Inventory Management at the Next Level

Dr. Charles R. Hurburgh, Jr.

Professor, Agricultural and Biosystems Engineering

Iowa State University Extension

EXCHANGE 2015

Iowa Grain Quality Initiative

Learning Objectives

Weight:

Quantity in – Dockage* =

Quantity out – Dockage – Cleanings – Shrink

Quality (discount):

Quality in * Discount > Quality out * Discount

AKA: Q and Q

***Dockage factors are subtracted from weight**

Learning Objectives

1. Learn the Operations that Affect Inventory
    * Grading and inspection Q and Q
    * Shrink (several causes) Quantity
    * Deterioration Q and Q

2. Understand Connection of Inventory Balance to Net Profit

Inventory management means keeping track of everything from inbound to outbound.

Inbound Grading

New – 149 mHz

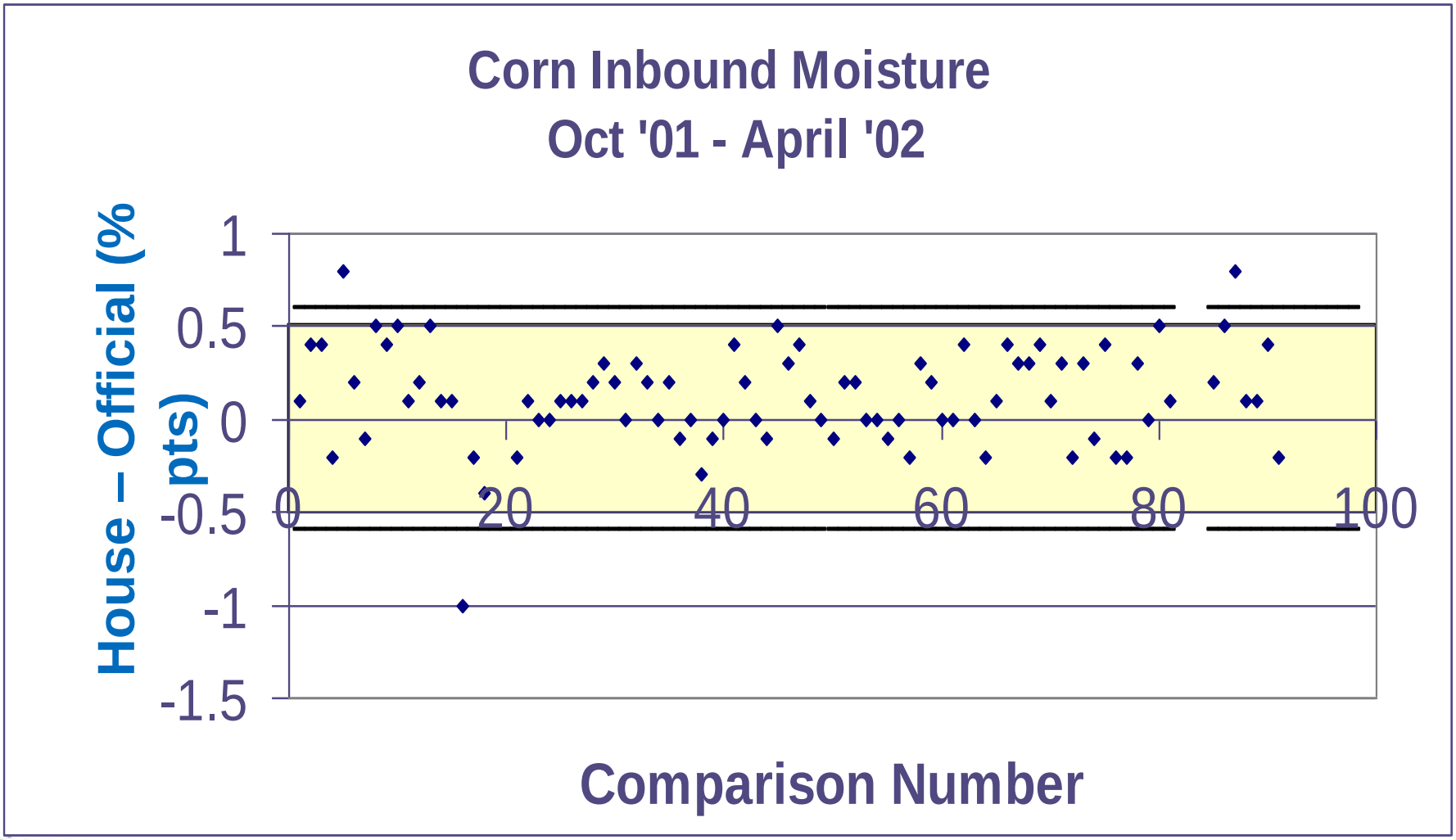
New – 149 mHz

Old – 2 mHz

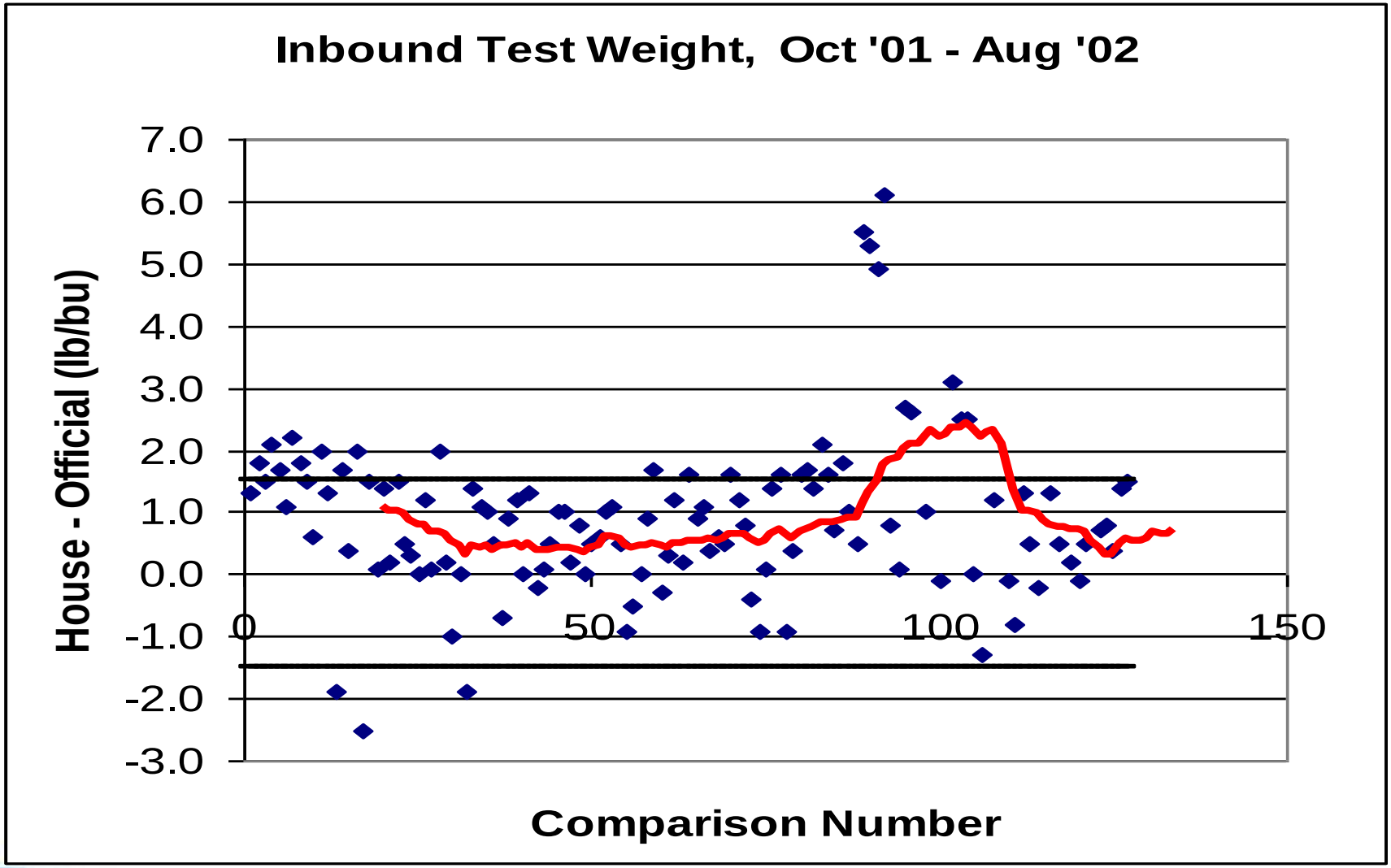
- **Moisture**
  - 1% Moisture = **5 - 12 cents/bu**
  - – Be within +/- 0.3% vs GIPSA
  - – Check more than just once a year
  - – Differences between new and old technologies.
- **Test Weight Cup or Meter TW**
  - 1 lb/bu = **1.5% measurement error**
  - – +/- 0.5 lb/bu vs GIPSA
  - – Cup? Training or worse than meter!

