# Lessons from an Agricultural Irrigation Initiative

July 2014

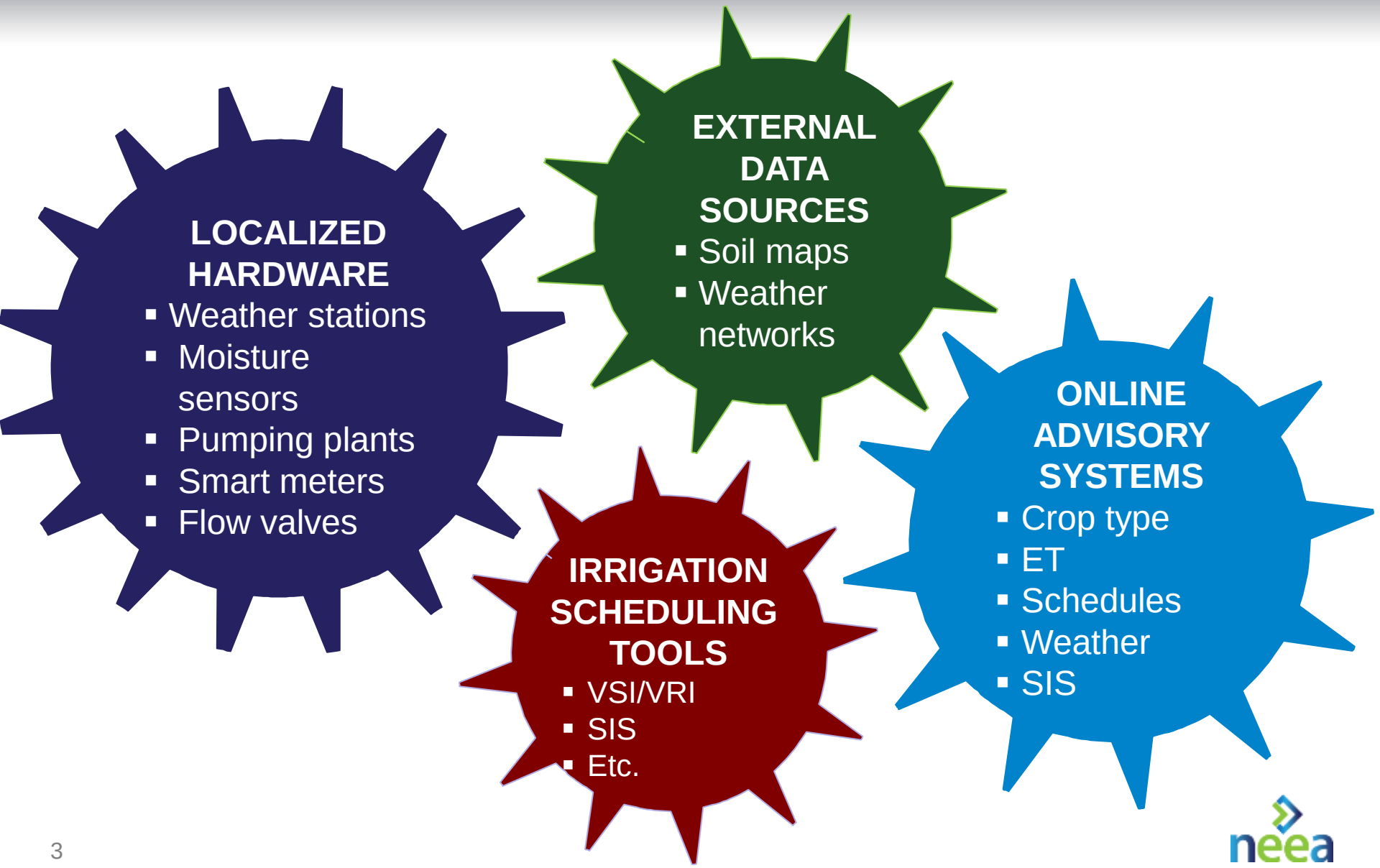
NORTHWEST ENERGY EFFICIENCY ALLIANCE

NEXT CHAPTER MARKETING

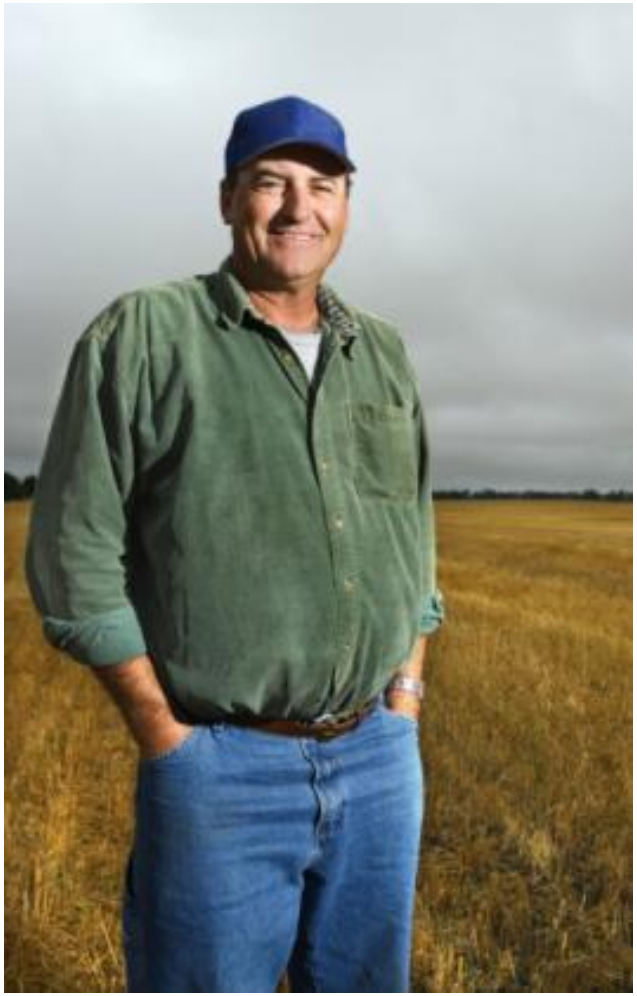
# NEEA's Role


- Fill the energy efficiency pipeline
- Accelerate market adoption
- Leverage the power of the region

# Today's Standalone Tools Don't Integrate



# What Growers Told Us



- We need a free flow of data to enable us to farm with the best real time data available to make real time management decisions

- Today: inundated with data, each with its own portal
  - diagnostic and performance data from each piece of equipment, on each and every field of the farm
  - soil moisture, rainfall and other climatic conditions
  - satellite imagery overlaid on field data
  - what and where all the crop inputs are being applied

- Complexity compounded when running a mixed fleet of equipment

- Valuable extra time spent trying to analyze data and interpret it to make us more productive

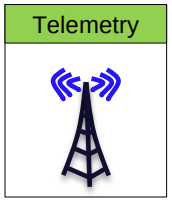
# Integrated Decision Support Solution

INPUTS

## ON-FARM INFORMATION

Weather

Moisture sensing

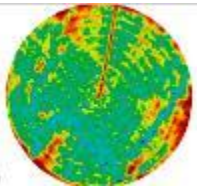



## ONLINE ADVISORY SYSTEM (ex. AgriMet)

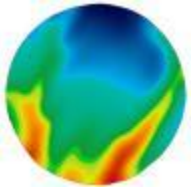
Crop type, ET, weather integration, irrigation scheduling, etc.

