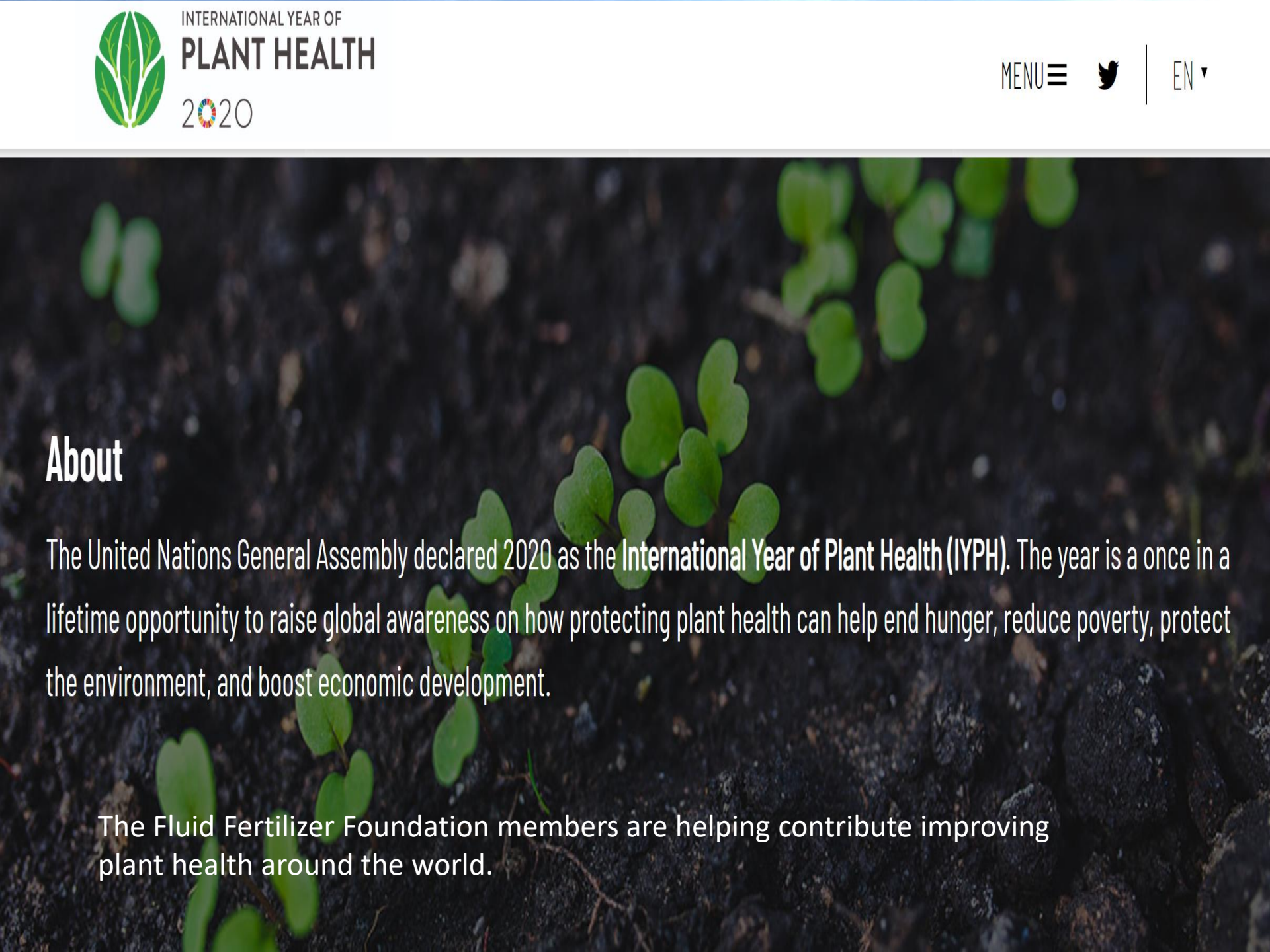
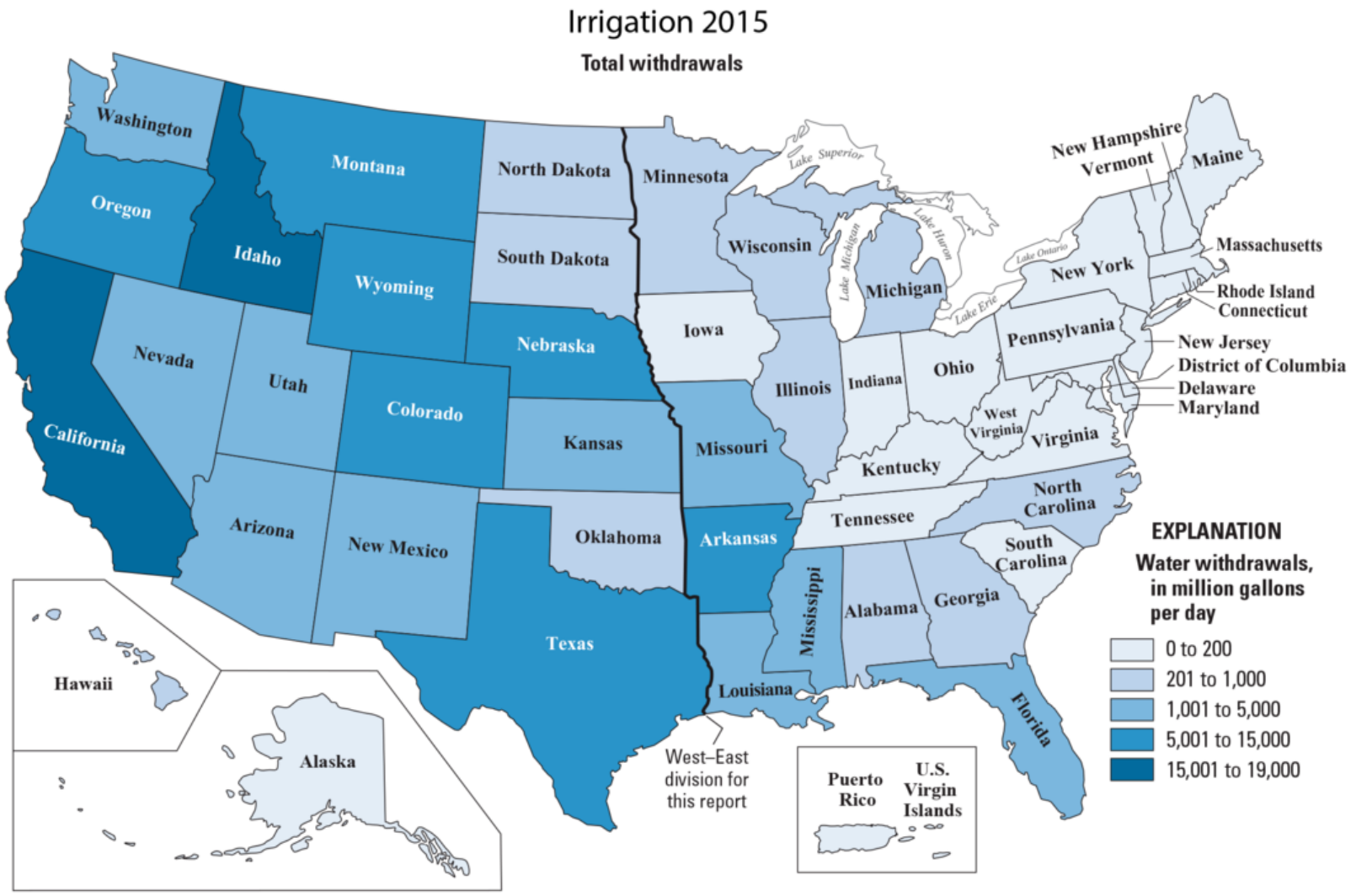
# Fluid Fertilizer and Water Quality and Quantity in Northwest Irrigated Agriculture

