COLLEGE OF AGRICULTURAL & LIFE SCIENCES
University of Wisconsin-Madison

Mechanical Harvesting Trials

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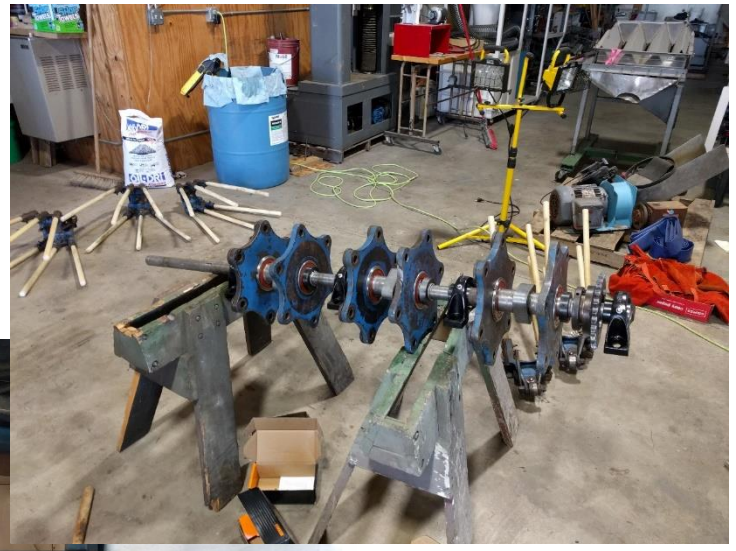
Machine Follies

- Roughly 1985 vintage
  - no serial number tag
- Well used !! But solid
- Rotary harvest unit – mechanically powered
- Requires lowboy trailer to move
  - Too high
  - 10 ft wide

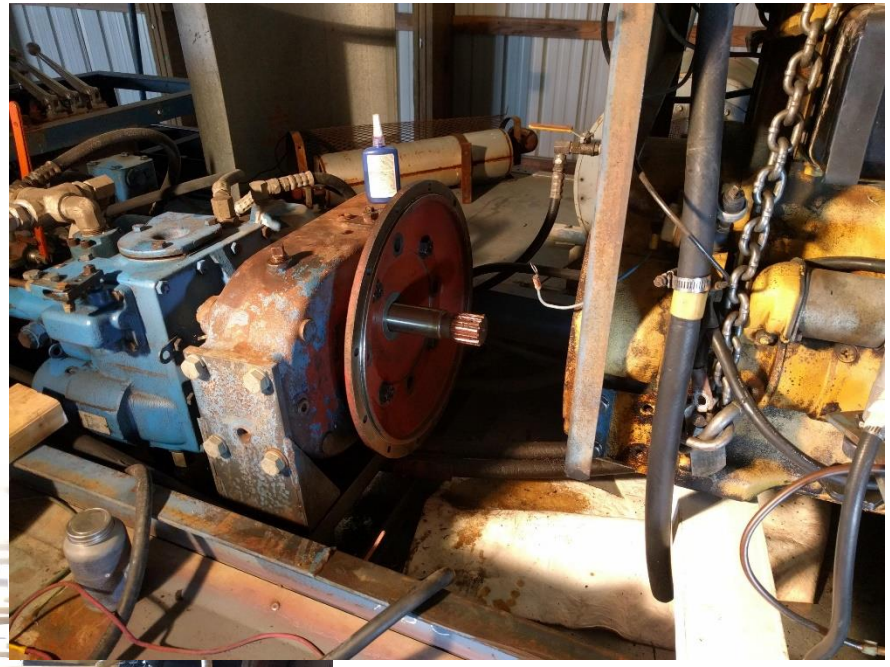
Rebuilding

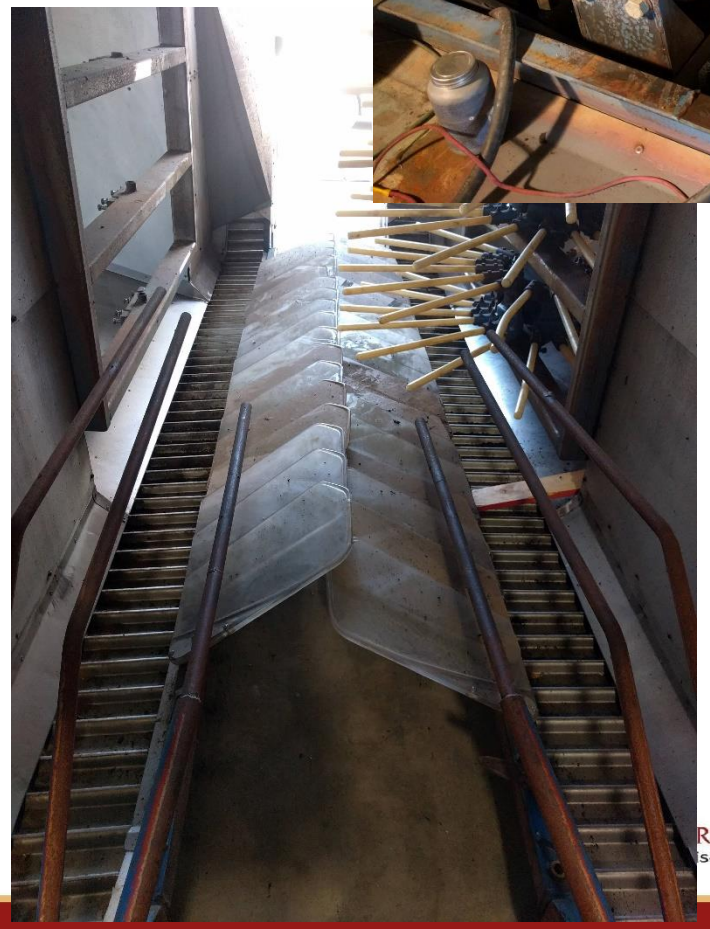
- Harvest unit
  - New bearings - ~ $4000
  - 2 new star plates
  - Some Urethane bushings
  - New Finger ass’y mounting bolts
  - Some new fingers – nylon rod
  - New brake pads and adj bolts
  - New drive chains
  - 2 Replacement Star plate covers



Rebuilding

- Gear Box input oil seal
- Many new hydraulic hoses
- Replaced broken catch plates
- Alternator & belt
- Replaced speed sensor (gps unit)
- Engine RPM meter





Field Trials - Barneveld

- Paul Ronsheim

Blue Mound Hazelnuts, LLC

- 6 acres
- 6 year old bushes
- 12 / 18 foot row spacing
- 30 foot headlands

From the Driver's seat

- Harvest speed ~ _____
- Some bushes towered 4-6 feet above driver platform – too BIG
- Drip Irrigation should be buried or next to bush
- Blown Hydraulic hoses – What a mess!!!
  - New machines use food grade Hydraulic oil
- Could only do ~ 2 rows before engine overheated
  - New thermostat
- Steering un-responsive
  - New steering control motor to be installed

Harvest unit rotary motor stops after oil warms up??

