Shelling

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8/5/2024

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Motivation

- Shelling processes have not seen significant innovation compared to other post-processing areas.
- Efficient optimization of shelling process will significantly impact pecan post-harvesting process.
- Implement advanced technologies to provide smarter machines and fine-tune shelling processes to control pecan half-yields and to promote overall effectiveness.

Research Objectives

1. Determine relationship between sheller processing parameters and pecan half-yield.
2. Determine impact of moisture on half-yield during shelling process.
3. Determine effects of pecan variety on previous objectives

Equipment

Fig: 14-inch Sheller

Fig: Blower

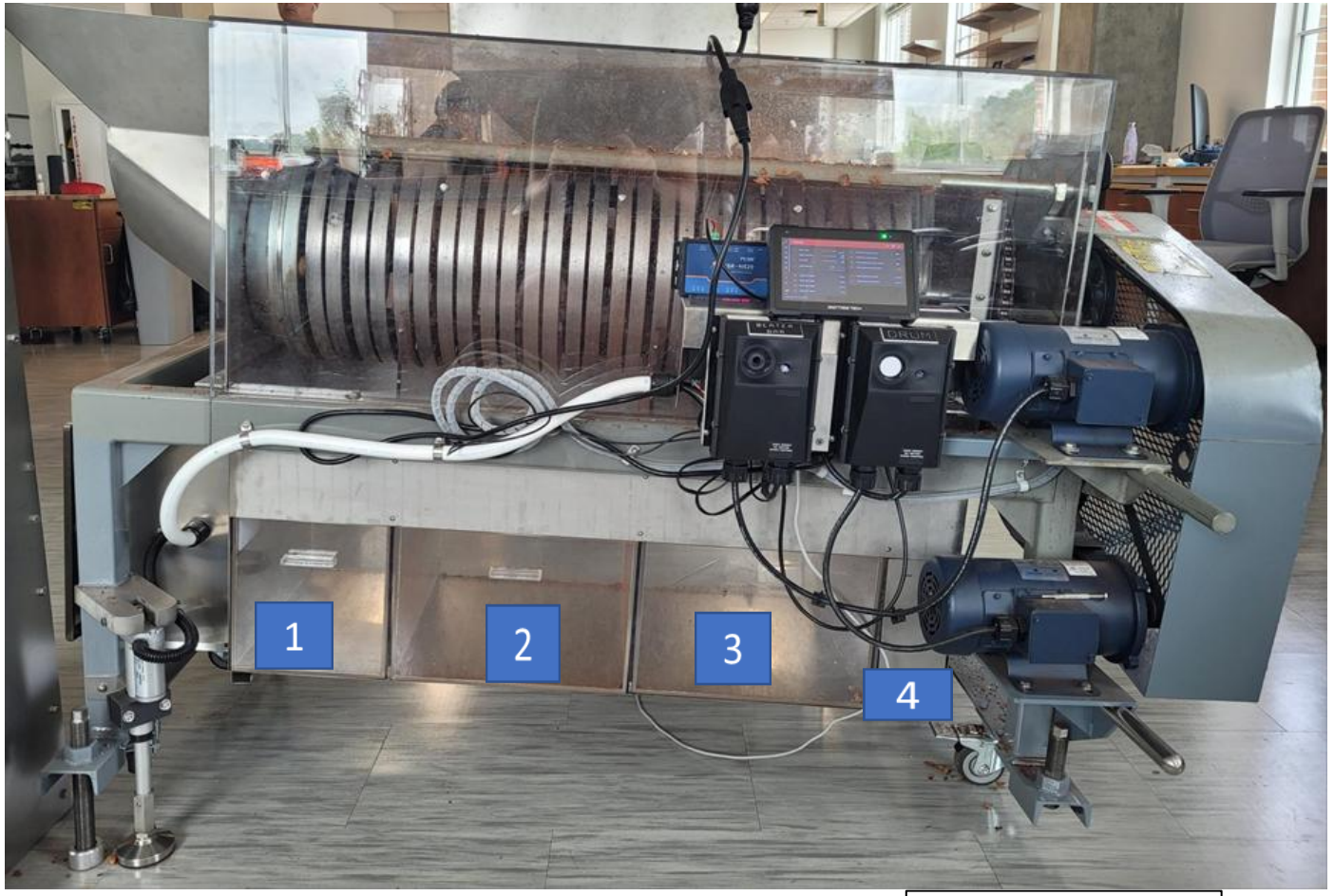
Modifications

Mod 1 – Replacement of metal panels with clear panels.

Mod 2 – Implementation of partitioned output locations.

Mod 3 – Instrumentation of digital displays for shaft and drum rpm.