Control Chart Example – Corn Moisture

95% confidence = +/- 2 std. dev.



Control Chart Example – Corn Test Wt.



Inbound Grading

Particle Size or Count Based Factors

Must use a divider on samples. Sampling is important.

Check the divider periodically by weight on each side.

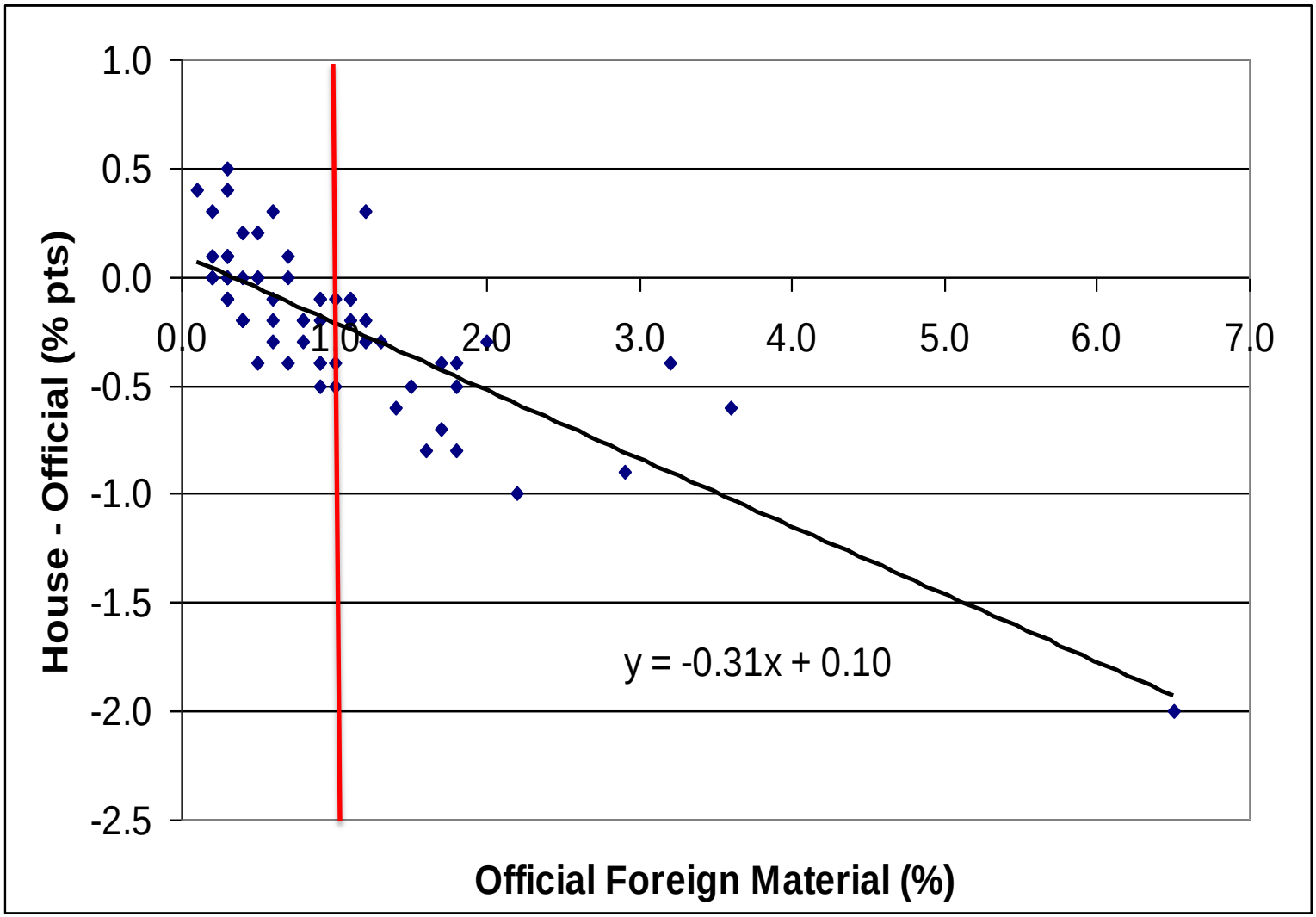
Compare 5-10 samples vs GIPSA; +/-0.2 – 0.5% depending