- After ~1 row
- Increased pressure
  - Was Low - ~ 900 psi
- Replaced hydraulic motor
- Separate oil cooler for Hydraulic system
  - Air going through
- BUT not enough air

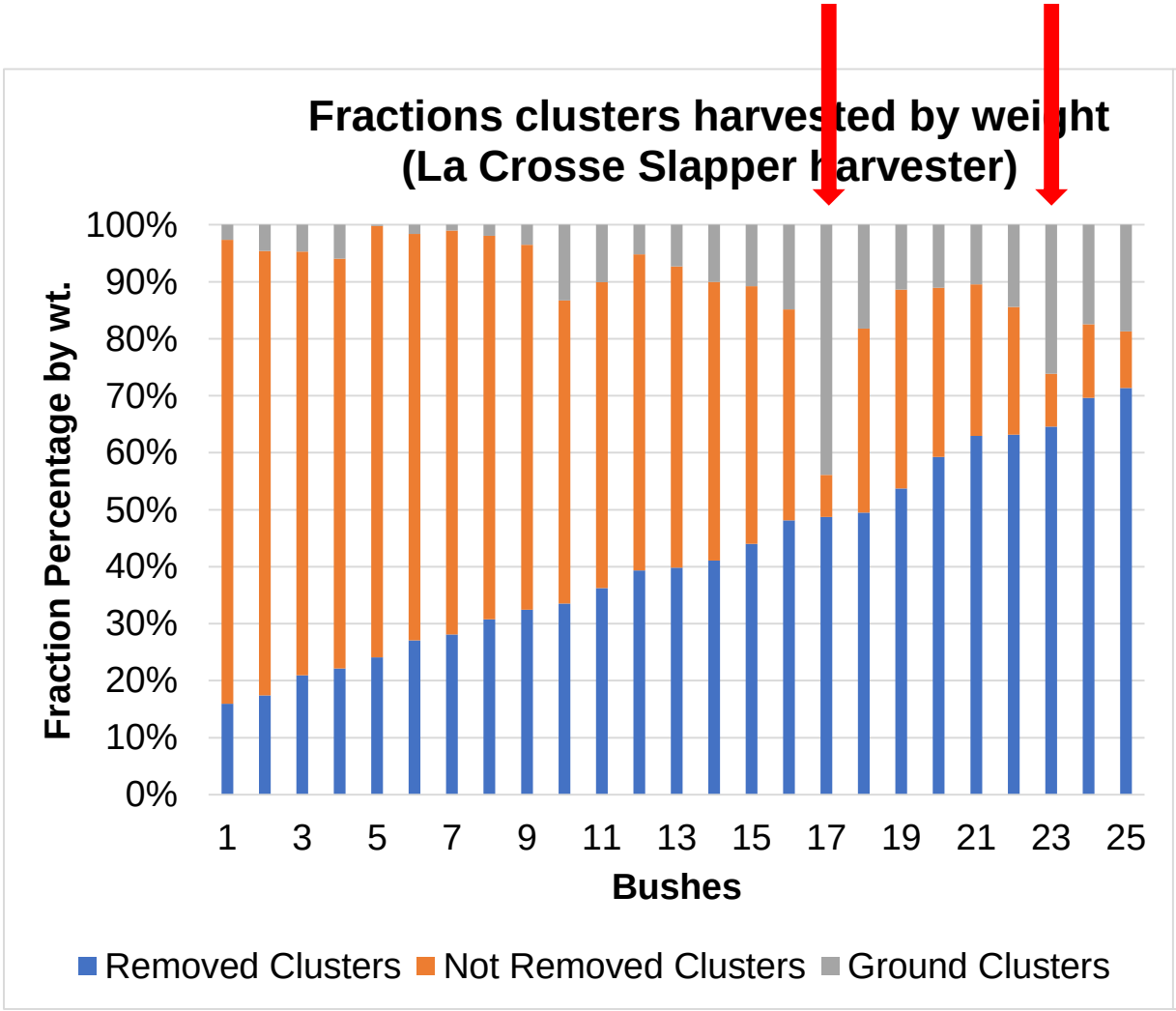
Experimental Design

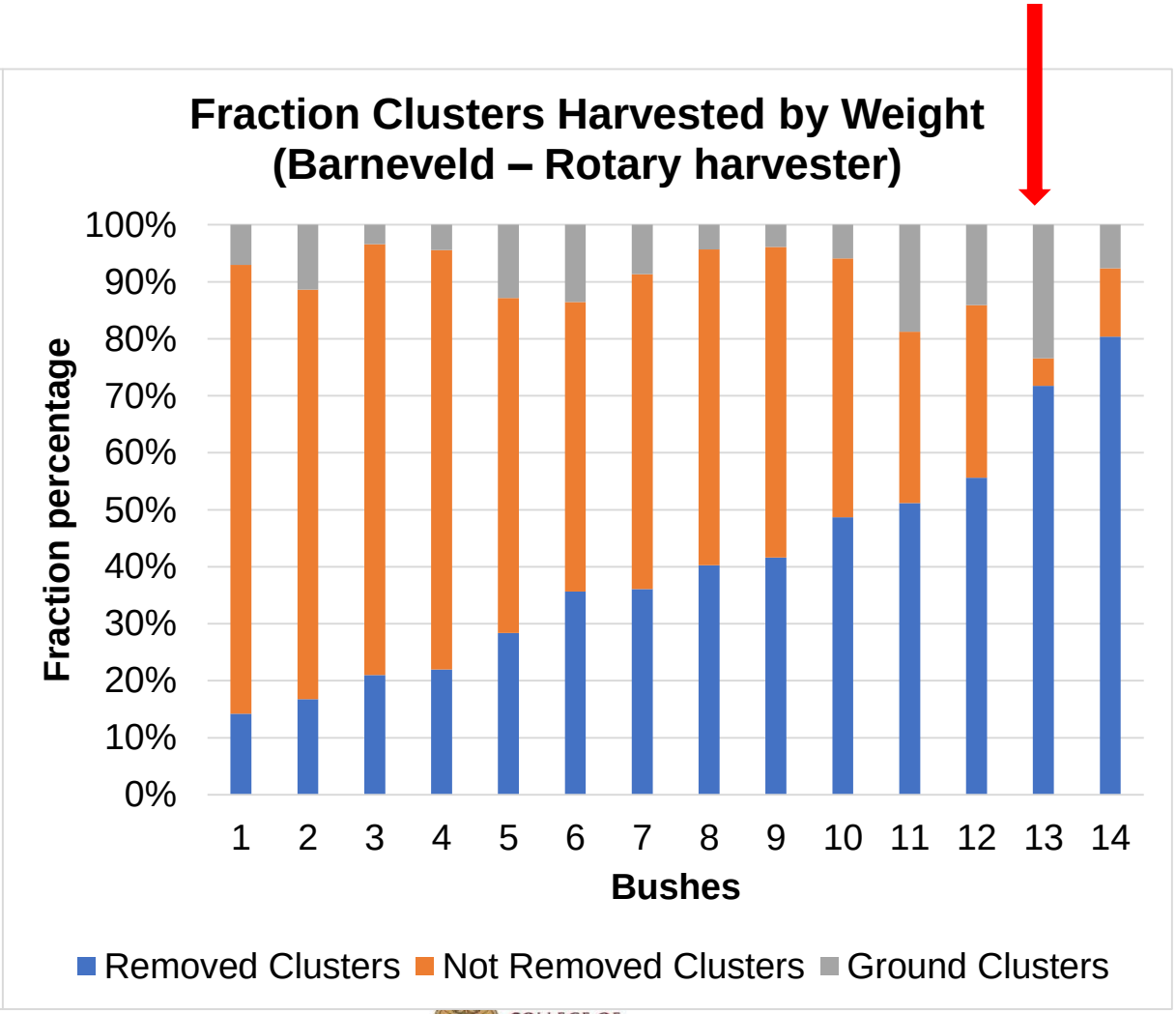
- Clean up dropped nuts/clusters from under bushes
- Remove 18 clusters per bush with force meter
  - Detachment force
- Harvest clusters from select bushes one at a time with machine
- Pick off un-harvested clusters.
- Pick up clusters/nuts on ground
- Weigh all fractions separately
- Count clusters
- Dry all fractions in oven
- Count nuts

