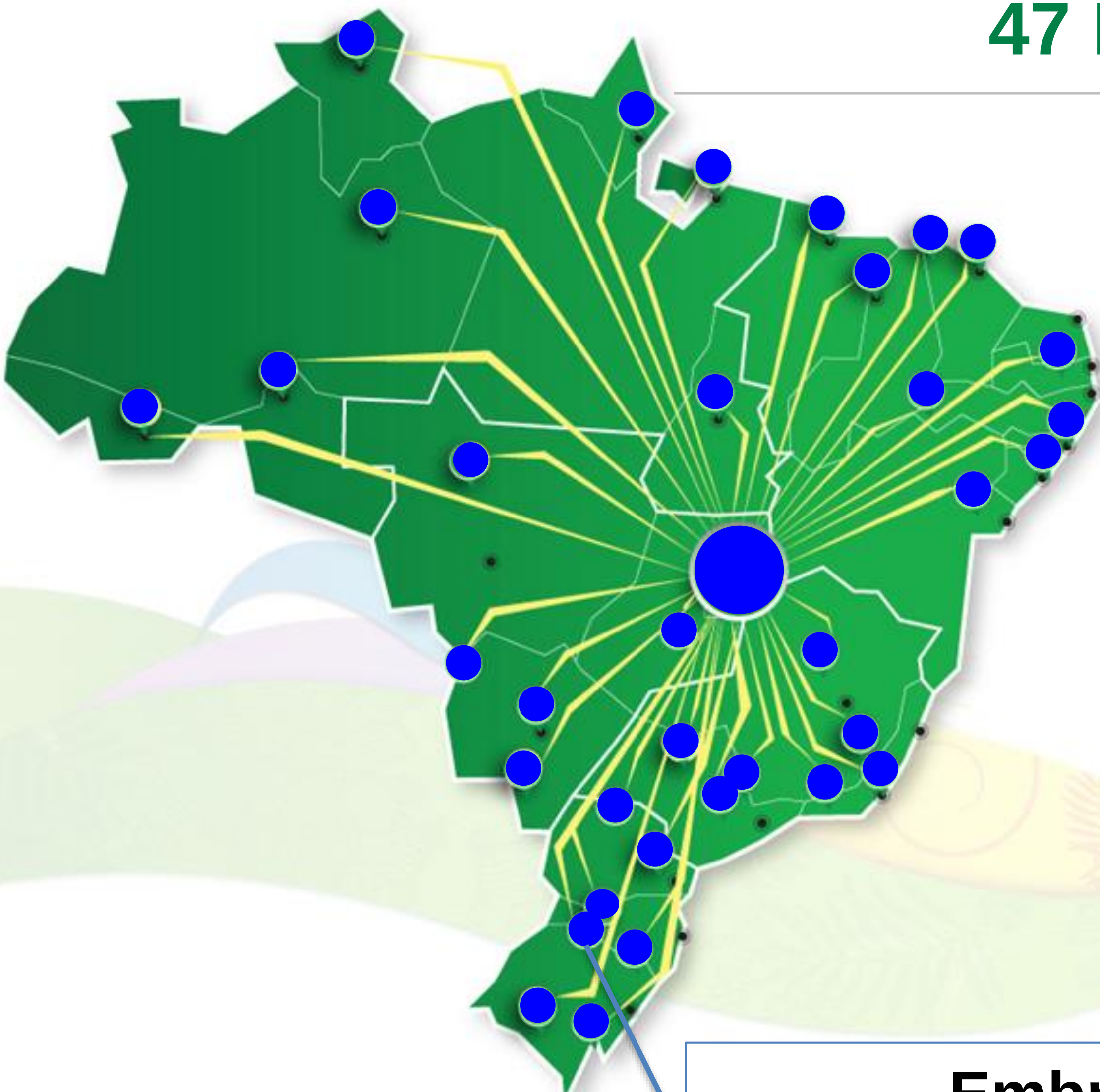
Keystone Crops and Soils Conference
October 25th, 2017

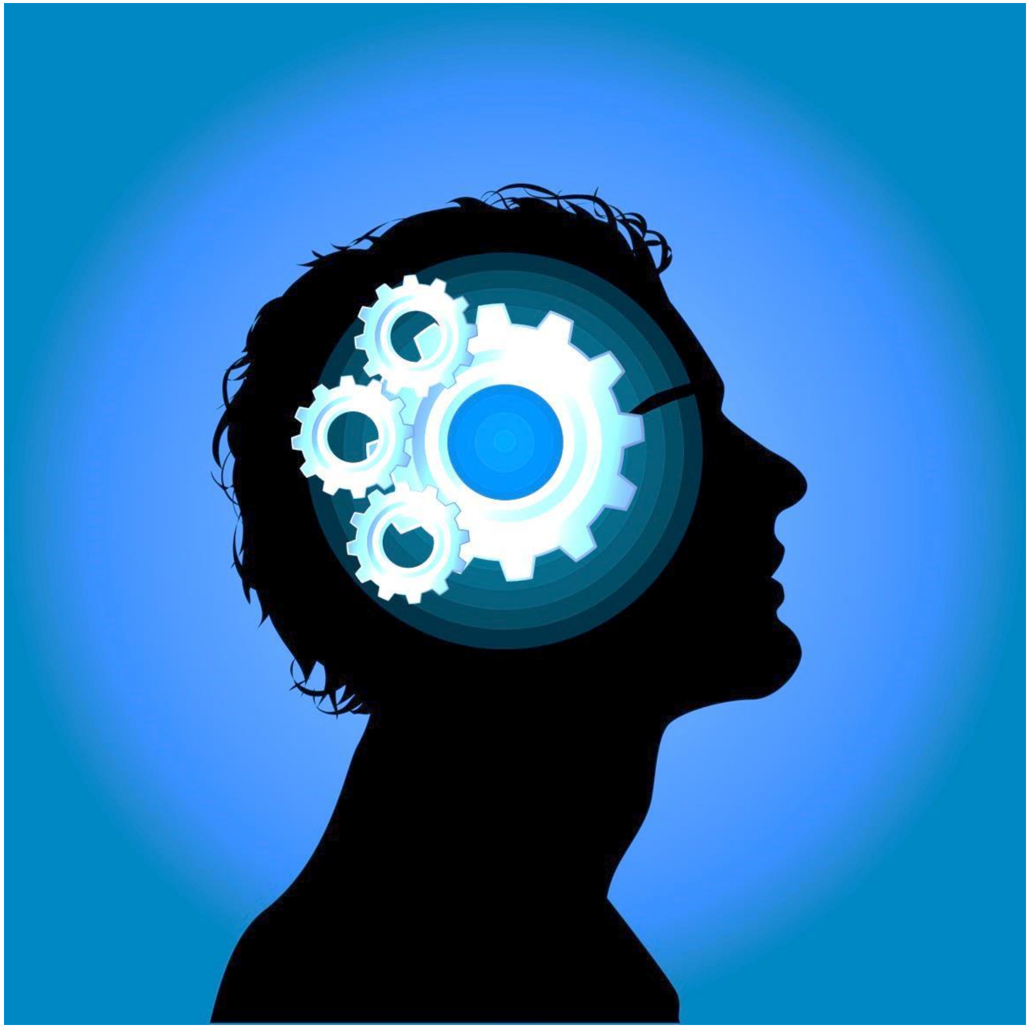

University Park
20 h 25 min
a partir de US$2.044
Embrapa Trigo

47 Research Stations



Embrapa Wheat
(28°15′ 46″S, 52°24′25″W)

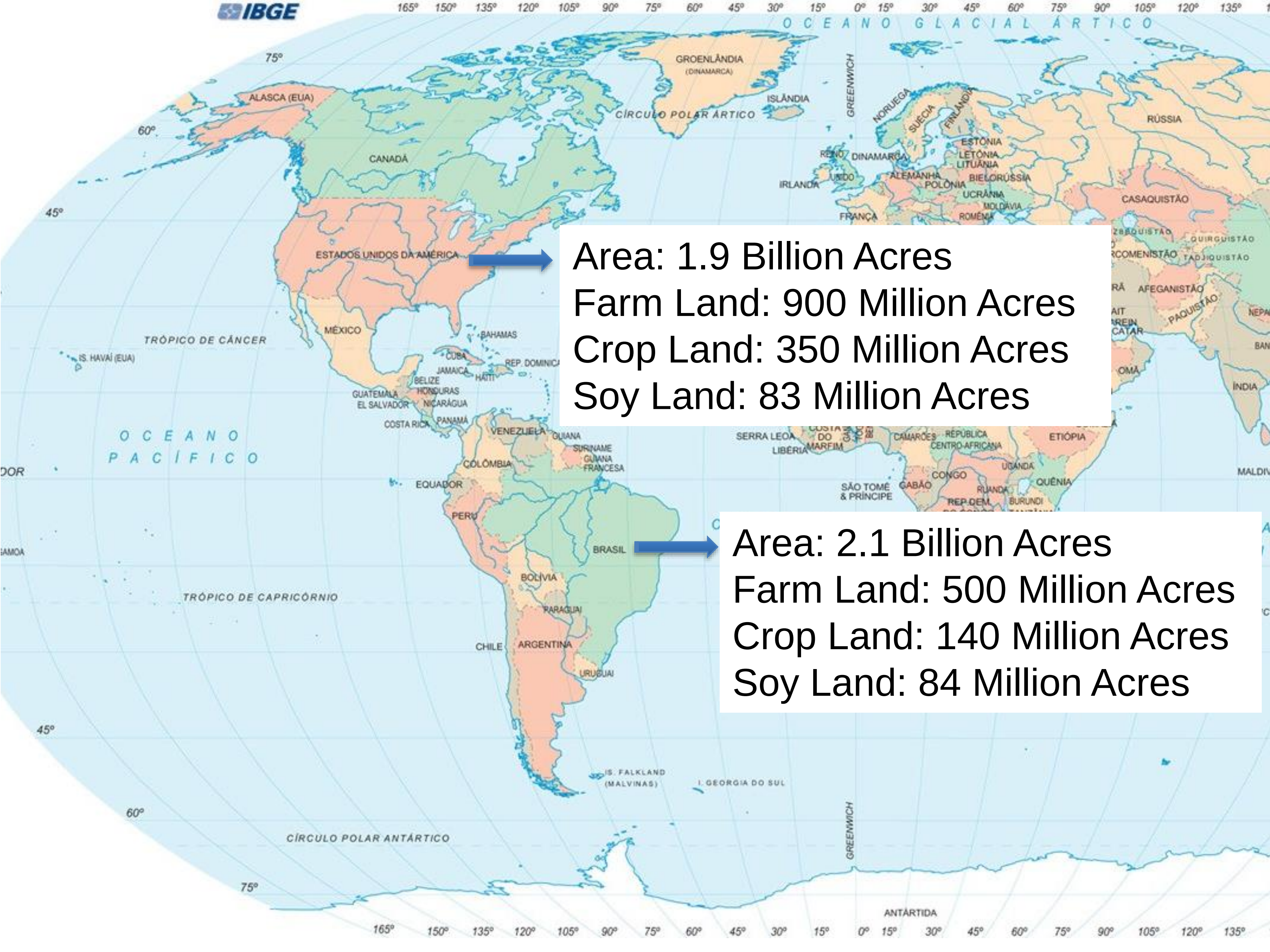
Why should we use Crop Models?



- It is a great tool to help you think over several agronomic questions
- It helps you to obtain a more refined understanding of the situation
- It allows you to answer questions that are almost impossible to assess in the field

Talk Messages

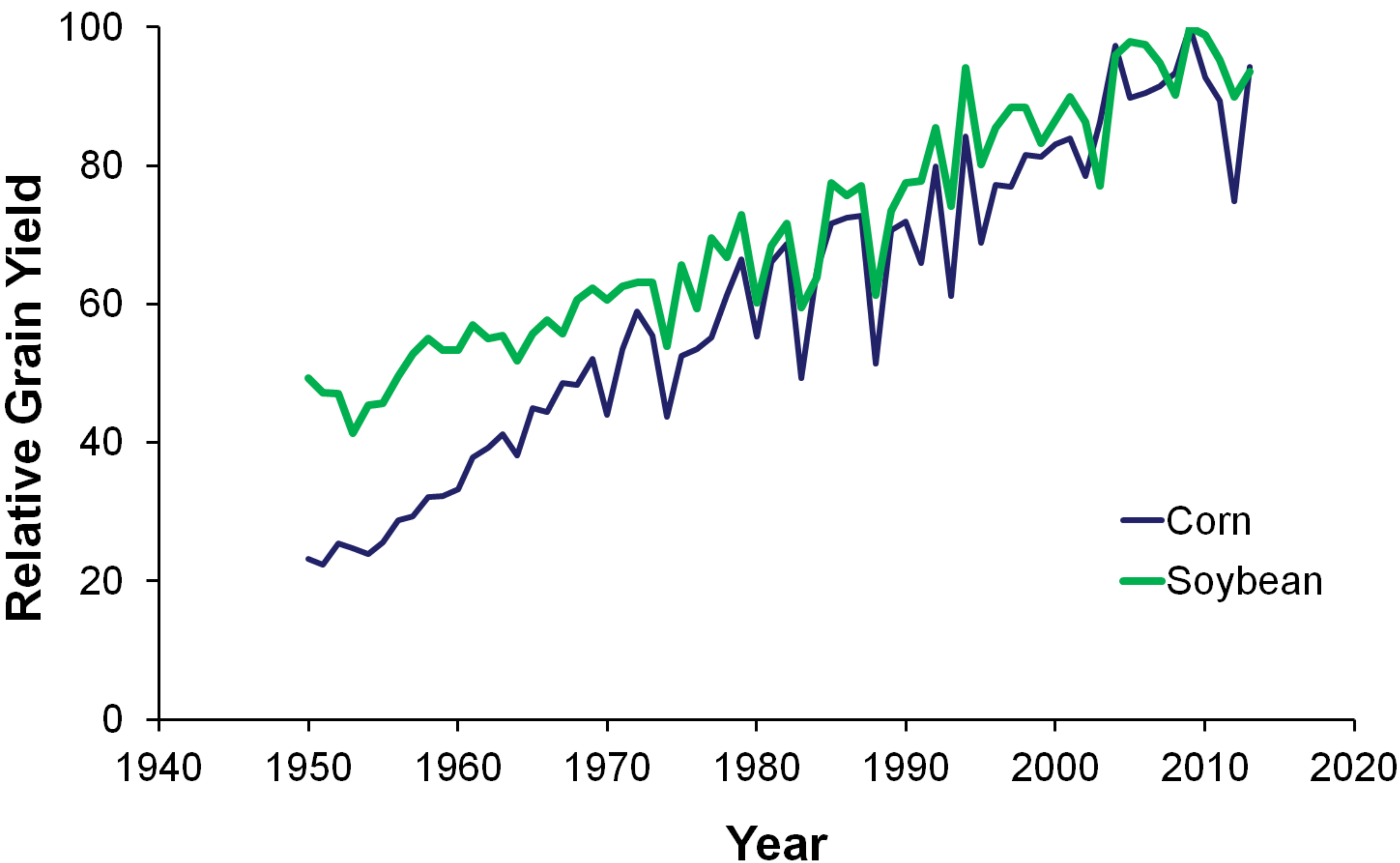
- Soybean yield overview
- Each location has its own yield potential
- How Cycles works
- Yield Simulations: soil depth, planting date, Brazil, population, cropping systems
- Soil health and yield
- 2018 International Soybean Production Tour