on level.

member: Some of these are dockage (Quantity)!

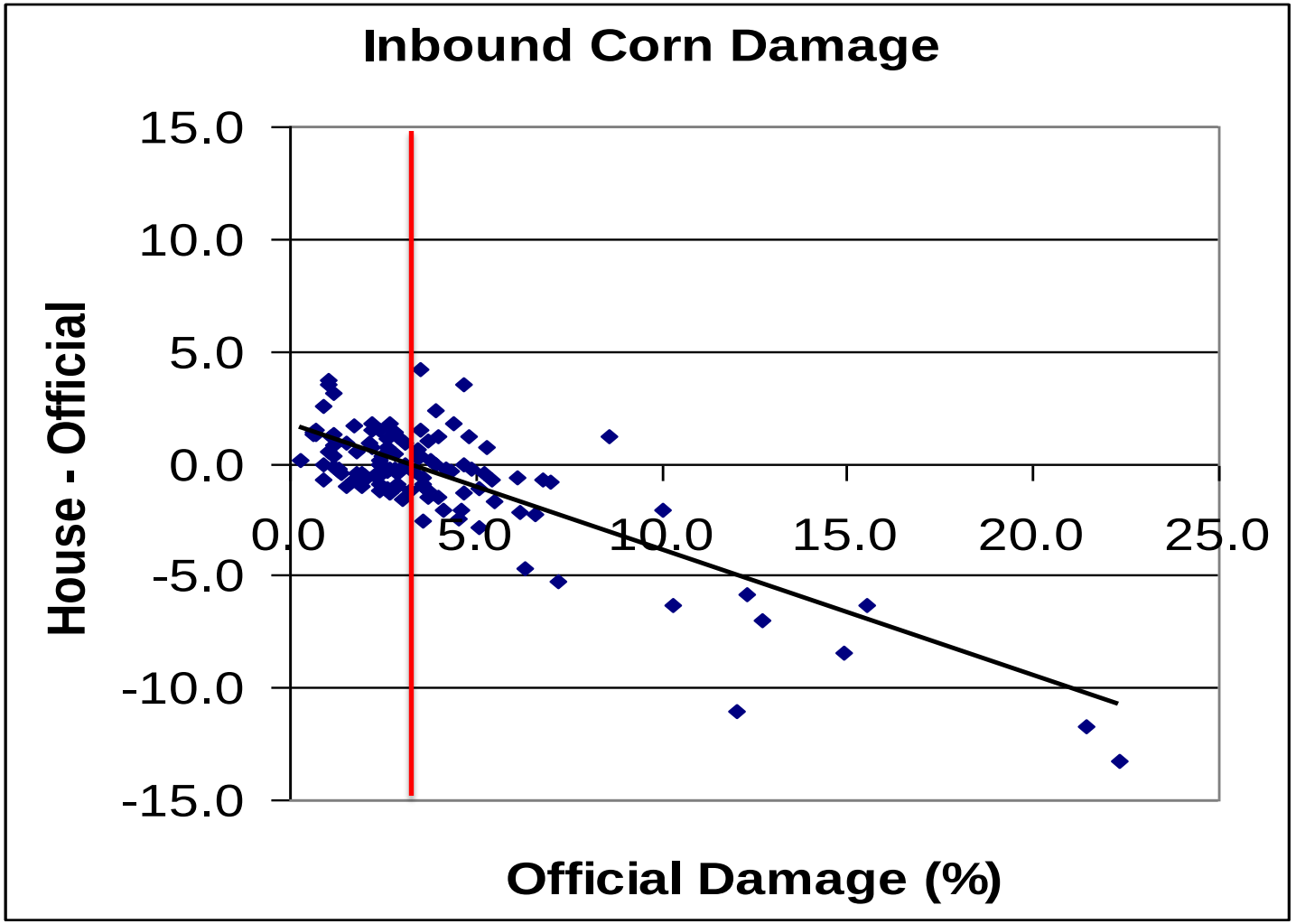
Quantity for sure ; Quality for sure

Control Chart Example - Soybean FM



Red Line = Standard Level

Control Chart Example - Corn Damage



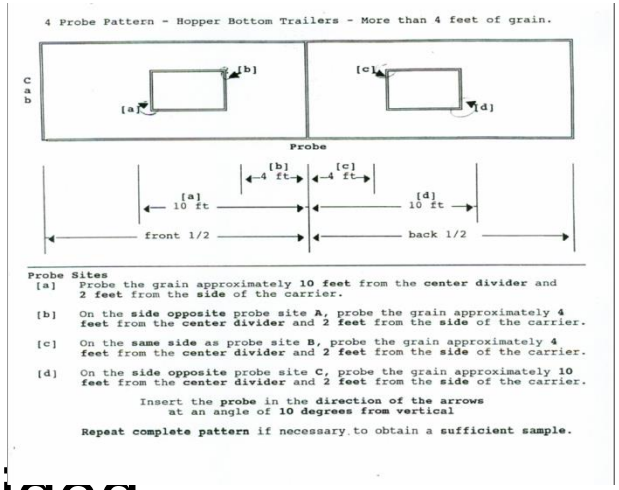
Red Line = Standard Level

EXCHANGE 2015

Quantity probably not; Quality for

Sampling and Sample Handling

- Have a written and consistent protocol for sampling and sample handling.



- Factors to be mechanically divided
  - FM or any other particle size based factor
  - Stones, toxins, GMO, Damage or any count factor
- Factors less prone to division error
  - Moisture
  - Protein, other composition factors

Shrink

Shrink = Water (dryer) +

Operating Losses

Water Loss

Percent of weight lost per % moisture removed

Operating Loss	**Impacts**
Handling loss	**material loss**
Moisture measurement miscalculation	
Deterioration	**spoilage**
Aeration below spec	**give away**

Quantity for sure; Quality if moldy or brok

Shrink Factors

$$W_o - W_f = \left(\frac{s}{100}\right)(M_0 - M_s)(W_o)$$

where: **s = shrink factor, percent loss in weight per percent moisture**
M_s = shrink (final) moisture content (%)
W_o, M_o = initial weight, moisture content (%)
W_f = final weight

Common s values: 1.30 – 1.50 % loss per % moisture

Water Loss only:

M_s	s	Typical use
12	1.136	wheat
13	1.149	soybeans
14	1.162	corn storage
15	1.176	corn market

Only final moisture changes water loss rate.
Not starting moisture, not grain type, not grain quality!!