Harvest Machines Used

- BEI Rotary - UW-Madison
  - Barneveld
- BEI Slapper - Mary Hovel
  - La Crosse

Data trends


Fractions clusters harvested by weight
(La Crosse Slapper harvester)
Fraction Percentage by wt.
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 3 5 7 9 11 13 15 17 19 21 23 25
Bushes
Removed Clusters
Not Removed Clusters
Ground Clusters


Fraction Clusters Harvested by Weight
(Barneveld – Rotary harvester)
Fraction percentage
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
1 2 3 4 5 6 7 8 9 10 11 12 13 14
Bushes
Removed Clusters
Not Removed Clusters
Ground Clusters

Harvester differences

Harvest unit	Removed (%)		Not Removed (%)		On Ground (%)	
	Cluster count	Weight Fraction	Cluster count	Weight Fraction	Cluster count	Weight Fraction
BEI Slapper	39.9	41.8	49.7	47.5	10.4	10.8
BEI Rotary	39.2	40.3	51.7	49.8	9.0	10.0

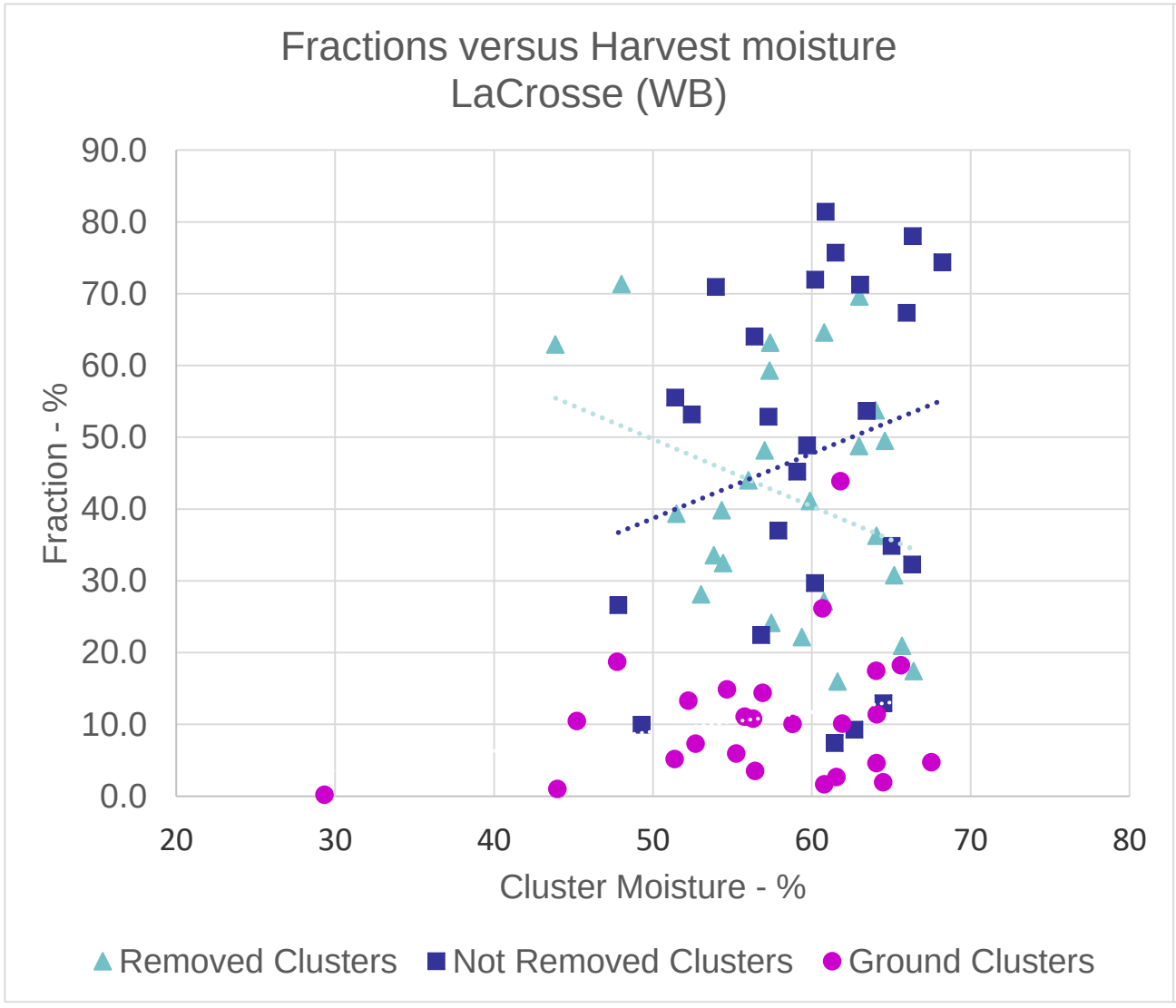
Cautions

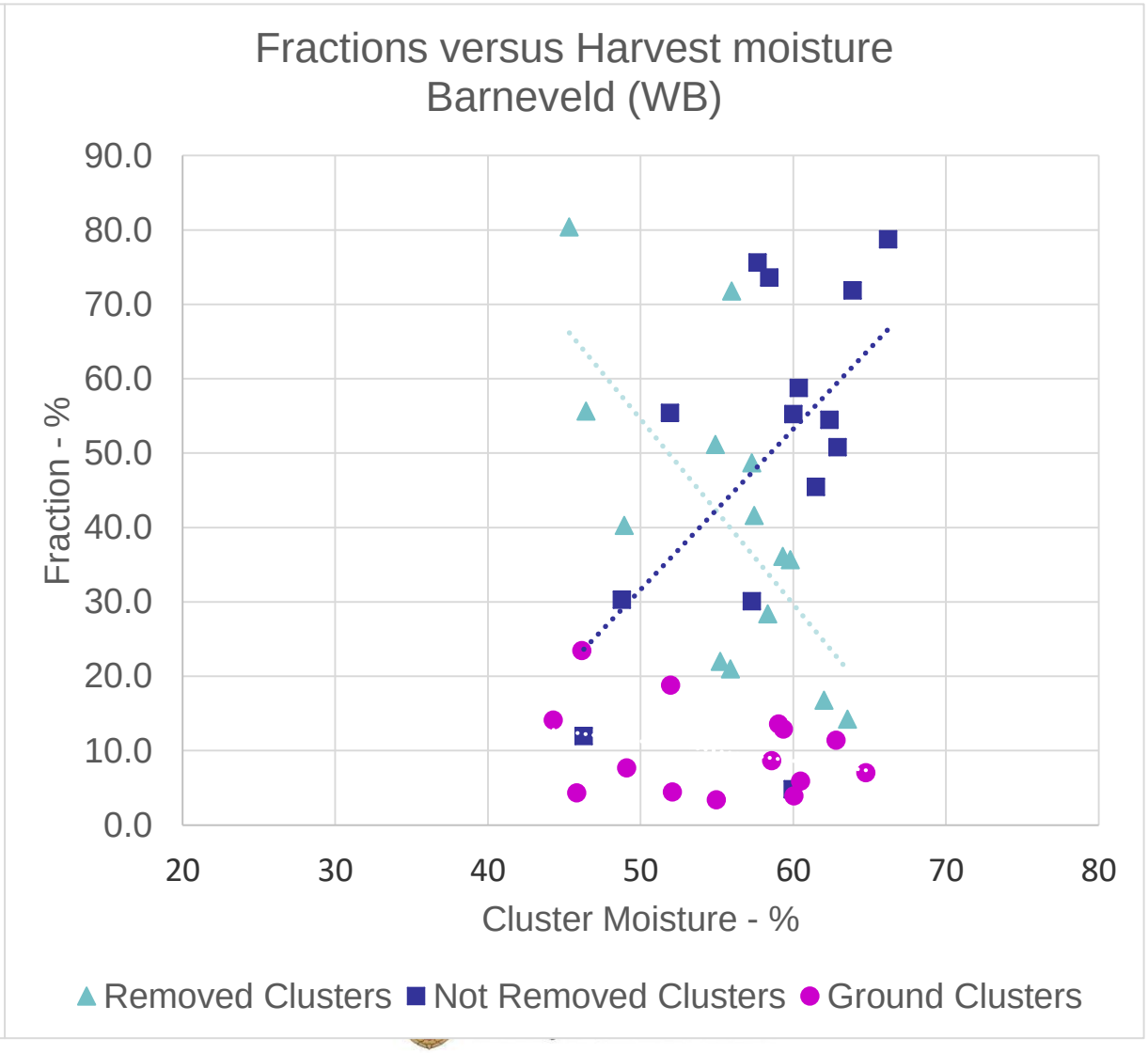
- Machines harvested at different sites – La Crosse & Barneveld
- Slapper unit harvest on 2 different dates 19 days apart – Aug 25, Sept 13
- Rotary unit was having hydraulic system issues, 2 dates, 6 days apart – Sept 4, Sept 11

