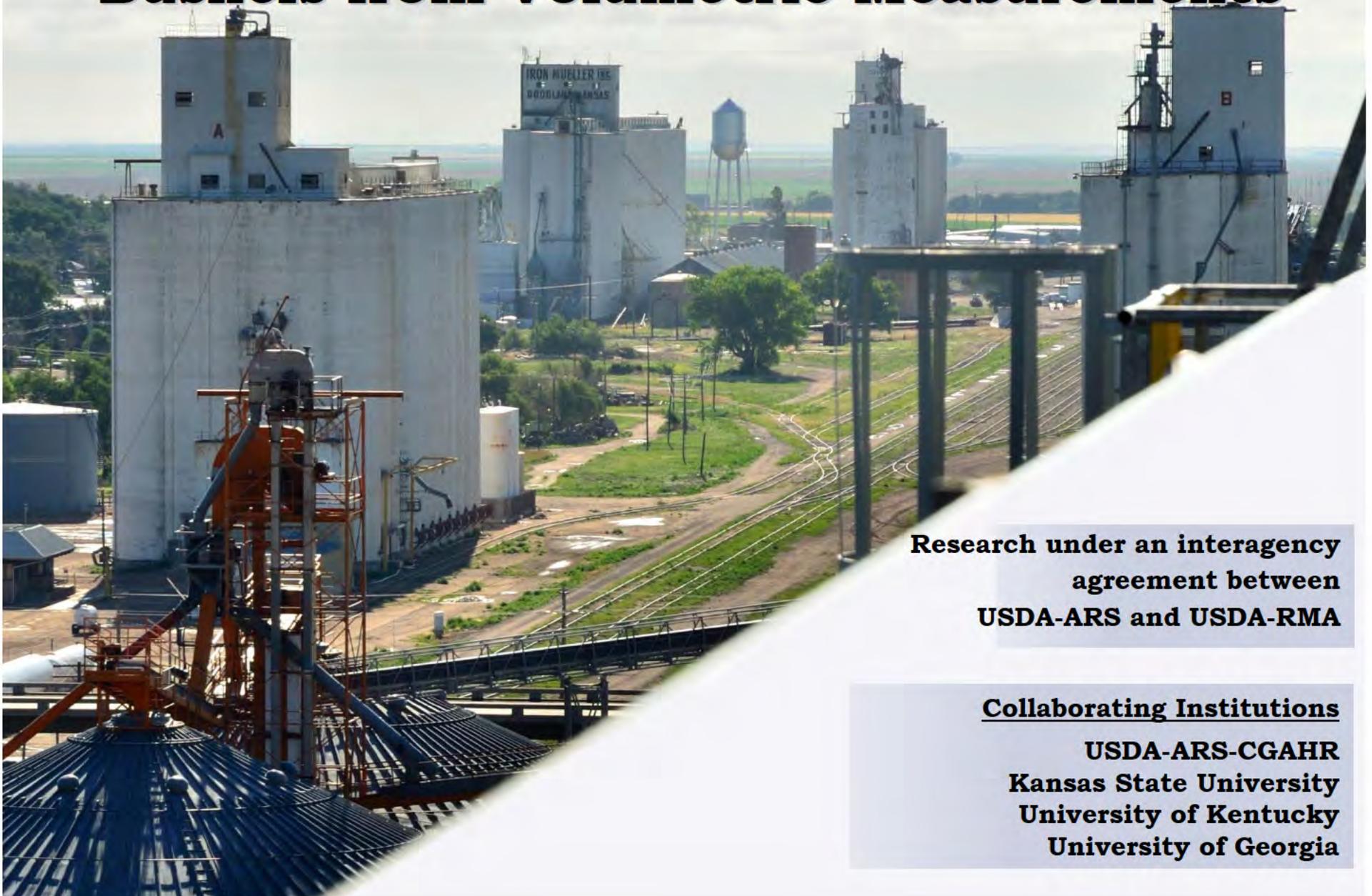


# Updating the Pack Factor for Calculation of Bushels from Volumetric Measurements



**Research under an interagency  
agreement between  
USDA-ARS and USDA-RMA**

## **Collaborating Institutions**

**USDA-ARS-CGAHR  
Kansas State University  
University of Kentucky  
University of Georgia**

# Research Team



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Sid Thompson  
Univ. of Georgia