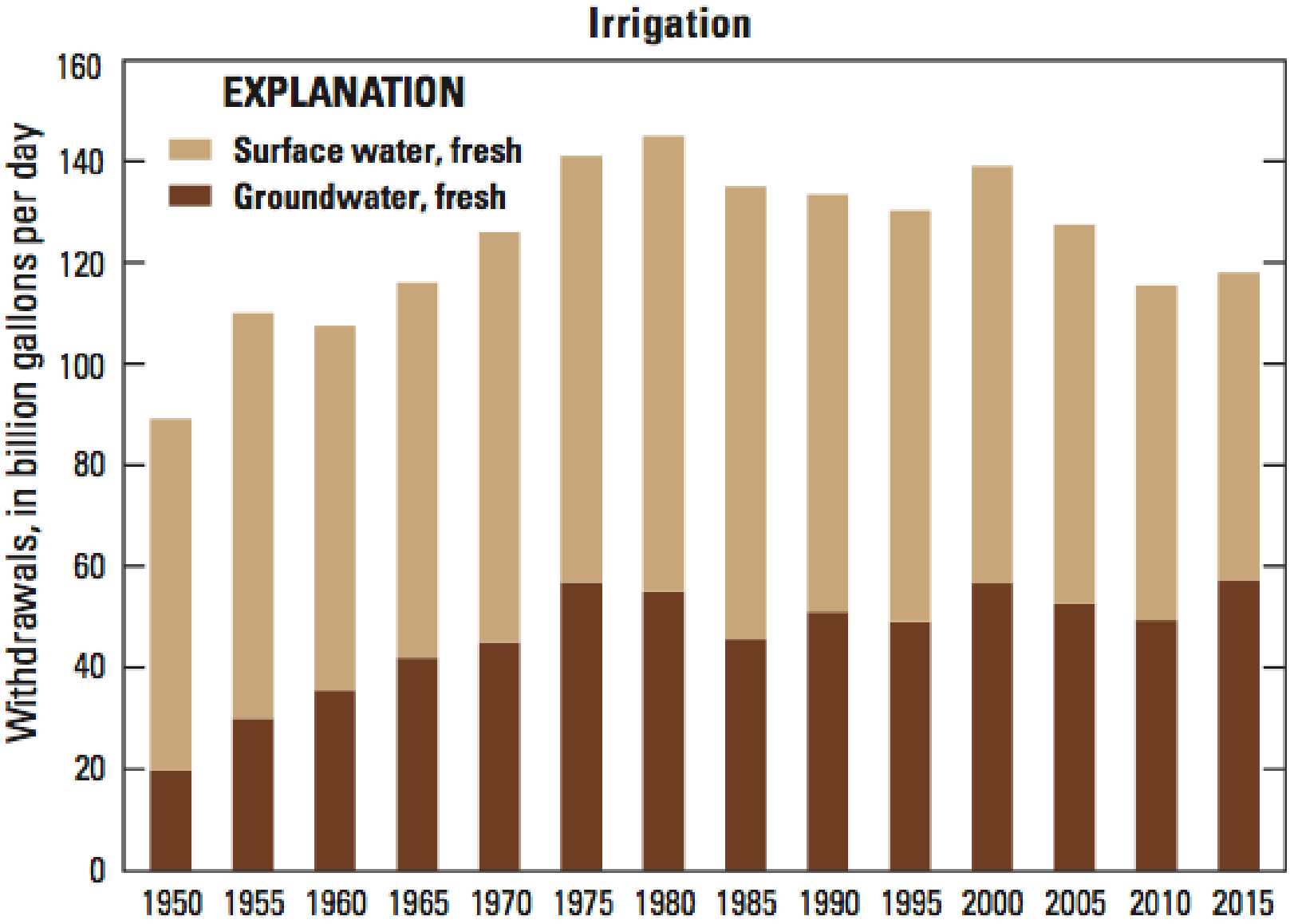
Dr. Galen Mooso and Dr. Terry Tindall
Agronomy Team, J.R Simplot Co.

Simplot

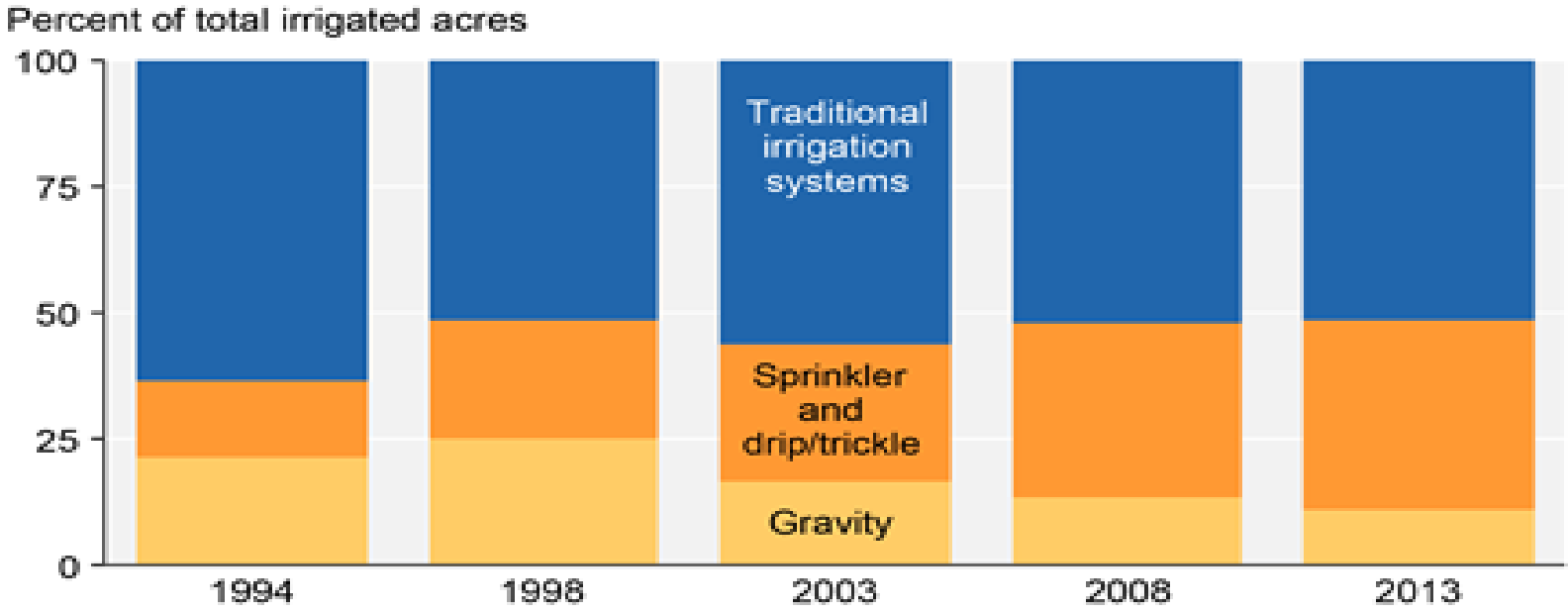

INTERNATIONAL YEAR OF
PLANT HEALTH
2020
MENU
EN
About
The United Nations General Assembly declared 2020 as the International Year of Plant Health (IYPH). The year is a once in a lifetime opportunity to raise global awareness on how protecting plant health can help end hunger, reduce poverty, protect the environment, and boost economic development.
The Fluid Fertilizer Foundation members are helping contribute improving plant health around the world.

# Irrigation water use withdrawals in 2015




Irrigation
EXPLANATION
Surface water, fresh
Groundwater, fresh
Withdrawals, in billion gallons per day
0
20
40
60
80
100
120
140
160
1950
1955
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
2010
2015

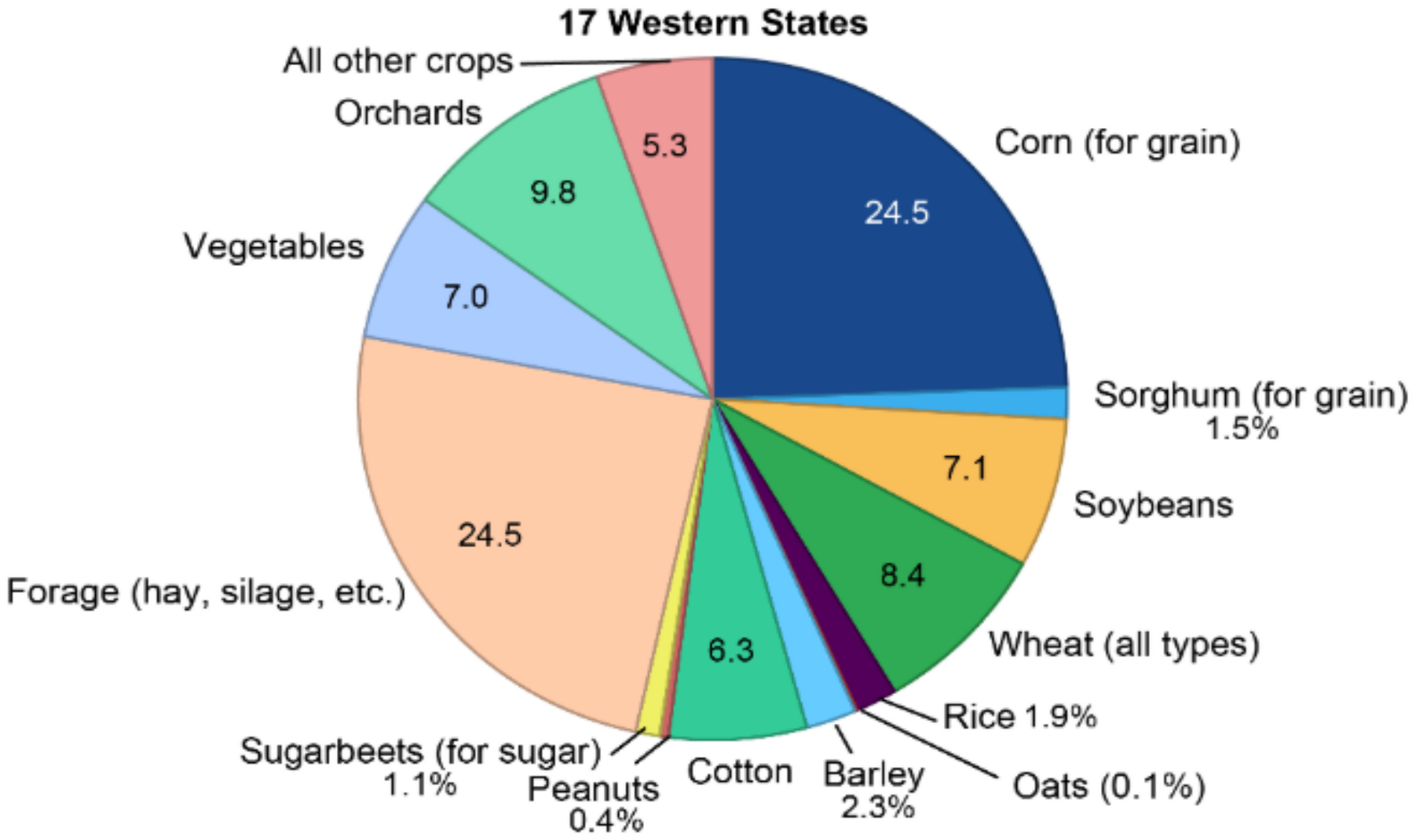
## Irrigated acres by system type, 17 Western States, 1994-2013




