

COMPARISON OF THREE COMMERCIAL AUTOMATIC BOOM HEIGHT SYSTEMS FOR AGRICULTURAL SPRAYERS: SUPPLEMENTAL INFORMATION

MATERIALS AND METHODS

TRACKS

Figure S1 shows an annotated satellite map of the courses and tracks.

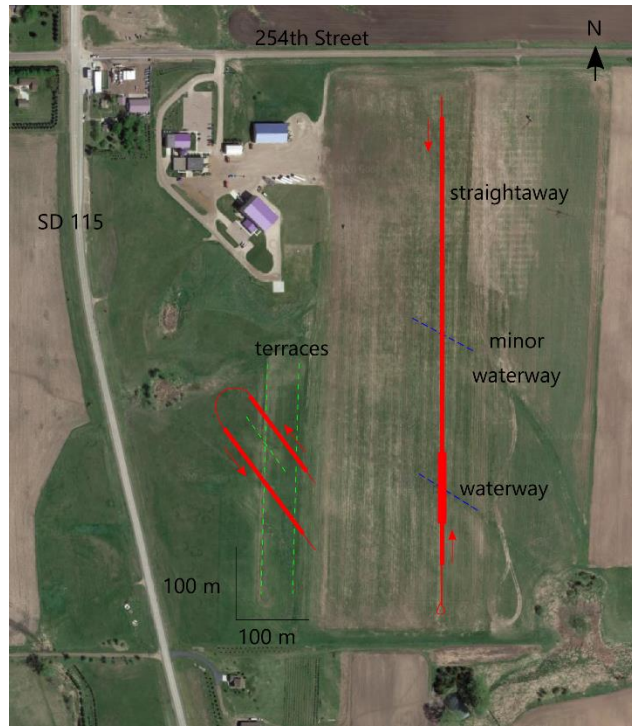


Figure S1: Satellite map of test tracks near the intersection of South Dakota Highway 115 and 254th Street. The thin red lines indicate the straightaway and terrace tracks, the medium thickness red lines indicate the straightaway and terrace courses (measurement regions), the thickest red line indicates the waterway course (measurement region), the green dotted lines indicate terraces and the blue dotted lines indicate dry waterways.

DATA ANALYSIS AND PERFORMANCE METRICS

The Herbst-modified Hockley Index (HHI) was calculated from Equation S1 (Herbst et al., 2018):

$$HHI = f_{10} + 0.75f_{25} + 0.25f_{40} - f_{>40} \quad (S1)$$

where

f_{10} = fraction of measurements with a deviation less than 10 cm (3.9 in) from the target height,

f_{25} = fraction of measurements with a deviation between 10 cm and 25 cm (9.8 in),

f_{40} = fraction of measurements with a deviation between 25 cm and 40 cm (16 in) and

$f_{>40}$ = fraction of measurements with a deviation of >40 cm.

Average system HHI differences were calculated from Equation S2.

$$\text{Average HHI Difference} = \text{Larger average HHI} - \text{Smaller average HHI} \quad (\text{S2})$$

RESULTS

Average HHI and HHI difference are shown in Table S1. System B had a significantly larger HHI than Systems A and C for each sensor location, at each speed, on each terrain. Compared to System A, System B had an average absolute HHI improvement of 0.30, 0.53 and 0.61 on the mild, medium and rough terrains, respectively. At the maximum common speed, the average absolute HHI improvement between the two sensors was 0.34, 0.51 and 0.76 on the three terrains, respectively (Table S1). Compared to System C, System B had an average absolute HHI improvement of 0.09, 0.20 and 0.40 on the mild, medium and rough terrains, respectively. At the maximum common speed, the average absolute HHI improvement between the two sensors was 0.11, 0.25 and 0.35 on the three terrains, respectively (Table S1).

Table S1: Average HHI and HHI difference for System B relative to Systems A and C. System B had a significantly larger HHI at each sensor location, at each speed, on each course.

Course	Sprayer	Sensor	System	Average HHI ^[a]			Average HHI difference ^[a]			Avg ^[b]	
				Speed (km/hr)			Speed (km/hr)				
				13	19	26	13	19	26		
Straight-away (mild terrain)	R4045	LO	A	0.63	0.55	0.50					
			B	0.90***	0.88***	0.85***	0.27***	0.32***	0.35***	0.32	
		RO	A	0.70	0.60	0.54					
			B	0.93***	0.90***	0.88**	0.23***	0.30***	0.34**	0.29	
		pooled	A	0.66	0.58	0.52					
			B	0.92***	0.89***	0.86***	0.25***	0.31***	0.34***	0.30	
	RoGator	LO	C	0.87	0.81	0.80					
			B	0.94**	0.90**	0.90*	0.08**	0.10**	0.10*	0.09	
		RO	C	0.88	0.82	0.79					
			B	0.95***	0.91***	0.92**	0.07***	0.09***	0.13**	0.10	
		pooled	C	0.87	0.81	0.80					
			B	0.95***	0.91***	0.91***	0.07***	0.10***	0.11***	0.09	
Water-way (medium terrain)	R4045	LO	A	0.32	0.37	0.21					
			B	0.88***	0.87**	0.82***	0.57***	0.50**	0.61***	0.56	
		RO	A	0.35	0.40	0.40					
			B	0.92***	0.92**	0.80***	0.57***	0.51**	0.41***	0.50	
		pooled	A	0.33	0.39	0.30					
			B	0.90***	0.89***	0.81***	0.57***	0.51***	0.51***	0.53	
	RoGator	LO	C	0.73	0.63	0.68					
			B	0.90**	0.87**	0.91**	0.17**	0.23**	0.22**	0.21	
		RO	C	0.78	0.61	0.53					
			B	0.93***	0.78*	0.80**	0.15***	0.17*	0.27**	0.20	
		pooled	C	0.76	0.62	0.61					
			B	0.91***	0.82***	0.85***	0.16***	0.20***	0.25***	0.20	
Course	Sprayer	Sensor	System	Speed (km/hr)				Speed (km/hr)			Avg ^[b]
Terraces (rough terrain)	R4045	LO	A	0.13	-0.13	-0.30	NA				
			B	0.56**	0.50***	0.49**	0.36	0.43**	0.63***	0.80**	0.62
		RO	A	0.04	-0.13	-0.26	NA				
			B	0.54*	0.45***	0.47**	0.36	0.51*	0.58***	0.73**	0.60
		pooled	A	0.08	-0.13	-0.28	NA				
			B	0.55***	0.47***	0.48***	0.36	0.47***	0.60***	0.76***	0.61
	RoGator	LO	C	0.19	-0.03	0.01	NA				
			B	0.61***	0.51**	0.40**	0.22	0.42***	0.54**	0.39**	0.45
		RO	C	0.21	0.18	0.17	NA				
			B	0.56**	0.59**	0.49***	0.39	0.35**	0.41**	0.32***	0.36
		pooled	C	0.20	0.08	0.09	NA				
			B	0.59***	0.55***	0.45***	0.31	0.38***	0.48***	0.35***	0.40

[a] For each sensor or pooled sensors, HHI was significantly larger for System B compared to System A or System C: * p < 0.05, ** p < 0.01, *** p < 0.001.

[b] Mean of averages at the three speeds were not tested for statistical significance.

[c] HHI was not tested for statistical significance at 19 km/hr on the terraces because only System B was tested at this speed.

REFERENCES

Herbst, A., Osteroth, H.-J., & Stendel, H. (2018). A novel method for testing automatic systems for controlling the spray boom height. *Biosystems Engineering*, 174, 115-125. doi:<https://doi.org/10.1016/j.biosystemseng.2018.06.003>