2018 | THE ALMOND CONFERENCE

HARVEST DUST: WHAT CAN BE DONE?

ROOM 308-309 | DECEMBER 6, 2018

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growing ADVANTAGE
The Almond Conference

AGENDA

- **Sebastian Saa**, Almond Board of California, moderator
- **Guangwei Huang**, Almond Board of California, moderator
- **Jesse Roseman**, Almond Board of California
- **Sergio Capareda**, Texas A&M
- **Ted Strauss**, NRCS
- **Chris Simmons**, UC Davis

Adoption of Harvest Dust Reduction Practices: CASP and Harvester Survey

Jesse Roseman, Senior Specialist
Environmental and Regulatory Affairs
Almond Board of California

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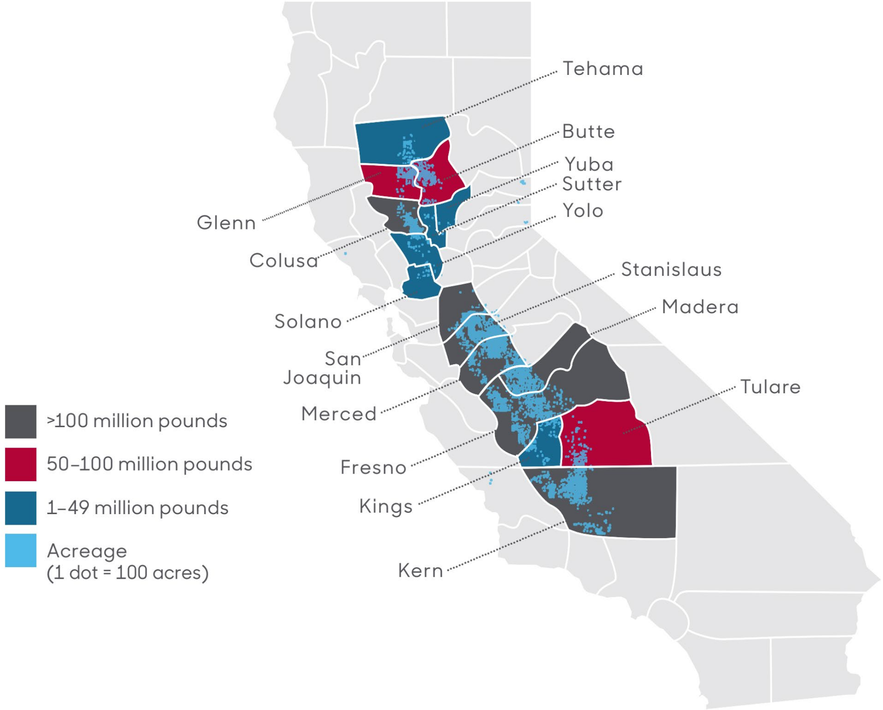
Reducing Dust from Almond Harvest

Research, Regulations and Tracking Progress

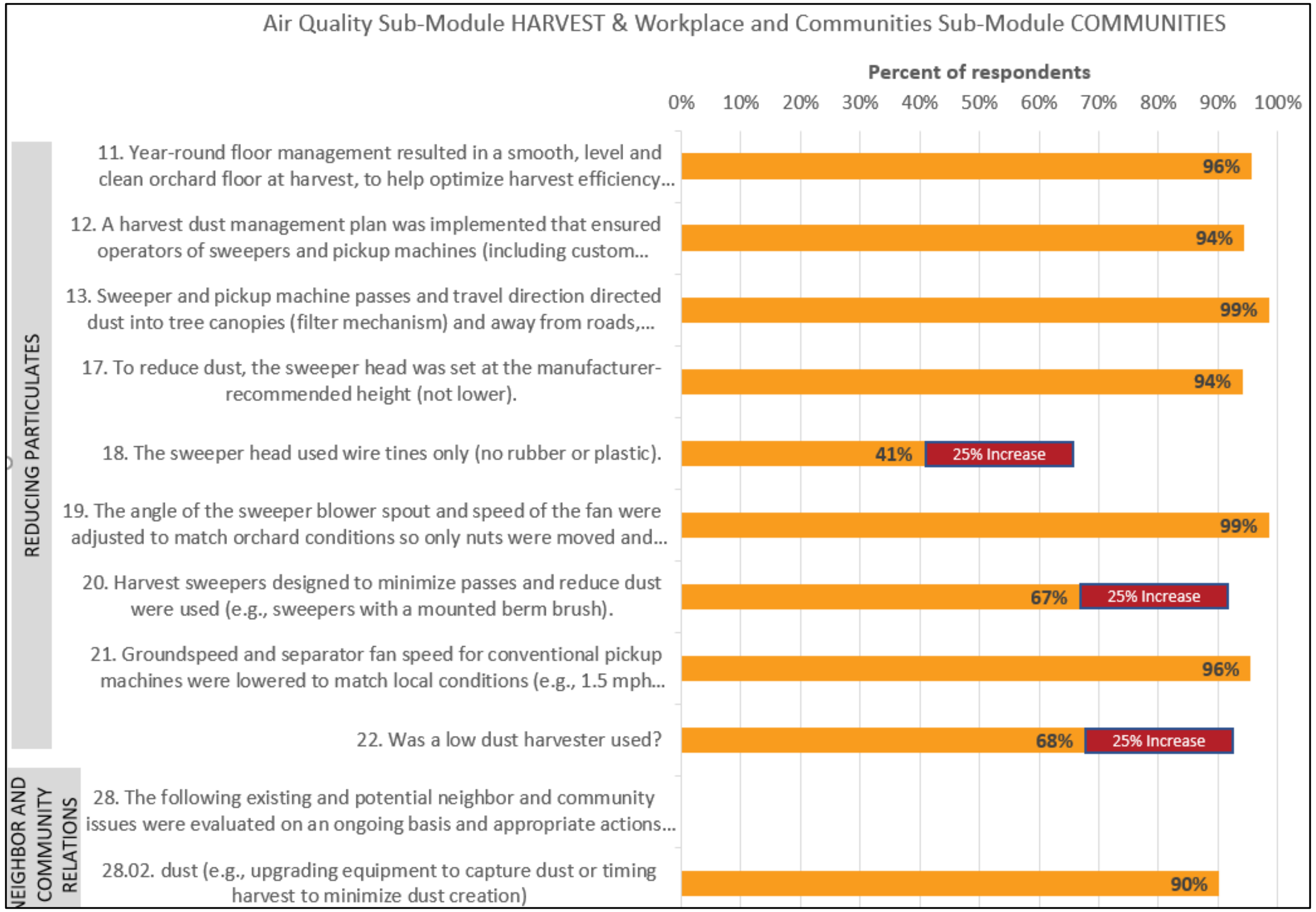
- 80% of almonds within San Joaquin Valley Air Basin (NASS, Land IQ)
- Extensive research by ABC for over 10 years into how to reduce dust emissions, partly to contribute to PM10 Attainment
  - 2012 white paper reduced estimated PM10 Emission Factor by 31%
- To track progress, California Almond Sustainability Program (CASP) has asked questions about dust reduction practices since 2009