## STATIC DATA

Yield maps



Soil maps



## RISK MANAGEMENT

Iterative Feedback Loop

## DECISION SUPPORT

OUTPUTS

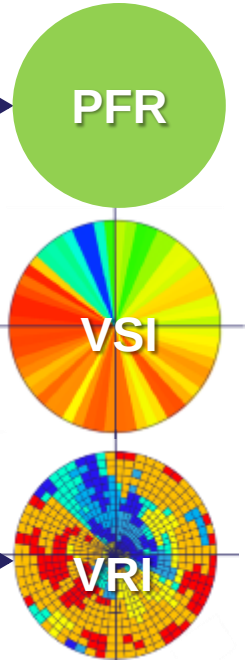
DYNAMIC

## OPTIMAL IRRIGATION MANAGEMENT

Tier 1 — PFR

Tier 2 — VSI

Tier 3 — VRI



FIXED

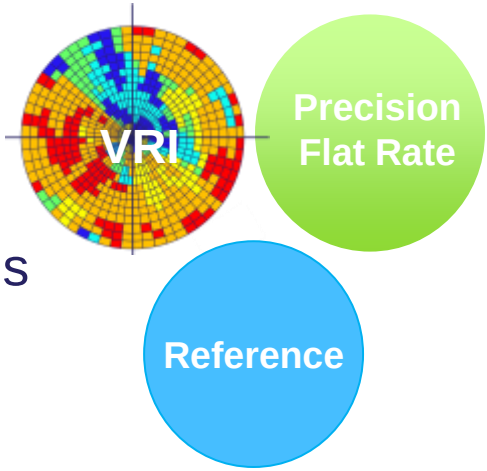
## DATA OUTPUT

Reports, trends, analysis, etc.

# 2013 Demonstration Sites: Summary

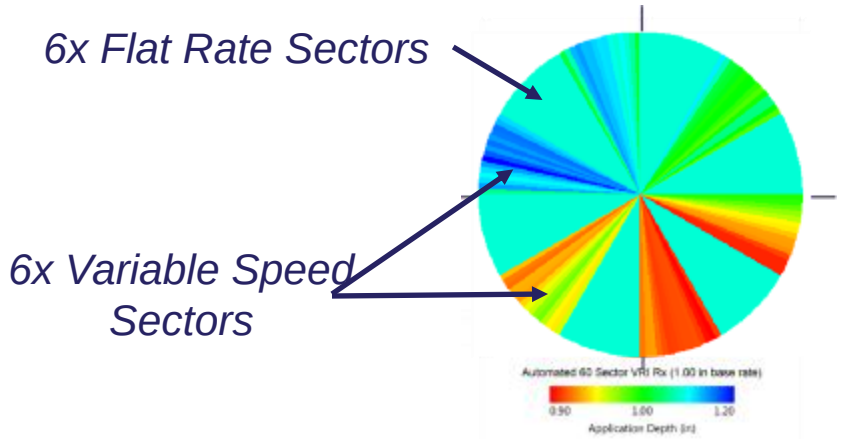
## VRI and Optimal Irrigation Demonstrations:

- 5x pivots w/VRI (4 under OSU management)
- 5x weather stations
- 15x fields w/experimental instrumentation
- Moisture measured at 3 locations per field @ 6 depths
- Locations:
  - 6 in Oregon
  - 6 in Washington
  - 3 in Idaho

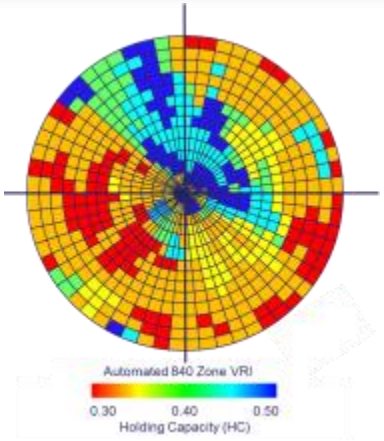



## VSI 30/30 Demonstrations:

- 8x pivots w/VSI
- Locations:
  - 1 in Washington
  - 7 in Idaho



# VRI Results: What Worked, What Didn't




## What Worked

- Remote Rx were successfully uploaded.
- VRI/VSI appears to put down water per the Rx

## What Can Work, But…

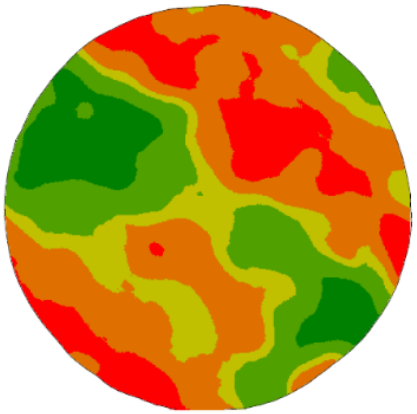
- Moisture Probe data quality had mixed results
- Telemetry reliability had mixed results
- Yield map data quality had mixed results
- VRI installation, commissioning and operator training was problematic

## What Didn't Work

- EC maps → HC and PAW maps; no Rx generated by IMO
  - Experiment could not start without maps
- Growers didn't follow recommendations in demonstrations
- Cost of technologies is a barrier

# Accurate Map = Accurate Prescription

**1** **DSS starts w/a Soil Map**



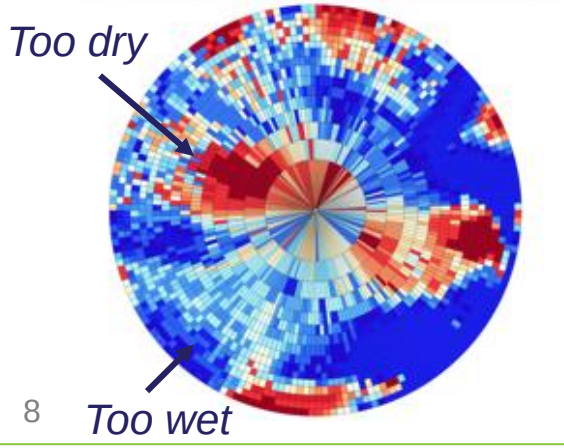
**2** **DSS adds current inputs**

- Current weather
- Plant growth model
- Water lost through evaporation or plant transpiration

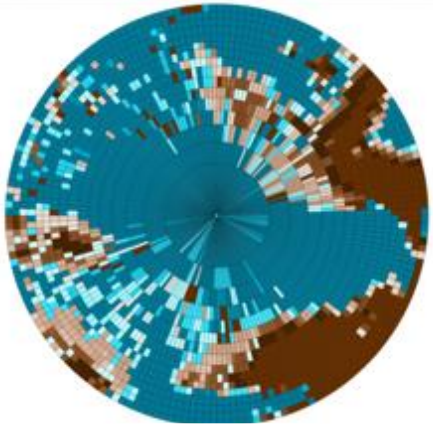
**3** **DSS models moisture level over entire field**