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

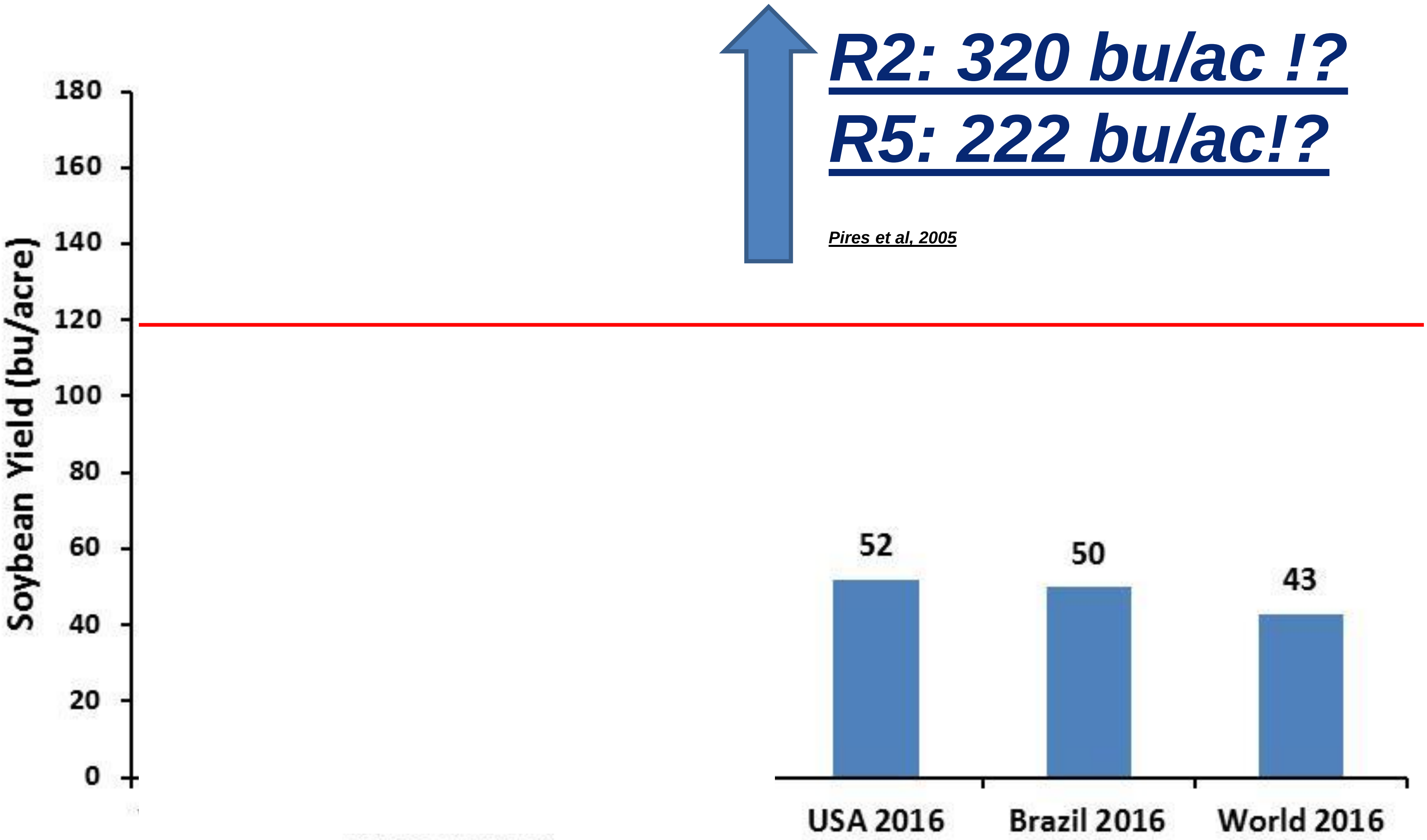


Yield gap

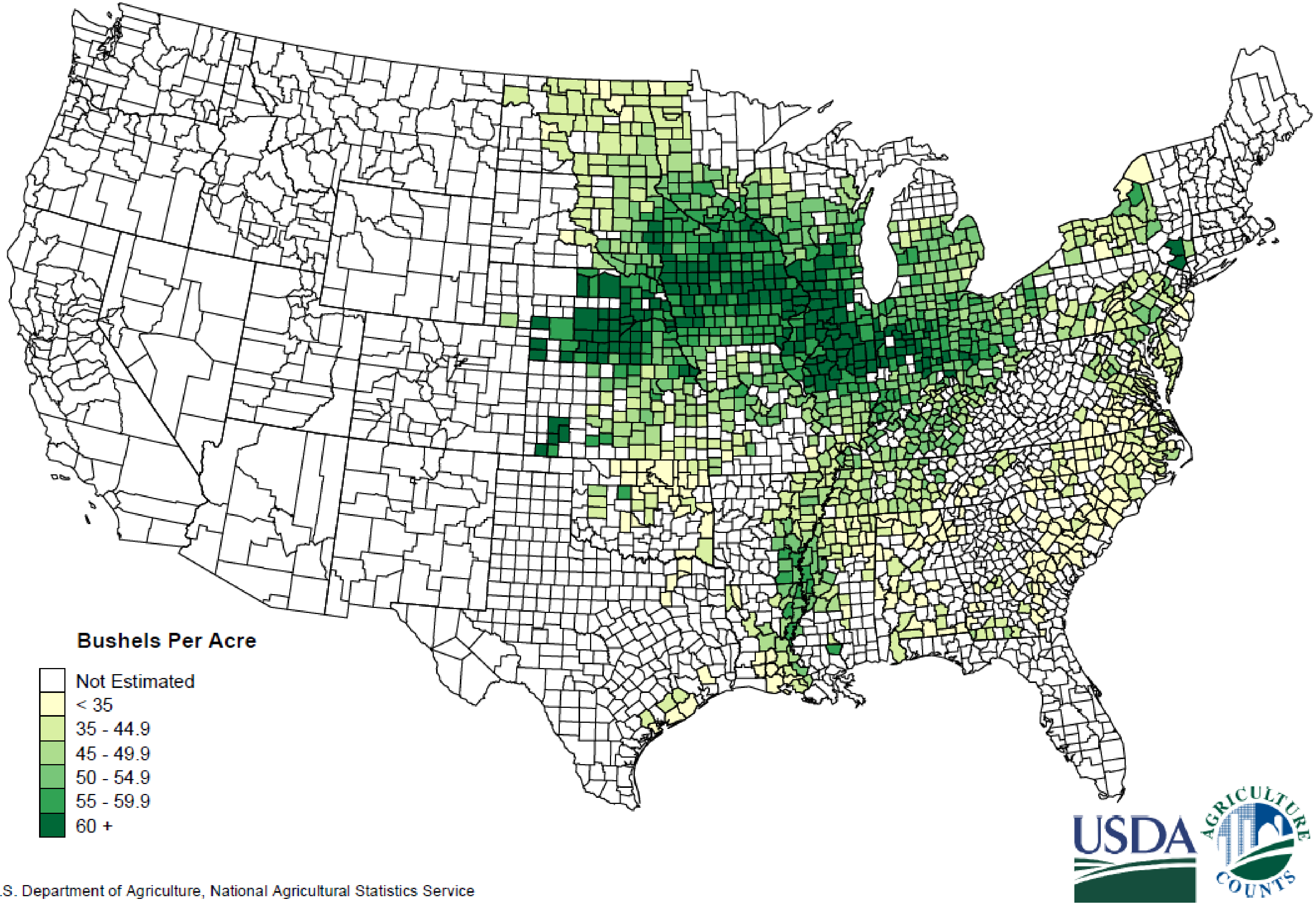
R2: 320 bu/ac !?

R5: 222 bu/ac!?

Pires et al, 2005



Soybeans 2016
Yield Per Harvested Acre by County
for Selected States

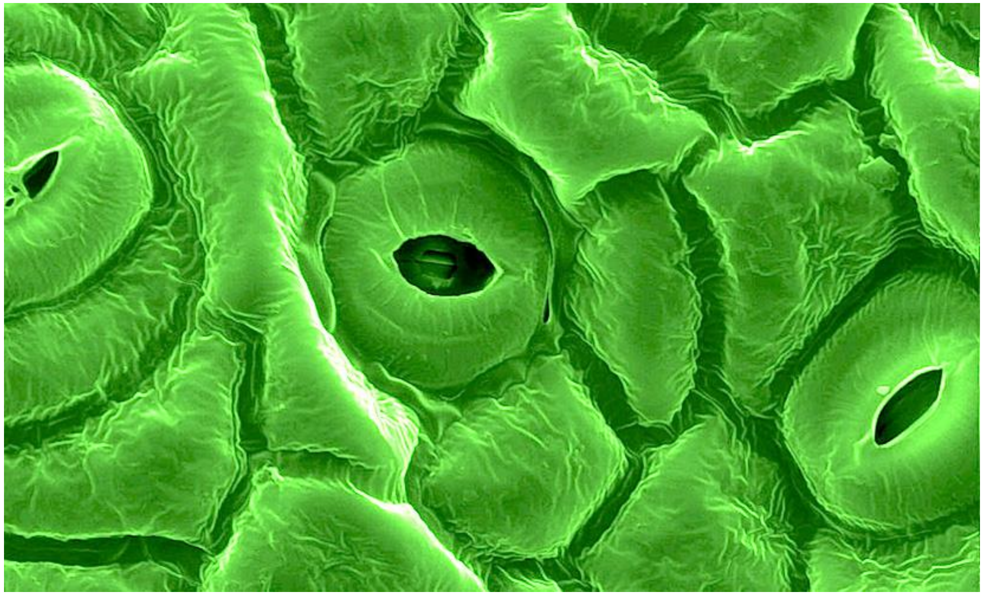


U.S. Department of Agriculture, National Agricultural Statistics Service

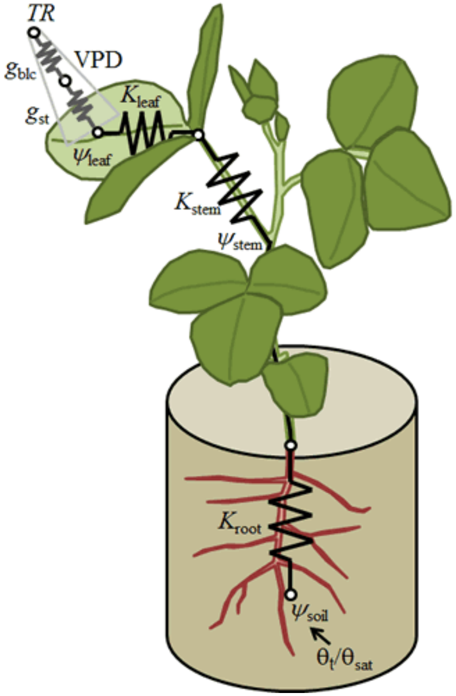
Radiation and Transpiration

Recall that:

- Radiation drives photosynthesis and plant water use
- H_2O and CO_2 leave and enter through stomata

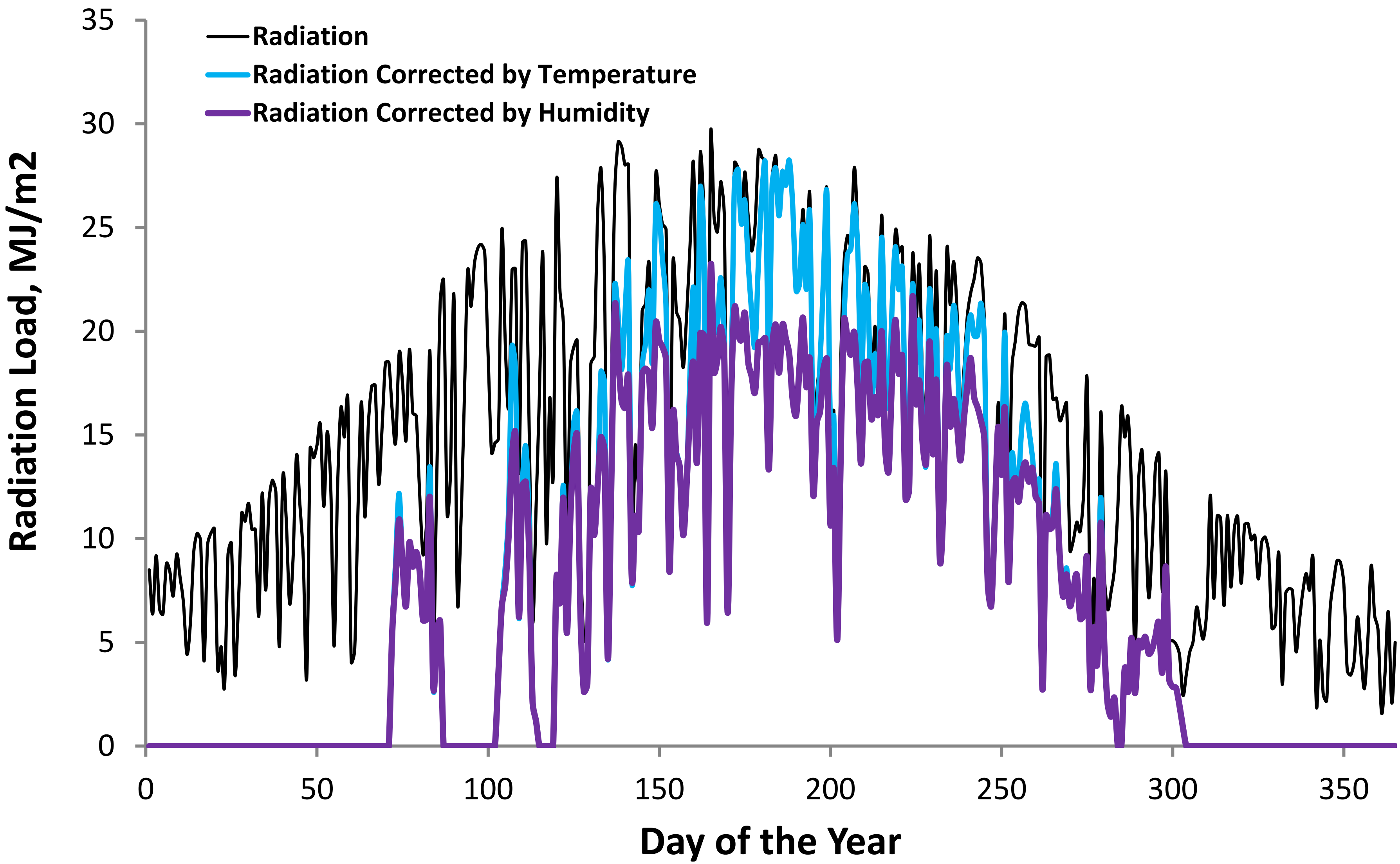


https://plantstomata.wordpress.com



http://www.plantsciences.ucdavis.edu/plantsciences_faculty/gilbert/main/stomata_water_use_research.htm

