



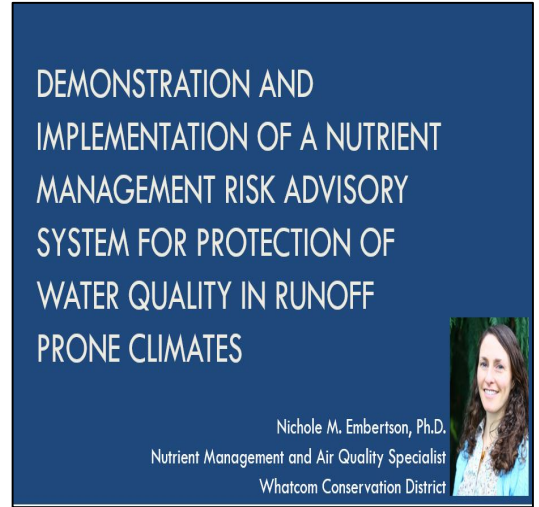
CIG

Conservation
Innovation
Grants



Subsurface Drip
Irrigation System

Utilizing Dairy
Manure Effluent



DEMONSTRATION AND
IMPLEMENTATION OF A NUTRIENT
MANAGEMENT RISK ADVISORY
SYSTEM FOR PROTECTION OF
WATER QUALITY IN RUNOFF
PRONE CLIMATES

Nichole M. Embertson, Ph.D.
Nutrient Management and Air Quality Specialist
Whatcom Conservation District



Conservation Innovation Grants: Water Quality

Natural
Resources
Conservation
Service

nrcs.usda.gov



United States
Department of
Agriculture



United States Department
of Agriculture,

Natural Resources
Conservation Service

Conservation Innovation
Grant 69-3A75-17-53

Subsurface Drip Irrigation System

Utilizing Dairy Manure Effluent



WUD

WESTERNUNITEDDAIRIES

UC
CE

UNIVERSITY OF CALIFORNIA
Agriculture and Natural Resources

UC Cooperative Extension

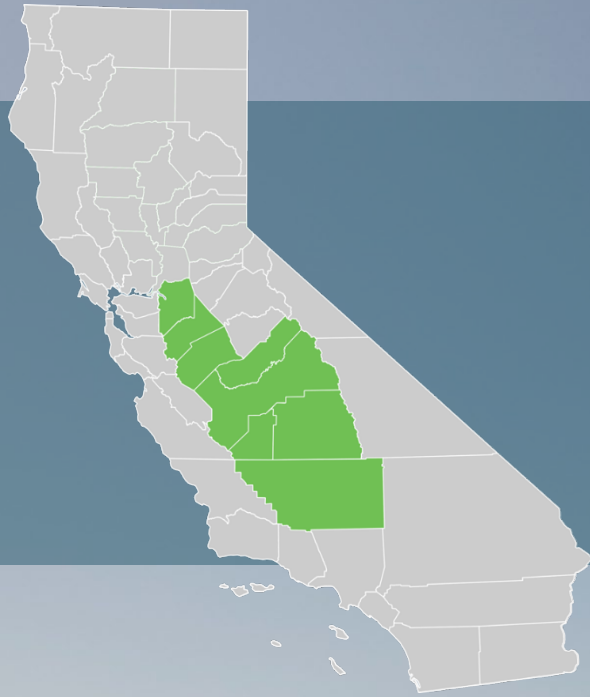


Sustainable Conservation



United States
Department of
Agriculture

Natural Resources Conservation Service



- **#1** milk-producing state 18%
- **\$6.37B** cash receipts in 2018
- **50,000** jobs in 2014





SUBSURFACE DRIP IRRIGATED FIELD

DAIRY

FILTRATION

LAGOON 2

SOLID SEPARATOR

LAGOON 1









McRee



De Jager



West Star



Fresno California

Bakersfield

Practice Standard Adoption

- 441 - Irrigation System,
Microirrigation
- Current rate for California:
\$2,871.00 per acre

Change in Net Income

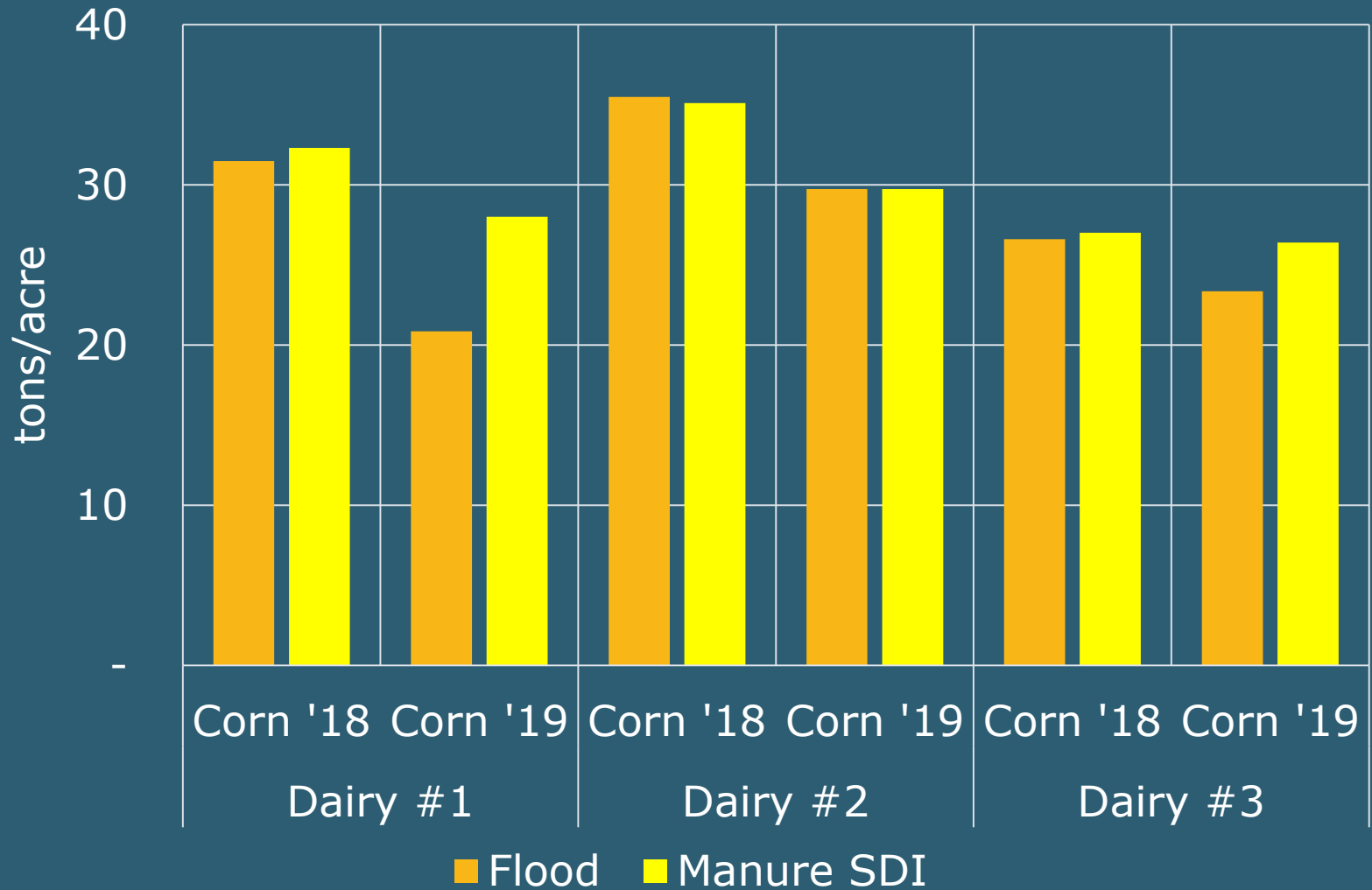
WITHOUT EQIP			
INCREASED REVENUE:	\$ 255.00	INCREASED COST:	\$ 189.71
Yield		Inputs (energy, maintenance, germination)	
DECREASED COST:	\$ 123.78	INCREASED COST:	\$ 107.25
Inputs (water, fertilizer)		Labor (maintenance, germination)	
DECREASED COST:	\$ 84.00	INCREASED COST:	\$ 342.32
Labor (system operation)		Depreciation	
Total Increased Net Income	\$ 462.78	Total Decreased Net Income	\$ 639.32

