Improving canola production and production systems with genetic and agronomic advances to increase canola acreage in the Pacific Northwest

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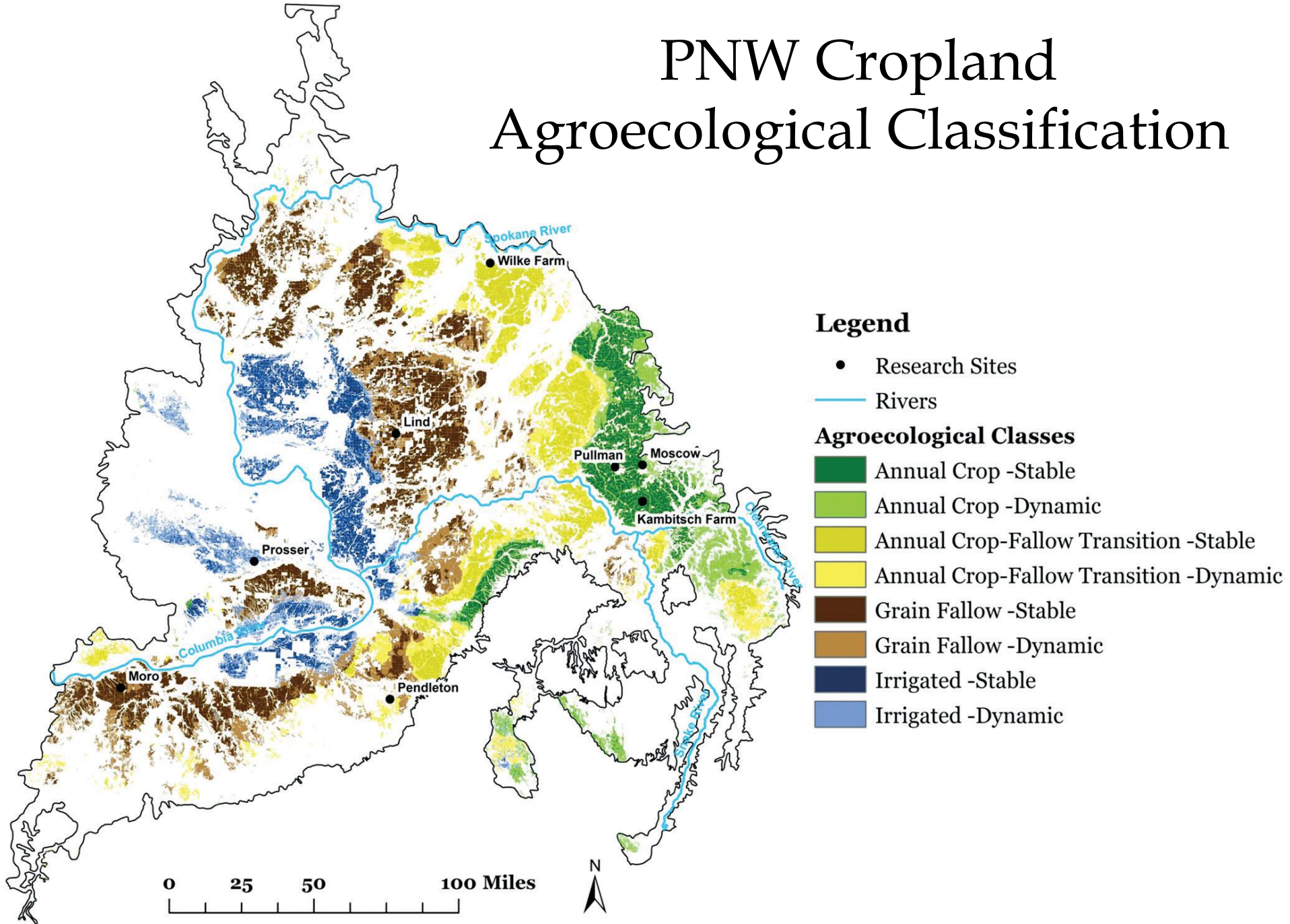
[1]University of Idaho, [2]Washington State University, [3]Oregon State University, [4]Montana State University.

PNW Cropland Agroecological Classification



Available Crops

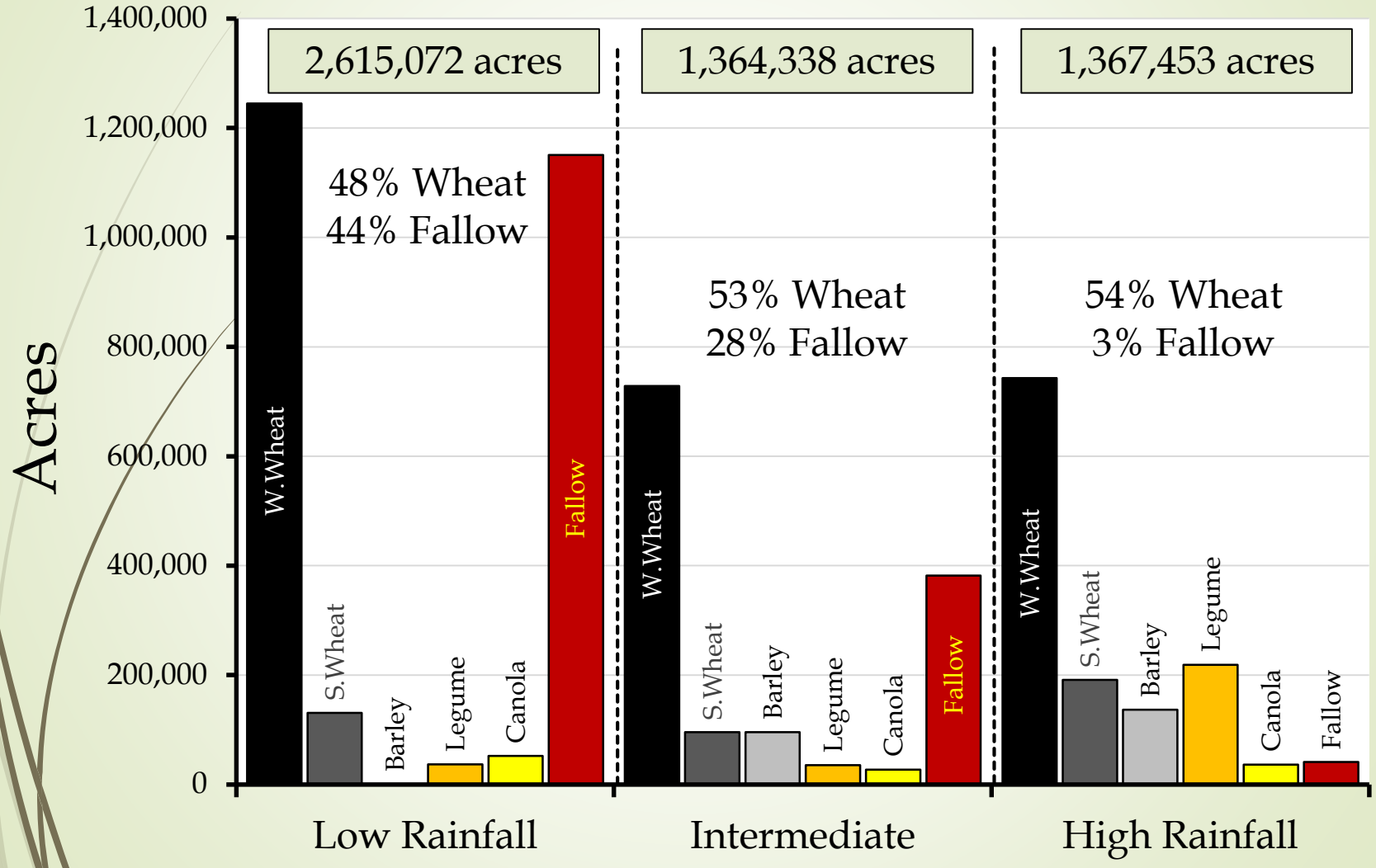
Spring:

- Wheat
- Barley
- Garbanzo
- Lentil
- Pea
- Canola

Winter:

- Wheat
- Canola
- AWP

Pacific Northwest Crops



- Yield loss;
- Grass Weeds;
- Diseases;
- Soil Acidification;
- Lack of diversity.

Increase US Canola Acreage

- ✓ Develop genetically adapted cultivars.
- ✓ Availability of cultivars resistant to biotic and abiotic stresses.
- ✓ Good fit into existing production management systems.
- ✓ Local knowledge of best crop production practices.
- ✓ Increase grower profitability.

More money – More acres

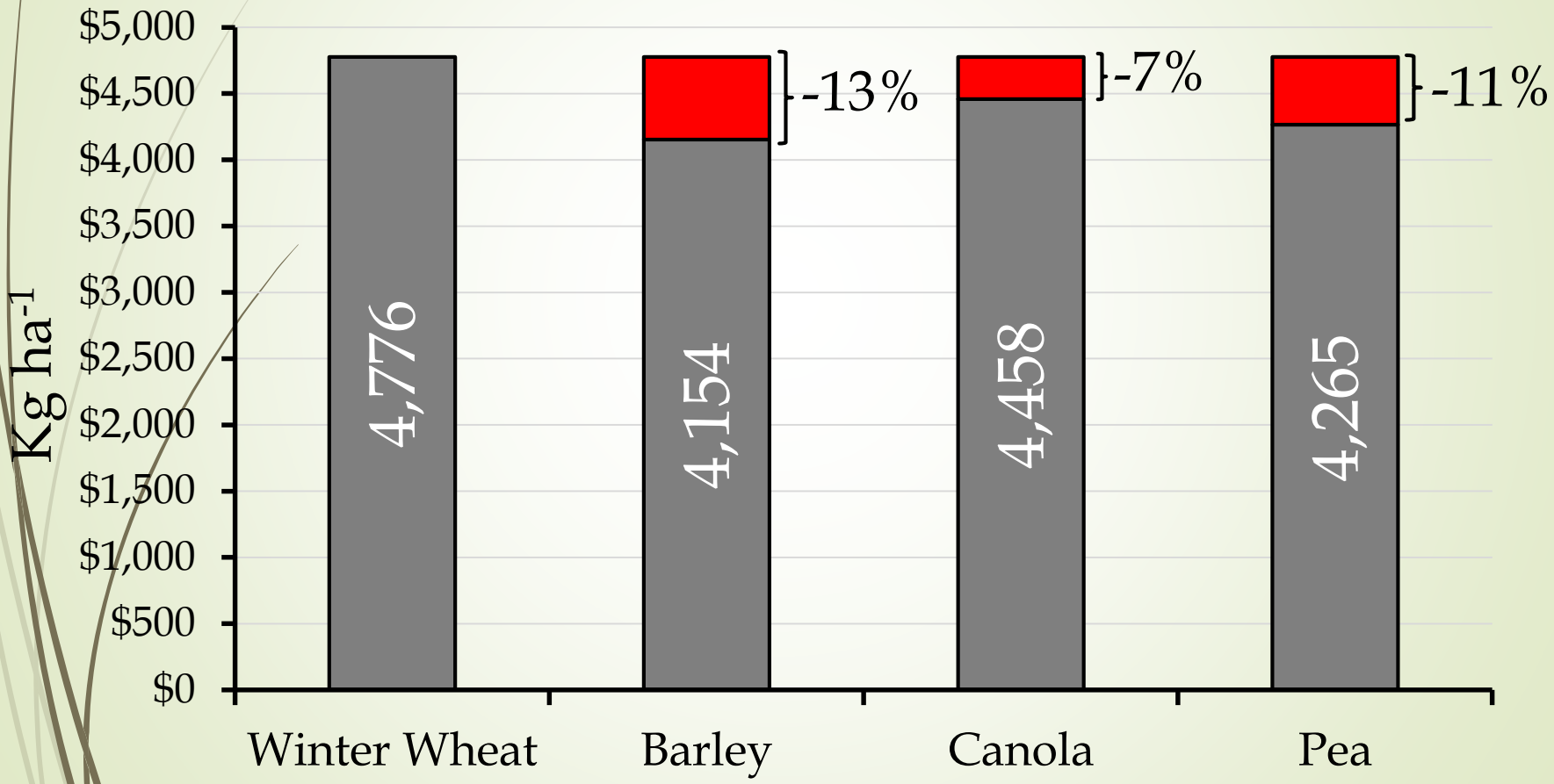
Objectives

- ✓Quantify the effects of growing canola in rotations with wheat in the PNW.

