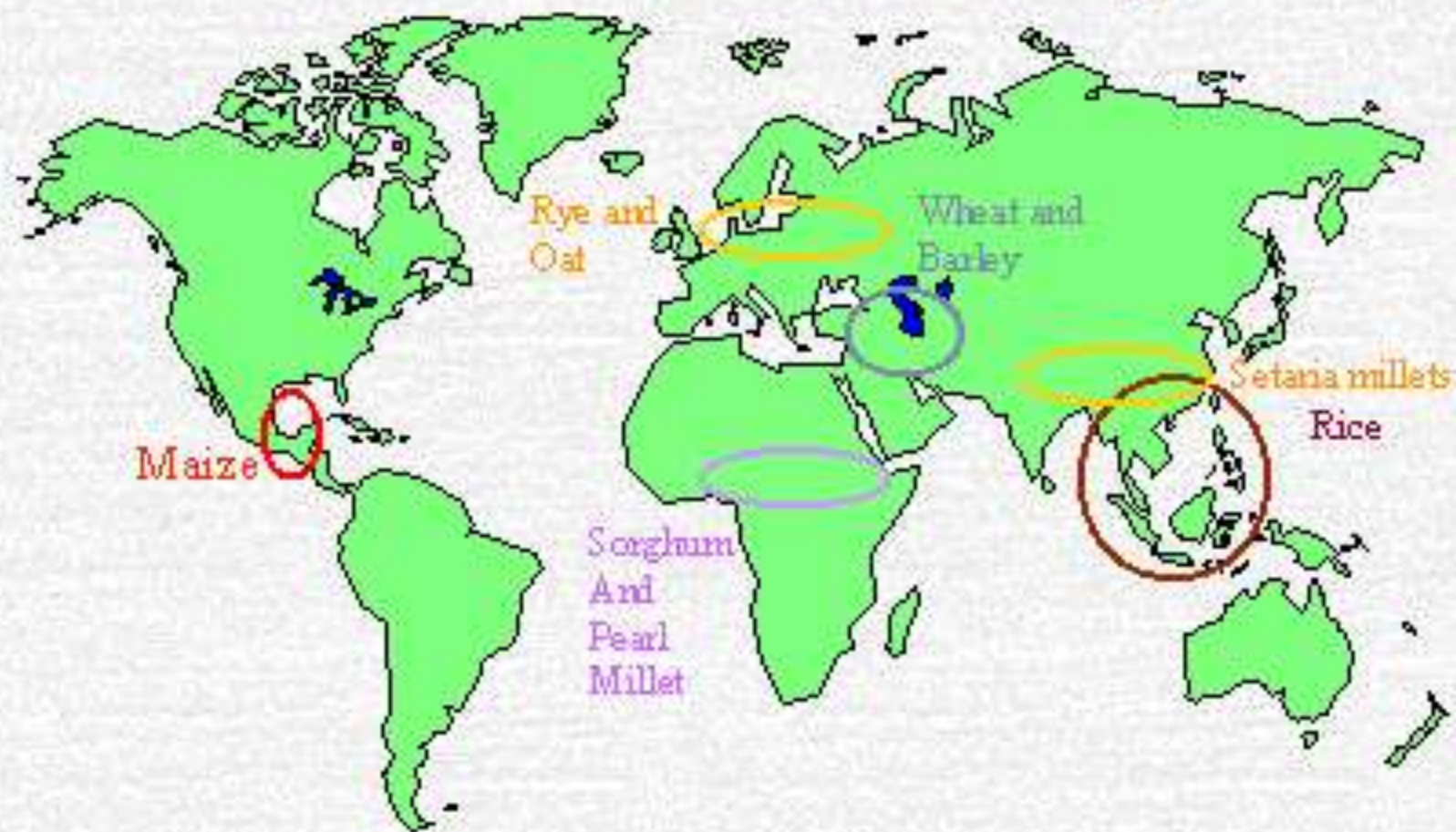


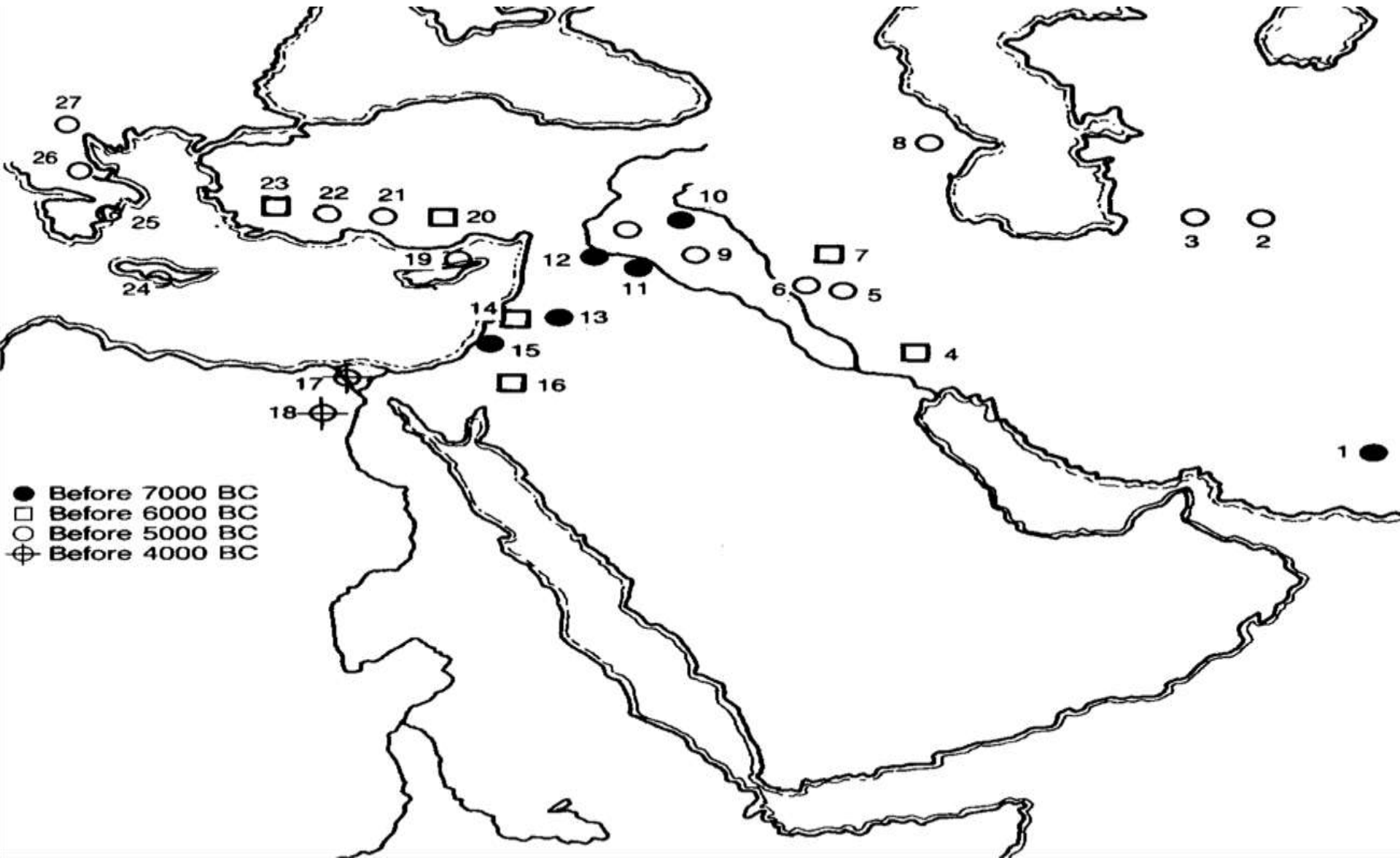


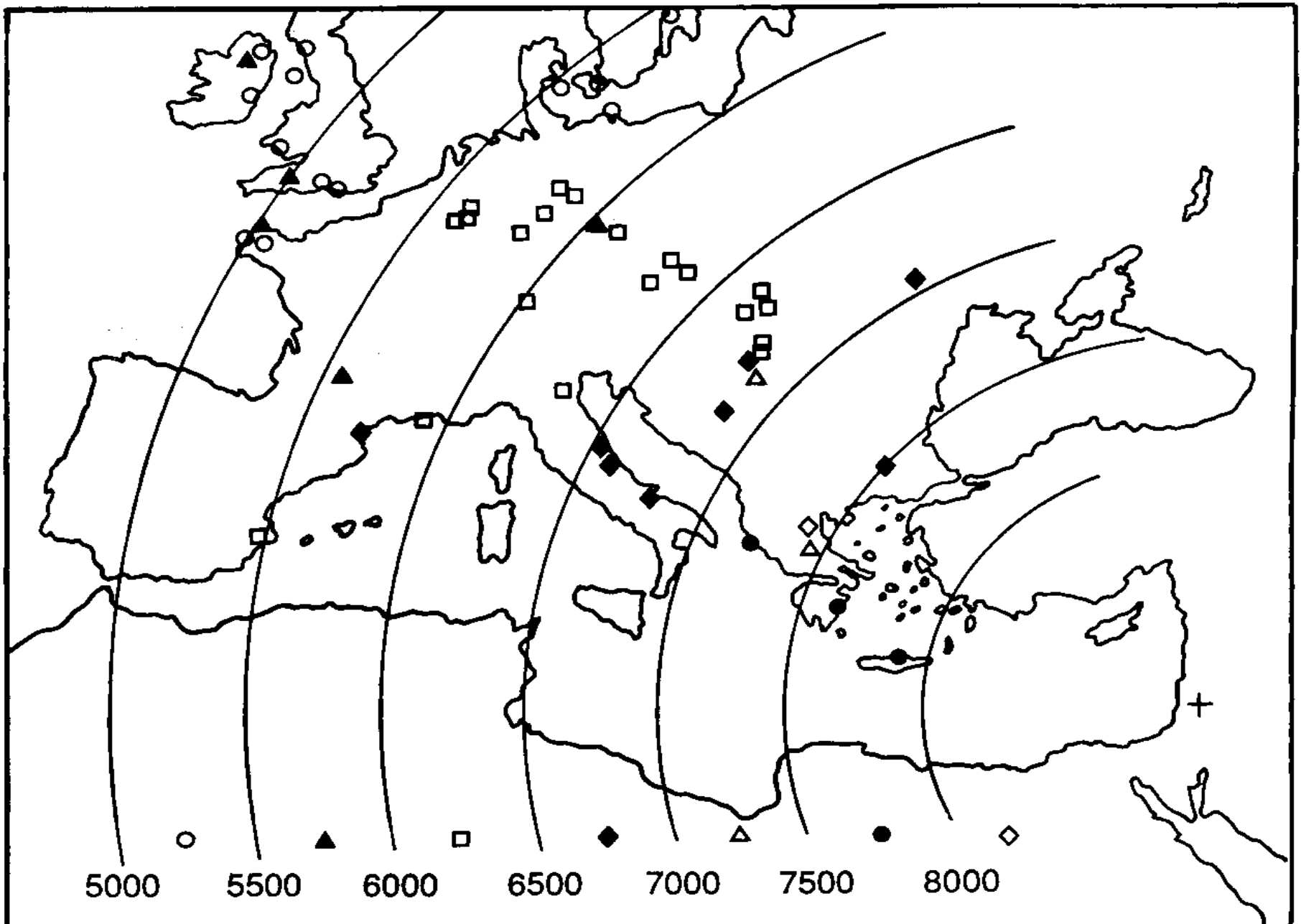
Wheat

Harlan Centers of Origin



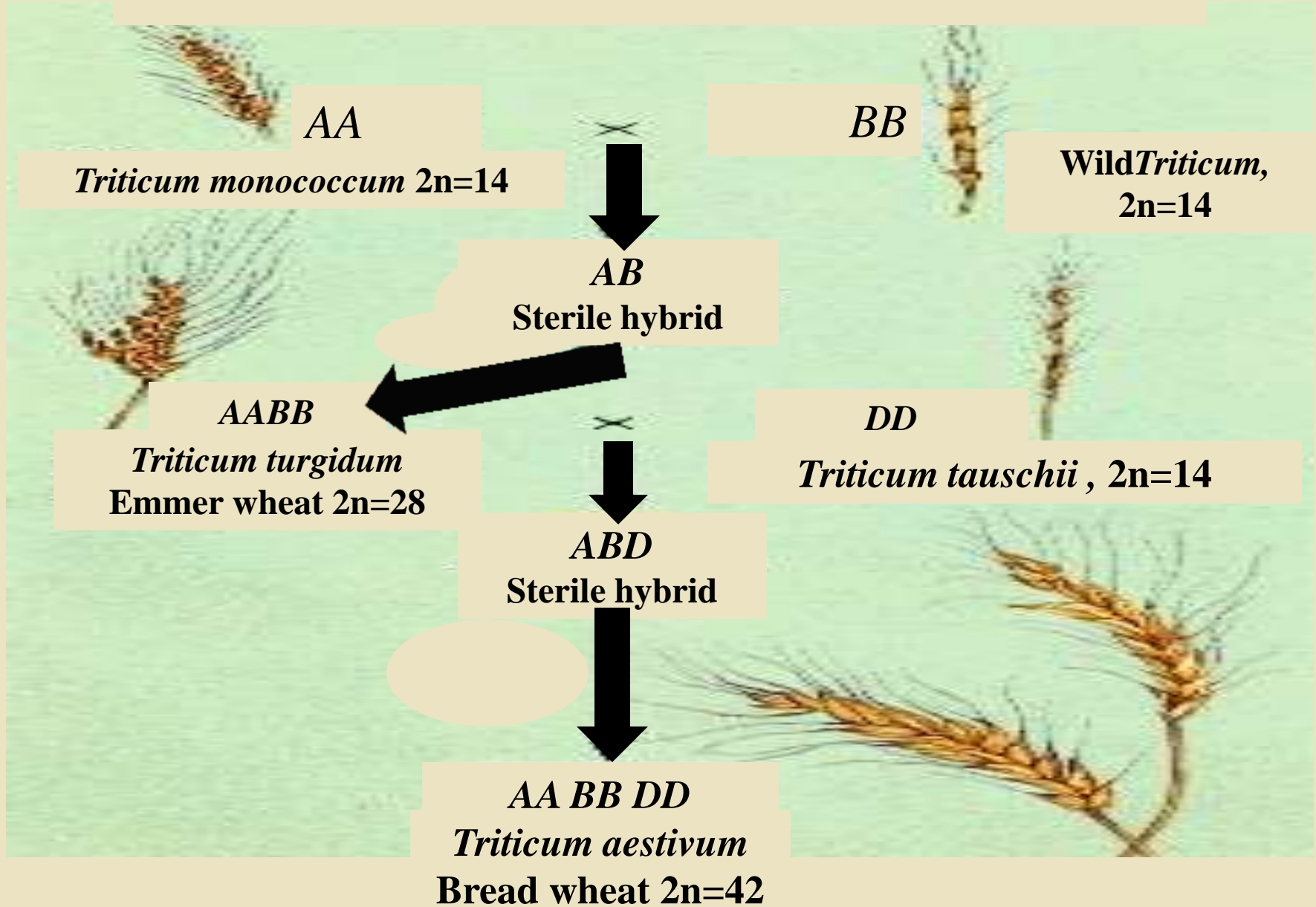
Archeological Wheat Remains





Diffusion of Wheat Based on Oldest Remains

Evolution of Wheat



Wheat-Species, Older

- ▣ Soft wheat *Triticum aestivum* subsp. *sphaerococcum* (21 chromosome pairs), round seed.
- ▣ Emmer/Polonicum wheat *T. turgidum* subsp. *dicoccum* (14 chromosome pairs), feed.
- ▣ Einkorn *T. monococcum* (7 pairs).

Wheat-Species, Minor

- ▣ Spelt - *Triticum aestivum* subsp. *spelta* (21 chromosome pairs) non-free threshing.
- ▣ Club *T. aestivum* subsp. *compactum* (21 chromosome pairs) - 2 gene difference controlling head density.

A close-up photograph of several spelt wheat spikelets. The spikelets are elongated and composed of numerous small, green, developing grains. They are surrounded by long, thin, green awns that radiate from the base of the spikelets. The background is a soft-focus green field.

Spelt Wheat

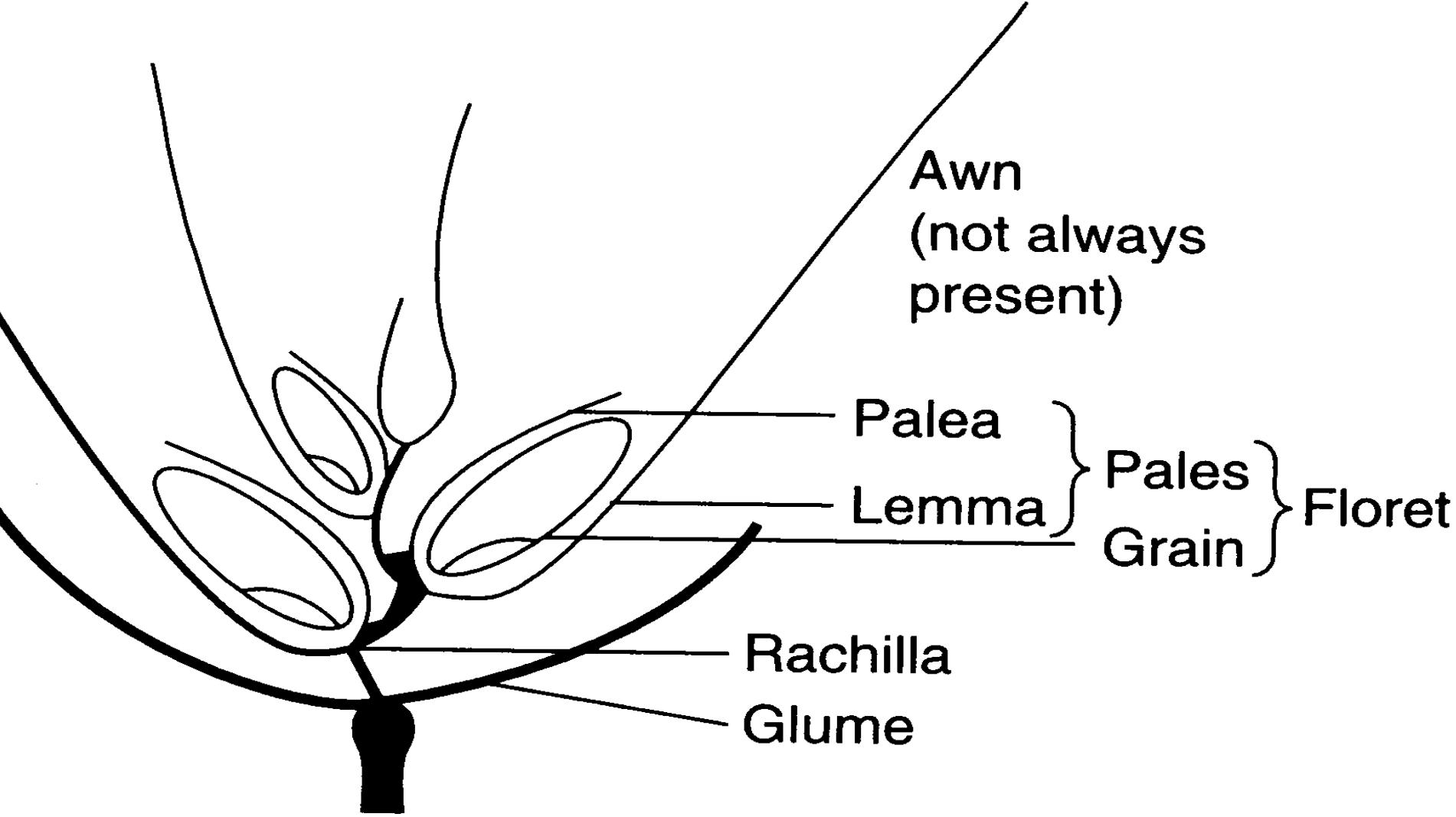
A close-up photograph of a single club wheat spikelet. The spikelet is shorter and more compact than the spelt wheat spikelets, with a distinct, rounded, club-like shape. It is covered in long, thin, green awns. The grains are visible as small, yellowish-green units along the central axis. The background is a soft-focus green field.