More efficient *gravity* irrigation includes furrow irrigated acres using above- or below-ground pipe, or a lined open-ditch field water-delivery system, plus acres in flood irrigation (between borders or within basins) on farms using laser-leveling and pipe or lined open-ditch field water-delivery systems. More efficient *pressure-sprinkler* irrigation includes acres irrigated using either drip/trickle systems or lower-pressure sprinkler systems (pressure per square-inch (PSI)< 30). The remaining irrigated acres were categorized as using "traditional" irrigation systems

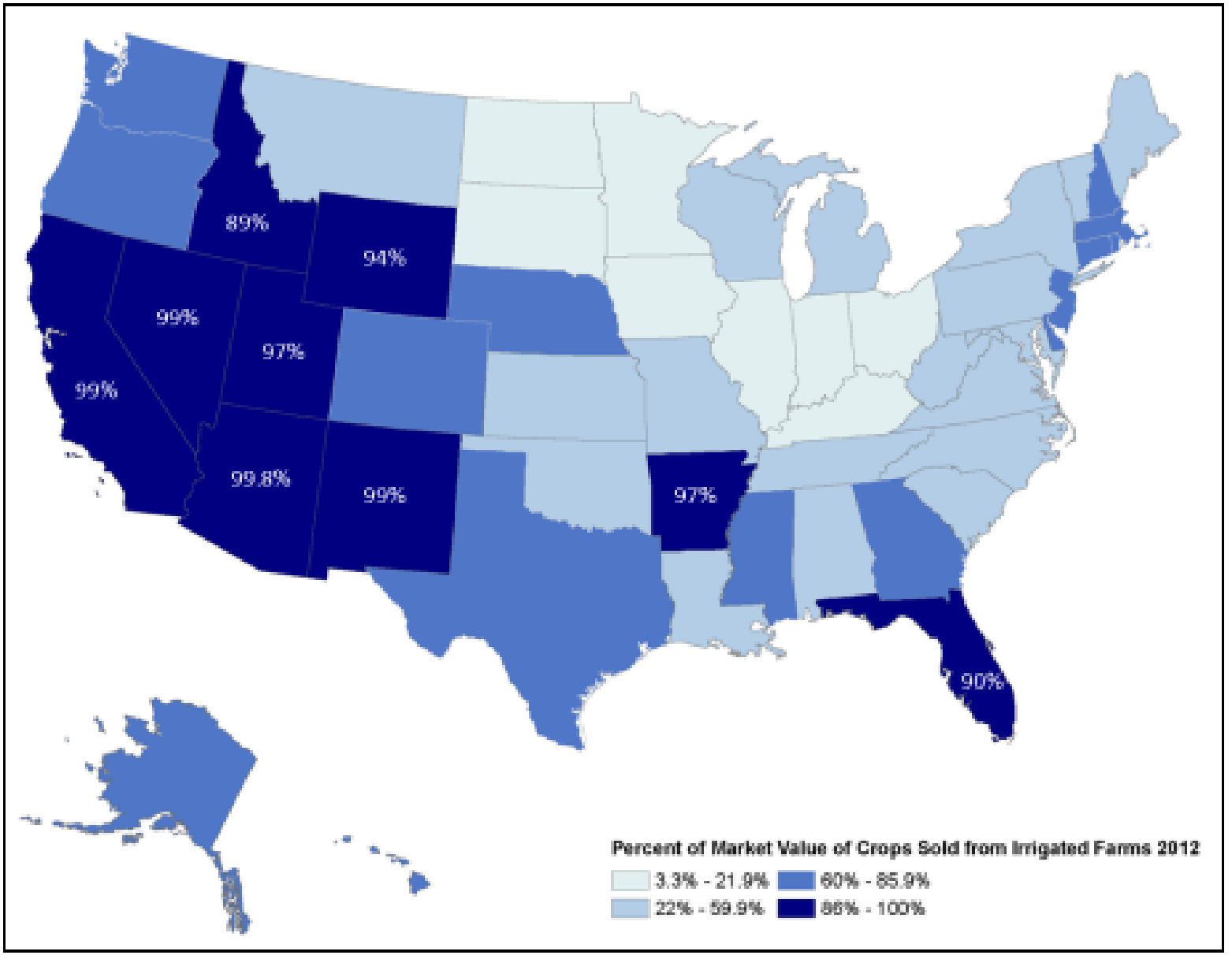
Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Farm and Ranch Irrigation Survey (FRIS) data, various years.

# Distribution of irrigated acres by crop, Western and Eastern States, 2012



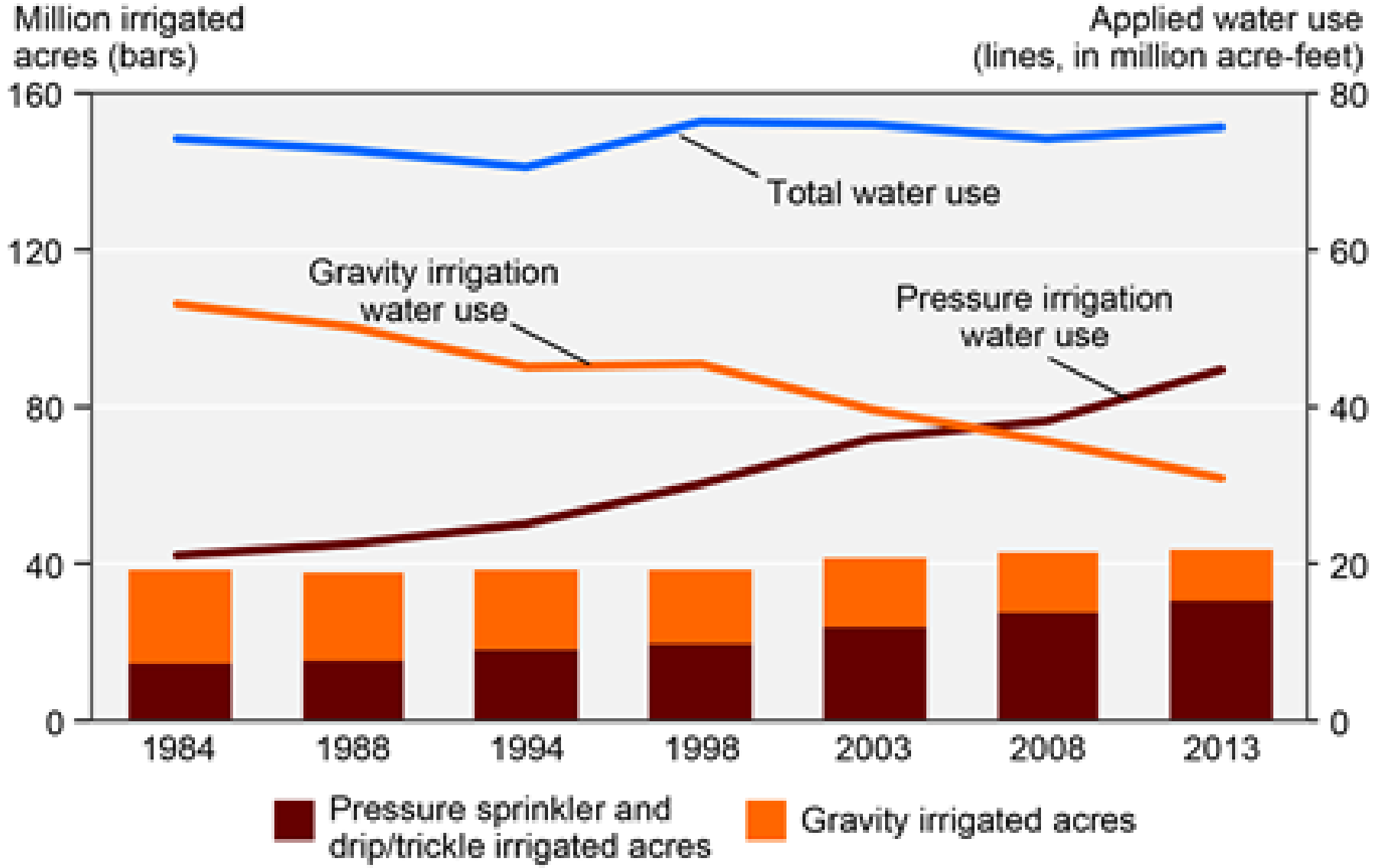

Simplot

**Figure 1. Percent of Market Value of Crops Sold from Irrigated Farms, 2012**




**Source:** CRS from USDA, National Agricultural Statistics Service (NASS), *2012 United States Census of Agriculture*, AC 12-A-51, Washington, DC, May 2014, http://www.agcensus.usda.gov/Publications/2012/