Agricultural Harvest Operation Emission Factor *Source: CARB Emission Inventory*	Lbs. PM10/ Acre/ Year
Almond Shaking	3.47
Almond Sweeping	4.15
Almond Pickup	23.6
Almond Total	**31.2**

CASP: Reducing Harvest Dust Practice Adoption

- To prepare for 2025 Goals, SureHarvest looked at related questions
- All 10 CASP harvest dust questions align with ABC’s Harvest Dust website content and publications.
  – http://www.almonds.com/sites/default/files/alm_2016_english_dust_technical_guide%5B1%5D.pdf
- 7 questions 90% or greater adoption
  – Growers are reporting they’re doing well preparing orchard floor, directing dust into canopy, etc.
- 3 practices show room for improvement
  – 41% used sweeper head with wire tines only
  – 67% used sweepers designed to minimize passes and reduce dust
  – 68% used a low dust harvester



CASP: Reducing Harvest Dust Practice Adoption

PRACTICE	REDUCTION	CASP ADOPTION	DESCRIPTION
Clean Orchard Floor	--	96%	Year-round floor management resulted in a smooth, level and clean orchard floor at harvest, to help optimize harvest efficiency and minimize dust.
Plan Route	--	94% and 99%	A harvest dust management plan was implemented that ensured operators of sweepers and pickup machines (including custom harvesters) and others involved in harvest activities were appropriately trained before harvest. Sweeper and pickup machine passes and travel direction directed dust into tree canopies (filter mechanism) and away from roads, homes and other sensitive locations such as schools, hospitals and day care centers.
Sweeper Height .5" (2012)	70%	94%	To reduce dust, the sweeper head was set at the manufacturer-recommended height (not lower).
Wire Tines Only	--	**41%**	The sweeper head used wire tines only (no rubber or plastic).

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CASP: Reducing Harvest Dust Practice Adoption

PRACTICE	REDUCTION	CASP ADOPTION	DESCRIPTION
Reduced-pass Sweeping (2009)	49%	**67%**	Harvest sweepers designed to minimize passes and reduce dust were used (e.g., sweepers with a mounted berm brush).
Fine Tune Settings	--	99%	The angle of the sweeper blower spout and speed of the fan were adjusted to match orchard conditions so only nuts were moved and not soil.
Ground Speed	--	99%	Groundspeed and separator fan speed for conventional pickup machines were lowered to match local conditions (e.g., 1.5 mph instead of 3 mph groundspeed, and 910 instead of 1,080 rpm fan speed).
Lower Fan Speeds (2011)	77% MAX	"	"
Low-dust Harvester	52% AVG.	**68%**	Was a low dust harvester used?

Development of Low-Dust Harvester Incentive

- March 2017 ABC asked by San Joaquin Valley Air Pollution Control District to evaluate adoption and efficacy of low-dust harvesters, as part of "leaving no stone unturned" in development of PM2.5 plan and associated agricultural incentives
  - Harvester Survey results analysis received July
  - Harvester Dust Results (Dr. Capareda) presented to AgTech on Sep. 24
- District approves $1M for pilot low-dust harvester program on Nov. 15

Flory 480 (Control)

Weiss McNair 9800

Exact 3800

Jackrabbit

Flory 860

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Harvester Survey

Background and Purpose

- The San Joaquin Valley Air Pollution Control District, in partnership with The Almond Board of California and California Walnut Board, developed a survey on harvester practices and perceptions to inform development of an incentive program encouraging growers to utilize low-dust technology harvesters.
- Both walnut and almond harvesters were covered, as they use similar machines

Methodology

SMS Research Advisors conducted an online survey among producers

- **Survey Length**: Up to 20 questions (length depending on question rotation) on 2017 production
- **Database**: Almond and Walnut Boards distributed the survey to their databases of member producers
  - SMS Research assumed all records in the databases were qualified to participate (no screener questions)
- **Sponsorship**: Almond Board and Walnut Board were revealed as study sponsors
- **Incentive**: All participants received a $10 Amazon gift card for participating
- **Field Dates**: April 20, 2018 – May 18, 2018

Survey Participation

Completes by Crop Type

164 completed surveys (26 excluded from analysis due to undetermined crop-type)

- Almond exclusive: 89 completes (54%)
- Walnut exclusive: 19 completes (12%)
- Both Almond and Walnut: 30 completes (18%)

Completes by Role

- 89 owner-operator (44 custom operators, 45 non-custom operators)
- 33 land-owners, non-operators (i.e., producers who hire custom operators)
- 16 operator, non-owners (i.e., borrow equipment)

Did Survey Reflect the Industry?

- 48% respondents greater than 250 acres (12% reported 2017 Almond Almanac); 584 acres avg. almond farm size

Owner-operator results

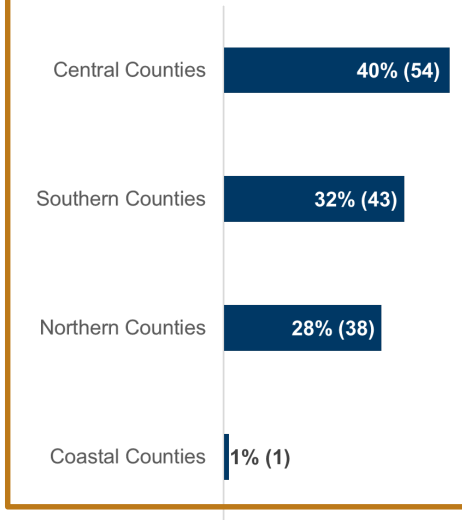
Average Acreage

Almonds

	Total Acres Owned/Rented	Total Acres Harvested
	659 acres (73)	988 acres (74)
Non-Custom	834 (42)	834 (42)
Custom	420 (31)	1189 (32)

Almond grower results

County Regions
(Multiple Responses Accepted)
(n=136)



Top Individual Counties
(Multiple Responses Accepted)
(n=138)

- Stanislaus, 25% (34)
- San Joaquin, 17% (24)
- Merced, 14% (20)
- Fresno, 13% (18)
- Butte,11% (15)
- Glenn, 9% (13)
- Kern, 9% (12)

