Handling Fresh Harvested Almonds

Project No.: **HARV3.Coates_Ehsani**

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A. Summary *(In laymen's terms – emphasize key findings and recommendations)*

This project is intended to run in back to back seasons in Australia and California, Unfortunately with the initial funding arriving in mid-February, the project began too late for the first Australian season. This left no time to engineer and build the deflecting attachment for the shaker. Instead we tested low velocity blowers to remove windfall and other debris from under the shield.

In California, the pin-wheel pickup was developed as an attachment to a tractor. The initial test had complications that were more related to the assembly of the device and after 3 passes, left a portion (~30%) of the fruit on the ground. After modifications, the second test was much more successful, where 3 passes collected all the fruit off the ground. This is being further developed with a slow-arm sweeper to bring fruit from near the drip line into the pin-wheel pickup.

B. Objectives *(300 words max.)*

1. Integrate a shield and blower onto an existing shaker arm as an aftermarket addition, to direct fruit into the row and prevent the fruit from accumulating on the tree line
2. Evaluate if pin-wheel (macadamia) technology can be adapted to existing pickup systems
3. Evaluate if slow-arm sweeping can be adapted to existing pickup or conditioner systems to accommodate a larger/wider windrow

C. Annual Results and Discussion *(This is the core function of this report)*

Year 1 Australian Season

Construction of the integrated shield and blower was delayed by a season owing to the lateness of project funding. Instead the focus was put on the blower that can blow at a near-parallel angle to the ground with 360º rotation. A blower head was developed (3D printed) that uses the force of the air to rotate itself on a bearing so that air is delivered in every direction, near parallel to the surface (Figure 1). Windfall takes a small percentage of the normally high velocity air used to move large volumes of fruit. It still allows the use of air to clear out under the tree without the associated dust plumes.

Figure 1. 3D-printed blower head attached to a typical leaf blower using lower velocity air, but adequate to remove leaves and windfall as it moves parallel to the surface, tested in Australia in 2019.

Year 1 California Season

During the first year of the project, a pick up prototype was built using a pin-wheel pickup system (detailed in Materials and Methods section). The prototype pick up system was tested on Independence® cultivar of almond at Houghson Nut near Modesto, CA.

For the first test, we tried seven pick-up passes and in each pass, we ran the pick up system three times for each section. Forward speeds tried were 0.12 m/s, 0.55 m/s, and 0.66 m/s. We also tried our machine with and without front frame wheels to check the effect of frame weight pressure on the fruit removal rate. The best result was obtained when the forward speed was 0.55 m/s with frame front wheel weight pressure; however, ~30% of the fruit remained on the ground after 3 passes. Based on the results from the first field trial, the prototype pick up machine was modified and the tested again in the field. The fruit pick up rate improved significantly in the second trial, and there were no fruit left on the ground after three pickup passes. In the second trial, the forward speed was set at 0.55 m/s. In addition, two sweeping wheels were added to each side of the frame to increase the pick-up area. The results of both trials are shown in Figure 2.

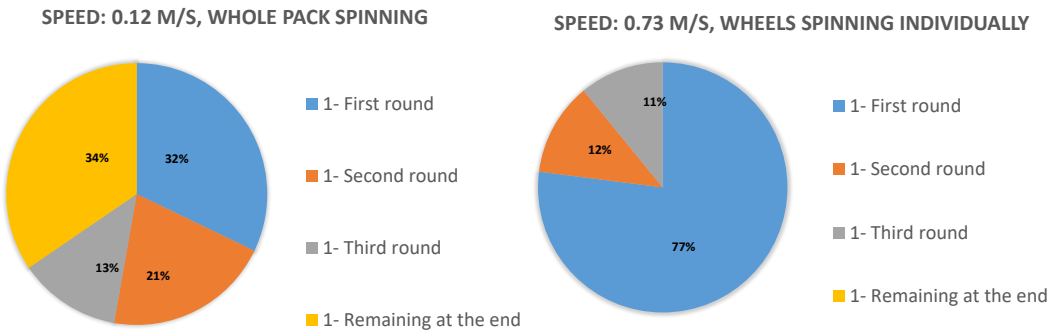

Figure 2. Proportion of almond fruit collected during each pass (round) along the almond row and the fruit remaining on the ground, from the first two tests of the pin-wheel roller in California in 2019. The first test used Independence® fruit (left) and after design modifications, the more successful second test used 'Aldrich' (right).

The system produced very little (almost zero) dust during the pick-up process; however, the trial was conducted in a low-yielding orchard and was running at full capacity, thus the pick-up rate was comparatively low for a commercial application. This, plus excessive debris (broken branches, stones, etc.) could interfere with the performance of the system. Based on the data and experience gained in the first year, a new system has been designed to improve the pickup rate. The new design is under development and will be tested during the harvest season in the second year of the project.

D. Outreach Activities

1. Australian Almond Board (ABA) R&D Conference, Loxton, SA, October 2019
2. California Almond Board (ABC) Conference, Sacrament, CA, December 2019

E. Materials and Methods *(500 word max.)*:

A pick up attachment prototype system using pin-wheel pickup arm was built and first tested on Independence® almond fruit at Houghson Nut near Modesto, CA (Figure 3).

Figure 3. Almond pick up attachment prototype for the California 2019 season.