Growth Radiation, Temperature, Humidity



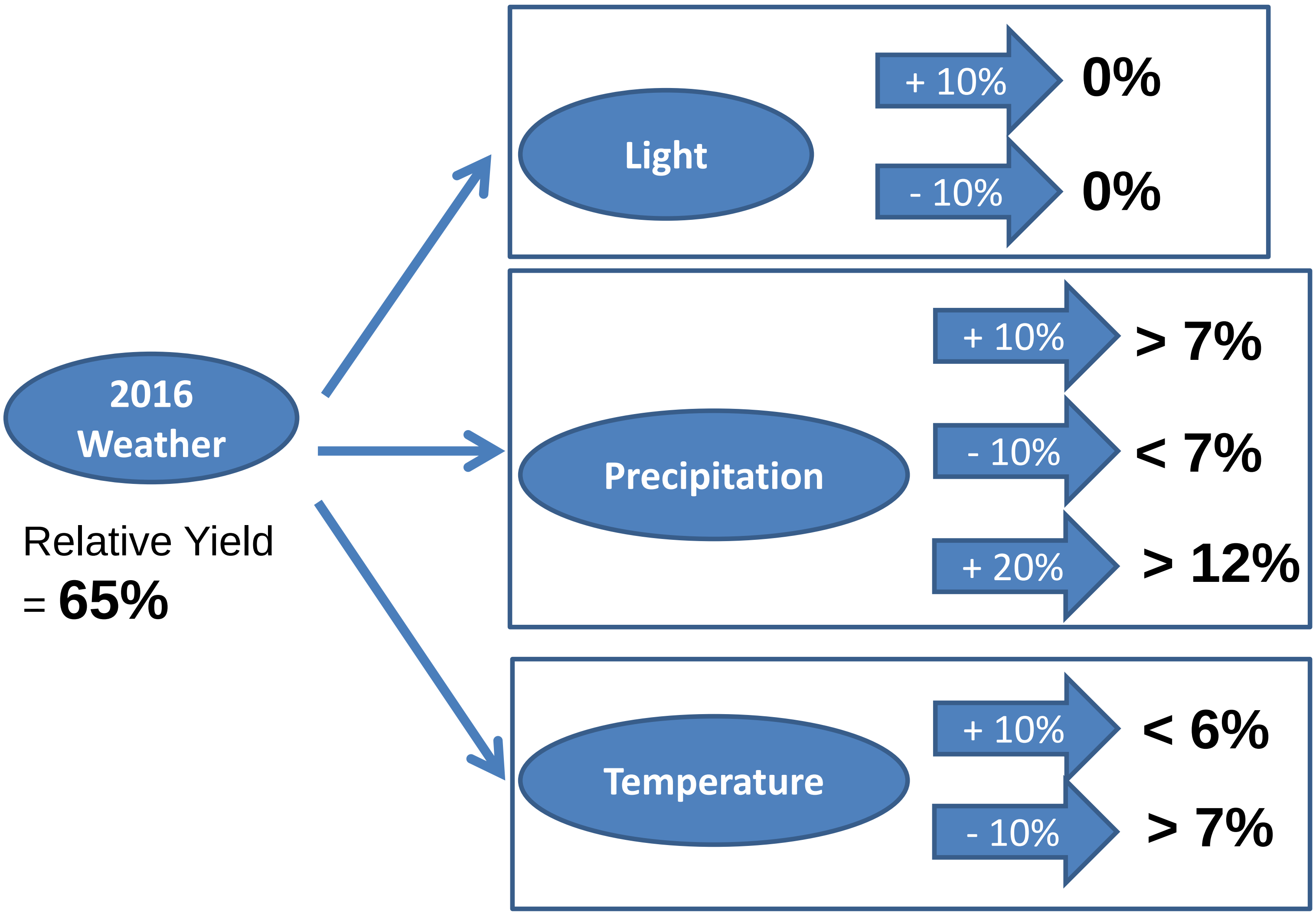
PA Compare with Urbana, IL

Variable	Lebanon, PA	St. College, PA	Urbana, IL
Thermal Time, Cd *	2460	2120	2670
Days of Growth	197	183	202
Radiation, MJ/m^2	3540	3200	3660
Rad x Temp, MJ/m^2	2640	2300	2860
Rad x Vapor, MJ/m^2	2280	2010	2410
Relative "Yield"	95	83	100

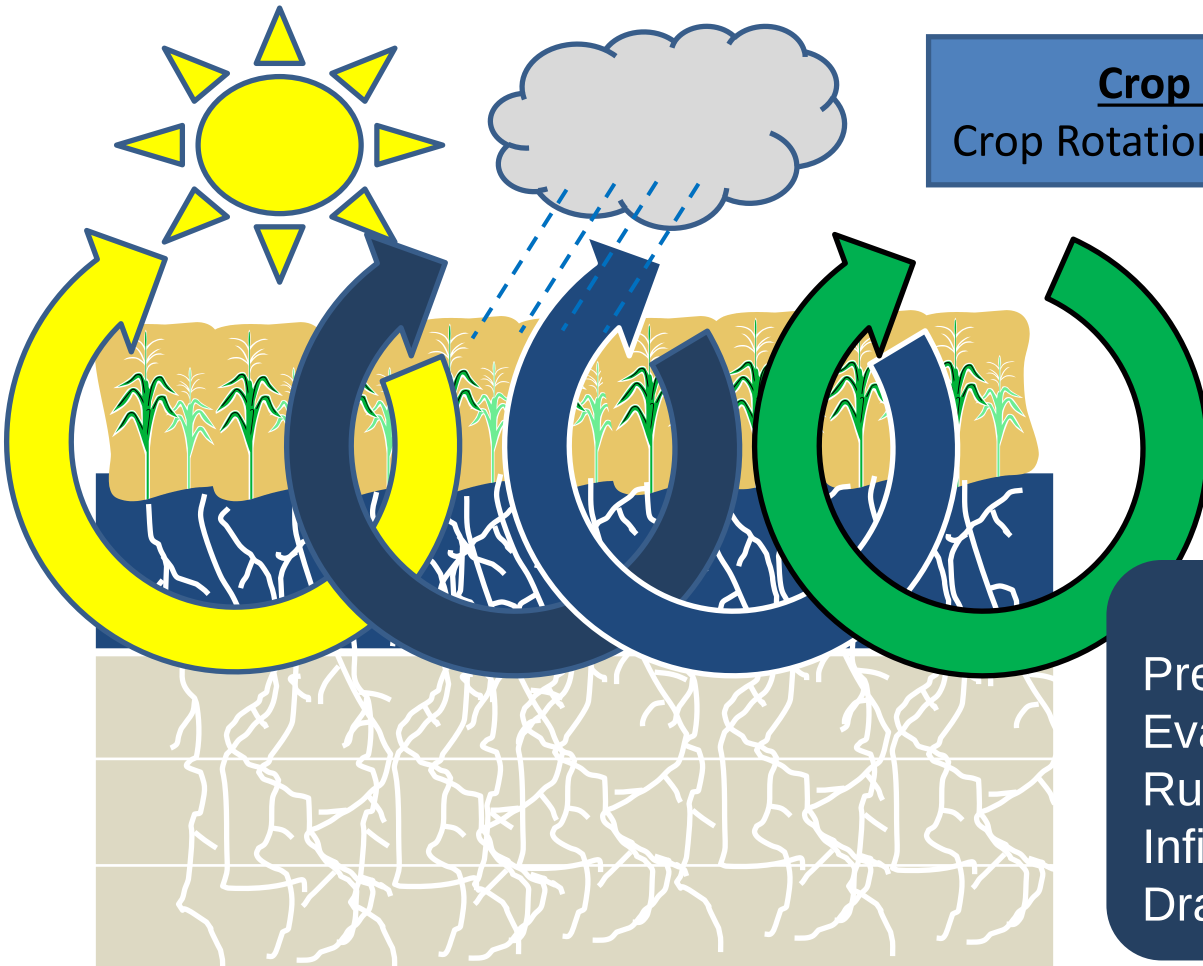
*(T_b = 6°C)

Simulations Cornwall, PA

Full Season_2016



Cycles Model



Crop Production Over Time

Crop Rotations and Management Practices

Energy
Solar Radiation
Photosynthesis
Evaporation
Heat gain/loss

Water
Precipitation
Evaporation
Runoff
Infiltration
Drainage

Carbon
Photosynthesis
Crop Yield
Residue Inputs
Respiration
Soil Storage

Nitrogen
N Fixation, Fertilizer Additions
N Mineralization, Crop Uptake
N Leaching and Gas Losses

The coupled cycles of energy, water, carbon, and nitrogen, interacting with the environment over time, in the context of agricultural crop production

Weather — A weather file formatted for Cycles

UEPP_workshop.weather - Notepad

File Edit Format View Help

```
LATITUDE          -33.25
ALTITUDE          57
SCREENING_HEIGHT  2
YEAR    DOY     PP      TX      TN      SOLAR   RHX     RHN     WIND
1995    1       0.0     35.8    19.3    29.59   83.84   31.91   1.40
1995    2       0.0     32.7    18.9    23.76   84.33   37.20   2.35
1995    3       0.0     31.4    21.6    17.68   87.31   48.99   4.03
1995    4       0.0     32.6    21.3    25.88   90.04   46.34   2.68
1995    5       0.0     31.2    20.3    23.80   95.76   50.17   2.34
1995    6       0.0     28.3    15.1    32.65   96.83   43.19   2.13
1995    7       0.0     32.7    10.5    29.84   88.01   22.58   2.02
1995    8       0.0     35.0    20.5    16.27   89.42   38.32   3.17
1995    9       0.0     27.8    14.0    22.03   97.43   41.67   1.91
1995    10      0.0     25.5    9.3     31.79   89.72   32.21   2.16
1995    11      0.0     25.7    12.1    26.39   91.15   38.96   3.12
1995    12      0.0     28.2    8.5     27.97   91.53   26.56   2.32
1995    13      1.7     21.9    19.0    12.85   89.31   74.67   2.87
1995    14      3.7     33.2    21.8    28.66   82.05   42.10   1.35
1995    15      0.0     31.1    21.5    27.68   89.50   50.77   2.36
1995    16      0.0     28.4    18.1    5.94    95.08   51.02   3.02
1995    17      41.3    26.9    16.8    22.93   93.23   50.31   2.03
1995    18      0.0     26.0    14.9    19.01   89.56   45.13   2.33
1995    19      0.0     27.5    16.1    22.61   85.12   42.41   3.53
1995    20      0.0     31.0    20.6    25.02   64.19   34.65   2.13
1995    21      0.0     30.3    20.5    23.22   89.42   49.93   3.62
1995    22      0.9     28.4    20.4    21.78   93.41   57.84   3.54
1995    23      0.0     33.5    19.3    26.46   93.94   40.62   2.03
1995    24      0.0     31.5    19.0    22.75   98.14   46.63   1.65
1995    25      0.0     31.4    13.8    26.57   84.87   29.12   1.92
1995    26      0.0     32.2    13.3    29.05   74.17   23.54   1.54
1995    27      0.0     34.2    17.4    26.39   79.92   29.50   3.31
```

PP = precipitation in mm

TX = maximum temperature in C

TN = minimum temperature in C

SOLAR= solar radiation MJ/m^2

RHX= Maximum Relative Humidity (%)

RHN=Minimum Relative Humidity (%)

WIND= Wind Speed in m/s

Weather Variables Control Crop Growth

Biomass Growth

- ***Radiation*** * Canopy Interception * Rad. Use Efficiency
- ***Transpiration*** * Transp. Use Efficiency ($\propto$ Vapor Pressure Deficit)

Radiation or Transpiration limited growth

Since GR and GT can be different, each day we select the minimum of the two

Sunny day: limited by transpiration

Cloudy day: limited by radiation

Soil Profiles
A soil profile formatted for Cycles

UEPP.soil - Notepad

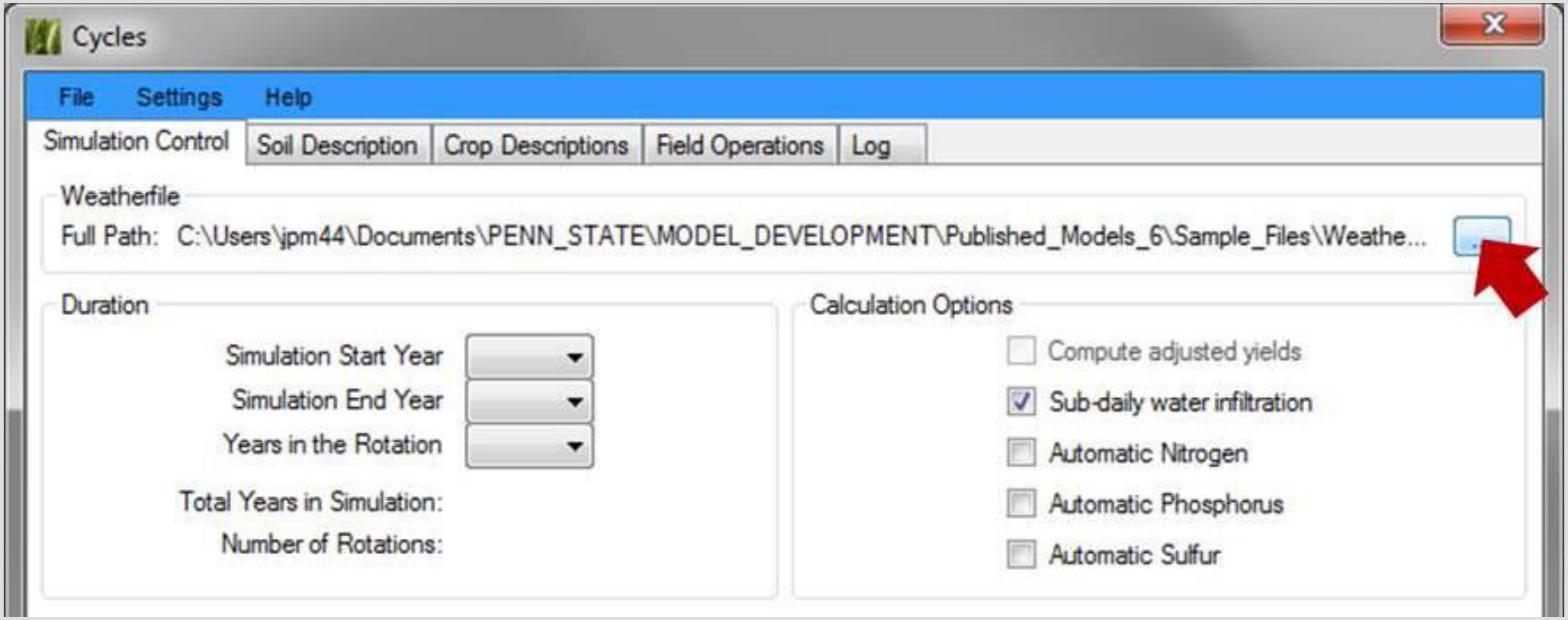
File Edit Format View Help

```
CURVE_NUMBER        70
SLOPE               0
TOTAL_LAYERS        10
LAYER   THICK   CLAY    SAND    ORGANIC BD      FC      PWP     NO3     NH4
1       0.09    20.70   39.20   3.30    1.16    -999.00 -999.00 20.00   3.00
2       0.18    19.60   39.00   1.50    1.39    -999.00 -999.00 15.00   2.00
3       0.14    46.90   24.40   1.00    1.39    -999.00 -999.00 7.00    1.00
4       0.20    48.30   22.20   0.70    1.34    -999.00 -999.00 2.00    0.50
5       0.10    45.80   22.80   0.34    1.37    -999.00 -999.00 1.00    0.20
6       0.28    40.40   28.50   0.20    1.42    -999.00 -999.00 0.50    0.10
7       0.26    44.40   37.20   0.09    1.73    -999.00 -999.00 0       0
8       0.16    47.30   39.30   0.02    1.55    -999.00 -999.00 0       0
9       0.31    32.60   48.60   0.02    1.55    -999.00 -999.00 0       0
10      0.18    28.90   55.70   0.02    1.57    -999.00 -999.00 0       0
```

Soil Depth

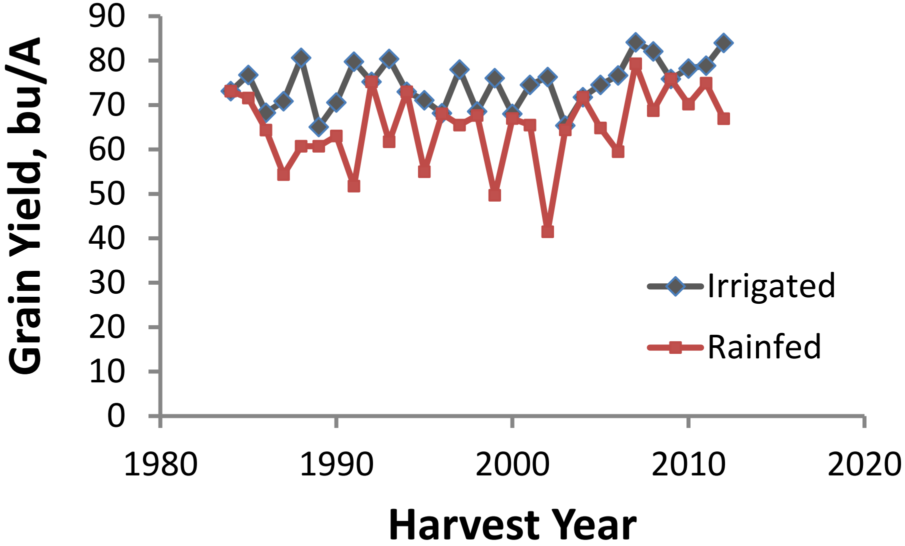
Yields PA Simulations using model Cycles

Location: Lebanon, PA
Climate: 1984 – 2012 daily time series
Soils: silt loam to clay loam, 2 ft and 4 ft deep
Crops: Corn and Soybean
Management: Irrigation included to estimate yield potential



