

# USDA-ARS Sunflower Crop Wild Relatives Genetic Resources Collection

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*H. anomalus*, Utah



**“The greatest service which can be rendered any country is to add a useful plant to its culture”**

**Thomas Jefferson 1790**



**Abraham Lincoln -- 16th  
president of the United  
States from 1861 to 1865.**



**USDA founded in 1862 as the “People’s Department”**

# History

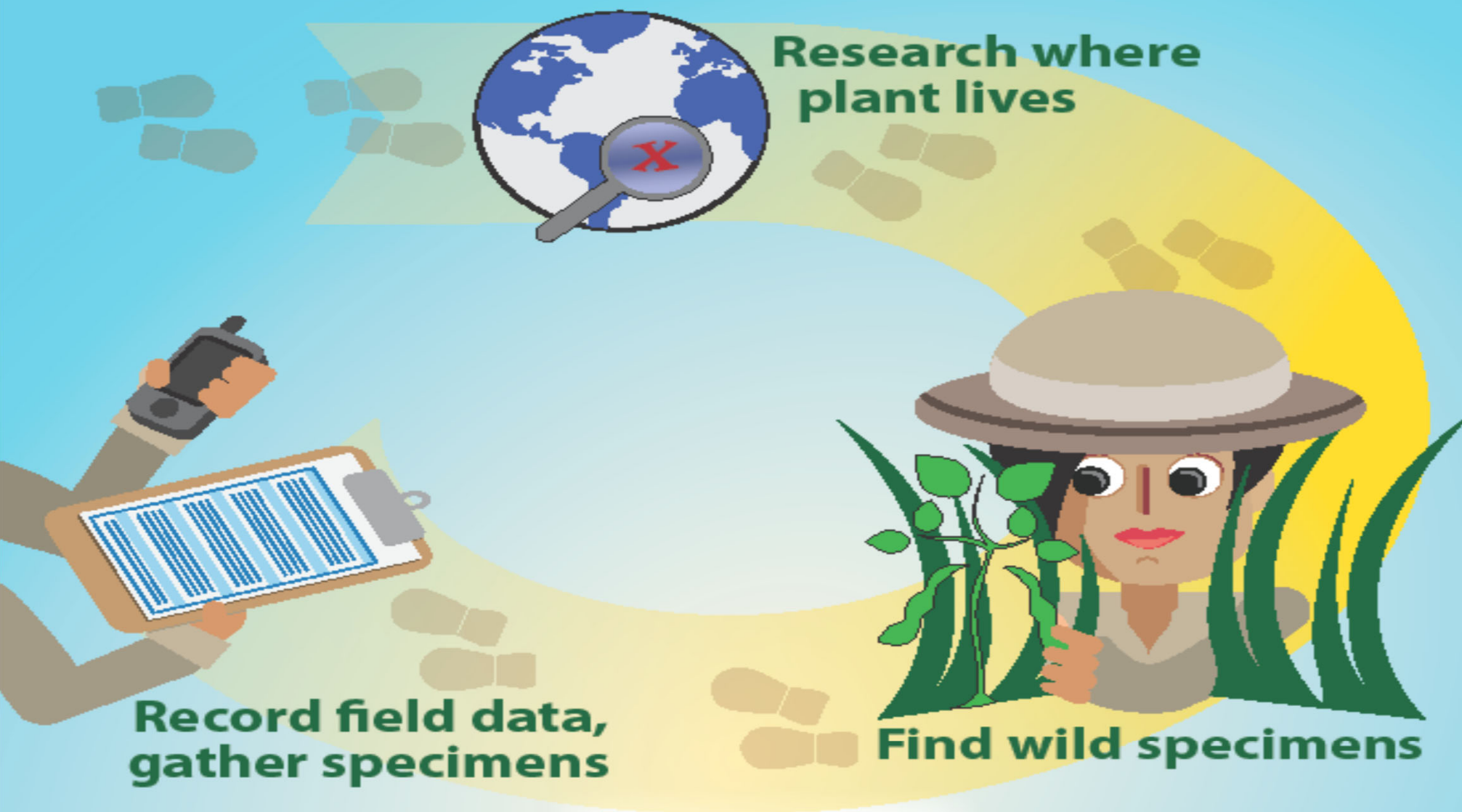


- **1898 - Section of Seed and Plant Introduction**
- **1946 - Research & Marketing Act (P.L. 733)**
- **1947-1952 - Regional Plant Introduction Stations**
- **1958 - National Seed Storage Laboratory**
- **1978 - Germplasm Resources Information Network (GRIN)**

# Mission

- **To collect, document, preserve, evaluate, enhance and distribute plant genetic resources for improving the quality and production of economic crops important to U.S. and world agriculture**

