

University of California  
Division of Agricultural Sciences

## PROJECT PLAN/RESEARCH GRANT PROPOSAL

Project Year: 2008-2009

Anticipated Duration of Project: One year

**Project Leader:** Uriel A. Rosa, Dave Smith, Louise Ferguson      Location: Tulare County  
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**Project Title: Performance evaluation of a canopy shaker harvester monitored by the olive yield monitor (OYM) developed at UCD. Part III of “Damage Mitigation of California Table Olives Mechanically Harvested”.**

Cooperating Personnel: Kitren Glozer, Bill Krueger, Jackie Burns, Diane Barrett, JX Guinard

Keywords: Field efficiency, effective field capacity, mechanical harvest

Commodity(s): Olives

Relevant AES/CE Project No.:

### **Problem and its Significance:**

Olive manual harvest costs in California are higher than \$300 per ton, accounting for more than 50% of grower's gross return. Decreasing harvest cost by implementing mechanical harvest with increased fruit removal efficiency without bruising the fruits is a promising way to increase the profit margin in olive production. However, to improve an available canopy shake-and-catch harvester to mitigate fruit injury, we first evaluated and quantified the contribution of individual machine components, such as the shaker head, the catching frame, conveyors and the bin, in causing fruit injury. In Oct 2006 experimental data were acquired with the harvester provided by Dave Smith Engineering (DSE) while working on 21 Manzanillo cultivars at the UCD experimental station in Lindcove, CA. Dynamic measurements of displacement, velocity and acceleration were obtained for fruit, branches and shaker rods by applying available three-dimensional video analysis software to the stereo high speed video images recorded at 500 fps in the field. Several design improvement suggestions were created based on the results of the analysis and the improved understanding of fruit detachment and injury causes. These suggestions were implemented by DSE during the 2006-2007 off season, which included appropriate angle of attack of the shaker drums to produce vertical force components to facilitate fruit detachment and padding of head rods and catching frame. In Oct 2007 experimental data were acquired in approximately four acres with the harvester provided by Dave Smith Engineering (DSE 007) while working on Manzanillo cultivars at the Rocky Hill Ranch. Fruit removal with this canopy shaker improved in the orchard with hedgerow trees. These trials were conducted to evaluate the prescribed design modifications and machine performance. Analysis of fruit injury, machine performance and component contributions to fruit injury have been investigated. Preliminary results have indicated quite successful design results on fruit injury mitigation and detachment. Extended fruit injury evaluations are being conducted by Musco Family Olive and Bell Carter Olive Companies in cooperation with Drs Barrett and Guinard.

The DSE 007 picking head olive harvester prototype was retro-fitted in 2007 with two synchronized yield monitoring systems; a UCD Bio-automation Lab (BAL) custom built yield monitor (OYMO7) and an AgLeader Insight monitoring system. The OYMO7 logged input from a custom built bin scale mounted on the harvester forks. It also had sensors that measured the drum speed of the picking head, enabling differentiation of head rotational speed. The Insight yield monitor was to record picking head speeds (rpm) and GPS data at the same rate as the OYM (BAL) logged selected variables: date, UTC time, latitude, longitude, ground speed (GPS) and yield. Results of 2007 olive harvest trials have been evaluated.

The objective of this proposal is to collect extensive field performance data with the DSE canopy shaker harvester improved by DSE to operate during the 2008 season.

**Objectives:**

To perform a complete machine field performance evaluation for the available DSE canopy shaker harvester during the 2008 season trials, and if the machine is field worthy, vary machine parameters such as ground (mph) speed and head speed (rpm) to try enhancing machine productivity.

**Plans and Procedures:**

The specific olive groves will be determined by Louise Ferguson's collaborators in Tulare County in October 2008, or in another orchard to be determined by the project leaders. The improved harvester modified by Dave Smith during the 2007/2008 off season, will be available for our evaluation tests and for full assessment of the harvester effective field capacity and field efficiency for the duration of the field tests. A complete randomized block analysis will be performed on to measure fruit injury levels and to optimize ground (mph) and drum (rpm) speeds for best performance. Samples will be collected from regular orchard operations by Louise Ferguson's group.

A complete analysis will be provided with the collected field data. These results can be used for machine costs analysis.