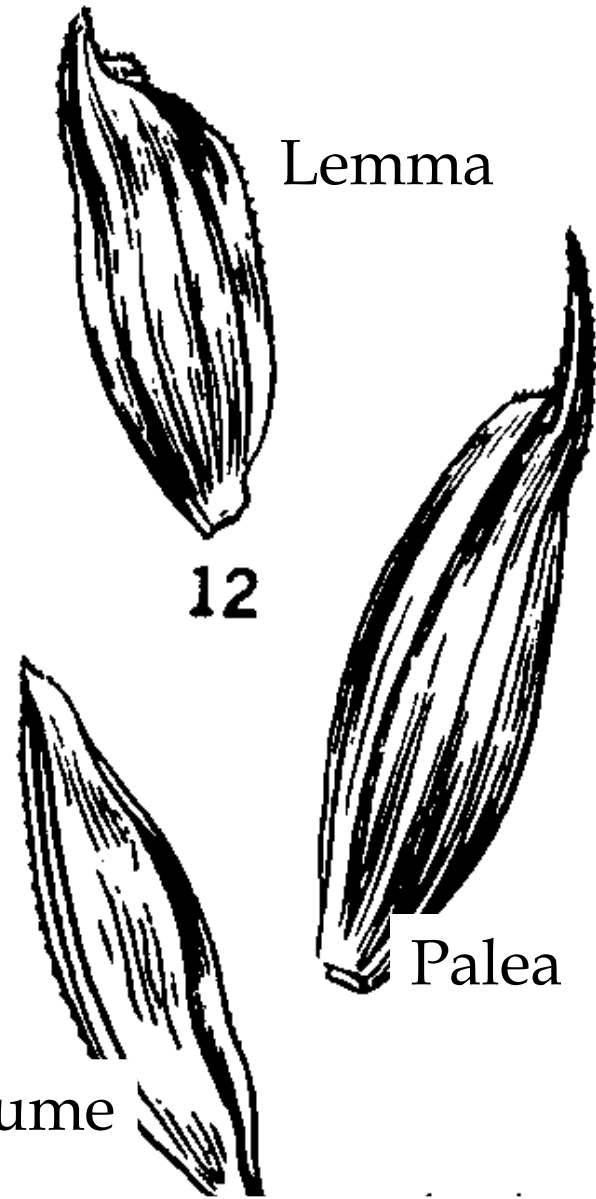
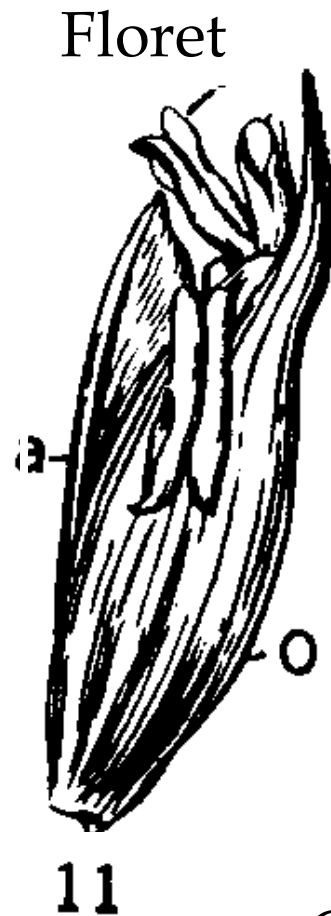
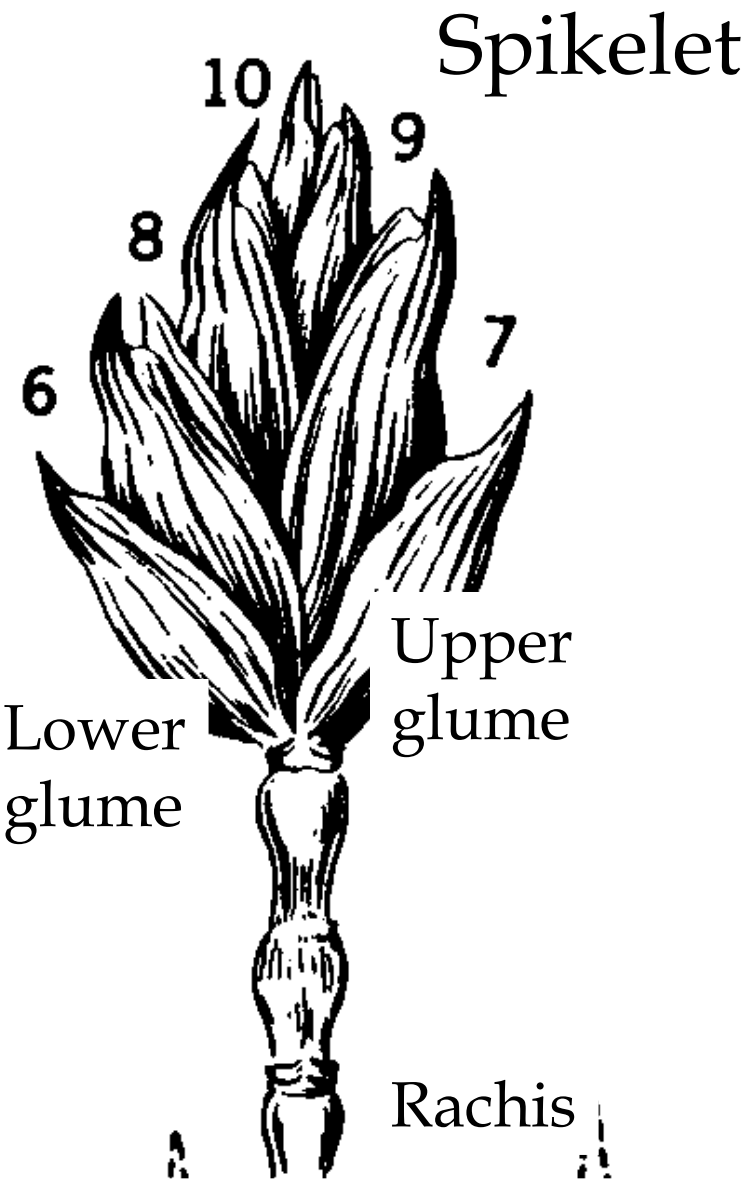
Club Wheat

Wheat-Species, Commercial

- ▣ Bread wheat *Triticum aestivum*
(21 chromosome pairs)
- ▣ Durum wheat *T. turgidum*
subsp. *durum* (14 chromosome
pairs)