# What is Pack Factor?

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- ▶ Pack factor - an adjustment factor used to accurately determine weight of grain stored in a grain bin
  - ▶ use grain volume measurements
  - ▶ accounts for the overbearing pressure of grain above
- ▶ Also called “Pack,” “Packing factor,” or “Compaction”
- ▶ Different impacts of pack factor on operations:
  - ▶ Grain Elevators
  - ▶ On-Farm Bins



# What is Pack Factor?

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- ▶ **Grain Elevators:**

- ▶ Important for accurate grain inventory
  - ▶ Internal use – Quality Management Systems
  - ▶ Auditing – state or federal warehouse officials
  - ▶ Loan collateral

- ▶ **On-Farm Bins:**

- ▶ Important for insurance or loan purposes (RMA and FSA county offices)

# Project Objectives

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- ▶ Develop new stored grain pack factors for six grains: wheat, corn, soybean, sorghum, oats, and barley
  - ▶ Obtain nationwide field data of pack factors in a wide range of bin sizes (small farm bin sizes up to Million bushel bins) along with laboratory compaction data
- ▶ Incorporate new pack factors into a user-friendly, windows-based software package for use by the grain industry

# General Trends on Packing Effects\*

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- ▶ Doubling the grain height
  - ▶ Increase pack factor by 0.5 - 1.2 %
- ▶ Doubling the bin diameter
  - ▶ Increase pack factor by 0.2 - 0.3 %
- ▶ Increasing the moisture by 3-6%
  - ▶ Increase pack factor by 0.20 - 0.90 %

\* Research from ASAE journals. The test crops were Wheat, Corn and Soybeans

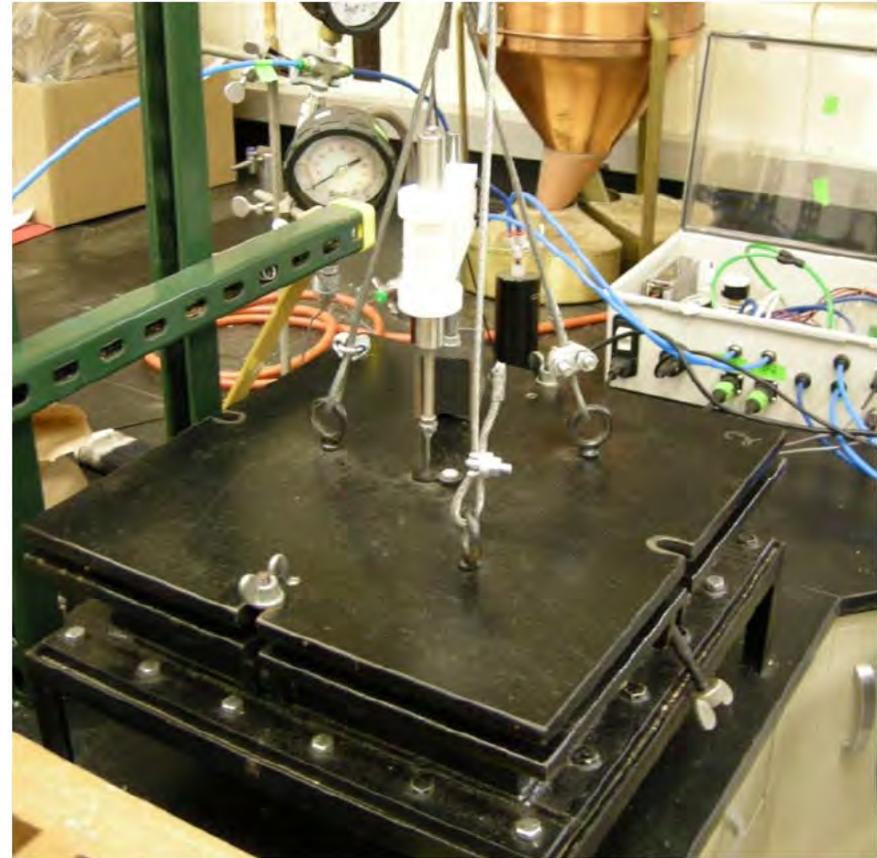
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# Laboratory Compressibility Tester