# The search for crop wild relatives



# What happens to crop wild relatives' seeds?



**Evaluate  
seed quality**



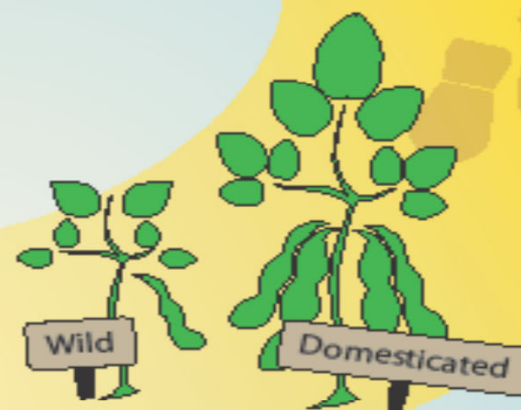
**Preserve seeds**



**Ship to  
interested crop breeders**



**Achieve better  
food security  
with new  
variety**



**Breed using  
crop wild relative**



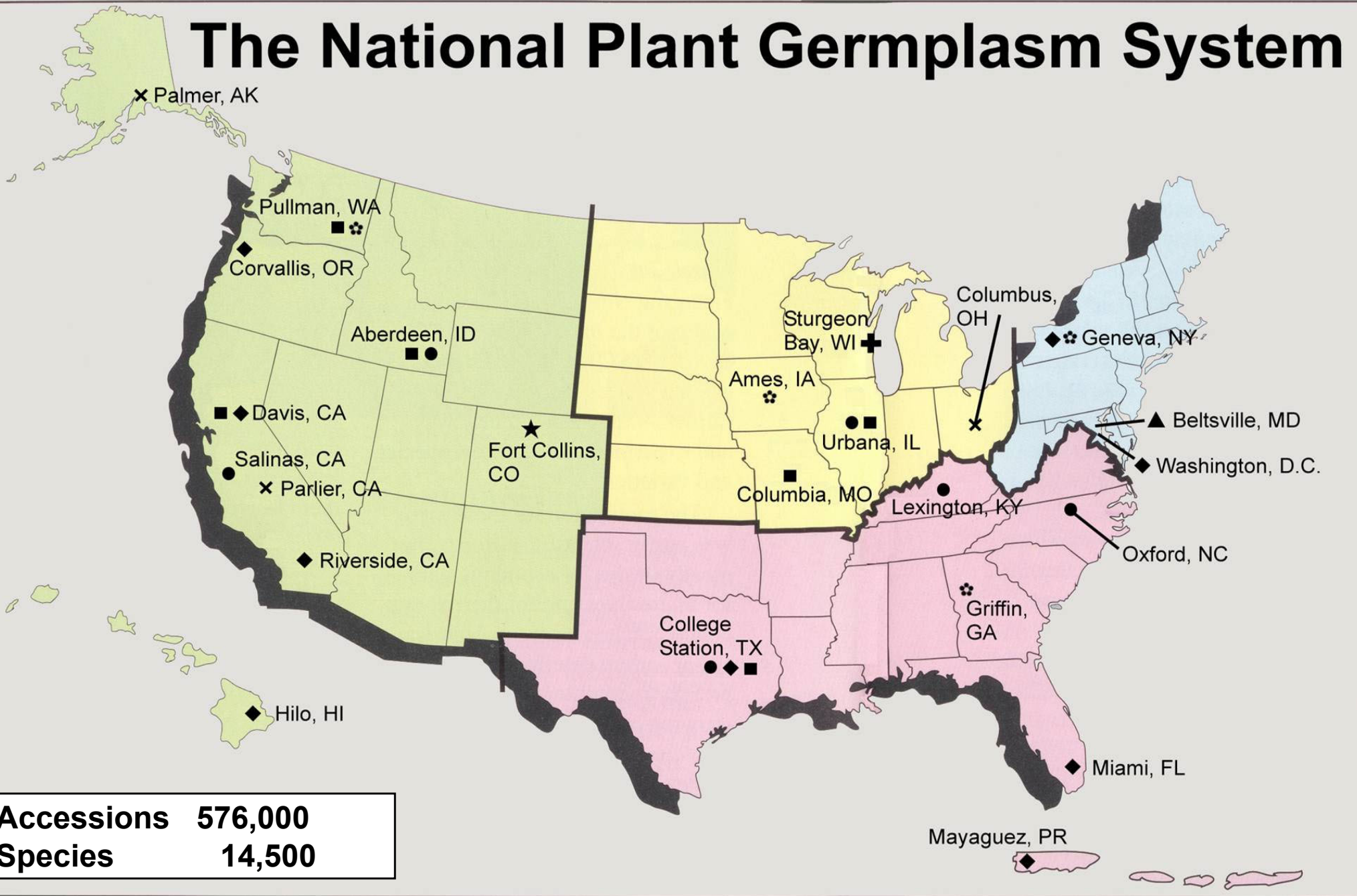
**Genetic resources are the biological basis of global food security.**

**Preservation of cultivars, landraces, and wild relatives of important plant species provides the basic foundation to promote and sustain agriculture.**