ANNUAL PER ACRE DECREASE IN NET INCOME = (\$ 176.54)

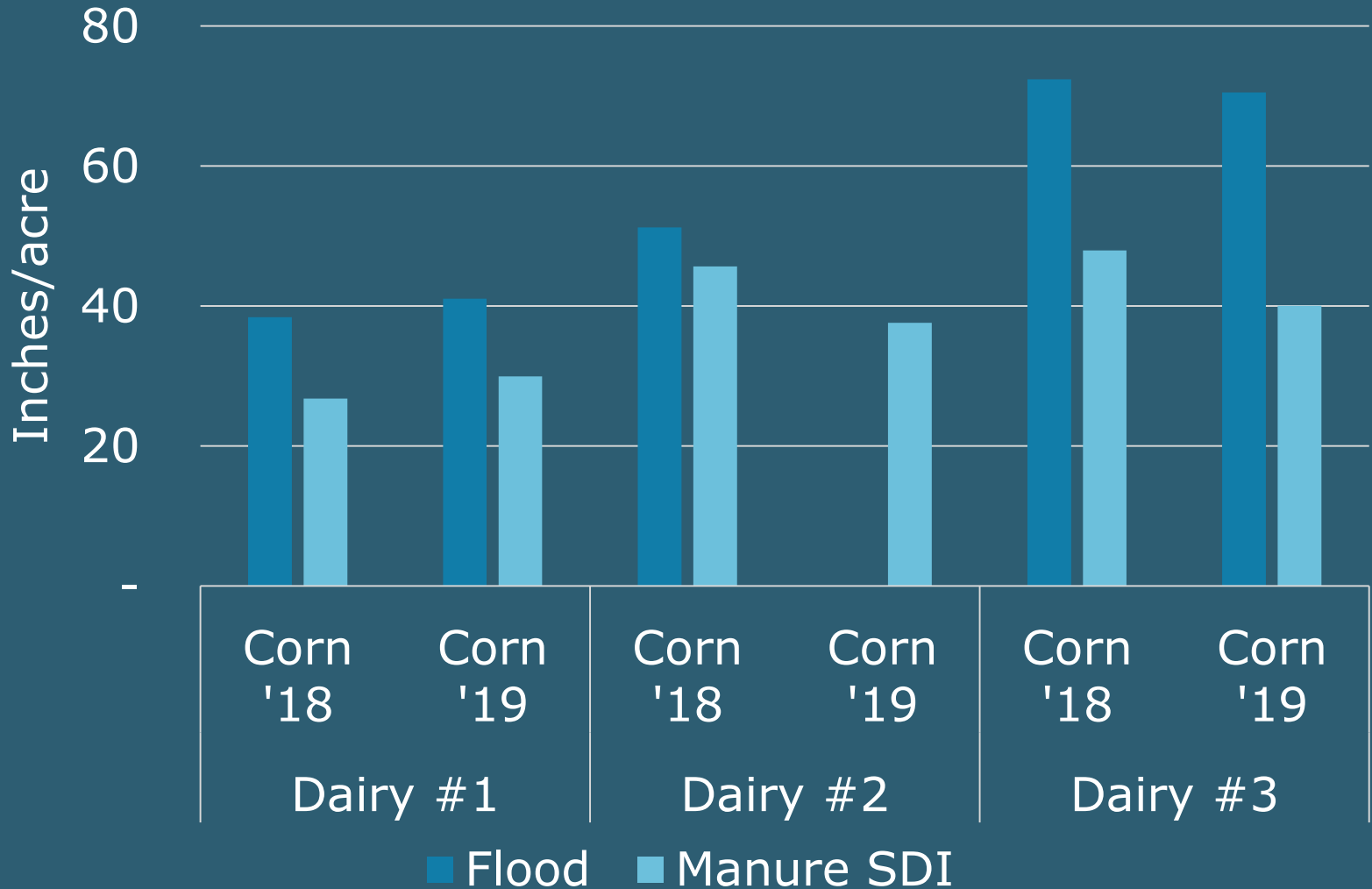
WITH EQIP			
INCREASED REVENUE:	\$ 255.00	INCREASED COST:	\$ 189.71
Yield		Inputs (energy, maintenance, germination)	
DECREASED COST:	\$ 123.78	INCREASED COST:	\$ 107.25
Inputs (water, fertilizer)		Labor (maintenance, germination)	
DECREASED COST:	\$ 84.00	INCREASED COST:	\$ 55.26
Labor (system operation)		Depreciation	
Total Increased Net Income	\$ 462.78	Total Decreased Net Income	\$ 352.22