Yields PA | Soybean

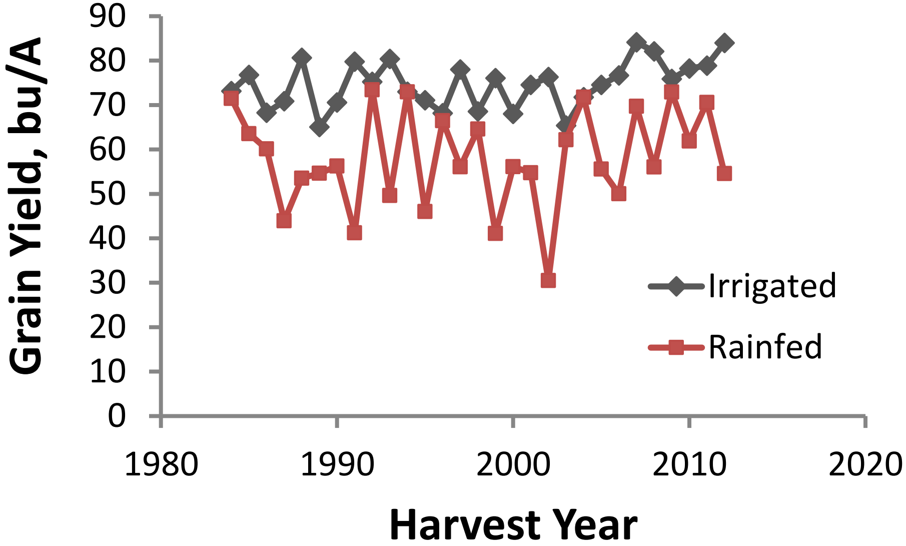
4 ft deep soil



	Yield bu/A	CV %
Irrigated	75	7
Rainfed	65	13

1/2 of years rainfed soybean was within 95% of potential

2 ft deep soil



	Yield bu/A	CV %
Irrigated	75	7
Rainfed	58	19

1/4 of years rainfed soybean yield was within 95% of potential

Virginia Tech

Increasing Yields and Profitability for Mid-Atlantic Double-Crop Soybean

Inventing Double Cropping's Future

USB Project #1620-832-8273

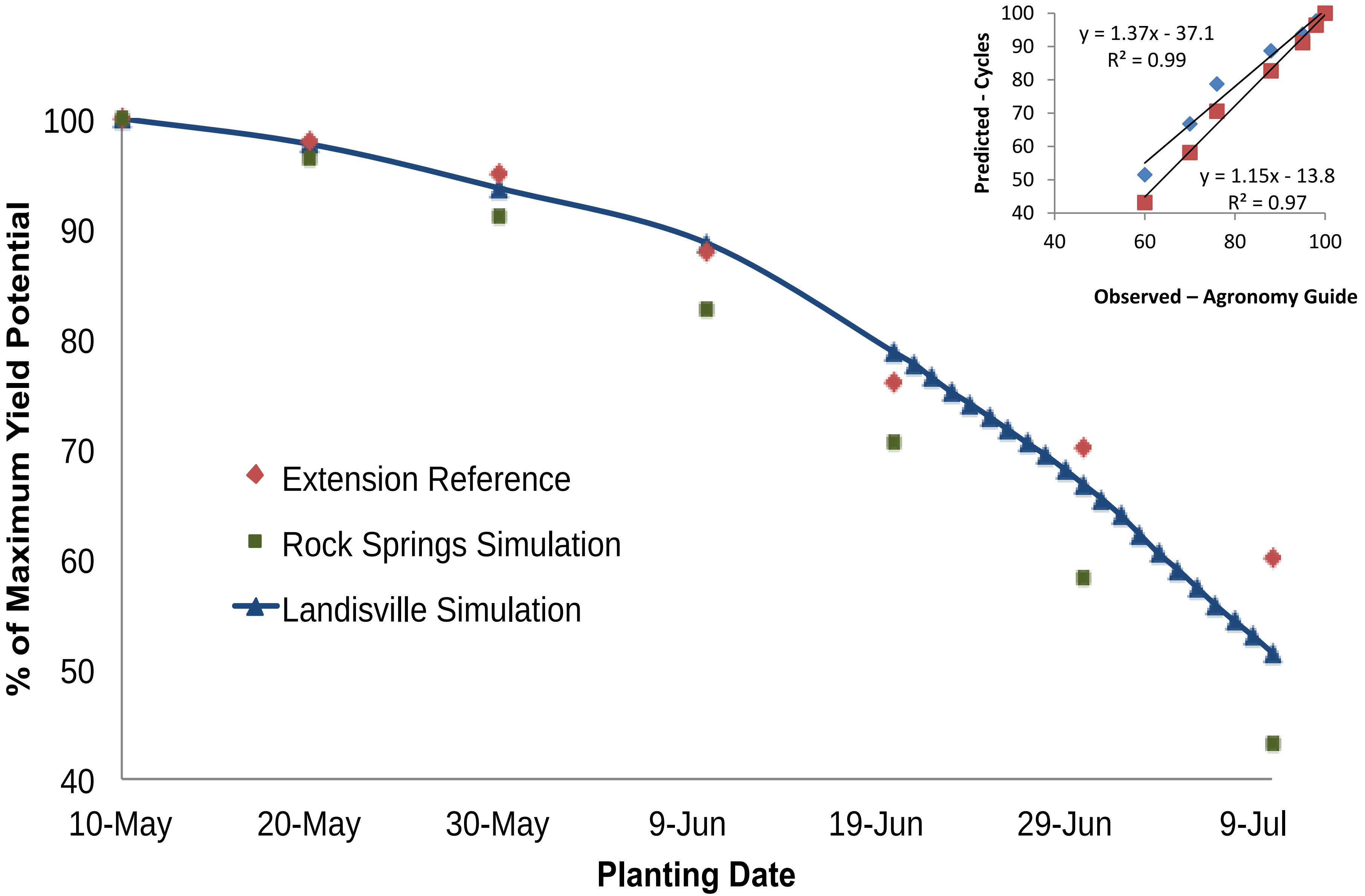
UNITED SOYBEAN BOARD

Making Your Checkoff Pay Off.

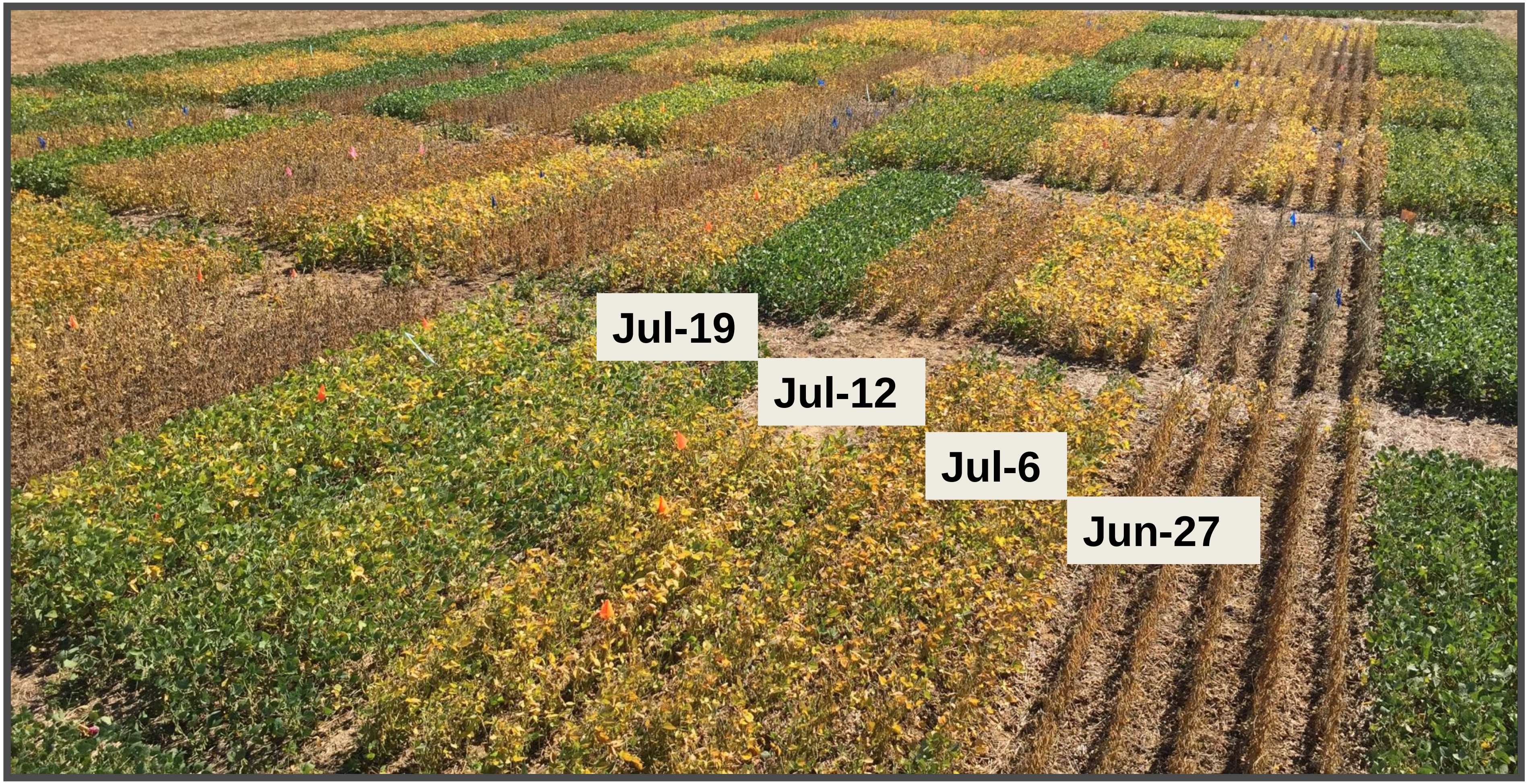
Tidewater Agricultural Research & Extension Center