- Moisture readings keep model calibrated

**4** **DSS creates a Depletion Map**




**5** **DSS calculates a Prescription**

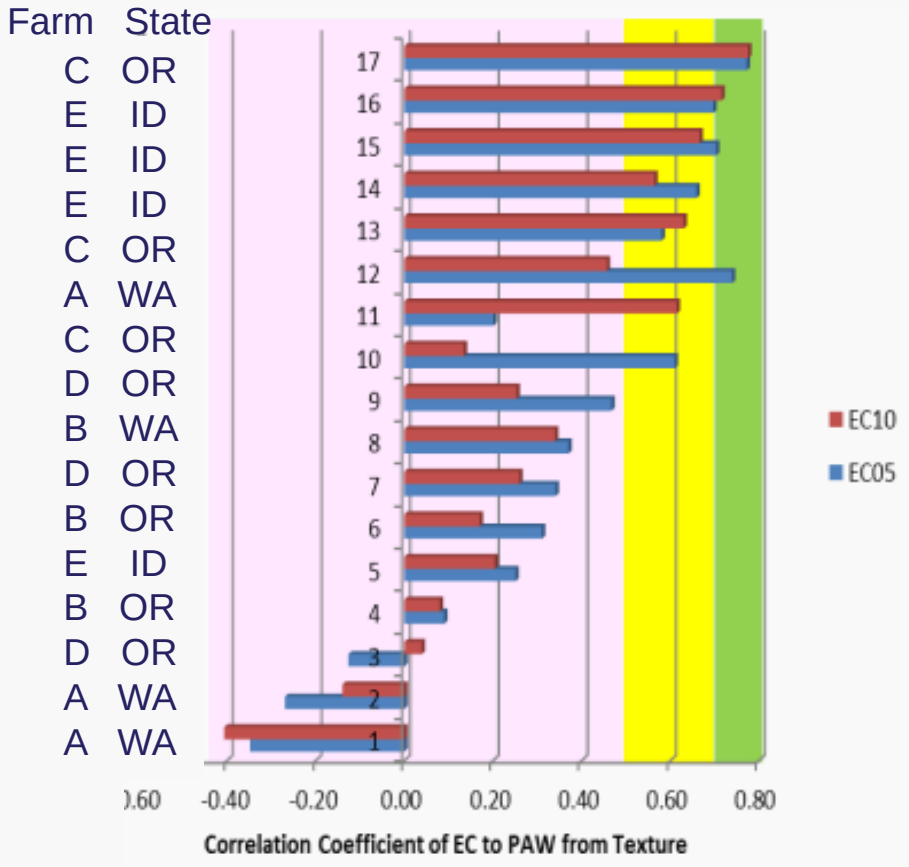


# Soil Mapping Summary

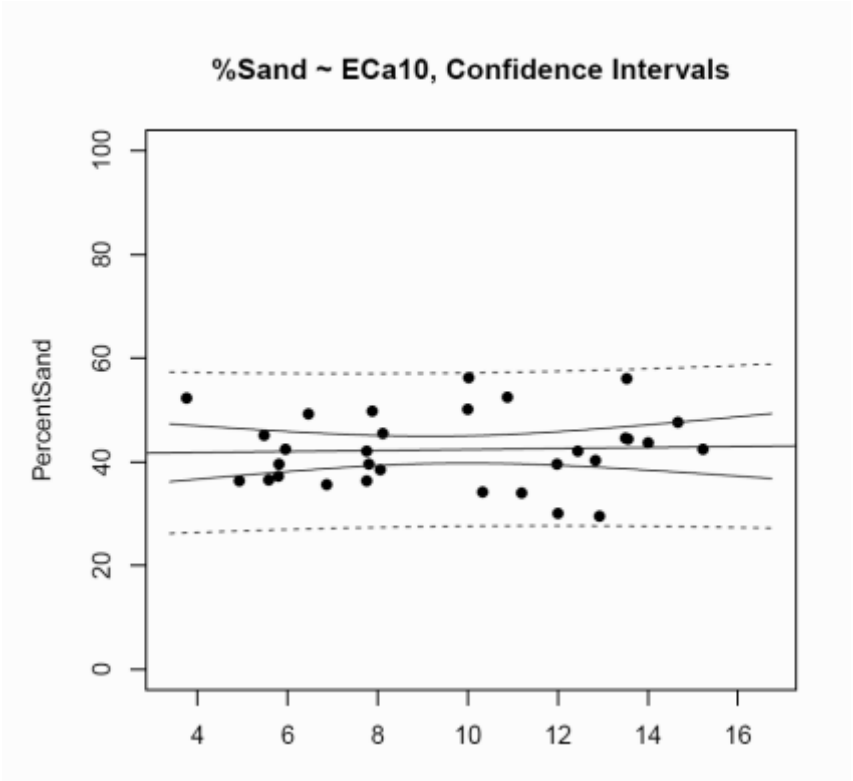
**EC maps not usable in many cases**

- Didn't match soil moisture, investigating cause
- More work underway on mapping methods

## EC Correlation w/PAW



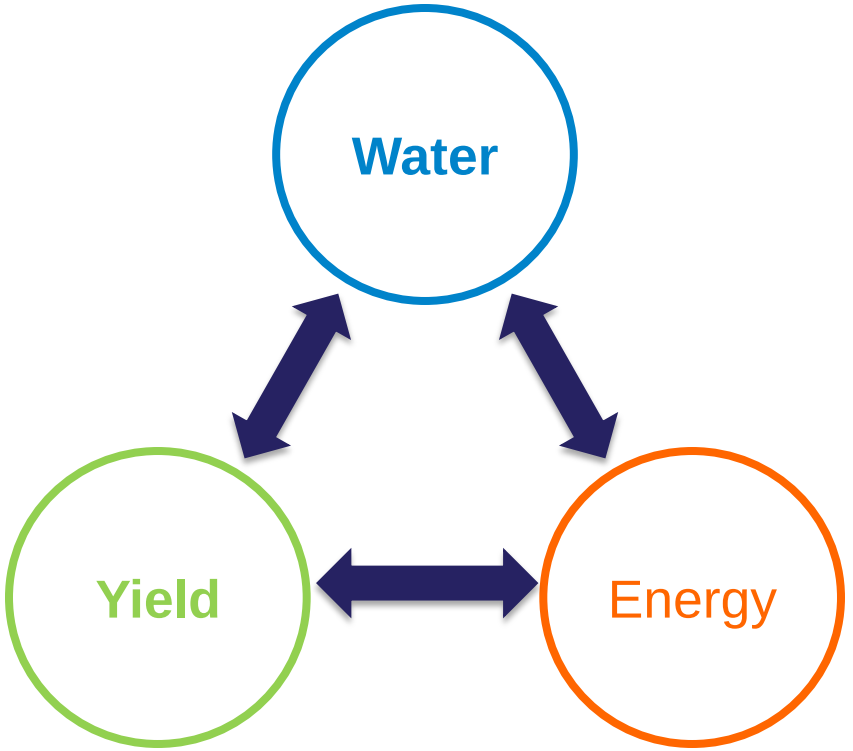

## EC Correlation w/Texture



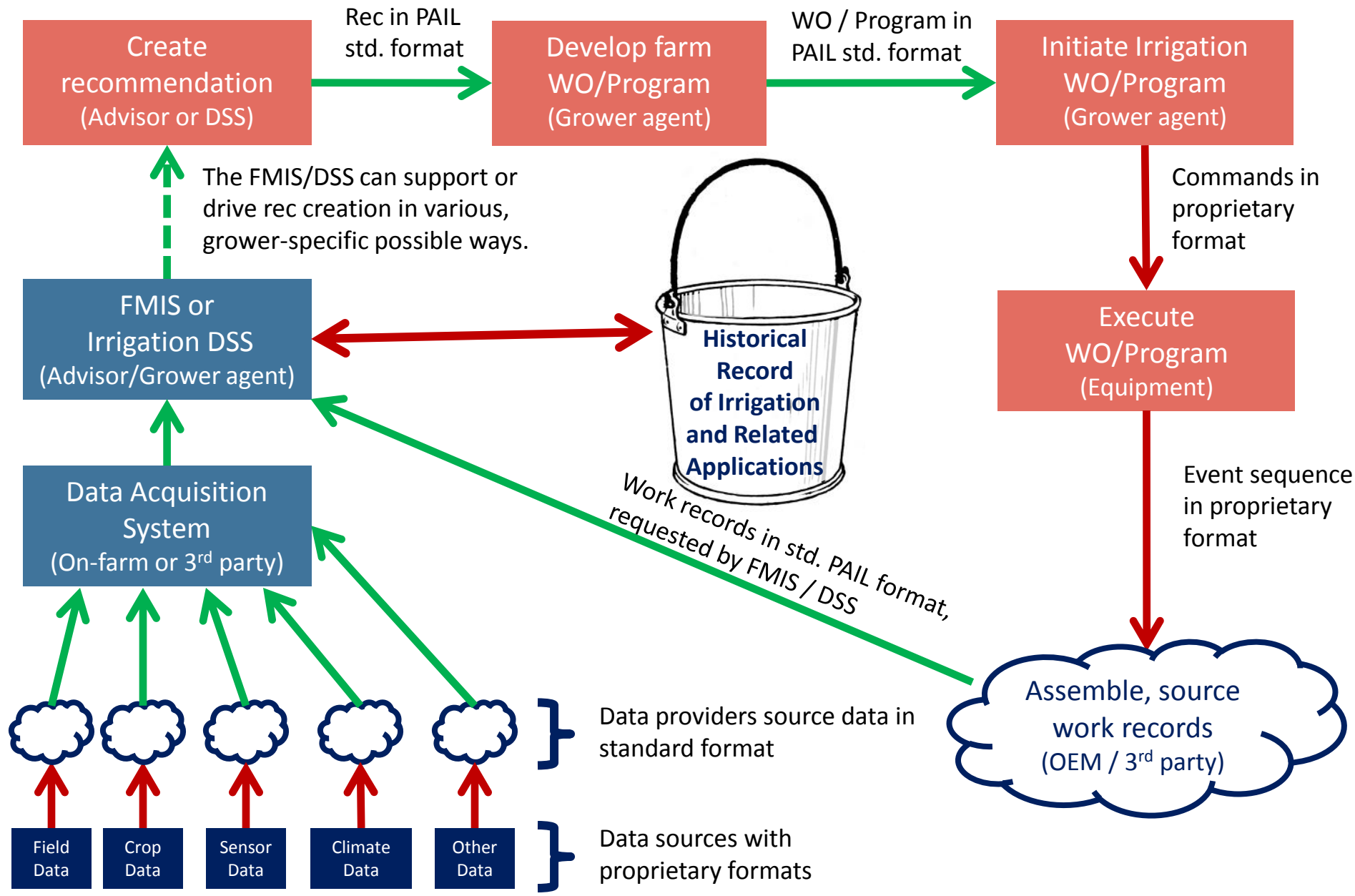

Can't estimate moisture holding capacity w/poor correlation between EC and texture (ex. % sand)