ANNUAL PER ACRE INCREASE IN NET INCOME = \$ 110.56

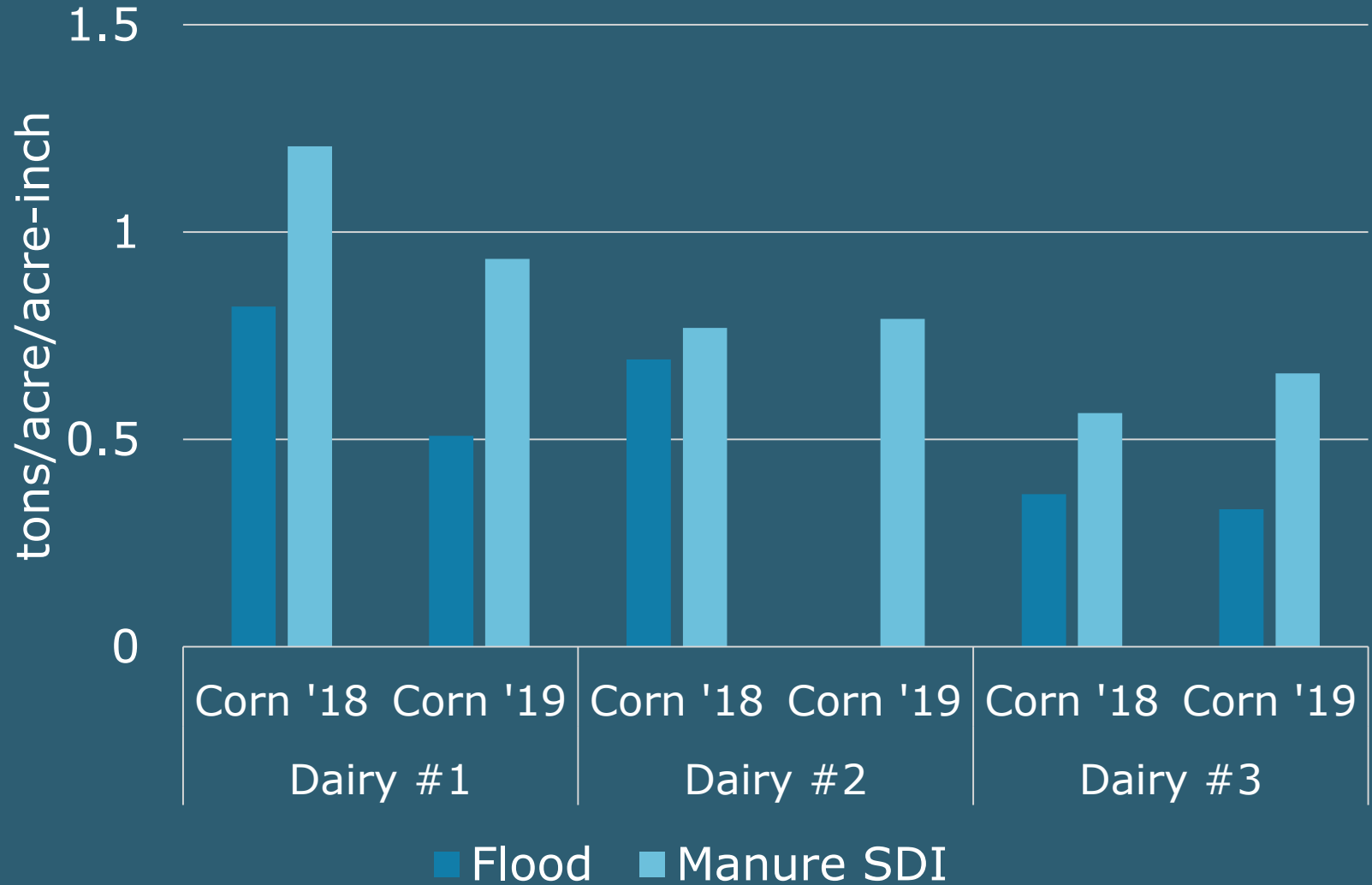
Yields



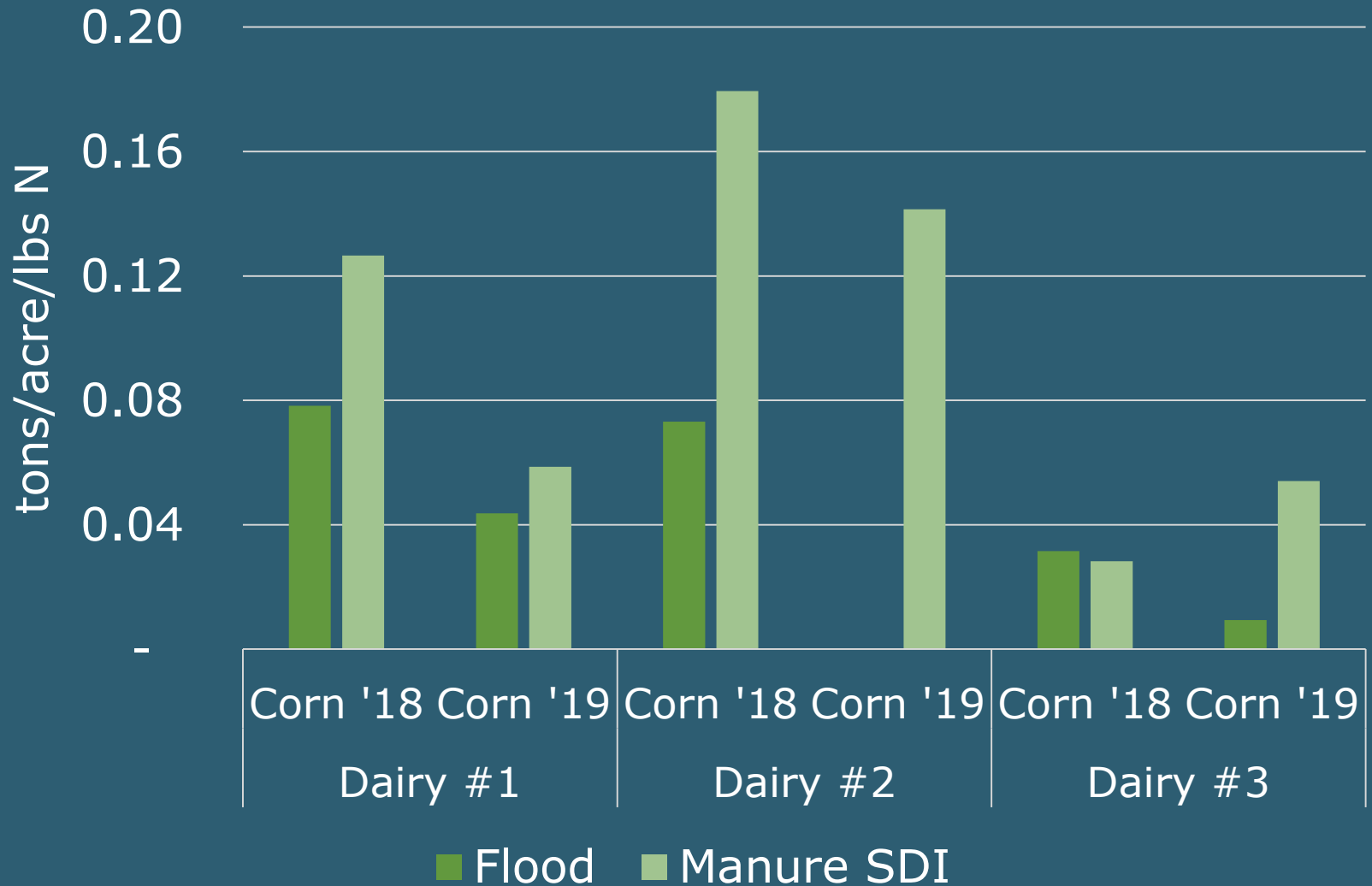
Water Applied



Water Use Efficiency



Nutrient Use Efficiency



Lessons Learned

- Whole farm nitrogen balance
- Management and staff capacity
- Secondary or tertiary lagoon
- Dedicated manure pipeline

Future for the Partners



De Jager Farms | McRee Dairy | West Star Dairy



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Reports available at
www.suscon.org/technical-resources

DEMONSTRATION AND IMPLEMENTATION OF A NUTRIENT MANAGEMENT RISK ADVISORY SYSTEM FOR PROTECTION OF WATER QUALITY IN RUNOFF PRONE CLIMATES

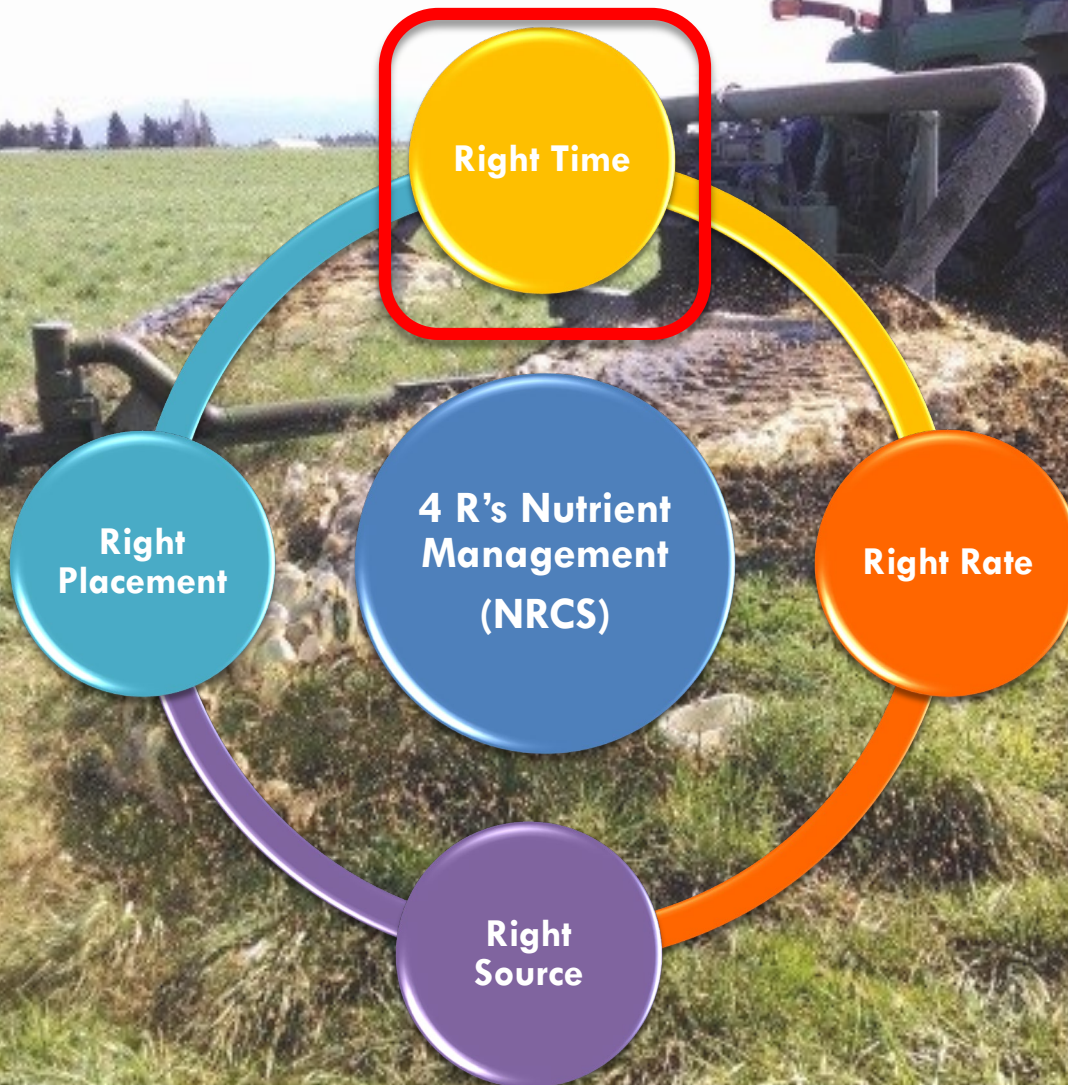
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Whatcom Conservation District



What Causes a Runoff Pollution Event?