Source: Rasel Parvej_ASA 2016

Relative Soybean Yield to Planting Date

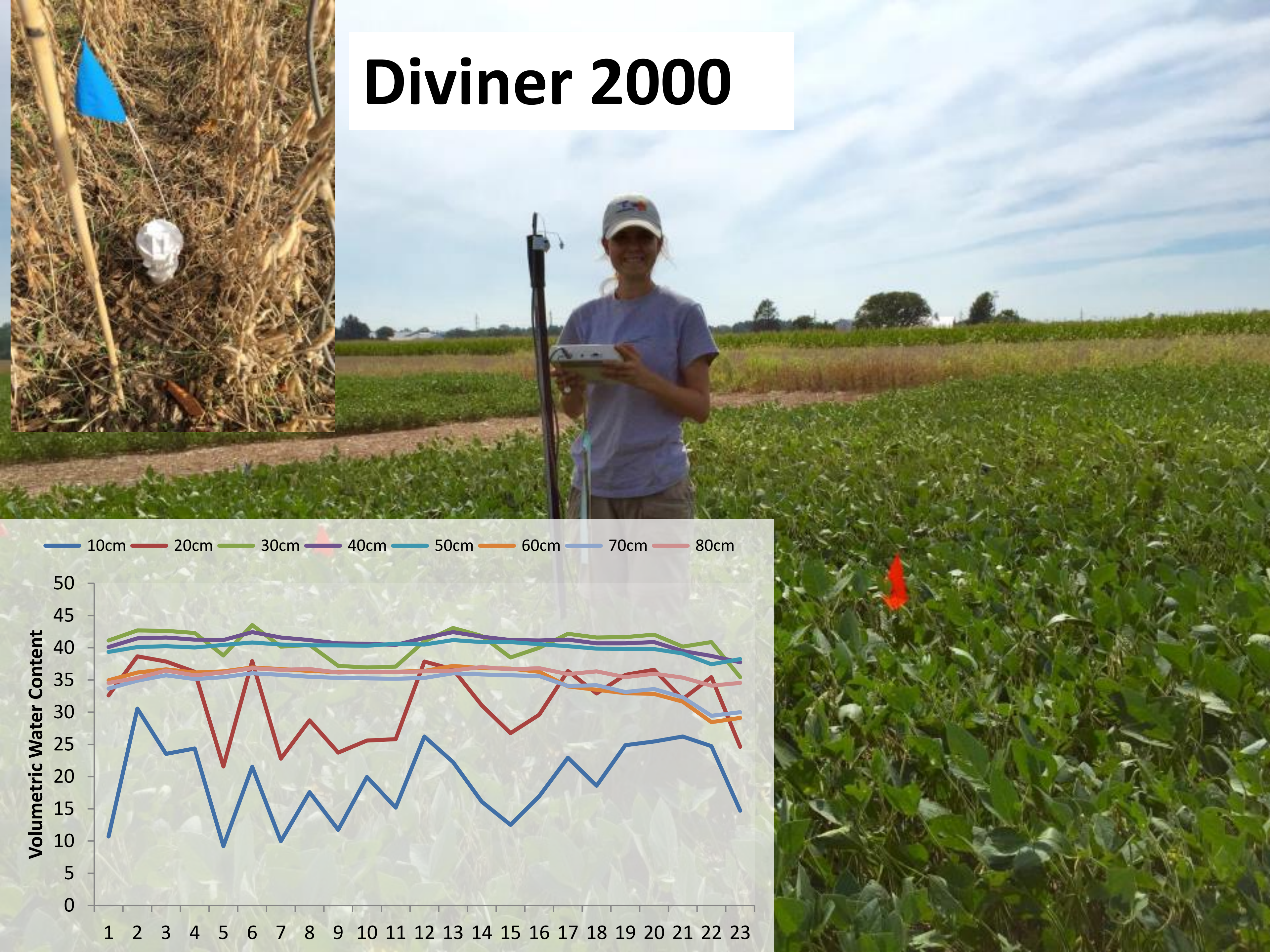


Planting Date Study - Landisville

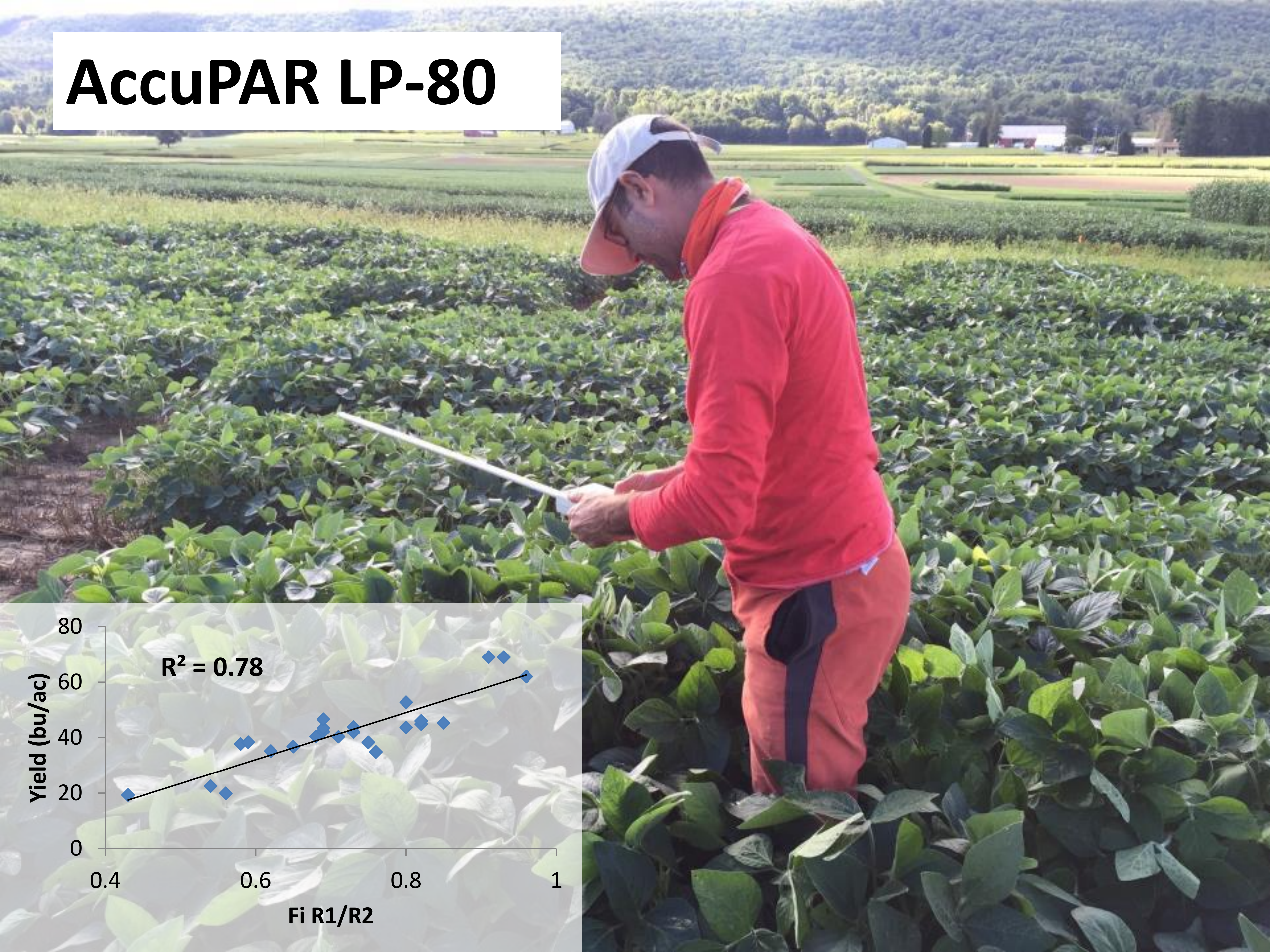


October 7th 2016

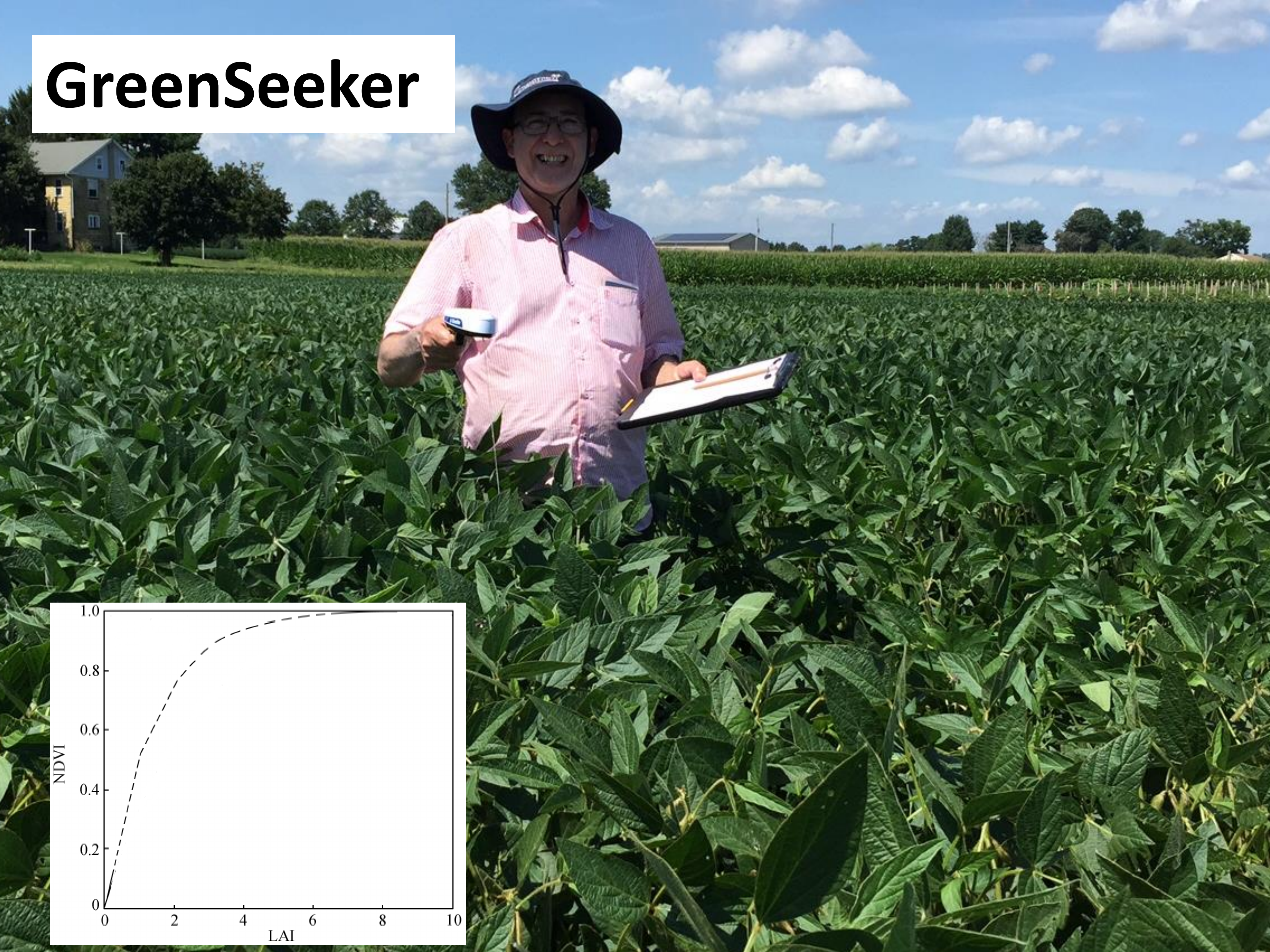
Diviner 2000



AccuPAR LP-80



GreenSeeker



Canopy Cover on August 19th

Landisville, PA



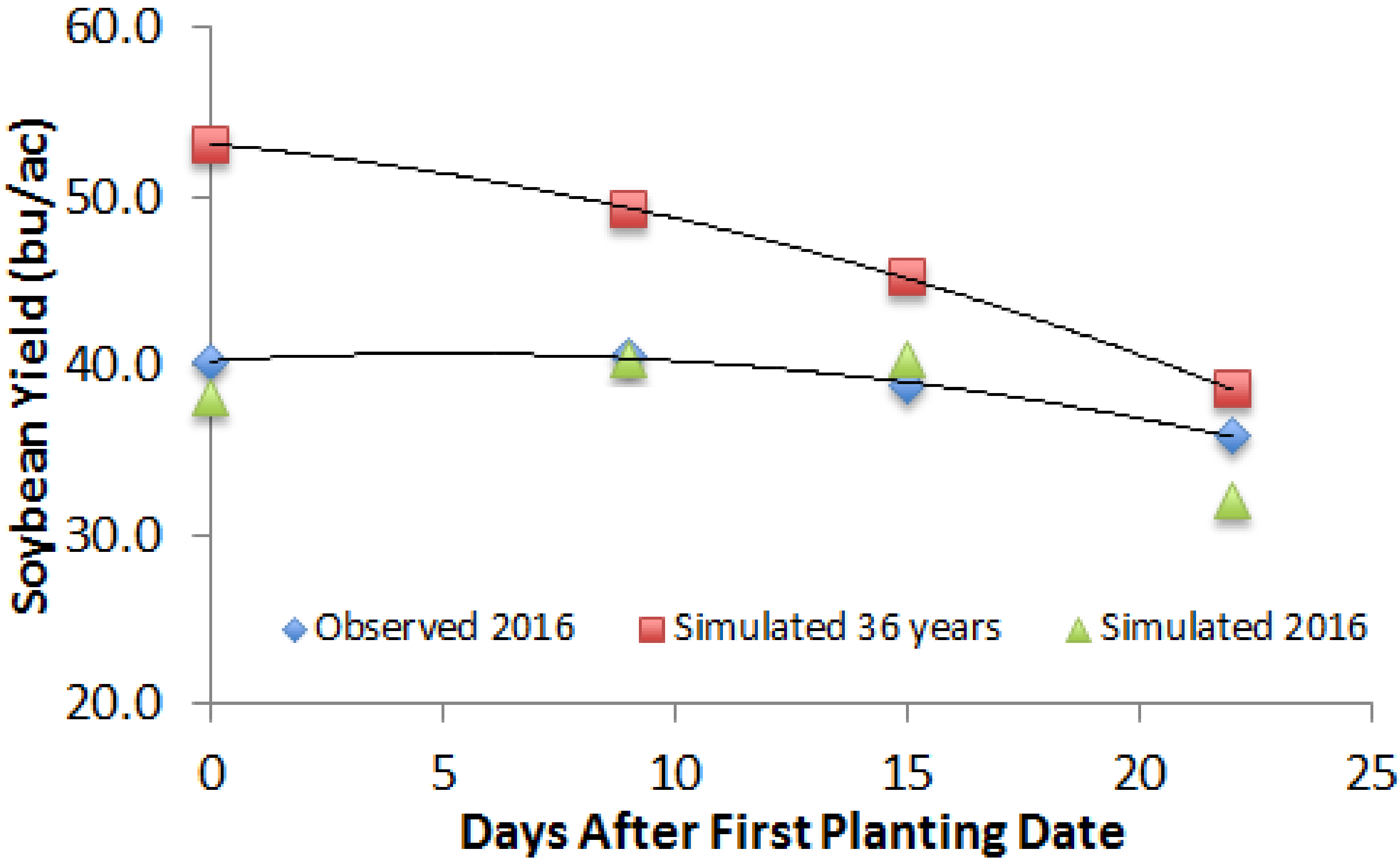

Plant. Date:	June 29th	July 6th	July 12th	July 19th
Stage:	R3	R2/R3	R2	R1
PAR Inter.:	93.3%	91%	84%	57.4%
NDVI:	0.73	0.71	0.62	0.46

Soybean Thermal Time

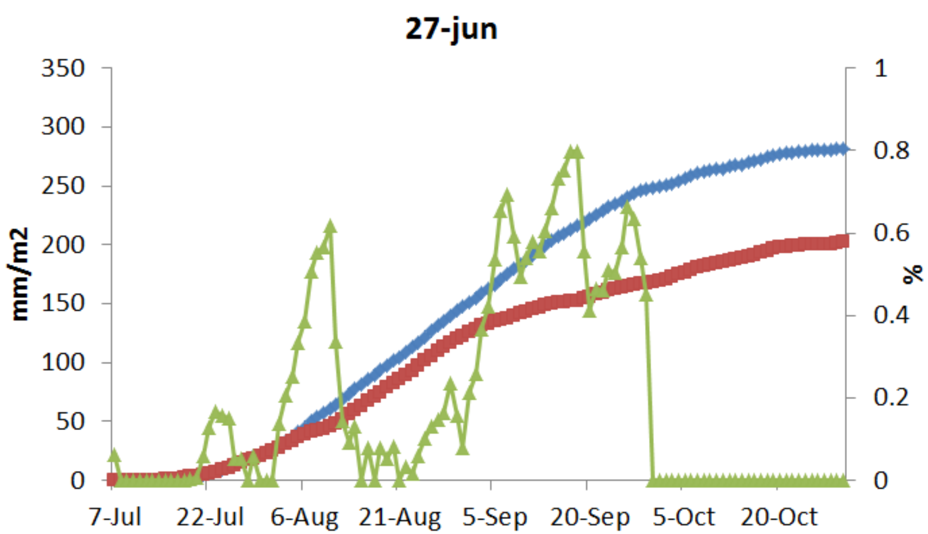
Landisville, PA_2016

Planting Date	Thermal Time (°Cd)	
	VE - R1/R2	VE - R8
26-May	682	1898
27-Jun	667	1589
6-Jul	625	1489
12-Jul	591	1402
19-Jul	531	1281

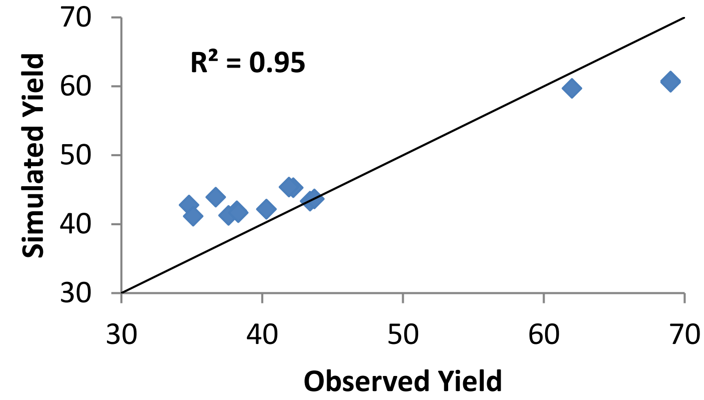
Double-Crop Soybean Yield Response to Planting Date

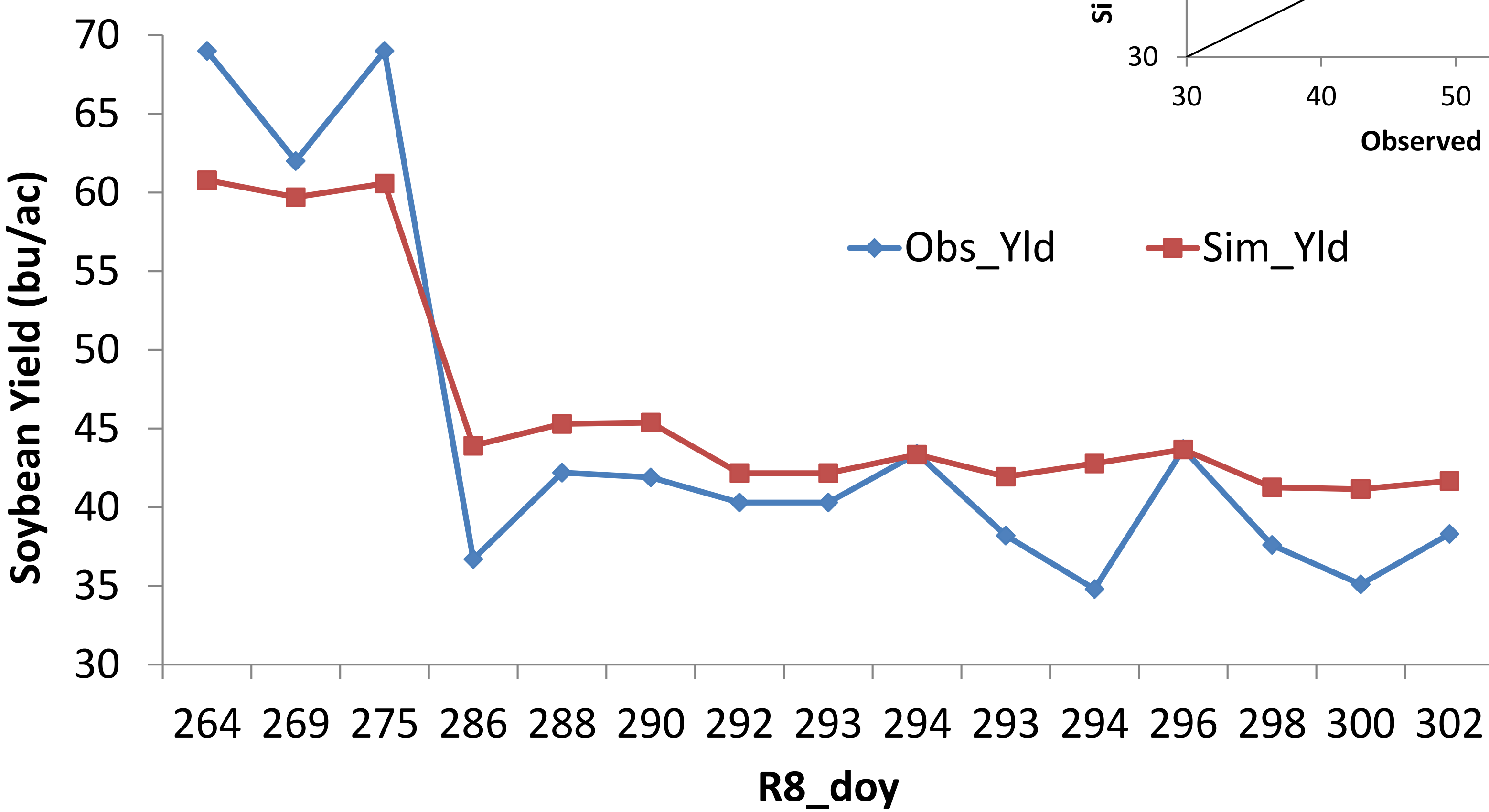


Simulated Cumulative Transpiration and Water Stress



2016 Landisville





Serviços e Sistemas

agraria

Webmail | Portal do Colaborador | Portal do CRM | FAPA Radar | Portal do Cooperado | Trabalhe Conosco

a Agrária | negócios | cultura | comunidade | sustentabilidade | canal de conduta | fale conosco

fundação de pesquisa - FAPA

Agrária / Pesquisas

- Perfil
- Histórico
- Missão, Visão e Valores
- Política da Gestão Integrada
- Cooperados
- Pesquisa
- Laboratório
- Unidades