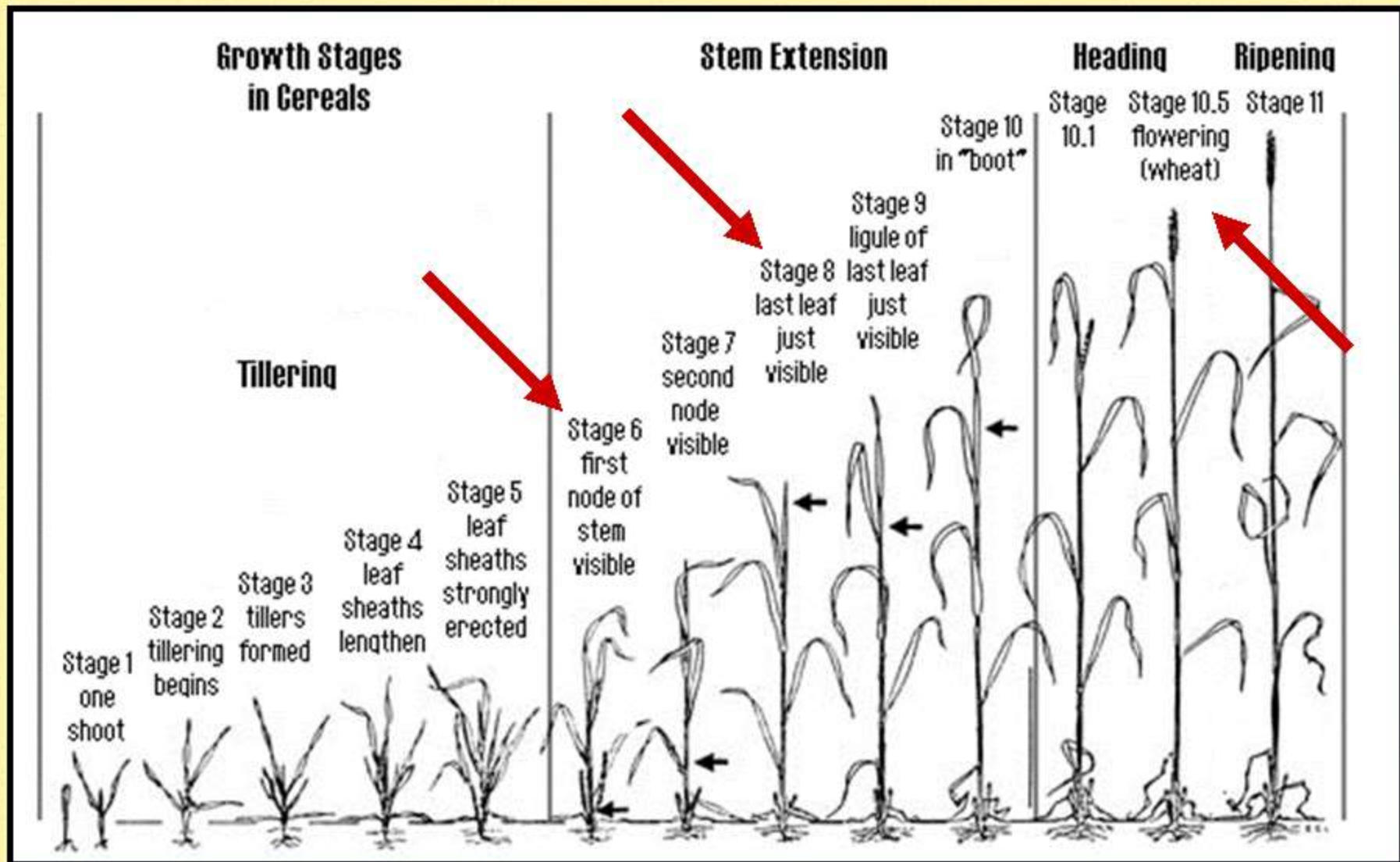
Wheat Inflorescence







Feekes Wheat Growth Stage Scale



Feekes stage 1



Feekes stage 9



Feekes stage 10



Feekes stage 8

Feekes stage 11



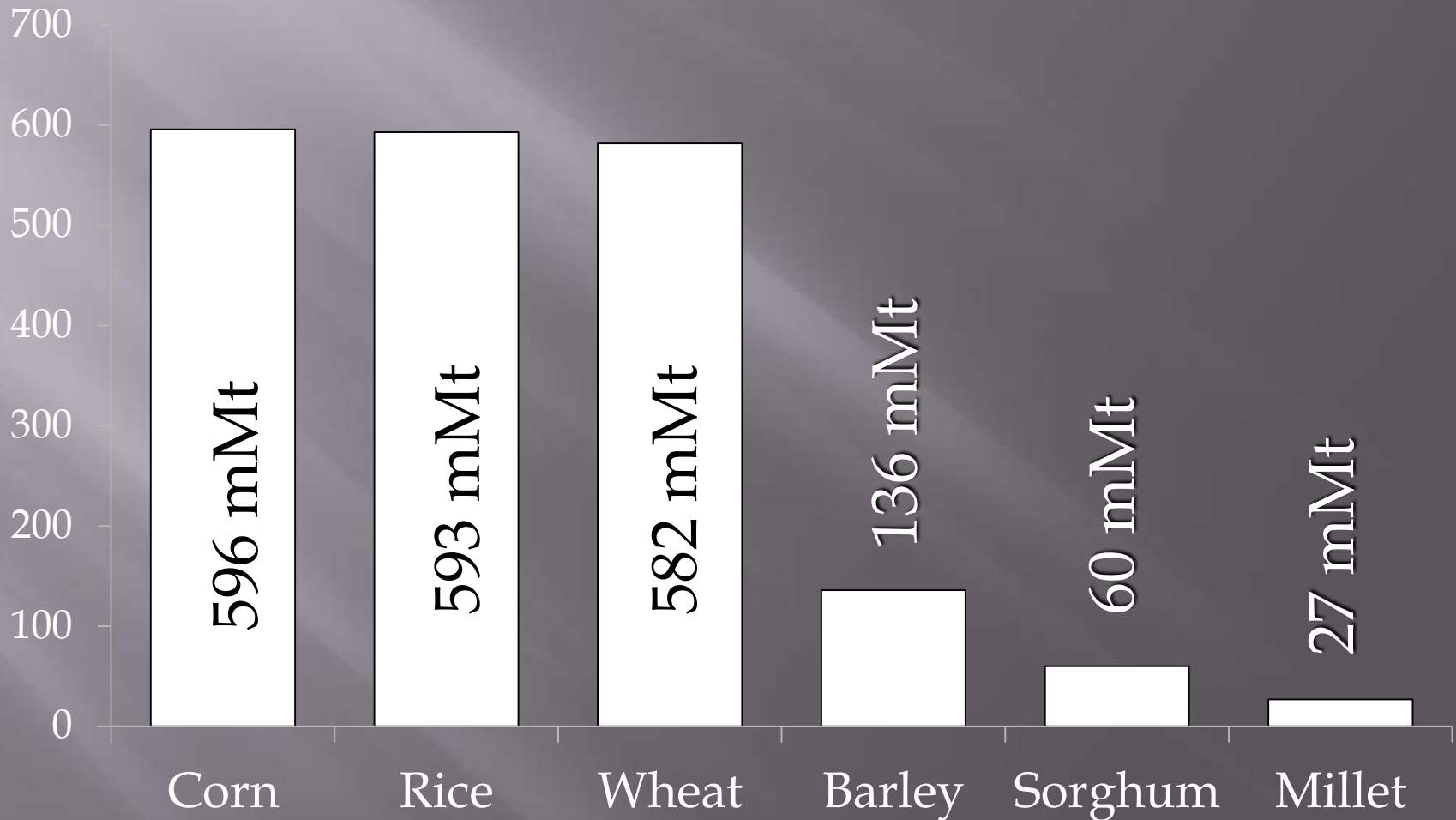
Feekes stage 10.2



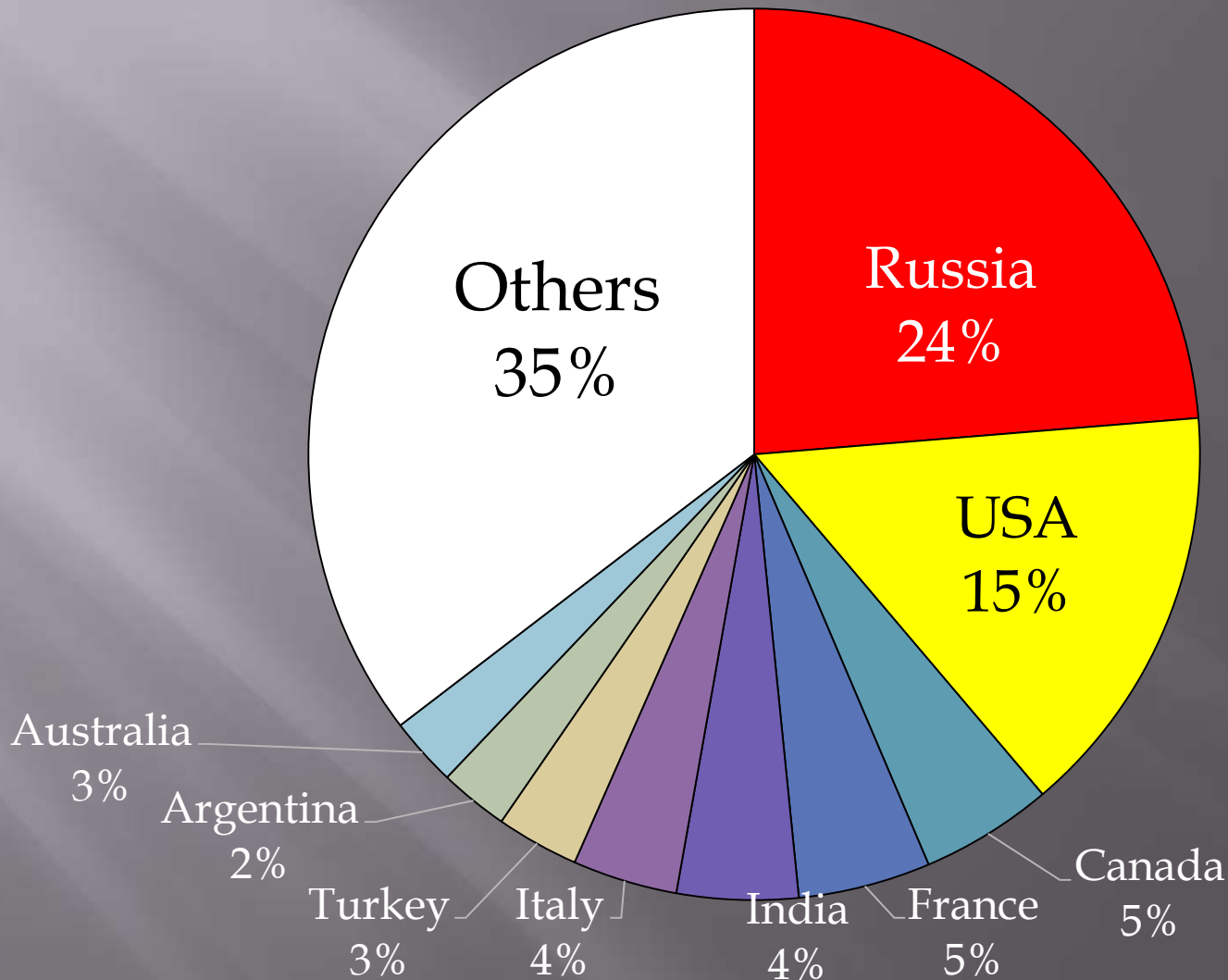
Feekes stage 10.5



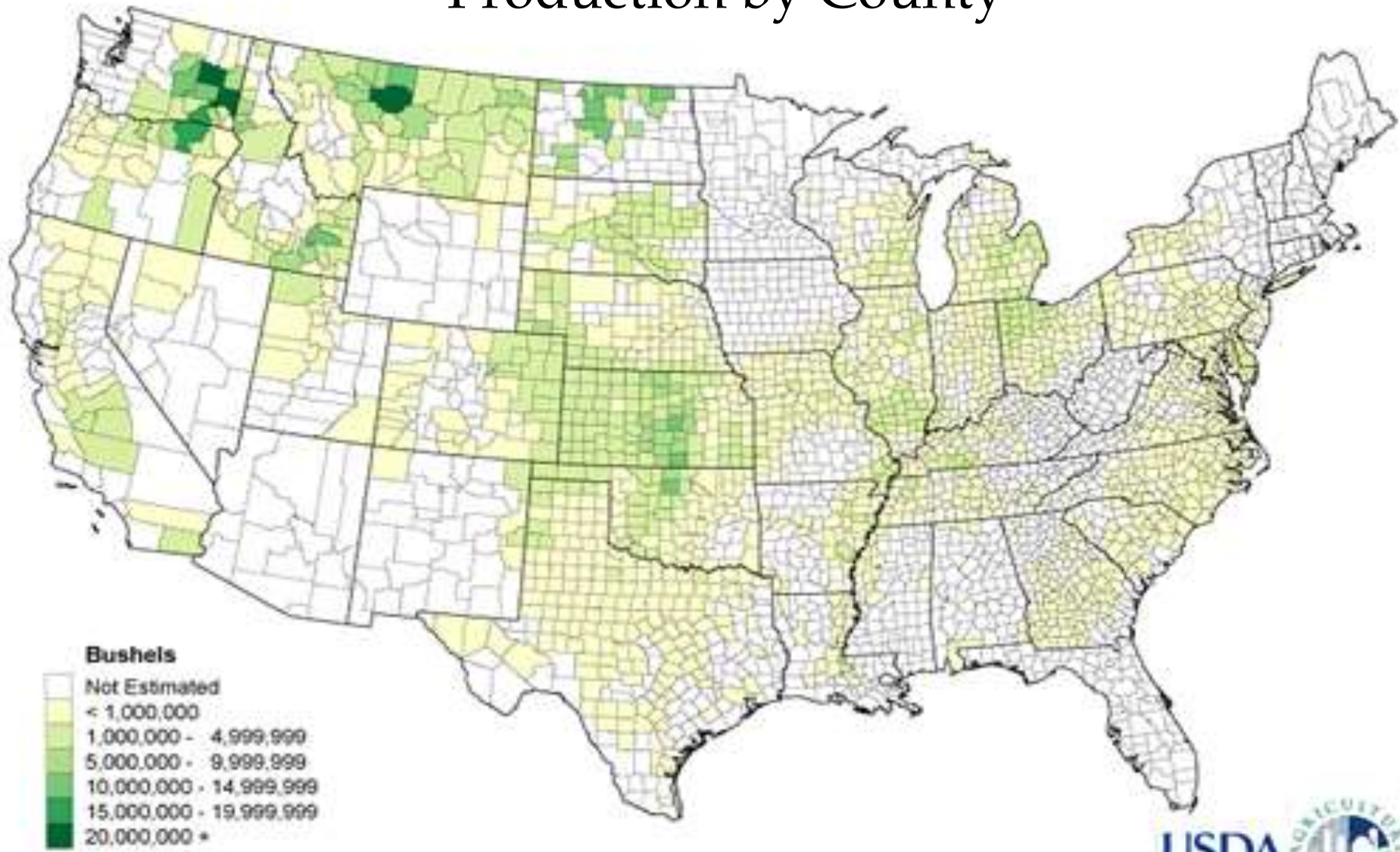
World Cereals Production



World Wheat Production



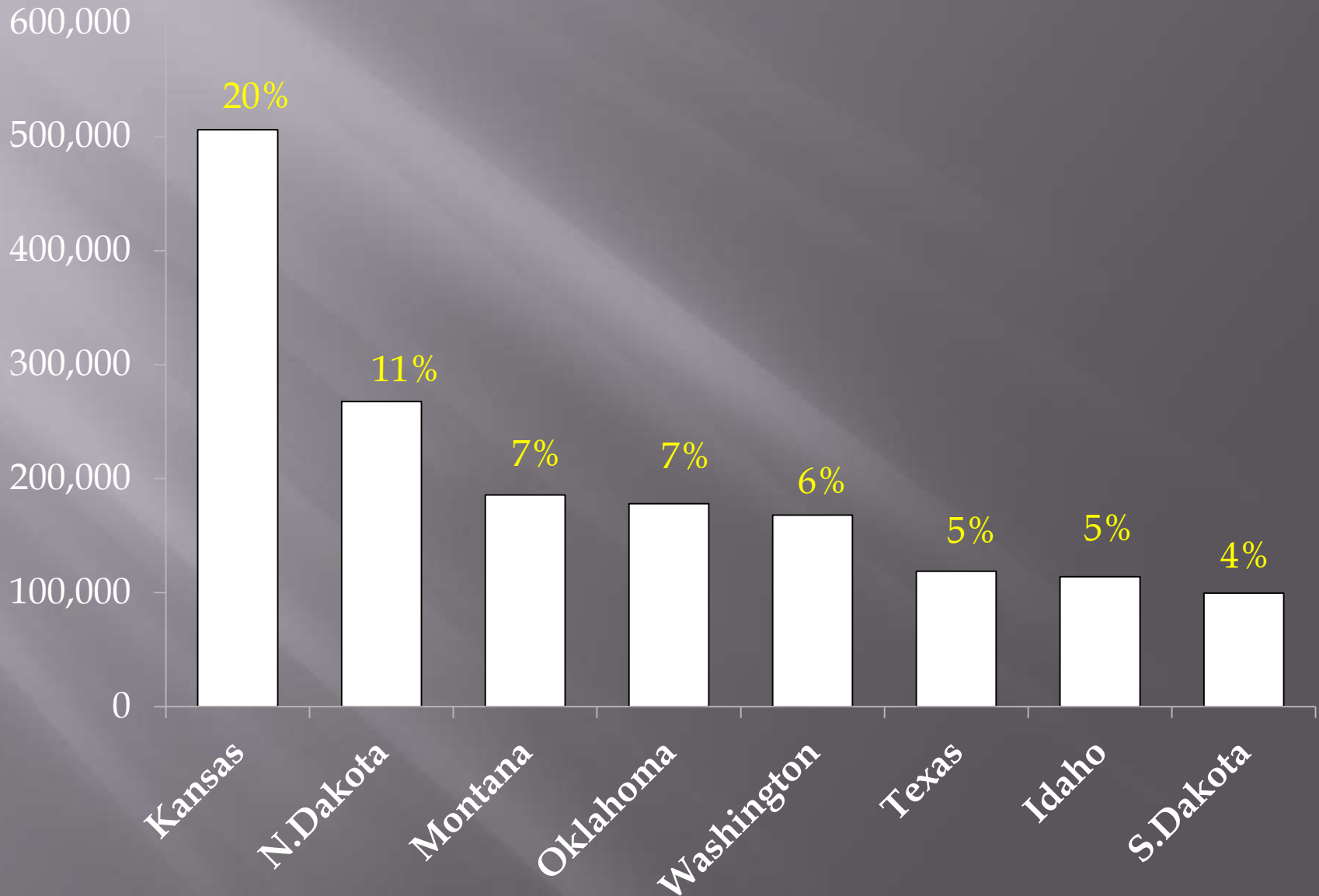
All wheat harvested - 2006 Production by County



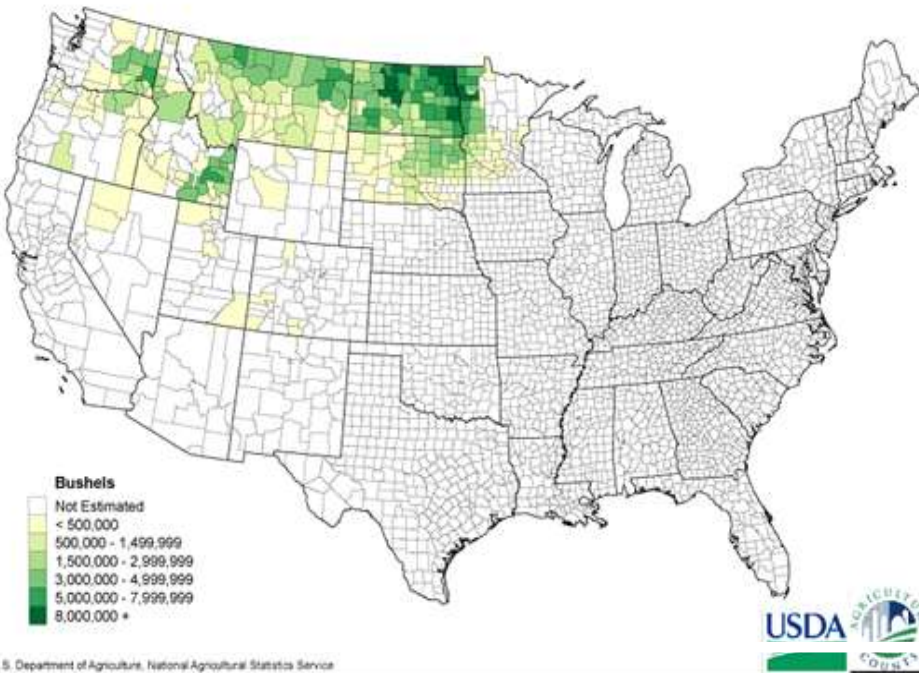
Bushels



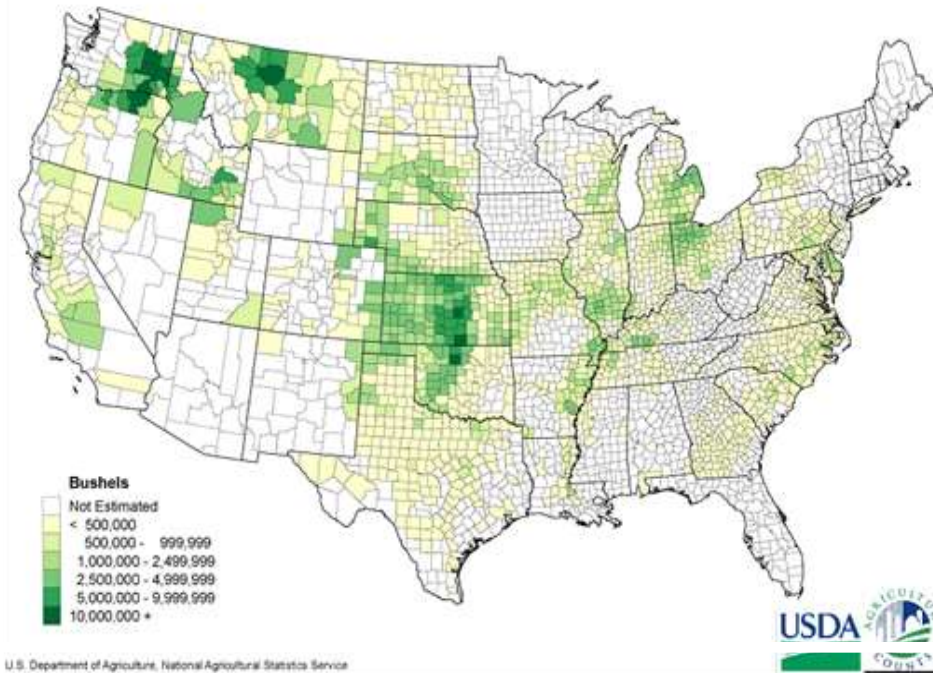
Major wheat production states



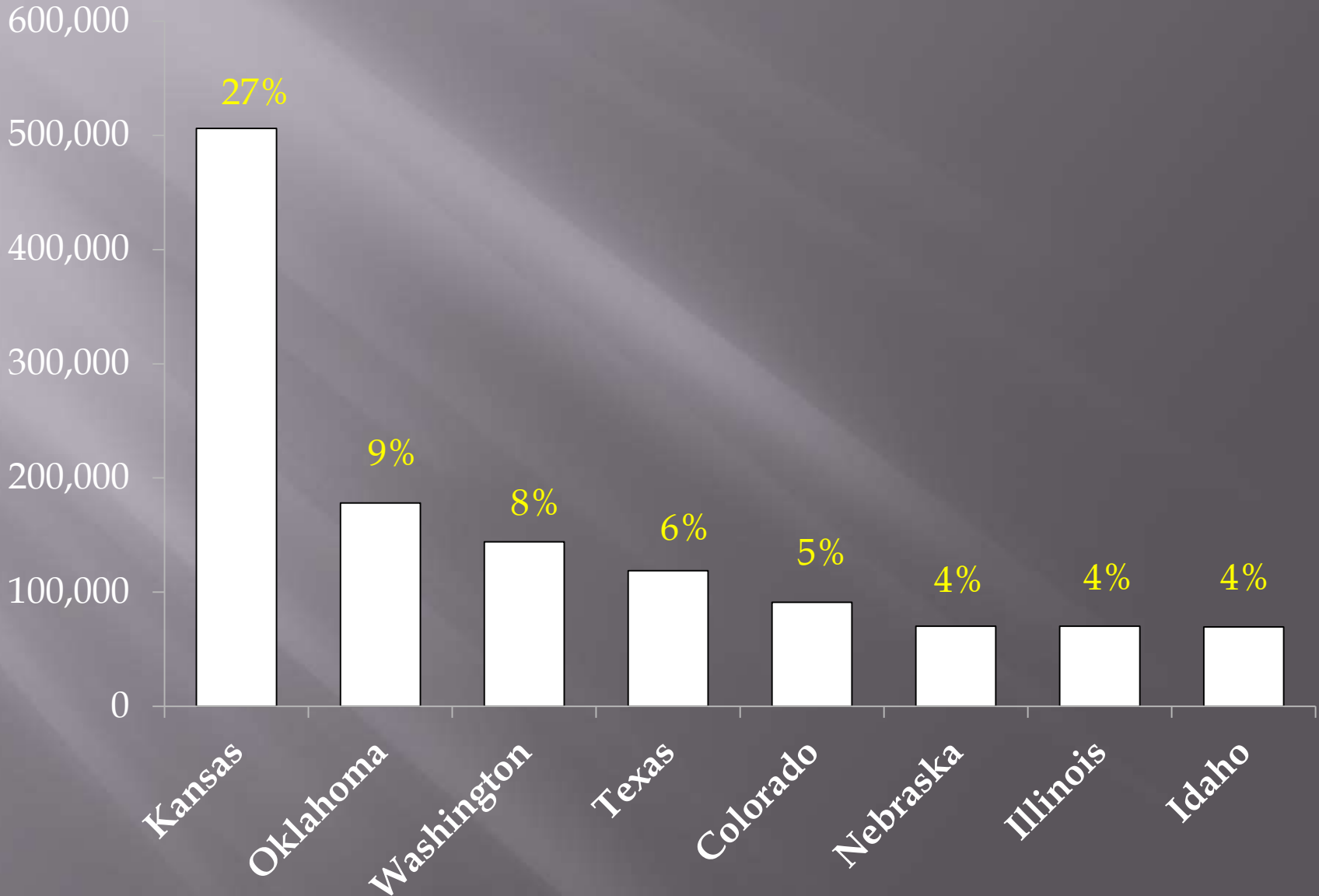
Spring wheat harvested - 2006 Production by County



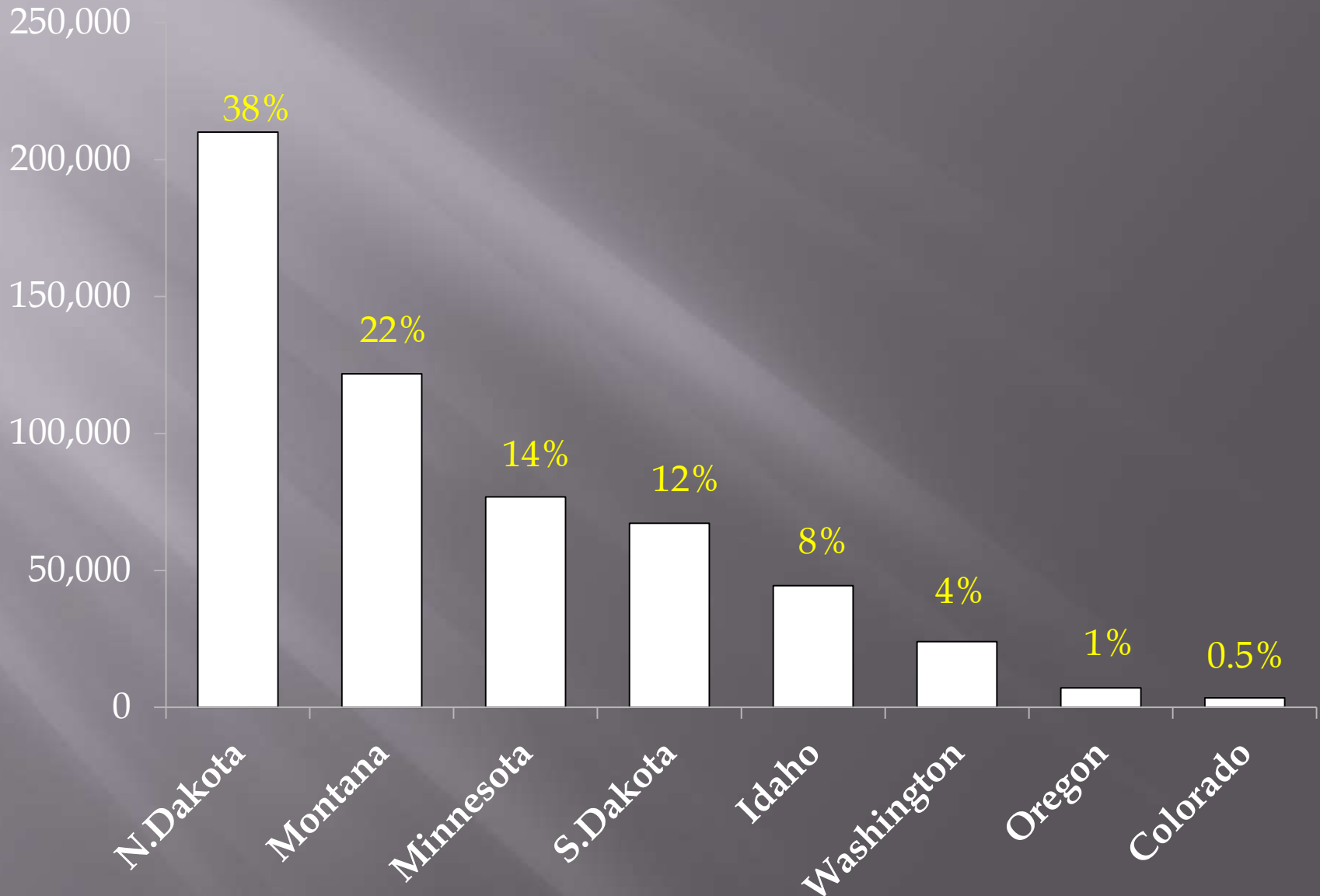
Winter wheat harvested - 2006 Production by County



