

Assessing the Effect of Machine Automation on Operator Heart and Breathing Rate During Mechanical Harvesting

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Introduction

- Over 80% of wild blueberries are harvested mechanically
- Harvesting is a laborious task due to the near constant requirement for picking head height adjustment

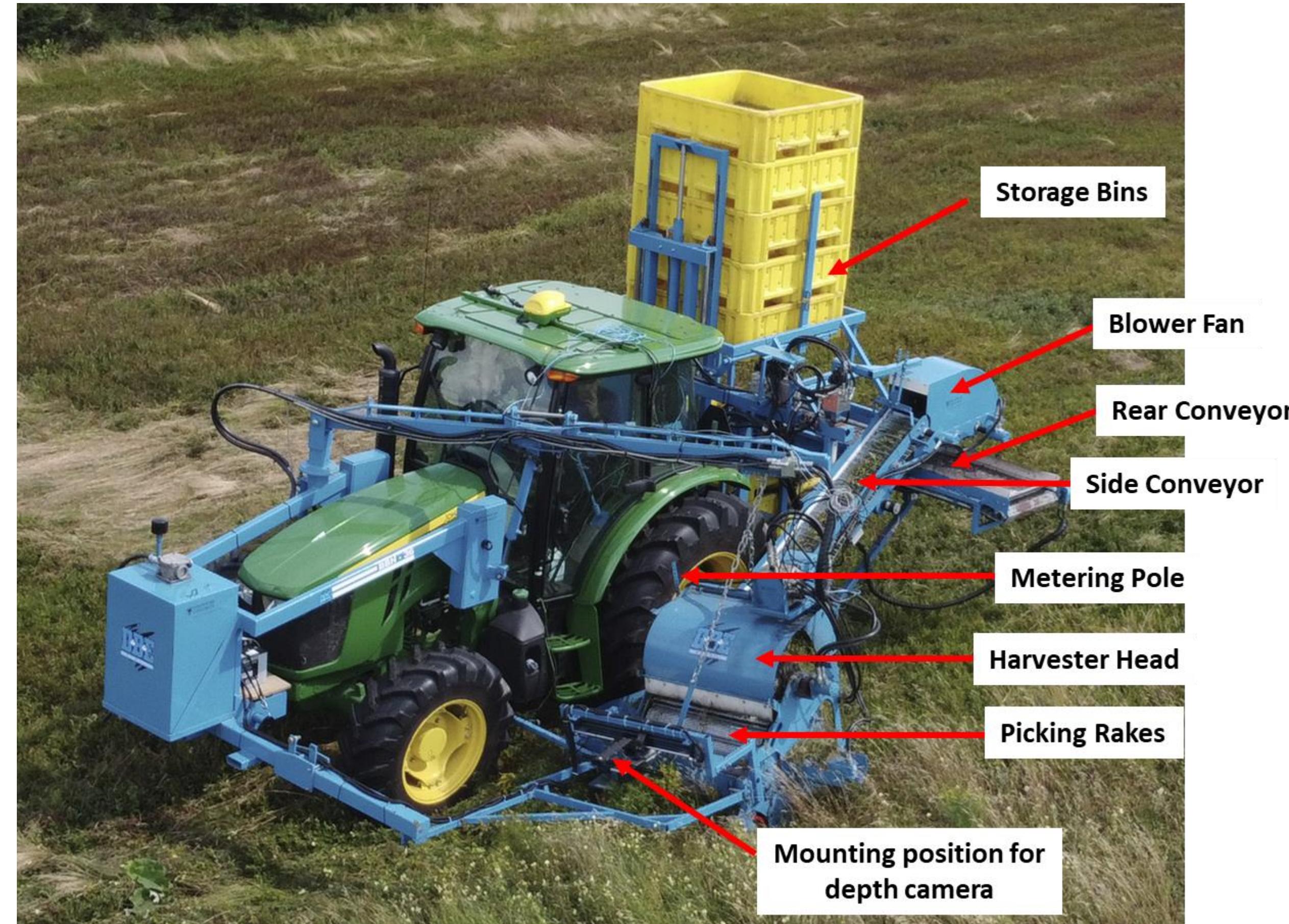


Fig. 1: Image of wild blueberry harvester actively harvesting

- Additionally, operators are required to steer the harvester, fill bins evenly, and change full bins
- This results in the operator's attention being pulled in three directions, increasing the potential for mistakes and yield reduction
- By incorporating automation in the form of autosteer and auto head adjustment, operator stress and fatigue can be reduced
- This should lead to fewer accidents and improved yields

Primary Objective

- Evaluate the effect of autosteer and auto head adjustment on harvester operator stress and fatigue
- Compare the differences in stress levels between new and skilled operators under manual, semi-automated and automated harvesting conditions

Methodology

- The study took place across two fields in 2021
- Both a new and skilled operator were assessed for how their heart and breathing rate varied across manual, semi, and fully automated harvesting conditions
- Heart and breathing rates were monitored using a Hexoskin wearable body metrics suit
- The following criteria define each of the harvesting conditions:
 - Manual – Traditional harvester setup with no automated aids
 - Semi-automated – Incorporating one of either autosteer or the automated head adjustment
 - Fully Automated - Incorporating both autosteer and automated head adjustment



Fig. 2: Hexoskin wearable body metrics suit

- Autosteering was achieved using John Deere's AutoTrac300, 4640 display and Starfire 6000 receiver
- Auto head height adjustment was achieved using a custom system based on 3D imagery and a blueberry detection neural network

Results and Conclusions

- Both the skilled and new operator found the manual steering and manual head adjustment combination to be the most demanding in terms of their heart and respiration rate
- Both the skilled and new operators saw significant reductions in heart and breathing rate as automation components were introduced

Tbl 1: Tukey's multiple comparison test on the significant two-way interaction for the responses of mean heart rate and mean respiration rate for both the skilled and new operator

Treatment Combination	*skilled operator*		*new operator*	
	Mean Heart Rate (bpm)	Mean Respiration Rate (rpm)	Mean Heart Rate (bpm)	Mean Respiration Rate (rpm)
AS_AH	62.74 d	13.84 c	89.08 c	8.98 d
AS_MH	65.24 b	18.26 a	87.37 d	16.21 c
MS_AH	63.81 c	15.29 b	91.83 b	18.12 b
MS_MH	67.08 a	18.34 a	97.61 a	20.41 a

AS = Autosteer, MS = Manual steering, AH = Auto head adjustment, MH = Manual head adjustment

Moving forward this study has the following goals:

- Assess additional new operators to observe the impact of the automation components
- Observe the effects of a newly developed head adjustment system
- Automate the bin loading system and observe the impact that has on operator stress and fatigue

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