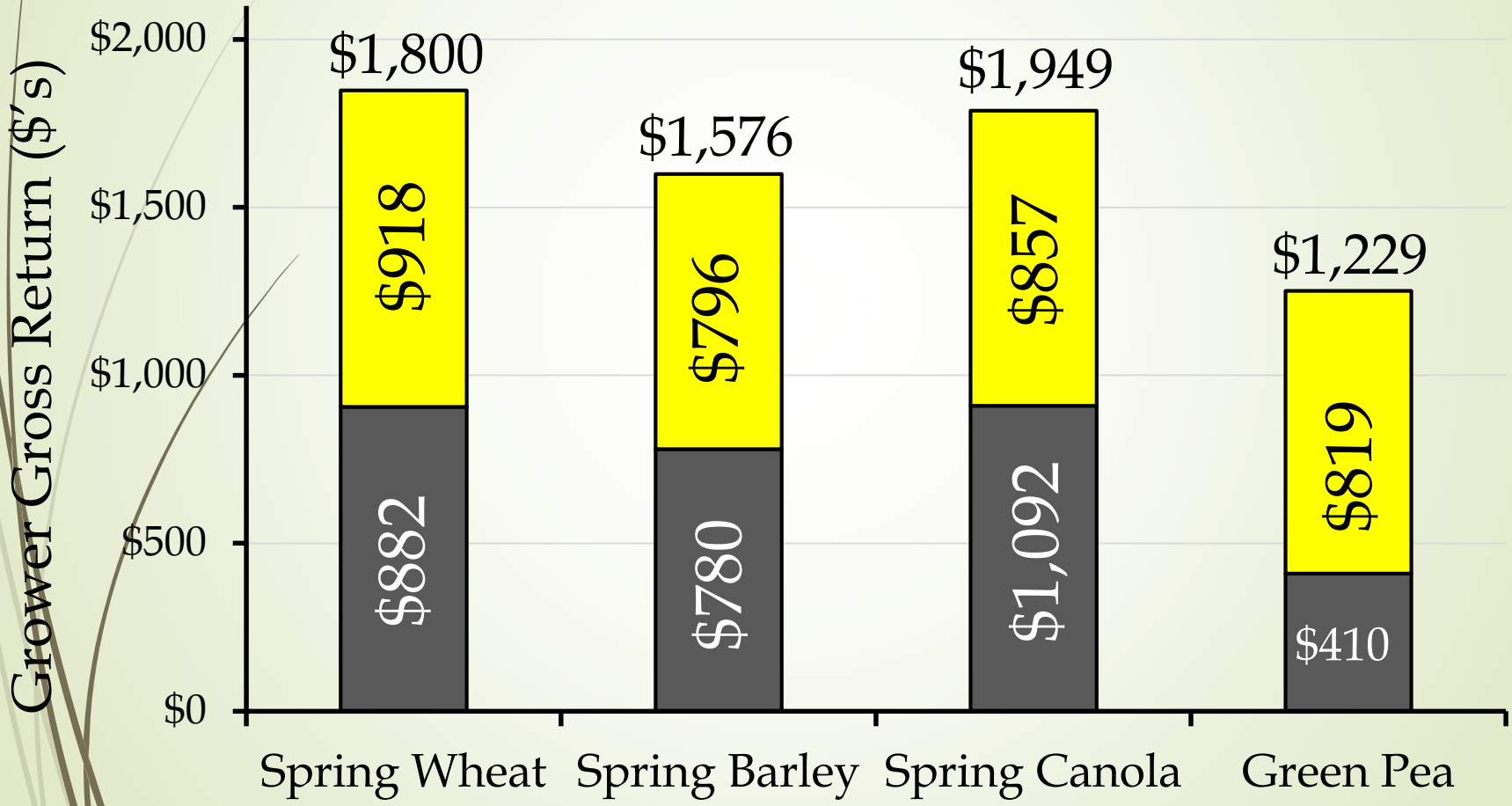
Crop Rotation Effects

Study Site	Year 0	Year 1	Year 2
ID Spring Rotation	Spring wheat	Spring canola Spring pea Spring barley Spring wheat	Winter wheat (SWWW)
ID Winter Rotation	Winter wheat & Fallow	Winter canola Austrian winter pea Winter wheat	Winter wheat (SWWW)
WA Spring Rotation	Spring barley	Spring canola Spring wheat Spring Garbanzo	Winter wheat (HRWW)

Winter Wheat Yield following Spring Rotation Crops

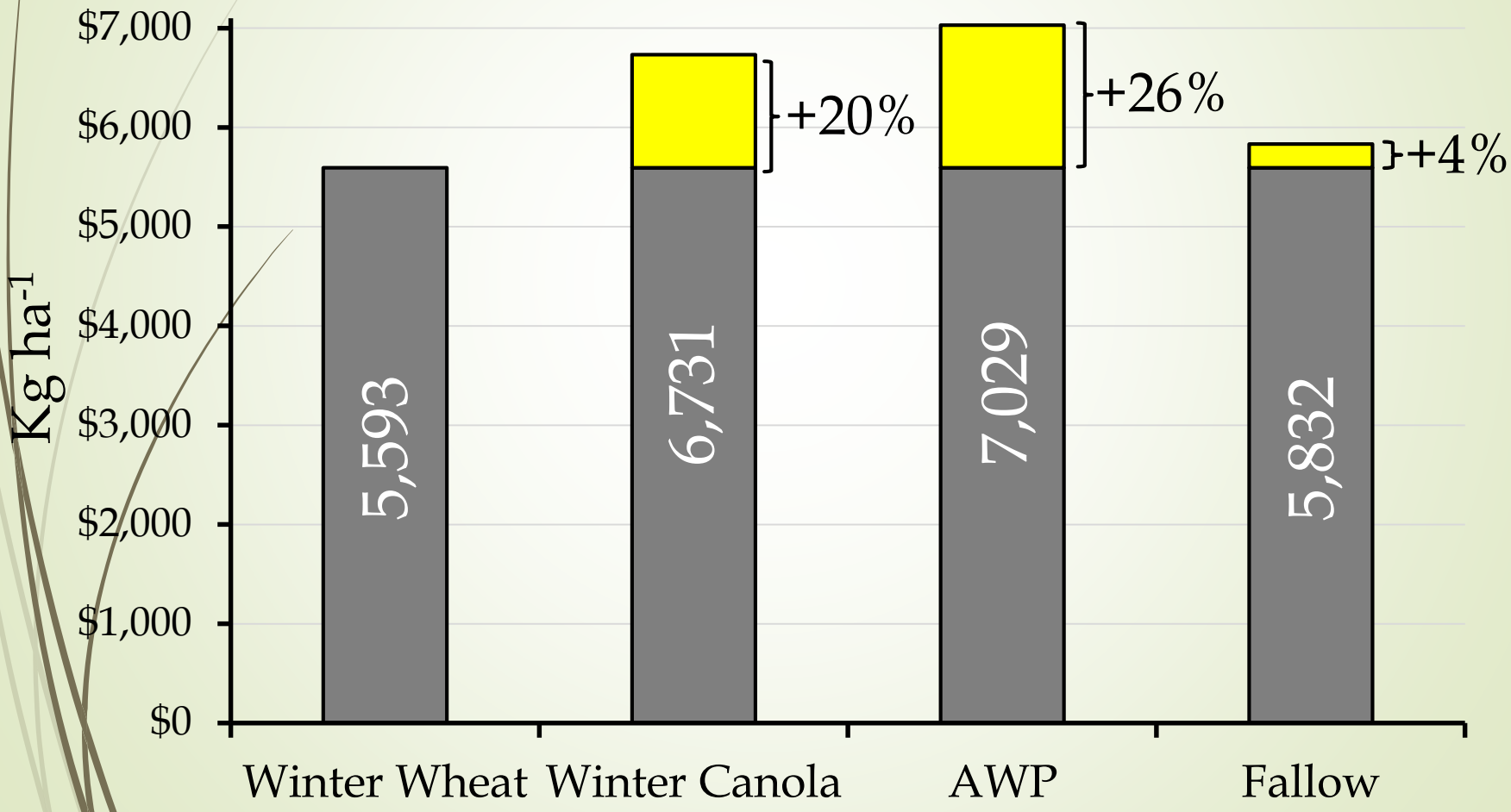


Spring Rotation 2-Year Returns
Idaho 2018

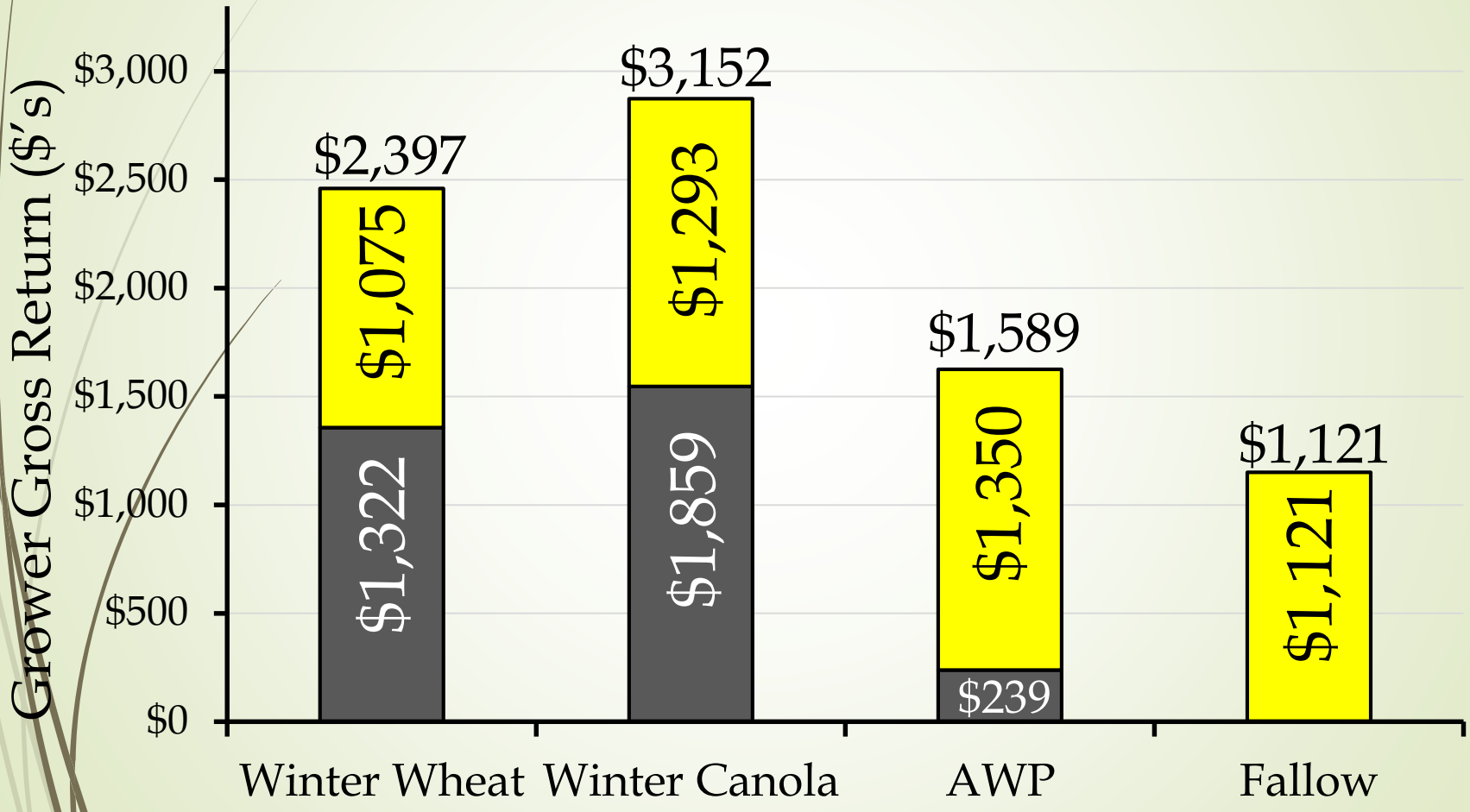


*Based on commodity seed prices of \$0.197 (\$5.36 bu^{-1}) kg^{-1} for soft white wheat, \$0.154 kg^{-1} for barley (\$140 ton^{-1}), \$0.484 kg^{-1} for canola (\$0.183 lb_{-1}), and \$0.276 kg^{-1} (\$0.125 lb^{-1}) for pea.