University of Kentucky  
Granular Mechanics Laboratory

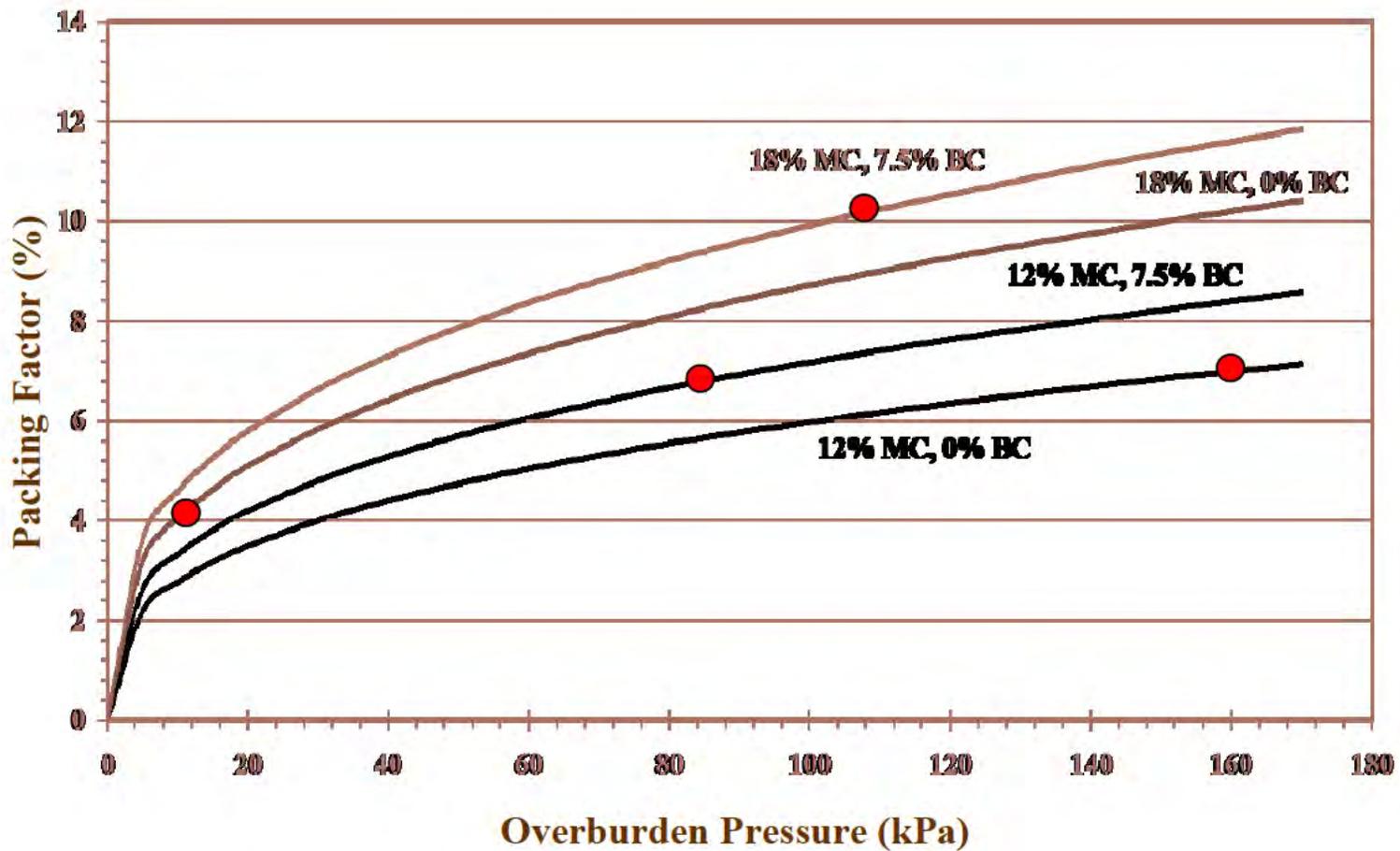


Fill the tester with grain



Compress the grain  