## Irrigated acres and applied water use, 17 Western States, 1984-2013




Source: USDA, Economic Research Service using USDA, National Agricultural Statistics Service, Farm and Ranch Irrigation Survey (FRIS) data. Note that FRIS reports onfarm

**Table 1. Land Irrigated in the Western States and Method of Water Distribution**

| | States | Acres Irrigated | Method of Irrigation Distribution | | |
|---|---|---|---|---|---|
| | | | Gravity Systems | Sprinkler Systems | Drip, trickle, or low-flow micro sprinklers |
| 1 | Arizona | 851,407 | 748,012 | 240,691 | 50,208 |
| 2 | California | 7,543,928 | 4,539,426 | 1,662,125 | 2,783,022 |
| 3 | Colorado | 2,309,178 | 1,196,805 | 1,470,829 | 10,126 |
| 4 | Idaho | 3,511,751 | 757,753 | 3,088,161 | 28,149 |
| 5 | Kansas | 2,851,085 | 106,984 | 2,865,244 | 72,663 |
| 6 | Montana | 1,872,286 | 1,144,584 | 849,332 | 1,079 |
| 7 | Nebraska | 8,297,457 | 1,251,630 | 7,362,241 | 36,168 |
| 8 | Nevada | 689,953 | 469,556 | 289,042 | 3,382 |
| 9 | New Mexico | 694,571 | 289,732 | 458,284 | 30,253 |
| 10 | North Dakota | 213,686 | 28,108 | 194,545 | 334 |
| 11 | Oklahoma | 426,296 | 14,010 | 429,033 | 7,747 |
| 12 | Oregon | 1,553,034 | 571,531 | 1,141,042 | 85,456 |
| 13 | South Dakota | 369,802 | 51,774 | 332,929 | 164 |
| 14 | Texas | 4,489,837 | 560,944 | 3,980,081 | 280,045 |
| 15 | Utah | 1,124,729 | 592,225 | 663,834 | 5,859 |
| 16 | Washington | 1,623,123 | 169,489 | 1,420,224 | 250,033 |
| 17 | Wyoming | 1,418,272 | 1,053,673 | 452,062 | 637 |
| **Total 17 Western States** | | **39,840,395** | **13,546,236** | **26,899,699** | **3,645,325** |

*Source: United States Department of Agriculture: 2013 Farm and Ranch Irrigation Survey, 2014a.*
Note: Several methods of water distribution are applied in some areas.

## Top States
## Irrigated Acreage and Water Use, 2018

### Irrigated Acres

| | million |
|---|---|
| California | 8.4 |
| Nebraska | 7.7 |
| Arkansas | 4.2 |
| Texas | 4.1 |
| Idaho | 3.4 |
| Colorado | 2.5 |
| Kansas | 2.4 |
| Montana | 2.1 |
| Washington | 1.9 |
| Mississippi | 1.7 |
| **U.S. Total** | **55.9** |

### Water Applied (acre-feet)

| | million | avg per acre |
|---|---|---|
| California | 24.5 | 2.9 |
| Idaho | 6.6 | 1.9 |
| Texas | 5.3 | 1.3 |
| Arkansas | 5.1 | 1.2 |
| Nebraska | 4.9 | 0.6 |
| Arizona | 4.4 | 4.7 |
| Washington | 4.1 | 2.2 |
| Colorado | 3.8 | 1.6 |
| Oregon | 2.7 | 1.7 |
| Montana | 2.5 | 1.2 |
| **U.S. Total** | **83.4** | **1.5** |

*California applied the largest total amount of irrigation water, 24.5 million acre-feet.*

*Arizona applied the most water per acre, an average of 4.7 acre-feet.*

Simplot

## Figure 10. Common Irrigation Technologies in the United States




| | | |
|---|---|---|
| 1. | Center Pivot | Sprinklers are attached to a wheel-driven frame that rotates around a central point to irrigate a large circular area. |
| 2. | Surface Drip | Surface drip irrigation uses small diameter tubing and to drip water directly to the root zone of plants through emitters. |
| 3. | Side Roll or Wheel Move | Sprinklers are attached to a wheel-mounted lateral pipe. Self-aligning sprinkler heads are used so that the sprinklers are always upright. |
| 4. | Low-Flow Micro Sprinklers | Micro sprinklers are similar to surface drip systems, except they spray water at low pressures over a wider area instead of dripping the water directly onto the root zone of a plant. |
| 5. | Big Gun or Traveler | A large, gun type sprinkler that is periodically moved by tractor. |
| 6. | Solid Set and Permanent | Sprinklers are attached to either to an above ground portable pipe system or a permanent buried system. Sprinklers are typically arranged in a diamond or triangular pattern. |
| 7. | Hand Move | Sprinklers are attached to an above ground portable lateral pipe system that can be moved by hand. |
| 8. | Furrow | Water is applied to the end of small parallel channels. The water then flows down the slope of a field and seeps into the soil. |
| 9. | Sub-Surface Irrigation | Subsurface irrigation is a microirrigation system that is buried in the ground, which allows the application of water directly to the root zone of a plant with very little evaporation loss. |
| 10. | Linear Move Tower | Sprinklers are attached to a continuous, self-moving system that irrigates a rectangular area. |





# It all started at U of Idaho, Parma R&E Center in 2015

Scott Simplot asked the question “Can we grow processing potatoes under drip irrigation?”


NETAFIM
IN


Potato Yields
2014
Simplot


TUBER SET AND YIELD
RANGER RUSSET


SPUDNIK


Netafim driptape (63 miles of tape on 21 acres) was inserted into the potato bed approximately 4 inches above the seed piece post planting but pre-emergence

Simplot

**Herbicide was applied with a ground applicator and the sprinkler irrigation was utilized to incorporated with sprinkler irrigation. Effective weed control in a drip irrigation potato field is a concern. Additional research is under way at OSU.**

Liquid fertigation tank

15 – 20 psi

45 psi

Pre filter

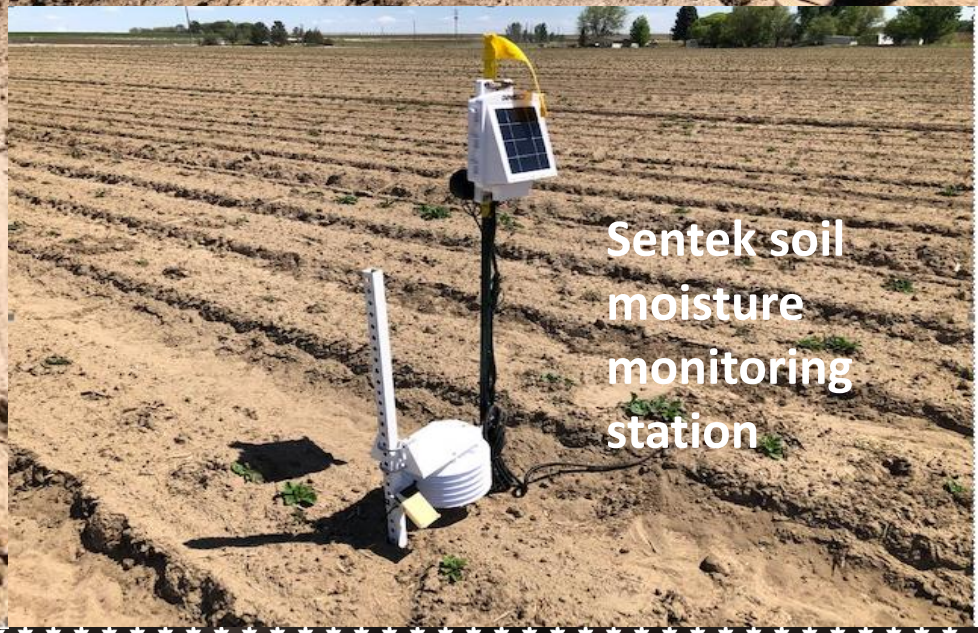
Disk filter station uses a pressure sustaining valve to backflush disk filters for cleaning