Winter Wheat Yield following Winter Rotation Crops



Winter Rotation 2-Year Returns
Idaho 2018

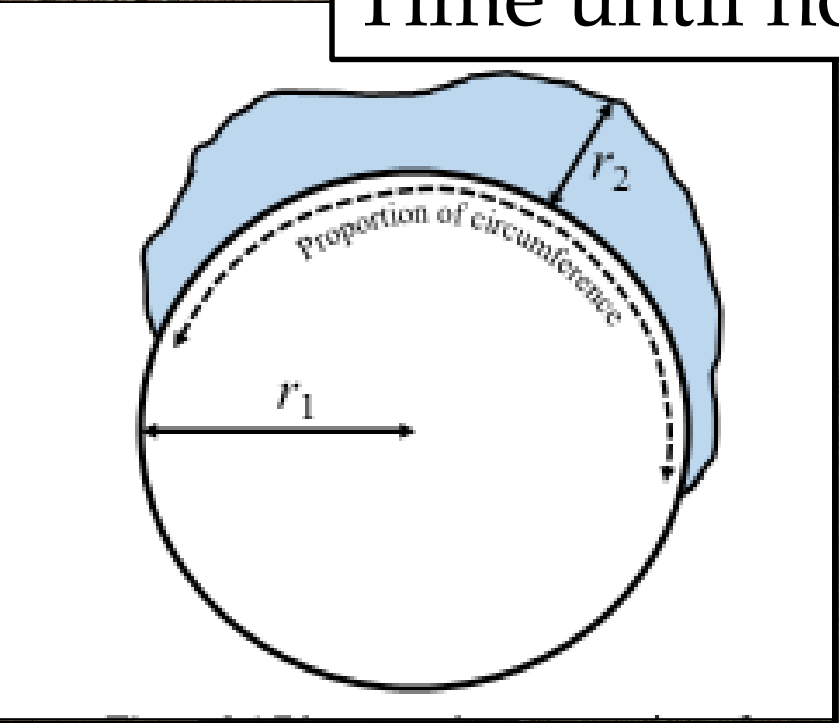


*Based on commodity seed prices of \$0.197 (\$5.36 bu^{-1}) kg^{-1} for soft white wheat, \$0.484 kg^{-1} for canola (\$0.183 lb_{-1}), and \$0.276 kg^{-1} (\$0.125 lb^{-1}) for AWP.

Shallow fibrous root systems of small grain cereal crops do not penetrate deep into the soil profile or reach deep profile nutrients

10” Cylinder + 1 liter water

Time until no more standing water



Spring Soil Infiltration

Crop	Water Infiltration	Water Seepage
	- liters h^{-1} -	-- cm^{-2} --
Spring Wheat	15.62	23.50
Spring Barley	40.19	14.84
Spring Canola	42.90	9.79
Green Pea	17.38	5.52

Very large variation between samples within crops

Winter Crop Soil Infiltration

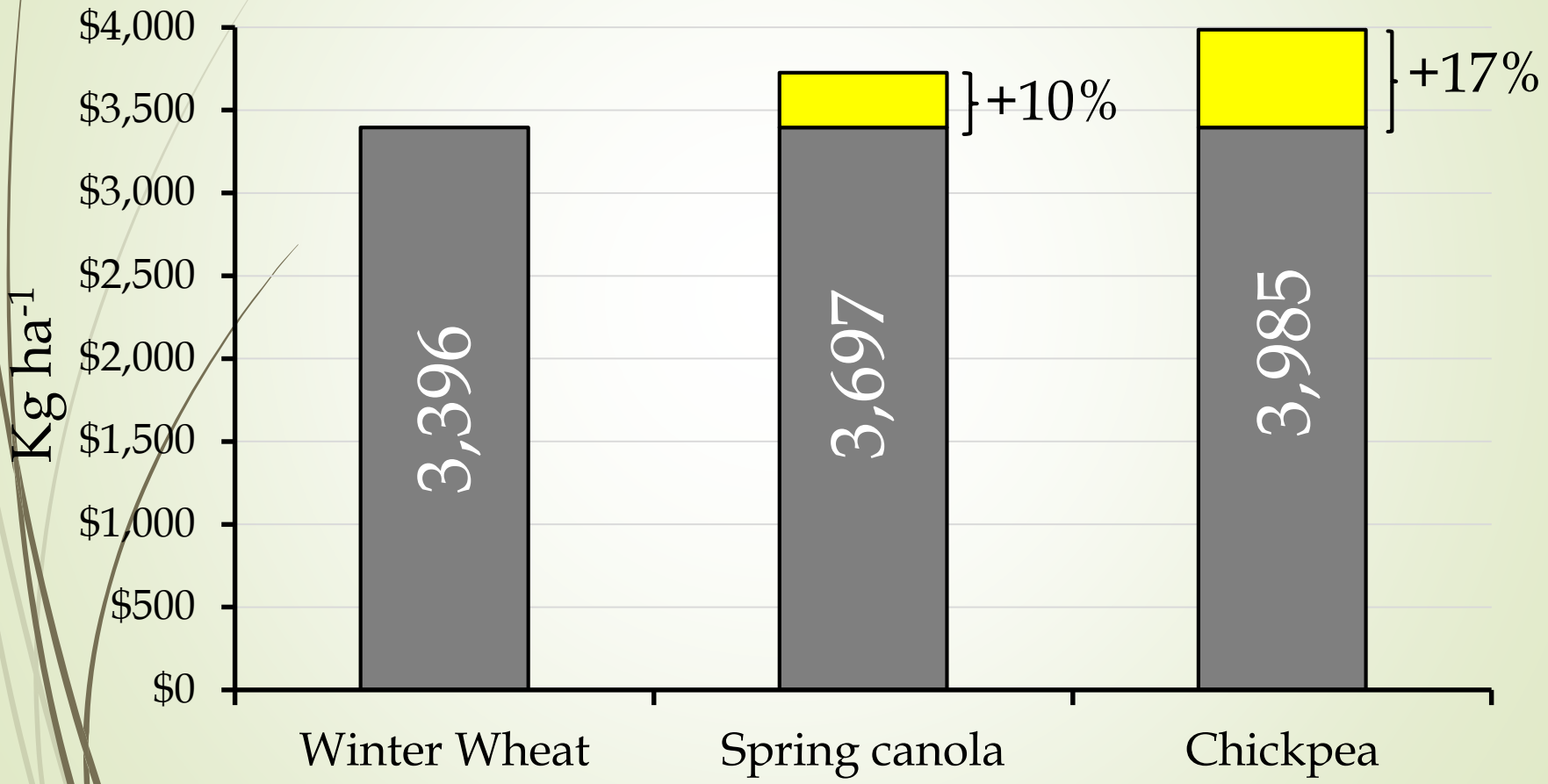
Crop	Water Infiltration	Water Seepage
	- liters h^{-1} -	-- cm^{-2} --
Winter Wheat	5.6 b	60.6 ab
Winter Canola	27.0 a	44.9 b
AWP	7.5 b	49.7 b
Summer Fallow	3.9 b	93.8 a

Washington Rotation Trials

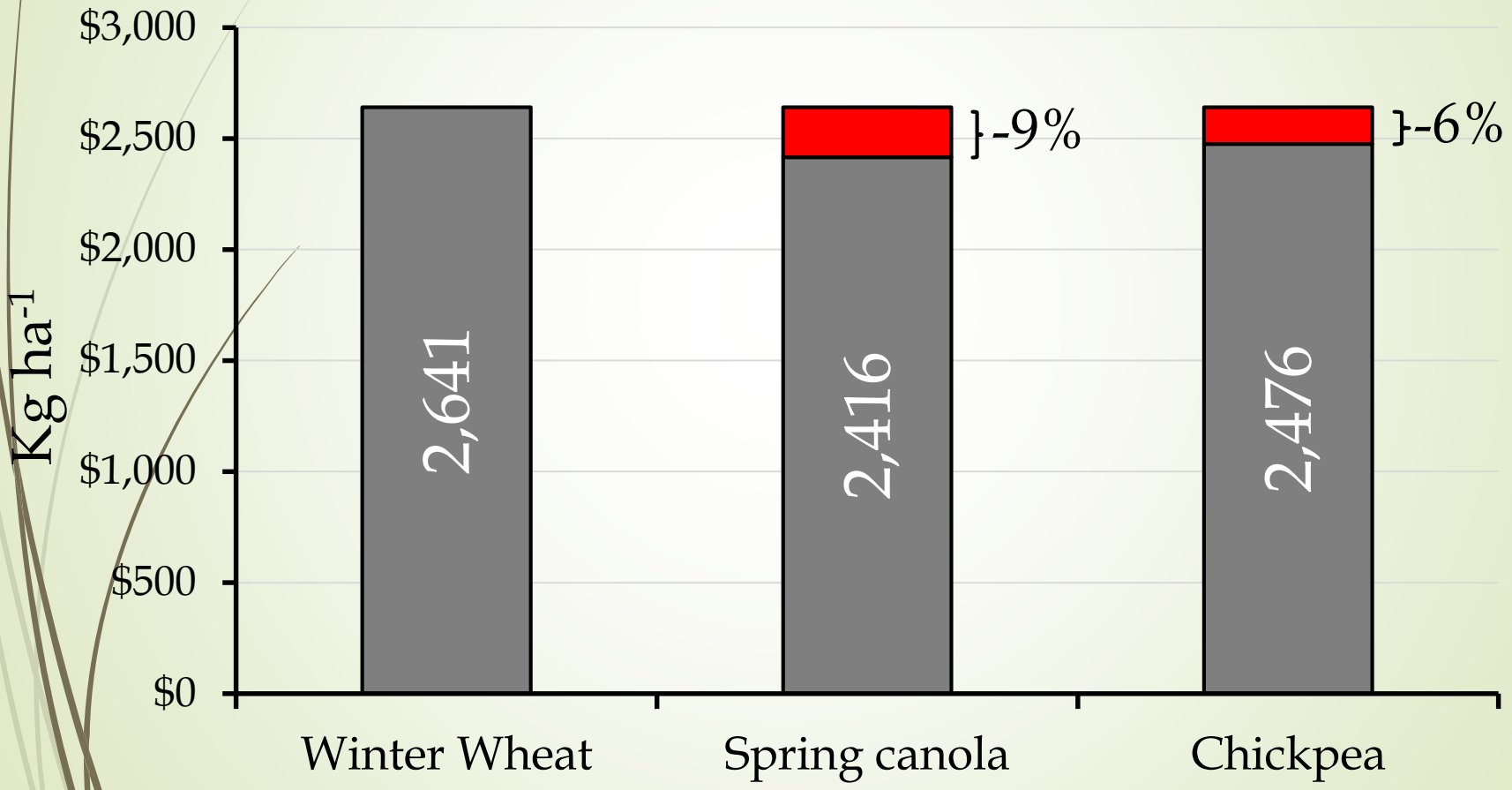
2014	2015	2016	2017	2018	2019	2020	2021
TRT	WW	SW	TRT	WW	SW		
	TRT	WW	SW	TRT	WW	SW	
		TRT	WW	SW	TRT	WW	SW