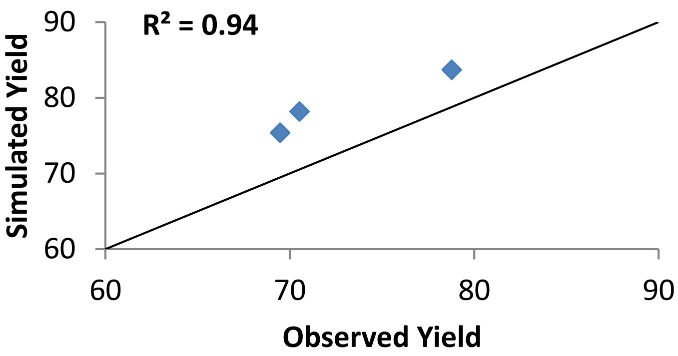
FAPA

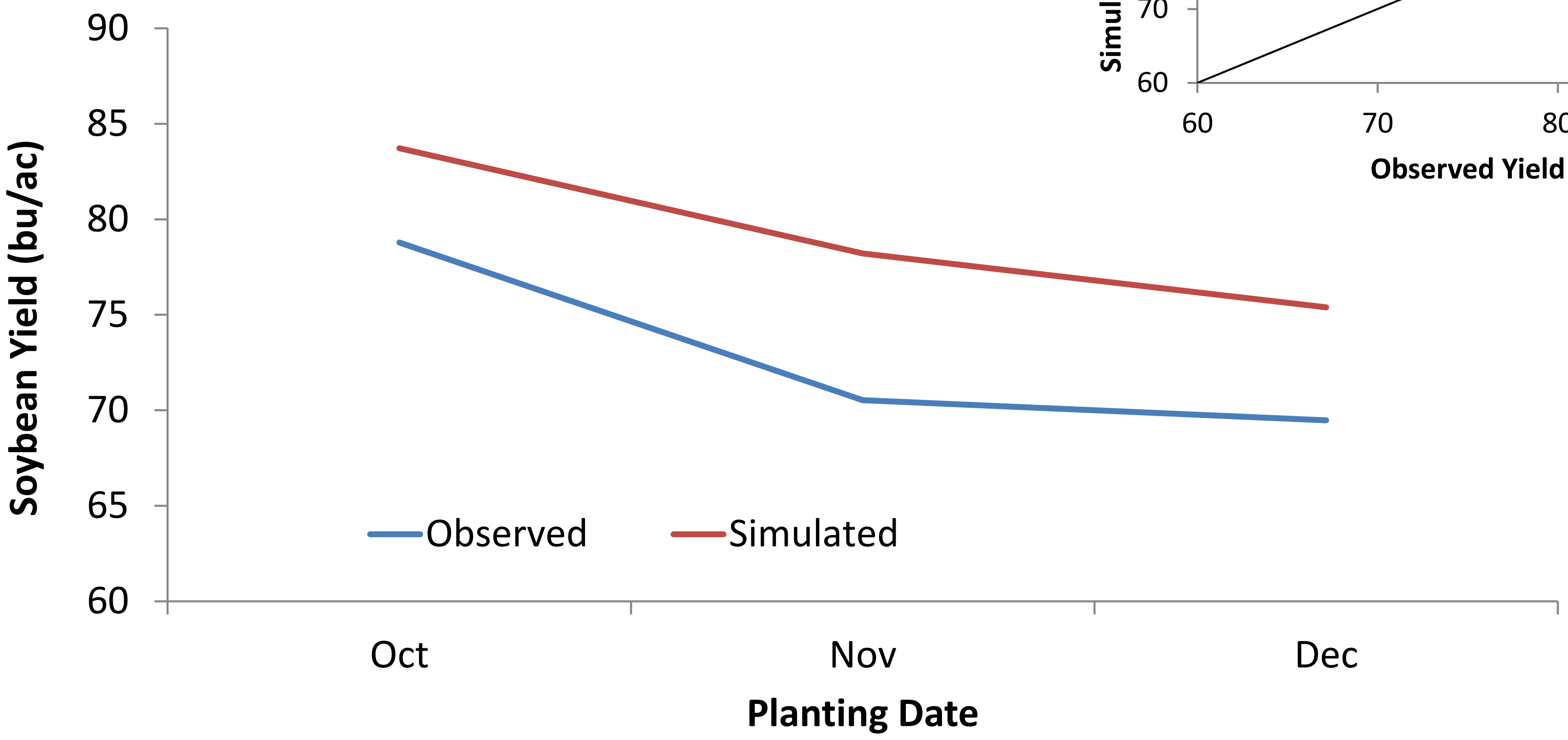
A FAPA (Fundação Agrária de Pesquisa Agropecuária) foi instituída pela Cooperativa para gerar e aplicar tecnologias que atendam à demanda de produtividade do cooperado, bem como à qualidade requerida pelas unidades de negócios e clientes.

Onze pesquisadores altamente qualificados atuam em áreas específicas, com o intuído de gerar informações completas e direcionadas às regiões de atuação dos cooperados. Os estudos envolvem avaliação e seleção de novos cultivares e híbridos, fertilidade do solo, épocas de plantio, densidade de plantas, controle de plantas daninhas, manejo de doenças e pragas, e mecanização agrícola.

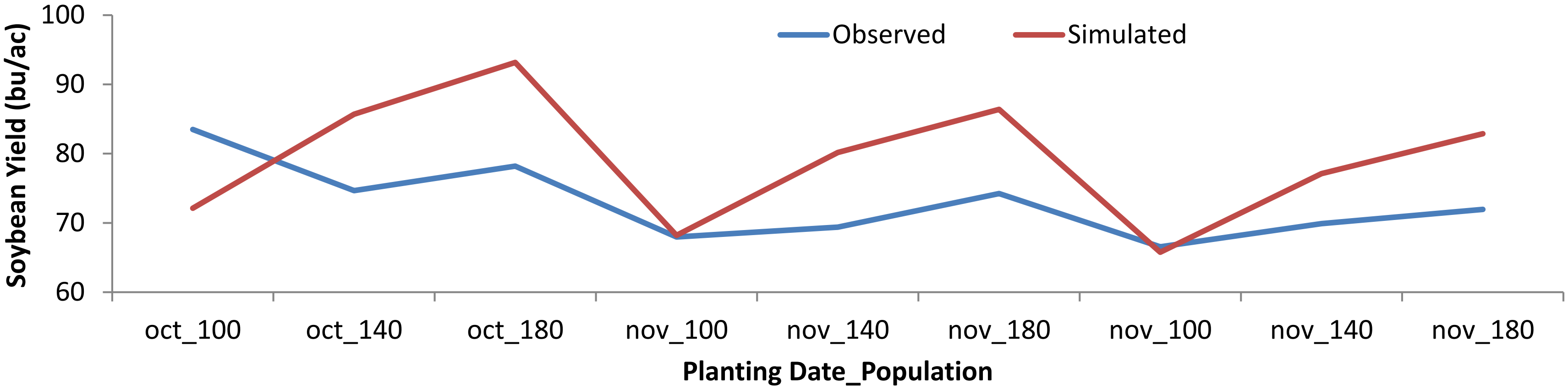
As informações técnicas provindas do trabalho de pesquisa são utilizadas pelos agrônomos da assistência técnica e aplicadas junto aos cooperados. As tecnologias também são difundidas por publicações, treinamentos, palestras e eventos técnicos específicos, como o Dia de Campo de Verão e o WinterShow – considerado o maior evento relativo a cereais de inverno no Brasil.

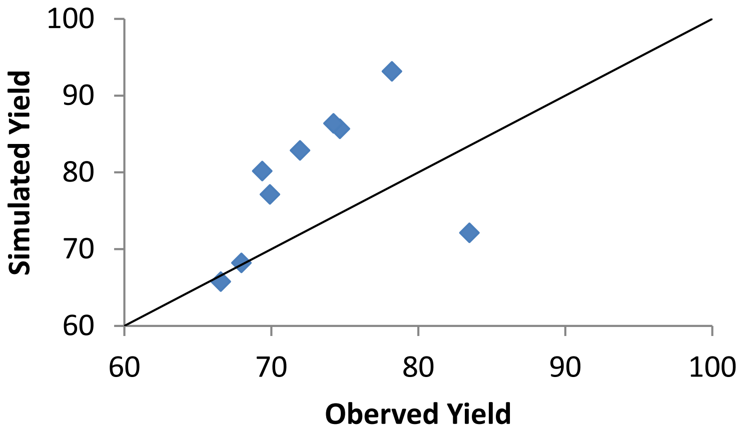
Guarapuava_Brazil
Double-Cropping 2013/2014



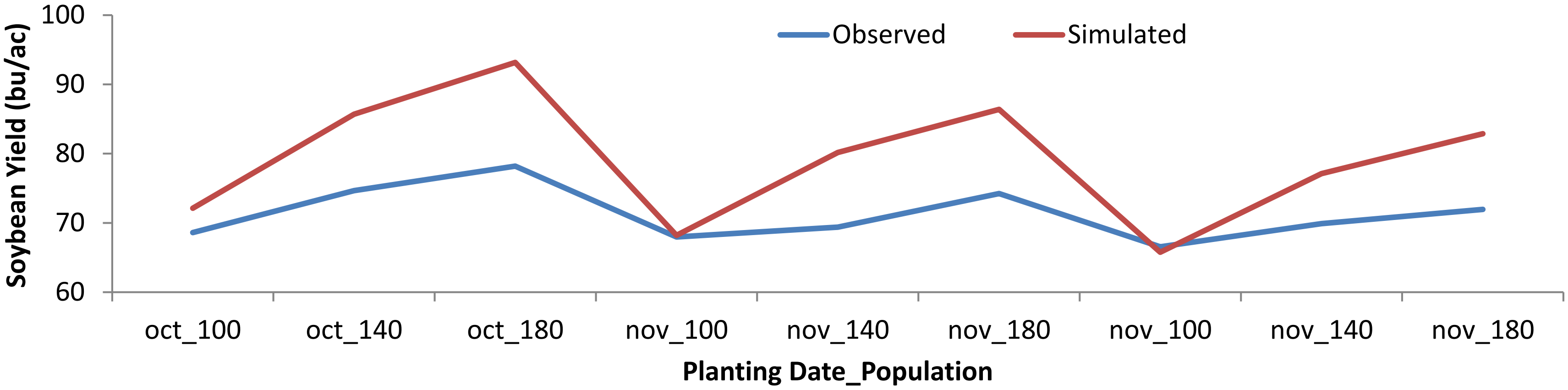


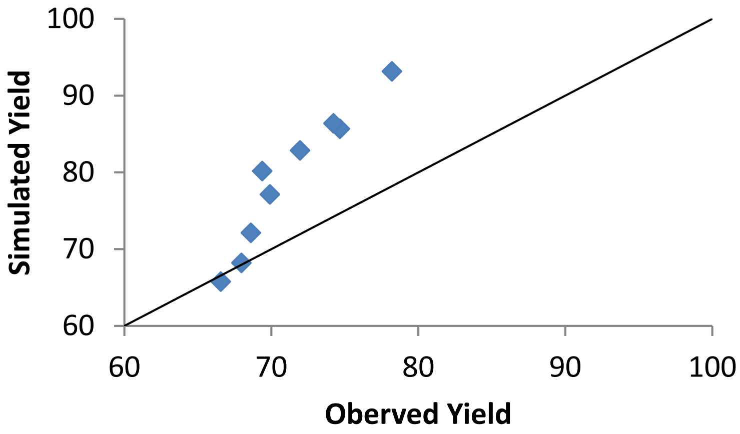
Guarapuava_Brazil
Double-Cropping 2013/2014