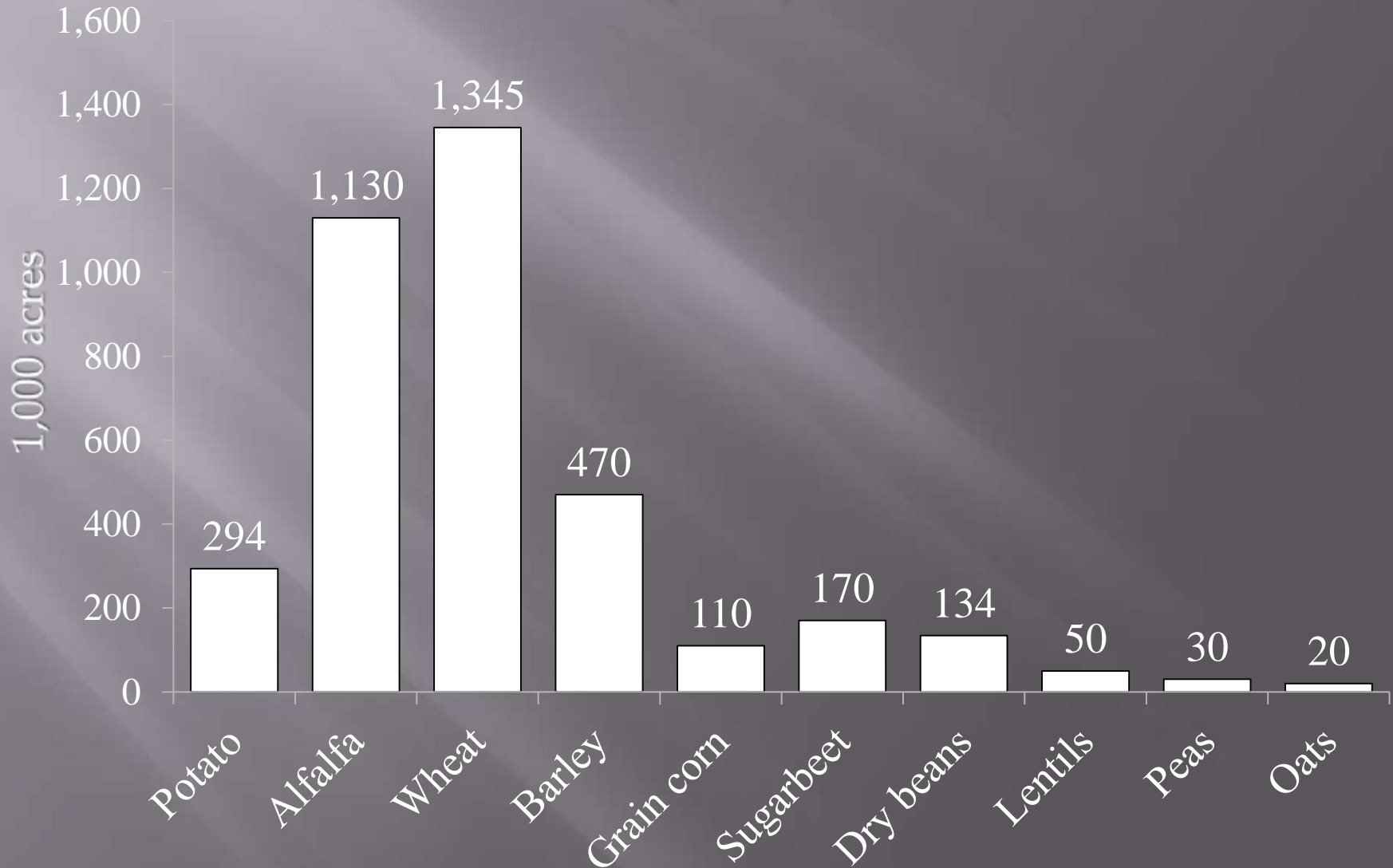
Major winter wheat production states



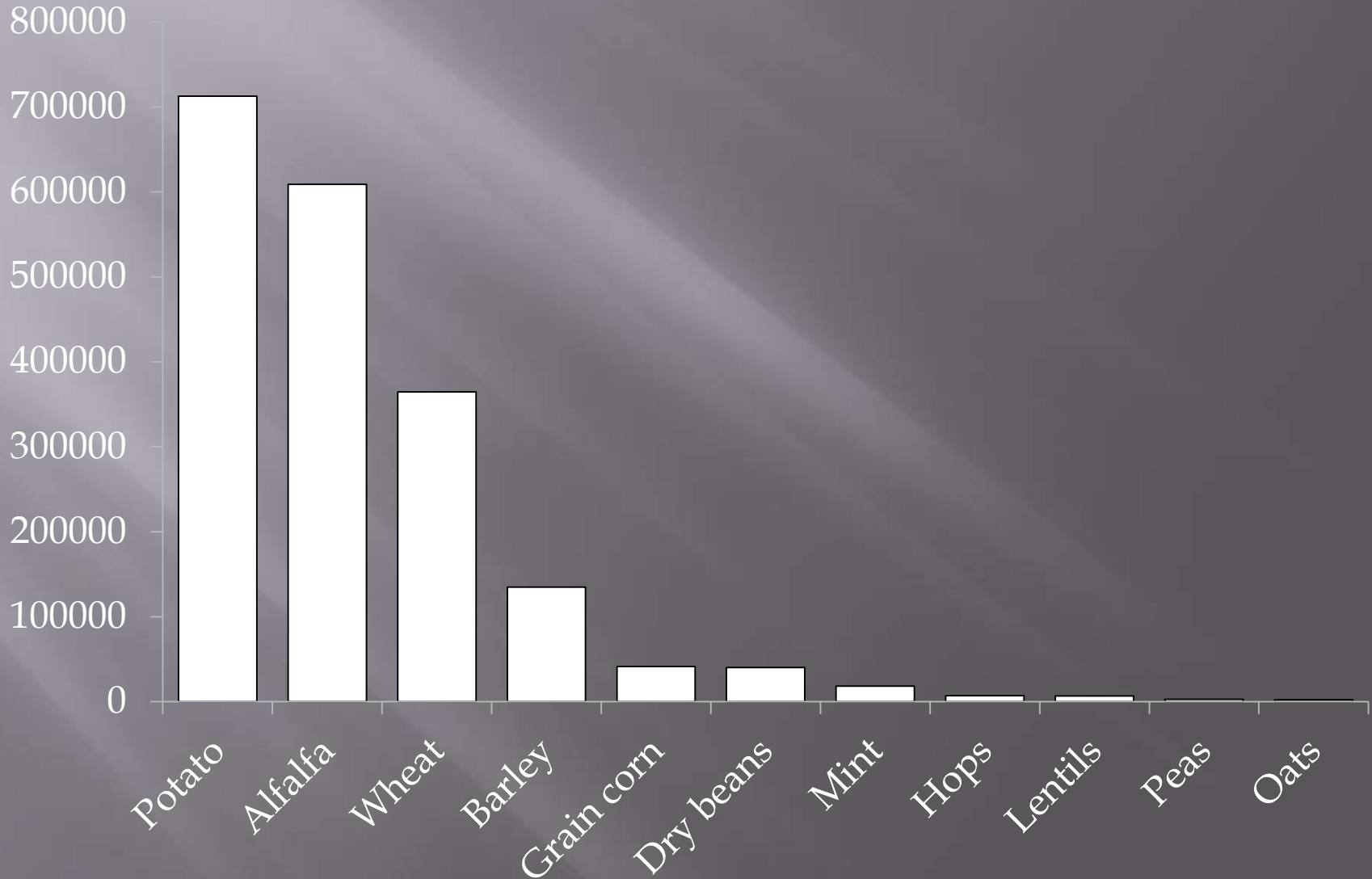
Major spring wheat production states



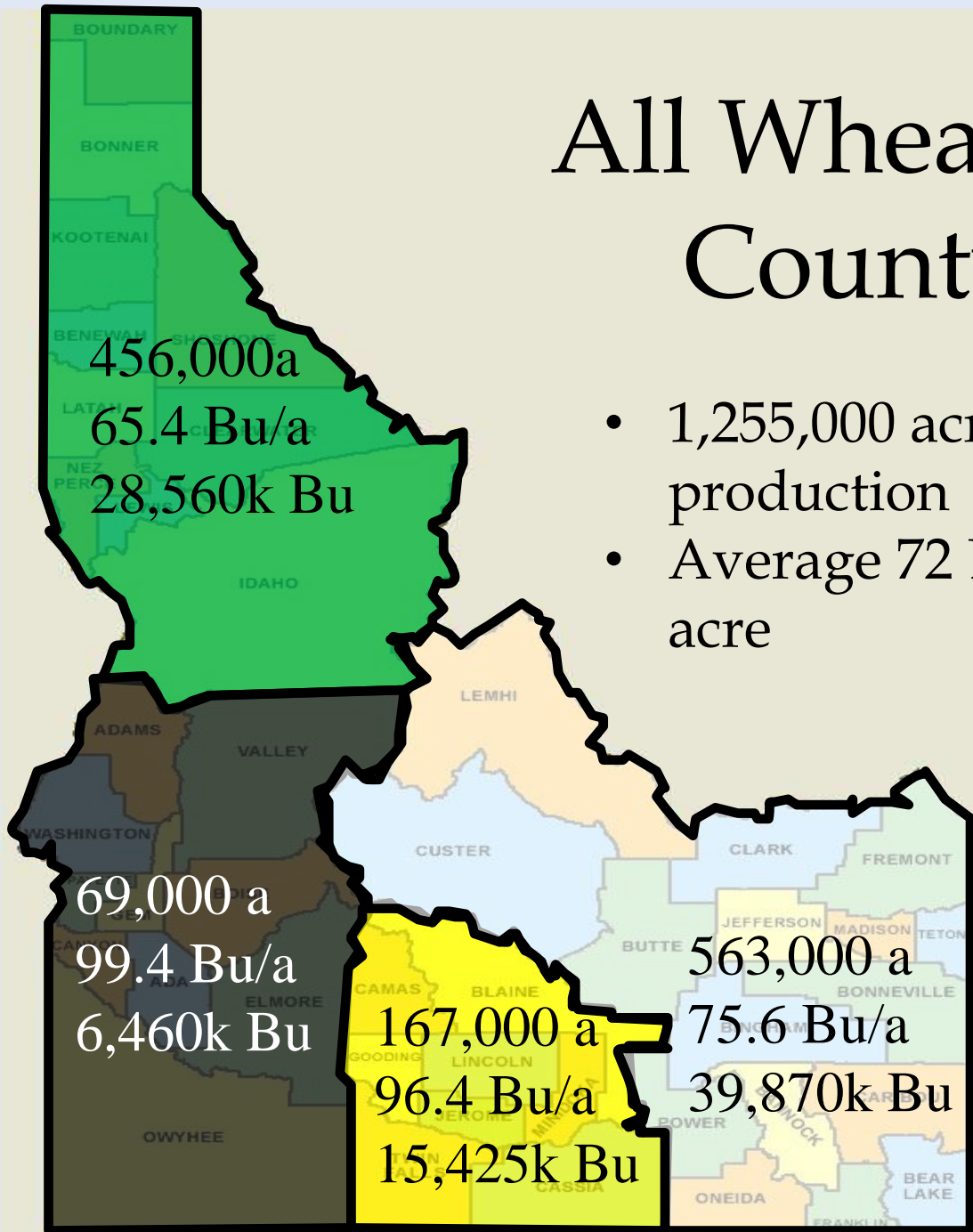
Harvested Acres (2012)



Idaho Dollar Value

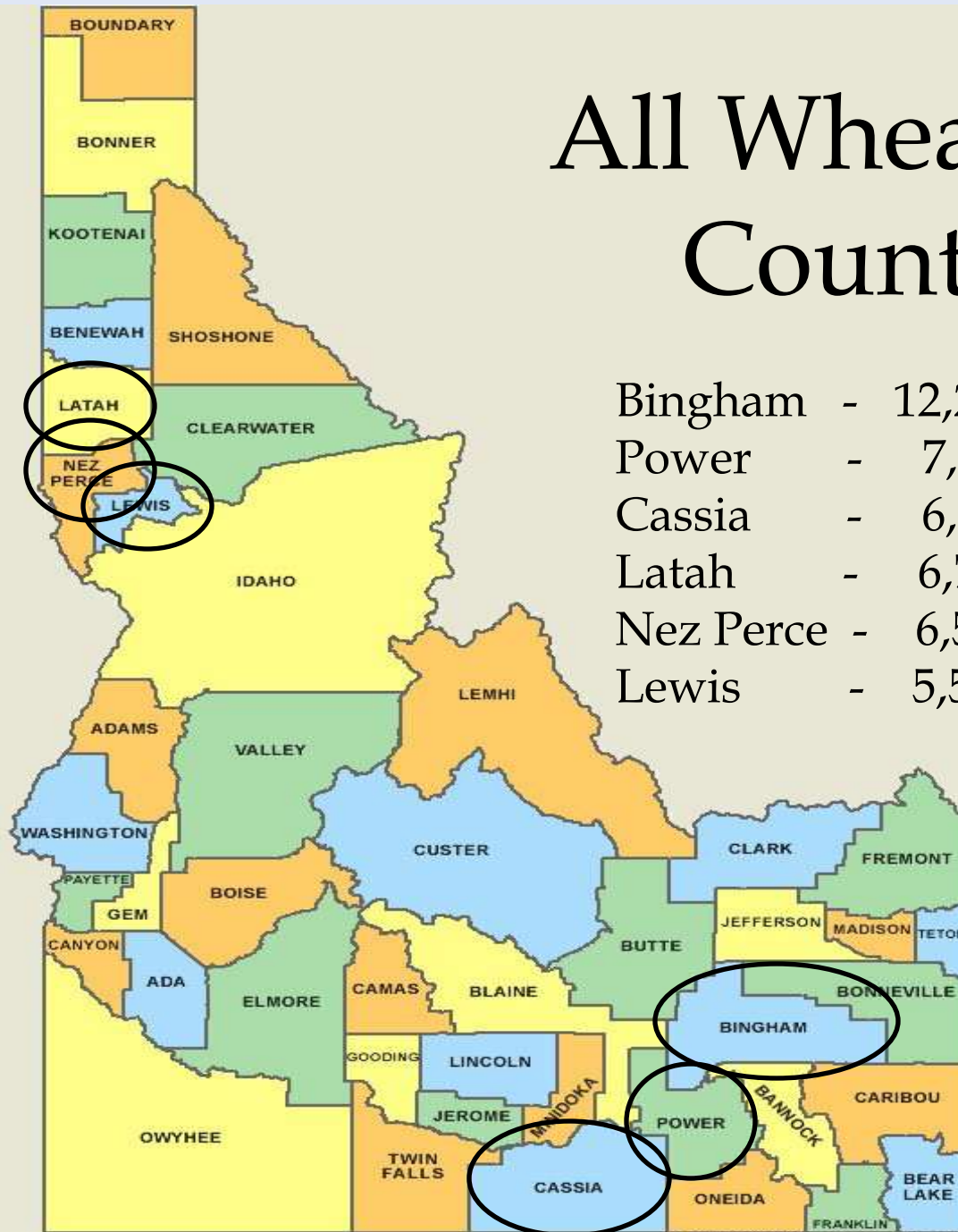


All Wheat by County



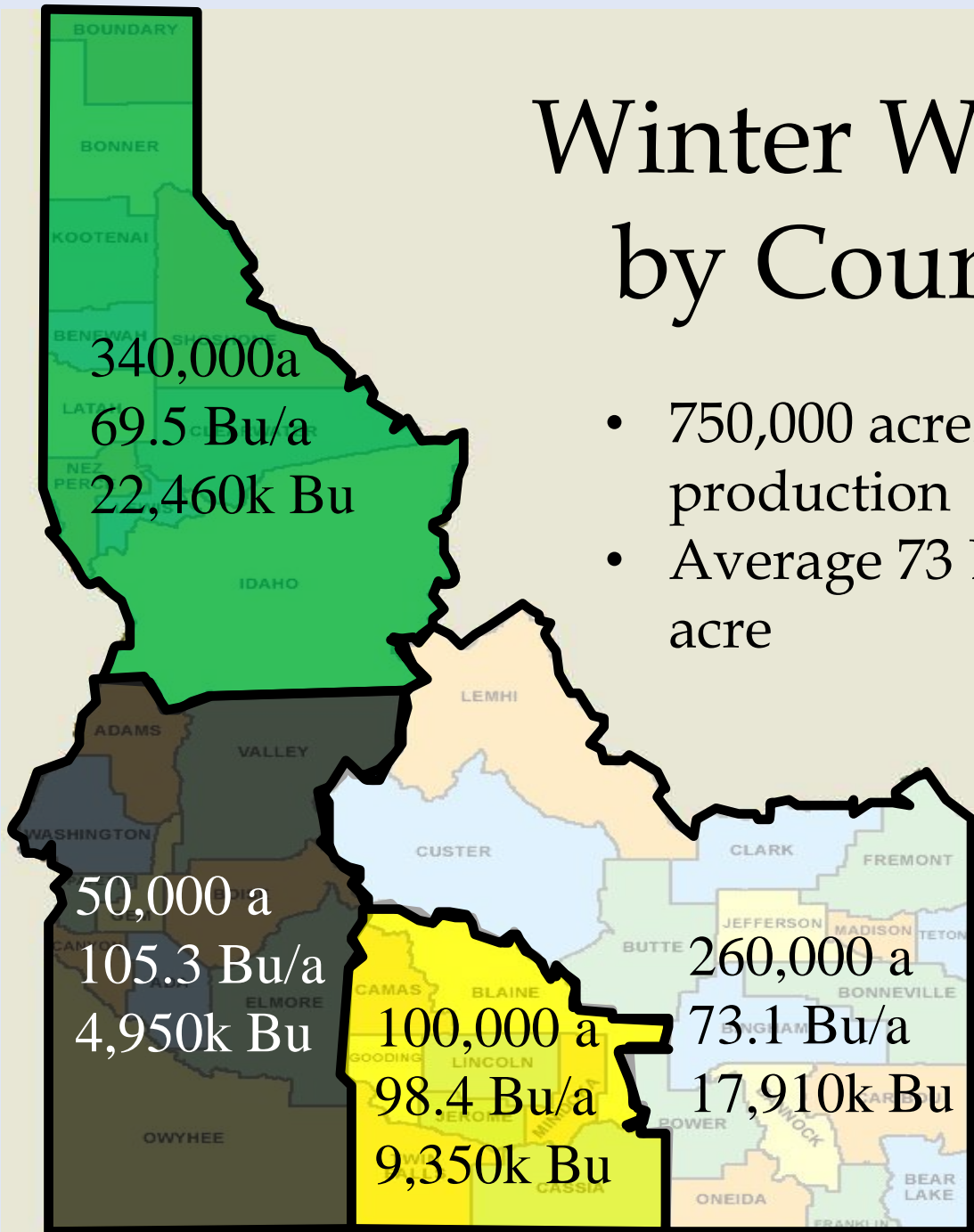
- 1,255,000 acres total production
- Average 72 Bu yield per acre

All Wheat by County



Bingham - 12,270k Bu
Power - 7,700k Bu
Cassia - 6,802k Bu
Latah - 6,770k Bu
Nez Perce - 6,590k Bu
Lewis - 5,580k Bu

Winter Wheat by County



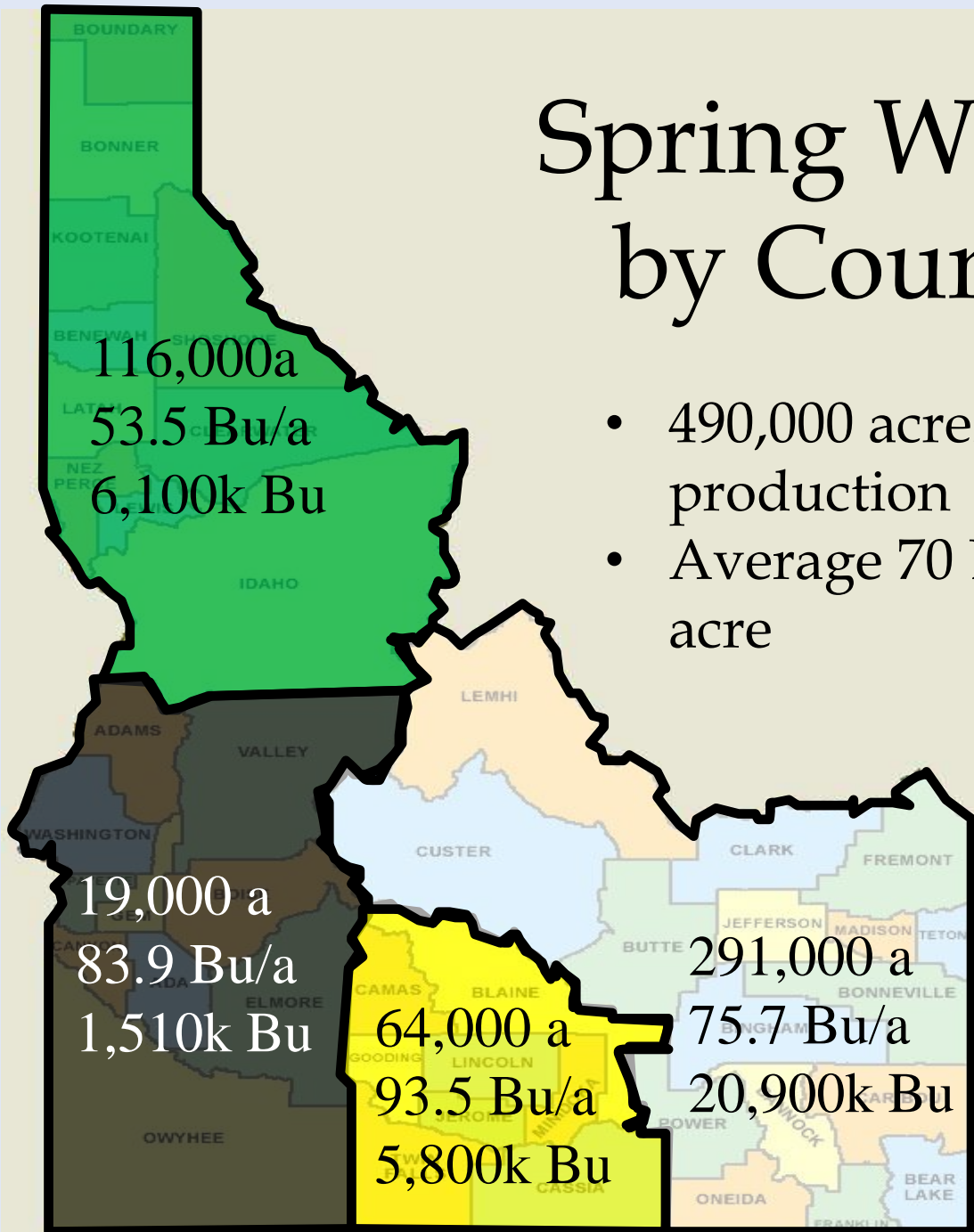
- 750,000 acres total production
- Average 73 Bu yield per acre

Winter Wheat by County



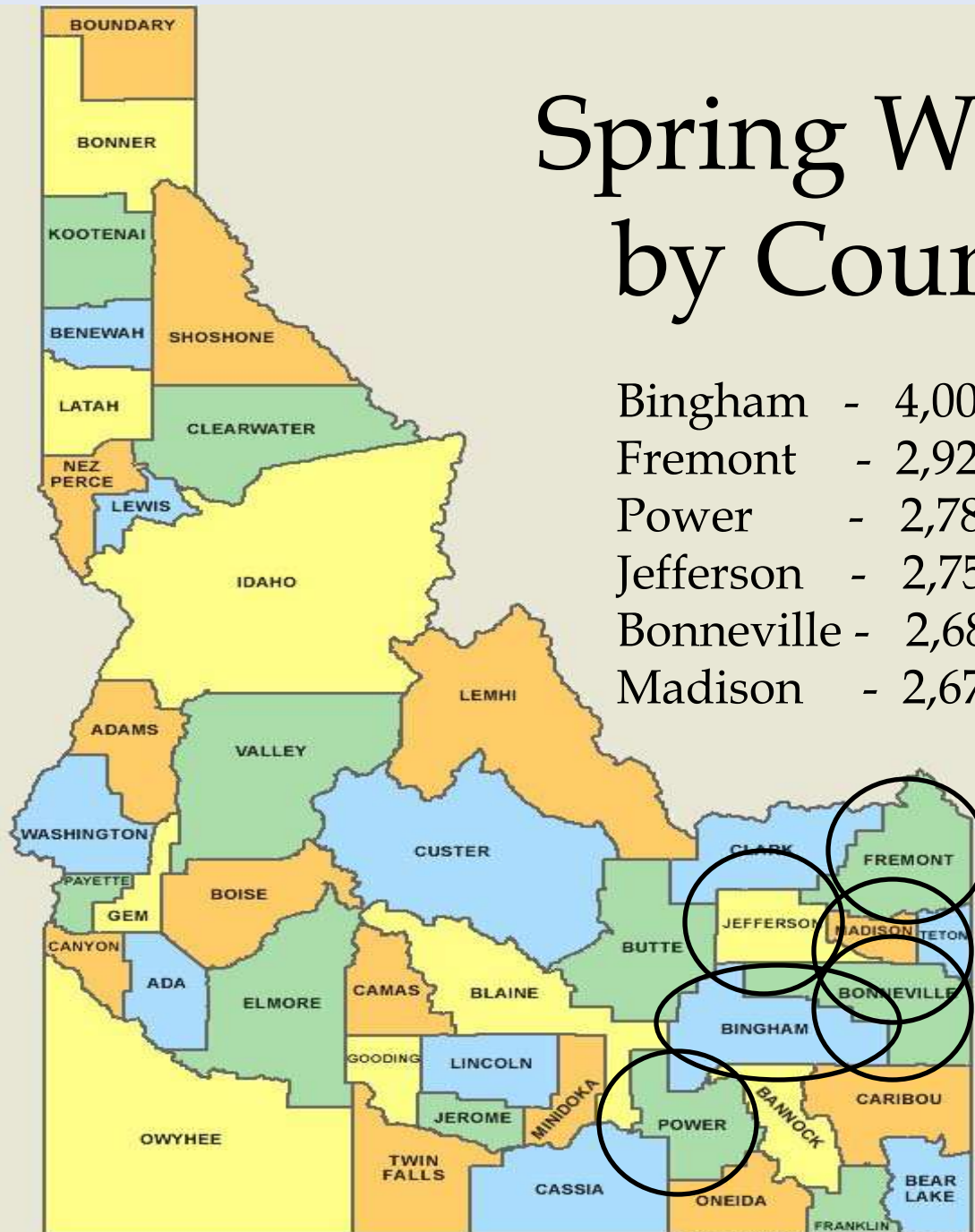
Bingham	-	12,275k Bu
Power	-	7,700k Bu
Cassia	-	6,802k Bu
Latah	-	6,770 k Bu
Nez Perce	-	5,580k Bu

Spring Wheat by County



- 490,000 acres total production
- Average 70 Bu yield per acre

Spring Wheat by County



Types of Wheat

- ▣ Winter habit - fall seeded requiring vernalization
- ▣ Spring habit - spring seeded no vernalization required
- ▣ Facultative - Development hastened by vernalization, often fall seeded

An overview of US wheat market classes

	Hard endosperm	Soft endosperm
Red Bran	Hard Red Spring Hard Red Winter	Soft Red
White bran	Hard White	Soft White

Generic classification of US wheat market classes

Gluten quality and quantity determines end use and value



Uses of Wheat

- ▣ Soft white wheat:
 - Cakes, cookies, crackers, flat bread, batter, breakfast cereal, pancakes.
- ▣ Hard red wheat:
 - Bread, rolls, other leavened food.
- ▣ Durum wheat:
 - Pasta and similar foods.
- ▣ Hard white wheat:
 - Oriental noodles.