**Campbell et al., 2010**



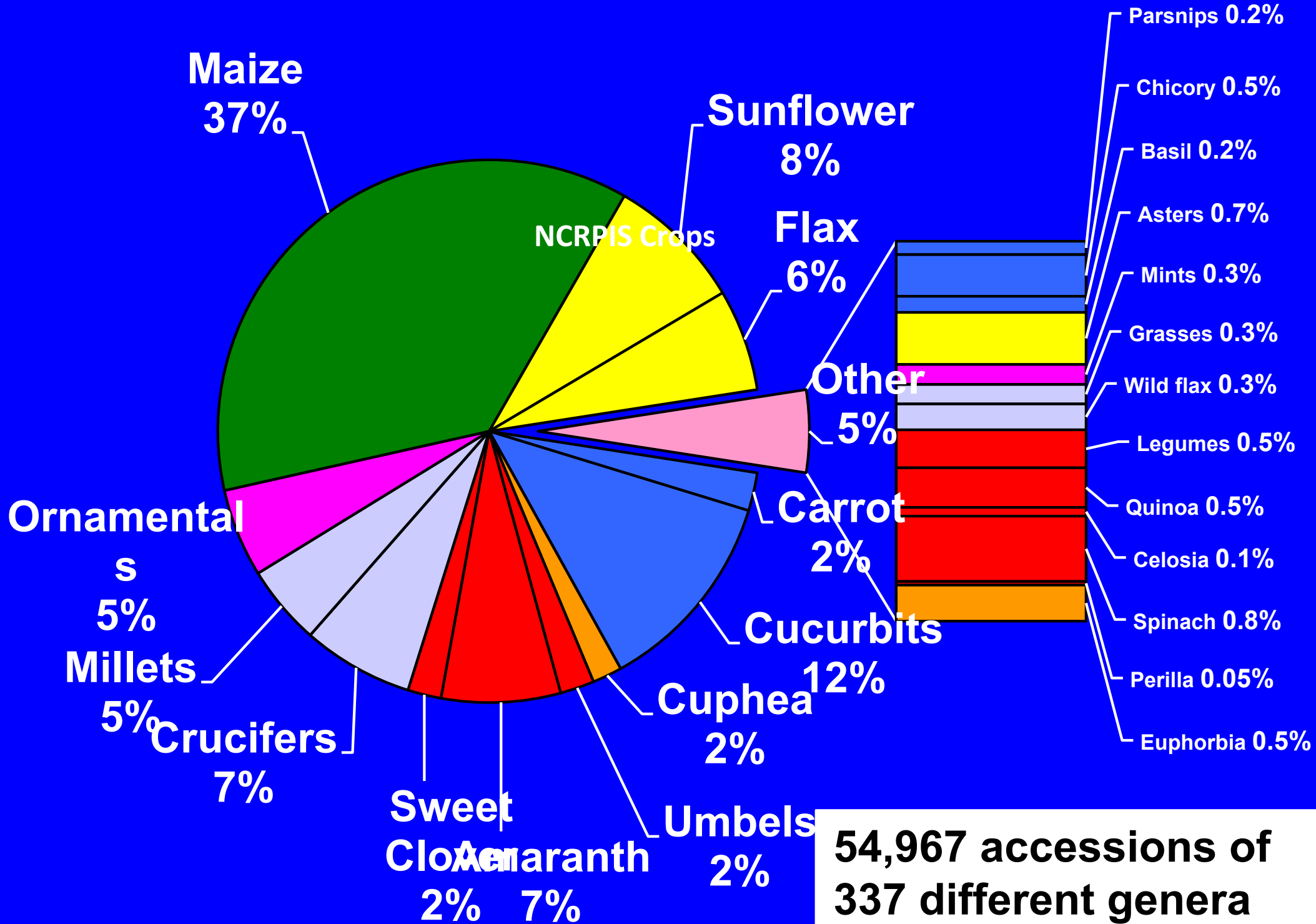
# The National Plant Germplasm System



- ✱ Regional Plant Introduction Station
- Crop-specific seed collection
- Crop-specific genetic stocks collection
- ◆ National Clonal Germplasm Repository
- ★ National Seed Storage Laboratory, Fort Collins, Colorado
- ✚ National Potato Introduction Station, Sturgeon Bay, Wisconsin
- ▲ National Germplasm Resources Laboratory, National Plant Germplasm Quarantine Center, Beltsville, Maryland
- ✕ Developing Site