**Drip irrigation controller and a good filter station are very important for the proper operation of the drip system**

Simplot


**Drip system design is important to deliver enough volume and pressure to each zone**

Simplot

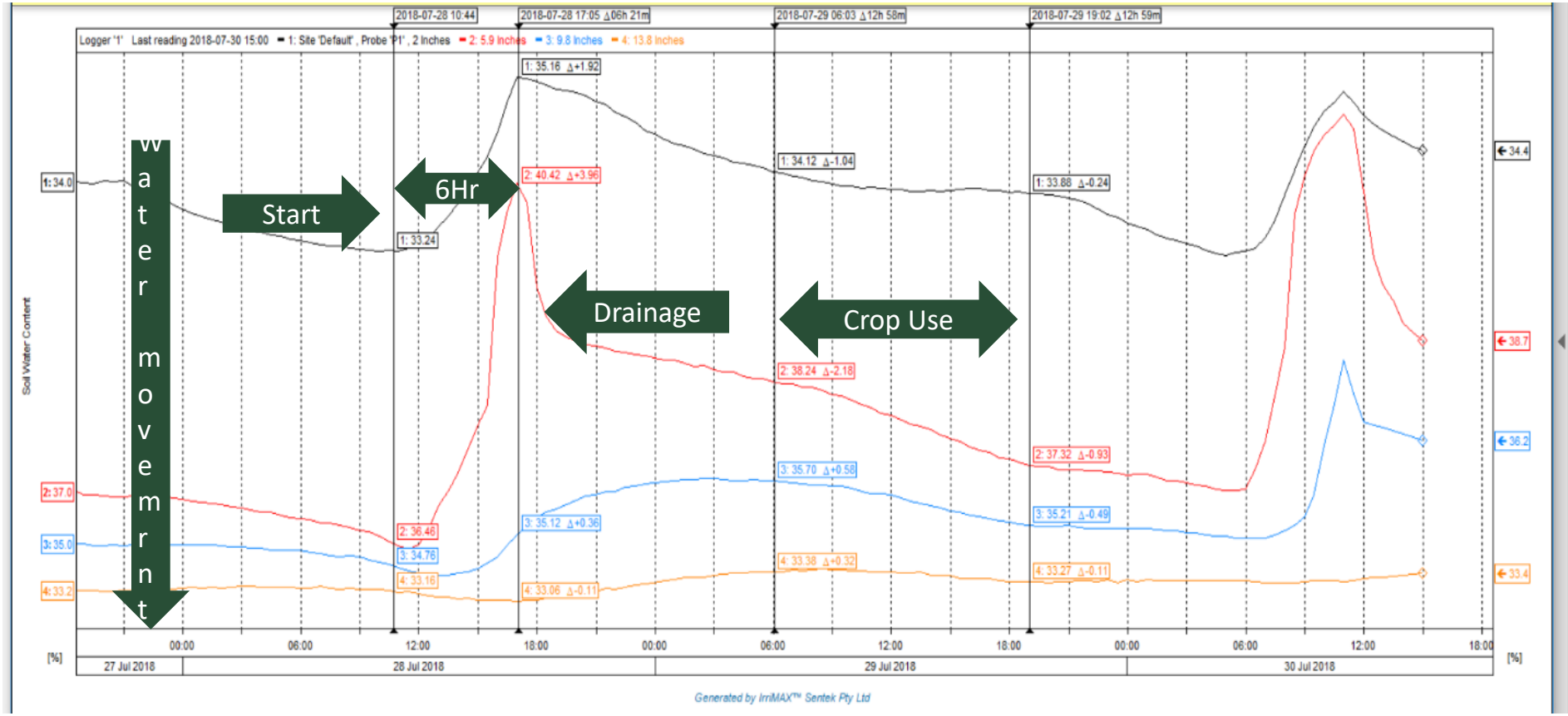

**Drip Irrigation delivers 0.08 inches/acre/hour at 12 inch spacing across the entire acre (approximately 18,500 plant). Spoon feed individual plants with liquid fertilizer with irrigation (fertigation)**

Simplot

| | A | B | C | D | E | F | G | H | I | J | K | L | M |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Month | 10 days | DAP | Phenologhy stage | Kc | Eto (Inch) | Etc (Inch) | Etc (Inch) | ater amount for irrigatio | irrigation interval | application rate (inch/hour) | Irrigation time (hour:minutes) | number of irrigation per 10 days |
| 2 | | | | | | 10 days | 10 days | Daily | Inch | days | | per irrigation | |
| 3 | march | 3 | | planting | | | | | | | | Hours:minutes | |
| 4 | April | 1 | 10 | pre-emergence | | | | | | | | | |
| 5 | April | 2 | 20 | pre-emergence | | | | | | | | | |
| 6 | April | 3 | 30 | pre-emergence | | | | | | | | | |
| 7 | May | 1 | 40 | pre-emergence | | | | | | | | | |
| 8 | May | 2 | 50 | mergence - early vegetatic | 0.3 | 2.4 | 0.72 | 0.07 | 0.5 | 7 | 0.08 | 06:00 | 1 |
| 9 | May | 3 | 60 | vegetation | 0.3 | 2.7 | 0.81 | 0.07 | 0.5 | 7 | 0.08 | 06:00 | 1 |
| 10 | June | 1 | 70 | egetation - tuber initiatio | 0.4 | 2.7 | 1.08 | 0.11 | 0.5 | 5 | 0.08 | 06:00 | 2 |
| 11 | June | 2 | 80 | vegetation - tuberization | 0.45 | 3 | 1.35 | 0.14 | 0.45 | 3 | 0.08 | 05:40 | 3 |
| 12 | June | 3 | 90 | vegetation - tuberization | 0.6 | 3.2 | 1.92 | 0.19 | 0.45 | 2 | 0.08 | 05:40 | 5 |
| 13 | July | 1 | 100 | Tuber bulking | 0.65 | 3.4 | 2.21 | 0.22 | 0.45 | 2 | 0.08 | 05:40 | 5 |
| 14 | July | 2 | 110 | Tuber bulking | 0.7 | 3.4 | 2.38 | 0.24 | 0.45 | 2 | 0.08 | 05:40 | 5 |
| 15 | July | 3 | 120 | Tuber bulking | 0.75 | 3.6 | 2.7 | 0.25 | 0.45 | 2 | 0.08 | 05:40 | 5 |
| 16 | August | 1 | 130 | Tuber bulking | 0.8 | 3 | 2.4 | 0.24 | 0.45 | 2 | 0.08 | 05:40 | 5 |
| 17 | August | 2 | 140 | Tuber bulking | 0.8 | 2.8 | 2.24 | 0.22 | 0.45 | 2 | 0.08 | 05:40 | 5 |
| 18 | August | 3 | | maturation | 0.8 | 2.9 | 2.32 | 0.21 | 0.45 | 2 | 0.08 | 05:40 | 5 |
| 19 | September | 1 | | maturation | 0.6 | 2.3 | 1.38 | 0.14 | 0.5 | 4 | 0.08 | 06:00 | 2 |
| 20 | September | 2 | | maturation | 0.5 | 1.9 | 0.95 | 0.10 | 0.5 | 5 | 0.08 | 06:00 | 2 |
| 21 | September | 3 | | maturation | 0.4 | 1.6 | 0.64 | 0.06 | 0.5 | 8 | 0.08 | 06:00 | 1 |
| 22 | October | 1 | | | | | | | | | | | |
| 23 | October | 2 | | | | | | | | | | | |
| 24 | October | 3 | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | |
| 26 | Total (Inch) | | | | | | 23.1 | | | | | | |
| 27 | | | | | | | | | | | | | |
| 28 | | | | | | | | | | | | | |