- **Pollutant availability**
 - Crop needs, variable uptake and/or conversion
- **Improper application practices (4R's)**
 - Timing, source, rate, placement, method
- **Weather event**
 - Precipitation, flooding, wind, snow
- **Poor field conditions**
 - Soil type, slope, surface cover, saturated soils, snow cover, frozen ground, high water table

4 R's of Nutrient Management



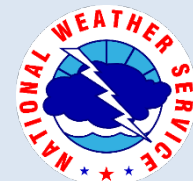
NRCS Conservation Innovation Grant

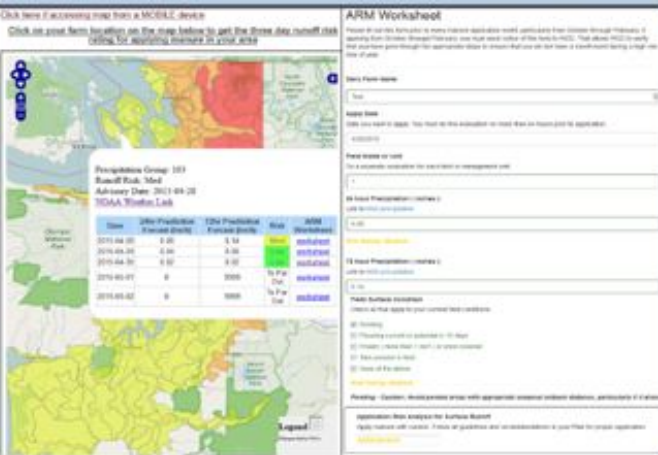
Demonstration and Implementation of a Nutrient Management Risk Advisory System for Protection of Water Quality in Runoff Prone Climates

- **Project States:** WA, OR, WI, MN, PA, NY, VA, MS, AR, SD, and ND
- **Timeline:** 2015 –2019
- **Project Partners:**

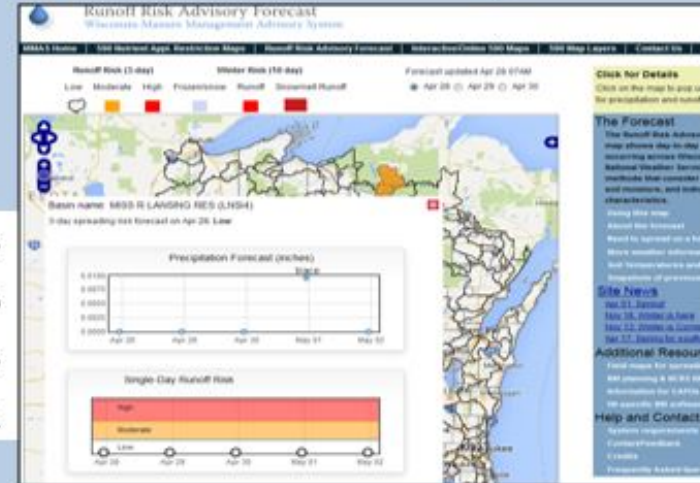


DISCOVERY
FARMS





Application Risk Management System (ARM) (WA, OR, BC) – WCD developed the ARM System that incorporates 590 Nutrient Management Standard and the right timing and placement 4Rs to address surface runoff and leaching.



Runoff Risk Advisory Forecast (RRAF) (WI, MN, OH, MI) – The RRAF is a decision support tool developed in Wisconsin to improve manure and fertilizer application timing to reduce agricultural nutrient loss and improve water quality.



Fertilizer Forecaster (PA) – This tool is in development as a web-based decision support system for nutrient management that identifies the relative probability of runoff or infiltrating events.

Saturated Area Forecast Tool (SAFT) (VA) - SAFT is based on the SWAT-VSA model framework that uses terrain-based metrics to identify runoff generation and soil moisture distribution to provide simple and accessible forecasts.



Comparative Paper on Tools

Journal of Environmental Quality, 2017

Short-term forecasting tools for agricultural nutrient management.

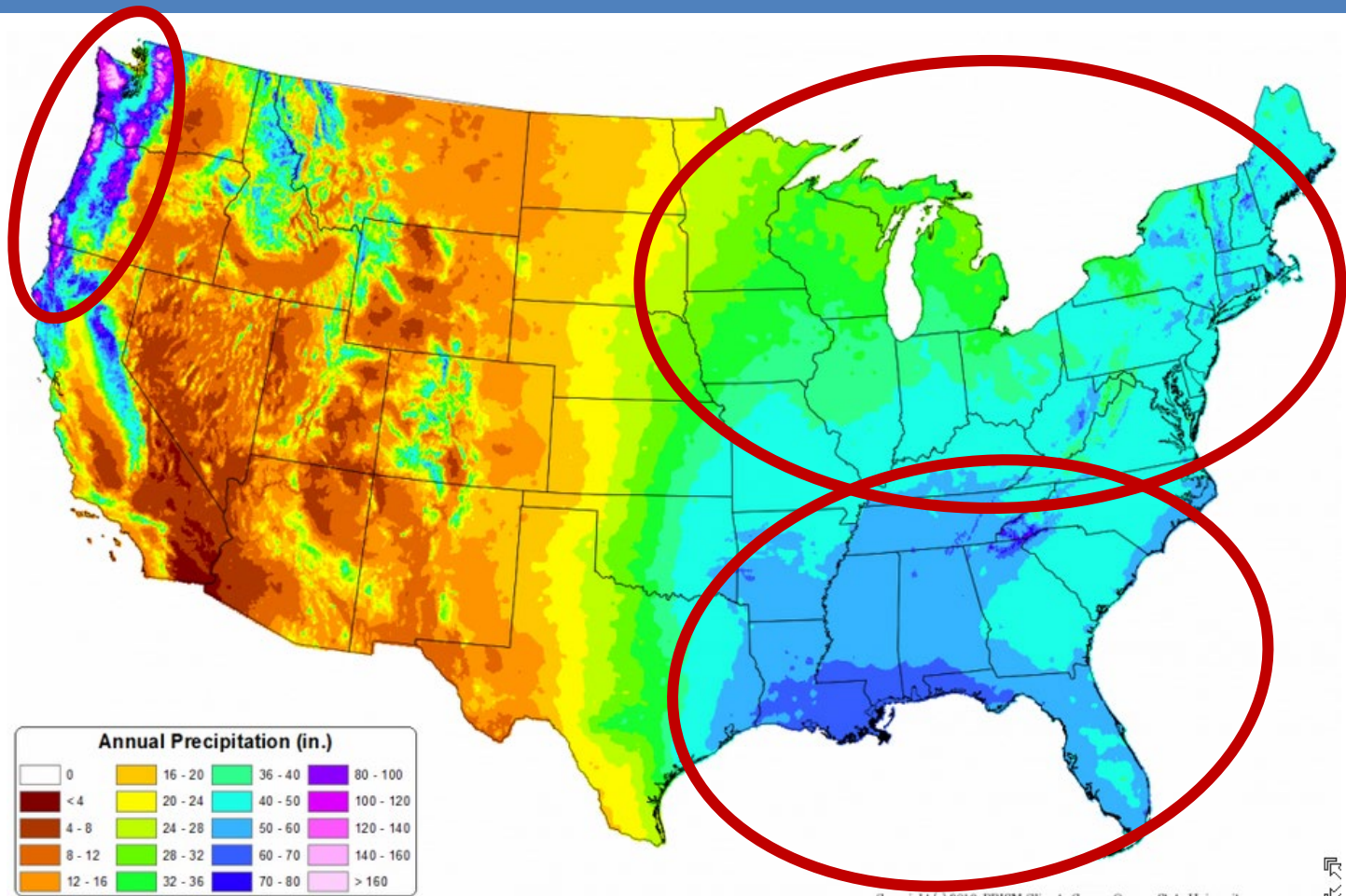
Easton, Z.M., P.J.A. Kleinman, A.R. Buda, D. Goering, N.M. Embertson, S. Reed, P.J. Drohan, M.T. Walter, P. Guinan, J.A. Lory, A.R. Sommerlot, and A. Sharply. 2017. Journal of Environmental Quality.

doi:10.2134/jeq2016.09.0377

CIG Runoff Advisory Project Objectives

- Qualitatively and quantitatively compare existing runoff advisory tools for strengths, limitations, and integration.
- Implement and demonstrate effectiveness of advisory systems in the field.
- Coordinate efforts to develop a runoff advisory system interface that can be adapted and implemented to applicable regions of the US.
- Identify needs of a runoff advisory system in various areas of the US. Promote existing runoff advisory tools and support expansion in applicable areas.
- Support advisory tools to improve implementation of the nutrient management 4R's with focus on *timing*.