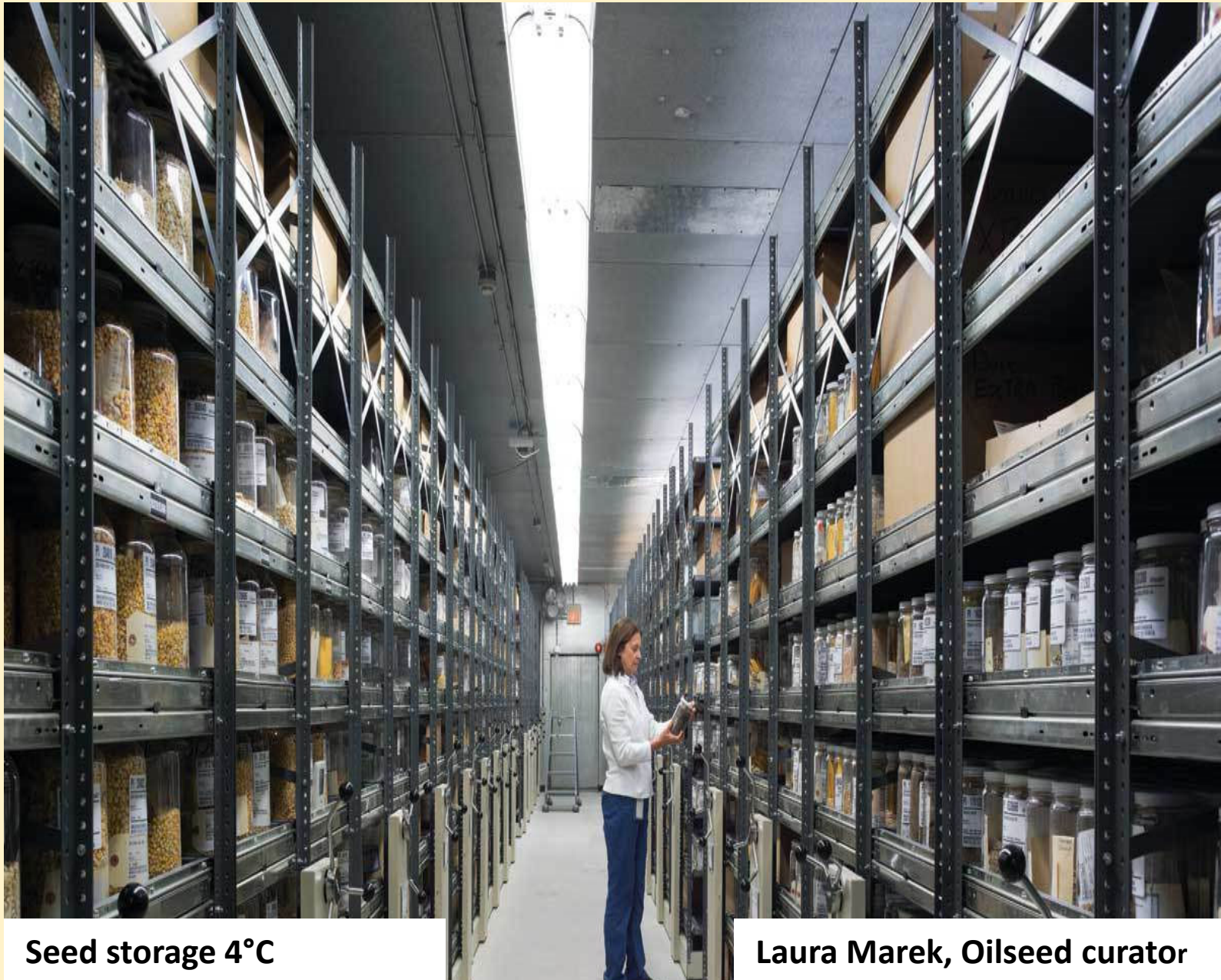
# USDA-ARS, National Plant Germplasm System, North Central Regional Plant Introduction Station (NC-7), Ames, IA