2018 Irrigation Plan

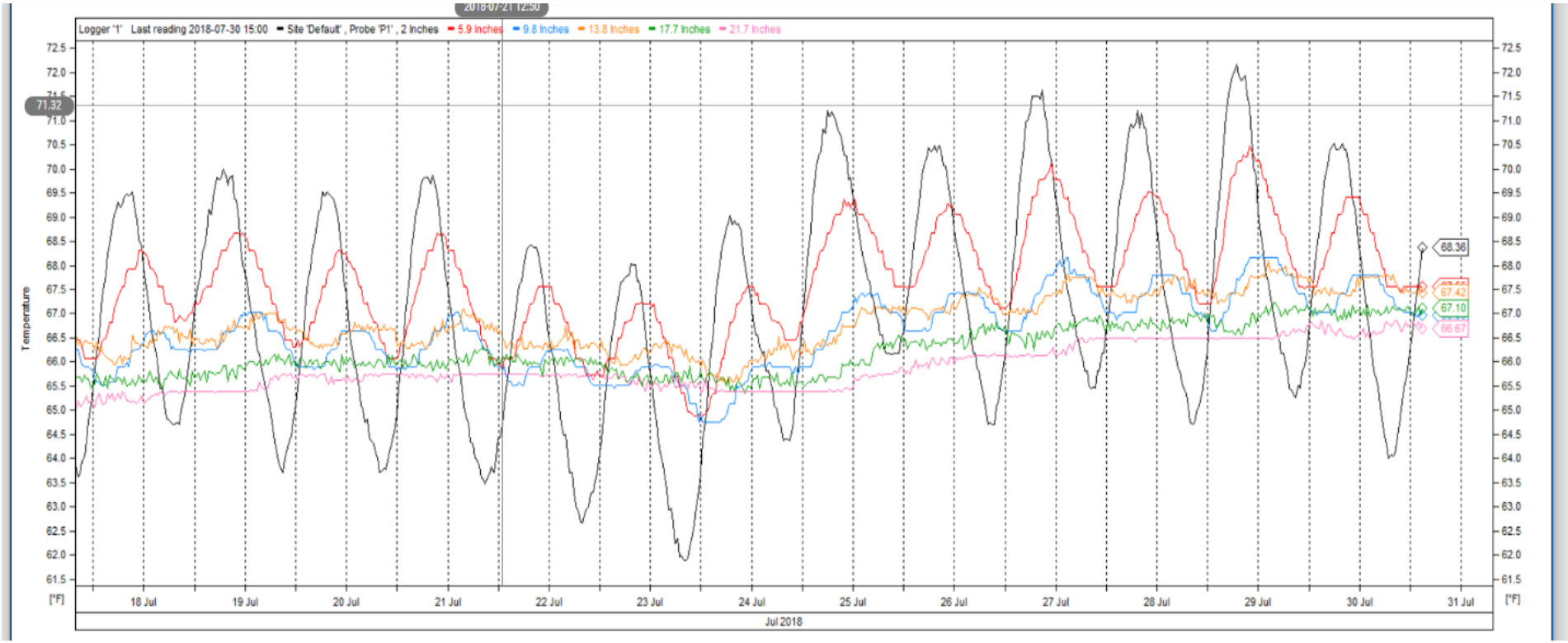
Simplot




Simplot Smartfarm

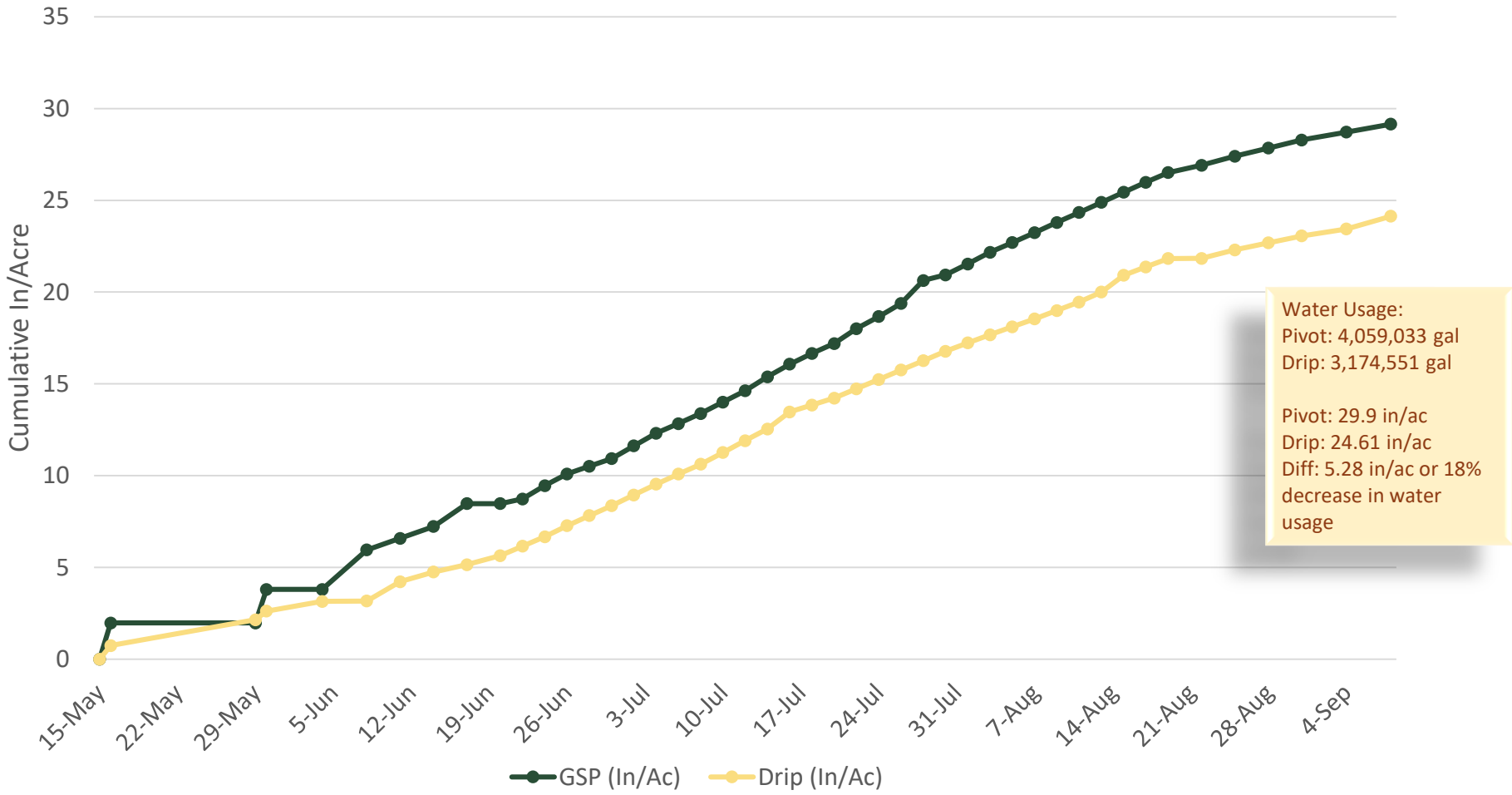
# Drip vs Pivot

# Temperature



# Irrigation:

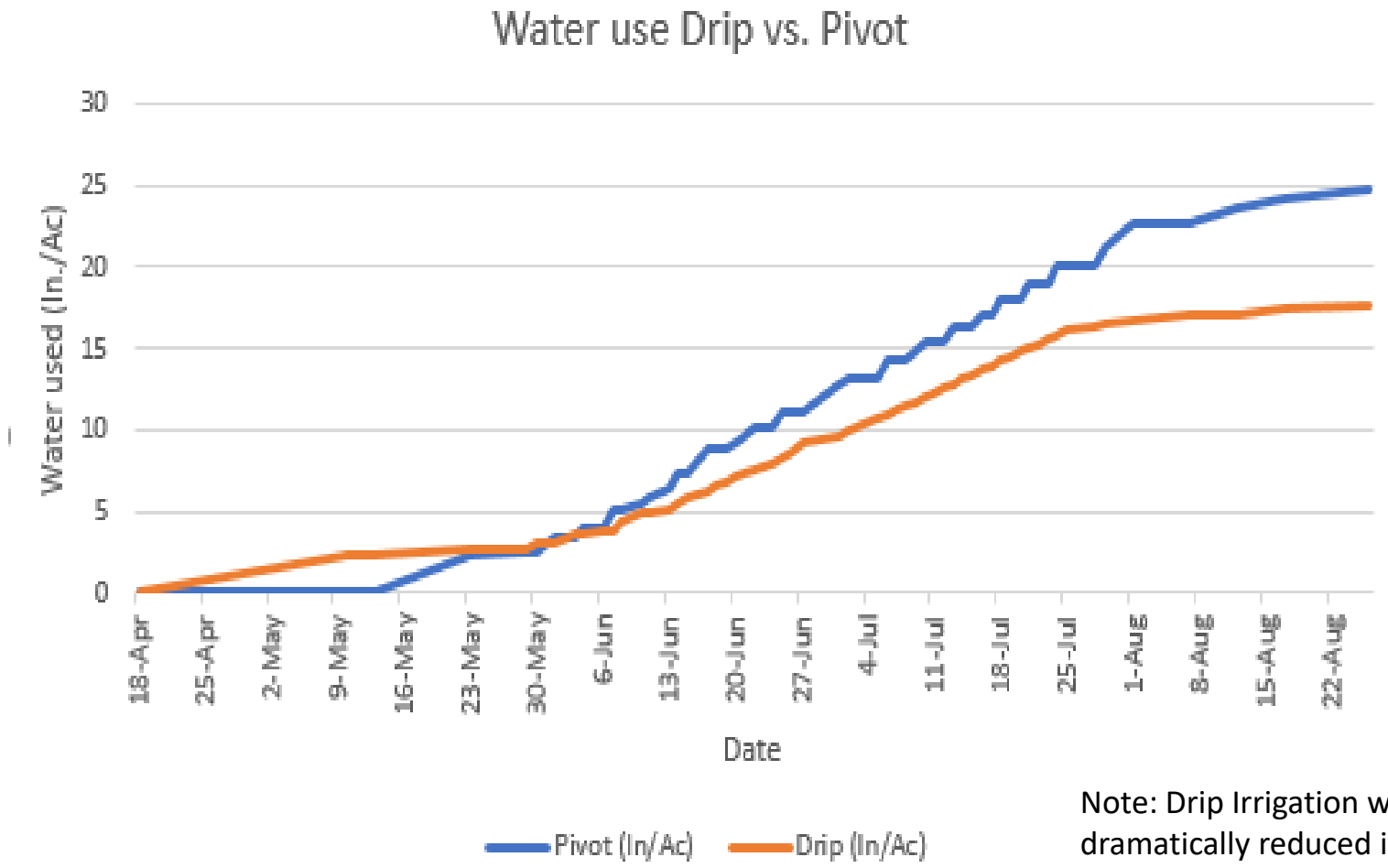
## Drip vs Grower's Standard Practice
## Irrigation 2018