Where you live makes a difference!

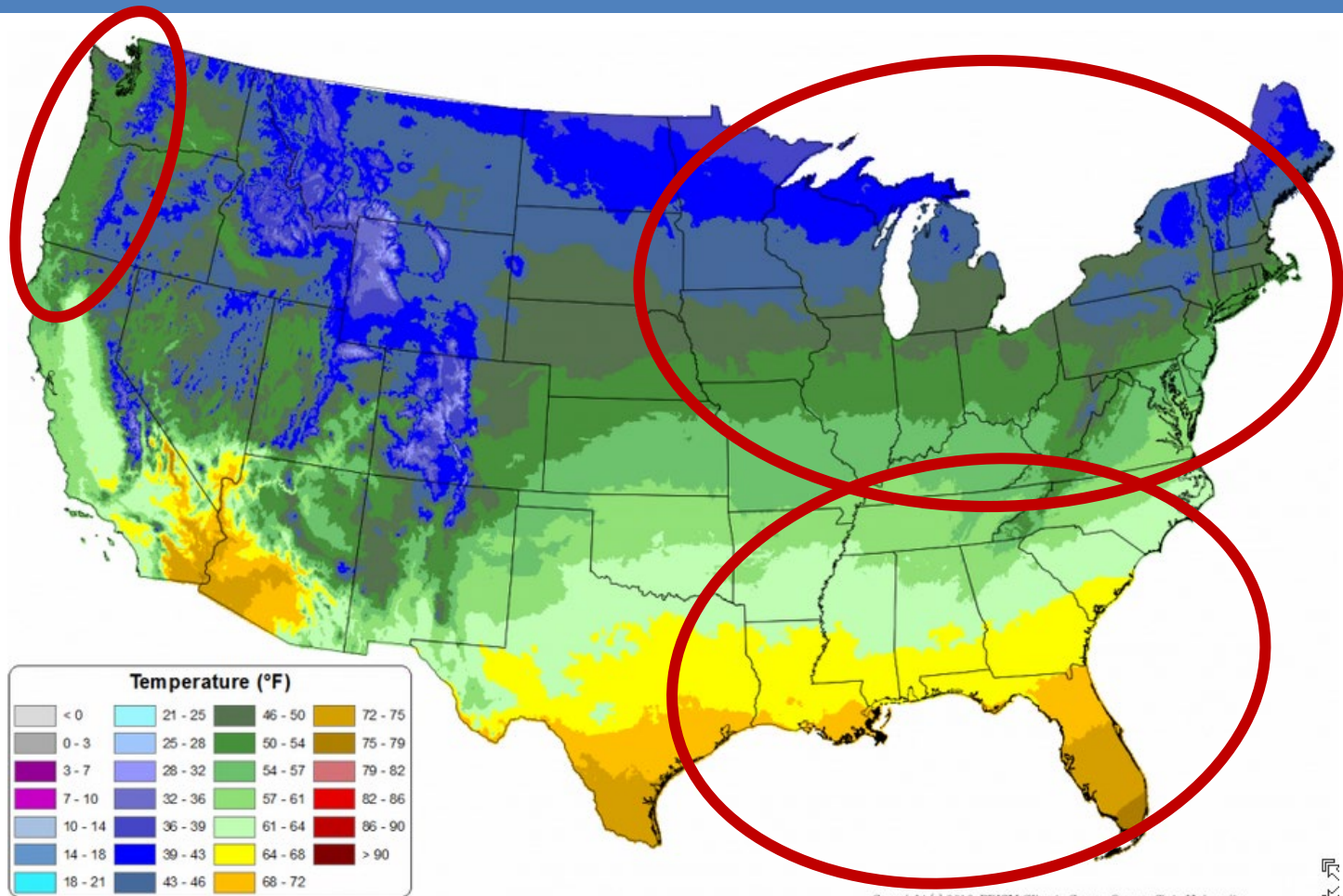


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30-yr Normal Precipitation: Annual
Period: 1981-2010

Where you live makes a difference!

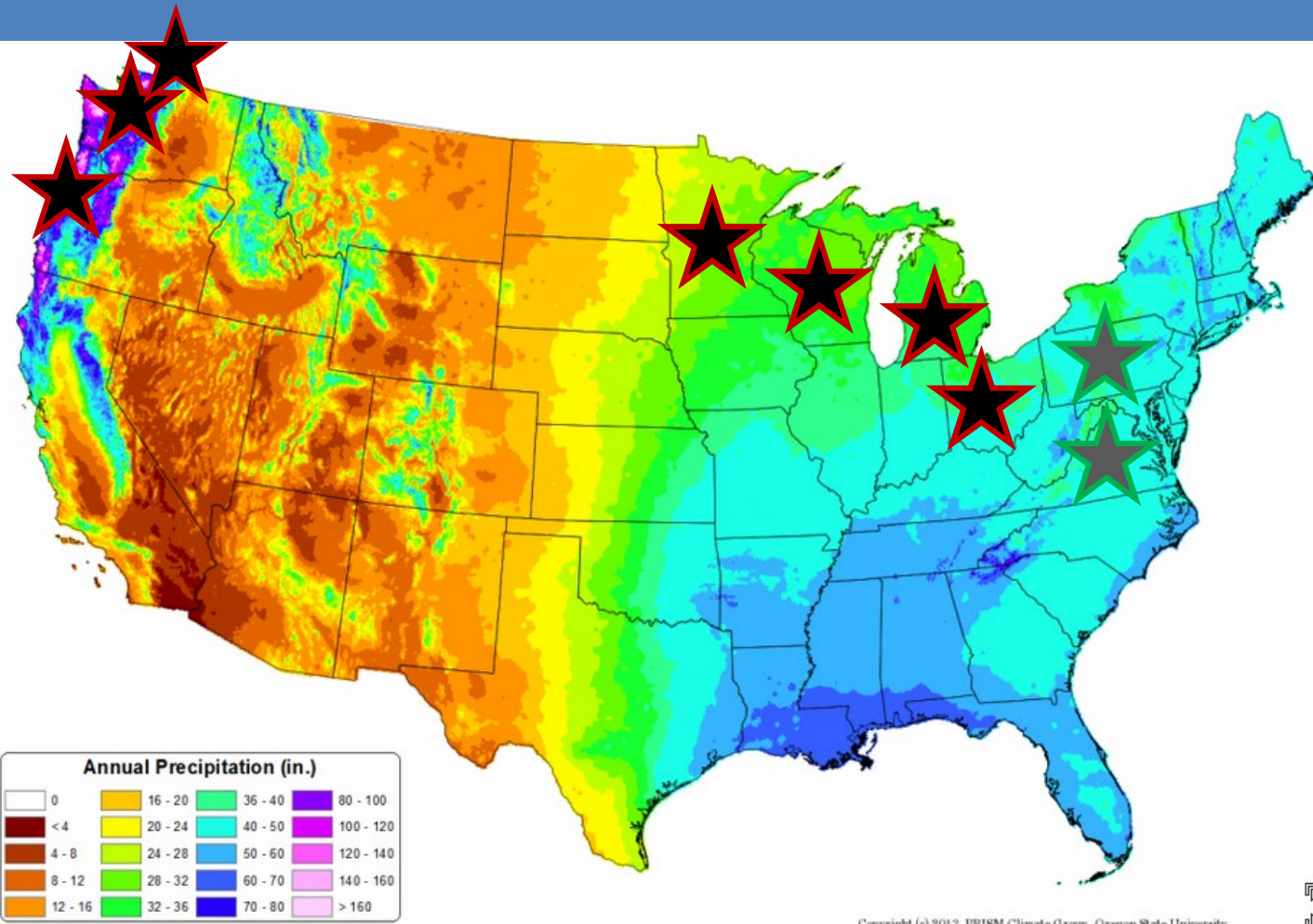


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30-yr Normal Mean Temperature: Annual
Period: 1981-2010