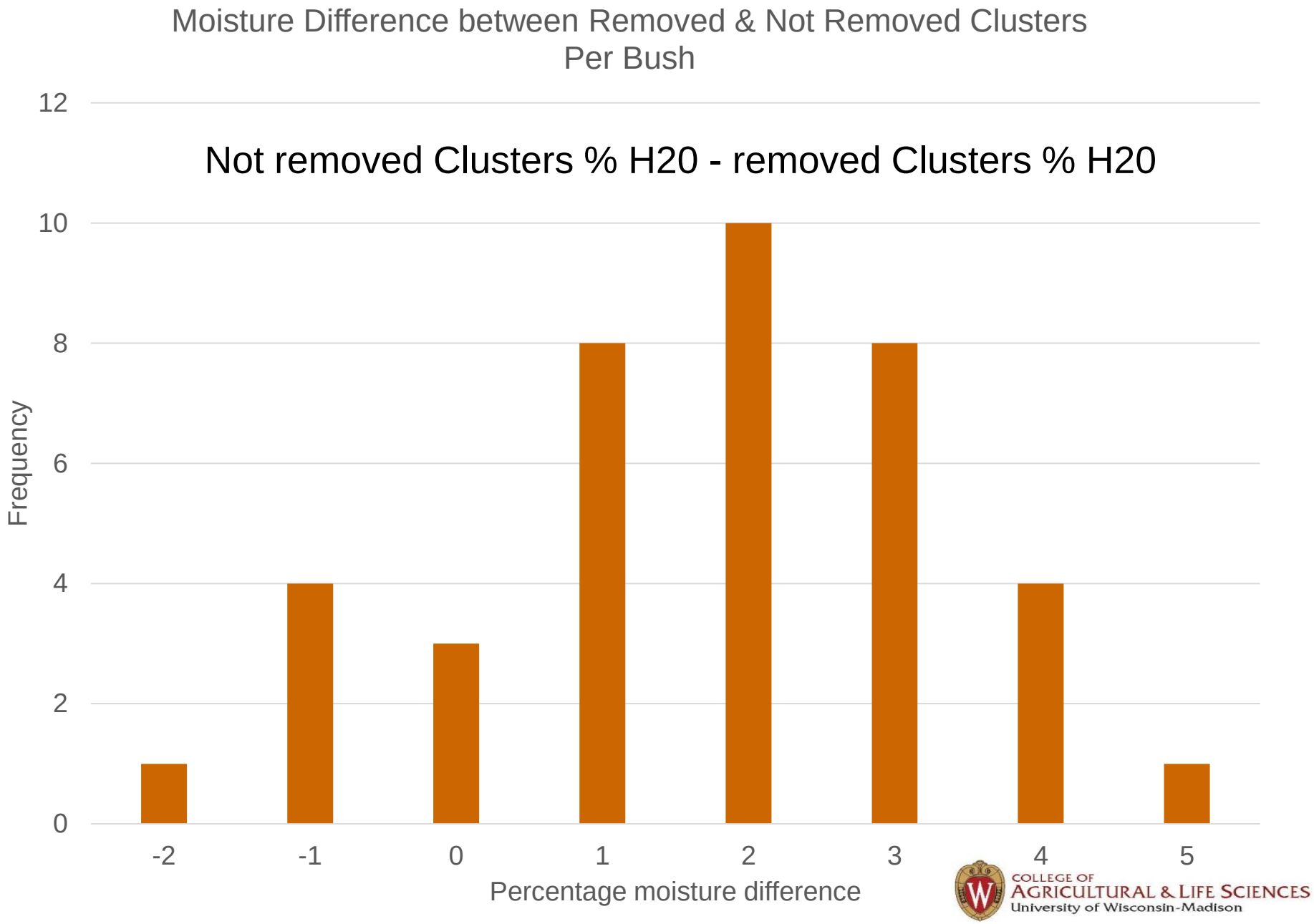
Causes for Ground Clusters

- Wide bush base – clusters fall between stems
- Large bush (tall & wide) – cluster fall off as stems are bent to enter tunnel

Data Trends


Fractions versus Harvest moisture
LaCrosse (WB)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Fraction - %
20
30
40
50
60
70
80
Cluster Moisture - %
Removed Clusters
Not Removed Clusters
Ground Clusters


Fractions versus Harvest moisture
Barneveld (WB)
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Fraction - %
20
30
40
50
60
70
80
Cluster Moisture - %
Removed Clusters
Not Removed Clusters
Ground Clusters