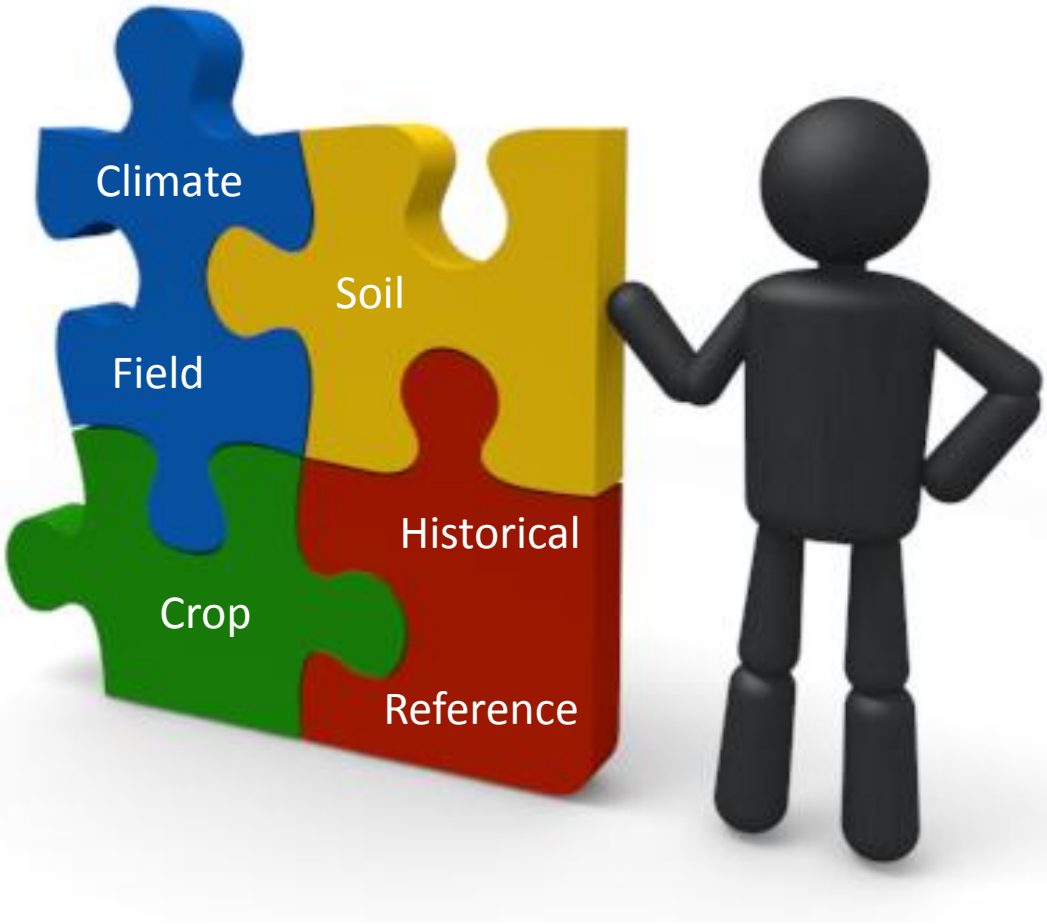
# Precision Ag Irrigation Leadership (PAIL) Data Standards

Improve agricultural irrigation by developing a common set of data standards and formats to convert data for use in irrigation data analysis and prescription programs.



