Straw Management and Crop Rotation Alternatives to Stubble Burning:

Assessing Crop Rotation and Weed Management Options

Co-Principle Investigators

Drew Lyon, Weed Scientist

Dave Huggins, Soil Scientist

Kate Painter, Ag. Economist

Producer incentives for burning stubble include:

- Facilitating the establishment of the next crop
- Decreasing incidence of soil-borne disease and weed/volunteer germination
- Decreasing nutrient (e.g. N) tie-up by decomposing cereal residues
- Positive response of crop growth, yield and economic return

Producer disincentives to burning stubble can be difficult to quantify

- Negative impacts on overall soil organic matter levels
- Loss of nutrients (N, P, S, K)
- Increased hazard of soil erosion if burning is combined with too much tillage

Project Objectives

(1) Initiate evaluation of harvest weed seed control (HWSC) systems that target and destroy weed seeds during or following commercial grain crop harvest.

(2) Identify and economically assess crop rotations and sequences that benefit from retaining winter wheat residues in direct-seed systems.

(3) Convey project findings through electronic and print media, field days and conferences.

The Role of Harvest Weed Seed Control in the Management of Herbicide-Resistant Weeds

Drew Lyon – Small Grains Extension & Research, Weed Science

WASHINGTON STATE UNIVERSITY
EXTENSION
World Class. Face to Face.

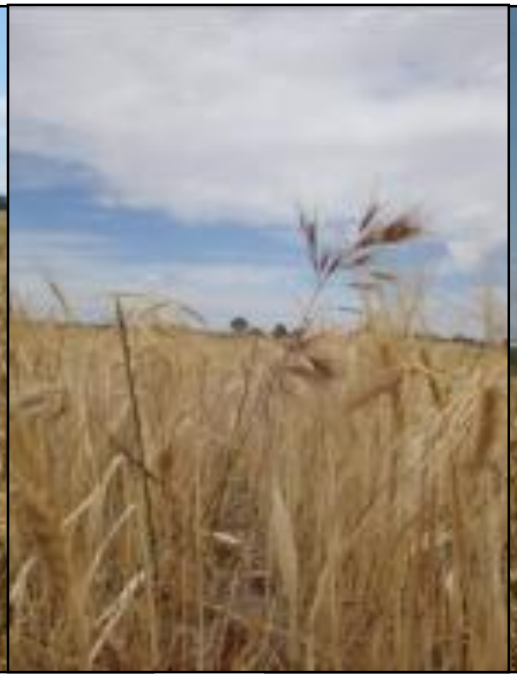
Conservation Farming and Herbicide Resistance

- Direct-seed and reduced tillage systems depend on herbicides for weed control
- Herbicide resistance is a growing problem worldwide and in the Pacific Northwest