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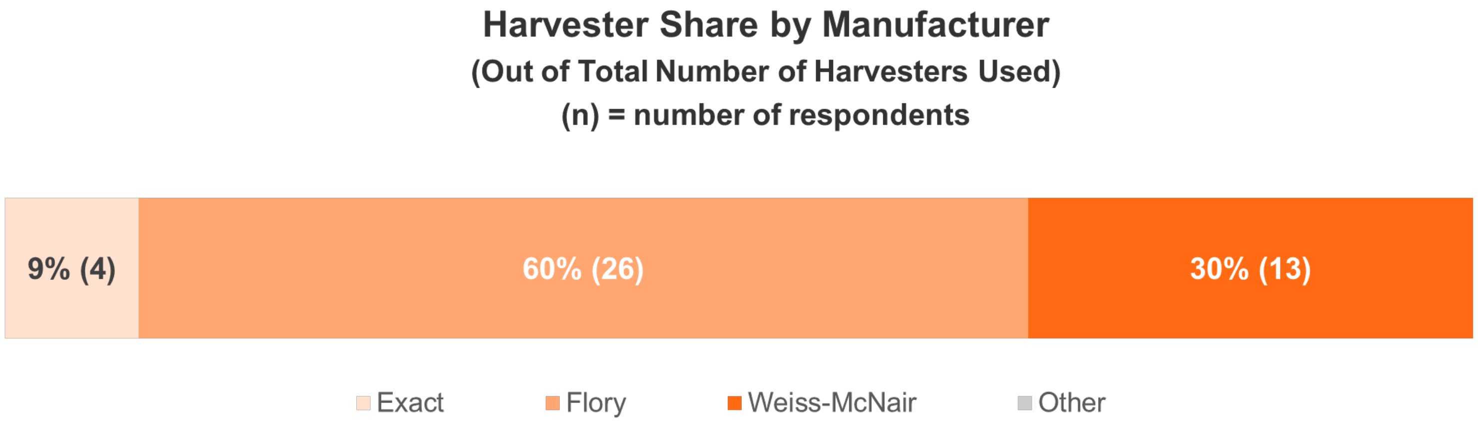
Current Harvester Fleet

- Almond growers likely to already use a low-dust harvester (69%)
- Higher use rate than walnuts
- Majority of Almond exclusive harvesters are Flory brand, remainder Exact and Weiss-McNair
- Majority of almond harvesters less than 10 years old (61%)
- Majority of Almond exclusive harvesters are PTO (67%)
  - Significantly different than Walnut exclusive harvesters, which are majority self-driven (87%)



Incentive Awareness

Incentive Awareness (Almond exclusive)

- 45% aware of current NRCS low-dust harvester program, but still have limited participation
  - 12% received incentives through the program
  - 21% aware, but don't qualify
  - 9% plan on enrolling in 2018

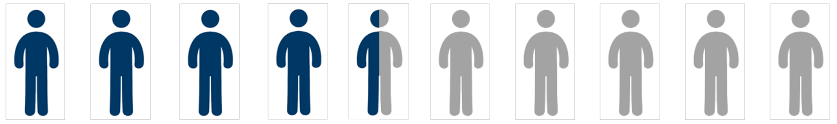
Incentive Interest

- 57% interested or somewhat interested in receiving information about new low-dust incentive
  - Those who are highly interested (9-10 rating) tend to be unaware of EQIP, or do not qualify for the program. Those who do not qualify for EQIP are still interested in additional programs
  - Those who already receive EQIP incentives are less interested in a new low-dust incentive program
  - Interest similar among both custom and non-custom operators
  - Participants who harvest both nut types show the greatest interest, followed by almond-exclusive participants

Expected Incentive

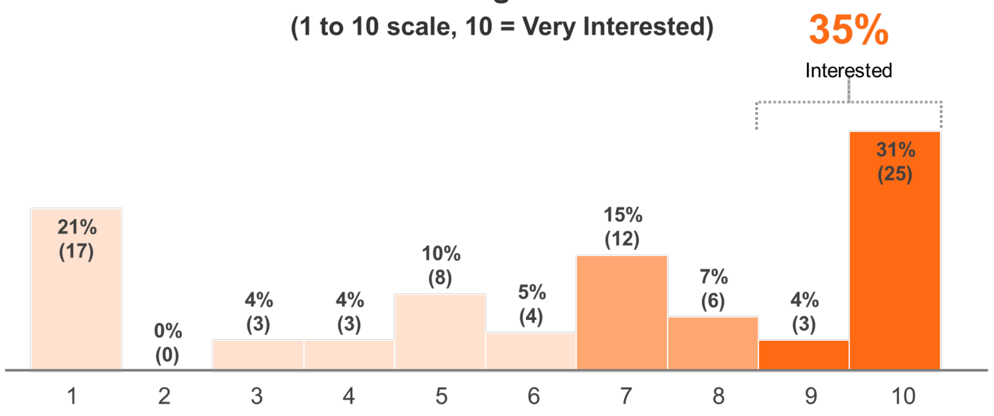
- 50% most common expected incentive level (avg. 37%)

Familiarity with NRCS EQIP Program

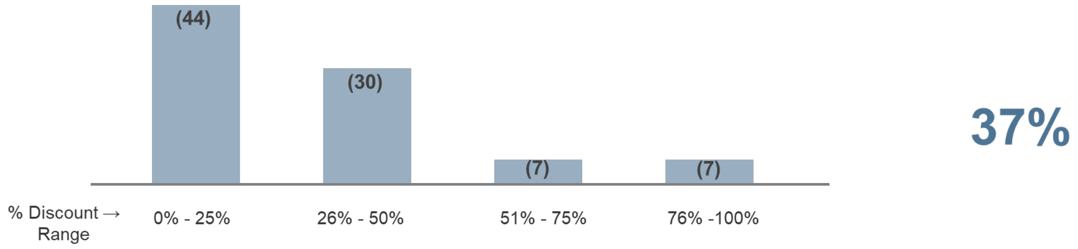


45% of participants are aware of the NRCS EQIP Low-Dust Harvester Program

Interest in New Incentive Program for Low-Dust Harvesters
(1 to 10 scale, 10 = Very Interested)

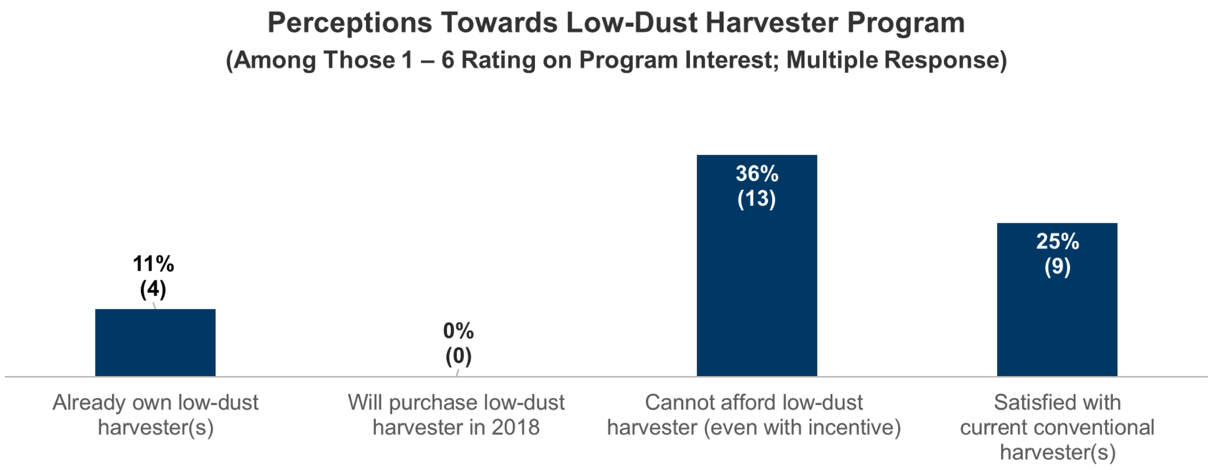


Minimum Expected Discount for New Low-Dust Harvester Program
(Distribution of Open-ended Responses)



Program Interest

- 1 in 5 (16%) almond exclusive respondents disengaged
- Those with low interest in incentive are either satisfied with current harvester, or view low-dust harvesters as financially unattainable (even with assistance)
  – Financial enticement does not strengthen program interest among 1 in 3 participants
  – The remaining moderate to low interest participants do not feel enough pressure or value to change– they are mostly satisfied with their current harvester(s)
- Producers who own land but do not personally harvest (hire custom harvesters) show potential as influencer audience
  – 1 in 4 of these participants show high interest in a low-dust program
  – Accept slightly lower discounts or incentives (avg. 28%)



Questions?