# NPGS Seed Storage Facility, Ames, IA

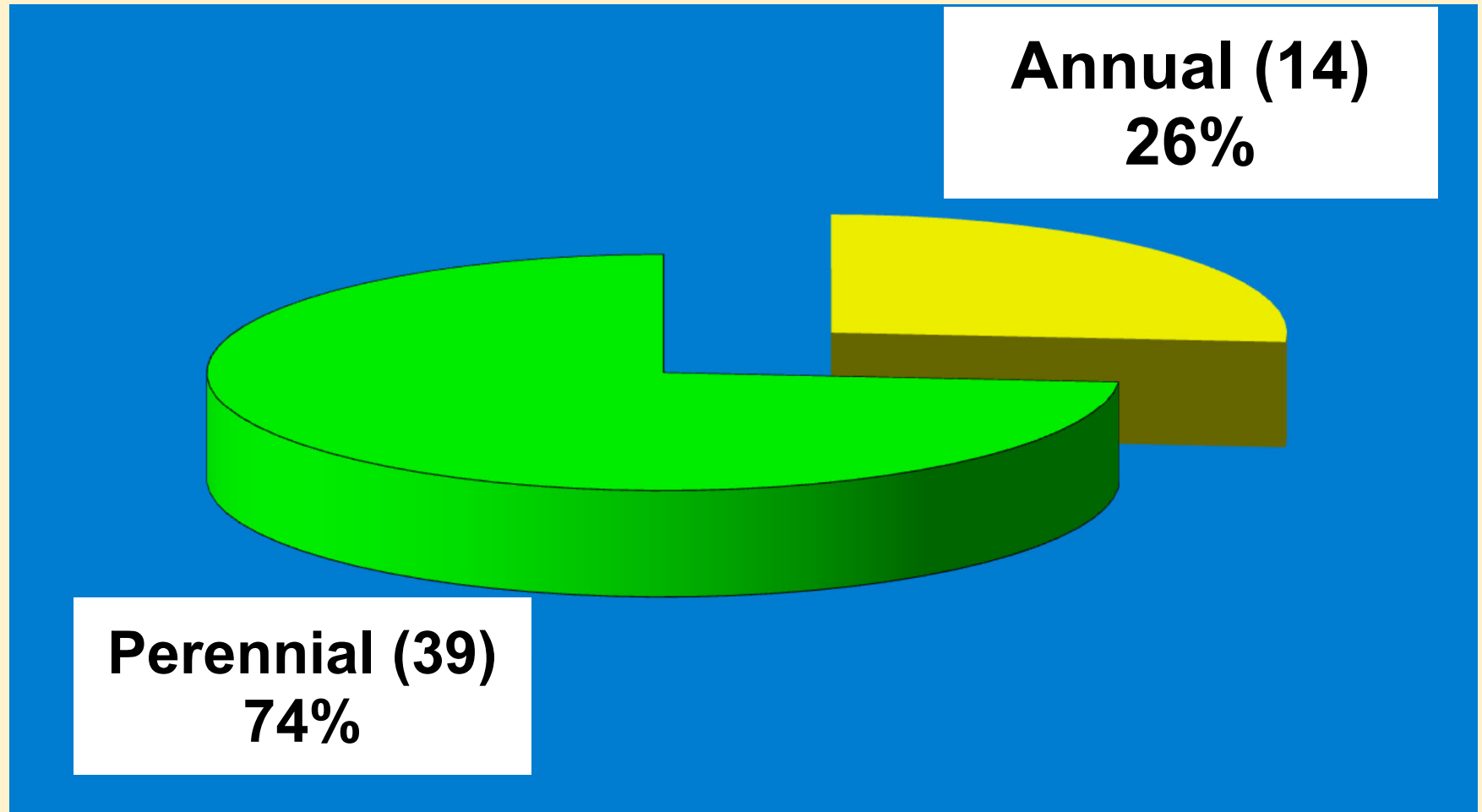


Seed storage 4°C

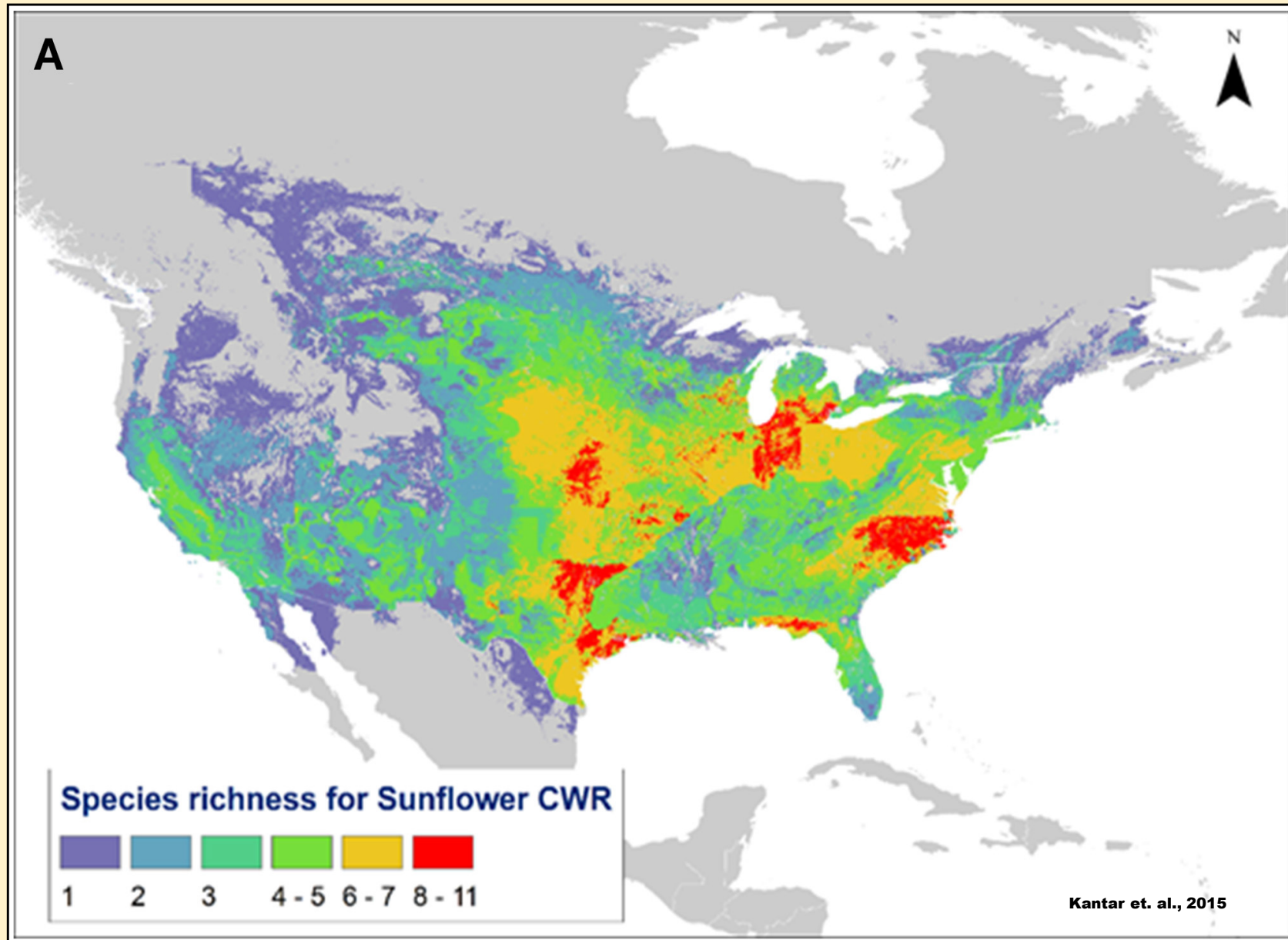
Laura Marek, Oilseed curator

Source: Modern Farmer (2015)

***Helianthus* Species  
(53 species, 67 taxa)**