Treatment crops → Recrop winter wheat → Spring wheat

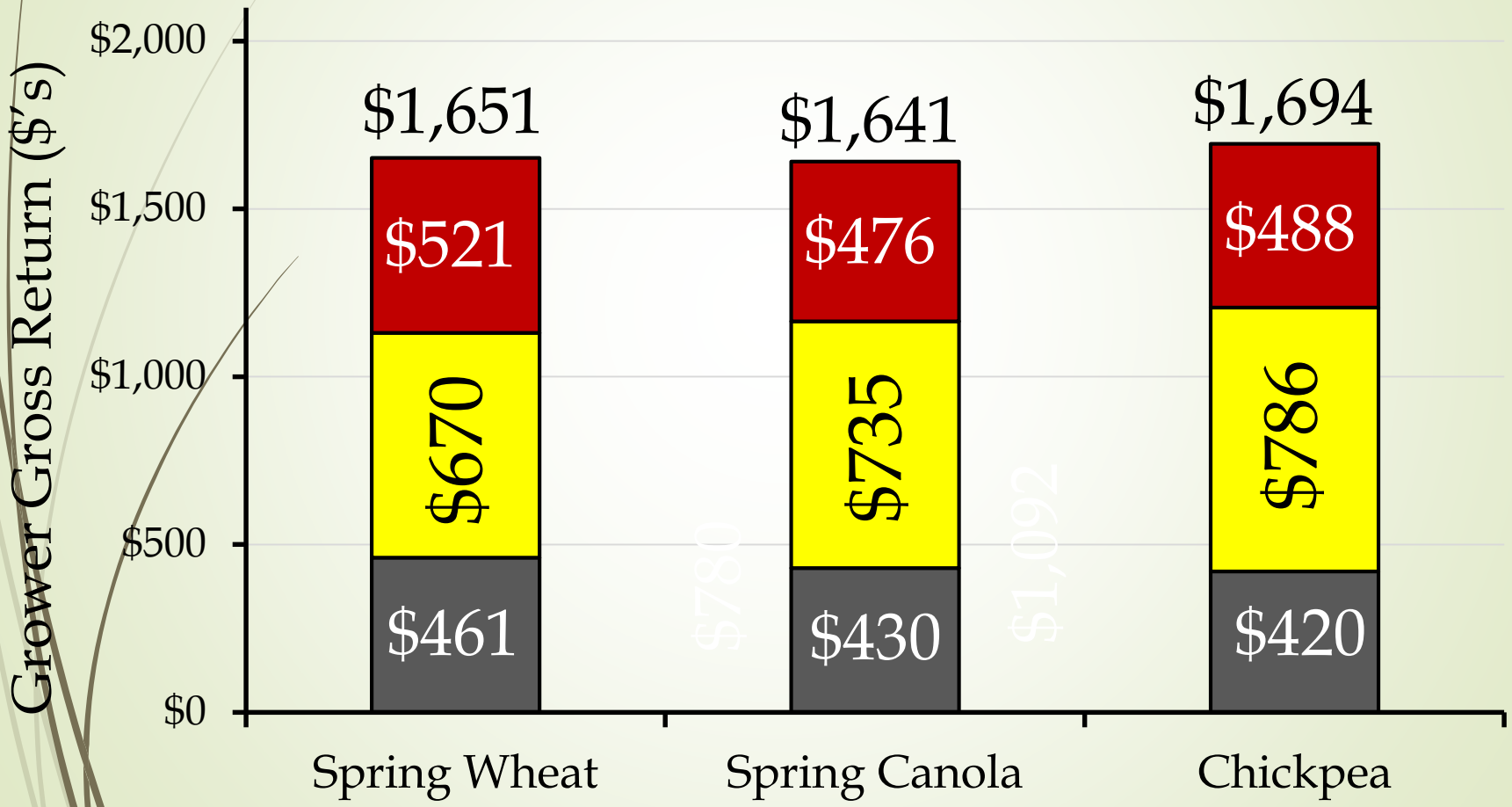
Winter Wheat Yield following Spring Rotation Crop - WA



Spring Wheat Yield following Winter Wheat Crop - WA



Spring Rotation 3-Year Returns Washington



*Based on commodity seed prices of $0.197 ($5.36 bu^{-1}) kg^{-1} for soft white wheat, $0.484 kg^{-1} for canola ($0.183 lb_{-1}), and $0.276 kg^{-1} ($0.19 lb^{-1}) for chickpea.

Objectives

- ✓Develop and identify canola cultivars that afford the highest productivity and greatest profitability for different agronomic zones in the PNW.

New Cultivar Releases

Winter Canola
'Chinook'

Spring Canola
'Monarch'
'Syringa'

Winter Rape
'Impress'

Spring Rape
'Industrious'
'Cataldo'

Indian Mustard
'Bruin'

Clearfield®

Production System for Wheat

Cheat grass

Wild Oat

- Wheat yield loss;
- Grass Weeds.

Winter Canola & Rapeseed

- '**Chinook**' winter canola (05.WC.15.7.5.IMI), has high yield, exceeding that of 'Amanda', and with good agronomic adaptability, high oil content and oil quality, and tolerance to IMI and other Group 2 herbicides.
- '**Impress**' winter rapeseed (05.WI.45.2.2.IMI), with higher yield than 'Durola', excellent winter hardiness, very high seed oil content, and excellent industrial oil quality, and tolerance to IMI and other Group 2 herbicides.
- Chinook and Impress can be planted in rotations where IMI herbicides are used on wheat or legumes.

Spring Canola

- '**Monarch**' (07.SC.27.19.B3), has specialty oil characteristics and produces High Oleic Low Linolenic (HOLL) quality canola oil suitable for use as non-hydrogenated (zero *trans* fat) oil in fry processing, while having long shelf-life.
- '**Syringa**' (07.SI.7.8.8.7.Gly-IMI) has dual (IMI/Group 2 & Glyphosate) herbicide tolerance, allowing it to be planted in rotations where IMI herbicides are used on wheat or legumes with Glyphosate applied in-crop for weed control.

Spring Rapeseed

- '**Industrious**' (07.SI.8.A10) has higher seed yield potential than 'Gem', excellent adaptability to a range of PNW environments, with very high oil content and excellent industrial oil quality.
- '**Cataldo**' (07.IR.1.5.4.5.Gly-IMI) has excellent oil quality and content and has dual (IMI/Group 2 & Glyphosate) herbicide tolerance, allowing it to be planted in rotations where IMI herbicides are used on wheat or legumes with Glyphosate applied in-crop for weed control.

Spring Brown Mustard

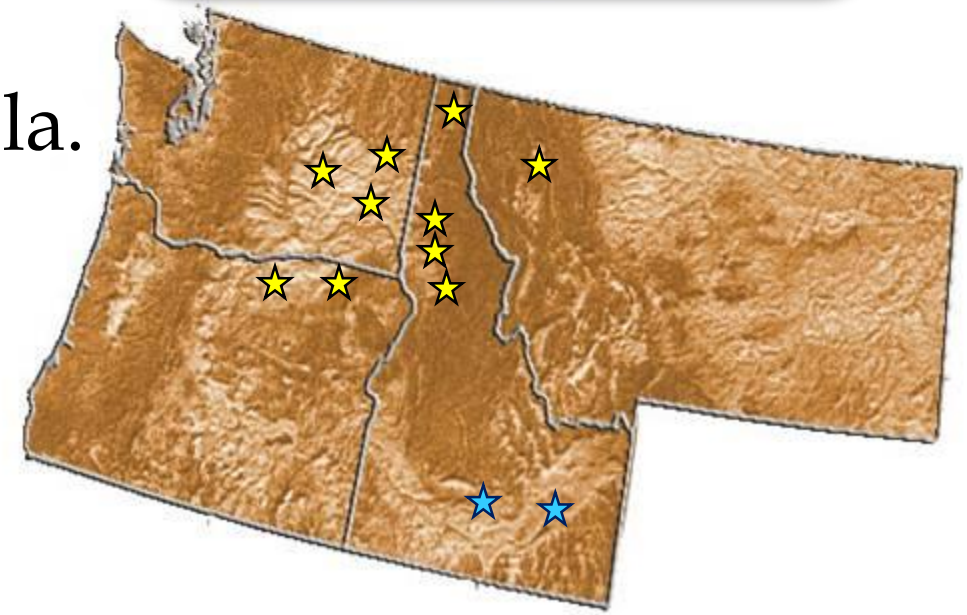
- '**Bruin**' is a new brown Indian condiment mustard, with brown seed (Dijon type).
- Bruin is tolerant to IMI- and other Group 2 herbicides allowing it to be planted in rotations where IMI-herbicides are used on wheat or legumes.
- Bruin has higher seed yield than 'Kodiak', with very high glucosinolates (spice) and can be utilized as a condiment seed crop or as a cover crop or a green manure for soil fumigation.

Cultivar Licensing

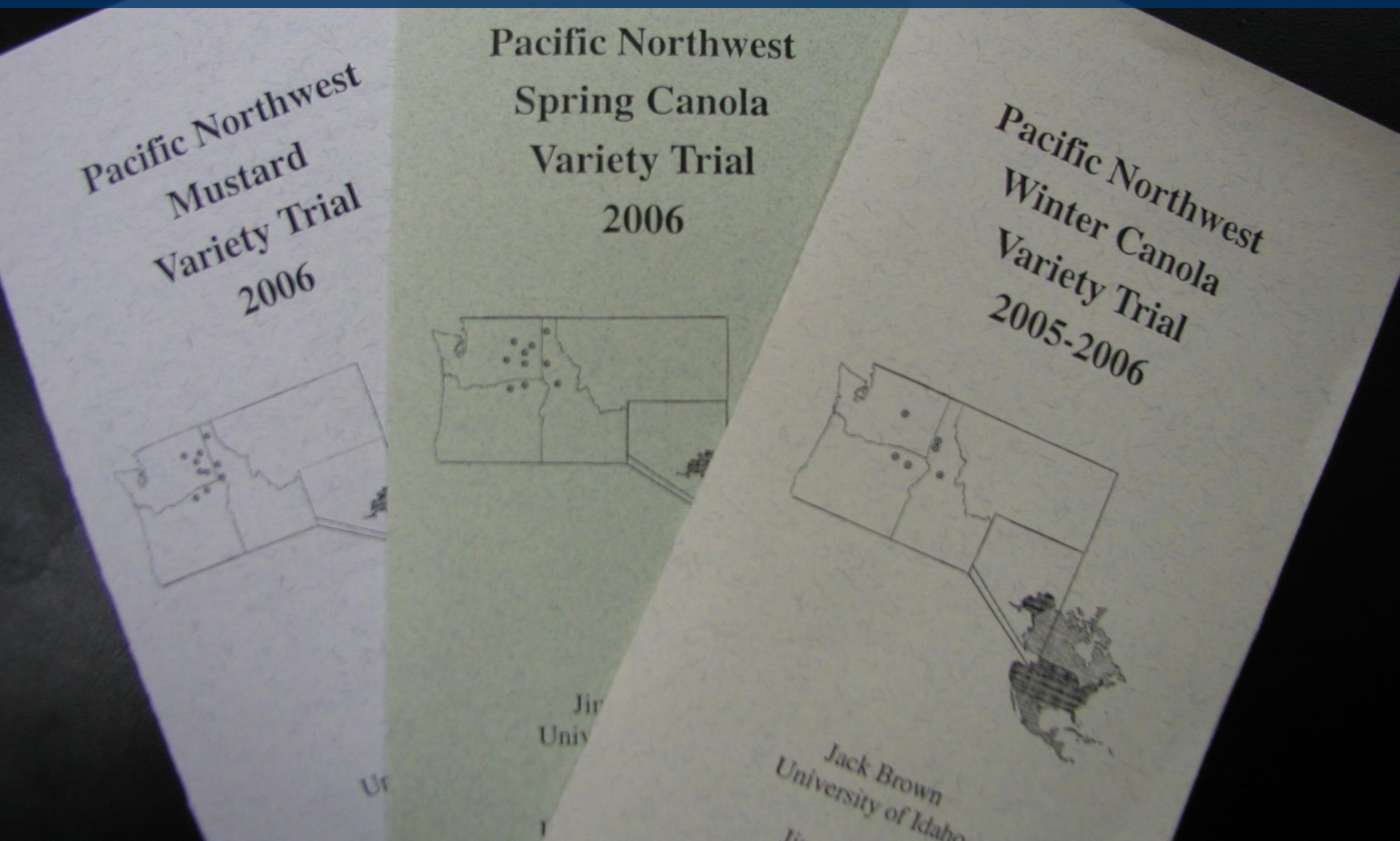
- All new cultivars are available for licensing.
- The University of Idaho Office of Technology Transfer manages all cultivar licensing.
- Contact Karen Stevenson at 208-885 4550 or *karens@uidaho.edu* for more information.
- Companies can elect to license new cultivars on an exclusive or non-exclusive basis.
- Licensees pay the University of Idaho a royalty based on the amount of Certified Seed sold.