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Project 1: Establishment of Newer $PM_{2.5}$ Emission Factors with Various Almond Harvesting Machinery

Project 2: Development of Simple Dust Measurement Techniques to Aid in Long-Term Dust Reduction Program for Almond Harvesting Operations Using Drone Technologies

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Sergio C. Capareda, PhD, PE
Biological and Agricultural Engineering Department
Texas A&M University

Problem and Significance

- Project 1 Significance
  - Provide newer and updated emission factor for almond harvesting focusing on $PM_{2.5}$
  - To support the new State Implementation Plan (SIP) and incentives to owning newer harvest machines

- Project 1 Work Objectives
  - Measure significant differences in PM emissions between old and new machines and report percent reductions
  - Evaluate collection efficiencies of newer machines
  - Report on ratio between PM_{10} and $PM_{2.5}$ using FRM Samplers

- Project 2 Significance
  - Evaluated simple and quick methods for visible dust measurements during harvest operations and establish correlation among methods
  - Aid in quick assessment of dust reduction strategies

- Project 2 Work Objectives
  - Quantify visible dust using total suspended particulates (TSP)
  - Evaluate various quick measurement techniques such as (a) EPA Method 9, (b) EPA Alt 082 (also called Digital Opacity Compliance System (DOCSII), (c) opacity meter and (d) laser detection system using drones

Overall goal is to reduce visible (and non visible) dust emissions during harvest by 50% by year 2025.

Machinery Tested for Project 1

Control = Flory 480

EPA Approved

FRM $PM_{2.5}$/PM_{10} Samplers

Weiss McNair 9800

% Reductions in PM Concentrations and Ratio of PM2.5/PM10

Machine	% Reduction in $PM_{2.5}$ Concentrations	% Reduction in PM_{10} Concentrations
A	43.5% ± 11.9%	53.5% ± 9.6%
B	61.5% ± 14.0%	37.3% ± 18.4%
C	57.7% ± 13.8%	43.6% ± 12.1%
D	42.1% ± 32.5%	33.0% ± 31.1%

Machine	Average from All Replicates
A	14.4%
cA (Control)	15.7%
B	17.9%
cB (Control)	8.3%
C	8.4%
cC (Control)	10.7%
D	15.9%
cD (Control)	11.5%
Overall Average	12.5%

Ratio of $PM_{2.5}/PM_{10}$ concentration ranges between 8% to 15%, with an overall average of 12.5% based from FRM PM samplers

Harvest collection efficiencies of all machines are not significantly different from control

Project 1 Final Results

Conclusion: All New Machinery Models Quality for NRCS EQIP Incentive Program

Machine	2017 Almond AQ Sampling (Capareda, 2017)			2010-2011 NRCS Results (Faulkner, 2013)		
	TSP	FRM PM_{10}	FRM$PM_{2.5}$	TSP	FRM PM_{10}	FRM$PM_{2.5}$
A Control	2,153 9,360	492 864	326 551	1,149 4,835	561 1,981	264 401
Reduction	77%	43%	41%	76%	72%	34%
B Control	1,590 2,820	747 1,706	225 456	2,281 3,891	1,034 1,599	359 280
Reduction	44%	56%	51%	41%	35%	-28%
C Control	2,911 9,080	1,360 5,200	108 281	7,871 2,292	3,156 771	279 14
Reduction	68%	74%	62%	71%	76%	95*
D Control	2,643 5,748	1,530 4,100	371 855	5,095 6,865	1,453 2,628	121 313
Reduction	54%	63%	57%	26%	45%	61%

Lessons Learned

- Proper machinery adjustment is critical and newer machines had lower emissions
- Dust emissions is reduced by half from the average of all machine models
- Orchard growers and operators should begin to invest on newer machines or take advantage of government programs to acquire newer machine models
- Newer harvesters have the potential to significantly reduce $PM_{2.5}$ emission factors with proper adjustments
- We now have the ability to detect PM EF differences among harvesters using FRM PM_{10} and $PM_{2.5}$ samplers including continuous FRM samplers
- While higher reductions were achieved, almond harvesting operations are still between 5-9x higher than other agricultural harvest processes (e.g. cotton and wheat).

Project 2: Four New Dust Test Protocol Evaluated

- **EPA Method 9 or Visual Emissions Evaluation (VEE)**
  - Use of EPA Certified Professionals to evaluate dust quality during harvest
- **EPA Alt 082 or DOCSII**
  - Use of digital camera and video camera to digitize captured image and determine opacity by certified professionals
- **Opacity Meter**
  - Directly measure opacity at the orchard floor during harvest
- **Laser (Diode) Attenuation Mounted on Drone Technologies**
  - Use of particulate matter (PM) measuring instruments attached to drones and follow the harvester during operations

Opacity Meters

Video and Digital Camera

Laser

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EPA Method 9 Visual Emissions Evaluation

Rely on EPA certified professionals to rate the quality of dust generated during harvest operations

EPA Alt 082 Digital Opacity Compliance System (DOCS II)