# Irrigation Data Flow and Program/Work Order Execution

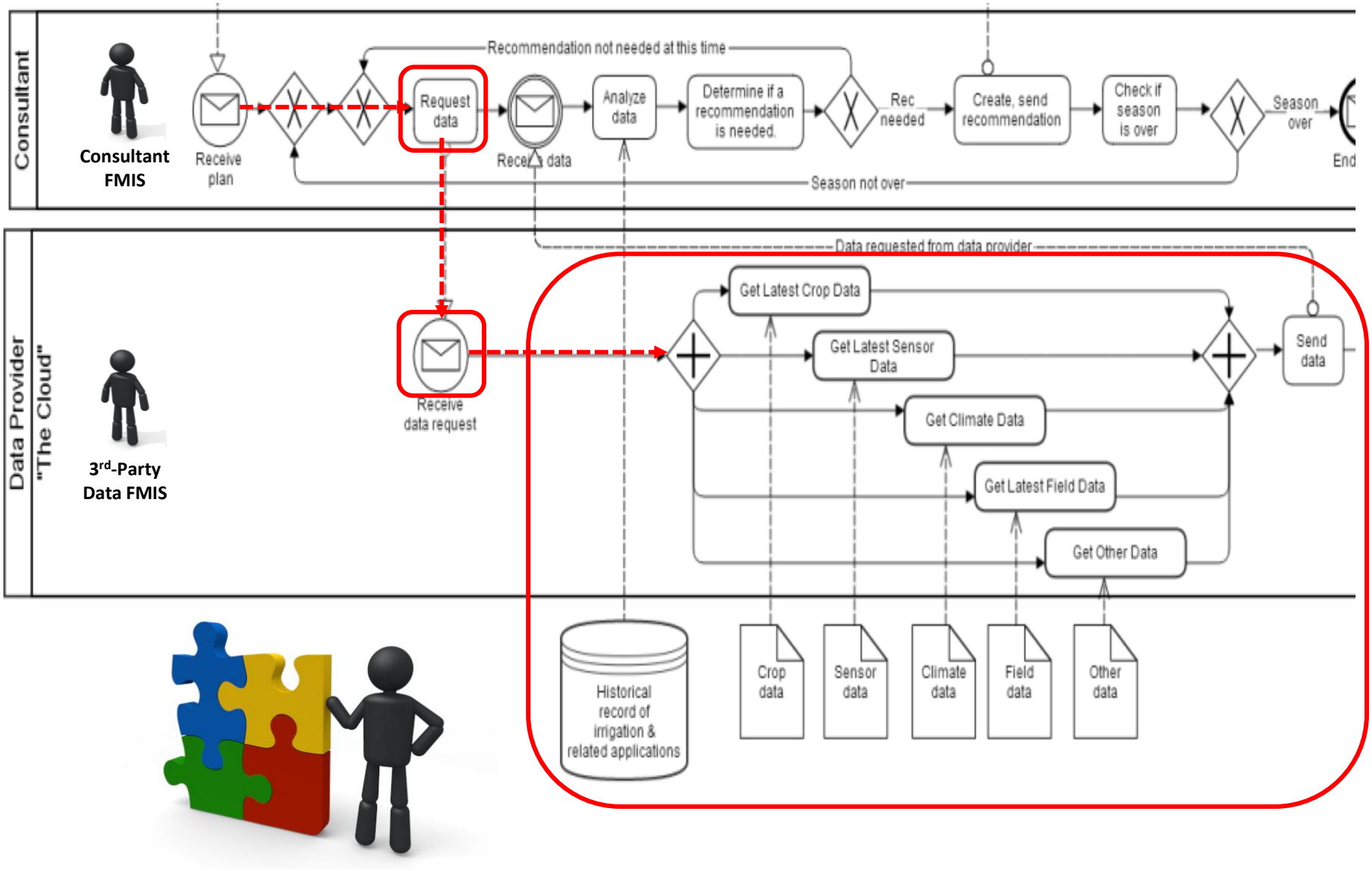


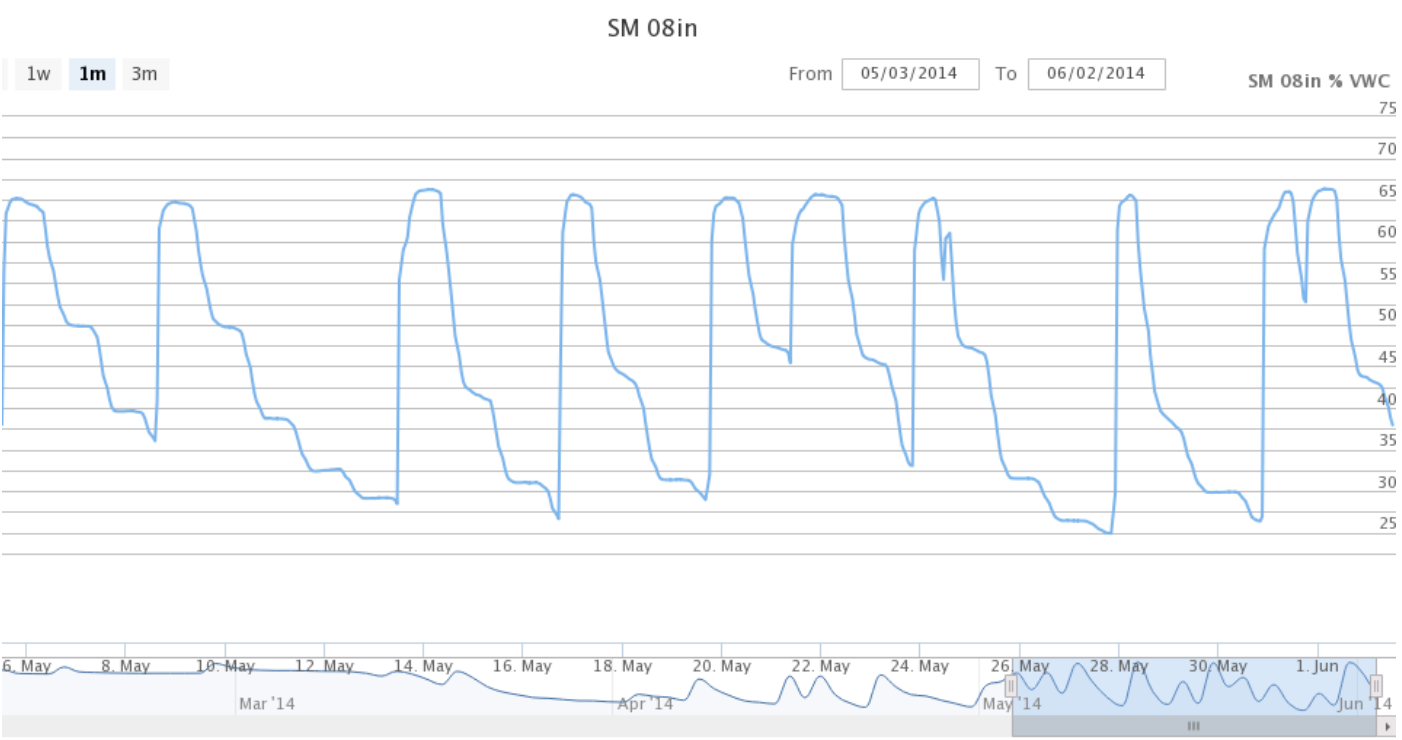



Decision Support System

# PAIL Irrigation Use Case

## Offsite and inbound data requested by consultant for recommendation.






# Soil Moisture Sensor Data

```
<?xml version="1.0" encoding="UTF-8"?>
<!--Sample XML file generated by XMLSpy v2013 rel. 2 sp2 (x64) (http://www.altova.com)-->
- <PAIL-Root-Element-Placeholder xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:noNamespaceSchemaLocation="Inbound-3.xsd">
  - <DataDocument>
    - <SensorData TransmissionStatus="fiveXfive" CollectionTime="2001-12-17T09:30:47Z" LoggerID="ID_1" SensorDataID="ID_1">
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        <SensorReading CollectionTime="2014-05-03T02:28:00Z" SensorReadingID="ID3">48.88</SensorReading>
        <SensorReading CollectionTime="2014-05-03T03:42:00Z" SensorReadingID="ID4">48.9</SensorReading>
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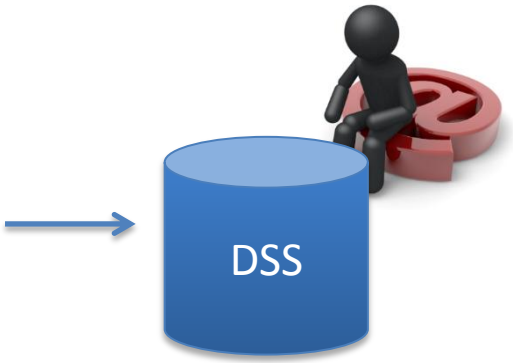
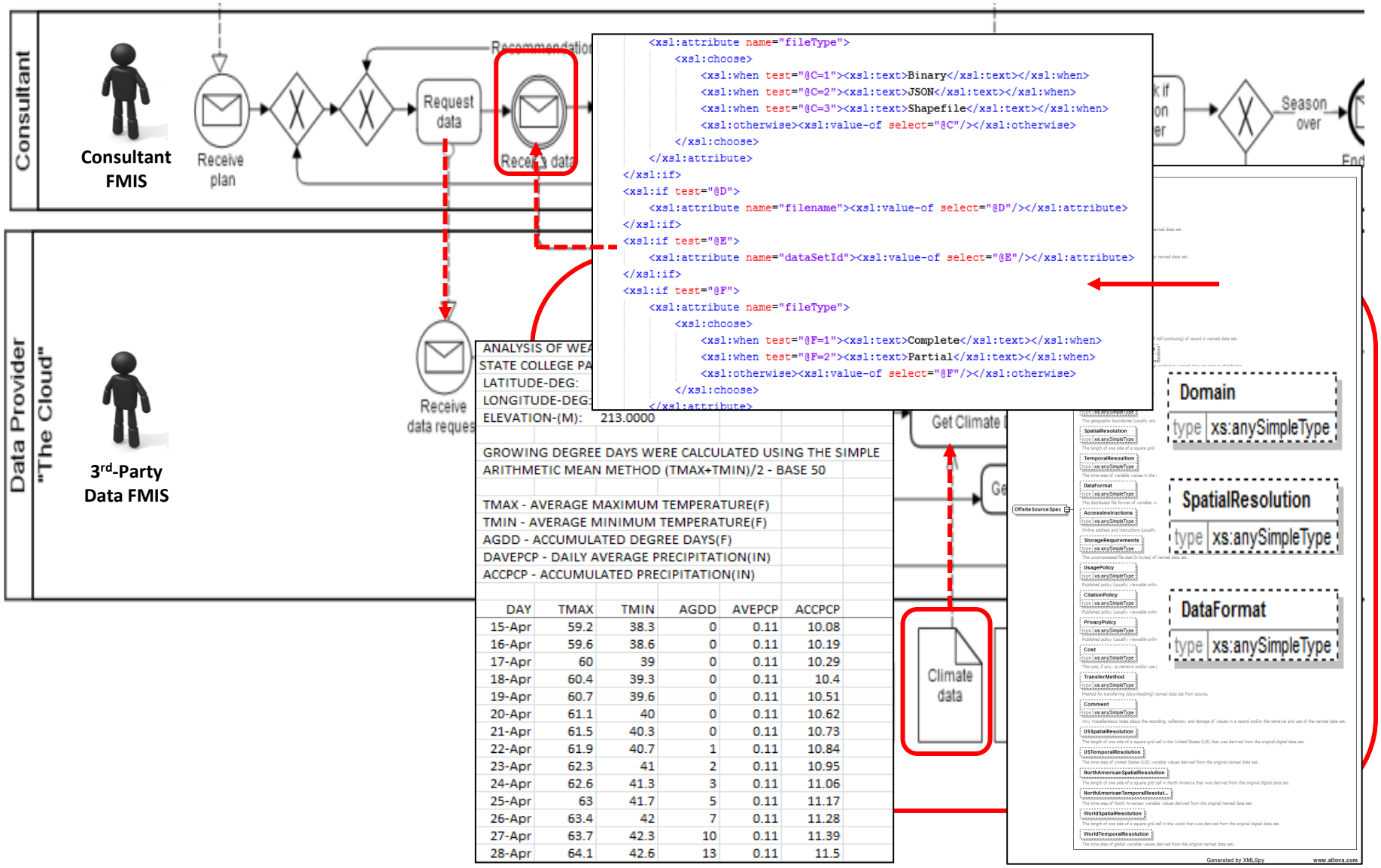


# PAIL Irrigation Use Case

## Climatic data converted to a standard XML format according to the schema.




