Off-ground Harvest of Almonds: Technoeconomic Cost and Benefit Analysis with Analysis of Barriers to Adoption

Project No.: **17-STEWCROP11-Simmons**

Project Leader: Christopher Simmons
Department of Food Science and Technology
University of California, Davis
One Shields Ave
Davis, CA 95616
(530) 752-2109
cwsimmons@ucdavis.edu

Project Cooperators and Personnel:
Patrick Brown, Department of Plant Sciences, UC Davis
Mae Culumber, UCCE – Fresno County
Michael Coates, Plant & Food Research Australia Pty Ltd
Bruce Lampinen, Department of Plant Sciences, UC Davis

Objectives:

1. The goal of the technoeconomic model is to predict the economic and environmental incentives and risks associated with off-ground harvesting relative to conventional practices. To this end, the project involves the following objectives:
2. Complete technoecomonic model to compare capital and operating costs for removing almonds from trees and the orchard across off-ground, conventional, and low-dust harvesting scenarios.
3. Expand technoeconomic model to include passive and active drying options for in-hull almonds for off-ground harvest. Use model to compare off-ground harvesting to conventional and low-dust harvesting in terms of capital and operating costs to obtain dry in-hull almonds.
4. Deliver global warming potential assessments for each harvest scenario.

Interpretive Summary:

This project was funded under a unique agreement and involves an atypical project timeline. Specifically, the project formally began in spring 2018 and, by design, uses a no-cost extension to extend the project into the following fiscal year with a targeted end date of summer 2019. In light of this unusual schedule, this report captures the early stage of the work. To date, a graduate student researcher has been hired from the Department of Agricultural and Resource Economics at UC Davis. This researcher, with guidance from the principal investigator and other participating experts, has focused on elucidating differences between conventional and off-ground harvesting scenarios in terms of equipment requirements, cultural practices, and product loss based on literature review and feedback from researchers, farm advisors, equipment manufacturers, and ABC. The initial modeling effort has focused on the steps necessary for releasing almonds from trees and removing them from the orchard. For off-ground harvesting followed by in-orchard windrow drying, it is

expected that the elimination of the blowing and sweeping steps will reduce production costs by $75/acre compared to conventional practices. However, if off-ground harvest is followed by immediate transport out of the orchard, a cost reduction of $236/acre is predicted based on expected reductions in equipment use and soil management. This figure accounts for a slight increase in expected loss as windfall almonds will no longer be collected when almonds are removed from the orchard immediately after off-ground harvesting.

Subsequent analyses will couple a technoeconomic analysis of passive and active drying options for off-ground harvesting without in-orchard windrow drying. Furthermore, pending analyses will seek to determine if harvester rental or capital costs will or can differ from current rates based on manufacturer feedback and any predicted production cost reductions for off-ground harvesting.

Materials and Methods:

A 2016 cost assessment conducted by University of California researchers provided cost data for conventional harvesting and served as the foundation for modeling costs associated with off-ground harvesting. Alterations to the baseline model were made to reflect changes to equipment and cultural practices that may occur under off-ground harvesting. These changes were rooted in discussions with harvester manufacturers, UC farm advisors and researchers, and ABC experts. Additional data and assumptions were drawn from published research regarding almond cultivation and other industries using off-ground harvesting. At this time, the analysis is focused on factors and processes that affect the removal of almonds from trees and their transportation out of the orchard under several harvesting scenarios. Expected changes to conventional harvest and cultural practices for the various harvest scenarios are listed in (**Table 1**.)

Table 1. Production practice comparison between three harvest scenarios (elements not listed are assumed to be same across all scenarios). Blue cells indicate conventional practices that will remain the same for off-ground harvesting. Green cells denote practices that will be modified for off-ground harvesting relative to conventional harvest. Orange cells show conventional practices that will be eliminated under off-ground harvesting.