Water Usage:
Pivot: 4,059,033 gal
Drip: 3,174,551 gal

Pivot: 29.9 in/ac
Drip: 24.61 in/ac
Diff: 5.28 in/ac or 18% decrease in water usage

# 2019 Irrigation:




Water Usage:

Pivot: 24.8 in/ac
Drip: 17.7 in/ac
Diff: 7.1in/ac or 29% decrease in water usage

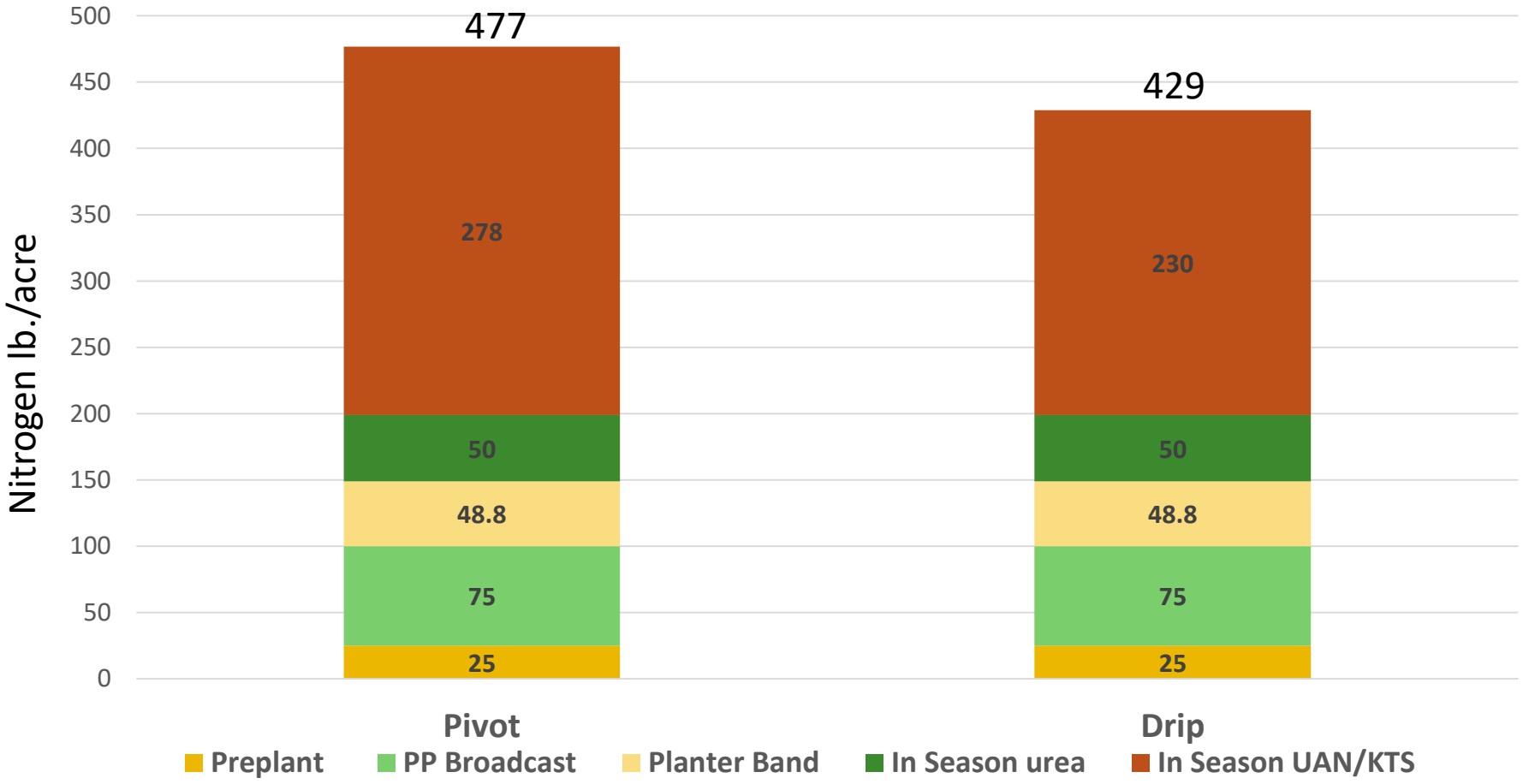
Note: Drip Irrigation was dramatically reduced in mid July when vines prematurely collapsed

| Month | 10 days | DAE | Phenologhy stage | # irrigation | N | | K | | P | | lb P2O5 | gal/2.5 ac | gal | gal/2.5 ac | gal |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | /10 day perio | lb/acre/day | lb/acre/period | lb/acre/day | K/ac/peric | lb/acre/day | b P/acre/perio | /ac/period | 30-0-0-3 /irrigation | 30-0-0-3 /period | 6-24-6 /irrigation | 6/24/2006 /period |
| march | 3 | | planting | | | | No Need | | | | | | | | |
| April | 1 | | pre-emergence | | | | | | | | | | | | |
| April | 2 | | pre-emergence | | | | | | | | | | | | |
| April | 3 | | pre-emergence | | | | | | | | | | | | |
| May | 1 | | pre-emergence | | | | | | | | | | | | |
| May | 2 | 10 | emergence - early vegetation | 1 | 1.5 | 15 | 1 | 10 | 0.2 | 2 | 4.58 | 11.5 | 23.1 | 4.7 | 9.3 |
| May | 3 | 21 | vegetation | 1 | 2.5 | 28 | 2 | 20 | 0.2 | 2 | 4.58 | 21.5 | 43.1 | 4.7 | 9.3 |
| June | 1 | 31 | vegetation - tuber initiation | 2 | 3 | 30 | 3 | 30 | 0.25 | 2.8 | 6.41 | 11.5 | 46.2 | 3.3 | 13.1 |
| June | 2 | 41 | vegetation - tuberization | 3 | 3.5 | 35 | 4 | 40 | 0.3 | 3 | 6.87 | 9.0 | 53.8 | 2.3 | 14.0 |
| June | 3 | 51 | vegetation - tuberization | 5 | 3.5 | 35 | 5 | 50 | 0.3 | 3 | 6.87 | 5.4 | 53.8 | 1.4 | 14.0 |
| July | 1 | 61 | Tuber bulking | 5 | 3 | 30 | 4 | 40 | 0.3 | 3 | 6.87 | 4.6 | 46.2 | 1.4 | 14.0 |
| July | 2 | 71 | Tuber bulking | 5 | 3 | 30 | 3 | 30 | 0.2 | 2 | 4.58 | 4.6 | 46.2 | 0.9 | 9.3 |
| July | 3 | 82 | Tuber bulking | 5 | 2.5 | 28 | 2 | 20 | 0.15 | 1.7 | 3.89 | 4.3 | 43.1 | 0.8 | 7.9 |
| August | 1 | 92 | Tuber bulking | 5 | 2 | 20 | 1 | 10 | 0.15 | 1.5 | 3.44 | 3.1 | 30.8 | 0.7 | 7.0 |
| August | 2 | 102 | Tuber bulking | 5 | 2 | 20 | 1 | 10 | 0.15 | 1.5 | 3.44 | 3.1 | 30.8 | 0.7 | 7.0 |
| August | 3 | 113 | maturation | 5 | | | | | | | | | | | |
| September | 1 | 123 | maturation | 2 | | | | | | | | | | | |
| September | 2 | | maturation | 2 | | | | | | | | | | | |
| September | 3 | | maturation | 1 | | | | | | | | | 416.9 | | 105.2 |
| October | 1 | | | | lb/acre/season | 271 | No Need | 260 | lb/acre/season | 22.5 | | | | | |
| October | 2 | | | | gal 30-0-0-3 | 417 | | | gal 6-24-6 | 105 | | | | | |
| October | 3 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| Total (Inch) | | | | | | | | | | | | | | | |