States with Runoff Advisory Tools



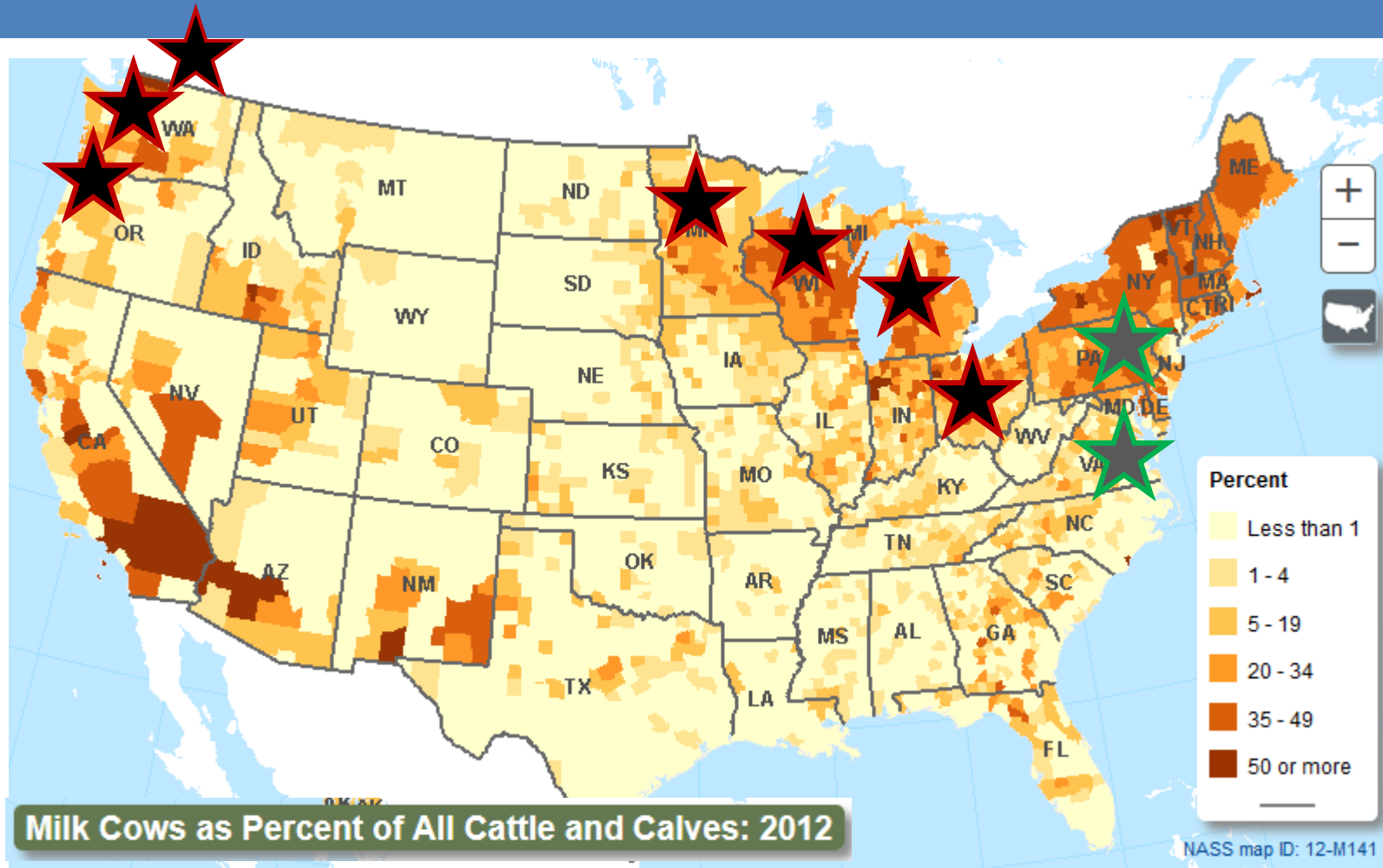
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-  Other advisory tools (PA, VT)
-  Current runoff advisory tools (WA, OR, BC, WI, MN, MI, OH)

30-yr Normal Precipitation: Annual
Period: 1981-2010

States with Runoff Advisory Tools



Other advisory tools (PA, VT)

Current runoff advisory tools (WA, OR, BC, WI, MN, MI, OH)

States with Runoff Advisory Tools

Current advisory tools (WA, OR, BC, WI, MN, MI, OH):

- **Washington:** <https://www.whatcomcd.org/msa>
- **Oregon:** <https://www.oregon.gov/ODA/programs/NaturalResources/Pages/MSA.aspx>
- **BC:** <https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/agricultural-land-and-environment/soil-nutrients/nutrient-management/manure-spreading-advisories>
- **Wisconsin:**
<http://www.manureadvisorysystem.wi.gov/runoffrisk/index>
- **Minnesota:**
<https://www.mda.state.mn.us/protecting/cleanwaterfund/toolstechnology/runoffrisk>
- **Michigan:** <https://enviroimpact.iwr.msu.edu/Resources.aspx>
- **Ohio:** <https://agri.ohio.gov/wps/portal/gov/oda/divisions/plant-health/resources/ohio-applicator-forecast>

Runoff Risk Advisory Tools Need...

- A regional need
- 24 and 72 hour forecast
- Provide a risk rating (low, medium, high, etc.)
- Color coded for ease of use
- Have good spatial resolution
- Reliable
- Accurate
- Accessible from multiple devices
- Minimal steps to access information



**EXAMPLE: WASHINGTON
MANURE APPLICATION RISK
MANAGEMENT (ARM) SYSTEM
FOR WATER QUALITY
IMPROVEMENT**

Application Risk Management (ARM)