by applying pressure

# Compressibility of Corn from Lab Measurements



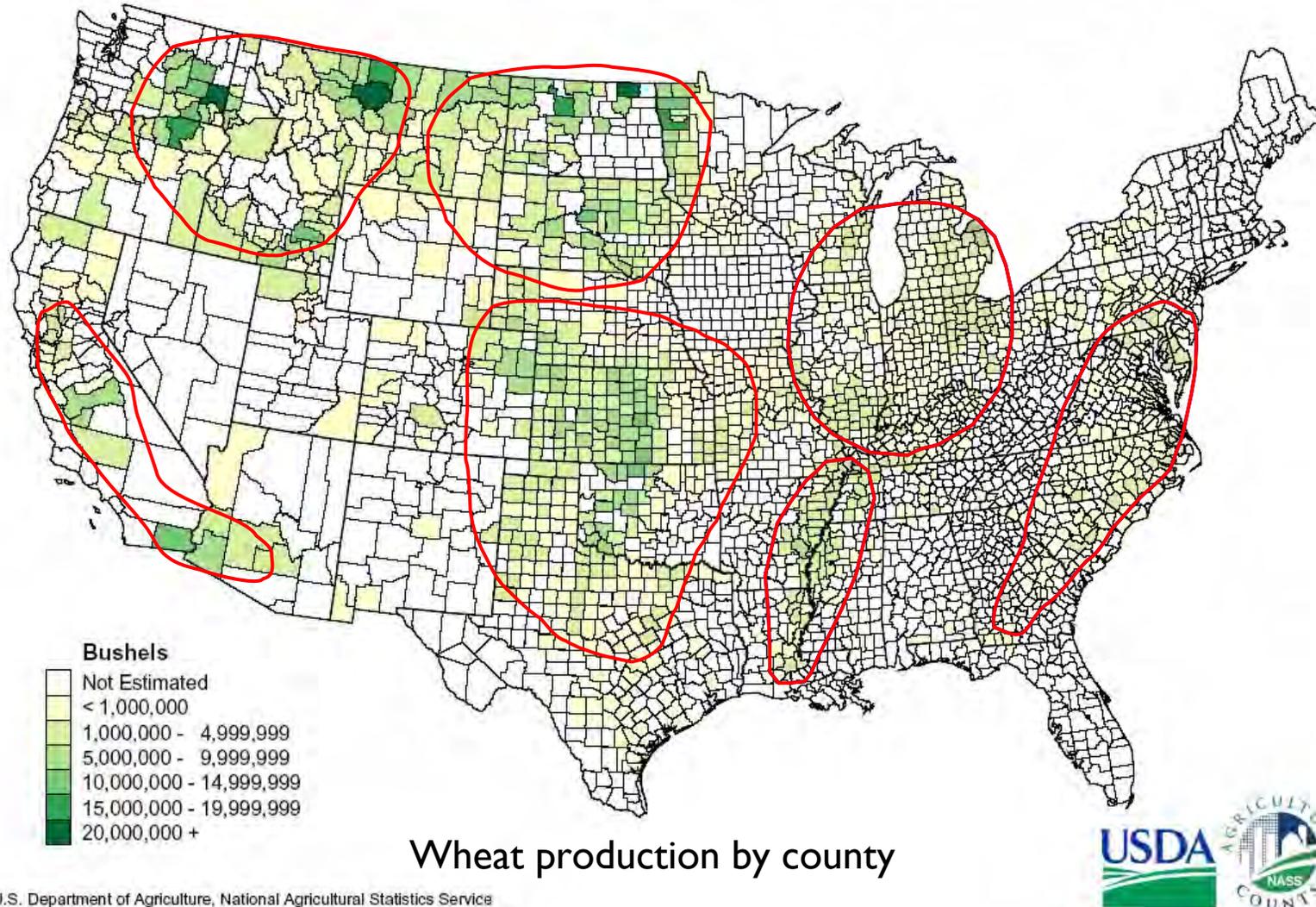
Note: Red dots may represent field measurements.