**Plans and Procedures:**

Overall Objective: Evaluation of 2008 Improved DSE Mechanical Harvester

Location: Block 17-J-W @ Rocky Hill Ranch: Tulare County

**First Specific Objective:** evaluate DSE 007 picking head harvester efficiency on a hedgerow orchard prepared for mechanical harvesting versus an unprepared orchard, and effects on fresh and processed fruit quality.

**Second Specific Objective:** evaluate different combinations of ground speed (mph) and head speed (rpm); specific combinations will be determined after preliminary field trials. If we are able to test more than one ground and head speed combination ground speeds will range from 0.25 MPH to 1 mph and head rpm from 140 to 180 rpm.

Before the experiment begins the 6 rows designated for mechanical harvesting will be divided into 5, 12 tree sets with 2 pre hand harvested trees in between each rep and 2 harvested border trees at the end of each row. This will allow 5, 12 tree replications per mechanically harvested row for testing different mph/rpm combinations.

In May, 2008

6 rows of 70 trees each will be conventionally pruned

6 rows of 70 trees each will be pruned for mechanical harvesting:

- All large, horizontal limbs extending into the row middle will be pruned off
- Trees will be skirted at 4 feet from the ground
- Trees will be topped at 14 feet

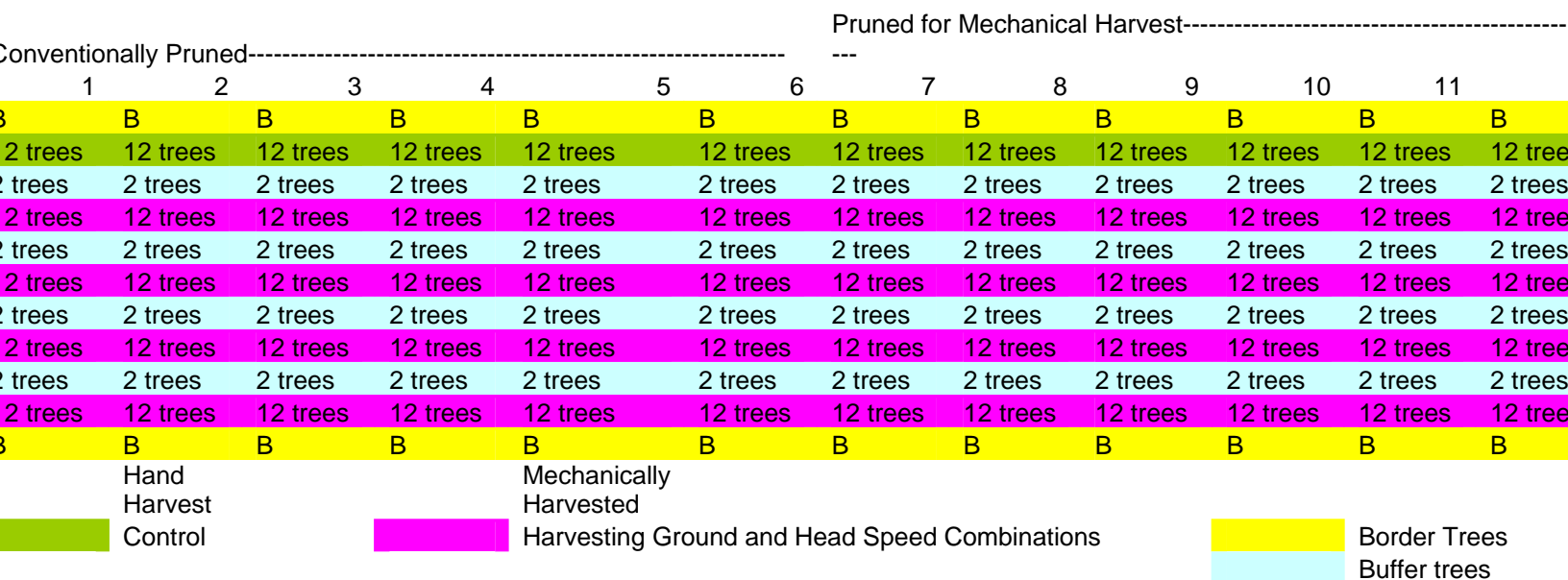
In late September – early October 2008

All the tree rows will be divided into 5, 12 tree, replications with 1 buffer tree at each row end, and two buffer trees between each 12 tree replication.

This will produce 5,12 tree, replications per row for different mechanical harvesting ground speed and head speed combinations if the machine is field worthy enough for this type of experiment.

The 10 harvested buffer trees per row can serve as the hand harvested controls for both pruning treatments.