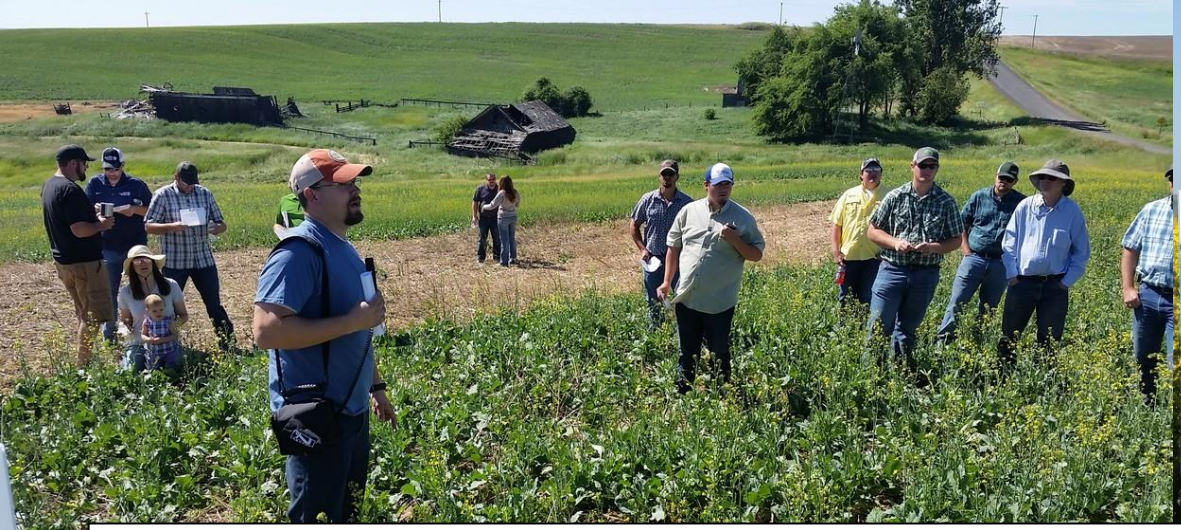
Pacific Northwest Cultivar Variety Trials

- Spring and winter cultivar evaluation trials in four PNW States.
- Identify regions specifically suited to spring or winter canola.
- Provide growers information of 'best' cultivars.



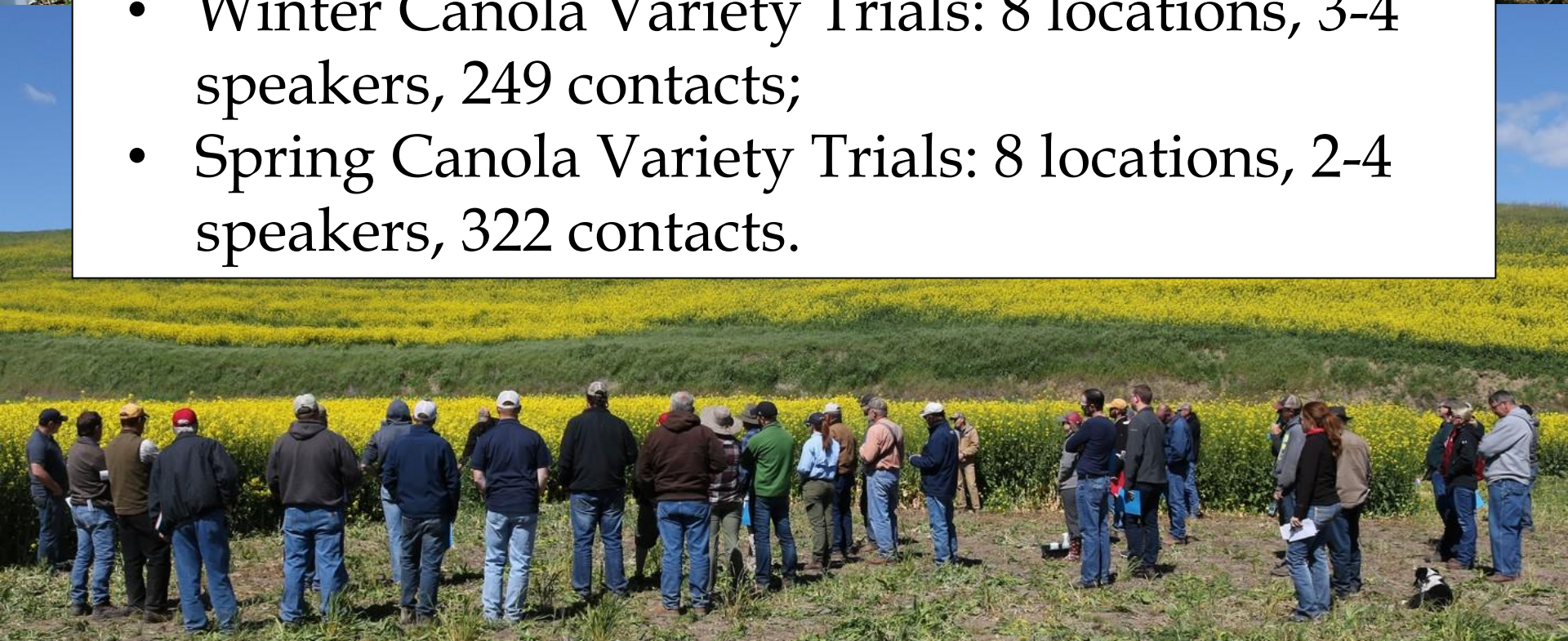
http://www.cals.uidaho.edu/brassica/
http://css.wsu.edu/oilseeds/





Field tours:

- Winter Canola Variety Trials: 8 locations, 3-4 speakers, 249 contacts;
- Spring Canola Variety Trials: 8 locations, 2-4 speakers, 322 contacts.



✓ WSU Davenport Field Day: 138 attending

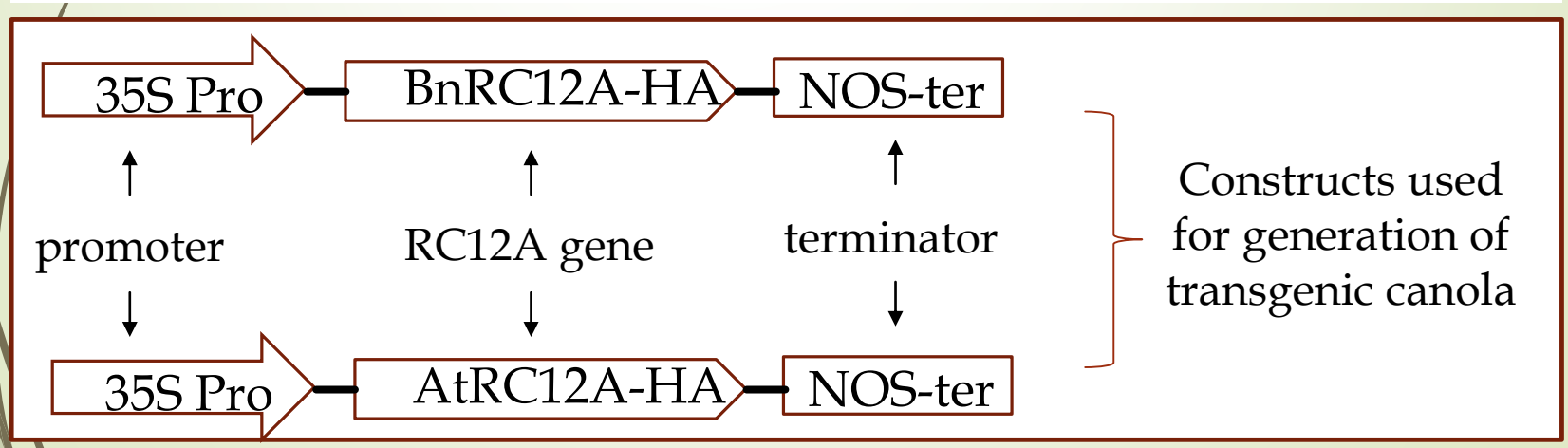

Winter Kill

Cold & Drought Tolerance

- ✓ Developing cold- and drought-tolerant canola varieties that efficiently utilize water and express extreme winter hardiness is major goal.
- ✓ The *RC12A* gene is known to play a significant role in abiotic stress.
- ✓ The *RC12A* gene encodes for a plasma membrane-related protein that is specifically related to cold stress tolerance.

Cold & Drought Tolerance

- ✓We generated the necessary cDNA's from both *Arabidopsis* and canola plants.
- ✓We generated plant expression constructs overexpressing *RC12A* genes (Canola *RC12A* gene (*BnRC12A*) and Arabidopsis *RC12A* (*AtRC12A*)) under the control of the strong CaMV 35S promoter.