Operating Losses

- Lost kernels, dust, increased FM
- Some Estimates (based on corn):
  - 0.5% (0.005) weight loss per in - out. Out to Pile counts double. Progressive if multiple turns.
  - 0.2% FM Increase per rotation (15% corn); 0.4% if 13%, etc. More with dryer stress cracks or low Test Weight (2x below 52 lb/bu)
  - **Cleaning if needed.**
- Moisture error: Buyer reads high=you dry more.
- **Individual facility specific! Measure them.**
- **Grade your grain periodically during handling**
  - **In-Process grading**

Cleaning

- **Cleaning shrink = Amount of cleanings removed.**
- **Take this on your physical inventory, then:**
- **Analyze screenings for true FM vs. grain.**

- **Grain loss (economic) is the difference in price of grain and screenings.**

- **FM loss is in two parts:**
  - **1) What you could have blended out and:**
  - **2) what you could not blend out.**

Cleaning Example

Physical Inventory

	Weight (bu)	%FM	%Corn
In	1,000,000	3.0 (graded)	97.0
Cleaned	**50,000**	50.0	50.0
Out	950,000	4.0 (graded)	96.0

Contract = 3YC, Max 5% FM

Economic Balance (screenings =70% of corn price)

Lost corn	25,000	2.5%*30% = 0.75%
FM removed	25,000	2.5%*30% = 0.75%
Lost Blend	9,500	**(5% - 4% actual)**
Not Blendable	15,500	**(0.47%)**

FM Created: 25,000 + 38,000 – 30,000 = 33,000 **(3.3%)**

removed + sold - bought = created

Deterioration: Storage Life

Maximum storage time (months); corn and soybeans*							
Temperature ° F	Corn, soybeans moisture content						
	13%, 11%	14%, 12%	15%, 13%	16%, 14%	17%, 15%	18%, 16%	24% N/A
40	150	61	29.0	15.0	9.4	6.1	1.3
50	84	34	16.0	8.9	5.3	3.4	0.5
60	47	19	9.2	5.0	3.0	1.9	0.3
70	26	11	5.2	2.8	1.7	1.1	0.2
80	15	6	2.9	1.6	0.9	0.9	0.06

*Based on 0.5% maximum dry matter loss—calculated on the basis of USDA research at Iowa State University. Corresponds to one grade number loss; 2-3% pts of Total Damaged seeds

Starts at harvest with 100% .

Progressively used up through the storage season

Quantity for sure; Quality for s

Storage Life Principles

- Grain is converted to carbon dioxide and water; heat is generated.
- Starts at 100%; percentages are used up at each condition.
  - eg. 1 day at 80F for 24% corn uses 50% life.
    3 months at 40F for 18% corn uses 50% life.
- Self-reducing if no aeration
- 0.5% weight loss for each 3% DKT increase.
  - eg 3% DKT to 12% DKT = (9/3)*0.5=1.5% shrink
  - Verify with in-process grading

Aeration and Shrink

- Beyond cooling cycles, aeration is a balance between spoilage and shrink
- If the Equilibrium Moisture Content is below the grain moisture, aeration will remove moisture.
- Spring/summer is the likely time for overdrying, not fall/winter.

Corn Equilibrium Moisture Content

Relative Humidity

Temperature	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
35°	11.0	11.6	12.3	12.9	13.5	14.2	14.8	15.6	16.3	17.2	18.2	19.5	21.1
40°	10.6	11.3	11.9	11.9	13.1	13.8	14.5	15.2	16.0	16.9	17.9	19.1	20.8
45°	10.2	10.9	11.5	11.5	12.8	13.5	14.1	14.9	15.7	16.6	17.6	18.8	20.5
50°	9.9	10.6	11.2	11.2	12.5	13.1	13.8	14.6	15.4	16.3	17.3	18.6	20.2
55°	9.6	10.2	10.9	10.9	12.2	12.8	13.5	14.3	15.1	16.0	17.0	18.3	20.0
60°	9.3	9.9	10.6	10.6	11.9	12.6	13.3	14.0	14.8	15.7	16.8	18.1	19.7
65°	9.0	9.7	10.3	10.3	11.6	12.3	13.0	13.8	14.6	15.5	16.5	17.8	19.5
70°	8.7	9.4	10.0	10.0	11.4	12.0	12.7	13.5	14.3	15.3	16.3	17.6	19.3
75°	8.5	9.1	9.8	9.8	11.1	11.8	12.5	13.3	14.1	15.0	16.1	17.4	19.1
80°	8.2	8.9	9.6	9.6	10.9	11.6	12.3	13.1	13.9	14.8	15.9	17.2	18.9