# Distribution of Sunflower Crop Wild Relatives in the US





# Sunflower CWR Genetic Diversity

Cultivated ( $2n=2x=34$ )

14            annuals ( $2x=34$ )

39            perennials

29    wild diploids ( $2x=34$ )

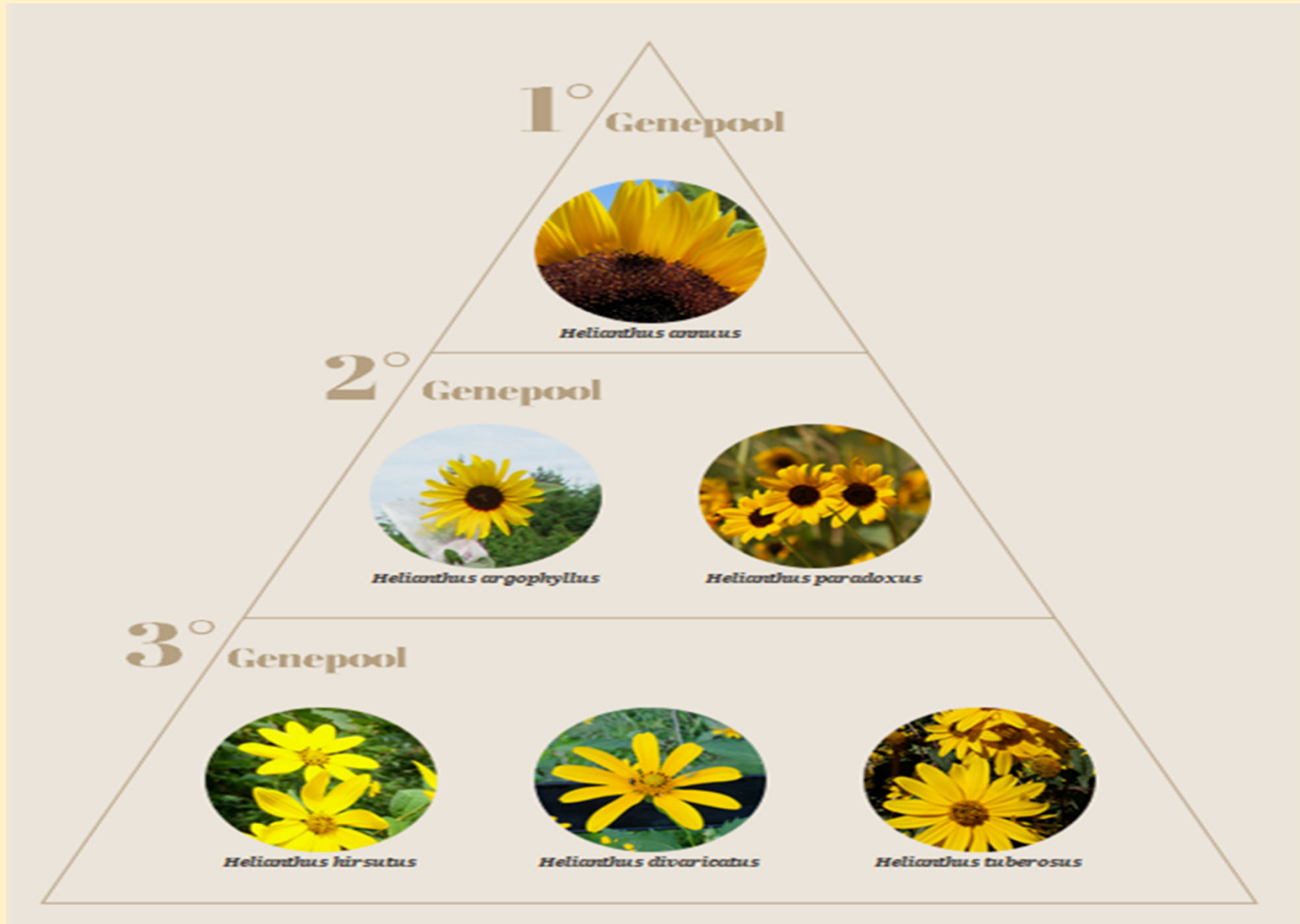
4    wild tetraploids ( $4x=68$ )