# Field Measurements

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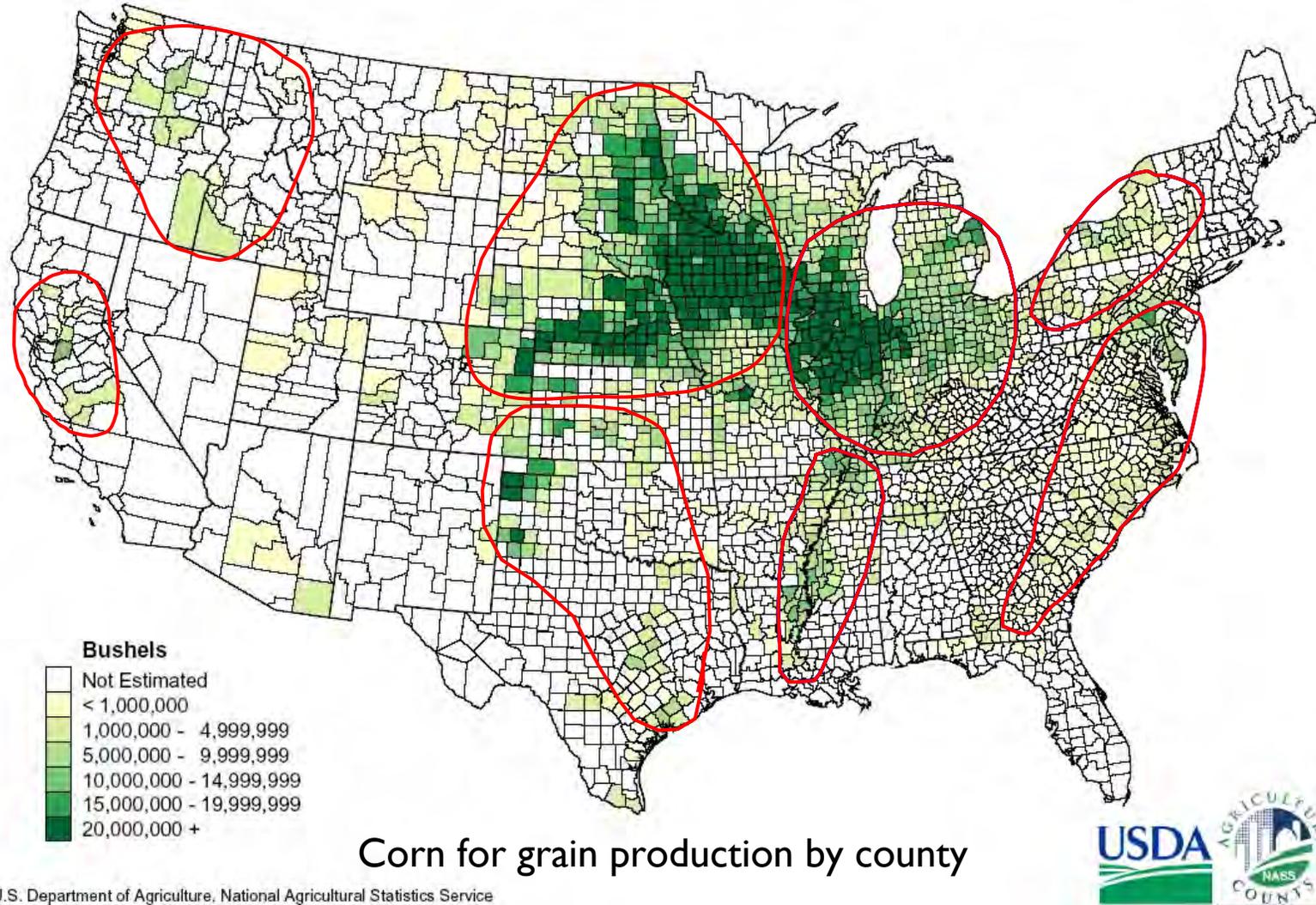
- ▶ Wide range of upright bin sizes, types
- ▶ Six grains: wheat, corn, soybean, sorghum, oats, and barley
- ▶ All major grain-producing locations within the U.S. emphasizing the:
  - ▶ Midwest,
  - ▶ Southern Mississippi River valley,
  - ▶ Central Plains,
  - ▶ Northern Plains.
- ▶ Expected locations for some crops illustrated next:

# Potential Location for Field Measurement – Wheat



U.S. Department of Agriculture, National Agricultural Statistics Service

# Potential Location for Field Measurement – Corn



U.S. Department of Agriculture, National Agricultural Statistics Service

## Data to be Measured/Collected

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- ▶ Grain type, Test weight, Moisture content
- ▶ Grain height (where grain intersects bin wall)
- ▶ Bin dimensions and Cone configuration
- ▶ Weight of grain at given depths (in lbs)
- ▶ Bin wall material
- ▶ Method used to fill bin
- ▶ Aeration practice

# Measurement Procedures

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## ▶ On-Farm Bins

- ▶ Measure bin dimensions and grain volume
- ▶ Collect weights and grain property data after the crop is sold

## ▶ Grain Elevators

- ▶ Measure bin dimensions and grain volume
- ▶ Collect weights and grain property data while incoming trucks are being unloaded