Mold Line. Overdry line

Soybean Equilibrium Moisture Content

Relative Humidity

Temperature	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
35°	6.6	7.5	8.3	9.1	9.9	10.8	11.7	12.6	13.7	14.8	16.1	17.7	19.7
40°	6.4	7.3	8.1	8.9	9.8	10.6	11.5	12.5	13.5	14.6	16.0	17.5	19.6
45°	6.3	7.1	8.0	8.8	9.6	10.5	11.4	12.3	13.4	14.5	15.8	17.4	19.5
50°	6.1	7.0	7.8	8.6	9.5	10.3	11.2	12.2	13.2	14.4	15.7	17.3	19.4
55°	5.9	6.8	7.7	8.5	9.3	10.2	11.1	12.1	13.1	14.2	15.6	17.2	19.2
60°	5.8	6.7	7.5	8.3	9.2	10.1	11.0	11.9	13.0	14.1	15.4	17.0	19.1
65°	5.6	6.5	7.4	8.2	9.0	9.9	10.8	11.8	12.8	14.0	15.3	16.9	19.0
70°	5.5	6.4	7.2	8.1	8.9	9.8	10.7	11.7	12.7	13.9	15.2	16.8	18.9
75°	5.3	6.2	7.1	7.9	8.8	9.7	10.6	11.5	12.6	13.7	15.1	16.7	18.8
80°	5.2	6.1	6.9	7.8	8.6	9.5	10.4	11.4	12.5	13.6	15.0	16.6	18.7

Average October, Iowa

Average November, Iowa

Cost of Overdrying

Moisture content of overdry corn (%)	Price of Corn ($/bu)					
	$2.00	$2.50	$3.00	$4.00	$5.00	$6.00
14	**$0.023**	**$0.029**	**$0.035**	**$0.047**	**$0.058**	**$0.070**
13	$0.046	$0.057	$0.069	$0.092	$0.116	$0.138
12	$0.068	$0.085	$0.102	$0.136	$0.170	$0.204
11	$0.090	$0.112	$0.135	$0.180	$0.224	$0.270
10	$0.111	$0.139	$0.167	$0.222	$0.278	$0.334

Top line is the cost for one percentage point.
At $4.00/bu, $47,000 per million bu

What about $10 - $14 soybeans?

A Cost Example: Pile Corn

1.5 Million Bushel pile; $4.00/bu

	Bu	Moist	DKT	TW
• In	1,500,000	19.0%	3%	56
• Out	1,420,000	18.5%	35%	53
• Lost	80,000	0.5%	32%	3

Then had to dry to 13% to keep the damaged corn

Corn Loss Calculation

DM Shrink Loss	Real	$	283,190
DKT Discounts	Pending	$	1,350,000
Lost MC Blending	Likely	$	233,882
Extra MC Shrink	Pending	$	125,198
Extra Transportation	Likely	$	136,320
Lost Storage Opportunity	Likely	$	340,800
Extra Handling Loss	Real	$	28,400
Interest	Real	$	340,800
		$	**2,838,591**

$3.3 million if $6.00 corn

Estimated Shrink Losses: $670,670

Summary

- Step by step analysis of sources for inventory losses.
  - Inbound Inspection
  - Dryer/moisture measurement
  - Handling and cleaning
  - Deterioration
  - Aeration
- In many cases, internal weighing and grading (in process analysis) will be very valuable.

Where To Find Us...

www.iowagrain.org

@ia_gqi

EXCHANGE 2015