The pick-up system used an eight pin-wheel pickup pack. Each wheel pack was made of 10 green finger wheels and two arms, which could freely and independently move up and down. The sweeping arms were spring loaded to provide good contact with the ground while accommodating the variation in ground height. The pin-wheel pack picked up the almonds from the ground and dropped them onto an auger, to transfer them to the side of the pickup head. The gap between the auger screw was filled with rubber and thin sheet metal to protect the nuts. Field tests were conducted to evaluate the effects of different parameters such as forward speed, wheel pack pressure to the ground, and wheel pack ground pressure on the fruit pick up rate.

The second field trial was conducted after the following modifications were performed on the pick-up machine after the first field trial:

1- Springs location changed to increase wheel packs' pressure to the ground
2- Sweeper added to guide almonds to the center of the frame
3- Wheels in the wheel pack freed to be able to spin individually to prevent wheel pack lock during rotation
4- A cover was used above the wheel packs and auger to prevent picked up almonds from jumping around.

F. Publications that emerged from this work

1. California Almond Board (ABC) Poster presentation (Appendix A)

Appendix A

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Handling Fresh Harvested Almonds

(Exploring dustless alternatives)

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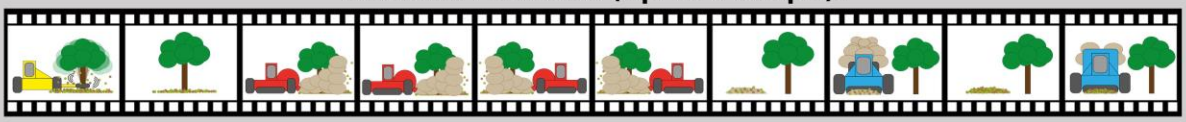
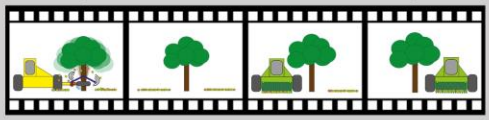
Visible dust is becoming a point of contention between almond growers and the local community as the industry expands into new regions and areas that were traditionally more agricultural and are becoming more urbanized. Growers are being challenged to address a dust problem that historically had no relevance but now is becoming more and more of a social issue. While fine dust particles (PM2.5 and PM10) have become more regulated, visible dust has not. This has the industry pursuing a 'good neighbor' policy to prevent further regulation.
This project looks to eliminate the sweeper/blower by integrating an aftermarket shield and blower onto the shaker to direct fruit into the row and away from the treeline. This is followed by adopting finger wheel technology as a method to pick the fruit up without windrowing. This has the potential to substantially reduce dust without extensive infrastructure changes.

Current Process (up to 7 steps):



Shake | Dry | Sweep 1 | Sweep 2 | Sweep 3 | Sweep 4 | Dry | Condition | Dry | Pickup

Proposed Process (3 steps):



Shake | Dry | Pickup 1 | Pickup 2

Note: Not all orchards include all steps.

Tree Shaking / Deflecting

A deflector is being built to attach to a typical side-arm shaker. The deflector will be large enough to span the typical 3'- 4' region under the tree where most of the fruit collects. It will run the length of the tree canopy. It will be fitted with low velocity fans to blow out the windfall from underneath the deflector as the boom arm moves in to shake the tree. Trials will begin in the 2020 Australian season.

Figure 2. A design rendering of how the screen would look on a side boom shaker (left). Testing a blower where the airflow runs parallel to the ground (right).

Fruit Pick-up

Finger wheel rollers, used in other nut industries such as macadamia nuts and pecans are being trialed as an option for dustless pick up. The initial prototype test was done with 16" diameter finger wheels in 8 packs of 10. The overall width was 65". Fruit is extracted through an auger lined with rubber to prevent crushing the product. The first test was conducted on Independence® fruit with a first pass accuracy of 32%. Modifications to the rig, included increasing wheel pressure to the ground and improved fruit containment brought the second test first pass accuracy up to 77%.

Figure 3. Version 1 of the finger wheel pick-up (left), Version 2 of the finger wheel pickup with side sweeper (middle), close up of how the finger wheels pick up fruit (right).

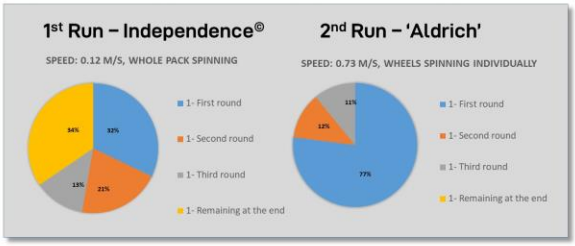


Figure 1. Results from the first two tests of the finger roller. The first test was Independence (left) and after design modifications, the more successful second test of 'Aldrich' on the right.

Next season may introduce a larger finger wheel and side sweeper to improve first pass accuracy. The wheel has potential as a primary fruit collection method, but also as a secondary collection method for orchard floor sanitation.

Summary

- Based on the initial field trial, optimal forward speed for maximum pick-up rate was about 0.7 m/s.
- One-wheel row is not enough for picking up the whole crop in one pass; additional rows or larger wheels may be required for the final system.
- The amount of dust generated with the system was very minimal.
- Extensive amount of broken branches could interfere with the rotation of fruit pickup wheels.

california almonds

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Report for:
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LIMITED PROTECTION

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