Mod 4 – Instrumentation of Machine feet for tilt angle automation.

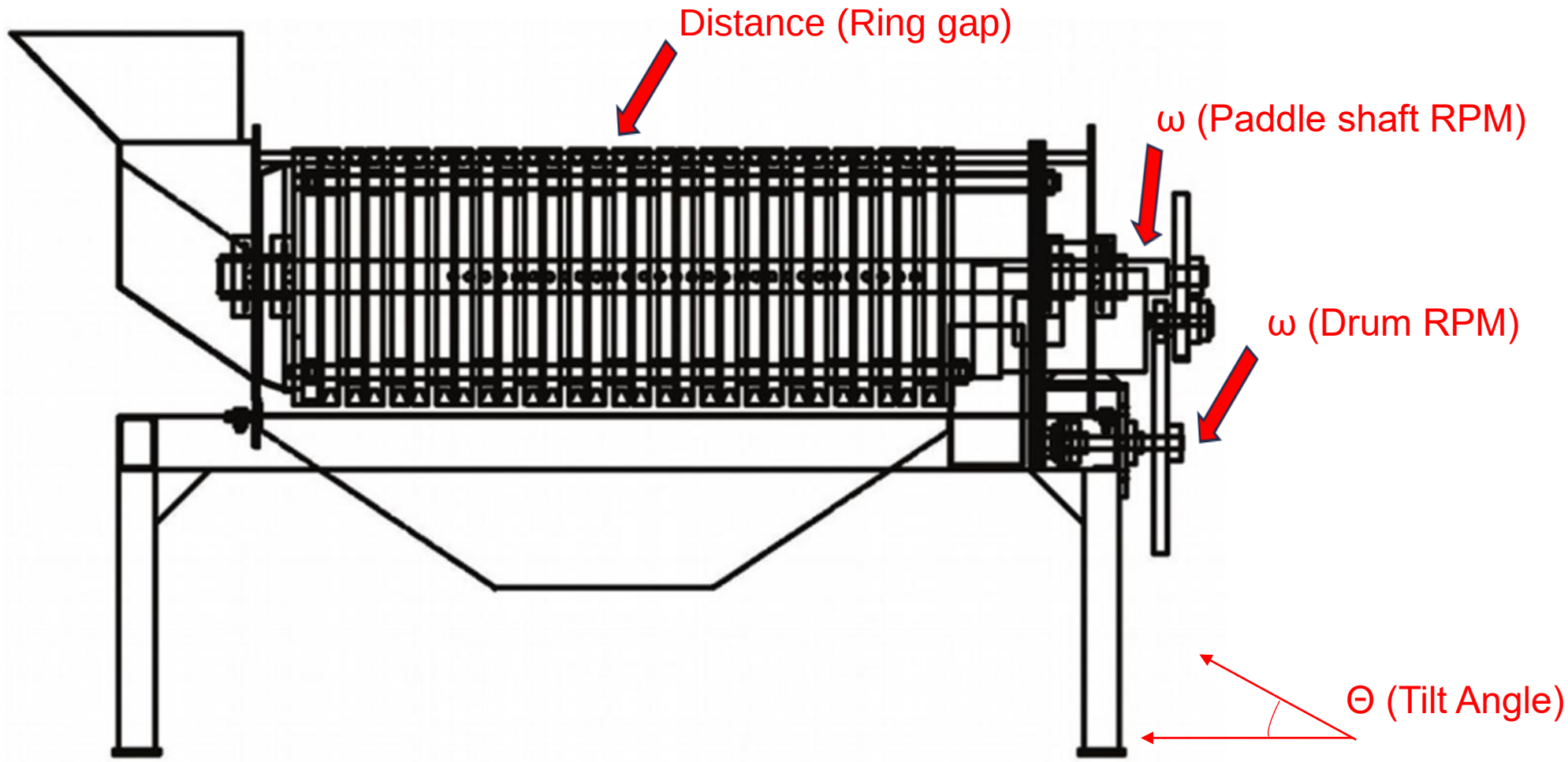


In figure
1. Output 1
2. Output 2
3. Output 3
4. Discharge

Design of Experiments for Studying Machine Parameters

Research Objectives (RO)	Independent Variables	Variations			Unit
		Levels			
RO1	Ring Gap	+0.0	+1/16	+1/8	In.
	Paddle Shaft Velocity	400	600	800	RPM
	Machine Tilt Angle	2.5	3.5	5	θ
	Drum Velocity	25	30	35	RPM
	Feed Rate	400	500	600	lbs./hr.
	Pin Material	Steel	Polymer		N/A
RO2	Moisture Level	5	7	9	%
RO3	Pecan Variety	Stuarts	Desirables	TBD	N/A