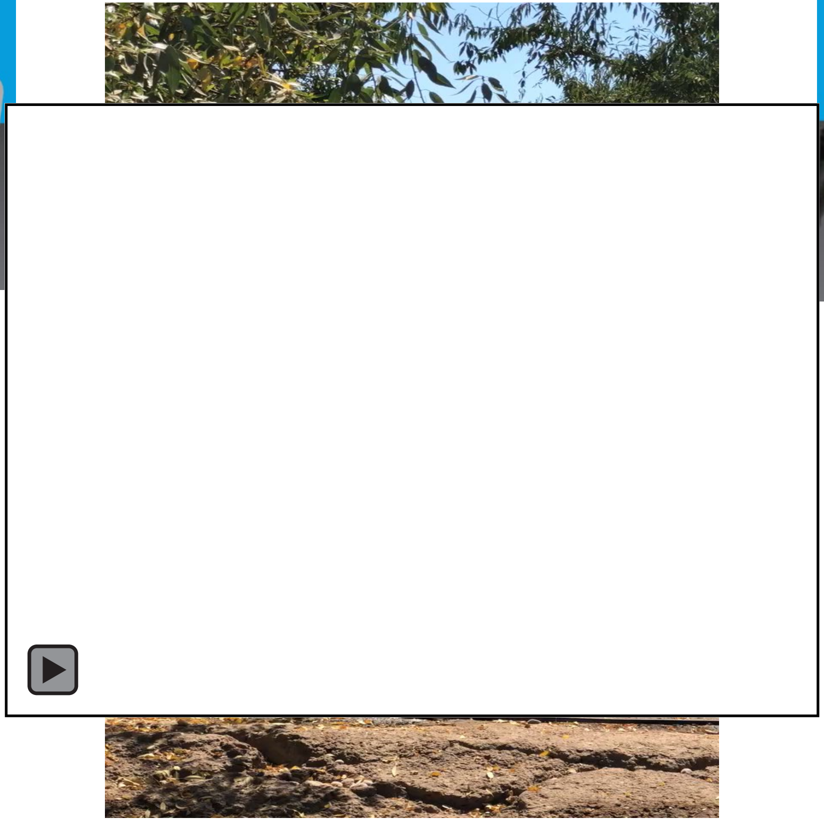
- Use of certified professionals to capture digital images and convert into digital opacity values

Canon Powershot SXH60 for still images

Sony Handy Cam HDRCXX for continuous video recording

Opacity Meter

EMX Industries, PMX particulate monitor



EMX Industries, OPAX-1000 opacity sensor

Use of Drone Technologies with PM Sampler & follows the Harvester

Method/Procedure:

1. PM laser sampler is loaded on each drone and on harvester
2. The sampler measures visible dust every second as it follows the harvester
3. Another drone takes real-time mages throughout harvest episode

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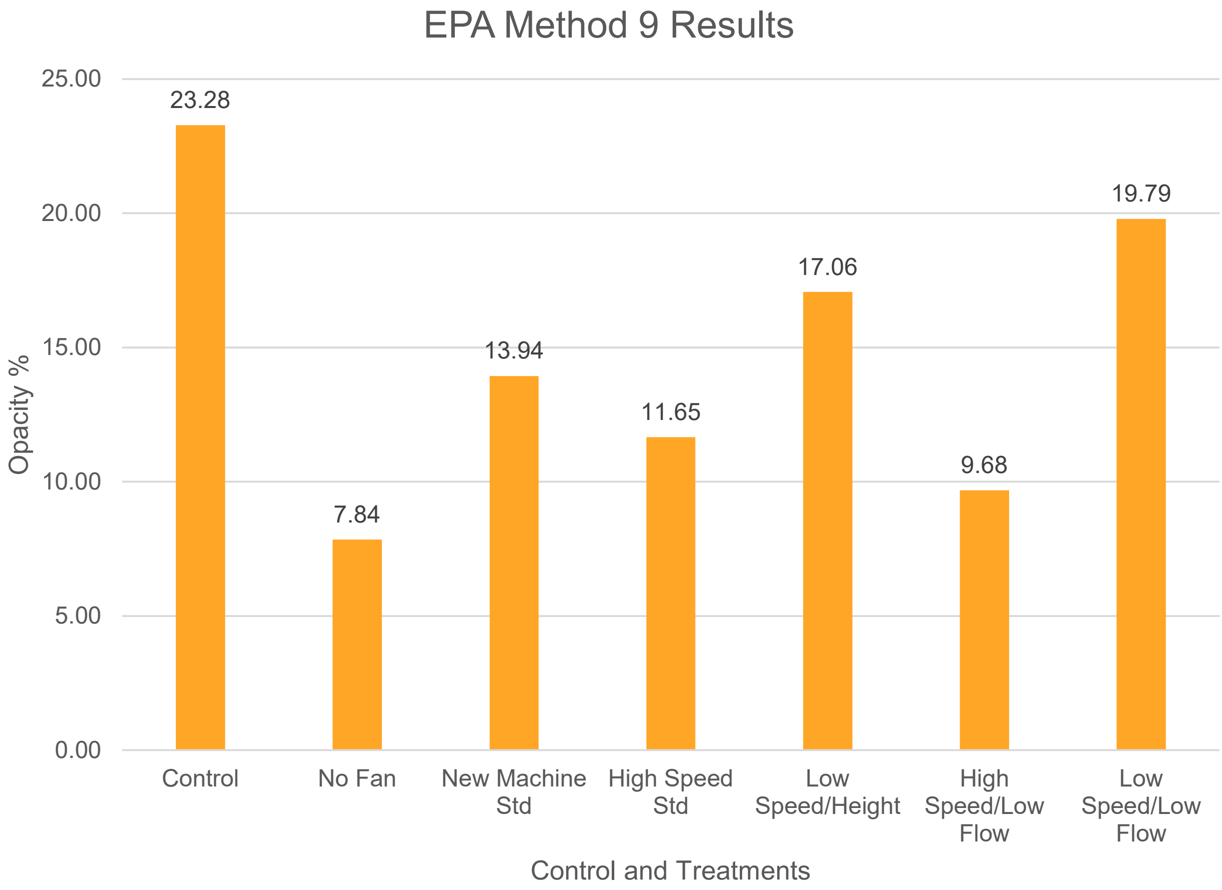
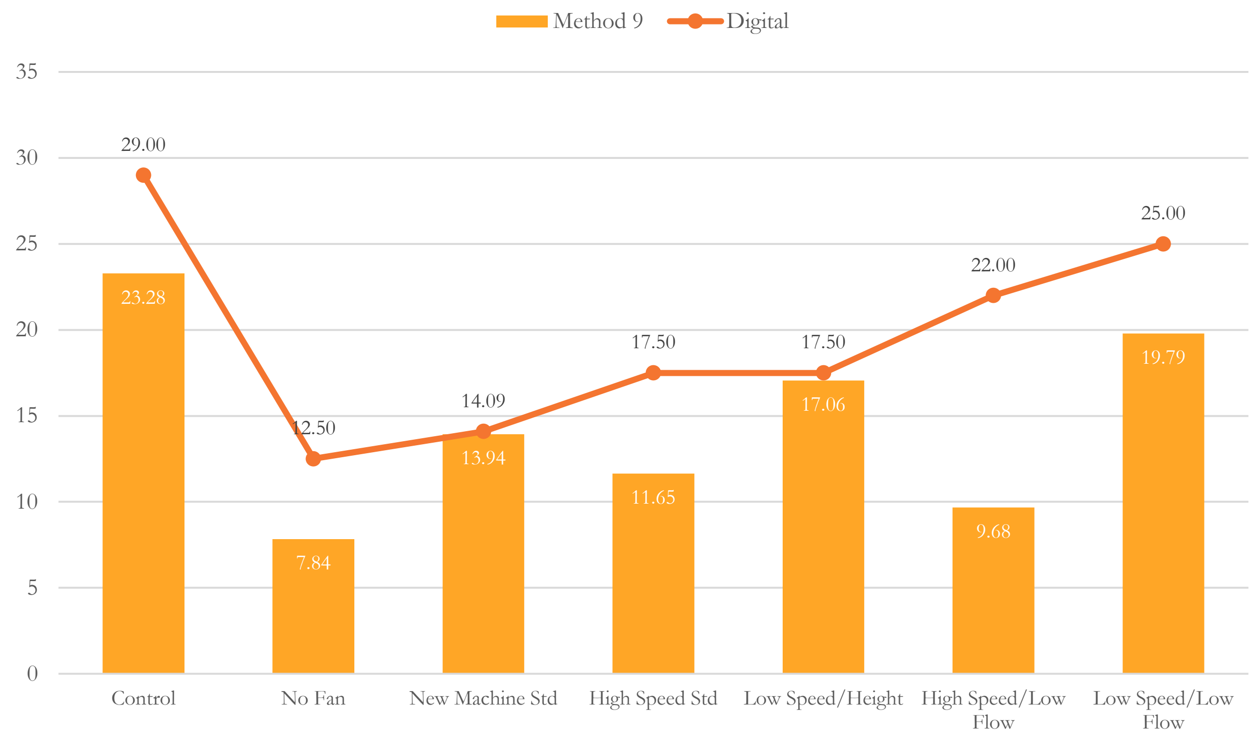
Results and Discussions