```
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        <xsl:when test="@C=3"><xsl:text>Shapefile</xsl:text></xsl:when>
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    </xsl:choose>
</xsl:attribute>
</xsl:if>
<xsl:if test="@D">
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</xsl:if>
<xsl:if test="@E">
    <xsl:attribute name="dataSetId"><xsl:value-of select="@E"/></xsl:attribute>
</xsl:if>
<xsl:if test="@F">
    <xsl:attribute name="fileType">
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            <xsl:when test="@F=2"><xsl:text>Partial</xsl:text></xsl:when>
            <xsl:otherwise><xsl:value-of select="@F"/></xsl:otherwise>
        </xsl:choose>
    </xsl:attribute>
```

ANALYSIS OF WEA
STATE COLLEGE PA
LATITUDE-DEG:
LONGITUDE-DEG:
ELEVATION-(M): 213.0000

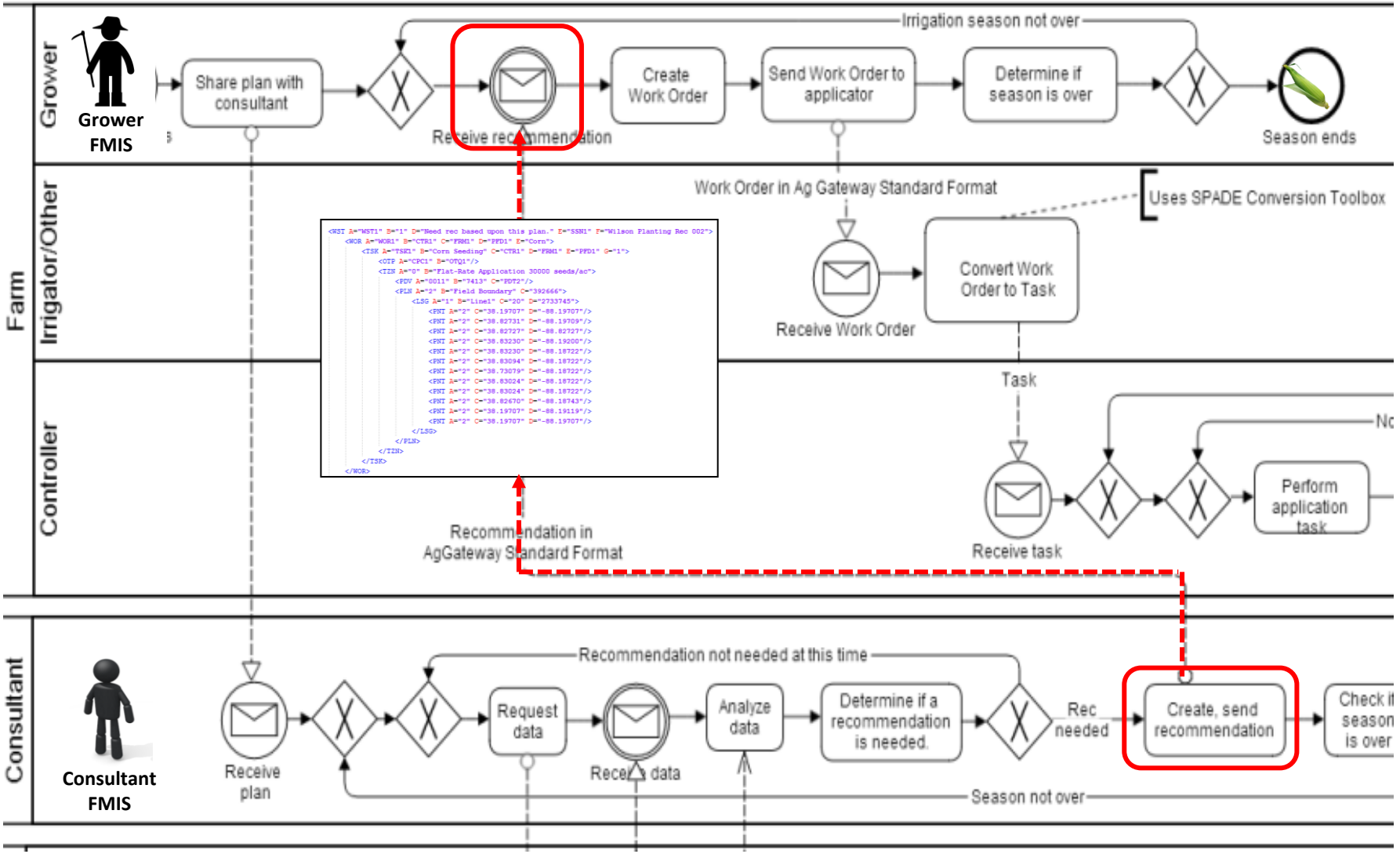
GROWING DEGREE DAYS WERE CALCULATED USING THE SIMPLE ARITHMETIC MEAN METHOD (TMAX+TMIN)/2 - BASE 50

TMAX - AVERAGE MAXIMUM TEMPERATURE(F)
TMIN - AVERAGE MINIMUM TEMPERATURE(F)
AGDD - ACCUMULATED DEGREE DAYS(F)
DAVEPCP - DAILY AVERAGE PRECIPITATION(IN)
ACCPCP - ACCUMULATED PRECIPITATION(IN)

| DAY | TMAX | TMIN | AGDD | AVEPCP | ACCPCP |
|---|---|---|---|---|---|
| 15-Apr | 59.2 | 38.3 | 0 | 0.11 | 10.08 |
| 16-Apr | 59.6 | 38.6 | 0 | 0.11 | 10.19 |
| 17-Apr | 60 | 39 | 0 | 0.11 | 10.29 |
| 18-Apr | 60.4 | 39.3 | 0 | 0.11 | 10.4 |
| 19-Apr | 60.7 | 39.6 | 0 | 0.11 | 10.51 |
| 20-Apr | 61.1 | 40 | 0 | 0.11 | 10.62 |
| 21-Apr | 61.5 | 40.3 | 0 | 0.11 | 10.73 |