Weed Seeds at Harvest

Harvest Weed Seed Control

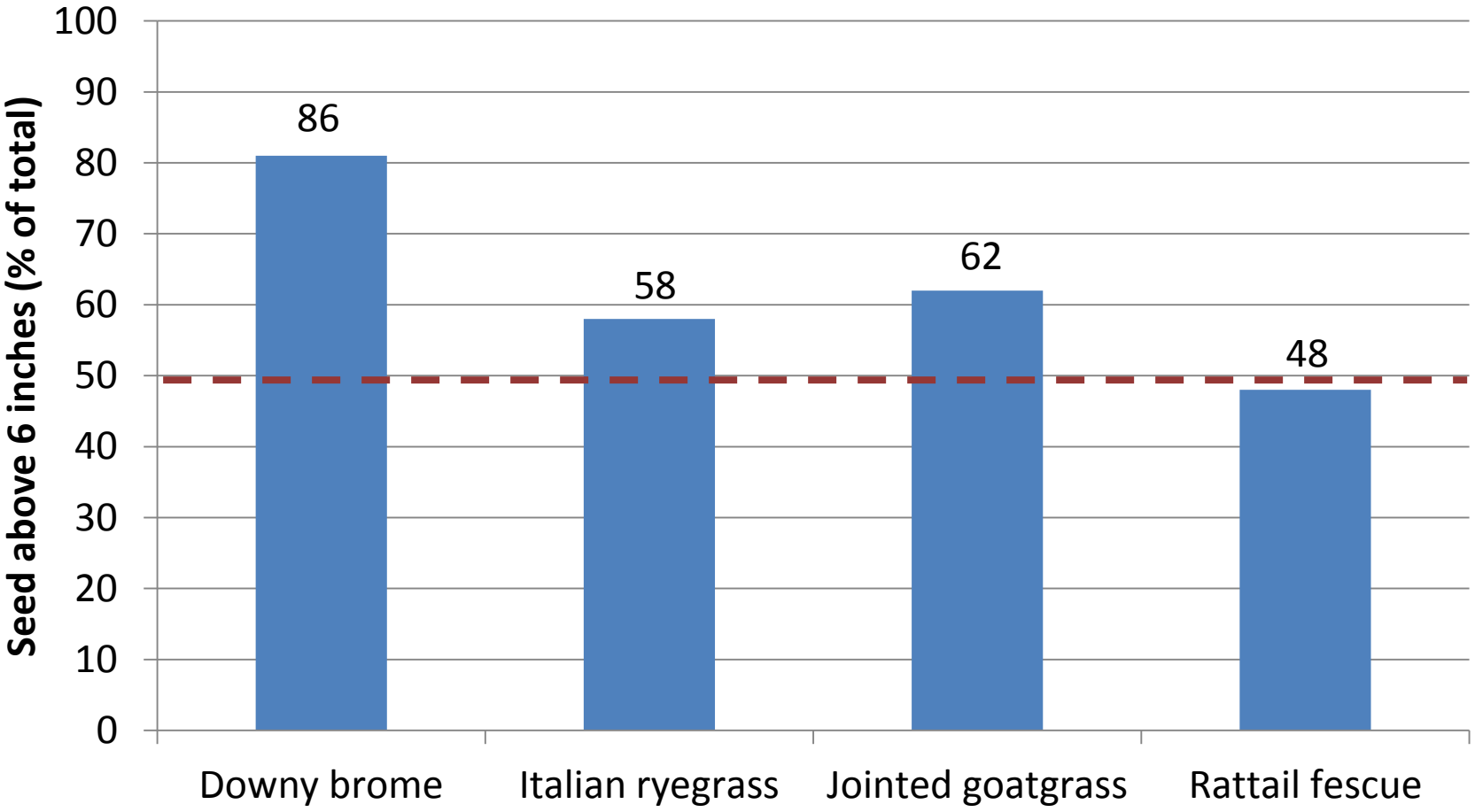
- Biological attribute needed for system to work:
  - mature seed do not shatter before grain harvest, held above cutting bar height


Objective 1

- **Objective 1. Initiate evaluation of harvest weed seed control (HWSC) systems that target and destroy weed seeds during or following commercial grain crop harvest. Methods:**
  - **Study one:** determine proportion of weed seed retained above (and below) a low harvester cutting height (6 inches) to determine the proportion of seed that could be collected during harvest.
    - **Weed species:** Italian ryegrass, jointed goatgrass, rattail fescue and downy brome will be monitored and weed seed samples collected just prior to harvest to determine the proportion of seed retained above a low harvester cutting height (six inches).

Seed Retention at Harvest



Objective 1

- **Objective 1. Initiate evaluation of harvest weed seed control (HWSC) systems that target and destroy weed seeds during or following commercial grain crop harvest. Methods:**
  - **Study two:** evaluate burning with three treatments: full combine header width spreading of straw, chaff, and weed seed with (1) and without (2) fall burning; and windrowing of straw, chaff and any weed seeds directly behind combine coupled with field burning of the windrow (3).
    - Emergence of Italian ryegrass evaluated for each treatment.