	Scenario 1	Scenario 2	Scenario 3
Harvesting method	Conventional	Off-ground	Off-ground
Drying method	In orchard	In orchard	Out of orchard
Pest management:			
Weeds-Mow Middles 6X	"Row middles are mowed six times, once per month March through August."		Assuming twice a year mowing in March and June.
Pests-Insects Ants	"Clinch is applied on the berms in July for ant control."		Floor management is avoided when no longer drying within the orchard.
Pests-Weeds Pre-Harvest	"A pre-harvest spray (Roundup, Goal 2XL) is applied in August to prepare the orchard floor for harvest."		
Pests-Weeds Strip Spray Dormant	"A dormant strip spray is applied in November or December using pre-emergent and contact herbicides (Roundup, Matrix) to control weeds in the tree rows."		
Winter Sanitation-Shake/Blow/Mow	"The mummy nuts are shaken from the trees, dropped to the orchard floor, blown into the row middles and shredded with a flail mower."	Shake & catch - windrowing - flail mowing	
Harvest:			
Shake-Trees	"The shaker head attaches to the tree trunk to shake the nuts from the tree. "	Shake & catch.	
Hand Rake/Blow Nuts			Almonds collected will be transported directly to drying site outside of orchard.
Sweep Windrows	"The nuts fall to the ground and in a separate operation are blown from around the tree and swept into windrows to dry."	Almonds collected will be deposited directly into windros within the orchard for drying	
Pickup/Haul Nuts	" A pickup machine gathers the nuts from the windrow and loads them into a cart or bankout wagon."		
Overhead: TBD			
Yield	Base yield: 2200 pound / acre.		0% to 2 % loss due to uncollected windfall.

Results and Discussion:

As the project began only recently, the technoeconomic model is still under development and many results are pending. To date, work on Objective 1 of the project is underway. Estimated changes to the net return per acre have been calculated based on the production practice changes outlined in (**Table 1**). These figures are provided in (**Table 2)**.

Table 2. Changes to the cost per acre to produce almonds for the 3 harvesting scenarios outlined in (**Table 1.**)

COSTS PER ACRE AT TO PRODUCE ALMONDS			
	Scenario 1	Scenario 2	Scenario 3
	2,200.00	**2,200.00**	**2,156.00**
OPERATING COSTS/ACRE:			
Cultural Costs	0.00	0.00	-73.00
Harvest Costs:	0.00	-75.00	-163.00
Interest on operating capital	0.00	-0.27	-0.47
TOTAL OPERATING COSTS/ACRE	0.00	-75.27	-236.47
Total Operating Costs/Pound	0.00	-0.03	-0.11
CASH OVERHEAD COSTS/ACRE	0.00	0.00	0.00
TOTAL CASH COSTS/ACRE	0.00	-75.27	-236.47
Total Cash Costs/Pound	0.00	-0.03	-0.11
NON-CASH OVERHEAD COSTS/ACRE	0.00	0.00	0.00
TOTAL COSTS/ACRE	0.00	-75.27	-236.47
Total Costs/Pound	0.00	-0.03	-0.11

NET RETURNS PER ACRE ABOVE COSTS			
PRICE	Scenario 1	Scenario 2	Scenario 3
$/Pound	**2,200.00**	**2,200.00**	**2,156.00**
ABOVE OPERATING COSTS	0.00	75.27	126.47
ABOVE CASH COSTS	0.00	75.27	126.47
ABOVE TOTAL COSTS	0.00	75.27	126.47

As stated previously, this analysis only captures a portion of the production process for off-ground harvesting and various drying approaches must also be considered to achieve parity with conventional harvesting. Additionally, the cost estimates shown in (**Table 2)** do not yet reflect possible variability in losses or equipment prices. A sensitivity analysis is needed to determine how deviations in assumed baseline values affects the net return value comparison. Furthermore, predicted changes to fuel consumption should be translated to changes in operational emissions for the off-ground harvest scenarios. These analyses will be conducted as the project progresses in accordance with Objectives 2 and 3.

Research Effort Recent Publications:

None to date due to project schedule.

References Cited:

Not applicable