| 22-Apr | 61.9 | 40.7 | 1 | 0.11 | 10.84 |
| 23-Apr | 62.3 | 41 | 2 | 0.11 | 10.95 |
| 24-Apr | 62.6 | 41.3 | 3 | 0.11 | 11.06 |
| 25-Apr | 63 | 41.7 | 5 | 0.11 | 11.17 |
| 26-Apr | 63.4 | 42 | 7 | 0.11 | 11.28 |
| 27-Apr | 63.7 | 42.3 | 10 | 0.11 | 11.39 |
| 28-Apr | 64.1 | 42.6 | 13 | 0.11 | 11.5 |

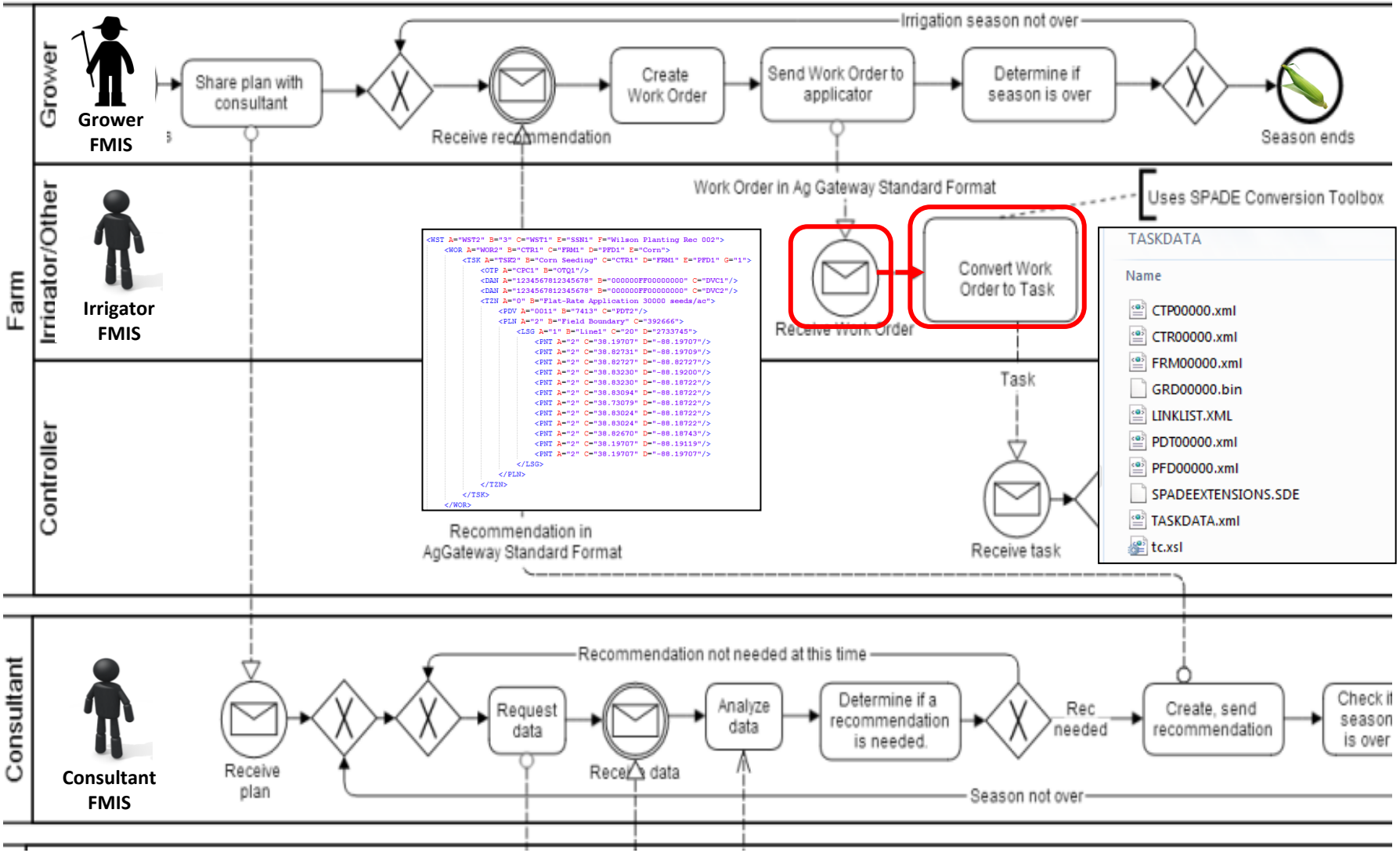
# PAIL Irrigation Use Case

## Consultant sends irrigation recommendation to grower in standard data format.



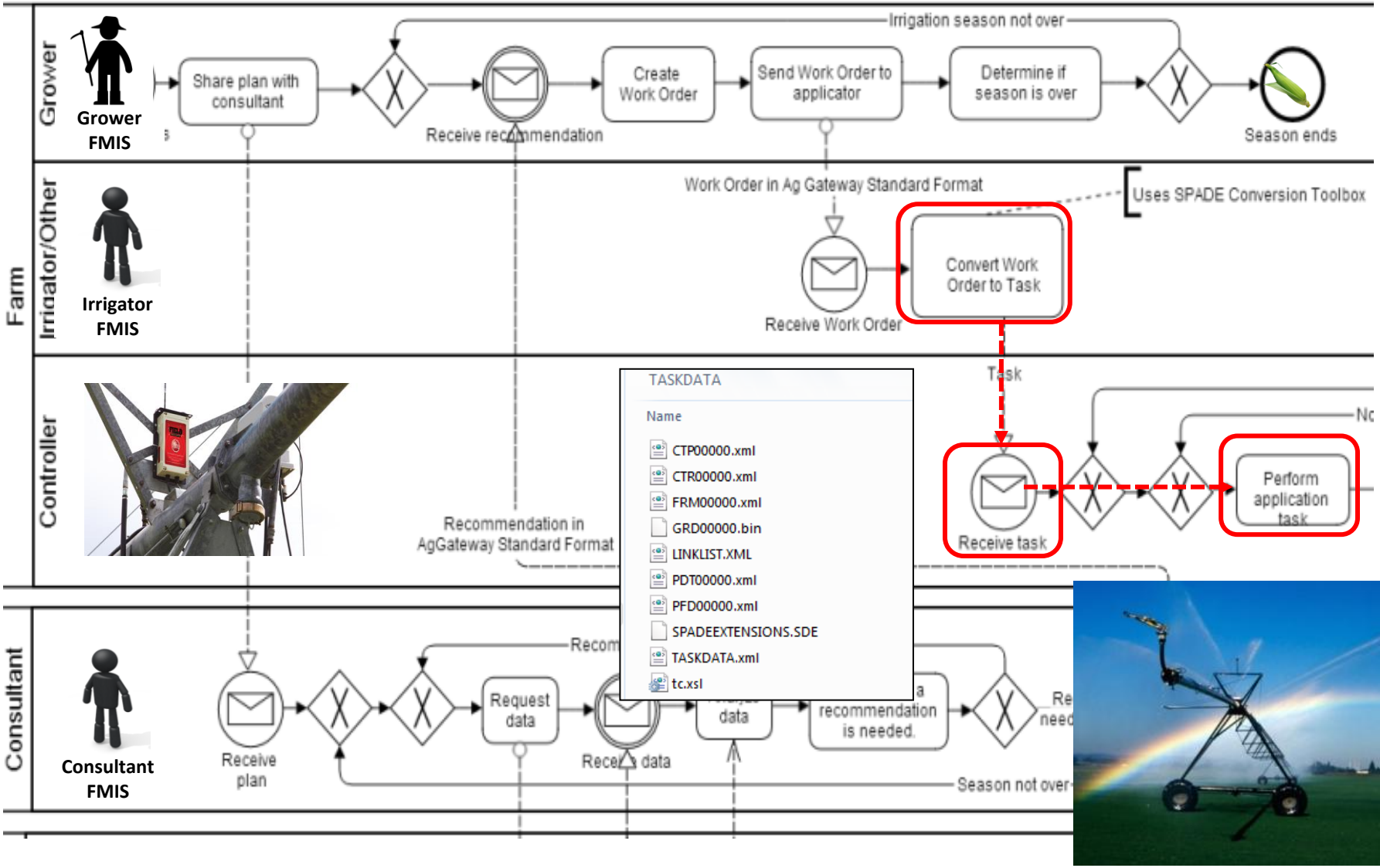
# PAIL Irrigation Use Case

## Irrigator converts work order to an ISO task using a conversion toolbox.

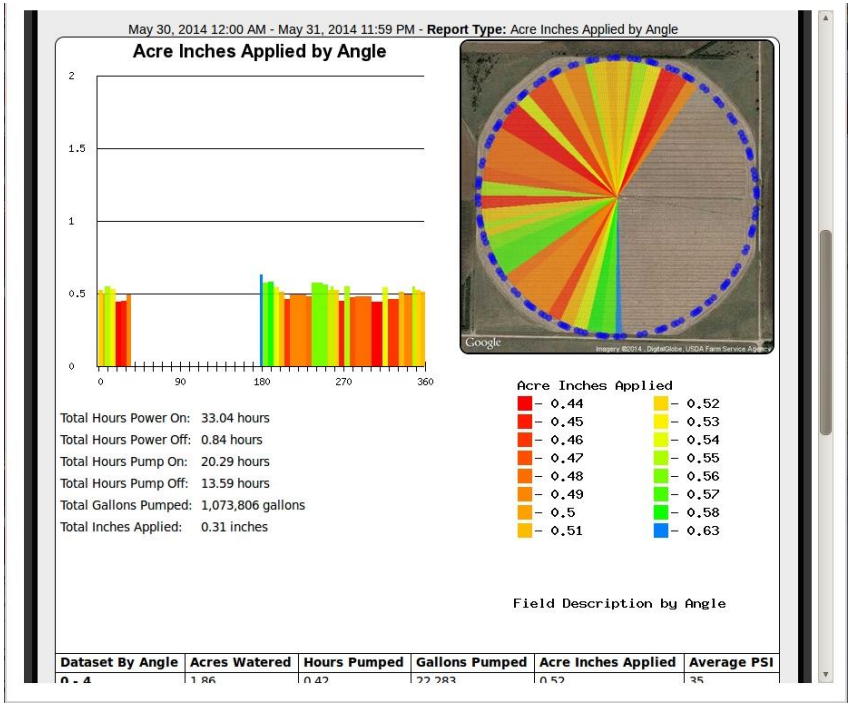


# PAIL Irrigation Use Case

## Irrigator sends ISO task to controller which performs the irrigation application.




# Work Record



May 30, 2014 12:00 AM - May 31, 2014 11:59 PM - **Report Type:** Acre Inches Applied by Angle

**Acre Inches Applied by Angle**







Total Hours Power On: 33.04 hours
Total Hours Power Off: 0.84 hours
Total Hours Pump On: 20.29 hours
Total Hours Pump Off: 13.59 hours
Total Gallons Pumped: 1,073,806 gallons
Total Inches Applied: 0.31 inches

Acre Inches Applied

| | |
|---|---|
| 0.44 | 0.52 |
| 0.45 | 0.53 |
| 0.46 | 0.54 |
| 0.47 | 0.55 |
| 0.48 | 0.56 |
| 0.49 | 0.57 |
| 0.5 | 0.58 |
| 0.51 | 0.63 |

Field Description by Angle

| Dataset By Angle | Acres Watered | Hours Pumped | Gallons Pumped | Acre Inches Applied | Average PSI |
|---|---|---|---|---|---|
| 0 - 4 | 1.86 | 0.42 | 22,283 | 0.52 | 35 |