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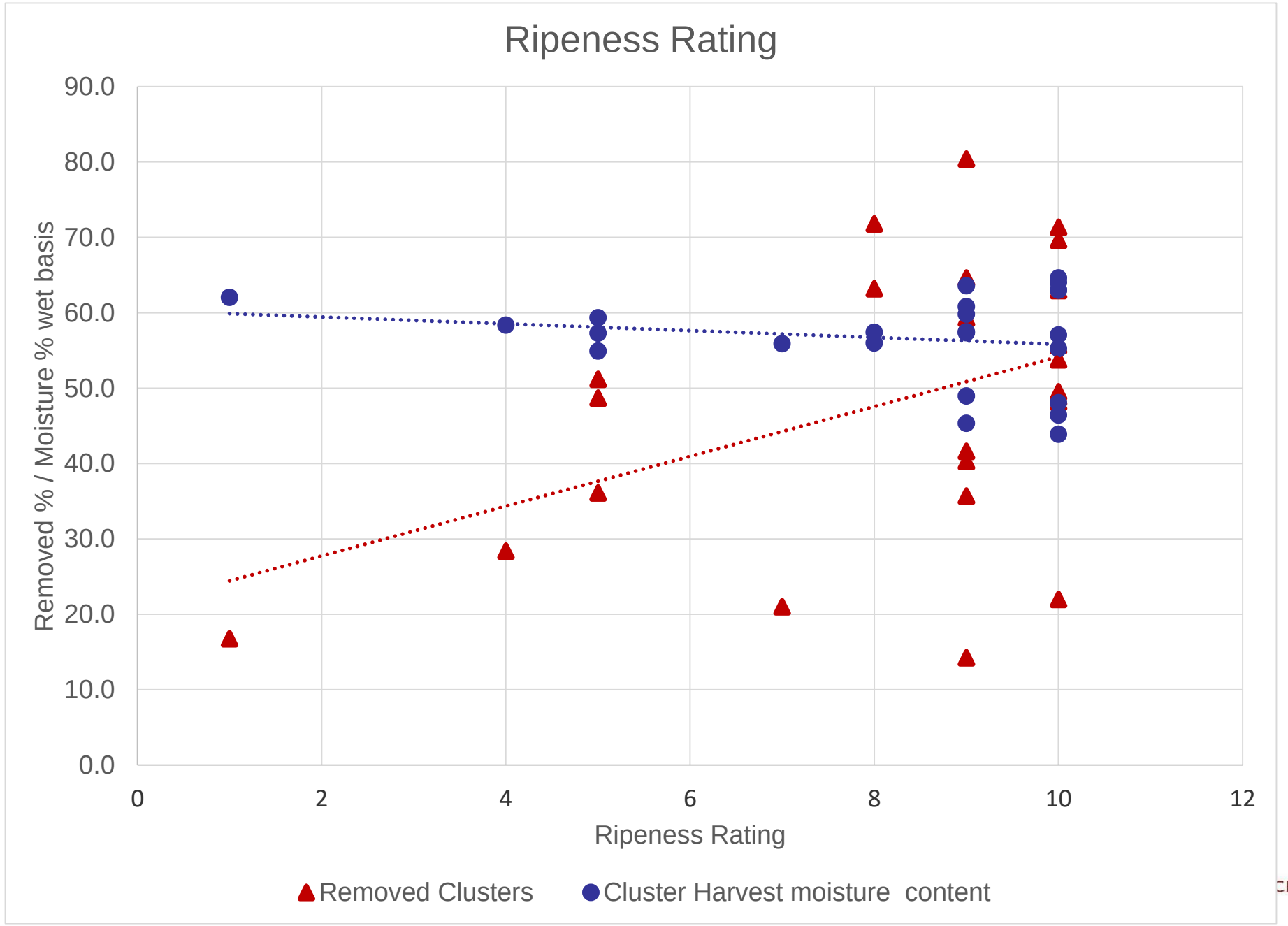
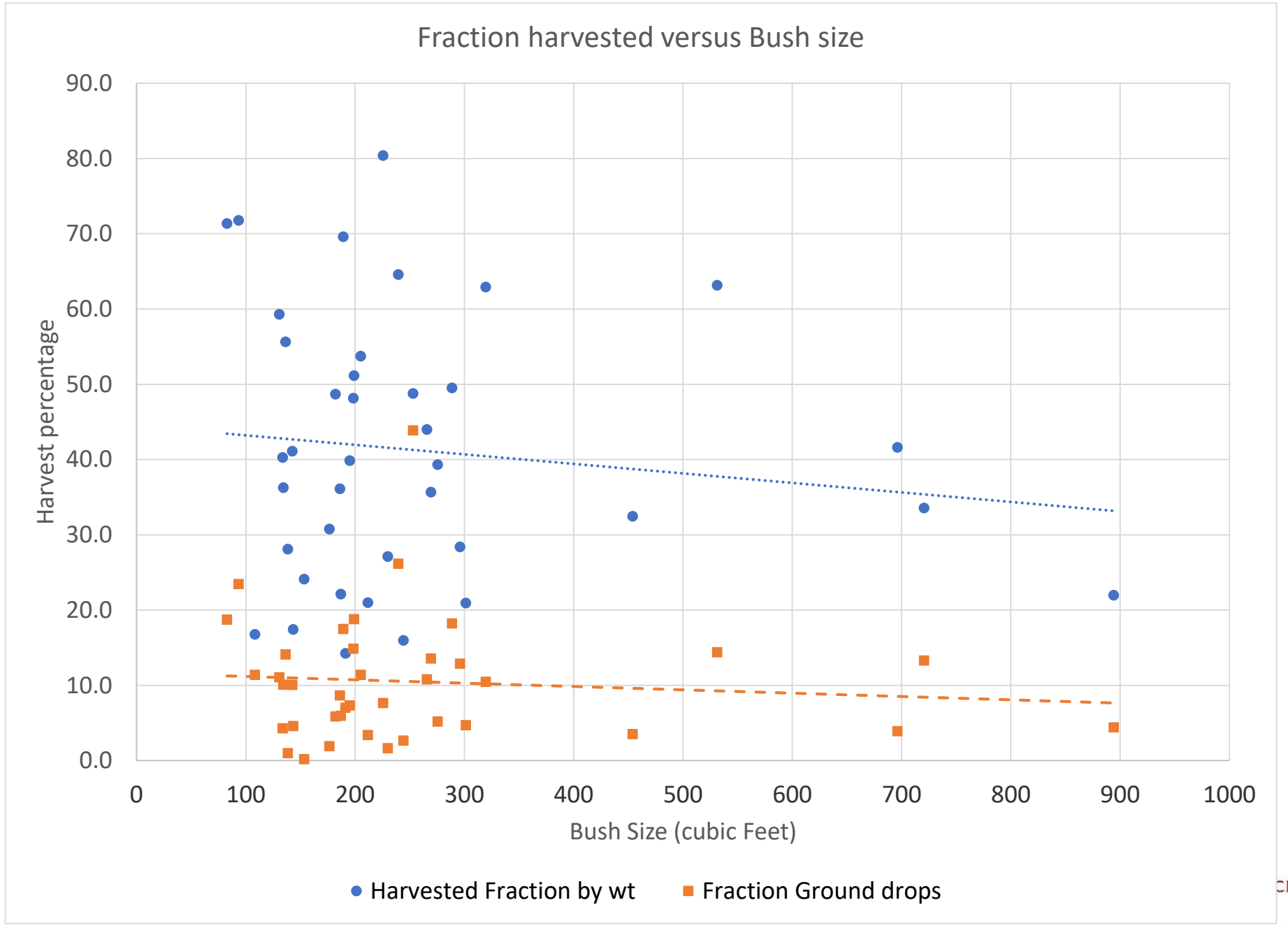
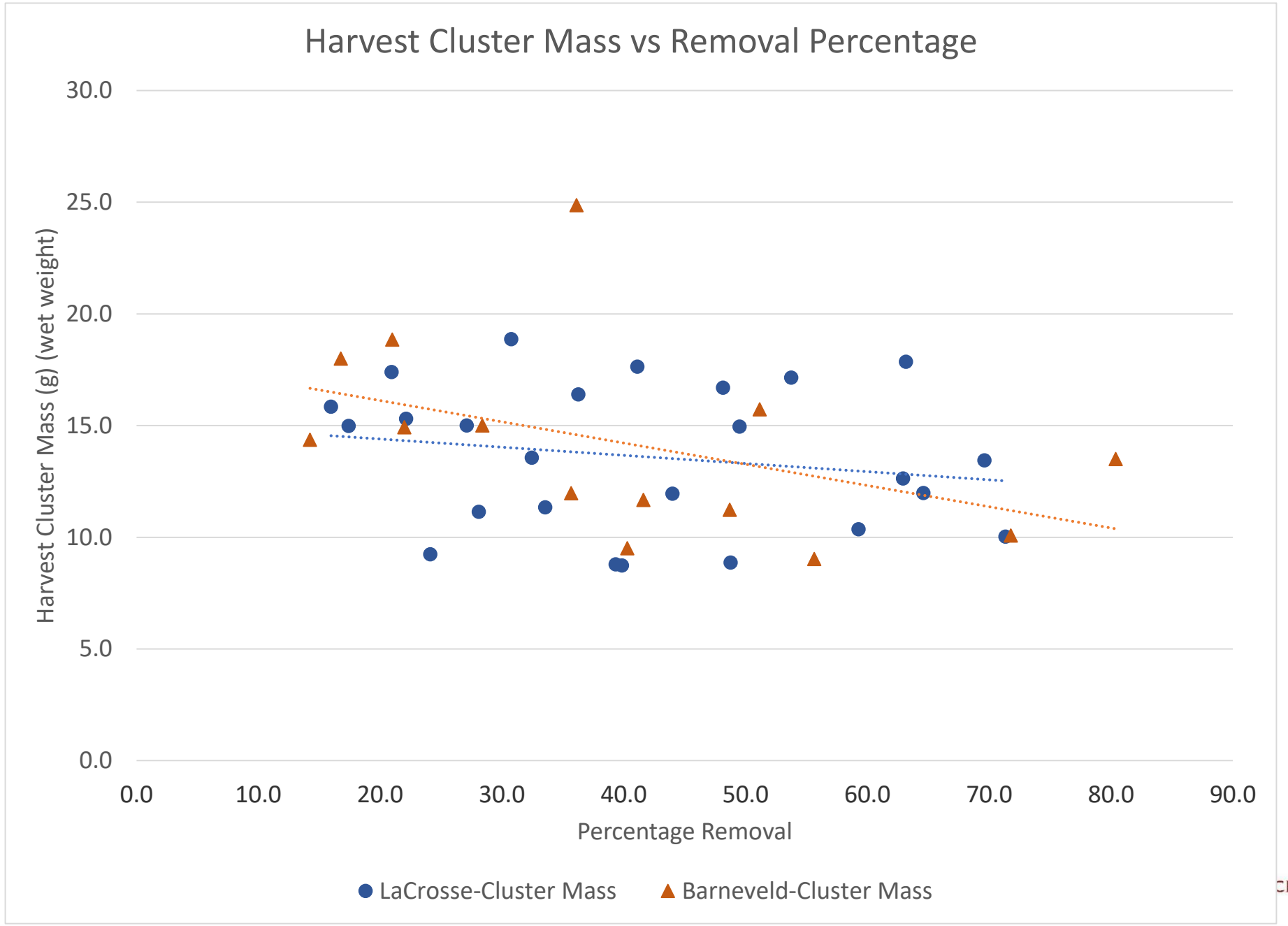
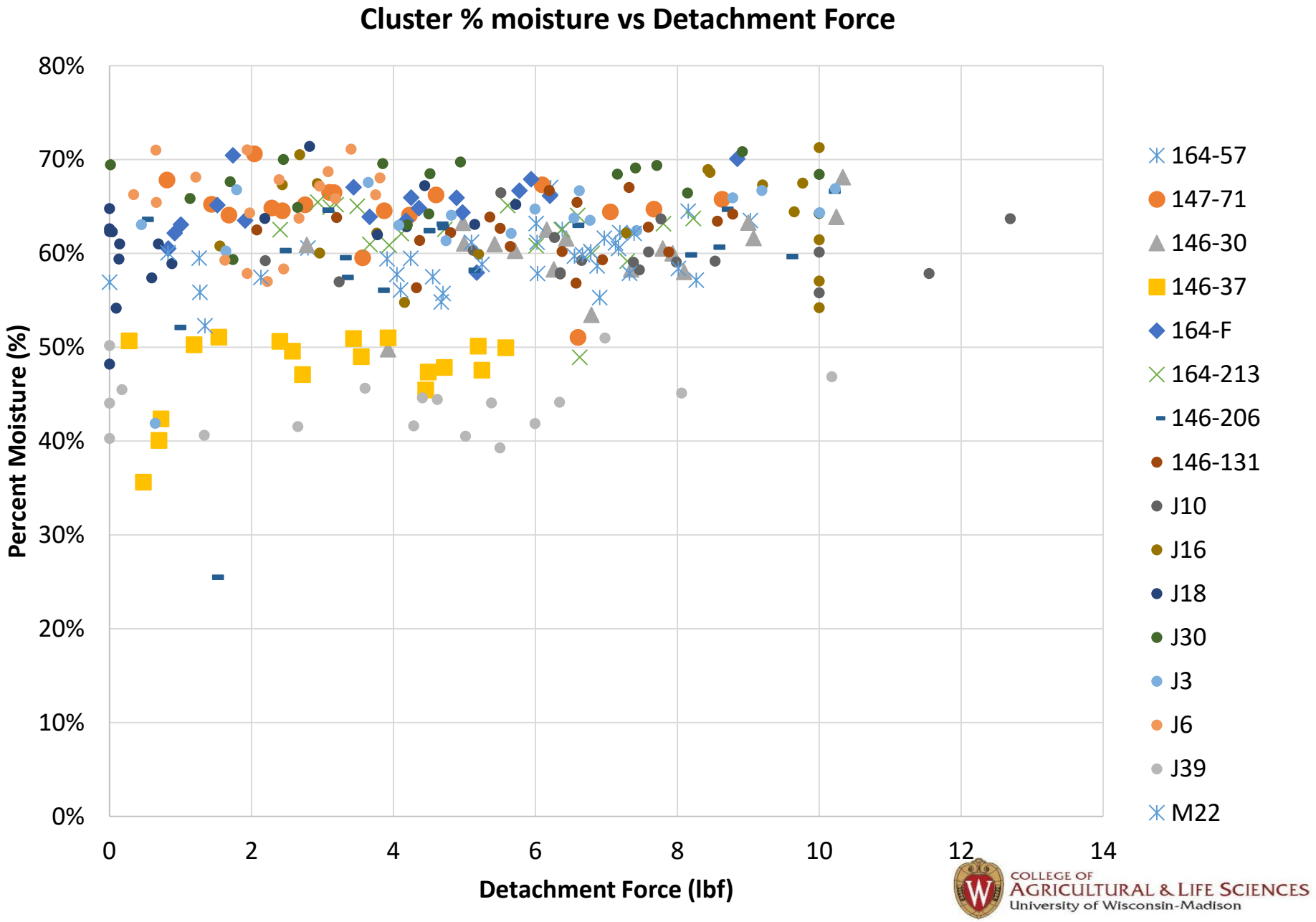
Ripeness Rating