# Equipment/Laser Holder

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Leica Disto D8 (laser meter mounted on digital protractor)

Laser meter



# Commercial & On-Farm Bins



# Bins Measured To Date

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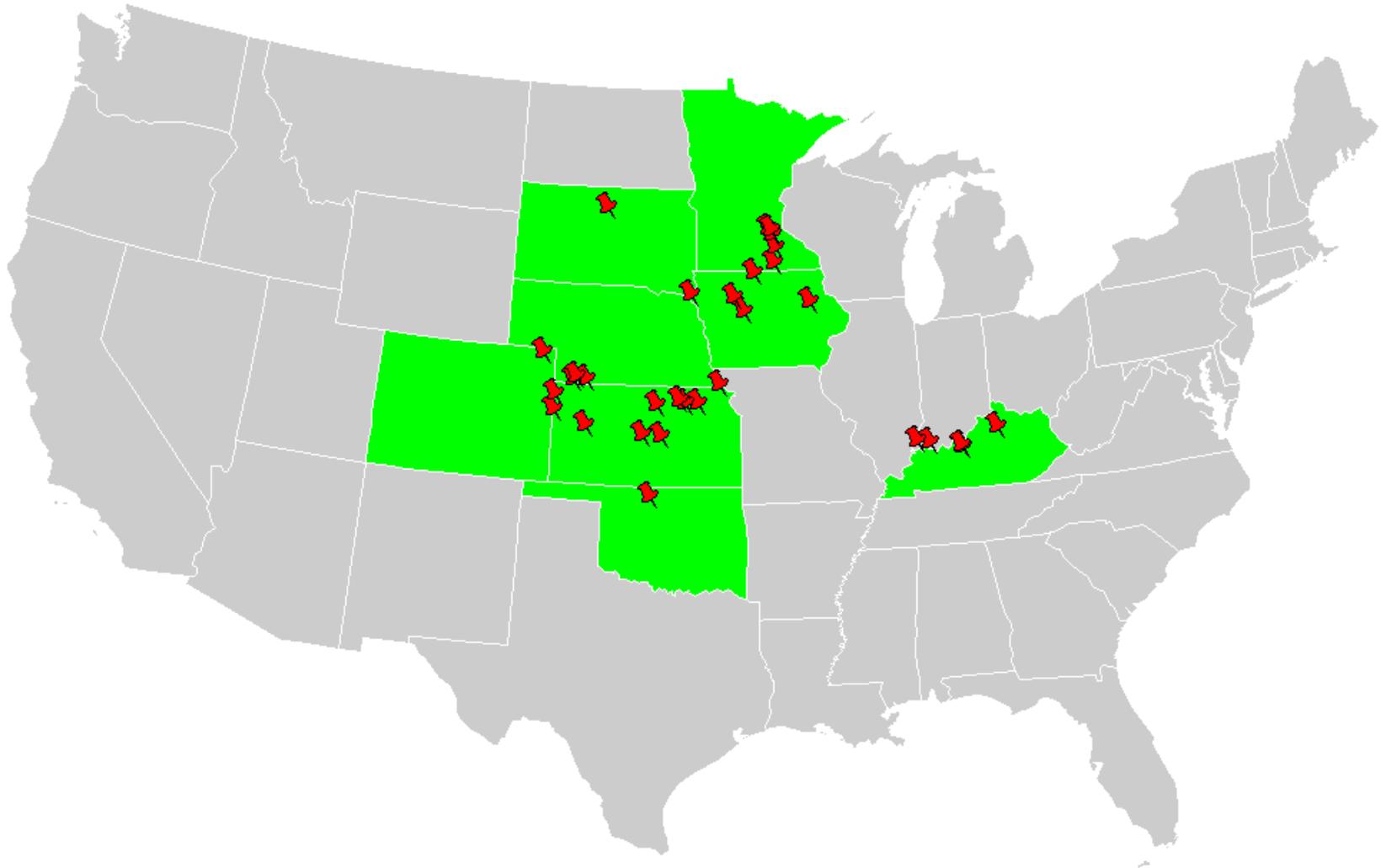
Summary		
Year	Crop	Total No. of Bins
2010	Corn	4
2010	Wheat*	15
2011	Corn**	29
2011	Wheat	32
2011	Sorghum**	4
2011	Oats	12
2011	Soybean**	12
<b>TOTAL</b>		<b>108</b>

\* For wheat, the dockage range was 0.30 – 1.0 %.