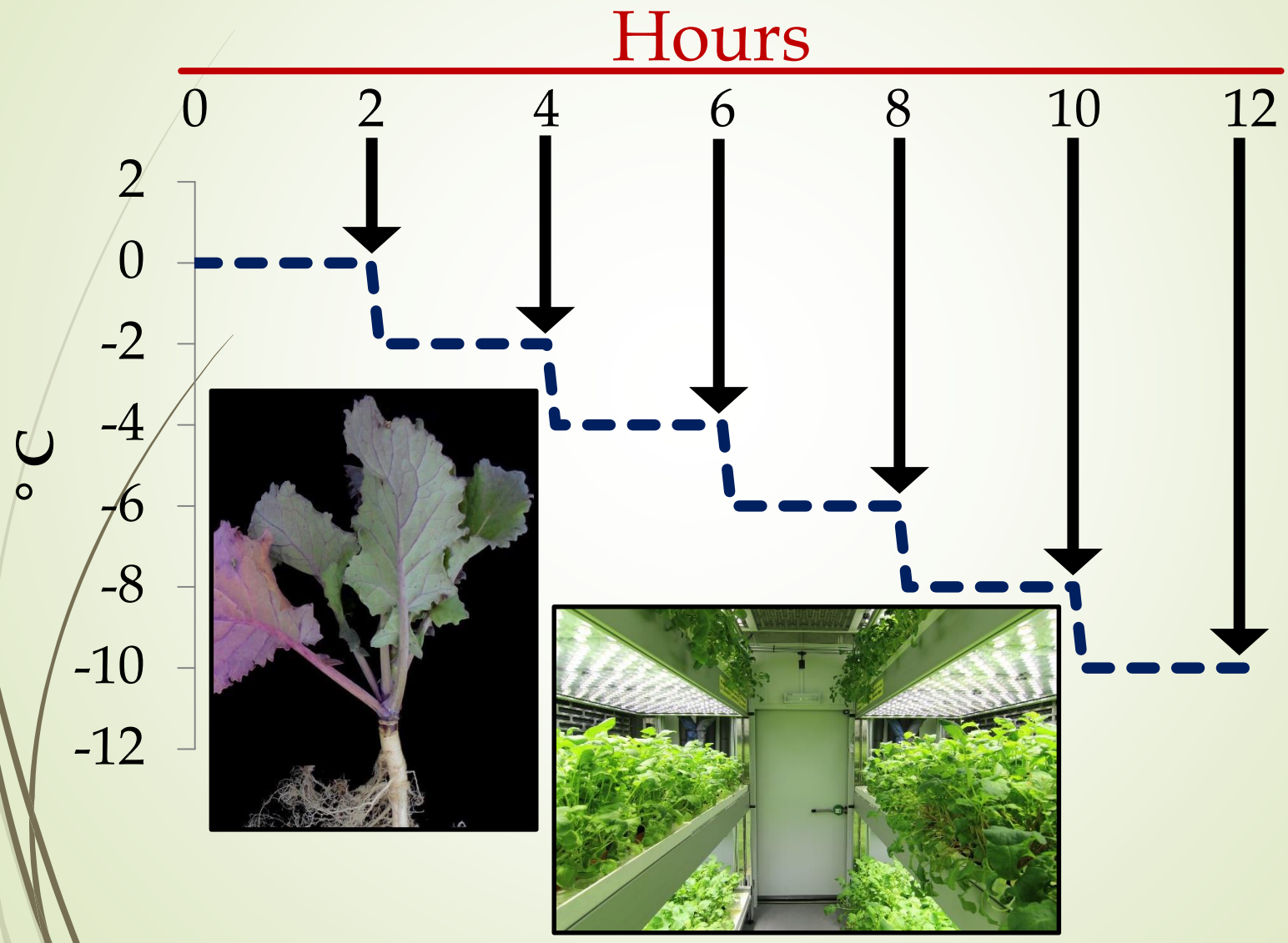


Progress

- ✓ Generated transgenic canola plants over-expressing *BnRC12A* and *AtRC12A* genes by Agrobacterium - mediated transformation and tissue culture.
- ✓ Two transgenic canola lines overexpressing AtRC12A gene have been generated.

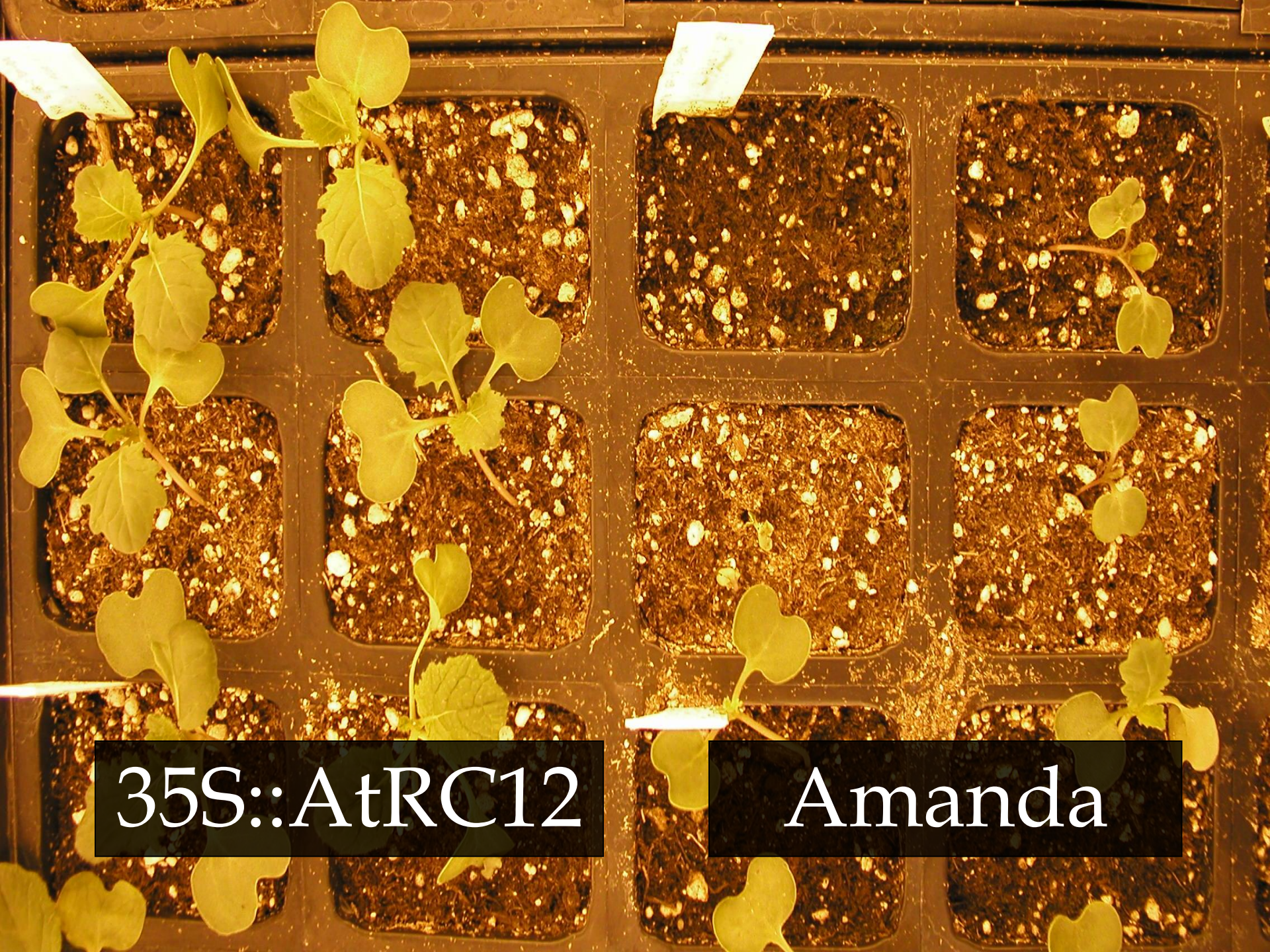
Vernalized 35S::AtRC12 transgenic canola plants in green house

Freeze Treatment



Freeze Treatment

35S::AtRC12 Amanda


35S::AtRC12
Amanda

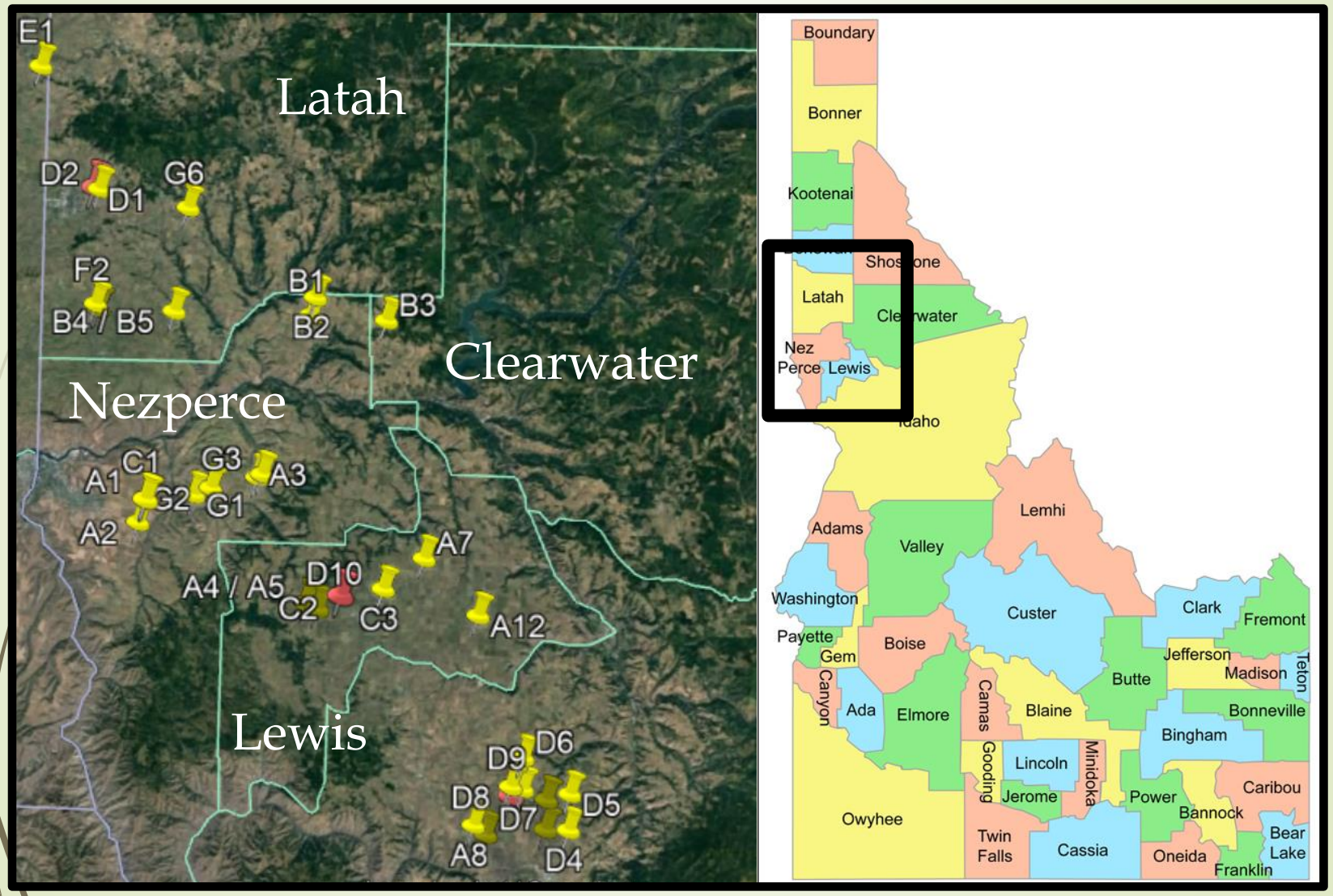
Objectives

- ✓ Survey the PNW's potential for development of blackleg.

Blackleg in idaho

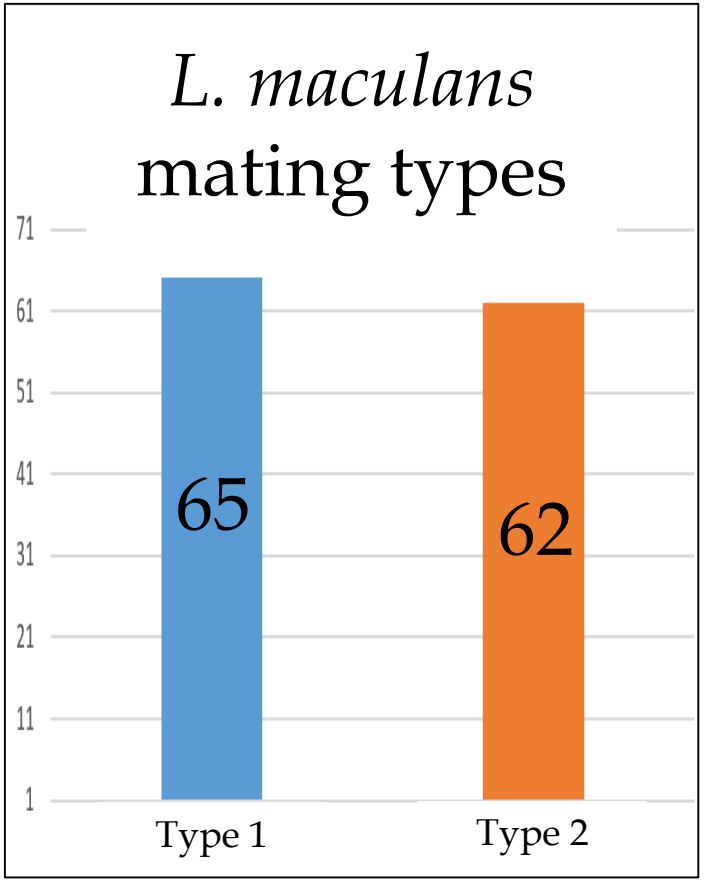
- ✓ Most important disease of canola in Canadian Prairies and Midwest.
- ✓ Was not observed in rainfed areas of PNW until 2011 discovery in Boundary County.
- ✓ In 2014, discovered in seed production fields in Nezperce County.
- ✓ Widespread during the spring of 2015 in Idaho, Lewis, Nezperce and Latah Counties.