Guarapuava_Brazil
Double-Cropping 2013/2014





Compare Crop Production Systems

May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct

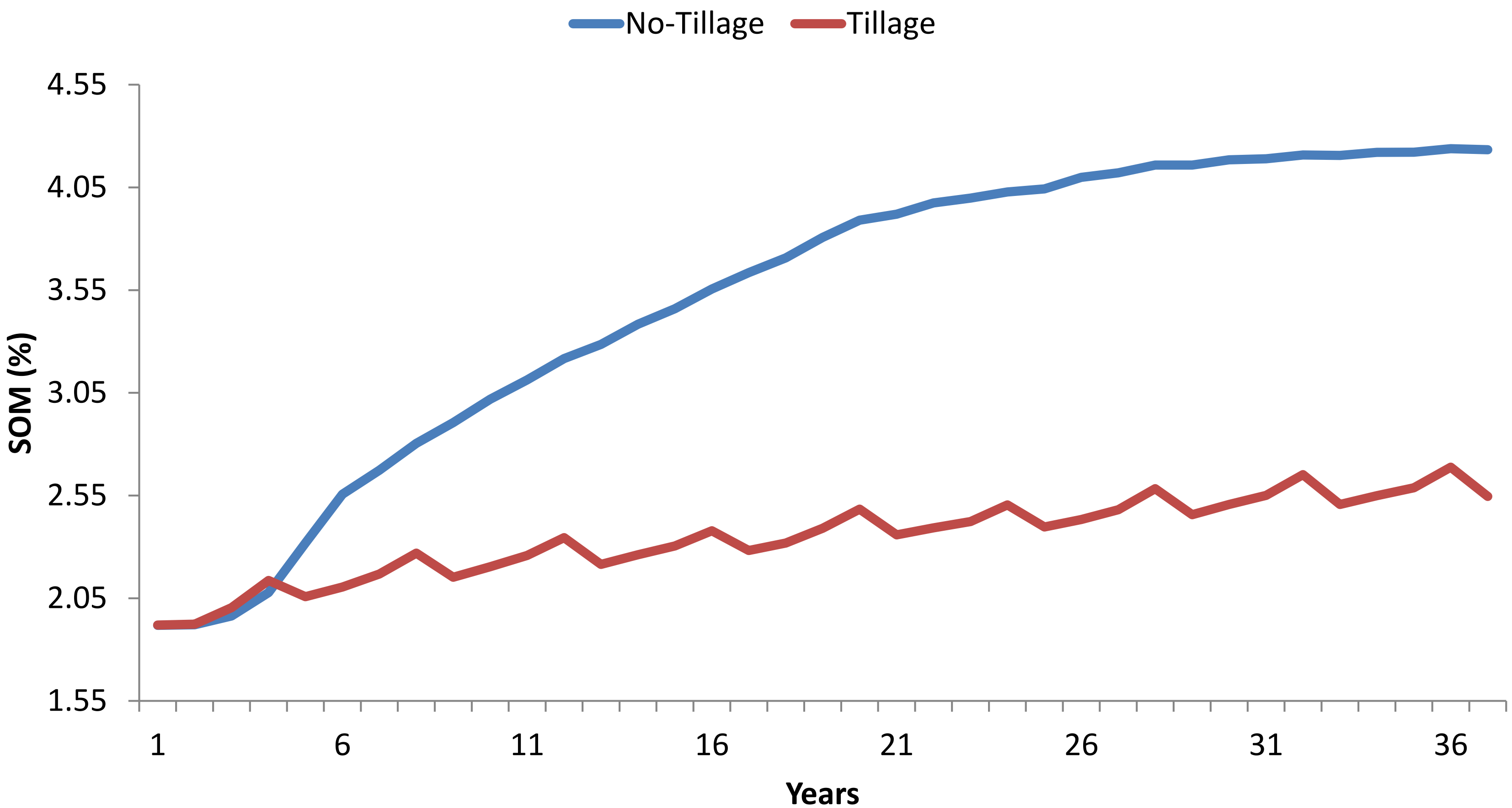


May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct

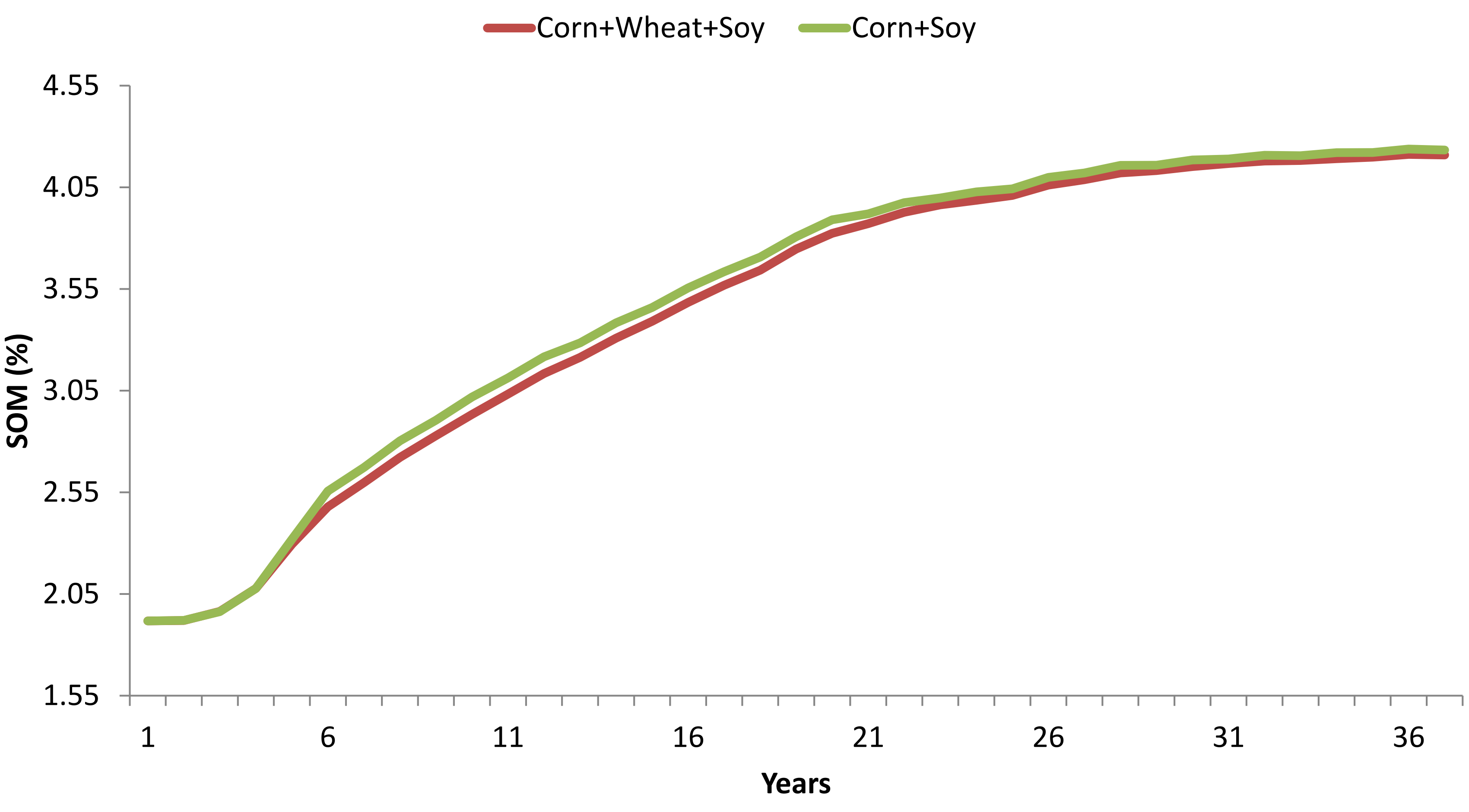

Landisville, PA – Comparing Production Systems Crop Yield – bushels/acre (1980 – 2016)

Commodity	Corn_Soy	Corn_Wheat_Soy
Corn	164	162
Wheat	0	118
Soybean	61	41
Total (bu/ac)	225	321

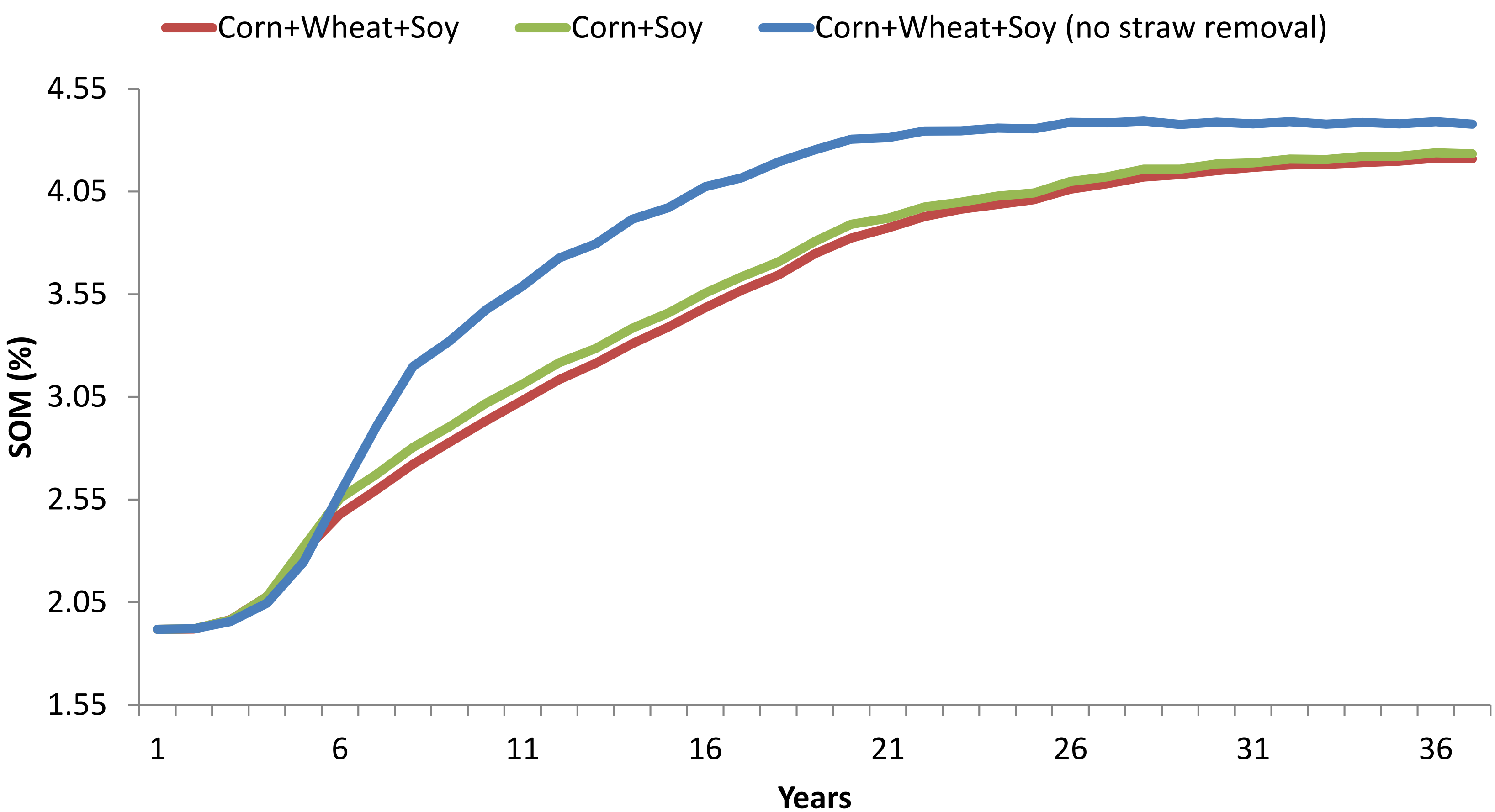
Landisville, PA – Managing Carbon
Corn – Wheat – Soybean System
Soil Profile: 2 inches



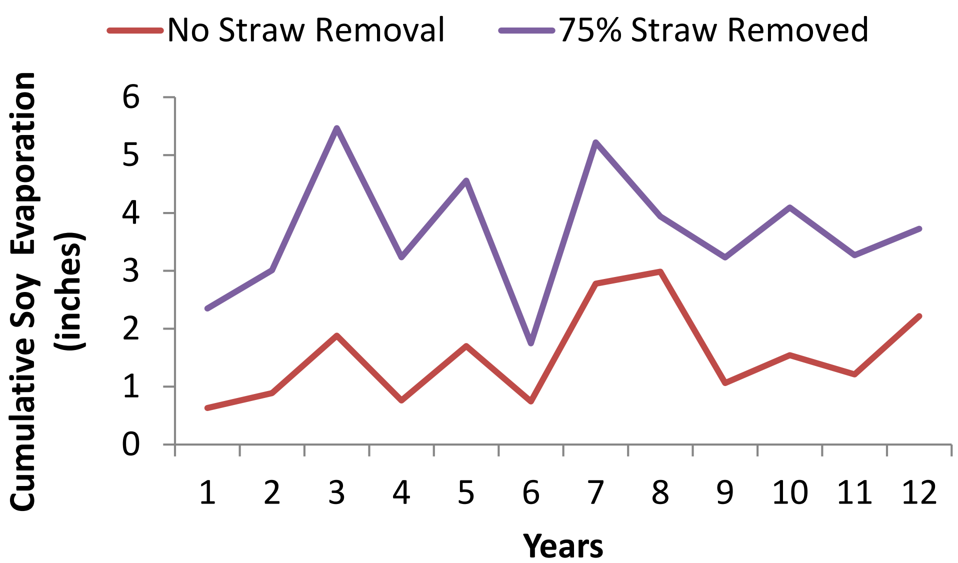
Landisville, PA – Managing Carbon Corn + Wheat + Soybean x Corn + Soy Soil Profile: 2 inches (No-till)

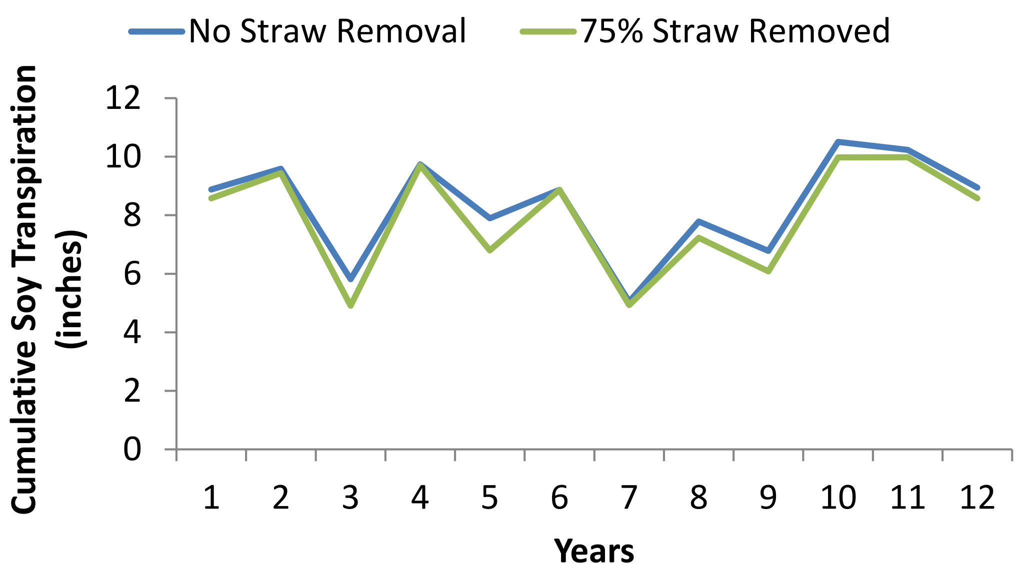


Landisville, PA – Managing Carbon
Corn + Wheat + Soybean x Corn + Soy
Soil Profile: 2 inches (No-till)



Landisville, PA – Managing Water

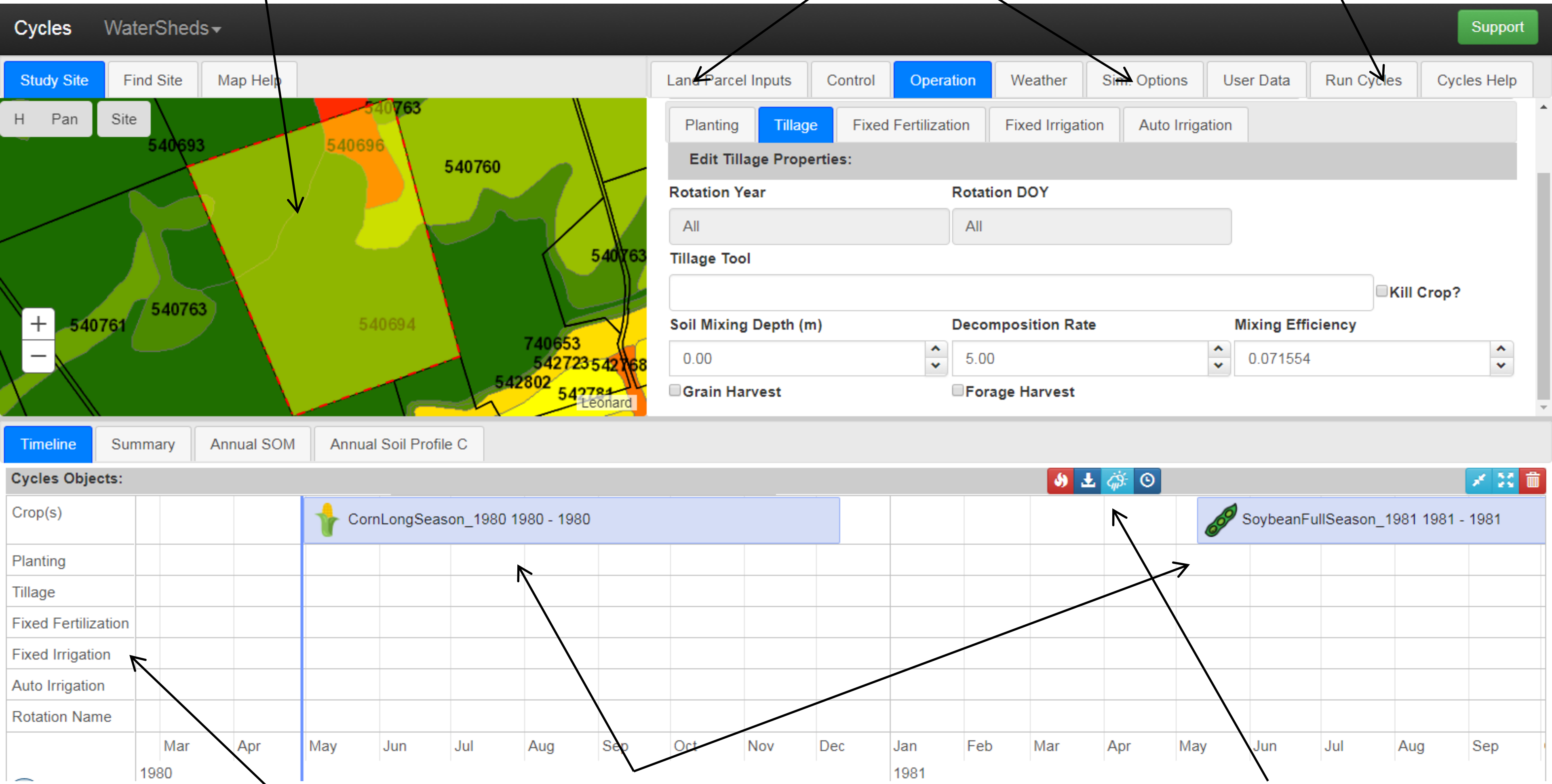




1) Identifying a land parcel of interest brings the soils and weather files to the menu

2) Tabs menu allows manipulating and saving rotation settings

3) Live simulation provides outputs in seconds.