Narrow Windrow Burning

Concentrate residues at harvest

Burn residues in autumn

Narrow Windrow Burning

99% control of *Lolium* and *Raphanus*

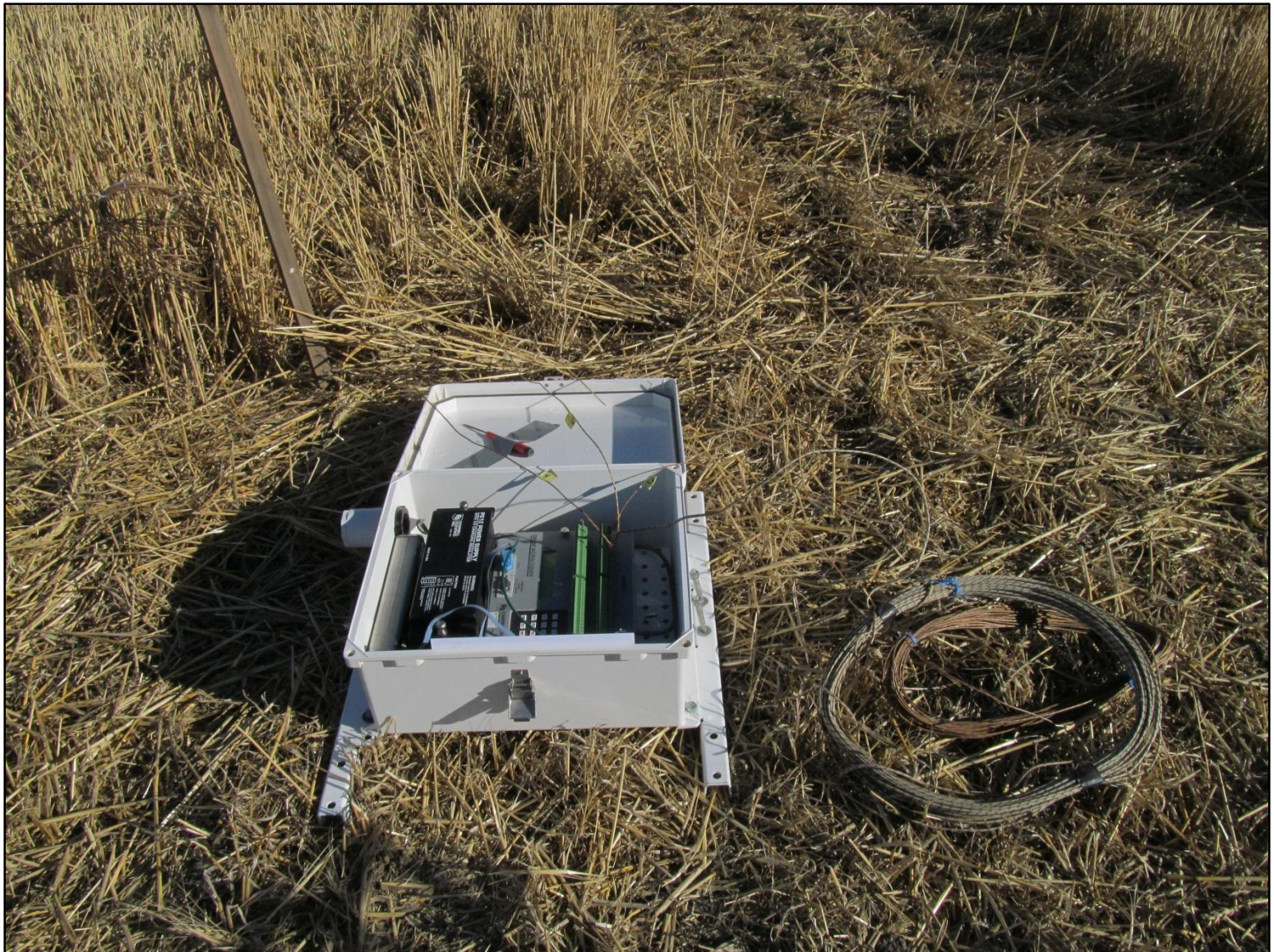
Most Western Australian growers use this technique