Split Plot Design with 6 Replications per Plot and Control + 4 Possible Treatments



In late September / early October 2008

After trial runs to determine harvesting ground and head speeds the different combinations will be selected.

- there will be 4 replications per row available so no more than four combinations can be selected.

- Tarps will be laid under each 12 tree replication.
- All 12 rows, 6 conventionally pruned and 6 pruned for mechanical harvest, will be mechanically harvested.
- The harvester will be timed as it harvests 12 trees, and be cleaned after each set.
- Bin weights will be taken in the field.
- Fruit will be collected from the tarps and weighed, but not combined with the fruit in the bin.
  - This fruit will be graded separately if the volume is high.
- Trees will be clean harvested by hand, bin weights taken, and submitted for a separate grade
- Each bin set will receive a receiving station weight and grade.
- Samples will be drawn from each bin set for Drs. Barrett and Guinard.

(2 pruning treatments) X (a maximum of 5 harvest combinations) X (12 row replications) = 120 samples

**Harvest Method**

<b>Pruning Method</b>	<b>Hand Harvest</b>	<b>Mechanical Harvest</b>
Conventional	Control for effect of pruning on yield.	Control for effect of conventional pruning on efficiency of mechanical harvesting and fruit quality
	6, 10 tree, replications	6, 12 tree, replications with a maximum of 4 ground + head speed combinations.
For mechanical harvest	Demonstrates effect of pruning for mechanical harvest on yield	Demonstrates effect of pruning for mechanical harvest on mechanical harvesting efficiency and Fruit quality
	6, 10 tree, replications	6, 12 tree, replications with a maximum of 4 ground + head speed combinations.

Fresh fruit samples will be evaluated by Drs. Diane Barrett and JXGuinard in cooperation with Dr. Jane Yegge of Bell Carter and Abdul Sigal MS of Musco Family Olives. How they grade and process fruit for evaluation will be determined by the results of March 2008 processed fruit evaluations.

Harvester Efficiency Calculations:

The yield for 12 trees and receiving station grade will be used to calculate harvested value per ton and per acre @ 139 trees per acre.

The combined weight of machine harvested, ground fruit after harvesting and gleaned from the tree post harvest tree give the total calculated tree yield per 12 trees.

The fruit weight left on the tree and dropped on the ground after harvest, divided by total tree yield will give harvester removal efficiency percentage.

The weight in the harvester bins divided by total tree yield will give final harvester efficiency percentage.

(2 pruning treatments) X (a maximum of 5 harvest combinations) X (12 row replications) = 120 samples

**There are 3 desired outcomes:**

- 1. Determine effect of pruning for mechanical harvesting on yield**
- 2. Determine effect of pruning for mechanical harvesting on efficiency of mechanical harvester.**
- 3. If possible, evaluate as many as 4 different head + ground speed combinations for harvest efficiency and effect on processed fruit quality.**

**BUDGET REQUEST**

Budget Year: 2008

Funding Source:

Salaries and Benefits:

Postdocs/RA's

SRA's (Jr. Specialist)

Lab/Field Assistance

Subtotal

Employee benefits: @ 35%

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\_\_\_\_\_

5,500

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Sub2 \_\_\_\_\_

Sub6 1,925

TOTAL 7,425

Supplies and Expenses

Sub3 Itemized below

Rental of DSE 007 for 5 days @ 500.00/hour

20,000

Transport to field: Ed Elliot of TEC Transport  
(based on previous transport costs)

2,500

Grower Compensation for decreased fruit value

4,500

Custom hand harvest crews Including bins, forklift rental, transport to  
Receiving station

17,000

Tarps, tagging supplies, sample bags and boxes

750.00

Grower compensation for decreased fruit value

5,000

Equipment

Sub4 2,500

Field Scale

Travel to research plot, accommodation, food.

Sub5 2,000

TOTAL 61,675.00

Department account number:

\_\_\_\_\_

Date \_\_\_\_\_

Originator's Signature

COOPERATIVE EXTENSION

County Director: \_\_\_\_\_

Date \_\_\_\_\_

Program Director: \_\_\_\_\_

Date \_\_\_\_\_

AGRICULTURAL EXPERIMENT STATION

Department Chair: \_\_\_\_\_

Date \_\_\_\_\_

UC COC LIAISON OFFICER: \_\_\_\_\_

Date \_\_\_\_\_