\*\*Waiting for grain properties for bins already measured.

# To Date: Field Locations Visited

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## Bins Measured To Date

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	Wheat	
	On-Farm Bins	Elevators
Pack Factor (%)	2.9 – 7.7	3.4 – 8.1
Moisture (% db)	10 – 13	10 – 13
Test Weight (lb/bu)	58 – 64	53 – 62
Bin Diameter (ft)	15 – 54	15 – 105
Grain Height (ft)	3.4 – 26	18 – 136
Total No. of Bins	13	34
States	KS and KY	OK and KS

# Bins Measured To Date

	<b>Corn</b>	<b>Oats</b>
	On-Farm Bins and Elevators	Elevators
Pack Factor (%)	2.7 – 8.0	19 – 33
Moisture (% db)	13 – 17	12 – 13
Test Weight (lb/bu)	55 – 58	39 – 43
Bin Diameter (ft)	12 – 105	22 – 90
Grain Height (ft)	8.6 – 97	46 – 99
Total No. of Bins	33 (13 finalized)*	12
States	KY, OK, IA, CO, KS and MN	NE and MN

\* Waiting for grain properties for 20 bins (for corn) already measured.

# Bins Measured To Date

	<b>Soybean</b>	<b>Sorghum</b>
	<b>Elevators</b>	<b>Elevators</b>
Pack Factor (%)	3.2 – 4.7	4.1 – 5.6
Moisture (% db)	8.5 – 11	13 – 15
Test Weight (lb/bu)	58 – 59	56 – 58
Bin Diameter (ft)	42 – 75	14.95 – 14.99
Grain Height (ft)	16 – 73	4.6 – 81
Total No. of Bins	12 (5 finalized)*	4 (3 finalized)*
States	SD and MN	OK

\* Waiting for grain properties for 7 bins (for soybeans) and 1 bin (for sorghum) already measured.

# Small vs. Large Bins

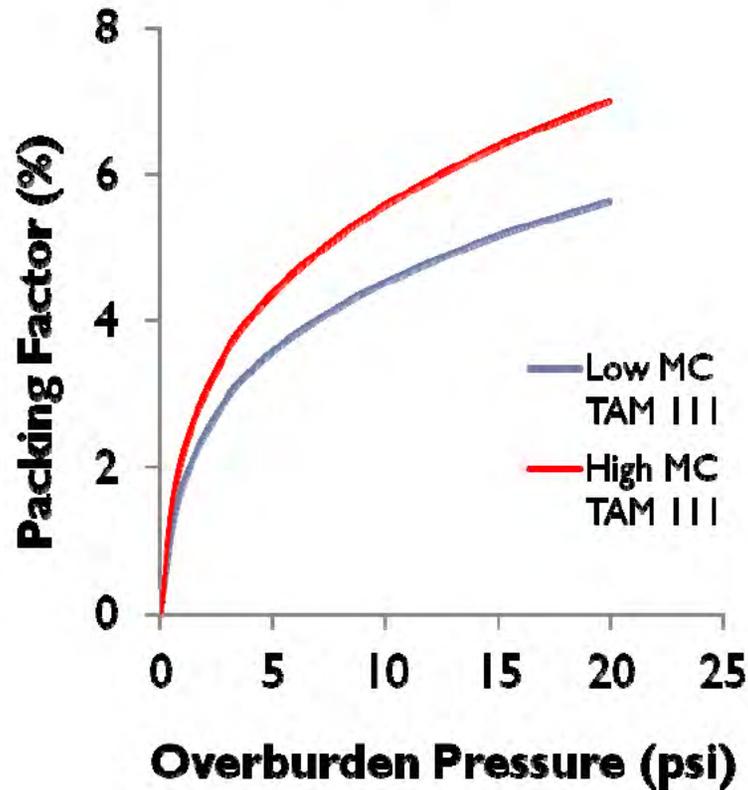
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## Crop: Corn

Properties	Small Bin	Large Bin
Grain Height (ft)	8.6	97
Bin Diameter (ft)	18	105
Test Weight (lb/bu)	55	55
Moisture Content (%)	15.5	15
Pack Factor (%)	2.7	6.6