```
- <AsApplied xsi:noNamespaceSchemaLocation="AsApplied.xsd">
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    - <SystemLocation>
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      </SystemLocation>
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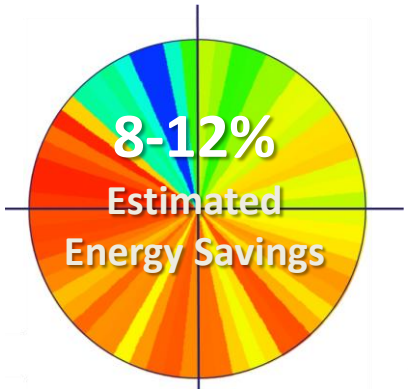
# Key Lessons and Implications

# Lesson: Integrated Solutions Must Evolve

**Tier 1 Solution –**
**Precision Flat Rate (PFR)**

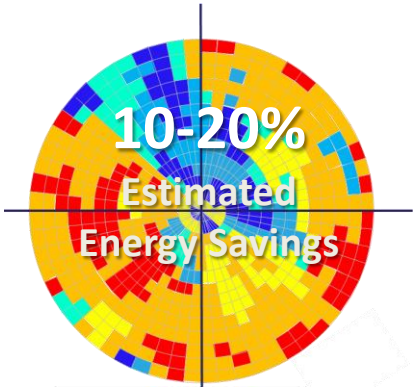

**Tier 1 - PFR**
- Focus on product usability
- Uses DSS
- Integrated inputs
- Data standards 1.0
- Commissioning

**Tier 2 Solution –**
**Variable Speed Irrigation (VSI)**




**Tier 2 - VSI**
- Soil mapping
- VSI/precision speed rate
- UI specifications
- Data standards 1.1
- Builds on Tier 1 components

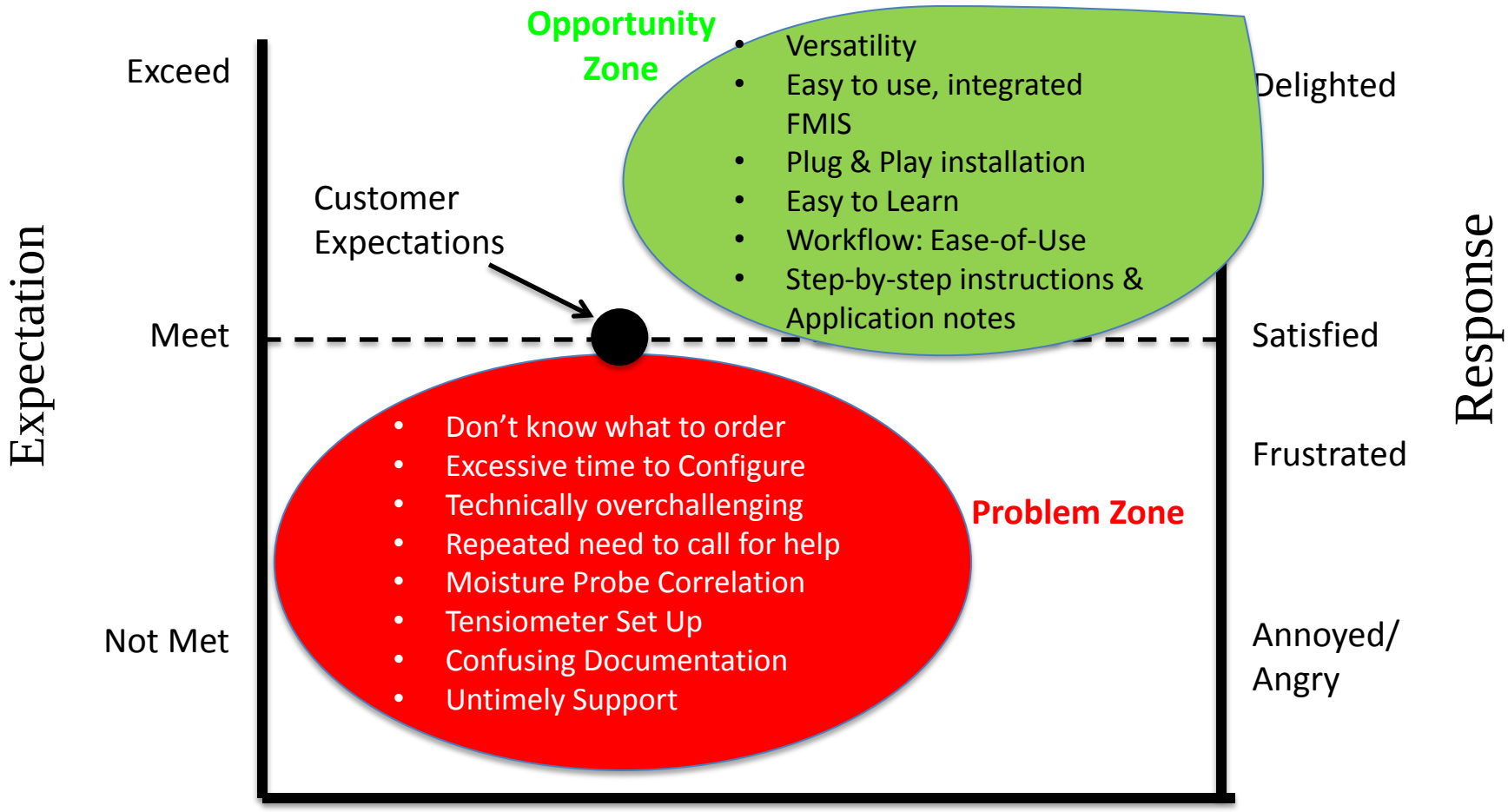
**Tier 3 Solution –**
**Variable Rate Irrigation (VRI)**




**Tier 3 VRI**
- VRI
- Reporting specifications
- Data standards 2.0
- Builds on components from Tier 1 and Tier 2

# Lesson: Start with the Foundational Elements

# Lesson: Must Improve the Grower Experience



# Lesson: Need to Make a Compelling Case

Precision Ag Adoption:

$4M + 3cv + 2 (i - h) - 2a$

# Thank You!

NEXT CHAPTER
MARKETING