Production

- ▣ Planting - cultivation decisions
- ▣ Weed management
- ▣ Fertility management
- ▣ Disease and insect problems
- ▣ Irrigation management
- ▣ Harvest and storage



Chisel Plow





Disc Cultivators





Harrow Cultivators



Production Recommendations

- ▣ Early stand establishment is critical to high yields.
- ▣ Plant locally adapted cultivars.
- ▣ Hard red or white wheats are favored in stress environments,
- ▣ Seeding rate varies from 750,000 plants per acre to 1.5 million plants/acre.
- ▣ Seeding rate 70-110 lb seed/acre.



Seed Drills



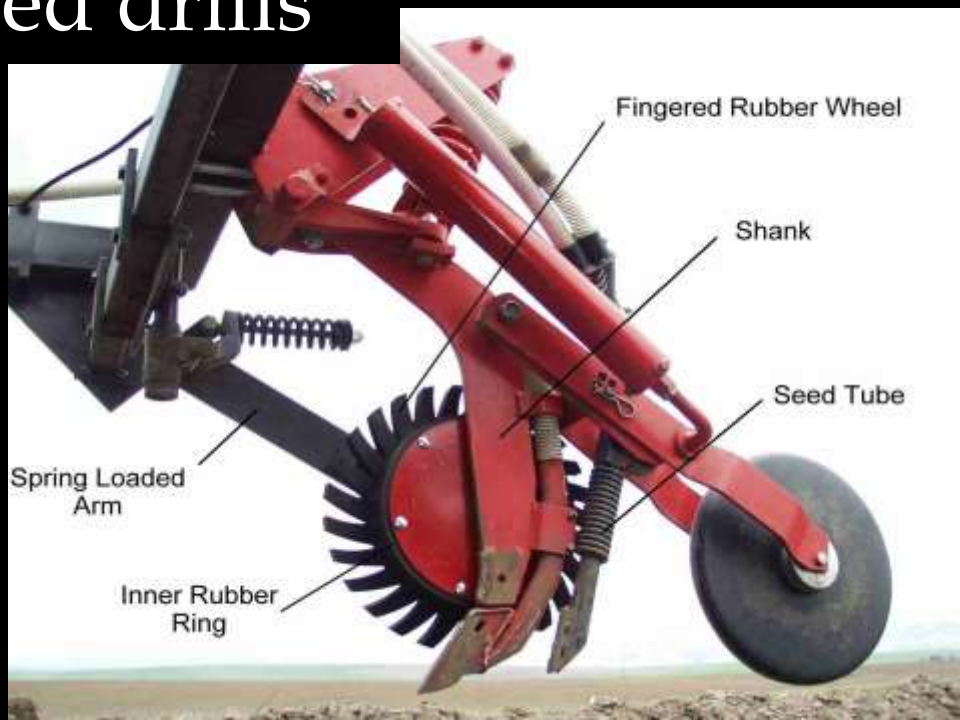


Air Seed Drills





Direct seed drills



Production Recommendations

- ▣ Stand establishment:
 - Plant early but avoid green bridges.
- ▣ Fertilizer management:
 - Longer period in field often requires split applications of N.
- ▣ Winter-kill and winter diseases.
 - Tolerant cultivars.

Fertility Management

- ▣ The amount of nitrogen (N) fertilizer applied on any wheat field depends on:
 - The cultivar, it's market class, and it's potential seed yield.
 - The amount of usable nitrogen in the soil profile.
 - Total precipitation.
 - Plant stand and density.
 - The previous crop.

Soil Sampling

- ✓ A soil sample should be taken at least once during each crop rotation cycle.
- ✓ Soil samples should be taken 2-4 weeks prior to planting.
- ✓ Allow 1-3 weeks to get results back from laboratory.
- ✓ Avoid sampling very wet, very dry, or frozen soils.

Dry Land Wheat



Nitrogen (N)

- ❖ N is essential for maximum yield, and accounts for the largest share of fertilizer costs for wheat production.
- ❖ Nitrogen determination:
 - Total N requirement.
 - Soil Test.
 - Residual inorganic N levels.
 - Previous crop residue levels.

Total Nitrogen Needed

Annual Precipitation (inches)	Total N Spring	Total N Winter
21 inches or less	2.3 x Yield (bu/a)	2.5 x Yield (bu/a)
22 to 24 inches	2.4 x Yield (bu/a)	2.6 x Yield (bu/a)
More than 24 inches	2.5 x Yield (bu/a)	2.7 x Yield (bu/a)

Hard red wheat (14% protein) requires between 3.1 and 3.5 lb N /bu of wheat harvested.

Managing N for High Grain Protein

- ❖ Use split-application of Nitrogen.
- ❖ Apply all but ~ 40 lbs N/ac pre-plant.
- ❖ Monitor protein level with flag leaf nitrogen.
- ❖ Apply the remaining 40 lbs N/ac as a top-dress at heading if needed.

Phosphorus (P)

- ❖ Spring wheat P requirements are typically less than other crops grown in Idaho.
- ❖ Soil test results <11 ppm at the 0-12 inch depth reflect deficient soil P levels.
- ❖ Fertilizer P must be applied pre-plant either as a broadcast application or banded with the seed.

Phosphorus

Soil test P	Application Rates	
0-12 inches	P ₂ O ₅	P
ppm	----- (lb/ac) -----	
0 - 3	160	70
4 - 7	120	53
8 - 11	60	26
over 12	0	0

$$P_2O_5 \times 0.44 = P$$

$$P \times 2.29 = P_2O_5$$

Potassium

- ❖ Spring wheat K requirements are typically less than other crops grown in Idaho.
- ❖ K fertilizer is not very mobile in soil and should be incorporated during final seed bed preparation.

Potassium

K soil test	Potassium rates	
	K ₂ O	K
0-12 inches		
ppm	----- lb/ac -----	
0 - 21	240	200
22 - 45	160	133
46 - 68	80	66
over 68	0	0

$$\text{K}_2\text{O} \times 0.84 = \text{K}$$

$$\text{K} \times 1.20 = \text{K}_2\text{O}$$

Sulfur

- ❖ Soils low in S (less than 10 ppm SO_4^{-2} in the plow layer or 8 ppm in the 0- to 12-inch depth) should receive 20 to 40 lbs S/acre.
- ❖ Fields irrigated with Snake river water should not be deficient.

Micronutrients

(B, Cl, Cu, Fe, Mn, Mo, Ni, Zn)

- ❖ Micronutrient response has not been observed in Idaho.
- ❖ Severely scraped soils may require micronutrient application.

Irrigated Wheat

Expected Yield (Bu/acre)	Total nitrogen (lb/acre)
80	160
100	200
120	240
140	270
160	300
180	330

Previous Crop Factor

Previous Crop	Nitrogen Credit (lb/acre)
Grain or corn residue	-50
Grain, residue removed	0
Potato, onion, sugar beet	0
Bean or pea	+40
Alfalfa plowed in early fall	+60
Alfalfa plowed in late fall	+40

Managing N for High Grain Protein

- ❖ Apply pre-plant N based on yield goal.
- ❖ Monitor protein level with flag leaf nitrogen.
- ❖ Top-dress 15- to 20-lbs N/ac from boot to heading if needed.

Nutrient Summary

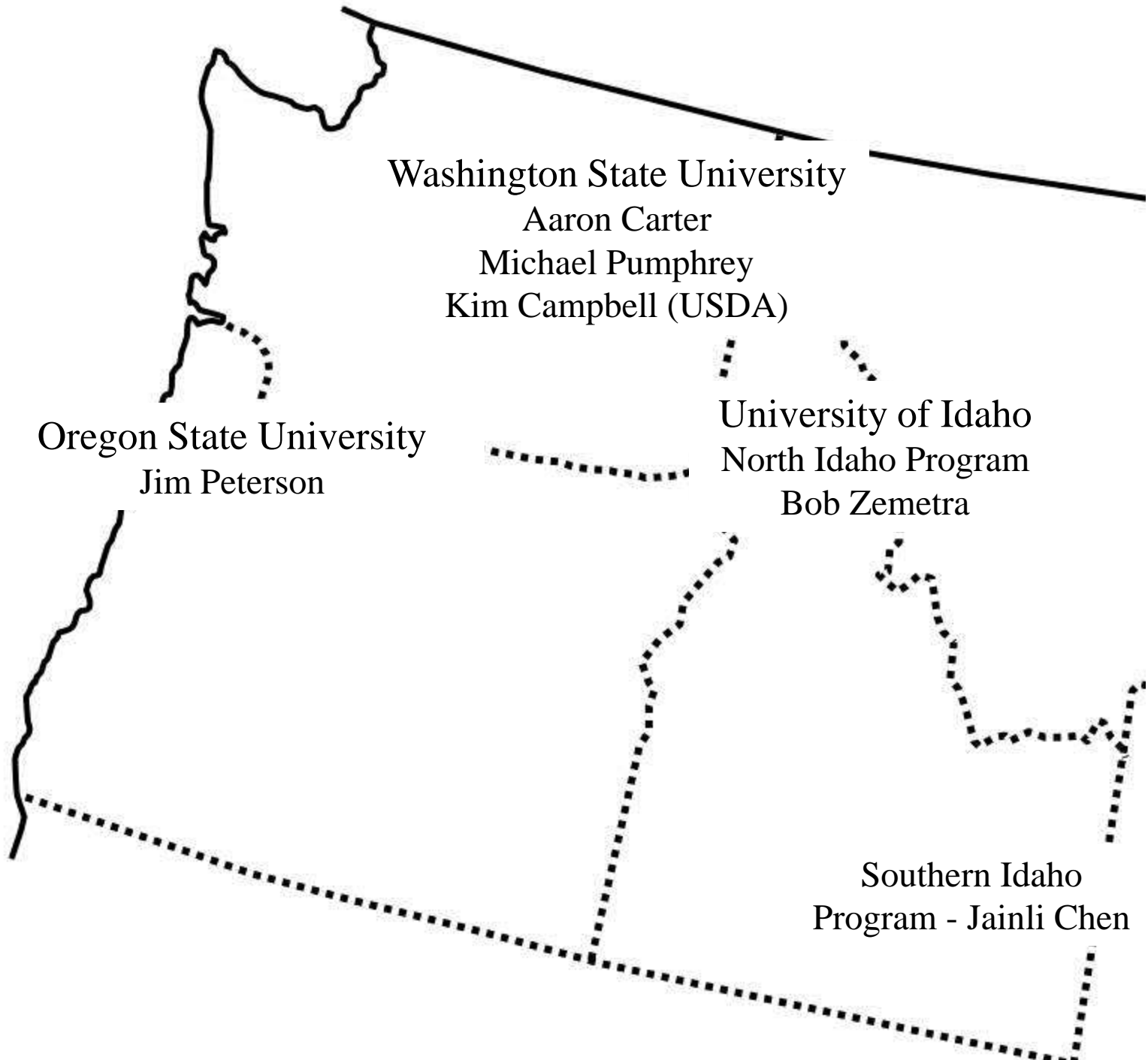
- ▣ Soil sampling is essential.
- ▣ Excessive nitrogen application results in nitrate leaching and ground water pollution; lodging and yield loss.
- ▣ Regions with less than 22 inches of precipitation use split-application of nitrogen.
- ▣ In regions with heavy winter precipitation (annual >24 inches) over 70% of nitrogen should be spring top-dressed.

Nutrient Summary

- ▣ Use caution in topdressing nitrogen after boot stage increases protein levels in soft white wheat.
- ▣ If banding nitrogen and phosphorus , reduce nitrogen application rate by 10%, and phosphorus by 20%.
- ▣ Ammonium and ammonia) do not leach as readily as NO_3 .



Wheat Cultivars



Washington State University

Aaron Carter

Michael Pumphrey

Kim Campbell (USDA)

Oregon State University

Jim Peterson

University of Idaho

North Idaho Program

Bob Zemetra

Southern Idaho
Program - Jainli Chen



Washington State University

Aaron Carter

Michael Pumphrey

Kim Campbell (USDA)

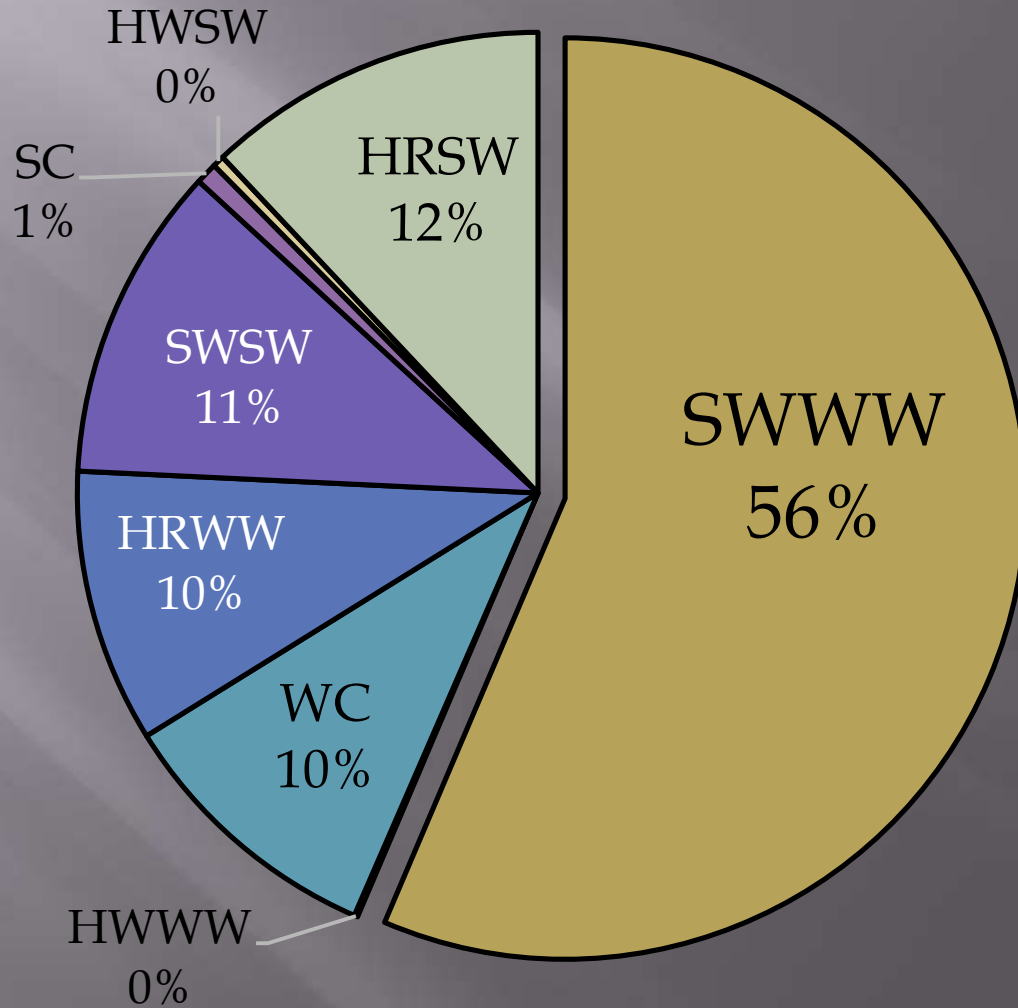
Oregon State University

Bob Zemetra

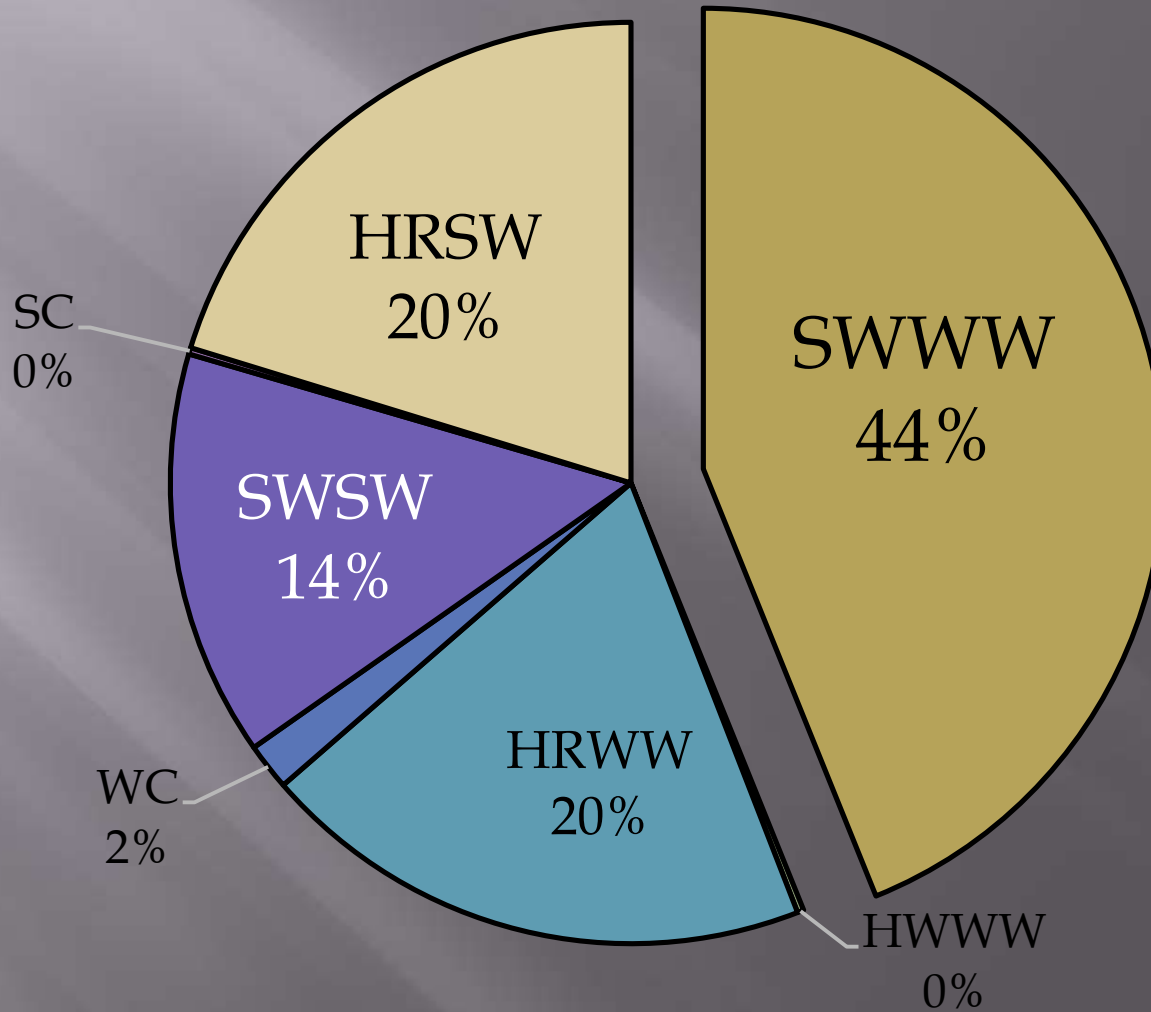
- Wayne McPride
- LimaGrain – UI
- Monsanto – WestBred
- Dow Ag.Sci – NW Plant Breeders
- Syngenta