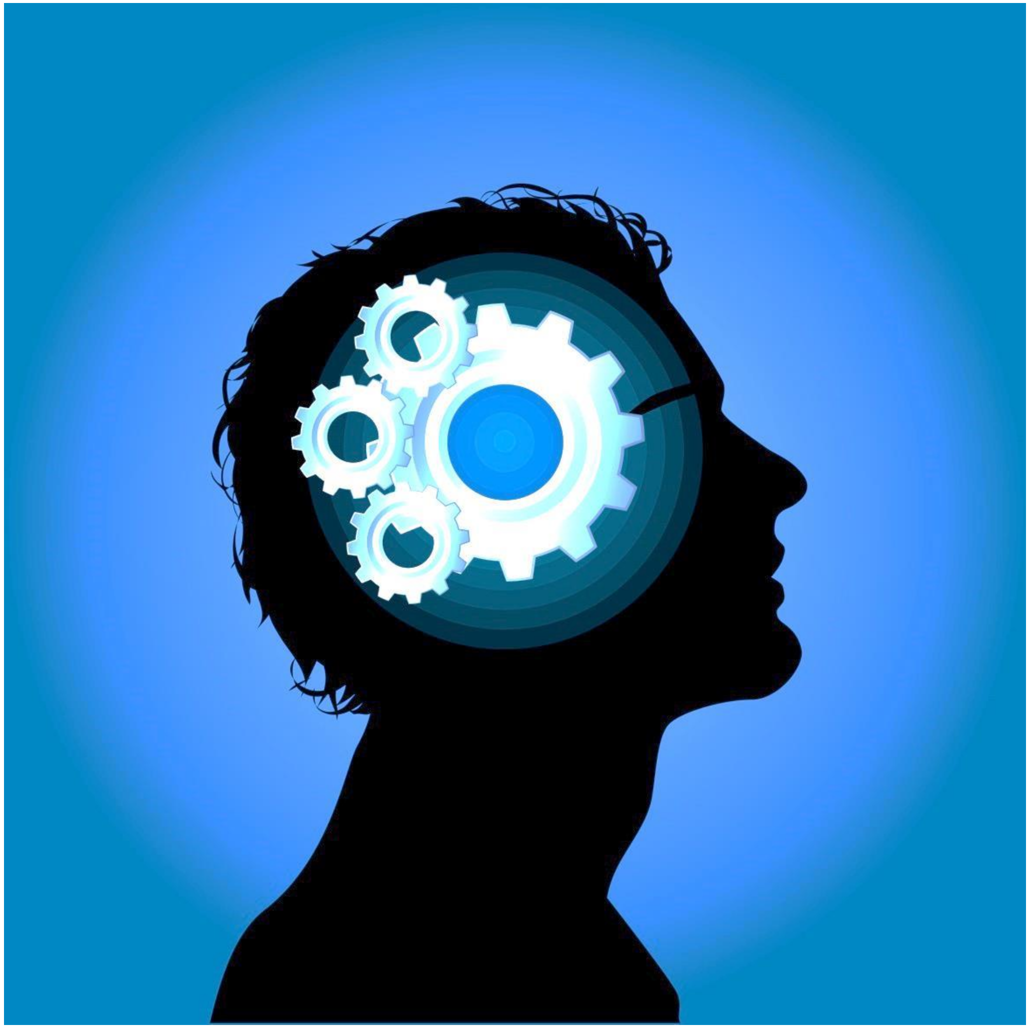


Crop sequence

Quick menu to add operations (tillage, manure application)

Friendly visualization of operations

Why should we use Crop Models?



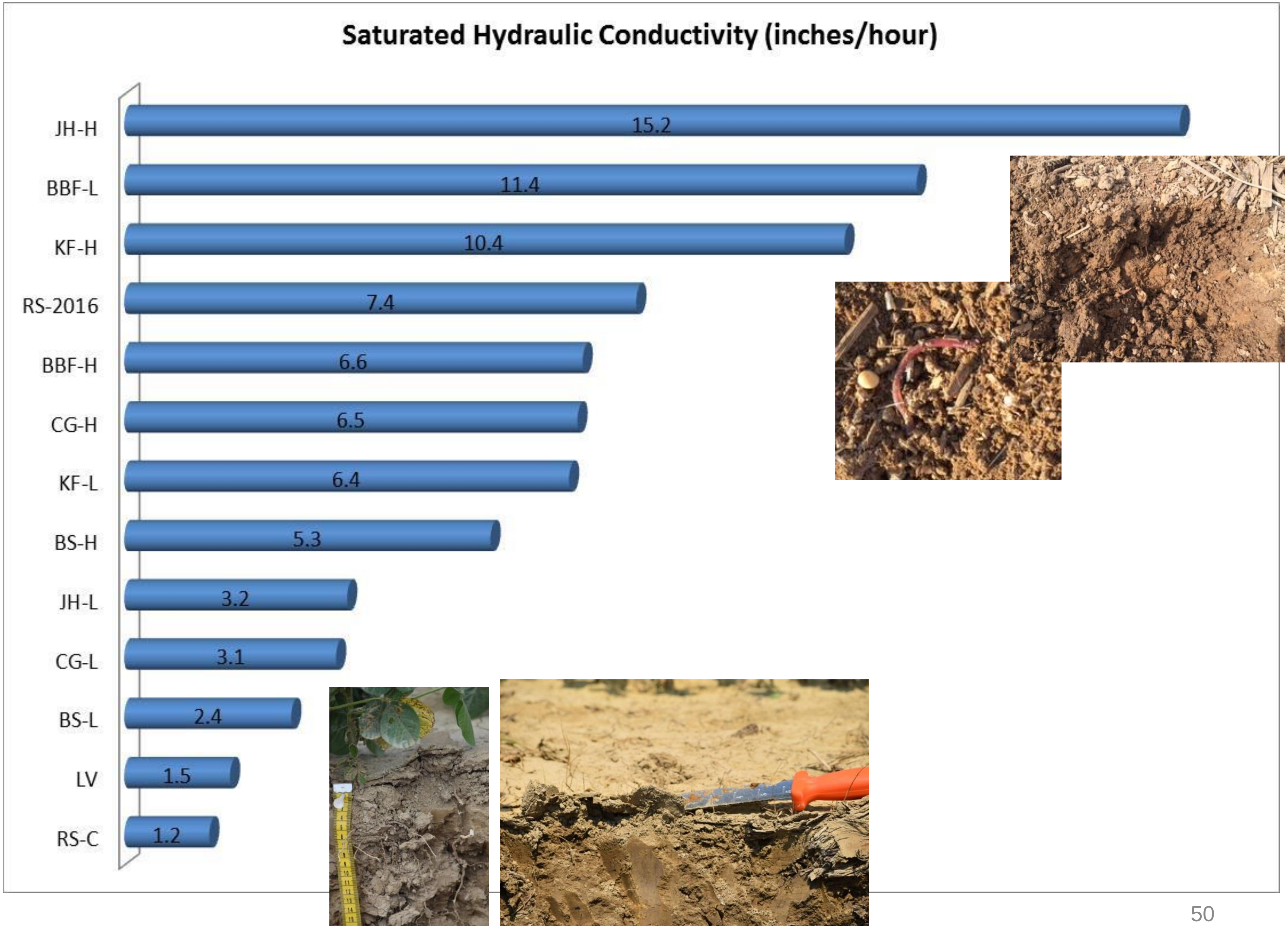
- It is a great tool to **help you think** over several agronomic questions
- It helps you to obtain a **more refined understanding** of the situation
- It allows you to answer questions that are almost **impossible to assess in the field**

NORTHEAST SARE
Sustainable Agriculture Research & Education

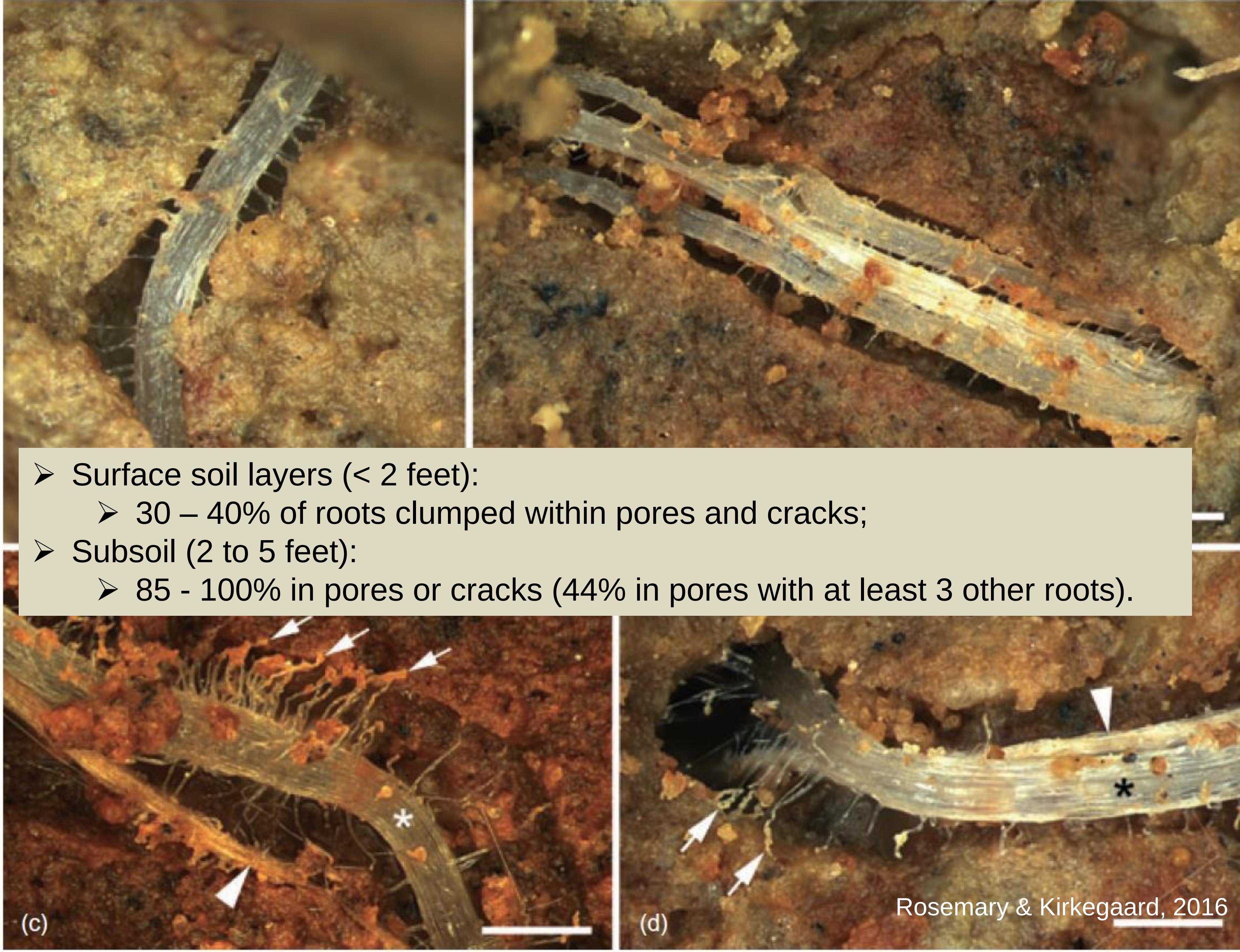
Targeting sustainable soil management practices using crop modeling in soybean systems


GIDDINGS

Dual Head Infiltrometer

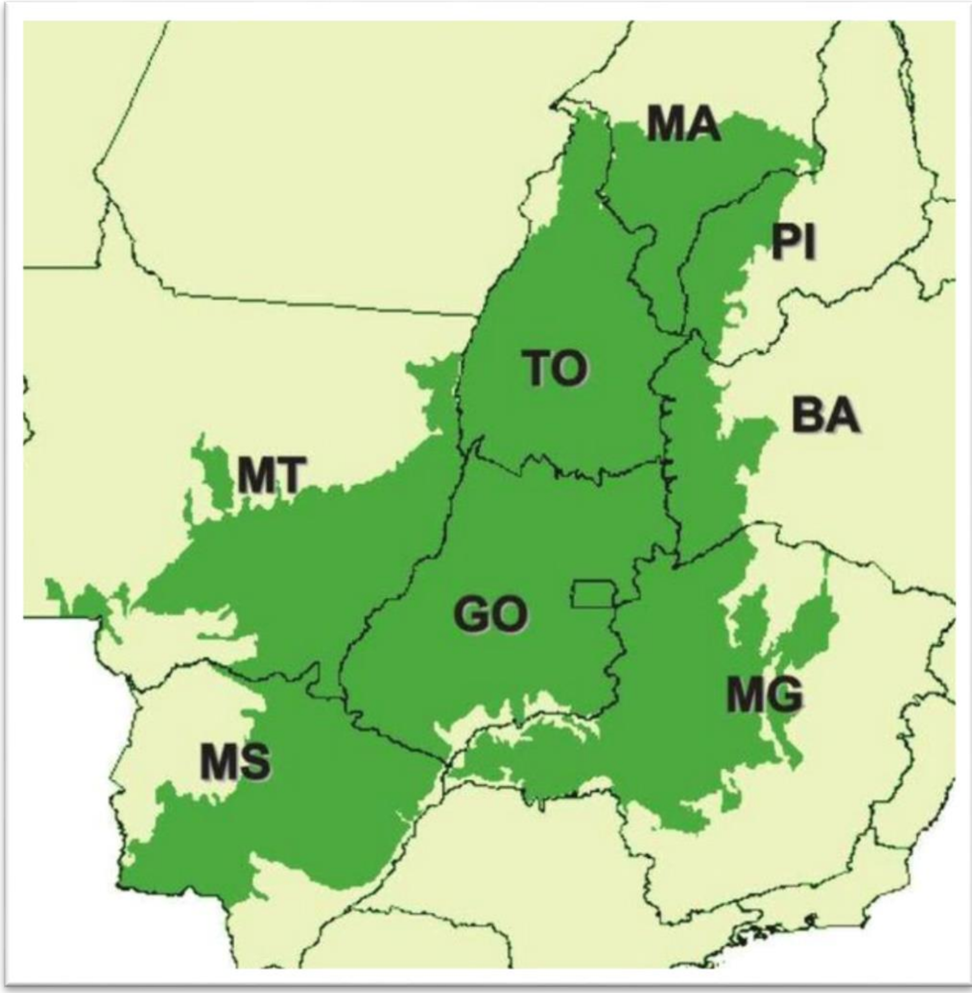

Saturated Hydraulic Conductivity (inches/hour)
JH-H 15.2
BBF-L 11.4
KF-H 10.4
RS-2016 7.4
BBF-H 6.6
CG-H 6.5
KF-L 6.4
BS-H 5.3
JH-L 3.2
CG-L 3.1
BS-L 2.4
LV 1.5
RS-C 1.2

- 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

Brazilian Cerrado (Savannas)



FAZENDA SANTA BRÍGIDA
Ipameri-GO.

Santa Brígida Farms

Embrapa

July 2010

100 days after the last rain

Source: Luis Adriano M. Cordeiro

Embrapa Cerrados

Corn + Brachiaria (Vegetative)

Corn + Brachiaria (Reproductive)

45 days after Corn Harvest

Brachiaria grazing during Dry Season


Brachiaria residue after grazing

Sowing of No-till Soybean


Development of Soybean on Brachiaria residue


Development of Soybean on Brachiaria residue

Embrapa
Cerrados

Brachiaria Roots

Horita Farms, West of Bahia

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Join Penn State researchers for this 11 day tour of Brazilian soybean production. We will begin in the central and finish in the southern region, visiting high yielding soybean production in different climatic zones, including long term no-till pioneers. This tour will provide you insights into state of the art crop management of leading Brazilian farms and be a valuable addition to your future development in soybean production.

Compare Brazillian soybean production to U.S.

Thank You!

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