1. Calculate agronomic rate



• Agronomic Rate Calculation

2. Identify application fields



• Field Risk Maps

3. Determine when to apply



• Manure Spreading Advisory

4. Assess field conditions



• Application Risk Management (ARM) Worksheet

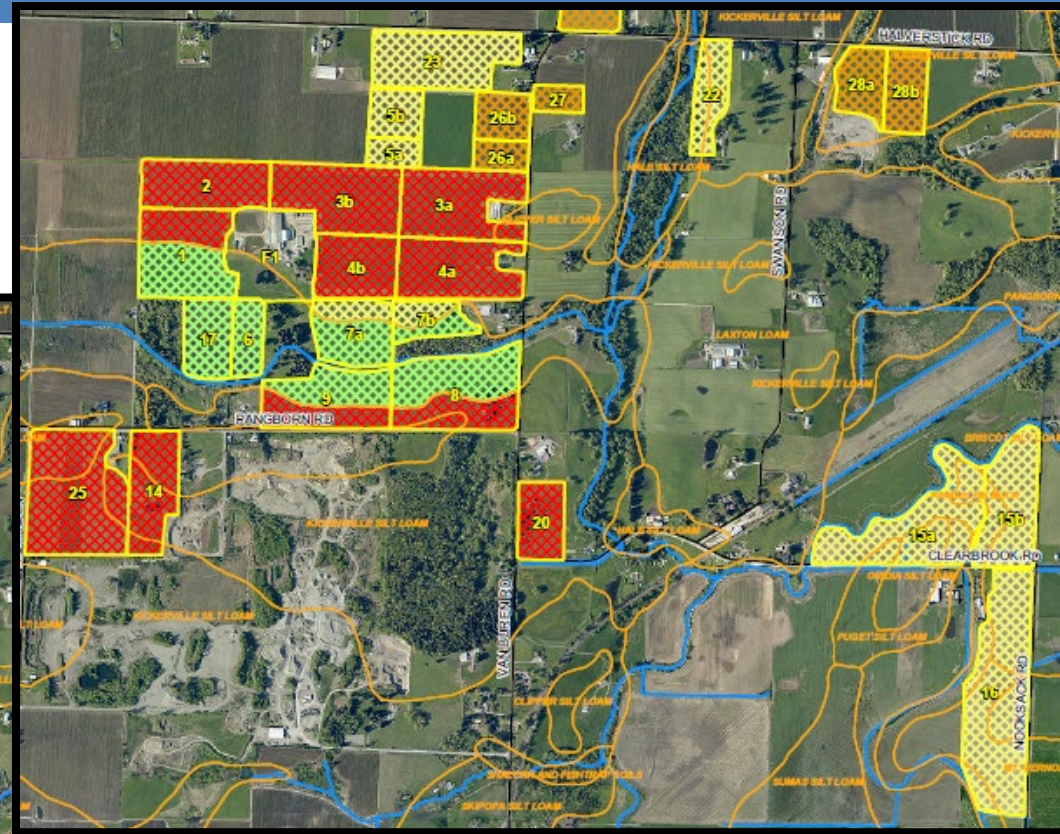
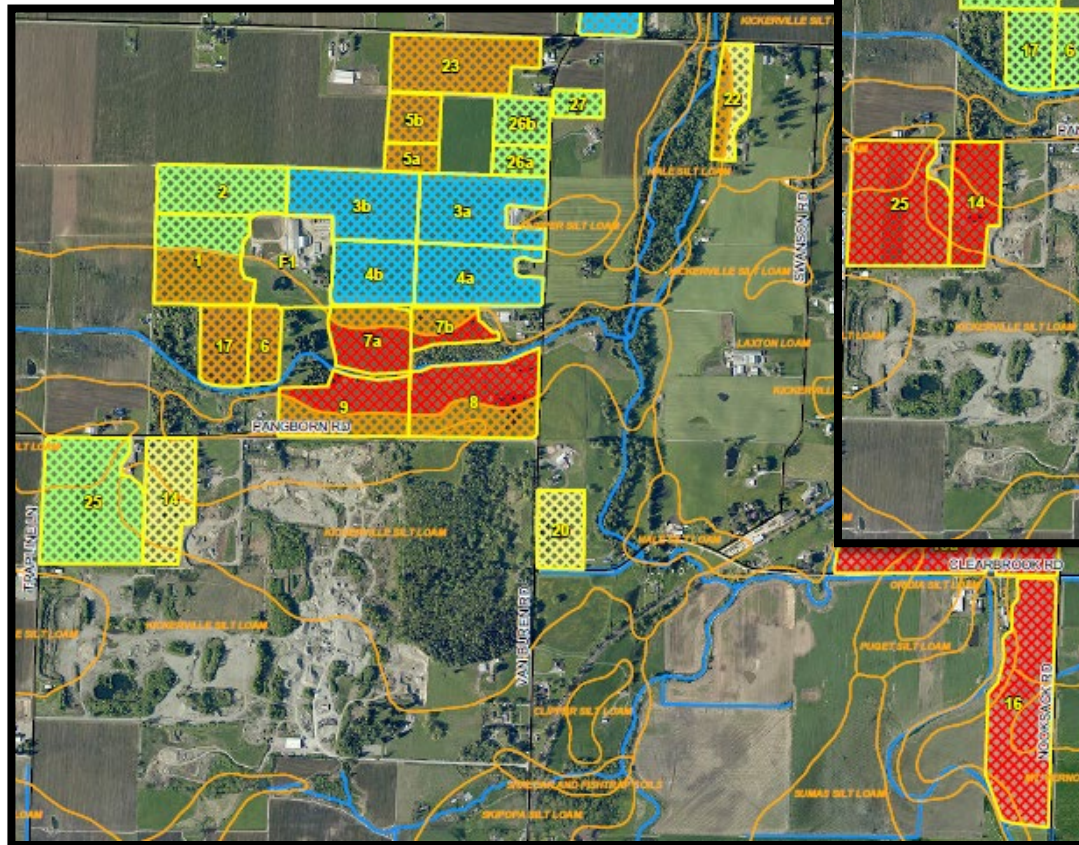
5. Apply and monitor fields



• Seasonal Manure Setbacks

Field Risk Mapping

Runoff Risk Rating (October-June)



Leaching Risk Rating (June-October)

Manure Spreading Advisory (MSA)

MANURE SPREADING ADVISORY (MSA)

The following Manure Spreading Advisory (MSA) should be used in conjunction with your Nutrient Management Plan and application guidance to help you determine when applying manure is advisable. It is your responsibility to use this information appropriately, and in conjunction with other risk management practices to avoid a runoff event. **If the risk is high, don't apply!**

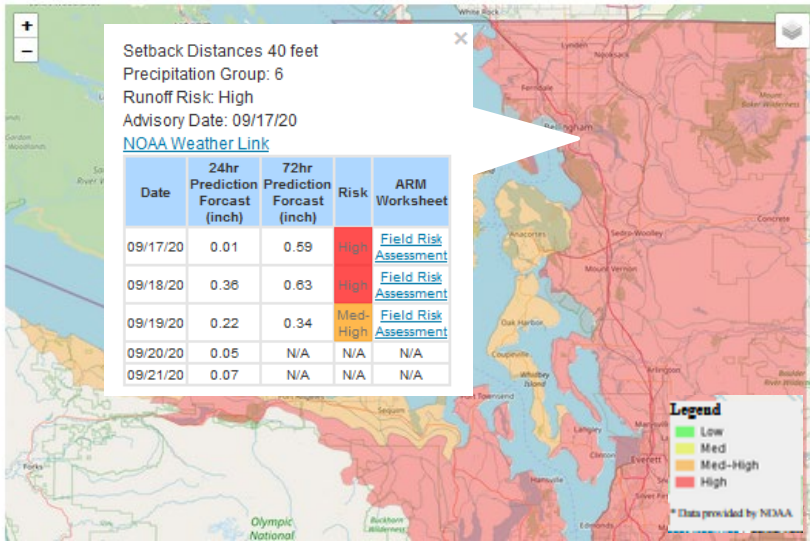
Consider these questions before you apply manure:



Click on your farm location on the map below to receive the runoff risk rating for your specific area and access the Field Risk Assessment Worksheet.

[Click here if accessing map from a MOBILE device](#)

[Click here for a LARGER map](#)



- Real-time runoff advisory
- 3-day risk forecast
- Auto-updated forecast from NOAA
- Decision making tool
- Color coded for easy use
- Link to ARM Worksheet for field risk assessment

ARM Worksheet

- Fill out Worksheet before application
- Provides field-level runoff risk by day
- Recordkeeping and accountability
- Based on 4 year field research project
- Mobile friendly

ARM Worksheet

Please fill out this form prior to every manure application event, particularly from October through February. If applying from October through February, you must send notice of this form to WCD. That allows WCD to verify that you have gone through the appropriate steps to ensure that you will not have a runoff event during a high risk time of year.

Dairy Farm Name
Example

Apply Date
Date you want to apply: You must do this evaluation no more than 24 hours prior to application.
09/29/2014

Field Name or Unit
Do a separate evaluation for each field or management unit.
1

24 hour Precipitation (inches)
Link to [MSA precipitation](#)
0.1
Risk Rating: Medium

72 hour Precipitation (inches)
Link to [MSA precipitation](#)
0.22
Risk Rating: Medium

Soil Type
Enter the general soil type you want to apply to. If you don't know your soil type, make your selection under "Don't know". Soil type can be found on your farm plan map.
 Sand
 Silt
 Clay
 Don't know

Soil Moisture
Enter moisture value in %. Click on the link for guidance on how to determine soil moisture [here](#)

Field Surface Conditions
check all that apply to
 Ponding
 Flooding current or
 Frozen (more than
 Tiles present in field
 None of the above
Risk Rating: Medium
Caution: Tiles must have been known prior to application. If tiles are present, plug immediately from tile, plug immediately.