6    wild hexaploids ( $6x=102$ )

2    Mixaploid perennials ( $2n=2x=34, 4x=68$ )

2    Mixaploid perennials ( $2n=4x=68, 6x=102$ )

# Sunflower Gene Pools



# USDA Sunflower CWR Collection



*H. debilis*, Florida



*H. pumilus*, Wyoming



*H. niveus*, California

Species	Number of accessions	Available %
<b>Annual</b>	<b>1,692</b>	<b>91</b>
<i>H. annuus</i>	<b>1,056</b>	<b>97</b>
<b>Other (13 species)</b>	<b>636</b>	<b>93</b>
<b>Perennial (39 species)</b>	<b>899</b>	<b>83</b>
<b>TOTAL</b>	<b>2,591</b>	<b>91</b>



# Wild Sunflower Species Seed Increases



# Wild Species Traits of Value

**Downy mildew resistance**

**Rust resistance**

**Powdery mildew resistance**

**Phomopsis tolerance**

**Verticillium wilt resistance**

**Sclerotinia resistance**

**Alternaria leaf spot resistance**

**Broomrape resistance**

**Cytoplasmic male sterility**

**Insect resistance**

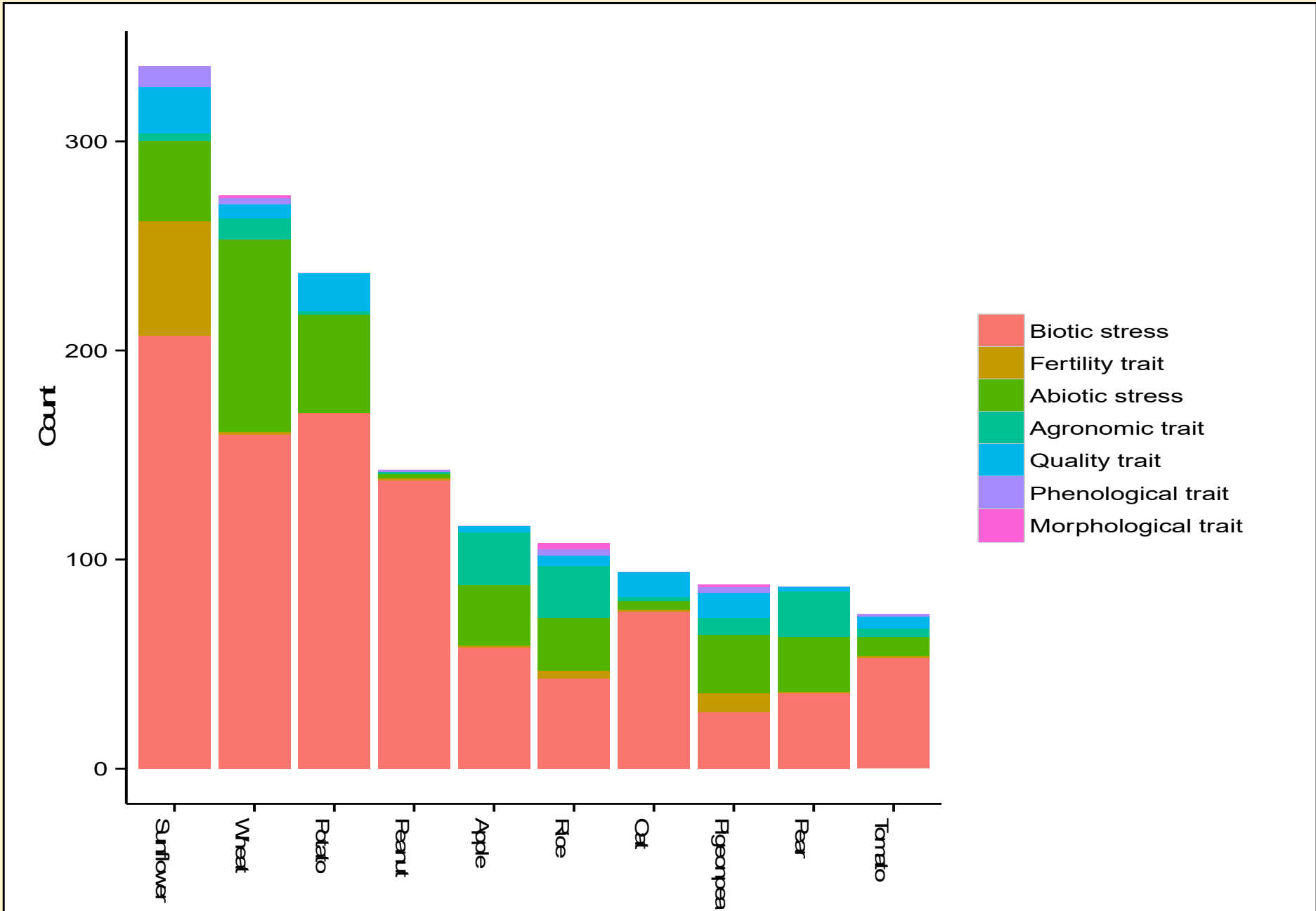
**Herbicide resistance**

**Salt tolerance**

**Early maturity**

**Drought tolerance**

# Sunflower CWR Are Widely Used in Breeding





## Use of CWR in the Past 20 Years for 13 Important International Food Crops

Crop	Diseases/ insects	Abiotic stress	Male sterility	Total traits contributed
	<b>Number of species</b>			
<b>Tomato</b>	<b>10</b>	<b>2</b>	<b>0</b>	<b>55</b>
<b>Rice</b>	<b>7</b>	<b>3</b>	<b>1</b>	<b>12</b>
<b>Potato</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>12</b>
<b>Wheat</b>	<b>11</b>	<b>0</b>	<b>0</b>	<b>9</b>
<b>Sunflower</b>	<b>5</b>	<b>1</b>	<b>1</b>	<b>7</b>

## **Wild *Helianthus* Sources of Resistance for Sunflower Diseases**

<b>Disease</b>	<b>Wild species</b>	
	<b>Annual</b>	<b>Perennial</b>
<b>Rust</b>	<b>3</b>	<b>5</b>
<b>Downy mildew</b>	<b>10</b>	<b>15</b>
<b>Sclerotinia</b>	<b>7</b>	<b>18</b>
<b>Phomopsis</b>	<b>7</b>	<b>18</b>
<b>Alternaria</b>	<b>3</b>	<b>9</b>
<b>Powdery mildew</b>	<b>3</b>	<b>9</b>
<b>Rhizopus</b>	<b>0</b>	<b>4</b>
<b>Phoma</b>	<b>2</b>	<b>8</b>
<b>Charcoal rot</b>	<b>0</b>	<b>5</b>
<b>Broomrape</b>	<b>5</b>	<b>25</b>
<b>Verticillium</b>	<b>4</b>	<b>3</b>

# **Distribution of Sunflower CWR Accessions 2010-2019**

- **36,000 individual samples distributed**