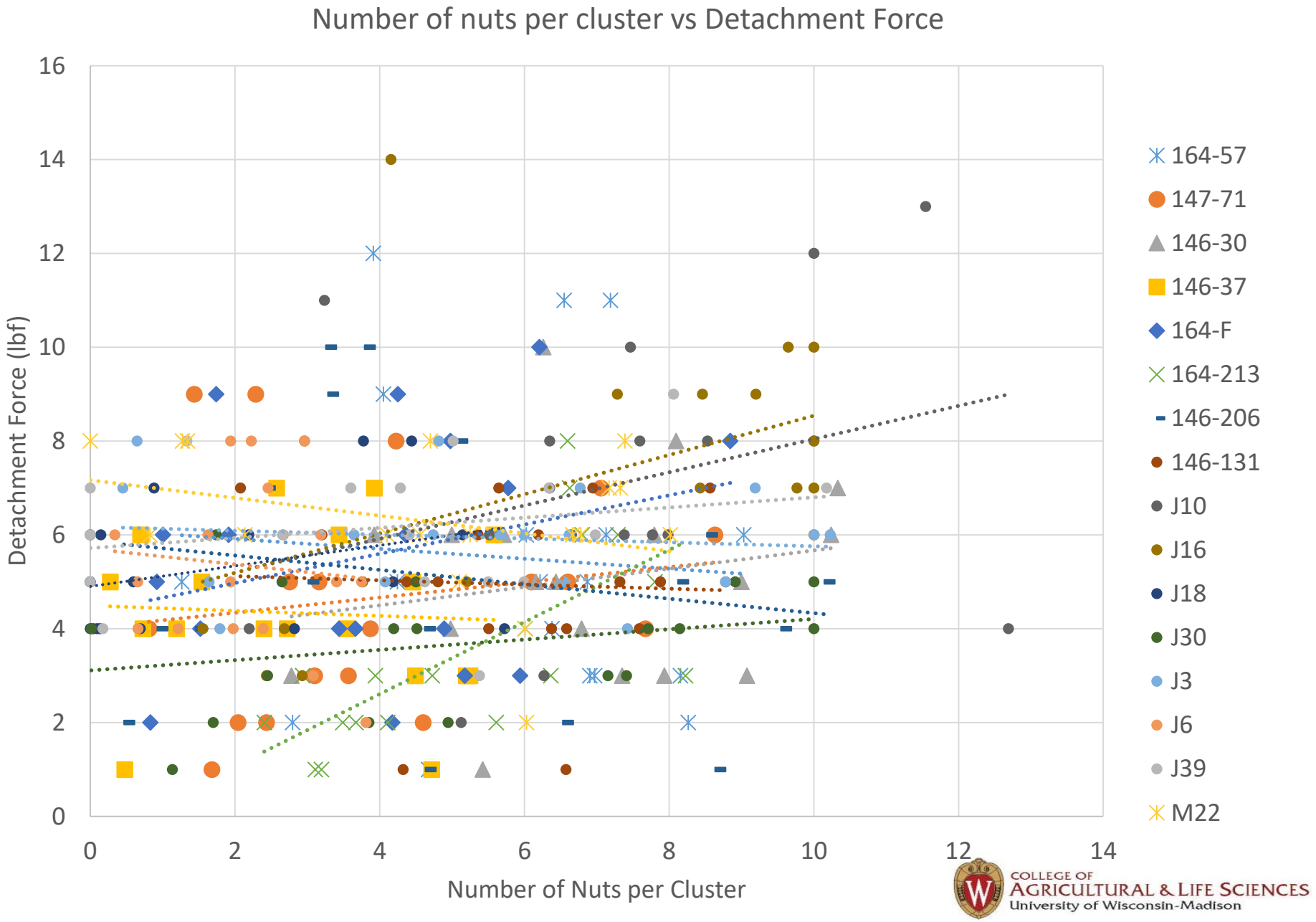
- Looking for a simple test that would indicate plants are ready to harvest
- Wiggled 10 nuts at random on the shrub
- Rating is the number out of 10 that had abscised and were loose in the husk