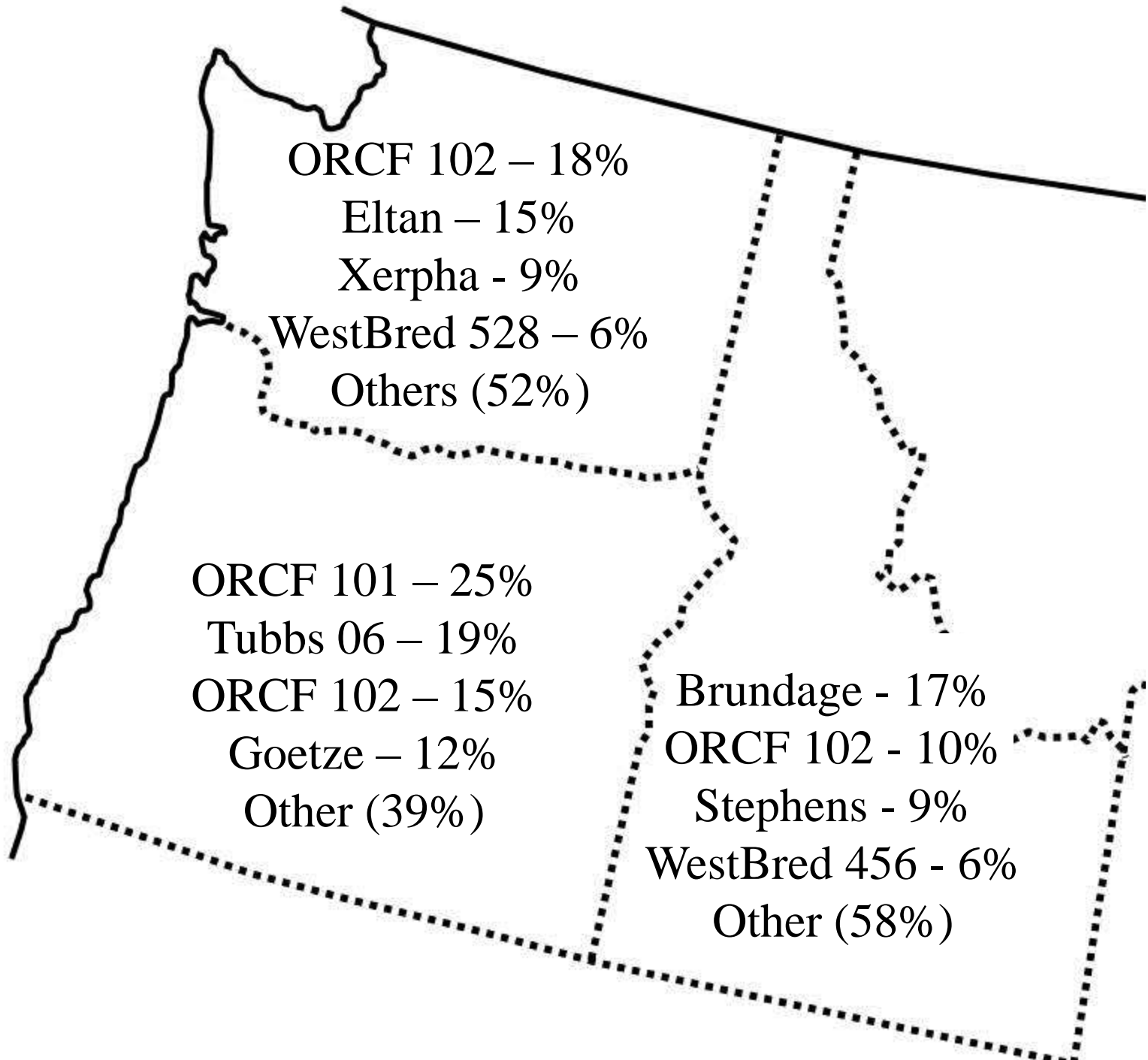
Southern Idaho
Program - Jainli Chen

Washington



Idaho





ORCF 102 – 18%

Eltan – 15%

Xerpha - 9%

WestBred 528 – 6%

Others (52%)

ORCF 101 – 25%

Tubbs 06 – 19%

ORCF 102 – 15%

Goetze – 12%

Other (39%)

Brundage - 17%

ORCF 102 - 10%

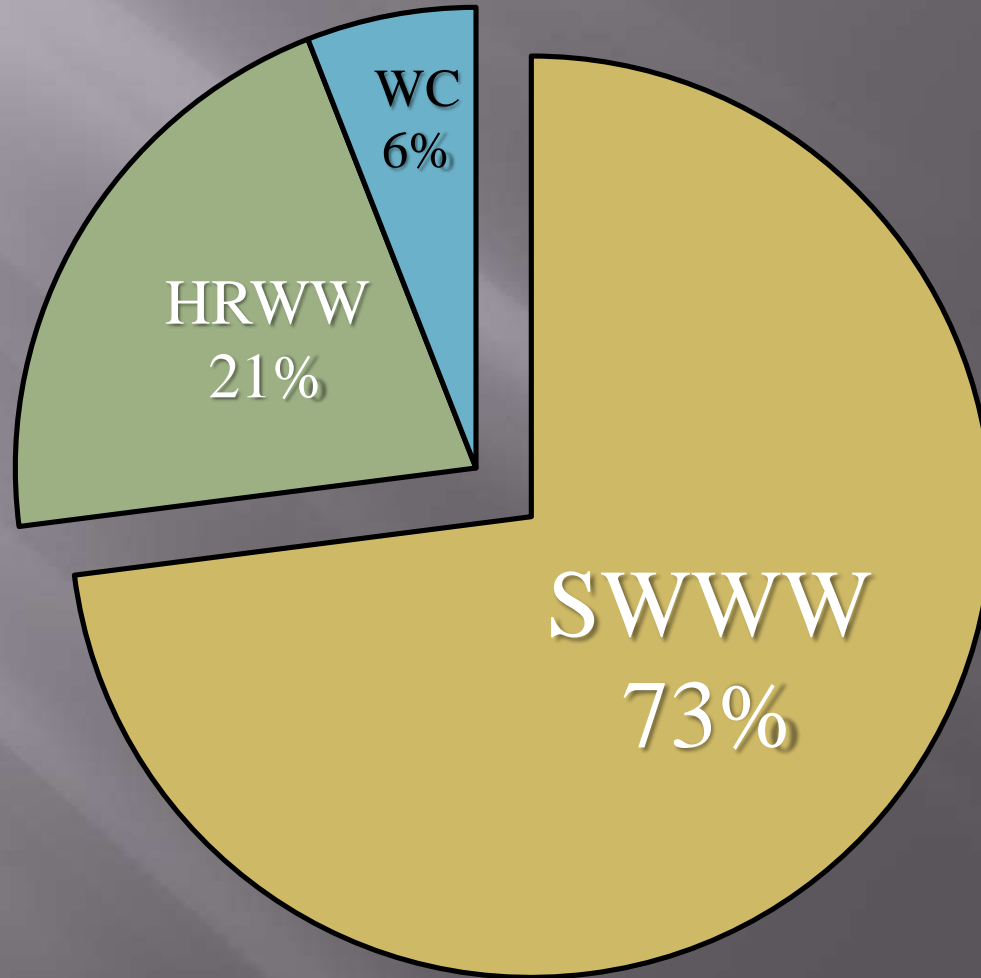
Stephens - 9%

WestBred 456 - 6%

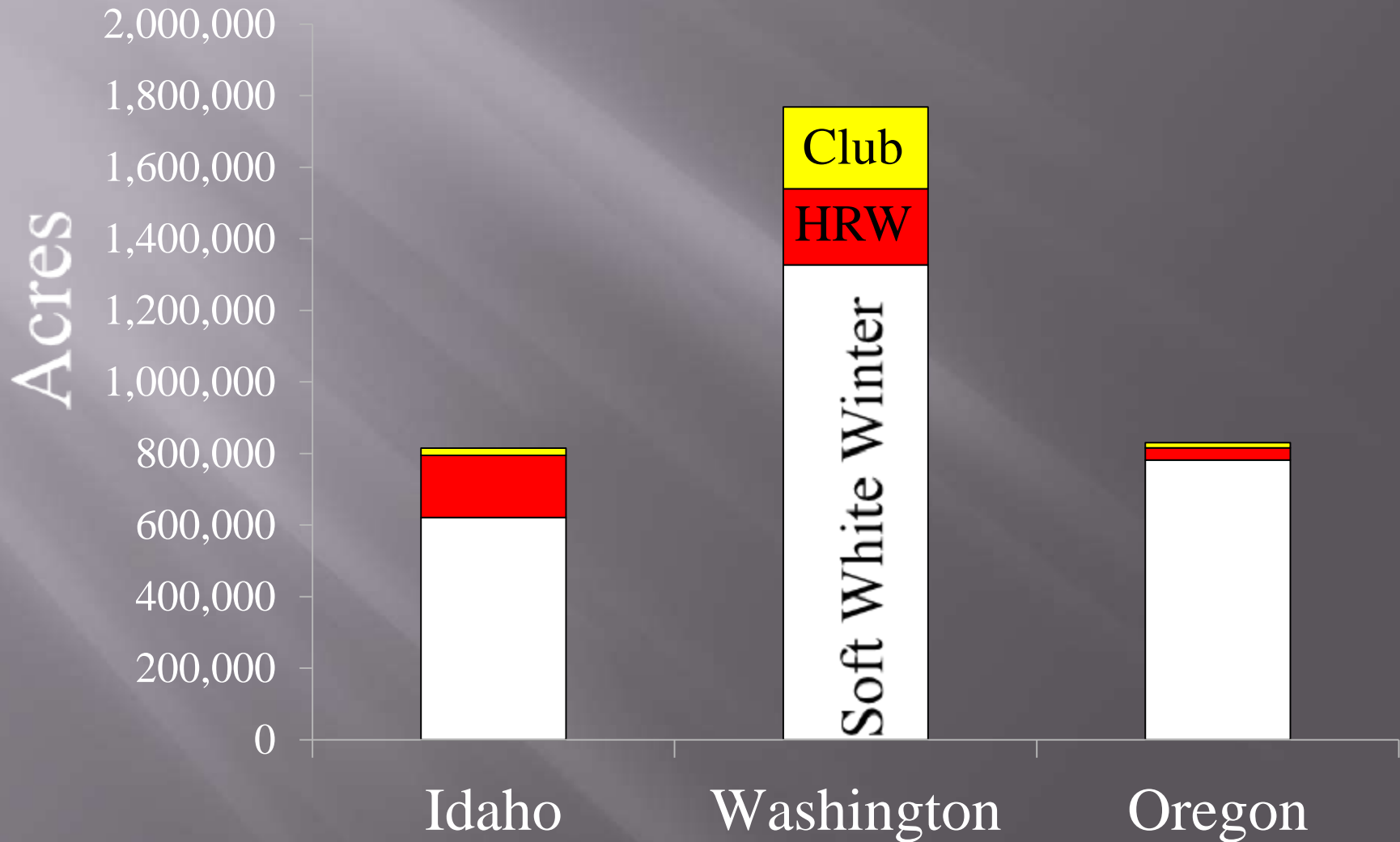
Other (58%)

Northern Idaho

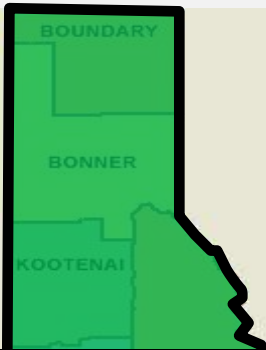
Winter Wheat



Winter Wheat by Class

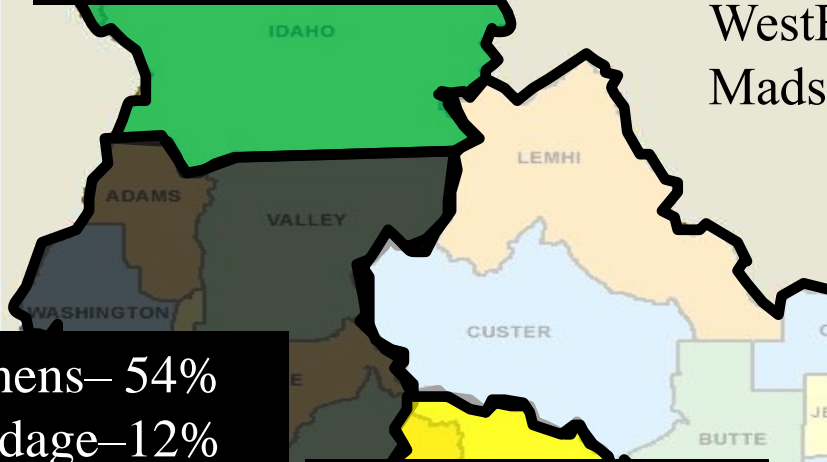


Idaho SWWW Cultivars



ORCF 102-20%
WestBred 528-11%
Madsen - 10%
Louise - 8%

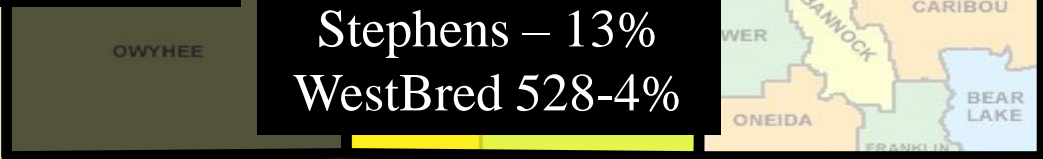
Brundage 17%
ORCF 102 10%
Stephens 9%
WestBred 456 6%
Madsen 5%



Stephens— 54%
Brundage—12%
WestBred 470— 5%
Brundage 96— 5%

Brundage—44%
WestBred 470-25%
Stephens – 13%
WestBred 528-4%

Brundage—51%
WestBred 456-20%
Lambert – 6%
Brundage 96-5%



Idaho Wheat Aces by Class

Class	District 10	District 70	District 80	District 90
Soft White Winter	270,000	89,000	64,000	162,000
Hard Red Spring	70,000	5,000	30,000	165,000
Hard Red Winter	78,000	1,000	55,000	126,000
Soft White Spring	46,000	8,000	29,000	107,000
Hard White Spring	1,000	23,000	53,000	77,000
Winter Club	22,000	-	-	22,000
Durum	-	-	3,000	12,000
Hard White Winter	-	-	1,000	2,000
Spring Club	3,000	-	-	-
Total	490,000	103,000	205,000	627,000

Selection of New Varieties

- ▣ UI Wheat Breeding
 - www.agls.uidaho.edu/cerealsci
- ▣ UI Extension Service
 - <http://www.uidaho.edu/aberdeen/cereals>
- ▣ WSU Extension Service
 - <http://variety.wsu.edu/>
- ▣ Oregon State University Extn. Service
 - <http://www.css.orst.edu/cereals/>
- ▣ On-farm testing guide
 - <http://pnwsteep.wsu.edu/onfarm.html>

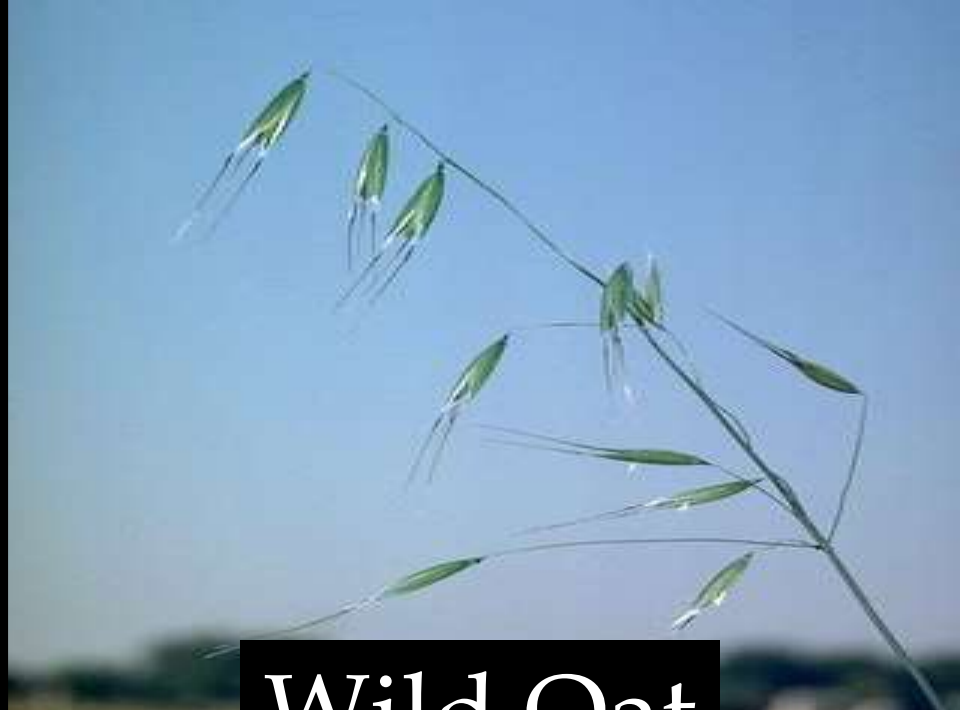
Weeds

- ▣ Winter annual grasses:
 - Wild oat, cheatgrass, jointed gloat grass
- ▣ Summer annuals:
 - Kochia, Russian thistle, pigweed, lambsquarter, wild buck wheat.

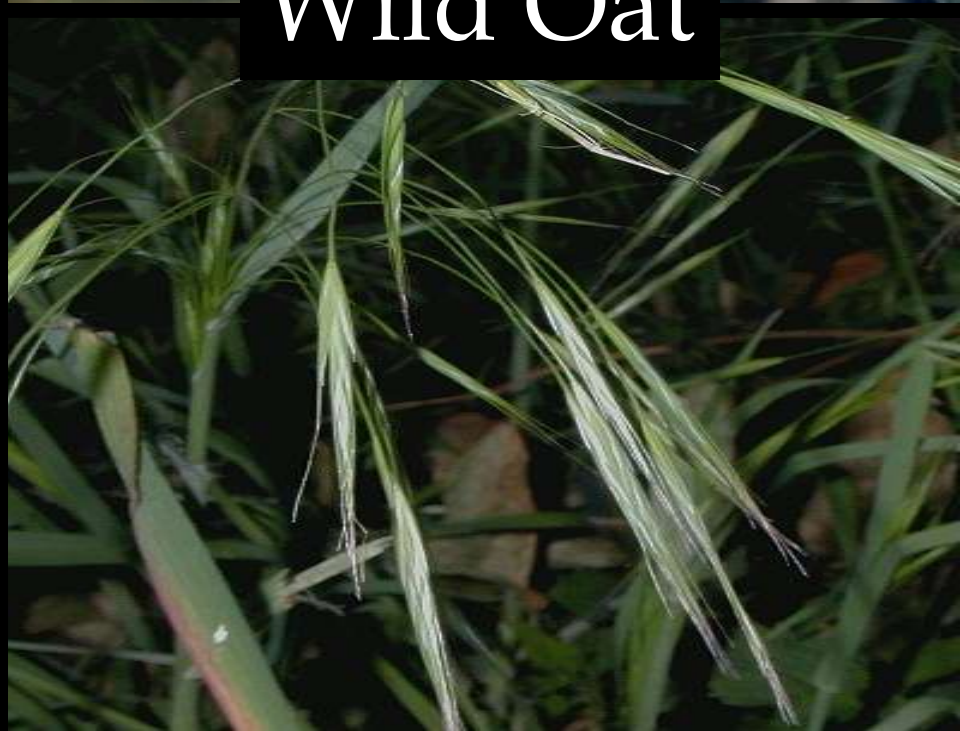
85% of Pacific Northwest and Northern Plains growers use herbicides, compared with only 20% in the Northern Central region.