- **1,214 orders, 923 domestic and 291 international**
- **Distribution roughly three fold increase over previous 10-year period**



# **Sunflower CWR Economic Impact**

## **\$\$\$**

- **310-445 million USD yearly**  
(Tyack et al., 2020)
- **267-384 million USD yearly**  
(Hunter and Weywood, 2011)

# USDA Releases for Herbicide Resistance (2007-2017)

<b>Line</b>	<b>Release Date</b>	<b>Herbicide</b>
HA 469	2007	SU
RHA 470	2007	SU
RHA 471	2007	IMI
RHA 474	2011	IMI
RHA 475	2011	IMI
HOSL 1	2015	IMI
HOSL 2	2015	IMI
HOSL 3	2015	IMI
HOSL 4	2015	IMI
RHA 480	2016	IMI
RHA 477	2016	IMI
RHA 478	2016	IMI
HA 487	2017	IMI
RHA 486	2017	IMI
RHA 484	2017	IMI
RHA 483	2017	IMI

# USDA Releases for Downy Mildew Resistance

<b>Sunflower Line</b>	<b>Type</b>	<b>Gene Origin</b>	<b>Release Date</b>
<b>RHA 477</b>	<b>Oilseed</b>	<b><i>H. argophyllus</i></b>	<b>2016</b>
<b>HA-DM2</b>	<b>Confection</b>	<b><i>H. arg/H. ann</i></b>	<b>2016</b>
<b>HA-DM3</b>	<b>Confection</b>	<b><i>H. annuus</i></b>	<b>2016</b>
<b>HA-DM4</b>	<b>Confection</b>	<b><i>H. argophyllus</i></b>	<b>2016</b>
<b>HA-DM5</b>	<b>Confection</b>	<b><i>H. annuus</i></b>	<b>2016</b>
<b>HA-DM6</b>	<b>Oilseed</b>	<b><i>H. argophyllus</i></b>	<b>2017</b>
<b>HA-DM7</b>	<b>Confection</b>	<b><i>H. argophyllus</i></b>	<b>2017</b>



# USDA Releases for Sclerotinia Basal Stock Rot Resistance

Line	Release Date	Gene Origin	Type
HA-BSR2	2017	<i>H. petiolaris</i>	Oilseed
HA-BSR3	2017	<i>H. argophyllus</i>	Oilseed
HA-BSR4	2017	<i>H. argophyllus</i>	Oilseed
HA-BSR5	2017	<i>H. argophyllus</i>	Oilseed
HA-BSR6	2017	<i>H. praecox</i>	Oilseed
HA-BSR7	2017	<i>H. praecox</i>	Oilseed
HA-BSR8	2017	<i>H. praecox</i>	Oilseed
BSR DIV 830	2017	<i>H. divaricatus</i>	Oilseed
BSR STR 1623	2017	<i>H. strumosus</i>	Oilseed
BSR MAX +1314+1323	2017	<i>H. maximiliani</i>	Oilseed

# Conclusion

**Sunflower CWR will be important in the future to combat emerging pests and environmental challenges, helping to maintain sunflower as a viable major global oilseed crop, preserving it for future generations, and serving as a genomic reservoir for plant breeders.**



**Thank you**