Design of Experiments

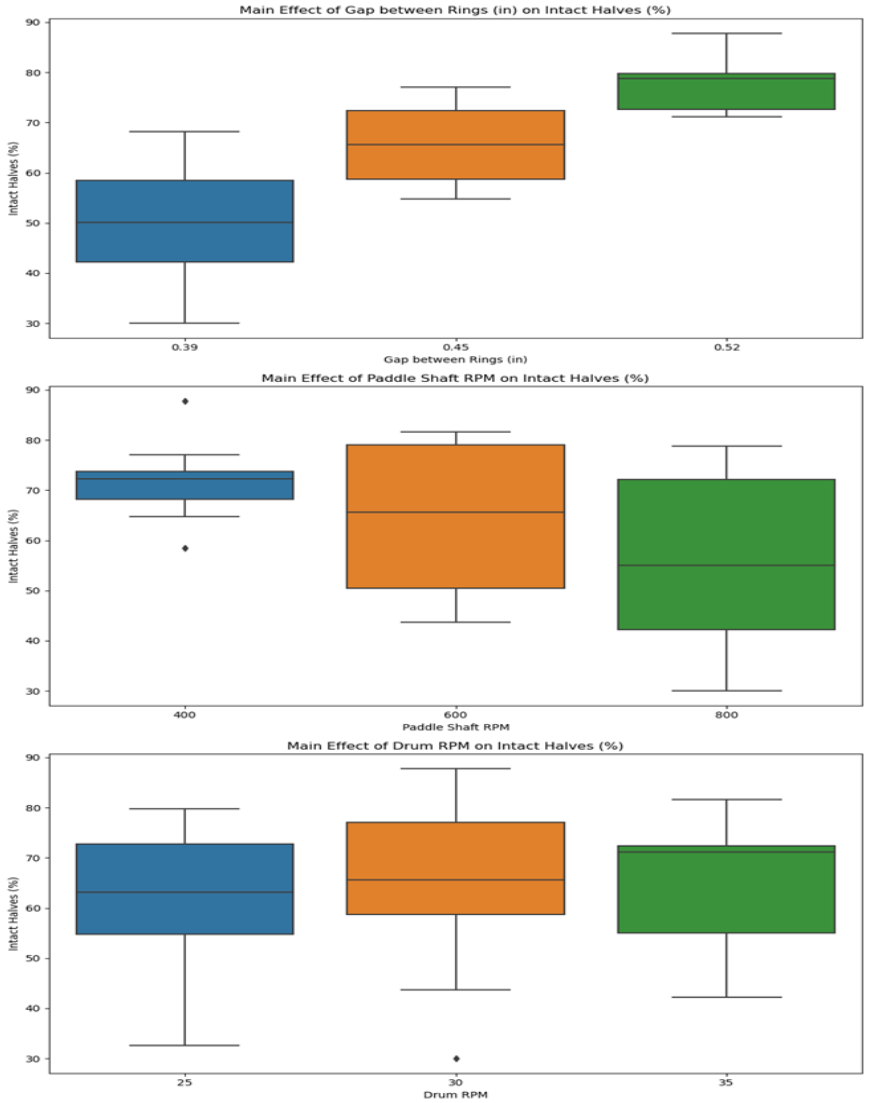


Experimental Study Results so Far

Source	Sum of Squares	DF	F-Value	P-Value
Gap between Rings (in)	3659.16	2	109.27	0.000002
Paddle Shaft RPM	1252.22	2	37.39	0.000087
Drum RPM	68.80	2	2.05	0.1905
Gap between Rings (in) : Paddle Shaft RPM	549.16	4	8.20	0.0062
Gap between Rings (in) : Drum RPM	86.13	4	1.29	0.3521
Paddle Shaft RPM : Drum RPM	140.90	4	2.10	0.1721
Residual	133.95	8		

- Significant Parameters from the table
  - Gap between Rings (inch)
  - Paddle Shaft RPM
  - Ring gap with Paddle Shaft interaction

Experimental Study Results Cont.