Pullman Study
Windrows to be Burned

Weed Seed Tray Placement

Weed Seed Tray Prior to Burn

Thermocouple Wires & Data Logger



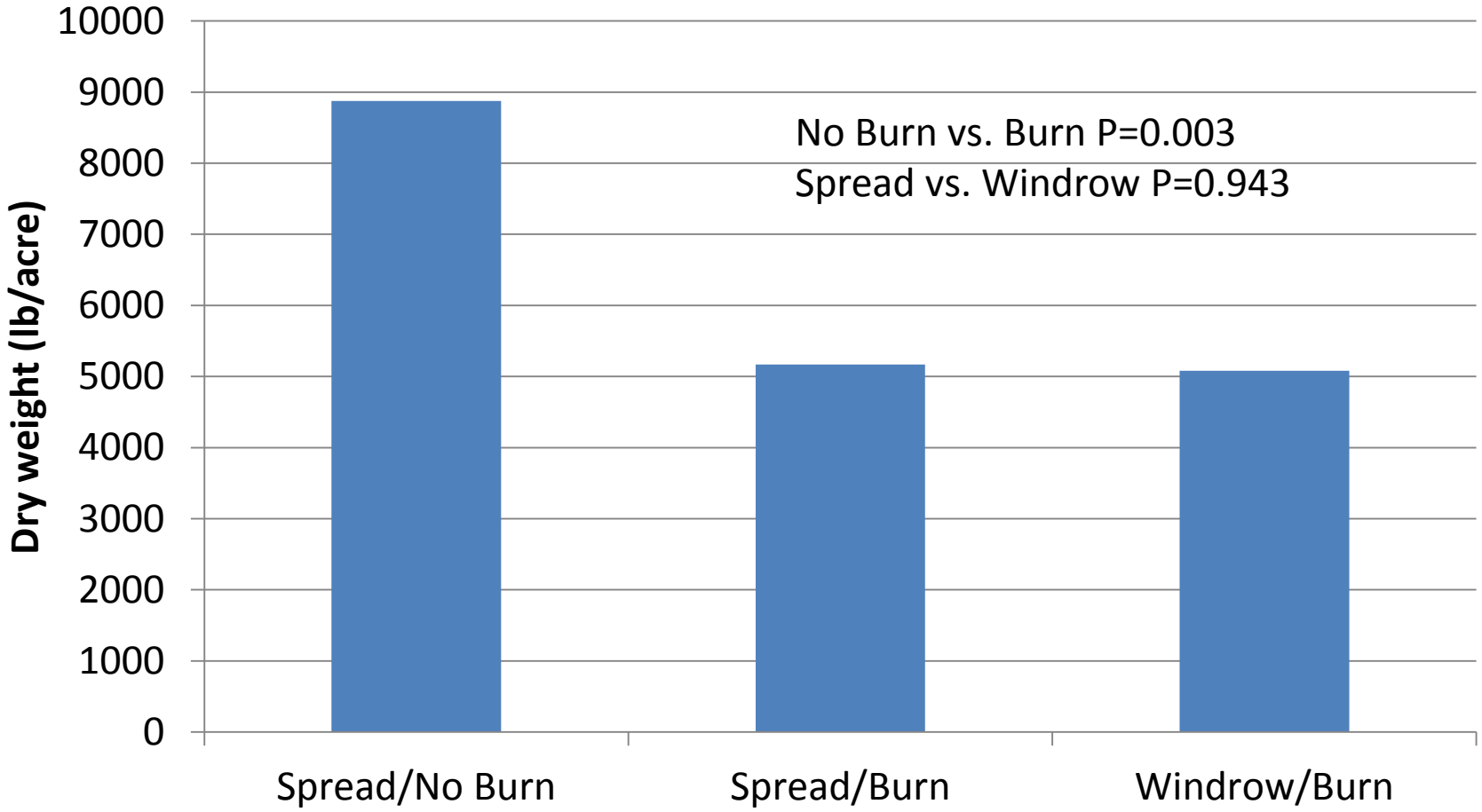
Burning Windrows

Burning All Crop Residue

Three Weeks After Burning

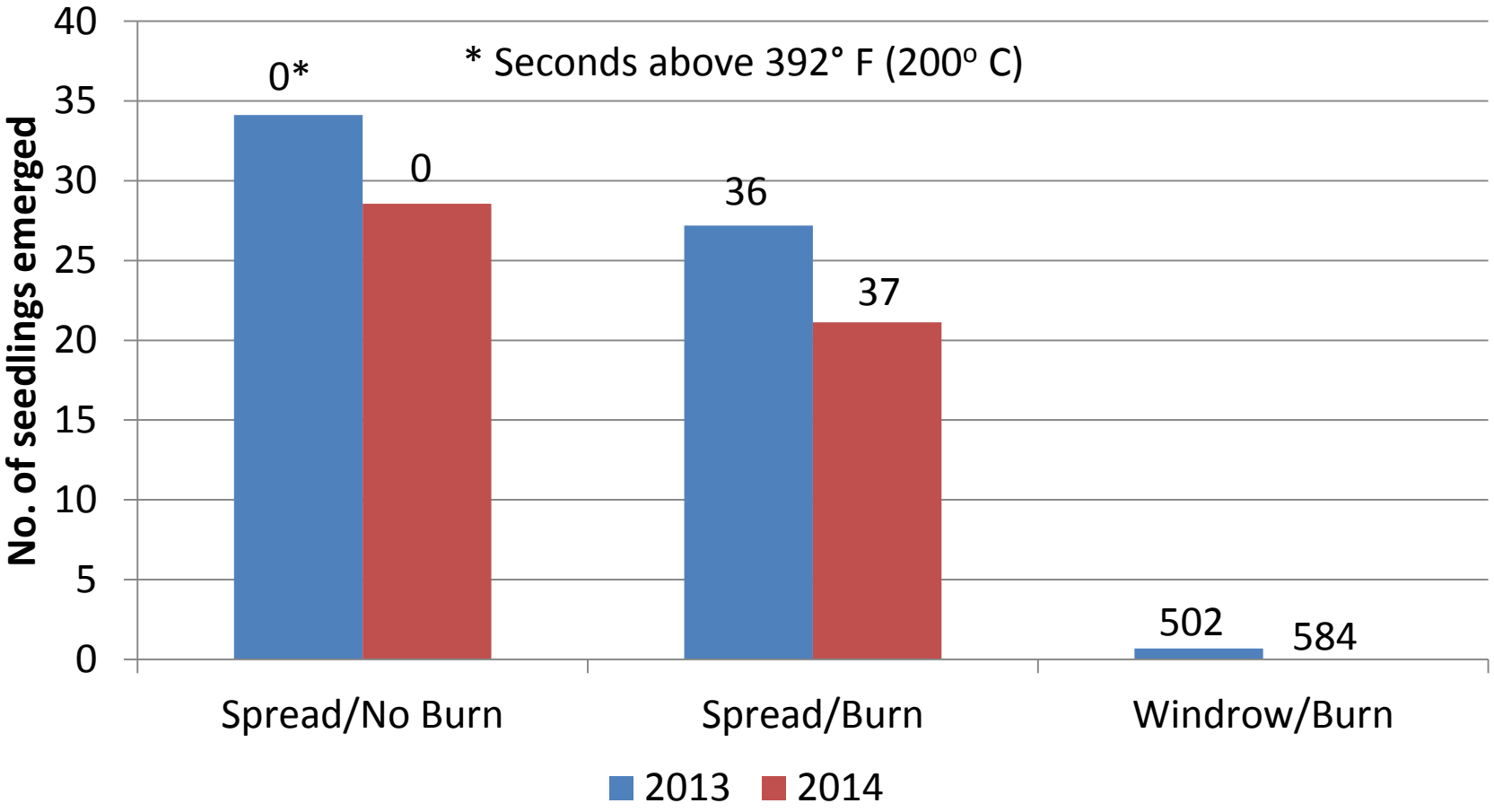
Collecting Crop Residues

Crop Residue After Burning Averaged Across Years



Germinating Italian Ryegrass After Burning

Italian Ryegrass Seed Survival