2017 In-season Nutrient Application Plan

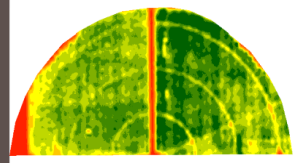
Simplot

# Comparison of Pivot vs Drip Fertility Programs

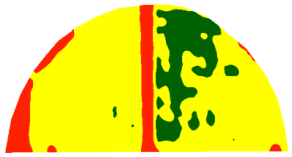



Planter Band = 34 gal of 11-37-0 + 3 gal KTS + 2 qt Che Zn+ 2 qt Che Mn+ 2 qt nutriB.A.N.D. + 1 qt Nexia / acre
Total Pivot fertility 477 lb N – 201 lb $P_2O_5$ – 342 lb $K_2O$ /acre
Total Drip fertility 429 lb N – 201 lb $P_2O_5$ – 320 lb $K_2O$ /acre

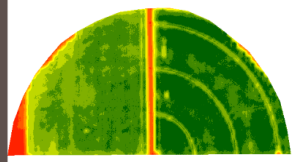
6/ 2/2018 >>



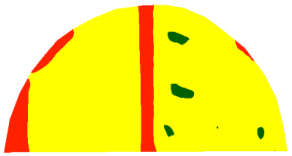
0.09 - 0.16
0.16 - 0.25
0.25 - 0.33
0.33 - 0.39
0.39 - 0.43
0.43 - 0.45
0.45 - 0.47
0.47 - 0.50
0.50 - 0.57



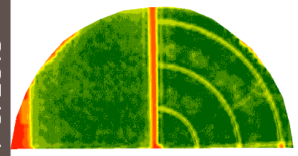
6/20/2018 >>



0.08 - 0.18
0.18 - 0.27
0.27 - 0.37
0.37 - 0.48
0.48 - 0.59
0.59 - 0.67
0.67 - 0.70
0.70 - 0.72
0.72 - 0.77

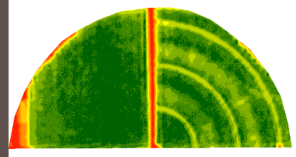


7/ 3/2018 >>



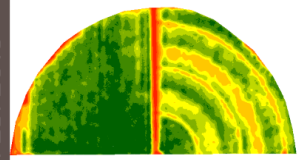
0.08 - 0.21
0.21 - 0.32
0.32 - 0.44
0.44 - 0.54
0.54 - 0.63
0.63 - 0.69
0.69 - 0.72
0.72 - 0.74
0.74 - 0.78

7/16/2018 >>



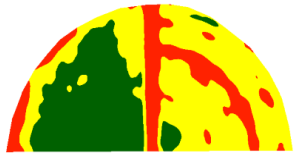
0.13 - 0.27
0.27 - 0.35
0.35 - 0.44
0.44 - 0.53
0.53 - 0.60
0.60 - 0.65
0.65 - 0.68
0.68 - 0.70
0.70 - 0.74

7/29/2018 >>

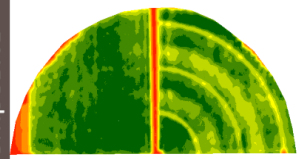


0.16 - 0.28
0.28 - 0.37
0.37 - 0.44
0.44 - 0.50
0.50 - 0.54
0.54 - 0.57
0.57 - 0.59
0.59 - 0.61
0.61 - 0.65

v

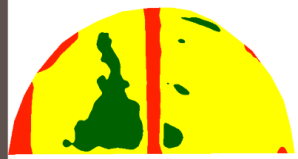


Composite >>

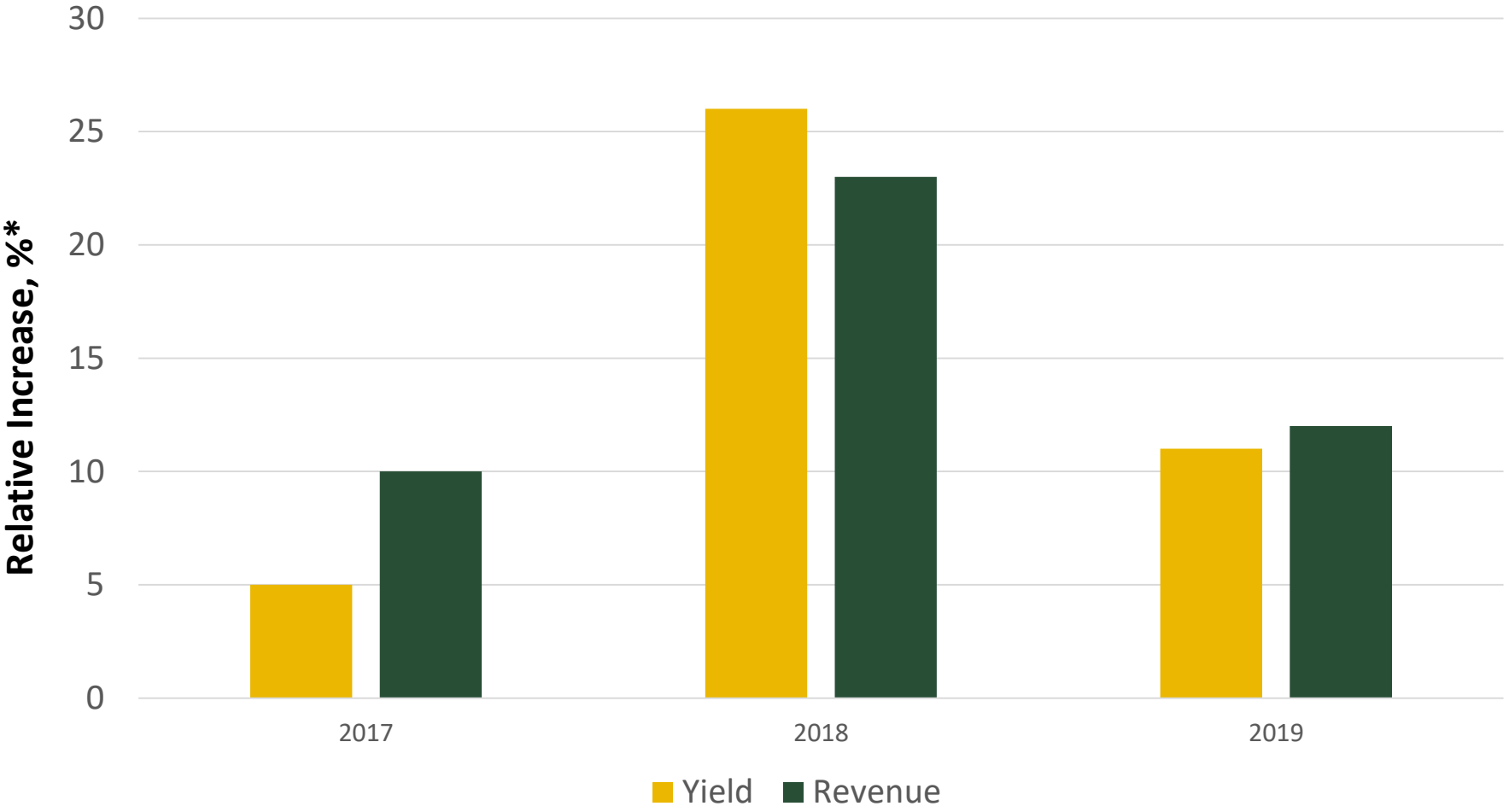


0.14 - 0.24
0.24 - 0.30
0.30 - 0.39
0.39 - 0.48
0.48 - 0.55
0.55 - 0.58
0.58 - 0.60
0.60 - 0.62
0.62 - 0.65

v Significant Areas



# Effect of drip irrigation on relative yield and revenue increase of potato production in SW Idaho




*Compared to sprinkler irrgation

Vines were shredded prior to lifting drip tape.  All driptape was completely removed from the field prior to harvest operations

Recycling of used drip tape is still an important consideration/drawback.  This tape went to a landfill because of no market or outlet for used driptape.

# Estimated Drip Irrigation Costs

- Cost of drip tape varies $250/ac to over $500/acre based on wall thickness (increased wall thickness is better for removal)
- 3 man hours/acre to lay drip tape
- 24 man hours/acre to operate system and monitor irrigation in-season
- 3 man hours/acre to lift tape, roll it and remove it from the field
- $50/acre to dispose of drip tape (no recycling available in 2018)
- Fertilizer savings (10% reduction in N usage)
- Water savings (18% reduction in water usage)
- Reduced disease pressure and improved plant health
- **No foreign material has been delivered to the potato processing plant in 3 years of small plots and 3 years of commercial evaluation**

Scott Simplot say “Yes we can grow potatoes for processing with drip irrigation without delivering foreign material to the processing plant”

Simplot