Manure Application
Check equipment/method
 Below surface application
 Surface application
 Surface aerator
 Irrigation sprinkler (or other)
Risk Rating: Medium
Caution: Recommend no compaction on your field.

Waterbody or Critical Area
Do you have a waterbody (stream, pond, wetland, etc) adjacent to the field?
 Yes (answer next two questions)
 No (click submit)

Application Risk Assessment
Apply manure following all guidelines and recommendations in your farm plan.
LOW-MED RISK

Submit

Decision Support Guidance

Washington Nutrient Management Planning


Home Contact More ▾

APPLICATION PARAMETERS

Prior to application of manure, the following parameters should be reviewed to determine if nutrient application is appropriate. The pre-application steps should be applied to the application process. An advisory should be issued for each field you are considering applying manure to. The following parameters could result in application of manure leading to a pollution event.

- [Forecast](#)
- [Water Table](#)
- [Available Water Holding Capacity \(Soil Moisture\)](#)
- [Field Characteristics](#)
- [Field Cover](#)
- [Application Method](#)
- [Current field Conditions](#)
- [Application Setback Distances](#)
- [Vegetative Buffers](#)

Each of these parameters will determine the ability to apply manure. The [Manure Spreading Advisory](#) and [Application Rate](#) are part of the process of evaluating if ambient and field conditions are suitable and at what rate.



NATIONAL WEATHER SERVICE

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

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No Warnings or Advisories In Effect for this Point.
For warnings and/or advisories in effect for adjacent areas to this point, see [/sew](#)

**Forecast For Lat/Lon: 48.7360/-122.7360
Bellingham**
Forecast Created at: 9am PST

Weather	Thu Sep 17				Fri Sep 18				Sat Sep 19	
	Smoke	Chance Rain Showers and Smoke	Chance Rain Showers and Smoke	Likely Rain Showers and Smoke	Rain Showers	Likely Rain Showers	Likely Rain Showers	Likely Rain Showers	High	Low
Daily-Temp	High 73 Low 58				High 68 Low 58				High	Low
Chance of Precip	5%	5%	15%	30%	45%	70%	80%	80%	75%	75%
12-hr Precip	0.00"	0.00"	0.00"	0.01"	0.07"	0.09"	0.09"	0.12"	0.11"	0.06"
12-hr Snow Total	0"	0"	0"	0"	0"	0"	0"	0"	0"	0"
6-Hour Temp	5am: 58	11am: 68	5pm: 73	11pm: 62	5am: 59	11am: 66	5pm: 67	11pm: 60	5am: 57	11am: 61
Cloudiness	83%	85%	73%	68%	80%	86%	89%	81%	86%	86%
Dewpoint	56	62	63	58	56	61	60	56	55	58
Relative Humidity	94%	81%	72%	87%	89%	84%	79%	87%	94%	89%
Wind	E 3	W 2	S 3	SE 1	S 5	SE 3	S 8	S 7	SE 7	S 10
Snow Level (ft)	10788	10006	10315	10637	10423	10748	10372	9816	9264	9330

FORAGE DENSITY DETERMINATION



SOIL MOISTURE DETERMINATION

Available Moisture in the Soil	Sands and Loamy Sands	Sandy Loam and Fine Sandy Loam	Very Fine Sandy Loam, Loam, Silt Loam, Silty Clay Loam, Clay Loam, Sandy Clay Loam	Sandy Clay, Silty Clay, Clay
< 25% Soil Moisture	Dry, loose and single-grained, flows through fingers.	Dry and loose; flows through fingers.	Powdery dry; in some places slightly crusted but breaks down easily into powder.	Hard, baked and cracked; has loose crumbs on surface in some places.
25-50% Soil Moisture	Appears to be dry; does not form a ball under pressure.	Appears to be dry; does not form a ball under pressure.	Somewhat crumbly but holds together under pressure.	Somewhat pliable; balls under pressure.
50 - 75 % Soil Moisture	Appears to be dry; does not form a ball under pressure.	Balls under pressure but seldom holds together.	Forms a ball under pressure; somewhat plastic, slicks slightly under pressure.	Forms a ball; ribbons out between thumb and forefinger.
>75% Soil Moisture	Sticks together slightly; may form a weak ball under pressure.	Forms a weak ball that breaks easily, does not stick.	Forms ball; very pliable; slicks readily if relatively high in clay.	Ribbons out between fingers easily; has a slick feeling.
100% Field Capacity	On squeezing, no free water appears on soil, but wet outline of ball on hand.	On squeezing, no free water appears on soil, but wet outline of ball on hand.	On squeezing, no free water appears on soil, but wet outline of ball on hand.	On squeezing, no free water appears on soil, but wet outline of ball on hand.
Above Field Capacity	Free water appears when soil is bounced in hand.	Free water is released with kneading.	Free water can be squeezed out.	Puddles: free water forms on surface.

www.wadairyplan.org

Seasonal Manure Application Setback Distances

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
80 ⁴	80 ⁴	40	40	40 ¹	10 ²	10 ²	10 ²	40	80	80 ^{3,4}	80 ^{3,4}

¹This is a floating date and should be evaluated based on current weather and forecast information.

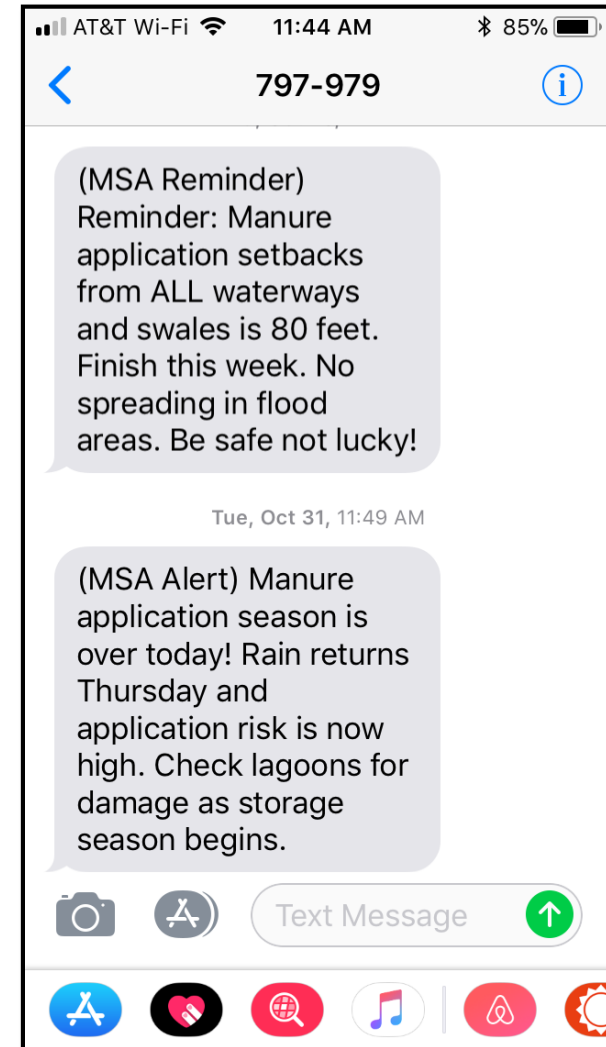
²A big gun applicator should NEVER be closer than 40 feet at any time of the year due to drift.

³Application during November and December is typically not necessary and must be shown to be agronomic before manure is applied.

⁴Any manure application made from November-February must have a winter spreading plan in place.

Advisory Text Alert System

- Manure application and extreme weather text alert system
- Can provide guidance in real-time
- Tailor lists to regions, groups, ag types, etc.
- Low cost or free text services available



Runoff Risk Advisory Considerations

- ❑ **Be realistic** on what you can provide.
- ❑ **Provide supplementary information** on how to use a tool and properly interpret the results.
- ❑ Forecast quality is key to the accuracy and thus usability any tool.
- ❑ **Choose tools based on the audience**; different user groups (i.e., farmers, regulators, advisors) have different interest and needs.
- ❑ **Tailor display and communication to the end-user** (i.e., format, color, wording, technology compatibility).
- ❑ **Regional considerations must be accounted for** in format and language of tool.
- ❑ **Involve local stakeholders in tool selection/implementation process.**
- ❑ Need a point person/organization/team to **own and maintain the platform and tool** once implemented.

Questions?

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