No Burn vs. Burn P=0.003
Spread vs. Windrow P=0.002

No Burn vs. Burn P<0.001
Spread vs. Windrow P<0.001

Weeds have the potential to evolve resistance to all forms of weed control




Low weed densities are the best insurance against resistance evolution

Project Objective (2)

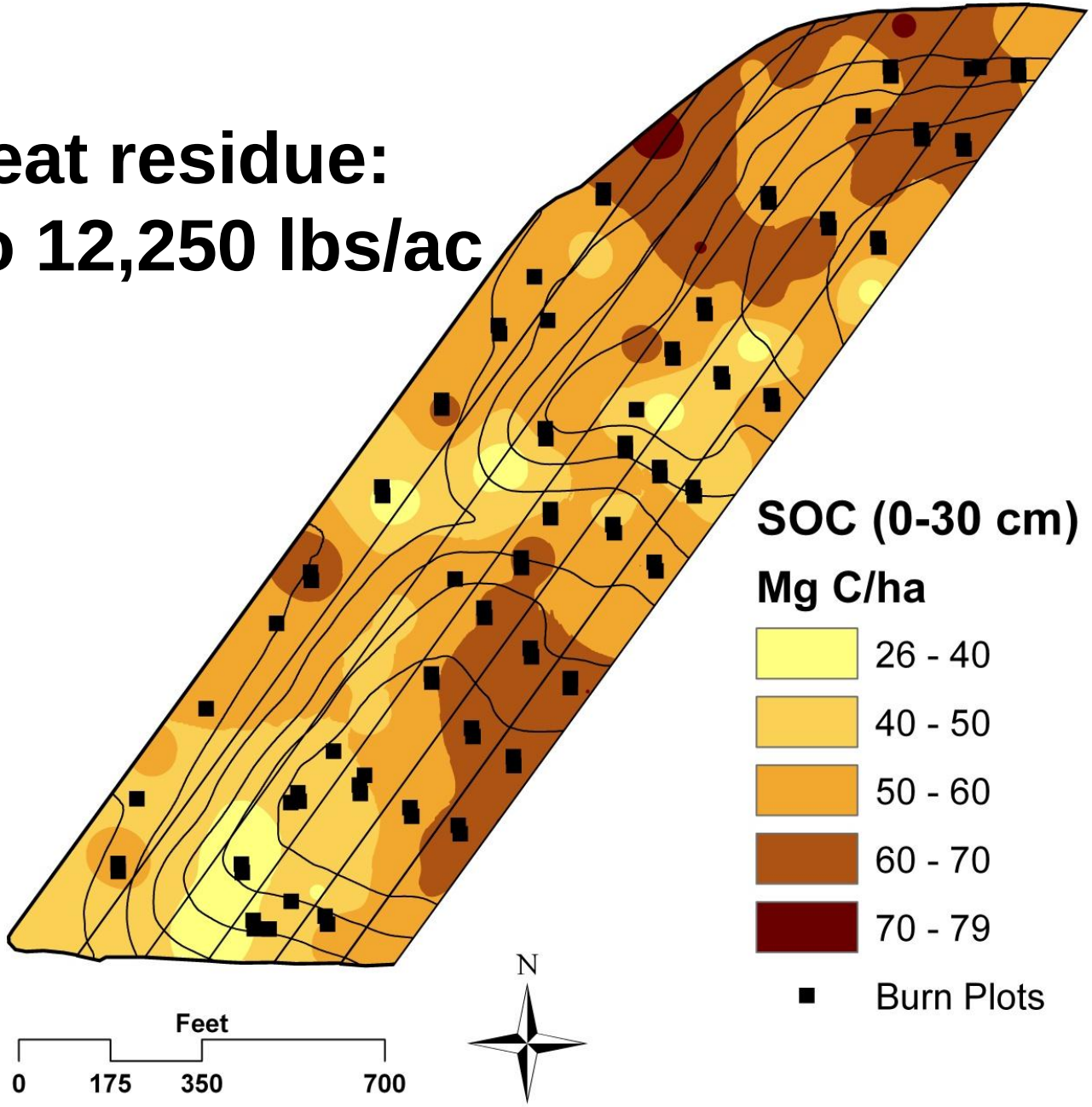
- (2) Identify and economically assess crop rotations and sequences that benefit from retaining winter wheat residues in direct-seed systems