Ripeness Rating
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
Removed % / Moisture % wet basis
0
2
4
6
8
10
12
Ripeness Rating
Removed Clusters
Cluster Harvest moisture content


Fraction harvested versus Bush size
Harvest percentage
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
0
100
200
300
400
500
600
700
800
900
1000
Bush Size (cubic Feet)
Harvested Fraction by wt
Fraction Ground drops


Harvest Cluster Mass vs Removal Percentage
Harvest Cluster Mass (g) (wet weight)
30.0
25.0
20.0
15.0
10.0
5.0
0.0
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Percentage Removal
LaCrosse-Cluster Mass
Barneveld-Cluster Mass





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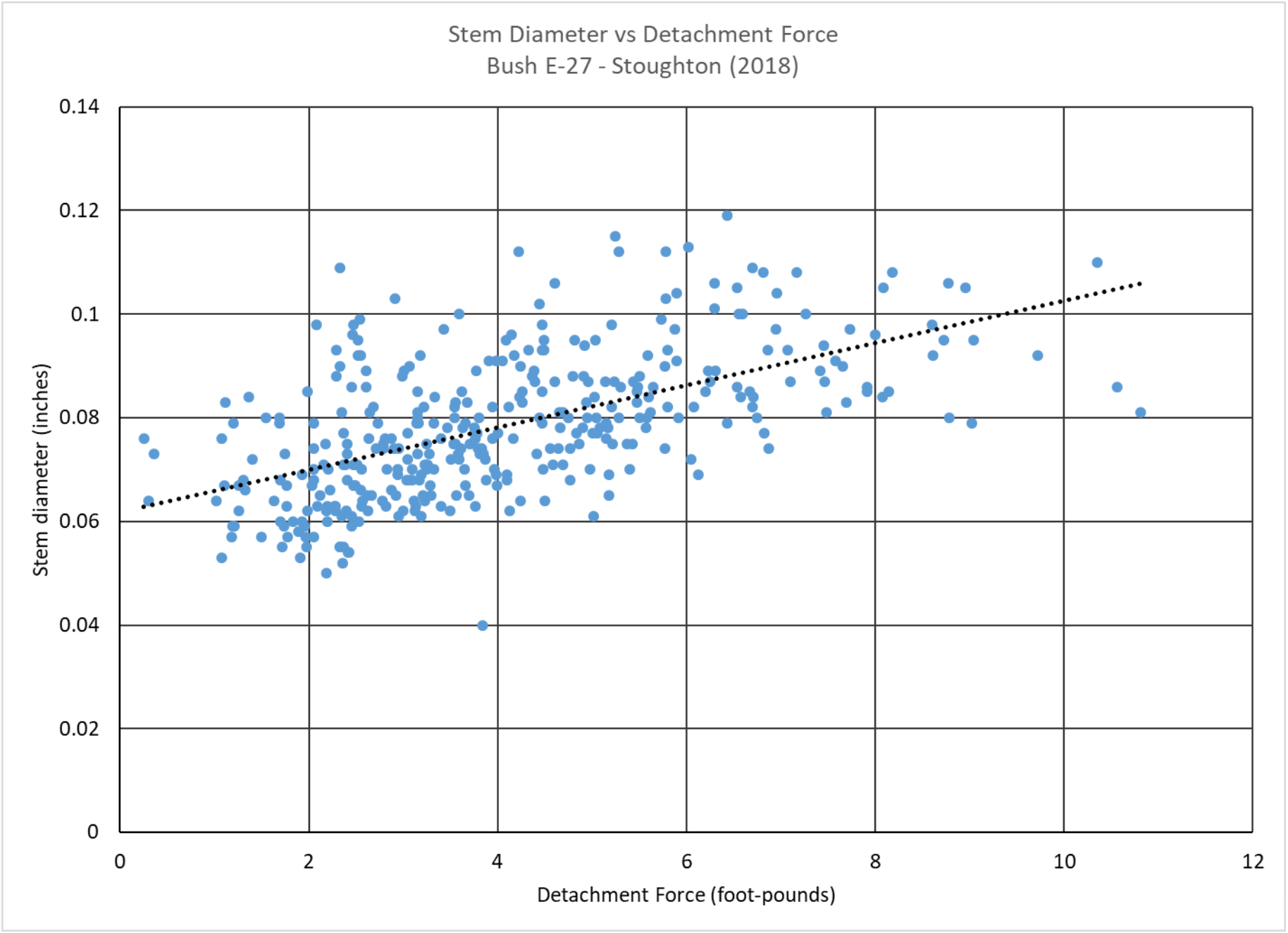

Stem Diameter vs Detachment Force
Bush E-27 - Stoughton (2018)
Stem diameter (inches)
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0
2
4
6
8
10
12
Detachment Force (foot-pounds)

La Crosse Harvest

Date of harvest

	Cluster % moisture	Removal rate
August 25, 2020	59%	30.2%
Sept 13, 2019	58%	59.1%

19 days different – double the removal rate

Bush Damage from Mechanical Harvest

- Loss of some Catkins
  - based on 2018 harvest trial, not a problem (Stoughton Planting)
- Broken branches / bark scraped off
  - Most low on bush

Conclusions

- Each bush is a different Phenotype (not clones)
  - Wide variations – hard to make generalizations / guidelines
- Bush size must fit machine
  - Some too big – Height and width & base
- Some bushes dropping clusters while others not ripe
  - Challenge for Mechanical Harvesting non-clone plantings
  - Need Clones for more uniform harvest
- Bush damage minimal from mechanical harvesting
  - Need straight rows
  - Operator skill
- Rows clear of obstructions
  - Irrigation, row markers, weed trees
  - Room in headlands to turn machinery (~50 ft)