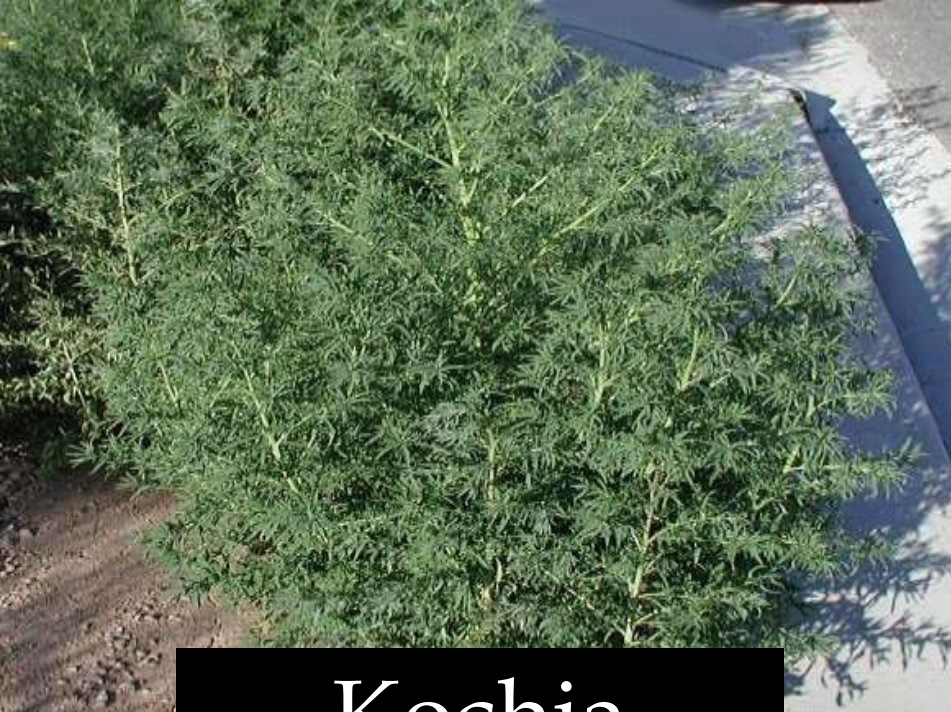


Cheat grass

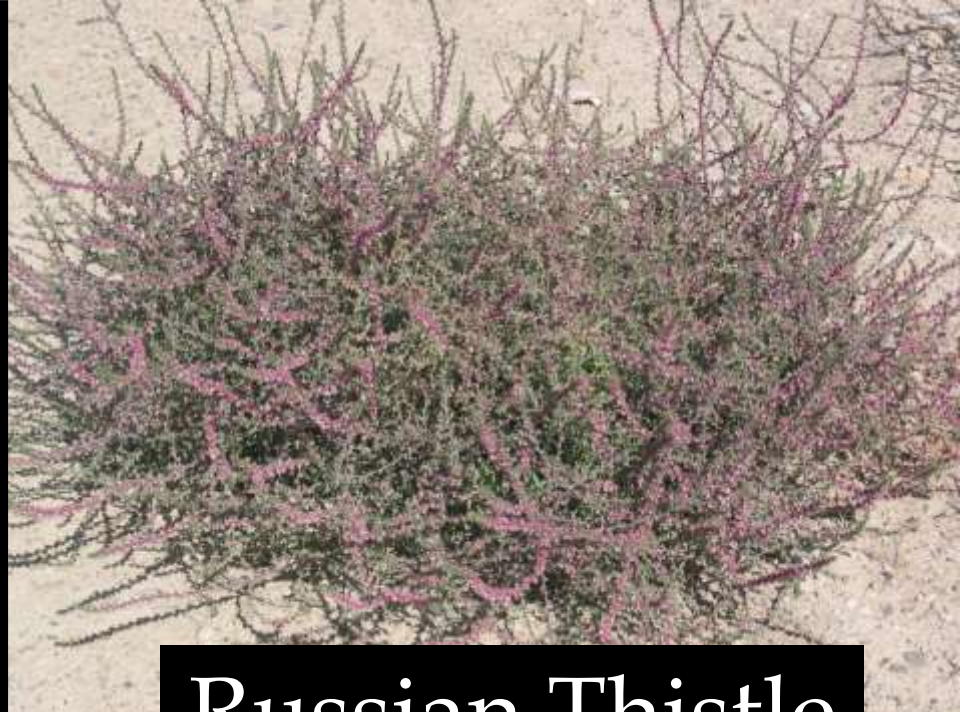


Wild Oat

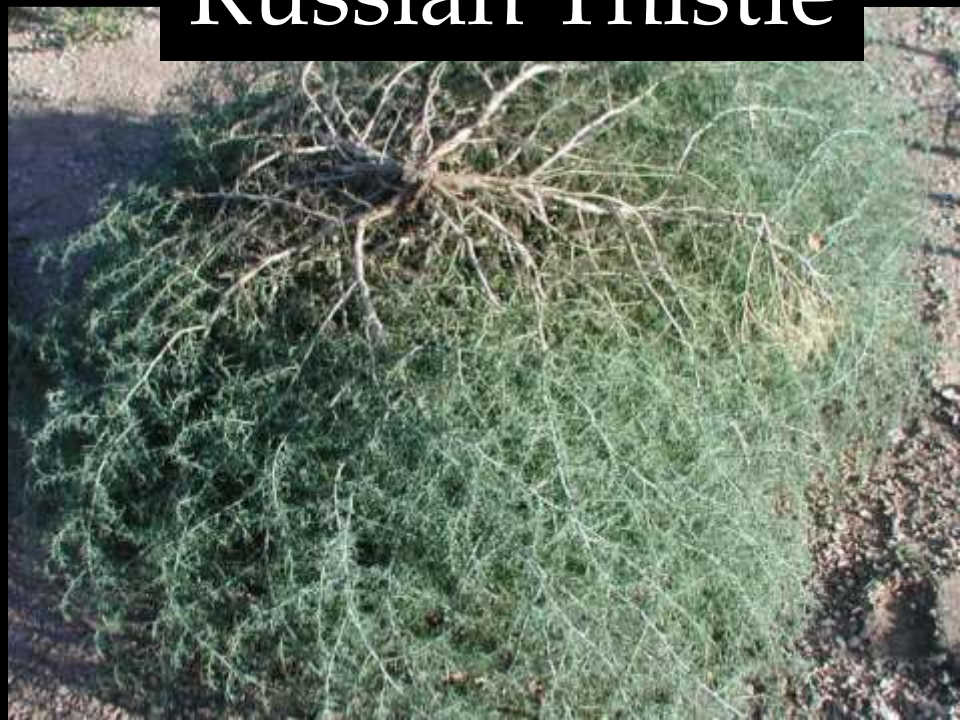
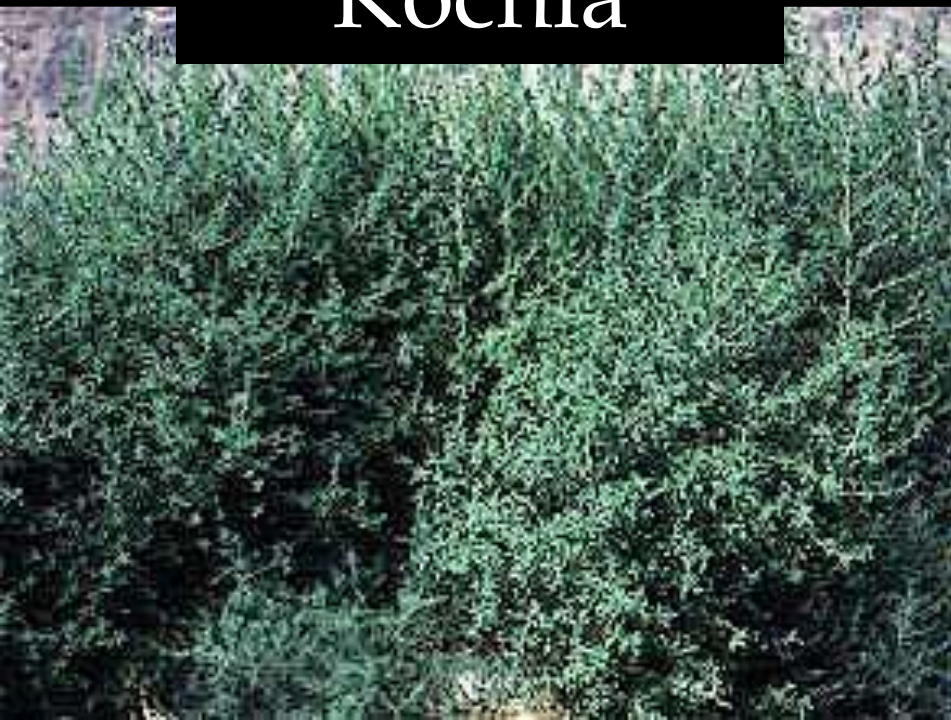


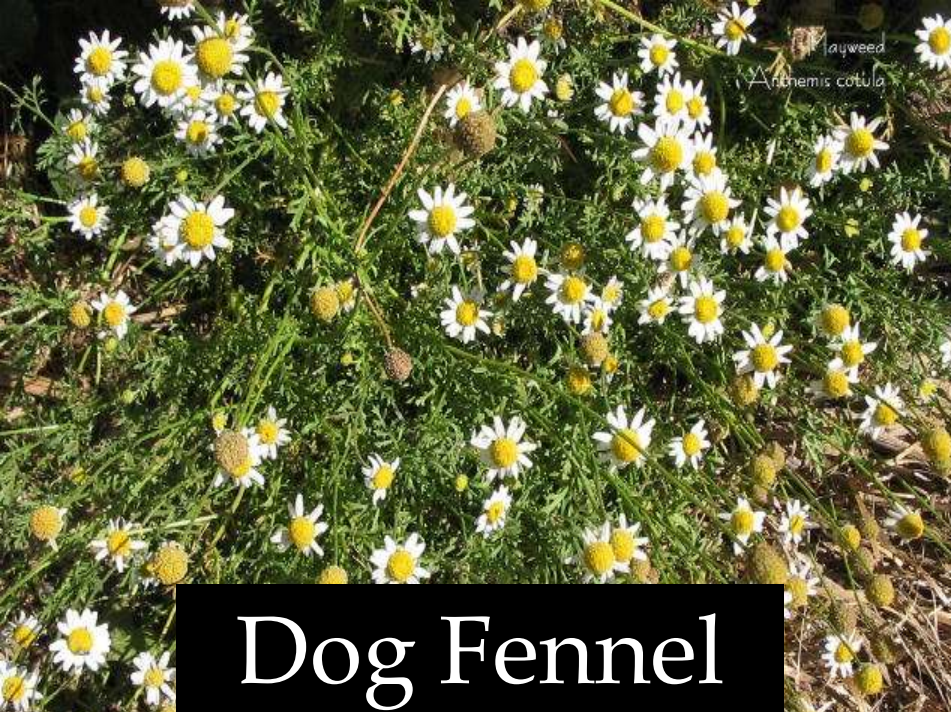


Kochia

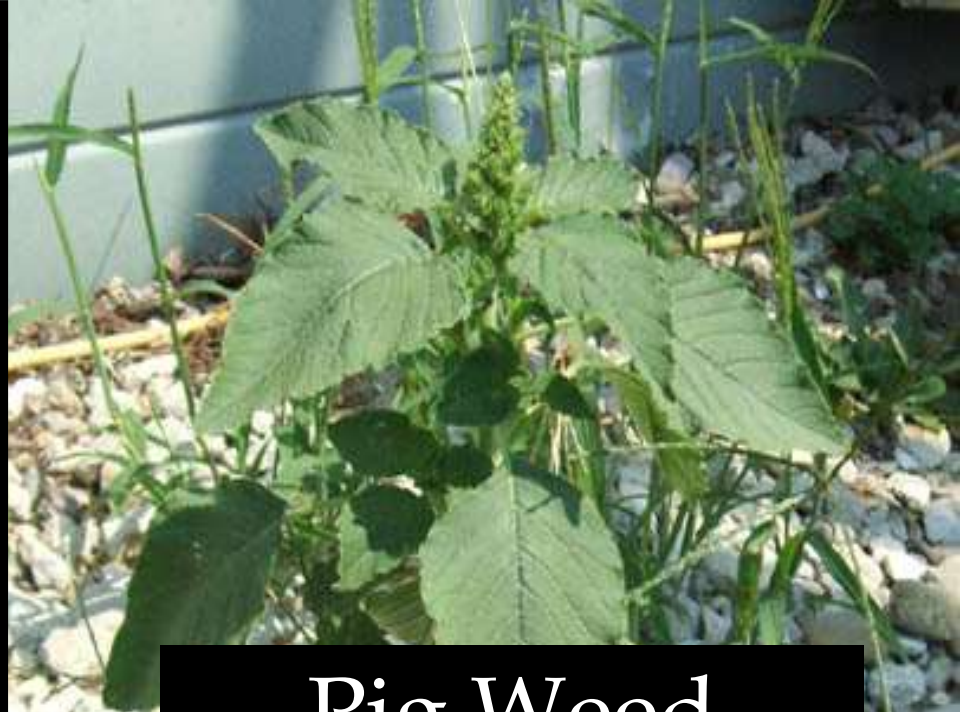


Russian Thistle





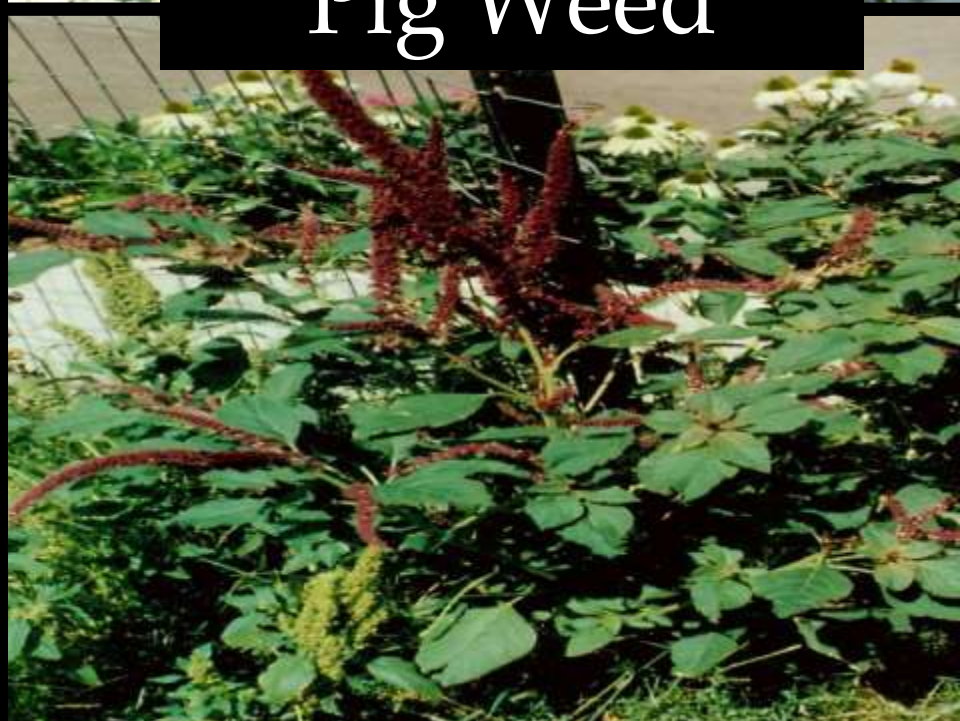
Dog Fennel



Pig Weed



Lamb's Quarter



Herbicides

Herbicide	Control
Axial XI	Annual ryegrass, wild oat, foxtails, barnyard grass, wild oat.
Bromoxynil	Broadleaves.
Curtail	Many annual weeds, i.e. ragweed, lambsquarter, field pennycress. Suppresses Canadian thistle.
Dicamba	Winter annual broadleaves.
Express	Broadleaves, i.e. shepherds purse, wild mustard. Partial control of Canadian thistle.
Harmony Extra	Broadleaves.
Maverick/Olympus	Suppress Downey broom, wild oat and cheat grass.
Metribuzin	Winter annuals, crop injury?
Puma/Discover NG	Wild oat.
Stinger	Canadian thistle, Russian thistle.
2,4-D	Broadleaves.



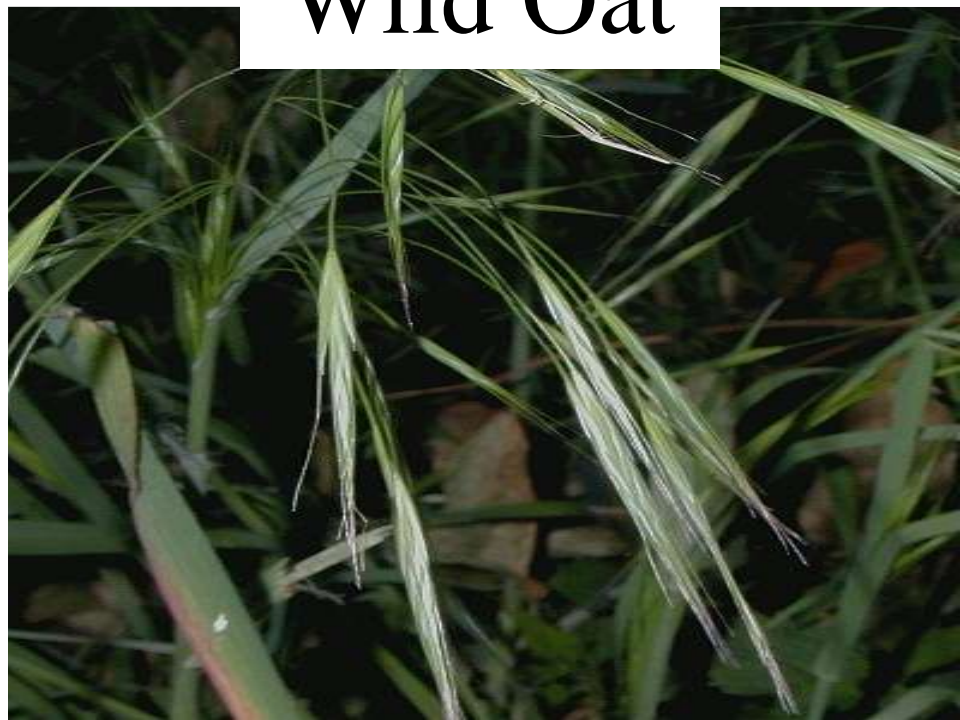
Clearfield[®]

Production System for Wheat

Cheat grass



Wild Oat



Common Pests & Diseases

▣ Pests:

- Armyworm, cutworm
- Russian wheat aphid, peach aphid, cereal beetle
- Cereal cyst nematode, root knot nematode.

▣ Diseases:

- Wheat stripe rust, cephalosporium strip, powder mildew.
- Common bunt, karnel bunt dwarf bunt, ergot.
- Takeall, *Fusarium*, strawbreaker snow mold.
- Barley yellow dwarf virus, wheat streak mosaic virus.



Armyworm



Cutworm



Russian Wheat Aphid



Cereal Leaf Beetle



Grasshopper

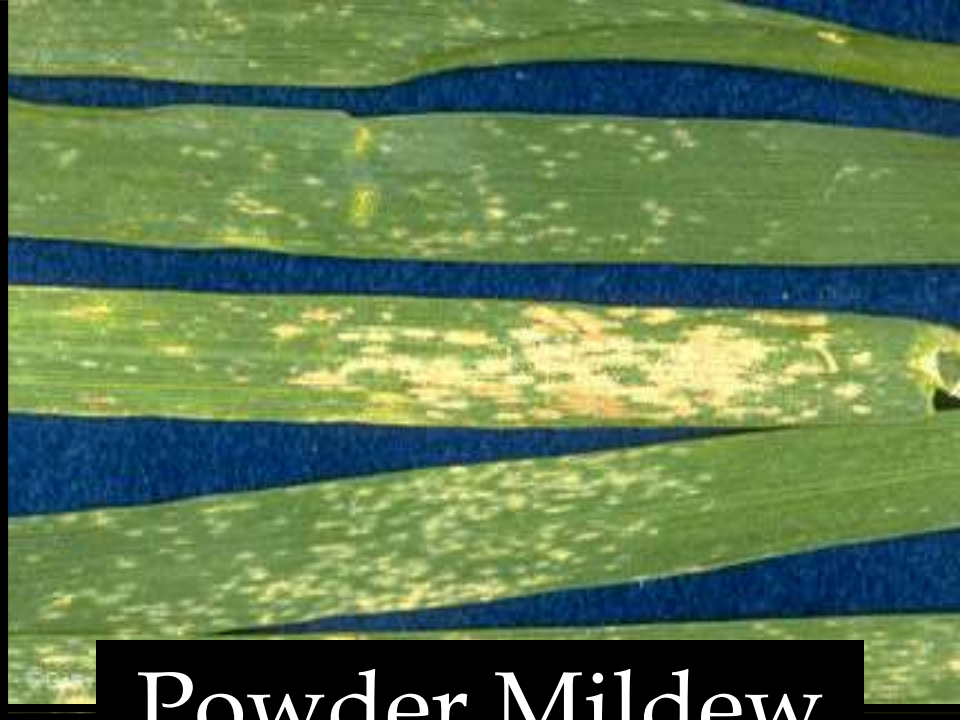
Labeled Wheat Insecticides

- ▣ Baythriod XL (*Beta-cyfluthrin*)
- ▣ Sevin (*Carbaryl*)
- ▣ Lorsban, Nufos, Pilot, Warhawk and Whirlwind (*Chlorpyrifos*)
- ▣ Cobalt (*Chlorpyrifos plus gamma-cyhalothrin*)
- ▣ Dimate (Cygon) (*Dimethoate*)
- ▣ Lannate (*Methomyl*)
- ▣ Tracer (*Spinosad*)
- ▣ Mustang MAX EC (*Zeta-cypermethrin*)