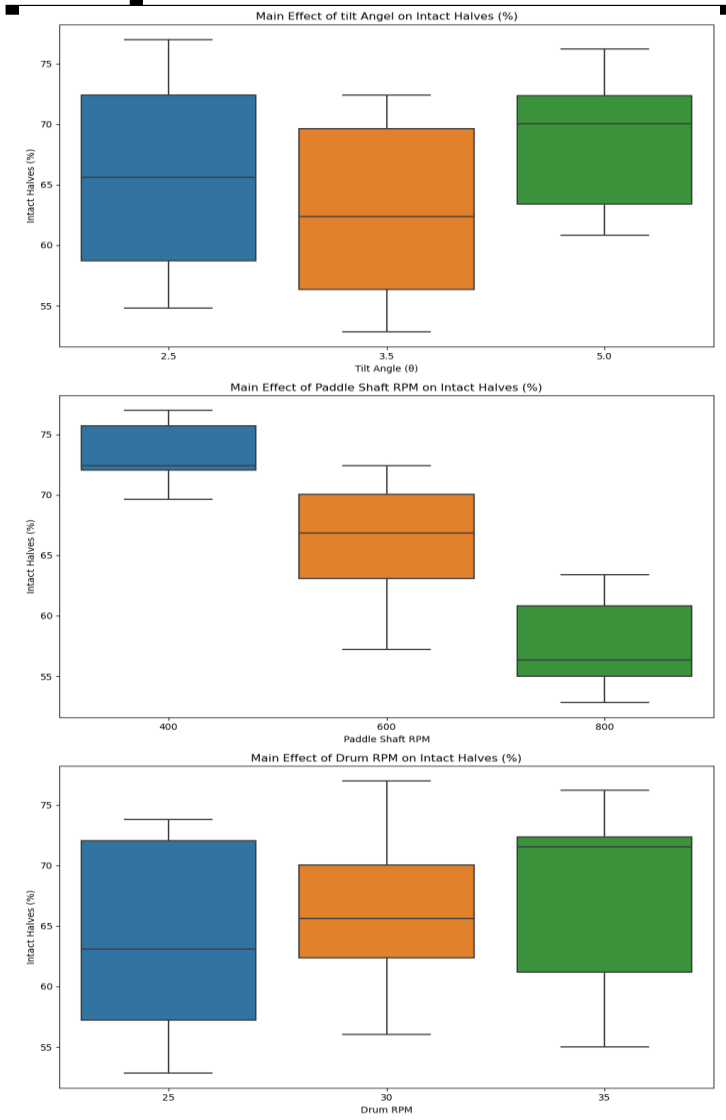
- Observation of a consistent positive trend in the percentage of intact halves as the gap between rings increases from the first graph.
- Observation of a negative trend in the percentage of intact halves as the paddle shaft RPM increases.
- No significant trend observed in the percentage of intact halves across the drum RPMs

Experimental Study Results Cont.

Source	Sum of Squares	DF	F-Value	P-Value
Tilt Angle (θ)	169.90	2	18.82	0.00094
Paddle Shaft RPM	1117.67	2	123.78	0.00000
Drum RPM	50.20	2	5.56	0.03066
Tilt Angle (θ)"): Paddle Shaft RPM	33.63	4	1.86	0.21057
Tilt Angle (θ) : Drum RPM	6.30	4	0.35	0.83789
Paddle Shaft RPM: Drum RPM	53.55	4	2.97	0.08920
Residual	36.12	8		

- Significant Parameters from the table
  - Tilit Angle (θ)
  - Paddle Shaft RPM
  - Drum RPM

Experimental Study Results Cont.



- Non-linear tend observed between Tilit Angle and intact halves. May be dependent on other factors.
- Observation of a negative trend in the percentage of intact halves as the paddle shaft RPM increases.
- Small positive trend observed in the percentage of intact halves across the drum RPMs, but further study needed to determine significance of trend.

Experiments in Progress

- Data has been collected for a kernel moisture range from 5%-7%, with data extending to 9% currently being collected.
- Data will be used to determine effects of kernel moisture specifically on the shelling process.

Independent Variables	Variations			Unit
	Levels			
Ring Gap	+0.0	+1/16	+1/8	In.
Paddle Shaft Velocity	400	600	800	RPM
Drum Velocity	25	30	35	RPM

Table: machine variables considered during moisture study

Modifications in Progress

- Constructed an automated system to move pecans from cracker to sheller without human intervention.
  - System allows for control of feed rate into sheller.
  - Designing a system for automatic transition of pecans to sorting process.
  - System will utilize imaging techniques to automatically track volumetric distribution of sheller output.

Fig: Current Setup in lab

Publications in Progress

- Paper 1
  - Based on sheller parameters' (e.g., paddle shaft velocity, drum velocity, ring gap) impacts on intact halves.
  - The estimated timeline for submission for publication is May 2025 to the Journal of Food Engineering.
- Paper 2
  - Based on various moisture level (e.g., 5%,7%, 9%) impacts with sheller parameters on intact halves.
  - This publication is expected to be submitted during Fall 2025.

Next Steps of Experimentation

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Thank you

Questions & Comments