Cook Agronomy Farm

Direct Seed and Precision Farming Systems

Develop principles and strategies that reduce risk, increase profits and improve environmental quality

W. Wheat residue: 4500 to 12,250 lbs/ac



Crop Yields (Obj. 2)

Crop	2010 Harvest		2012 Harvest		2014 Harvest	
	Control	Fall Burn	Control	Fall Burn	Control	Fall Burn
Winter Wheat following W. Wheat, (bu/ac)	82a	82a	72b	82a	71a	73a
Garbanzo Bean Yield following W. Wheat, (lbs/ac)	1624a	1634a	1934a	2008a	1384a	1347a
Spring Barley Yield following W. Wheat, (lbs/ac)	4733b	5234a	4059b	4415a	3139b	3582a
Spring Wheat Yield following W. Wheat (bu/ac)	59a	57a	51b	60a	50a	49a

Project Objectives (3)

- (3) Convey project findings through electronic and print media, field days, conferences and research site tours

Straw Management and Crop Rotation Alternatives to Stubble Burning: Outreach

November 11, 2014 – Annual Meeting of the Washington Crop Improvement Association in Airway Heights, WA

December 4, 2014 – Hermiston Farm Fair in Hermiston, OR

January 6, 2015 – Harvest Ag Grower Meeting in Walla Walla, WA

January 13, 2015 – Walla Wall County Extension Cereal Seminar in Walla Walla, WA

February 5, 2015 – Pacific Northwest Farm Forum in Spokane, WA

February 5, 2015 – Wilbur-Ellis Grower Meeting in Pullman, WA

Items to Complete

- **Continue economic assessment**
- **Complete final report**
- **Continue outreach efforts to communicate project findings**
- **Complete scientific publication of results**
  - Advanced draft “Residue Burning in an Annual Cropping System I. Nutrient Cycling and Crop Development” (plan to submit by end of June, 2015).
  - Assembled bibliography on burning and related issues: currently 148 references.

Alternatives for Managing Wheat Straw:

Assessing Soil Water Storage, Micronutrient Status and Removal and Weed Management