Survey Sites

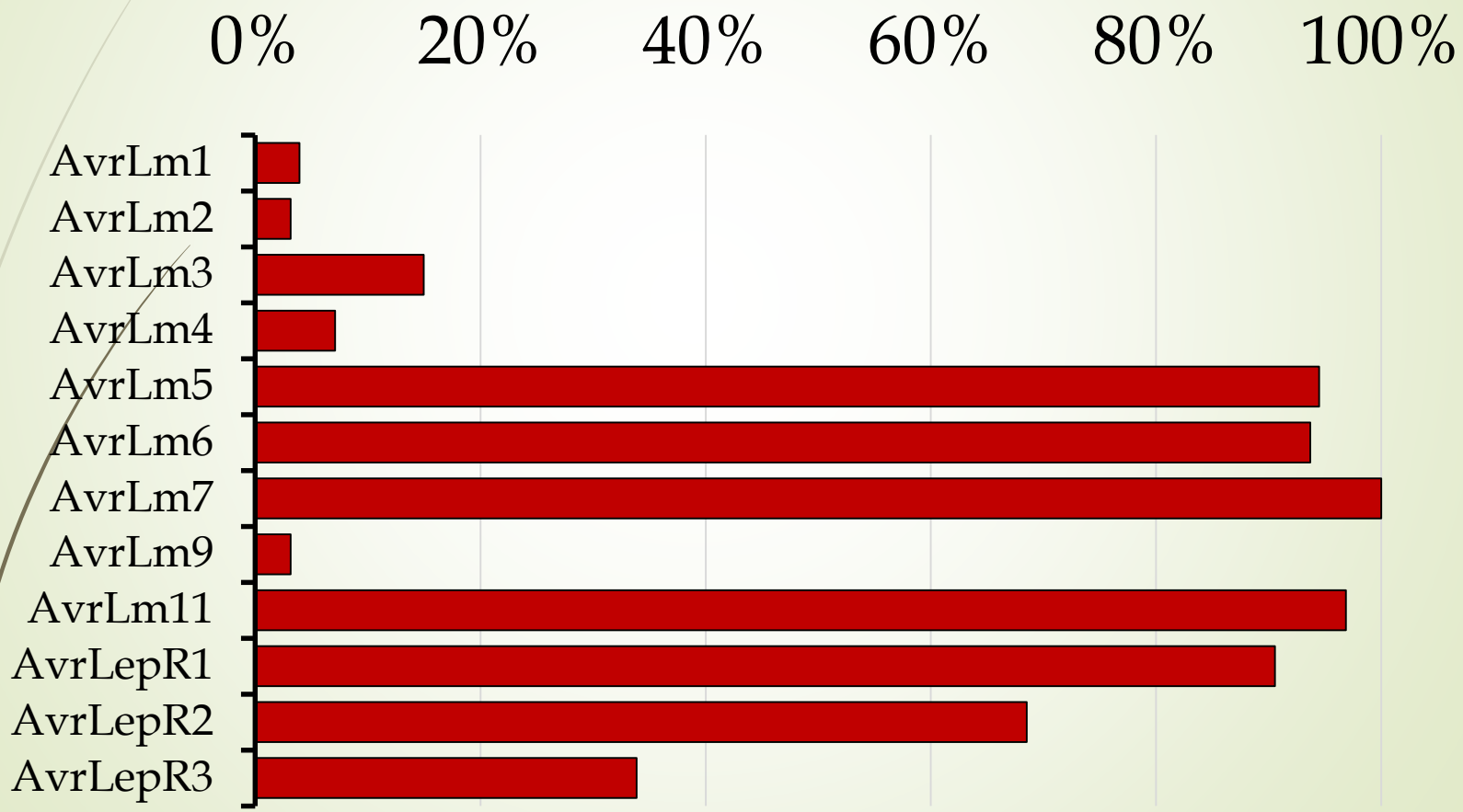


Summary of survey

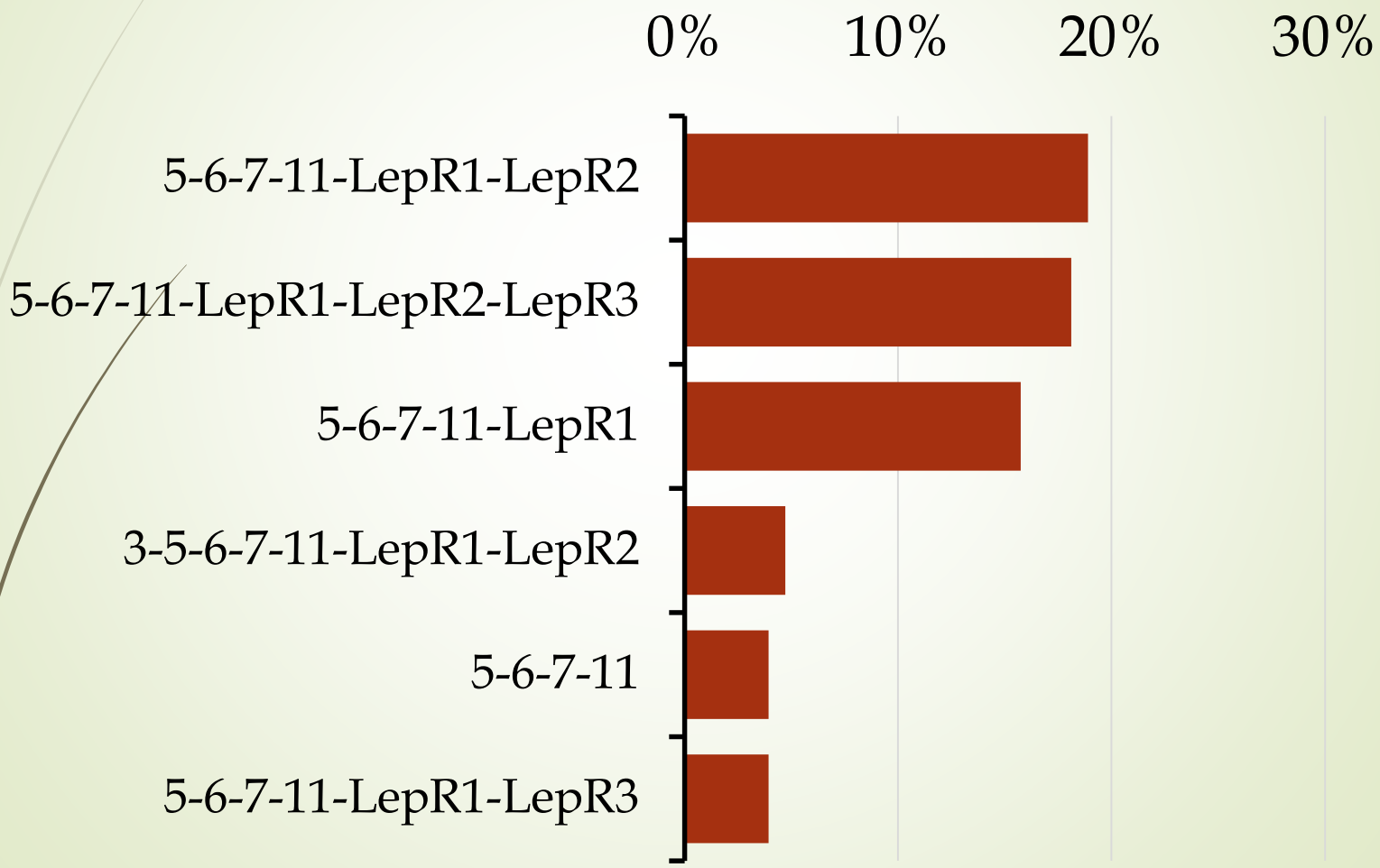
- ✓ 50 Locations surveyed Blackleg confirmed at 39 locations (78%)
- ✓ 128 isolates of *L. maculans* 10 isolates of *L. biglobosa.*
- ✓ Confirmed by pathogenicity tests and PCR.



Frequency of *avirulence* genes in Northern Idaho (125 isolates)



Most common genetic races of *L. maculans* in Northern Idaho



Genetic Resistance

- ✓ Canola has 14 identified resistance genes (*Rlm*)
- ✓ Corresponding 14 *avirulence* genes, 9 are cloned and mapped.
- ✓ Collected genetic differentials to characterize pathotypes and to better characterize isolates.

Host Differentials

Cultivars	Type	*Rlm* genes
Westar	S. Canola	None
Columbus	W. Canola	1, 3
Glacier	W. Canola	2, 3
Bristol	W. Canola	2, 9
02.22.2.1	W. Canola	3
Jet Neuf	W. Canola	4
Cutlass	S. Mustard	5,6
01.23.2.1	W. Canola	7
Goeland	W. Canola	9
Topas LepR1	S. Canola	LepR1
Topas LepR2	S. Canola	LepR2
Topas LepR3	S. Canola	LepR3

- 12 varieties;
- 11 *Rlm* genes;
- New isogenic lines;
- INRA, AAFC, USDA.

Objectives

- ✓ Compile and make available a comprehensive PNW *Canola Production Manual* to growers and local industry to allow them to make decisions on how best to utilize winter and spring canola in their existing crop rotation systems.

Education

Students

3 MS Students, 2 graduated last December:

- Breeding;
- Molecular Genetics;
- Pathology.

8 Undergraduate Students:

- Full-time over summer;
- Part-time during semester.

Oral Presentations at Field Days and Grower Meetings

✓ **Oregon**

- Pendleton Field Day June 12, 2018 Blackleg Fungicide Trial, **150 attendees**.
- Blackleg in Oregon, presented at US Canola November 6, 2018, Baltimore. **45 attendees**.
- 100+ additional grower/industry contacts.

✓ **Idaho**

- Prairie Area Crop Tour, June 26, 2018, **53 attendees**, Craigmont ID, 'PNW Canola Variety Trial'.
- Boundary County Field Day, June 28, 2018, **12 attendees**, Bonners Ferry, ID. 'PNW Canola Variety Trial' and 'Flea Beetle Control in Spring Canola'.
- Northern Idaho Cereal School, Jan 24, 2019, **21 attendees**, Bonners Ferry, ID. 'Challenges in Canola Production (Weed, Insect and Disease Control in Canola)'.

Oral Presentations at Field Days and Grower Meetings

✓ **Washington**

- Wilke Farm Field Day, June 26, 2018 Davenport WA, 'PNW Canola Variety Trial'. **138 attendees**.
- Pacific Northwest Direct Seed Assoc. Cropping Systems Conference, Fundamentals, Fertility and Food. Kennewick, WA, Jan 8-9, 2019. **441 attendees**.
- Prairie Area Cereal School, 'Challenges in Canola Production (Weed, Insect and Disease Control in Canola)'. Greencreek, ID, Jan 22, 2019, **61 attendees**.
- Lewiston Cereal School, 'Challenges in Canola Production (Weed, Insect and Disease Control in Canola)'. Lewiston, ID, Jan 23, 2019, **58 attendees.**
- Washington State Oilseed Cropping Systems Workshop, Wilbur, WA, **125 attendees.**
- Washington State Oilseed Cropping Systems Workshop, Clarkston, WA, **150 attendees.**

Publications

Thesis:

- ✓Pickard, J., 2018. 'Investigating the Distribution and Diversity of *Leptosphaeria maculans* in Northern Idaho' MS Thesis, University of Idaho, December 2018.
- ✓Ireton, E., 2018. 'Optimized production practices for winter canola (*Brassica napus* L.), and rotation effects of winter and spring canola in Northern Idaho', MS Thesis, University of Idaho, December 2018.