EPA Method 9 Works!

Treatments and Control	Opacity	% Lower
Control	23.28	0%
No Fan	7.84	66%
High Speed/Low Flow	9.68	58%
High Speed Standard	11.65	50%
New Machine Standard	13.94	40%
Low Speed/Height	17.06	27%
Low Speed/Low Flow	19.79	15%

Results and Discussions



EPA Alt 082 Method Also Works!

EPA Alt 082 Digital Opacity Compliance System		
Treatments & Control	**Opacity**	**% Lower**
Control	29.00	0%
No Fan	12.50	57%
New Machine Standard	14.09	51%
High Speed Standard	17.50	40%
Low Speed/Height	17.50	40%
High Speed/Low Flow	22.00	24%
Low Speed/Low Flow	25.00	14%

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Lessons Learned

- EPA Method 9 Works! Industry may take advantage of hundreds of Certified EPA Method 9 Professionals to help evaluate dust level generation during harvest and evaluate reductions through best management practices
- Laser Sampler on drones also works but we need to develop a better protocol for consistent gathering of dust PM concentrations data
- EPA Alt 082 Digital Opacity Compliance System also works but may be a little bit costly for some interested parties due to monopoly of certified analysts. Video and digital camera are quite cheap and affordable.
- The TAMU Group is developing a correlation software such that the EPA Method 9 data are correlated properly with digital format without having to spend for additional party analysis

Opacity meters did not provide consistent results and will not be used for future experiments

Acknowledgements

Project 1

- Harvest Contractor: Matthew Efird of Double E Farms, Inc. and Roger Isom
- Harvest Machinery: (Flory Industries, Exact Corp., Weiss McNair and Jack Rabbit)
- Funding: The San Joaquin Valley Air Pollution Control District and the Almond Board of California (ABC)
- Beta Lab Crew (Amado Maglinao, Walter Oosthuizen, and EJ Baticados)

Project 2

- Orchard Owner: Dan Visser
- Harvest Contractor: Matthew Efird of Double E Farms, Inc. and Jeff Noorigian
- Harvest Machinery: Flory Industries (c/o Mike Flora and his Engineer Operators)
- EPA Method 9 Group
  - Cameron Donnahoo (Reliable Emissions Measurements)
  - Paul Schafer and Jose Landeros (SCS Engineers)
- ALT 082 Group
  - Dr. Amado Maglinao, Jr and El Jerie Baticados
- Opacity Meter Crew
  - Dr. Butch Bataller
- Drone For Hire Group (c/o Thomas Davis)
- Funding: Almond Board of California (ABC)

QUESTIONS?

“Low-Dust” Harvesters

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Air Quality Resource Conservationist
USDA Natural Resources Conservation Service

The Almond Conference
Sacramento Convention Center
December 6, 2018

Environmental Quality Incentive Program

- Authorized through the Farm Bill
- Provides eligible producers with technical and financial assistance for implementing practices through conservation planning
- The 2014 Farm Bill approved $25 million annual through Fiscal Year 2018 to address air quality resource concerns and to meet Federal, State and local regulatory requirements
- NRCS-California obligates approximately $20 million annually through the National Air Quality Initiative
- Priority projects offer creditable emissions reductions for meeting State Implementation Plan goals and Federal ambient air quality standards

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Environmental Quality Incentive Program

- Use of "low-dust" harvesters for surface harvesting of nut crops
- Replacing in-use diesel powered nonroad mobile agricultural equipment
- Repowering in-use irrigation engines
- Conservation tillage and residue management
- Reduce tillage acre-passes
- Combined-tillage implements
- Proper handling and disposal of chemically-treated wood grape stakes
- Dust suppressants on unpaved roads and traffic areas
- Chipping woody debris from orchard removals and vineyard removals
- CAFO dust control, windbreaks, and manure injection
- Precision pesticide spray application through Integrated Pest Management
- Mulching with wood chips

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376 – Field Operations Emissions Reductions

- The conservation practice standard (CPS) that applies to “low-dust” harvesters
- 2010-11 Texas A&M demonstration
  - Conducted under NRCS-CA Conservation Innovation Grant (CIG) 68-9104-0-1
  - Defined the 376 Specifications of 30 percent PM10 control efficiency
- NRCS list of “low-dust” harvester pick-up machines
  - NRCS-CA Air Quality Technical Note 8
  - Continue to update as new peer-reviewed information comes available (e.g. 2017 Texas A&M demonstration)

Photo credit:
Brenda Phrakonekham
USDA NRCS

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CPS 376 “Low-Dust” Harvesters

Manufacturer	Model	Drive	Technology
Exact Corporation	E-3800	Pull-behind PTO	Water misting and brush system at the separation fan discharge and reduced discharge air speed.
	E-4000	Pull-behind PTO	
	E-7000 SP	Self-Propelled	
Flory Industries	Model 860	Pull-behind PTO	Reduced fan speed, cleaning chain length, and location of dust discharge.
	Model 8550	Self-Propelled	
	Model 8600	Self-Propelled	
	Model 8700	Self-Propelled	
	Model 8770	Self-Propelled	
Jackrabbit	Harvester	Pull-behind PTO	“Constant Race” disk-based cleaning section.
Joe DiAnna	Clean Air Concepts	Retrofit	Cyclonic separator.
Weiss McNair	9800 California Special	Pull-behind PTO	Reduced fan speed, fan location, enlarged vacuum and separation chambers, and cleaning chain design.
	Magnum X	Self-Propelled	

This list is not in any way an endorsement by the USDA NRCS. These manufacturers have demonstrated that their designs and technologies will reduce PM10 emissions by at least 30 percent over conventional surface-harvester pick-up machines. Any modifications or changes to the equipment are discouraged, as they could adversely impact the integrity of the PM control technology. This list is subject to change as new designs, technologies, and information comes available.