Fall 2020 Trials

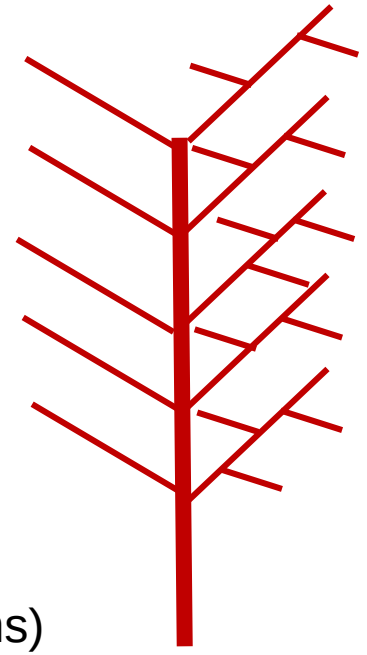
- BEI – Rotary unit
- BEI – Slapper
- OXBO – Bow rod / Sway bar

- Looking for cooperating growers
- Need 2 + acres
- Good weed control
- Accessible for Lowboy tractor-trailer

Bush conformation for mechanical harvesting

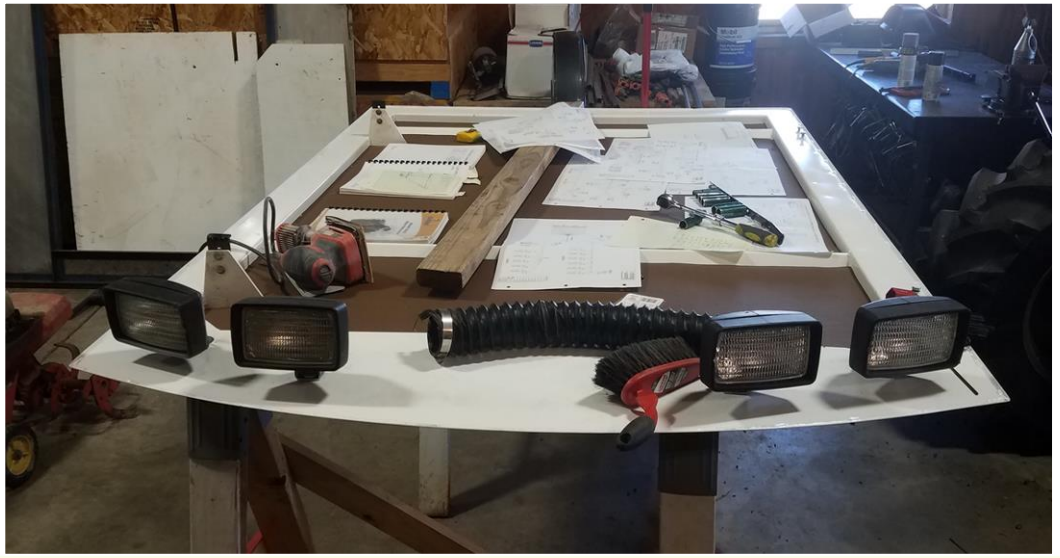
Engineer's viewpoint

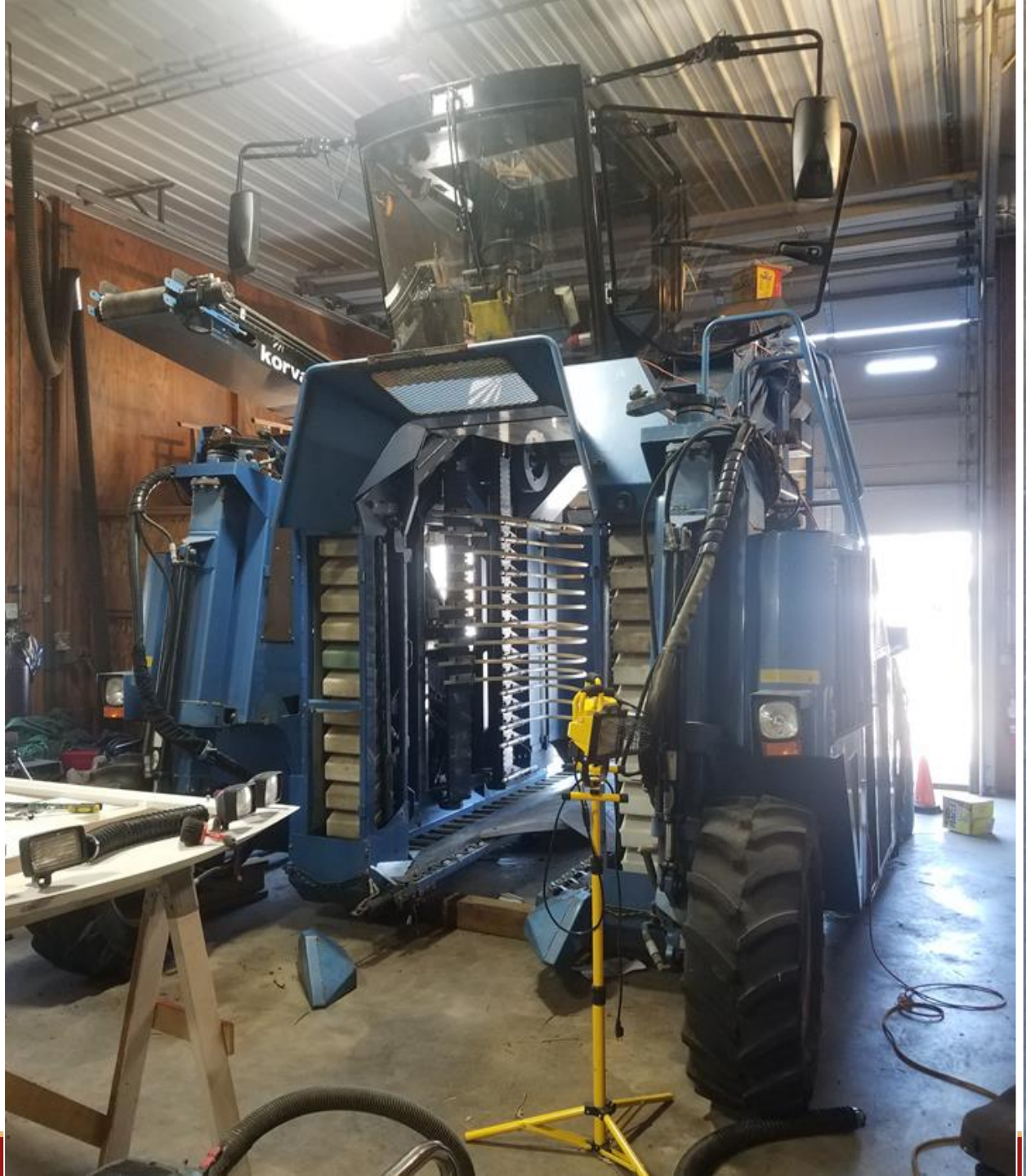
- Single stem – 12-24" long – No Suckering
  - Reduces ground drops
  - Ensures base of bush not too wide for machine
- Max height – 8 ft; Max diameter/width – 6 – 8 ft
  - Big bushes – increased bush and machine damage
  - More ground drops
- Bush pruning?
  - Fruits on 3rd year wood
  - Trim any 4th year wood?
  - Keep from getting too tall or too large in diameter at base (with multi stems)
- Involucre – clasping so nut doesn't drop until after mechanically harvested.
  - Disadvantage – might be harder to husk
- Even dry down
  - Fewer passes for harvesting



Big Blue Issues

- Destroyed wire (animals & UV)
- Parasitic draw
- System oil leaks
- Blow seals
- Busted bow rods
- Missing parts
- Bent/broken guard rails/shoes
- Stuck conveyors
- Cracked bearing
- Denigrated cab lining
- Wipers/light replacements
- Collection bin



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- (CA, OR, FL in USA)

Questions?

Hazelnut Thief?

Shamrock Orb-weaver spider (Araneus trifolium)