# Effects of Additional Variables

**Variable: Moisture Content**  
**Crop: Wheat**

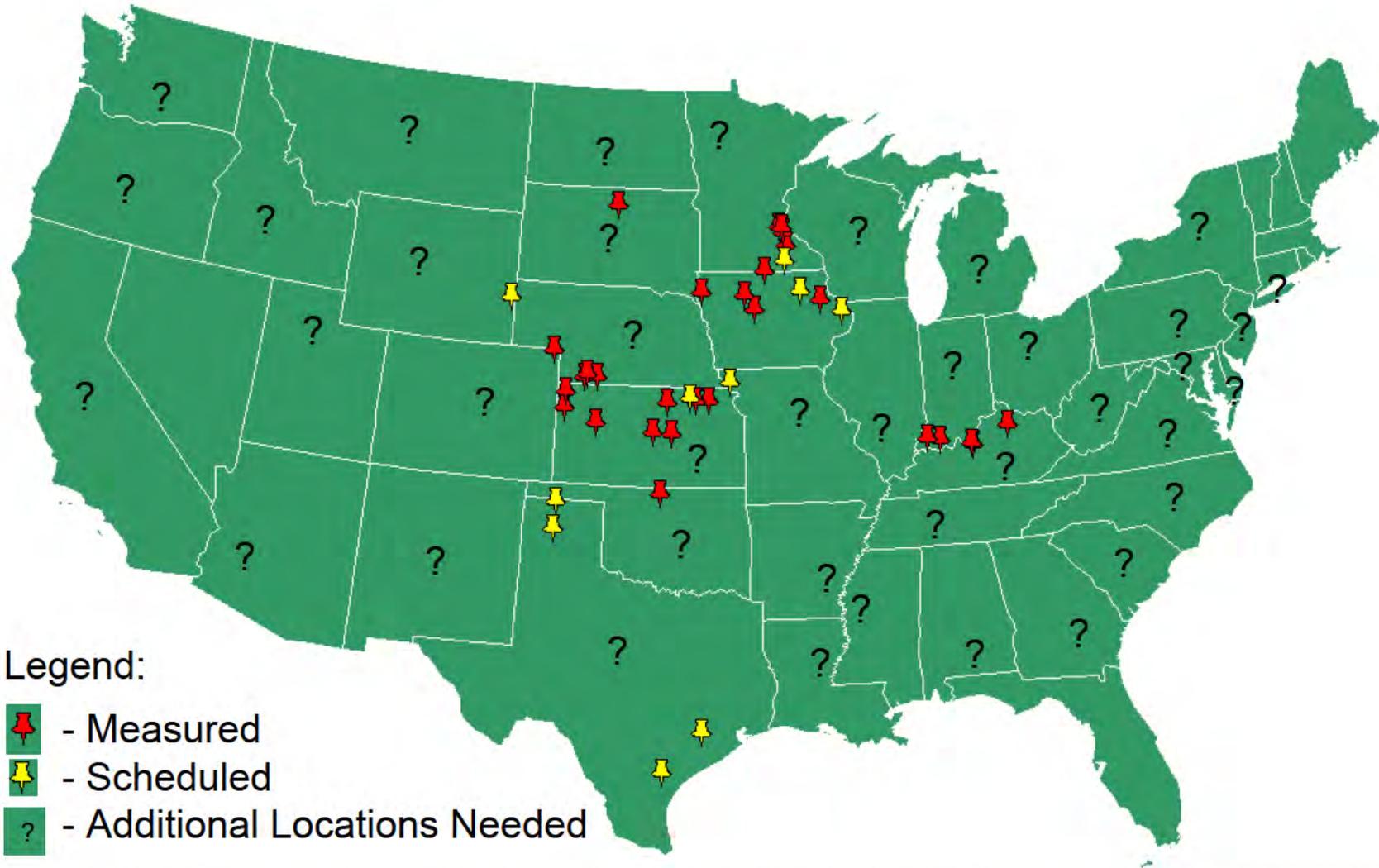


**Variable: Grain Height**  
**Crop: Wheat**

Properties	Short Grain Height	Tall Grain Height
Grain Height (ft)	37.5	127.5
Bin Diameter (ft)	14.95	14.95
Test Weight (lb/bu)	61	61
Moisture Content (%)	11.6	11.6
Pack Factor (%)	3.4	4.3

# Field Locations

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# More Field Locations

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Thank you.



Questions?

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