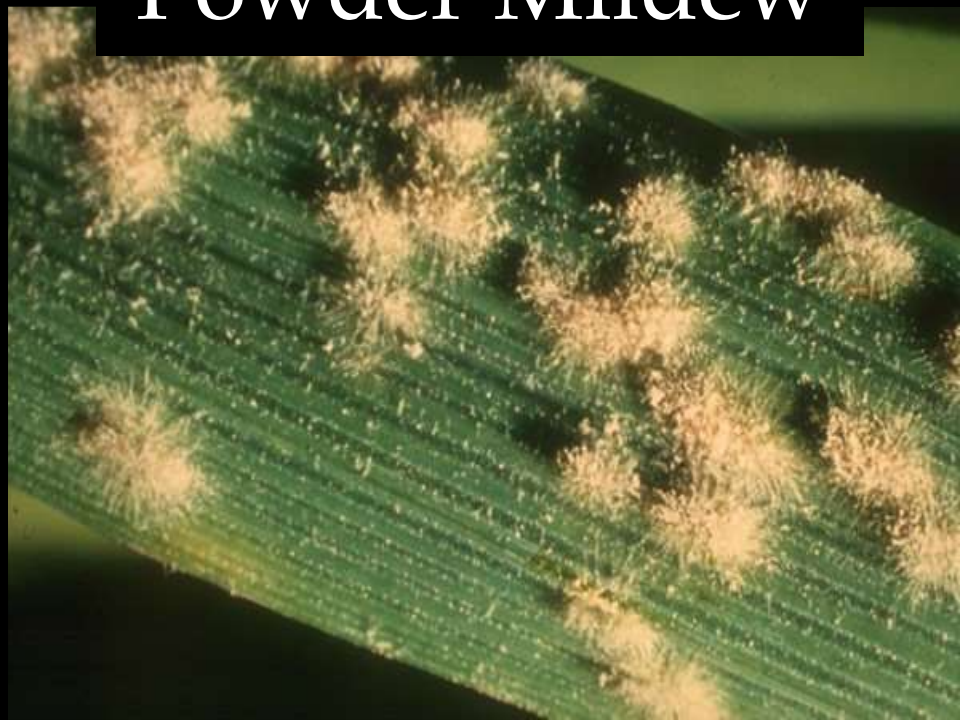


Wheat strip rust





Powder Mildew





Cephalosporium stripe



Labeled Wheat Foliar Fungicides

- ▣ Quilt
- ▣ Tilt
- ▣ Headline
- ▣ Caramba

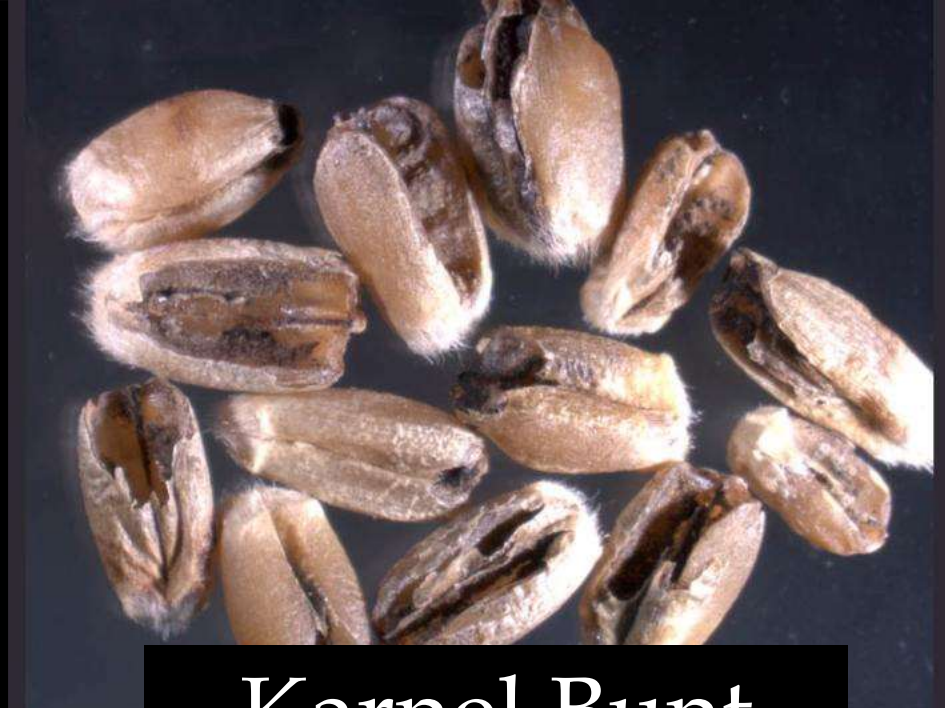
- ▣ Tank mixes:
 - Headline 2.08 EC/Tilt 3.6 EC
 - Headline 2.08 EC/Carama

- ▣ Include non-ionic surfactant

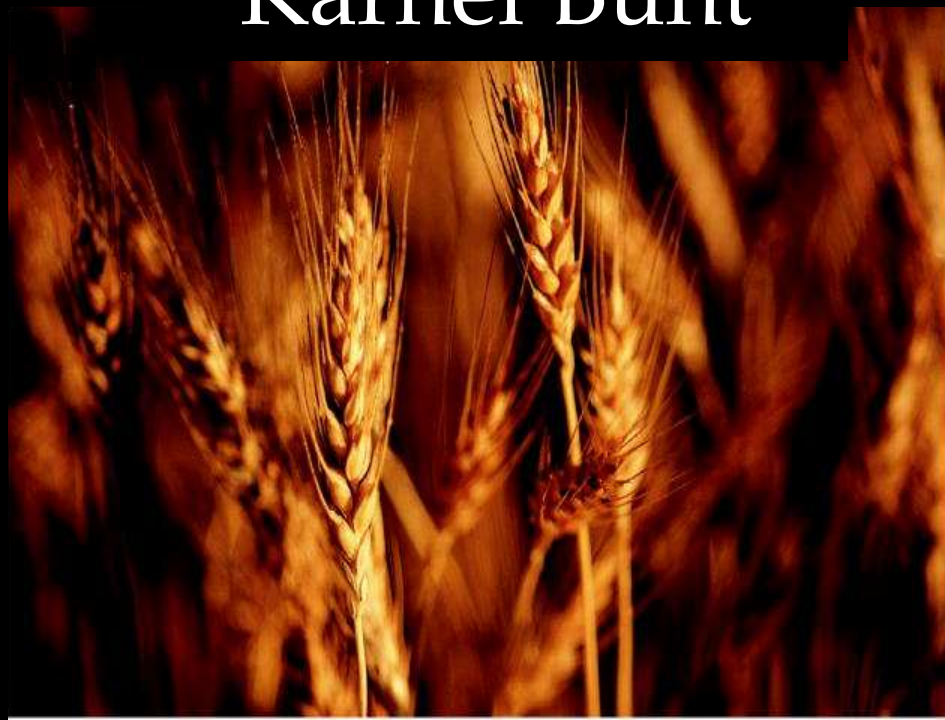


Common Bunt





Kernal Bunt



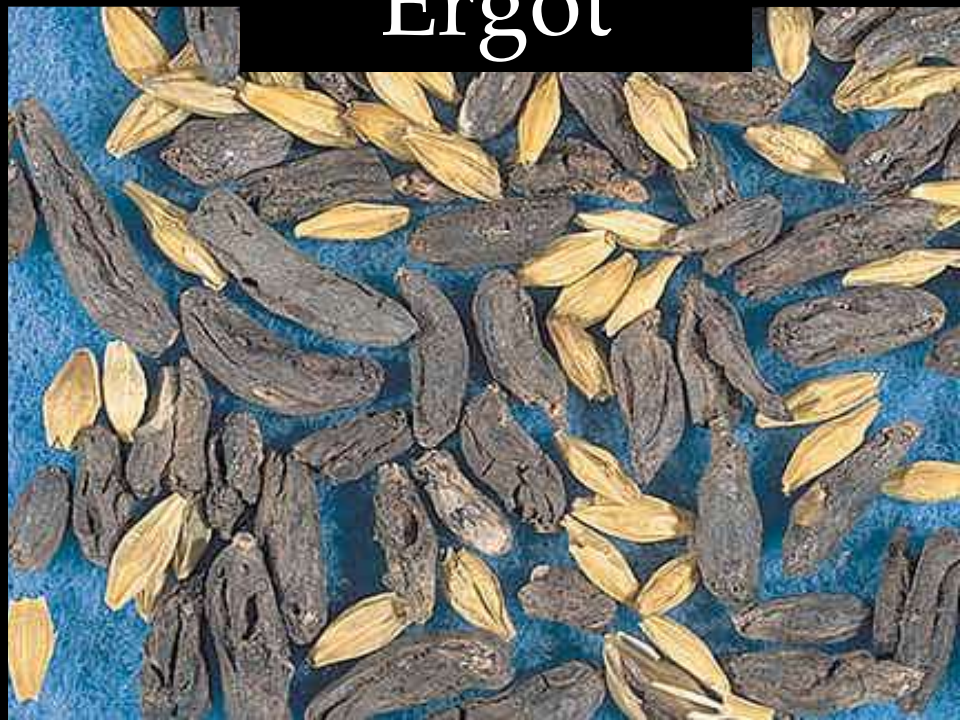


Dwarf Bunt





Ergot





Take all



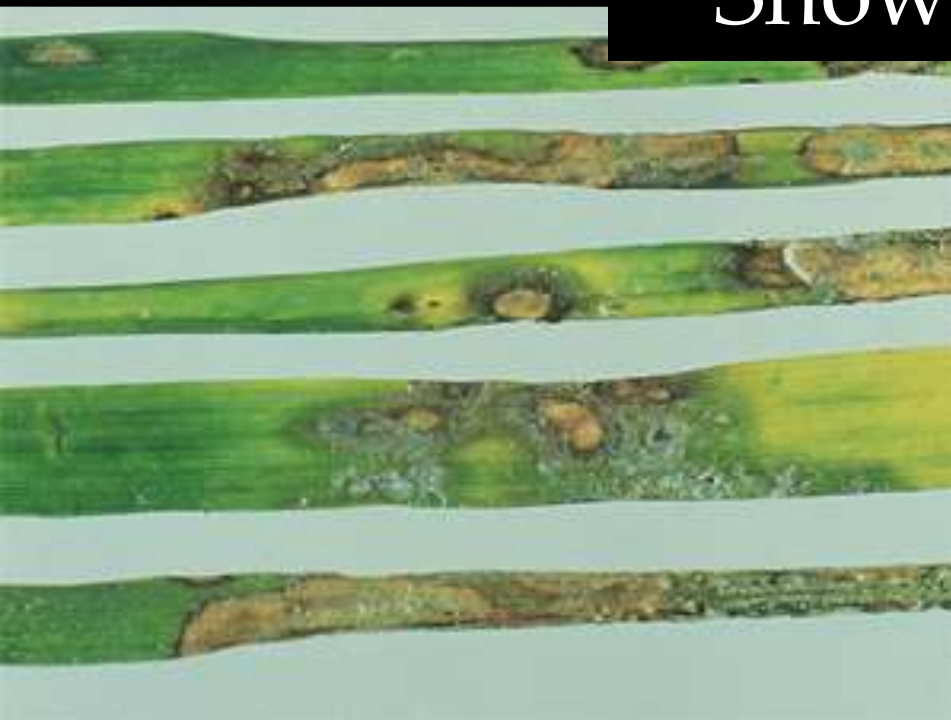


Fusarium



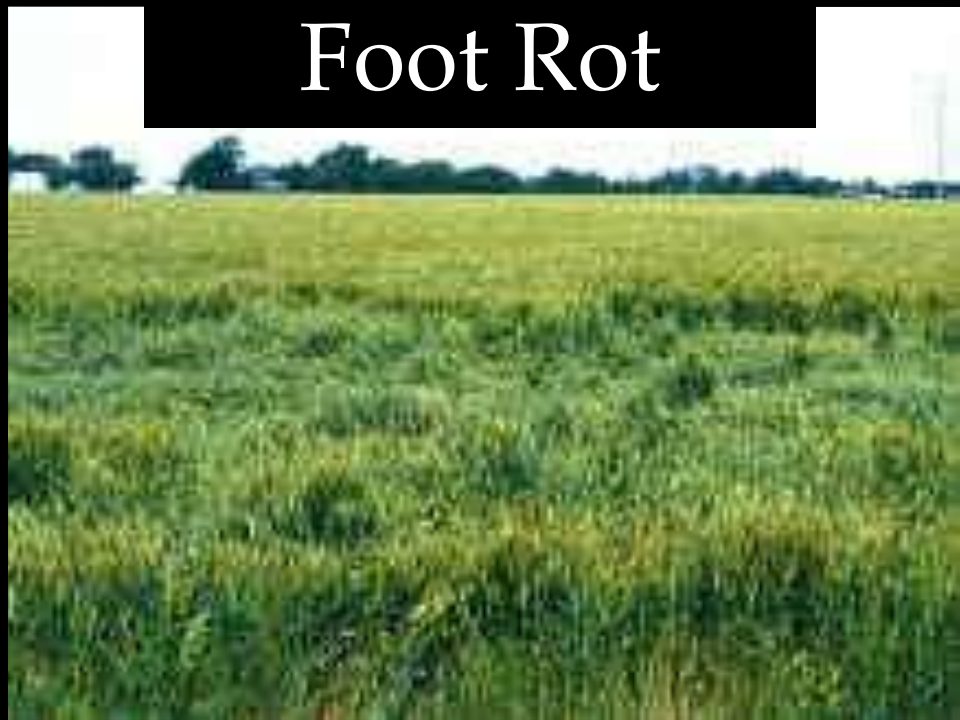


Snow Mold





Strawbreaker
Foot Rot



Labeled Wheat Seed Treatments

- ▣ Poncho 600 FS (Insecticide)
- ▣ Gaucho 600 FS (insecticide)
- ▣ Cruiser (Insecticide)
- ▣ Helix Extra (Fungicide & Insecticide)
- ▣ Dividend Extreme FS/ Apron XL ES (Fungicide)
- ▣ Raxil XT WP (Fungicide)



Barley Yellow Dwarf Virus



WSMV

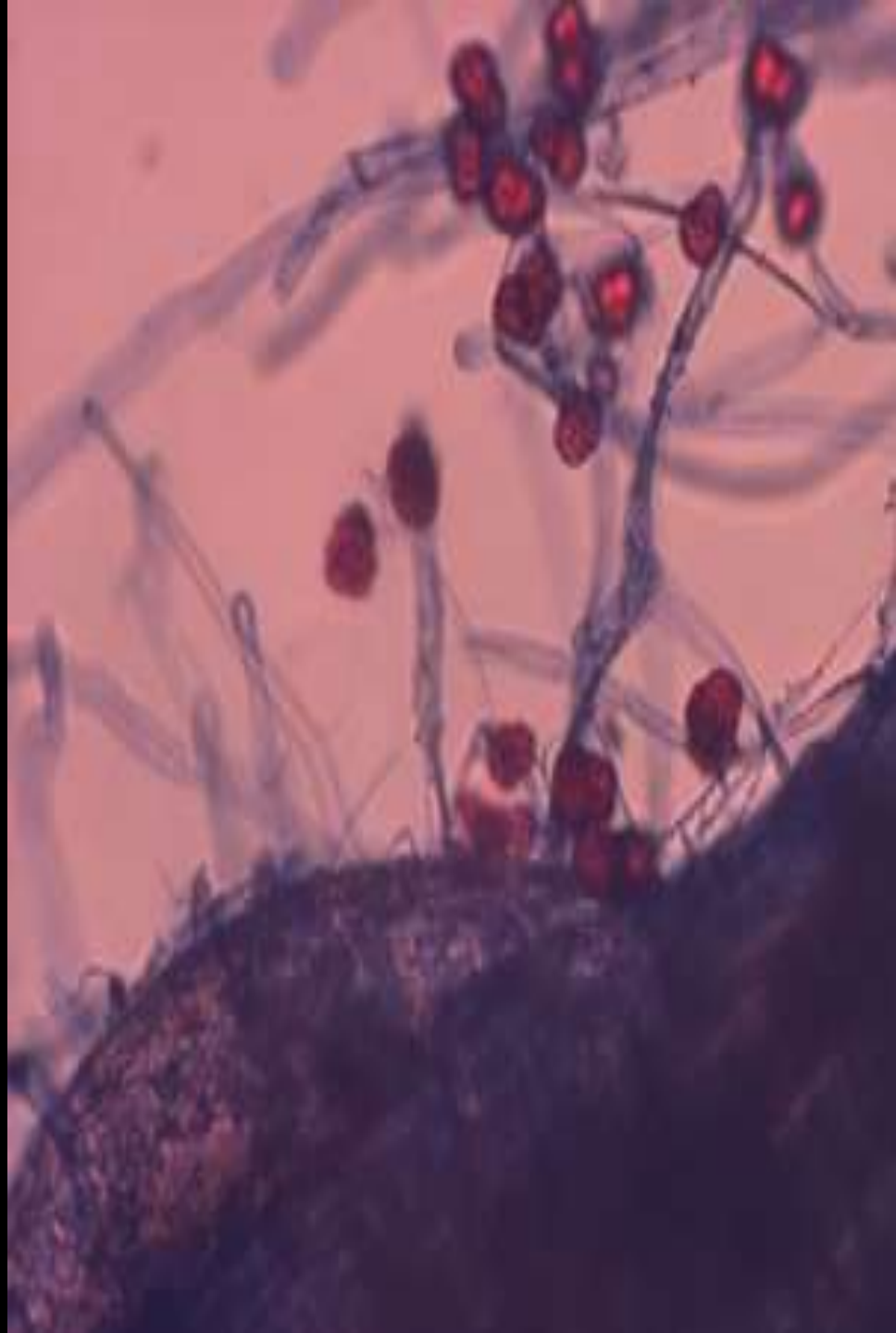




Cereal cyst nematode



Root knot



Crop Rotation

- ▣ Wheat performs best:
 - with non-cereals
 - with other cereals
 - with winter/spring cereals
- ▣ Wheat one of the few cereals where monoculture is attempted.

Crop Rotation

- ▣ Wheat one of the few cereals where monoculture is attempted:
 - Continuous winter wheat.
 - Winter/Spring/Fallow.
 - Winter wheat/crop fallow.
 - Winter/Winter/Potato (irrigated) or pea/canola (rain fed).

Effects of Monoculture

- ▣ Winter annual grasses.
- ▣ Seedling diseases:
 - *Pythium*.
- ▣ Root diseases:
 - *Rhizoctonia*, Take-all,
 - Strawbreaker (*Pseudocercospora*) foot rot.
- ▣ Effects Compounded by Reduced Tillage:
 - Hessian fly.
 - *Cephalosporium* strip.

Avoid Monoculture Effects

- ▣ Hessian fly (Spring wheat)
 - Resistance monogenic (H3 common)
- ▣ Strawbreaker foot rot resistance
 - VPM1: (*pch1*) Madsen, Weatherford
- ▣ Cephalosporium strip resistance
 - Eltan, Karl (Midwest)

Avoid Monoculture Effects

- ▣ Pop-up fertilizer to manage seedling diseases.
- ▣ Grasses managed with:
 - Selective sulfonylureas (Maverick).
 - Non-selective spring application followed by spring crop.
 - IMI-tolerant wheat cultivars.



Wheat

Hybrid

JGG



Irrigation Effects

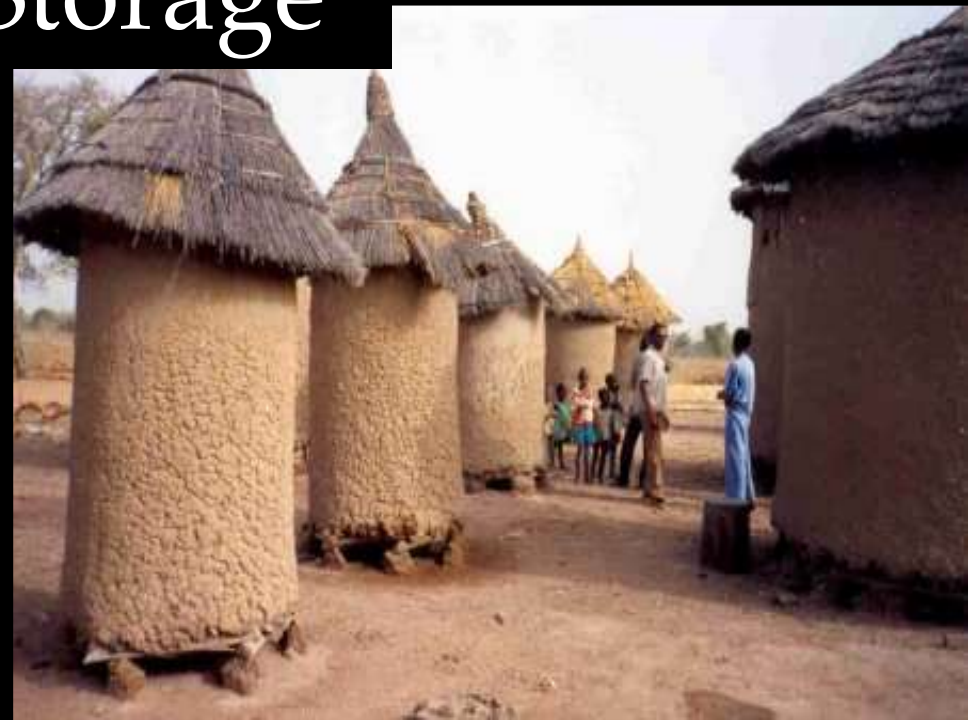
Irrigation Treatment	Yield	Flour Yield	Flour Protein	Flour Ash
	Bu/a	%	%	%
Minimum	100.7 c	63.9 c	12.0 a	0.406 b
Moderate	111.7 b	64.8 b	12.1 a	0.391 a
Optimum	131.5 a	65.9 a	11.5 b	0.389 a

Harvest





Grain Storage



Grain Storage

- ▣ High purity: Cleaned to remove admixtures, weed seeds and chaff.
- ▣ Good physical condition: no shrinkage or discoloration.
- ▣ Minimal physical damage: cracks and splits.
- ▣ High viability: If used for planting.
- ▣ No insect damage (holes or devoured contents).
- ▣ No disease or molds: Suitable drying prior to storage can reduce these.

Grain Storage

- ▣ No contamination from rodent droppings.
- ▣ No pesticide residues, particularly is treated with pesticides while in storage.
- ▣ No toxic microbial metabolites as a result of mold infection.
- ▣ No loss of flavor caused by excessive heat .
- ▣ No foul odor caused my high moisture or disease.
- ▣ Adequate seed moisture (i.e. US grade 1, 2 and 3 = 13, 14 and 15% moisture in soybean).

Wheat Grades

Factor	U.S. Grade Numbers				
	1	2	3	4	5
Test weight	Minimum pounds limit of:				
HRS or White club (lbs/bu)	58	57	55	53	50
All other classes	60	58	56	54	51
	Maximum % limits of:				
Heat damaged kernels	0.2	0.2	0.5	1.0	3.0
Total damaged kernels	2.0	4.0	7.0	10.0	15.0
Shrunken & broken kernels	3.0	5.0	8.0	12.0	20.0
Foreign material	0.4	0.7	1.3	3.0	5.0
Other contrasting wheat classes	1.0	2.0	3.0	10.0	10.0
Other wheat classes total	3.0	5.0	10.0	10.0	10.0
Stones	0.1	0.1	0.1	0.1	0.1



Barley