Co-Principle Investigators

Wayne Thompson, Regional Extension Agronomist

Drew Lyon, Weed Scientist

Dave Huggins, Soil Scientist

Cooperators: Dwelley Jones, Walla Walla County Producer

Greg and Gary Ferrel, Walla Walla County Producers

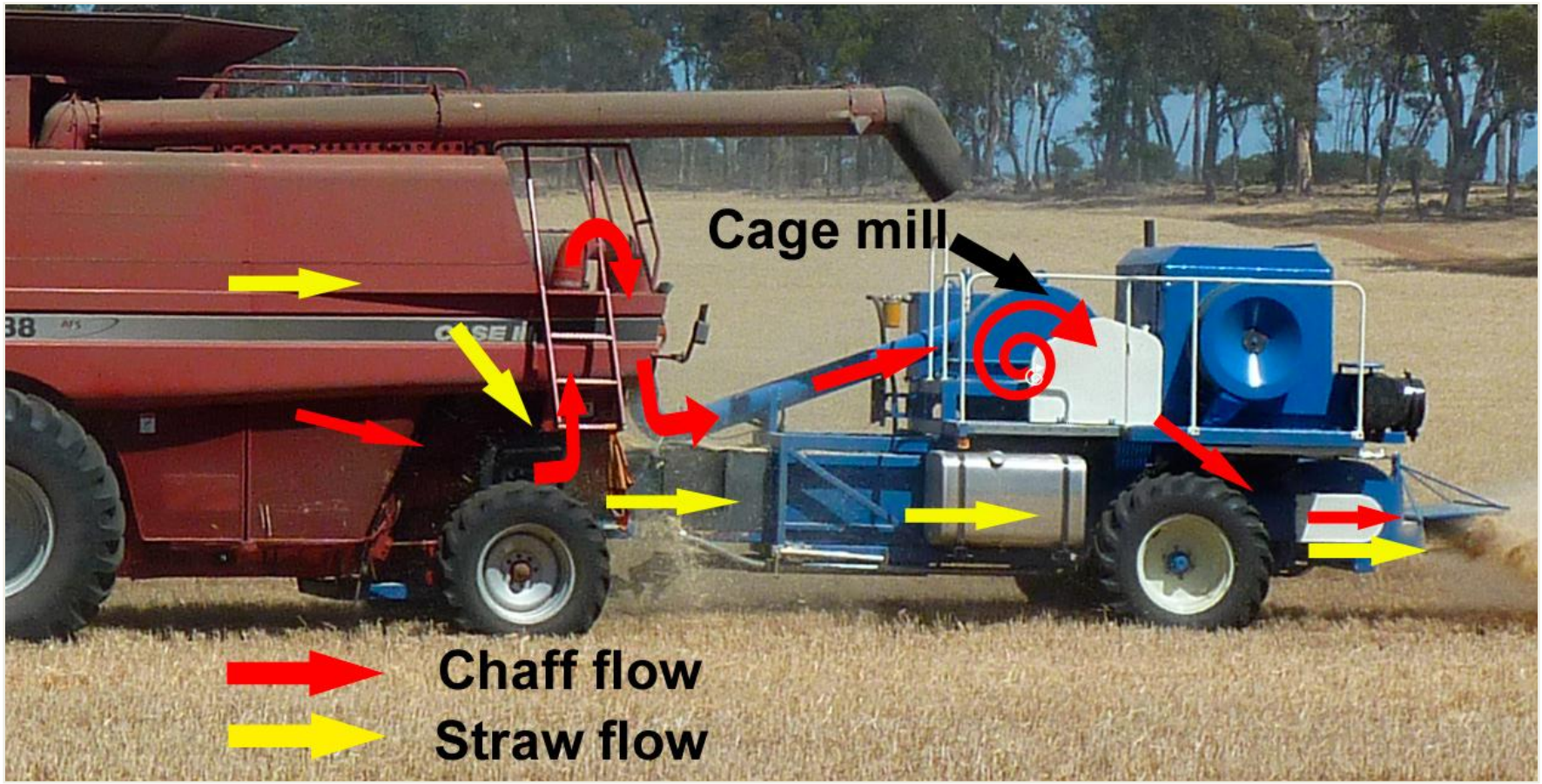
Alternatives to Field Burning
Chaff Collection

Up to 85% of *Lolium* and *Raphanus* seed collected and removed

Glenvar Bale Direct System

Up to 95% of *Lolium* seed collected and removed in baled harvest residues

Harrington Seed Destructor



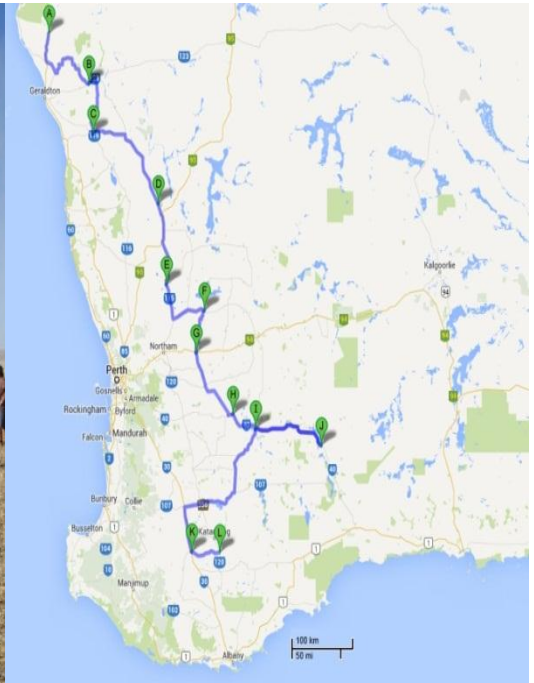
Comparison of HWSC systems

WA wheat belt 2010

Replicated treatments at 12 sites over 3,000 km

Demonstration of HWSC systems

Autumn emergence counts



Lolium emergence - autumn 2012

Averaged across 13 sites SE Aust.