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Exact E-7000SP

Photo Credit: Sonya Miller, USDA NRCS

Weiss McNair Magnum X

Photo Credit: Jesse Samson, USDA NRCS

Flory Model 8700

Photo Credit: Sonya Miller, USDA NRCS

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Clean Air Concepts

Installed on a Weiss McNair 9600 California Special

Photo by Ted Strauss, USDA NRCS

Jackrabbit Harvester

Photo by Ted Strauss, USDA NRCS

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Funding Opportunities for "Low-Dust" Harvesters

- Offered statewide with priority on orchards located within PM nonattainment areas
- The air quality resource concern is excessive PM emissions from using conventional surface-harvester pick-up machines
- NRCS payments for this treatment applies only to the use of the "low-dust" technologies on the contracted acres
- CPS 376 is a management practice with a one-year project lifespan
- Through a conservation plan, EQIP contracts and annual payments may be available for up to three years
  - $36.23 per acre for contracts awarded in FY2019
- As deliverables, participating producers provide NRCS with a post-harvest report annually

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“Low-Dust” Harvesters Contracted Acres (FY 2016-18)

- Represents $2,473,000 in EQIP obligations

Harvest Season	2016	2017	2018	2019	2020	2021
Completed Acres	2,751	10,091	14,263	-	-	-
Planned Acres	-	-	-	17,907	11,098	7,210
*PM10 Reductions (Tons/Season-Year)	9.74	35.72	50.49	63.39	39.29	25.52

*Notes:

“Pick-Up” emission factor is 23.60 pounds PM10/acre/year (California Air Resources Board 2013)
“Low-Dust” Harvester minimum control efficiency is 30 percent (CPS 372 Specifications)

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Please visit your nearest USDA Service Center for more information

https://offices.sc.egov.usda.gov/locator/app?state=CA

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FSA | NRCS | RMA | BUSINESS CENTER

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

Christopher Simmons
Department of Food Science and Technology, UC Davis

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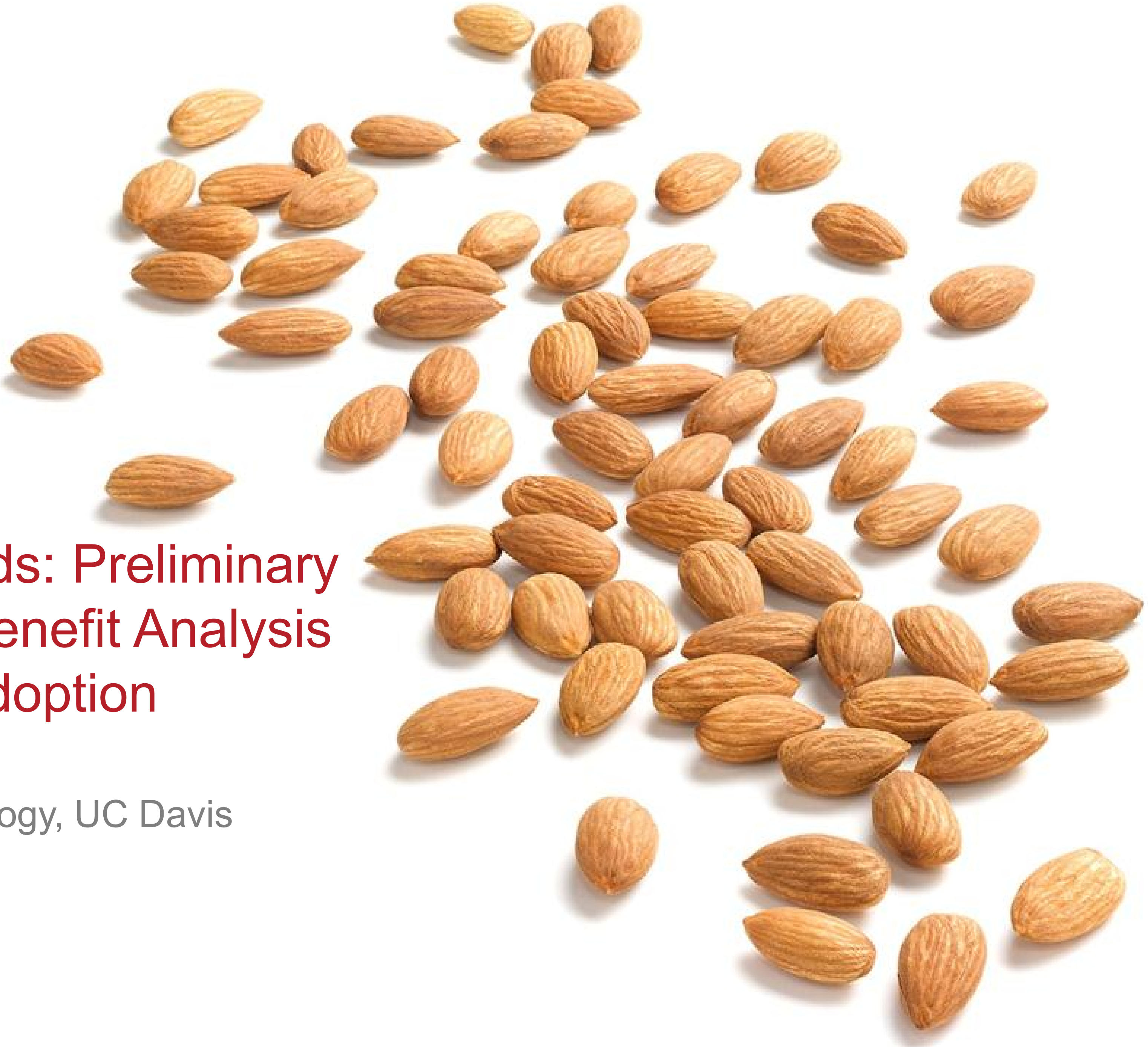
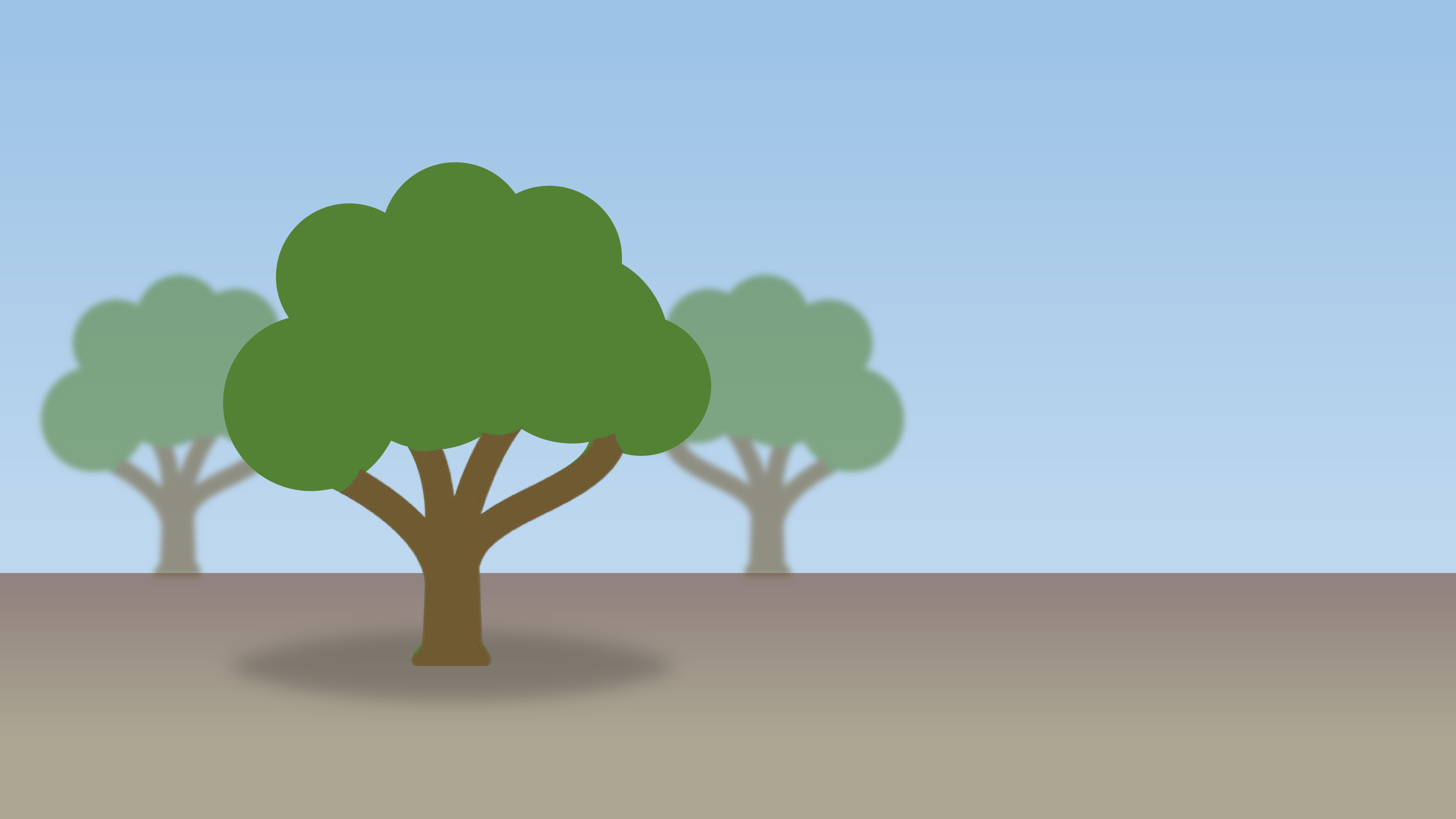