Conference Abstracts:

- ✓Esser, A.D., J. Brown, and J.B. Davis. 2018. Spring canola and chickpea value in a cereal grain rotation. *In:* Abstracts ASA and CSSA Meeting, Baltimore, MD, November 4-7, 2018.
- ✓Brown, J., J.B. Davis, M. Wingerson, and A. Job. 2018. Early generation selection efficiency: 1001 ways how not to breed canola. *In:* Abstracts ASA and CSSA Meeting, Baltimore, MD, November 4-7, 2018.
- ✓Job, A., J.B. Davis, M. Wingerson, and J. Brown. 2018. Breeding for improved blackleg resistance in the PNW region. *In:* Abstracts ASA and CSSA Meeting, Baltimore, MD, November 4-7, 2018.
- ✓Schroeder, K.L., J. Brown, J.B. Davis, and J., Pickard. 2018. Investigating the distribution and diversity of *Leptosphaeria maculans* on canola in northern Idaho. *In:* Abstracts ASA and CSSA Meeting, Baltimore, MD, November 4-7, 2018.

Poster Presentations

- Ireton E., J.B. Davis, A. Job, and J. Brown. 2018. Effect of Spring and Winter Rotation Crops on Subsequent Winter Wheat Productivity and Profitability in a Two-Year Crop Rotation in Northern Idaho. PNW Direct Seed Conference, Pasco Washington January 2018.
- Job A., J.B. Davis, J. Brown, A. Wernsing and D. Wysocki. 2018. Results of the 2018 Pacific Northwest Canola Trials. PNW Direct Seed Conference, Pasco Washington January 2018.
- Davis J.B., E. Ireton, M. Wingerson, A. Job and J. Brown. 2019. Effect of Row Spacing on Winter Canola Yield in Northern Idaho PNW Direct Seed Conference, Pasco Washington January 2019.
- Sowers K., J. Brown, J.B. Davis and A. Job. 2019. New Cultivar Releases from the University of Idaho.
- Ireton E., J.B. Davis, A. Job, and J. Brown. 2019. Effect of Spring and Winter Rotation Crops on Subsequent Winter Wheat Productivity and Profitability in a Two-Year Crop Rotation in Northern Idaho. Washington State Oilseed Cropping Systems Workshop, Wilbur, WA.
- Job A., J.B. Davis, J. Brown, A. Wernsing and D. Wysocki. 2019. Results of the 2018 Pacific Northwest Canola Trials. Washington State Oilseed Cropping Systems Workshop , Wilbur, WA.
- Effect of Row Spacing on Winter Canola Yield in Northern Idaho. Jim B. Davis, Eric Ireton, Megan Wingerson, Ashley Job and Jack Brown. Washington State Oilseed Cropping Systems Workshop , Wilbur, WA.
- Brown J., J.B. Davis and A. Job. New Cultivar Releases from the University of Idaho. Washington State Oilseed Cropping Systems Workshop, Clarkston, WA
- Ireton E., J.B. Davis, A. Job, and J. Brown. 2019. Effect of Spring and Winter Rotation Crops on Subsequent Winter Wheat Productivity and Profitability in a Two-Year Crop Rotation in Northern Idaho. Washington State Oilseed Cropping Systems Workshop, Clarkston, WA
- Job A., J.B. Davis, J. Brown, A. Wernsing and D. Wysocki. 2019. Results of the 2018 Pacific Northwest Canola Trials. Washington State Oilseed Cropping Systems Workshop, Clarkston, WA
- Davis J.B., E. Ireton, M. Wingerson, A. Job and J. Brown. 2019. Effect of Row Spacing on Winter Canola Yield in Northern Idaho.

Extension and Outreach Activities in PNW

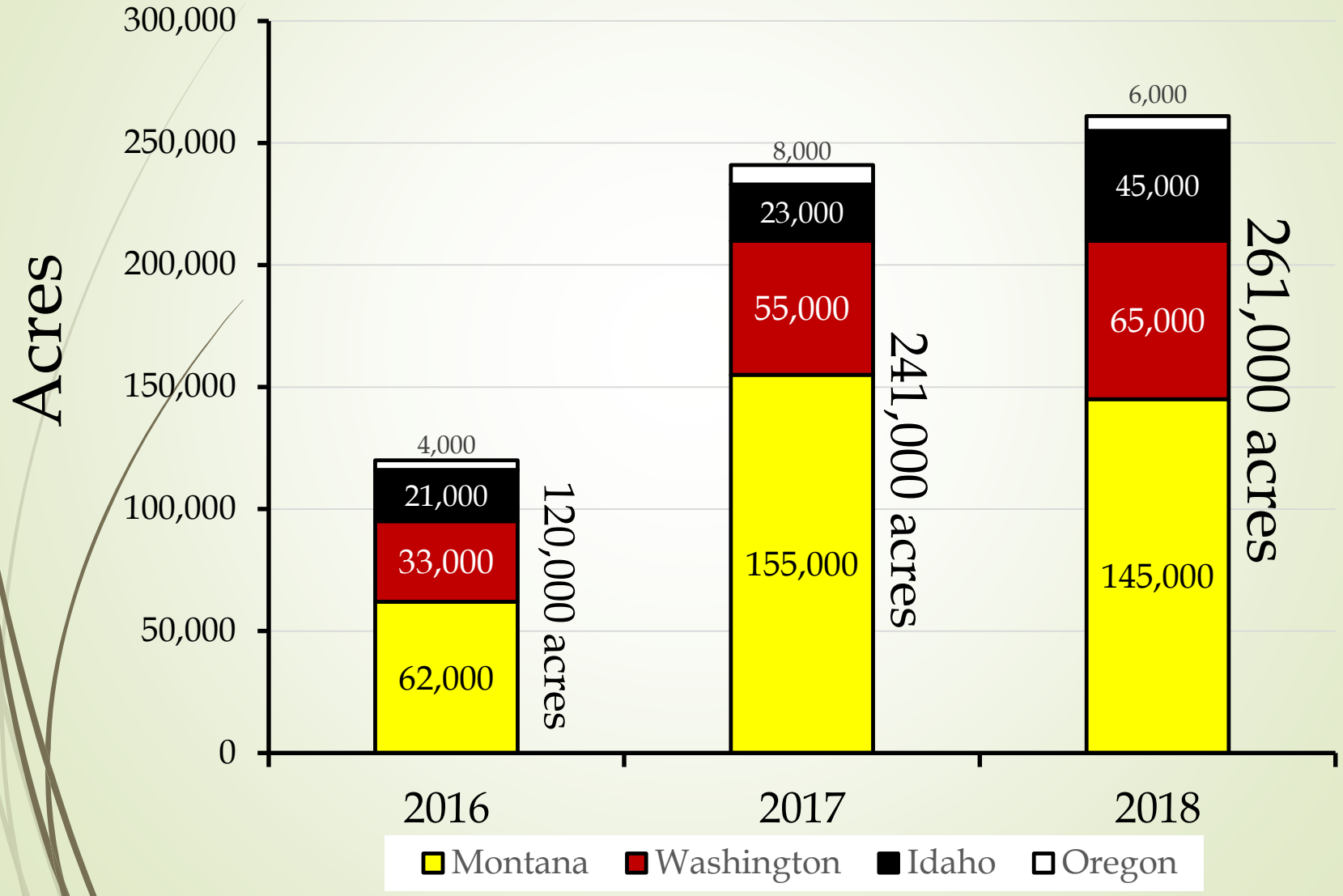
✓ **WSU-WOCS Oilseed Workshops**
- 2018: 3 locations, 318 attendees
- 2019: 3 locations, 306 attendees

- **UI Cereal/Grain School**
  - 2018: 6 locations, 425 attendees
  - 2019: 2 locations 241 attendees

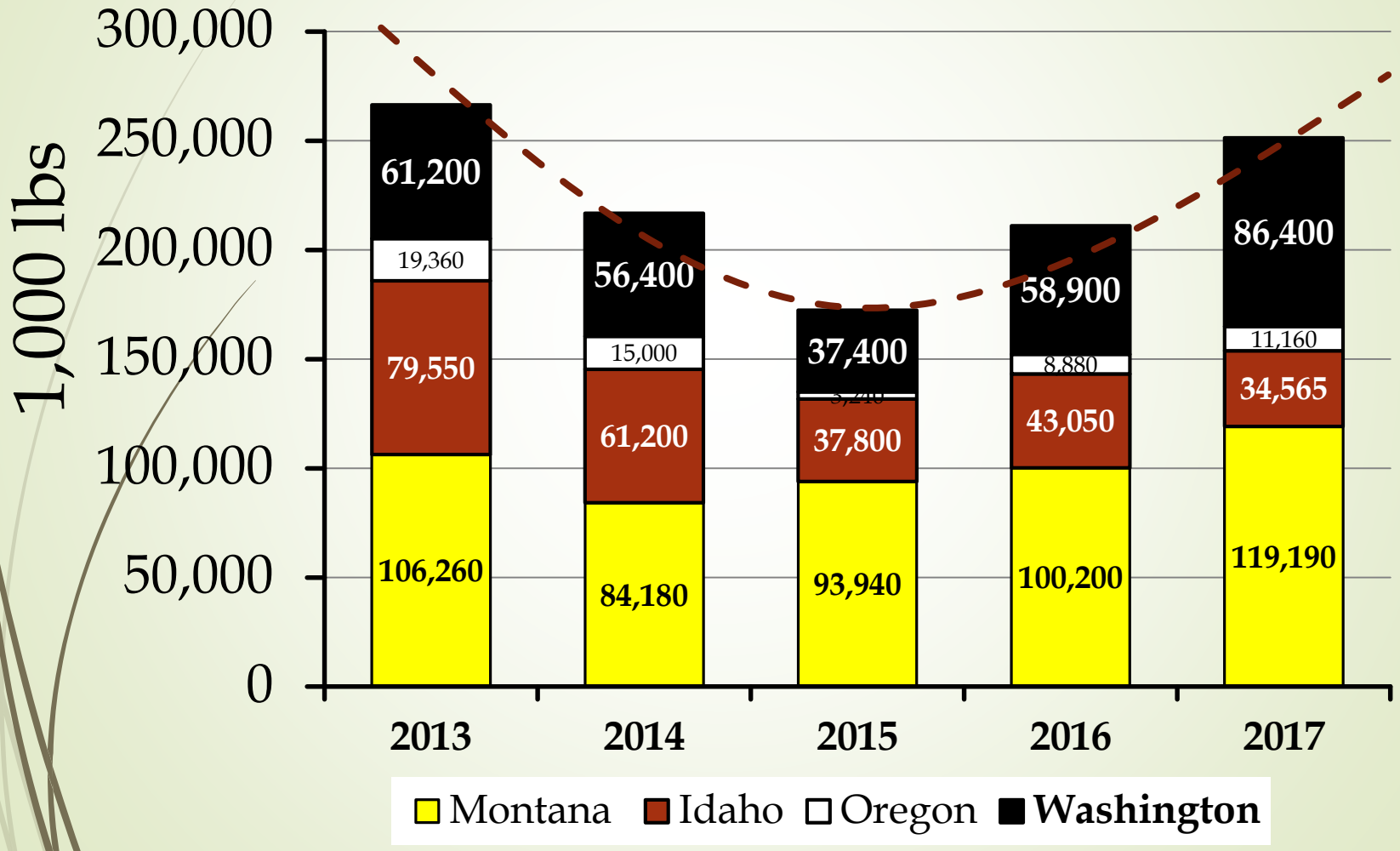
✓ **Field tours**:
- Variety Trials: 13 locations, ~300 attendees;
- Other with canola component: ~250 attendees.

✓ **Presentations**: 400+ contacts.

PNW Canola Acres



PNW Canola Production, 2013-2017



Source: USDA, National Agricultural Statistics Service

Questions

http://www.cals.uidaho.edu/brassica/
http://css.wsu.edu/oilseeds/