Treatment	Reduction in *Lolium* emergence (%)
HSD	58
Chaff cart	55
Narrow windrow burn	55
LSD (P=0.05)	9

Lolium emergence -High density site

Treatment	*Lolium* density (plants/m^2)	Reduction in *Lolium* emergence (%)
Control	238	
HSD	148	38
Chaff cart	161	32
Windrow burn	170	29
LSD (P=0.05)		31

Assessment of HWSC

Systems deliver the same result

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New Project Objectives

- Assess straw residue removal on:
- (1) soil water storage; (2) micronutrient removal; and (3) several troublesome grassy weeds.
- (4) Convey project findings through electronic and print media, field days, conferences and research site tours.

Objective 1, Methods

- **Objective 1.** Assess soil water status under four straw residue management systems, replicated under both weed-free and weed infested conditions (Thompson, Huggins).
- **Methods:**
  - Soil water status trials will be located in Walla Walla County within the collaborating farmer's field and repeated on the PCFS in Pullman.
  - Within-field trial positions will be established prior to winter wheat harvest with treatments that consist of straw residue removal by direct baling, fall burn, windrow burn and no burn under both weed-free and weed-infested conditions.
  - Microclimate stations coupled with field sampling will be used to monitor soil water, temperature to evaluate evaporative water loss relative to evapotranspiration rates of the crop.
  - Crop samples will be assessed for biomass production and grain yield.

Objective 2, Methods

- **Objective 2.** Evaluate and agronomically assess micronutrient status and removal by winter wheat residues in direct-seed systems (micronutrient status and removal) and straw ash (Thompson, Huggins).
- **Methods:**
  - Same field trials/treatments as in Obj. 1.
  - Composite soil samples and crop yield/residue samples will be gathered and assessed for micronutrient status.
  - Micronutrient removal and crop performance (micronutrient status and yield) will be evaluated for all treatments.

Objective 3, Methods

- **Objective 3.** Continue evaluation of HWSC systems that capture weed seeds during or destroy following commercial grain crop harvest (Lyon, Thompson).
- **Methods:**
  - **Study one:** determine proportion of weed seed retained above (and below) a low harvester cutting height (6 inches) to determine the proportion of seed that could be collected during harvest.
    - **Weed species:** Italian ryegrass, jointed goatgrass, rattail fescue and downy brome will be monitored and weed seed samples collected just prior to harvest to determine the proportion of seed retained above a low harvester cutting height (six inches).

Objective 3, Methods

- **Objective 3.** Continue evaluation of HWSC systems that capture weed seeds during or destroy following commercial grain crop harvest (Lyon, Thompson).
- **Methods:**
  - **Study two:** evaluate burning with four treatments: full combine header width spreading of straw, chaff, and weed seed with (1) and without (2) fall burning; windrowing of straw, chaff and any weed seeds directly behind combine coupled with field burning of the windrow (3); direct bale system (4)
    - Emergence of weed species and volunteer winter wheat will be monitored in the fall and following spring to assess treatment differences in population densities.

Objective 4 (Extension)

- **Objective 4.** Convey project findings through electronic and print media, field days, conferences and research site tours (Thompson, Lyon and Huggins).
  - As research results become available, many opportunities for presentations at field days, conferences and research site tours will occur.
  - In addition, we will submit a minimum of one manuscript to a peer-reviewed journal, for example, Soil Science Society of America Journal, to publish research from the DOE project combining these results with the experiments just completed.

Proposed Budget		
Salaries - 00	$	4,951
Wages - 01	$	13,464
Personal Service Contracts - 02	$	-
Goods/Services - 03	$	24,900
Travel - 04	$	5,000
Equipment (Capital) - 06	$	-
Benefits - 07	$	1,989
Stipends -08	$	-
F&A - 13	$	14,329
Subawards - 14	$	-
Equipment (Non-Capital) - 16	$	-
Total	$	64,633

Questions?