Goals

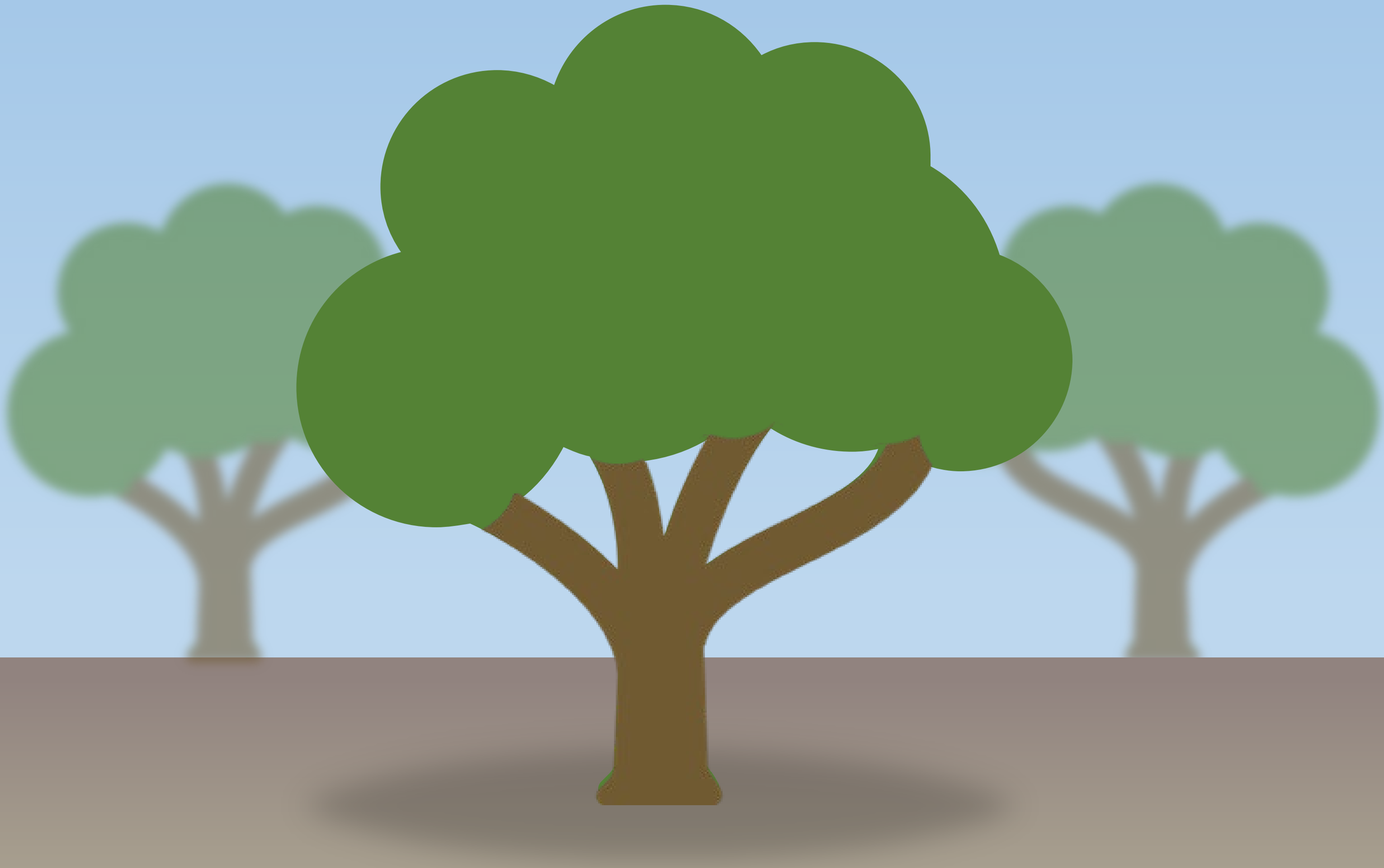
Understand the economic opportunities and risks associated with potential off-ground harvesting approaches compared to conventional methods.

Goals

- Inform **decision making** on off-ground harvest strategy
- Highlight **technological aspects** of off-ground harvest that are cost drivers and warrant **research to reduce cost**
- Identify **goods and services** that are **cost drivers** for off-ground harvest to gauge effect of price volatility
- Identify **cost drivers** for off-ground harvest that could be targets for **new policies and incentives**

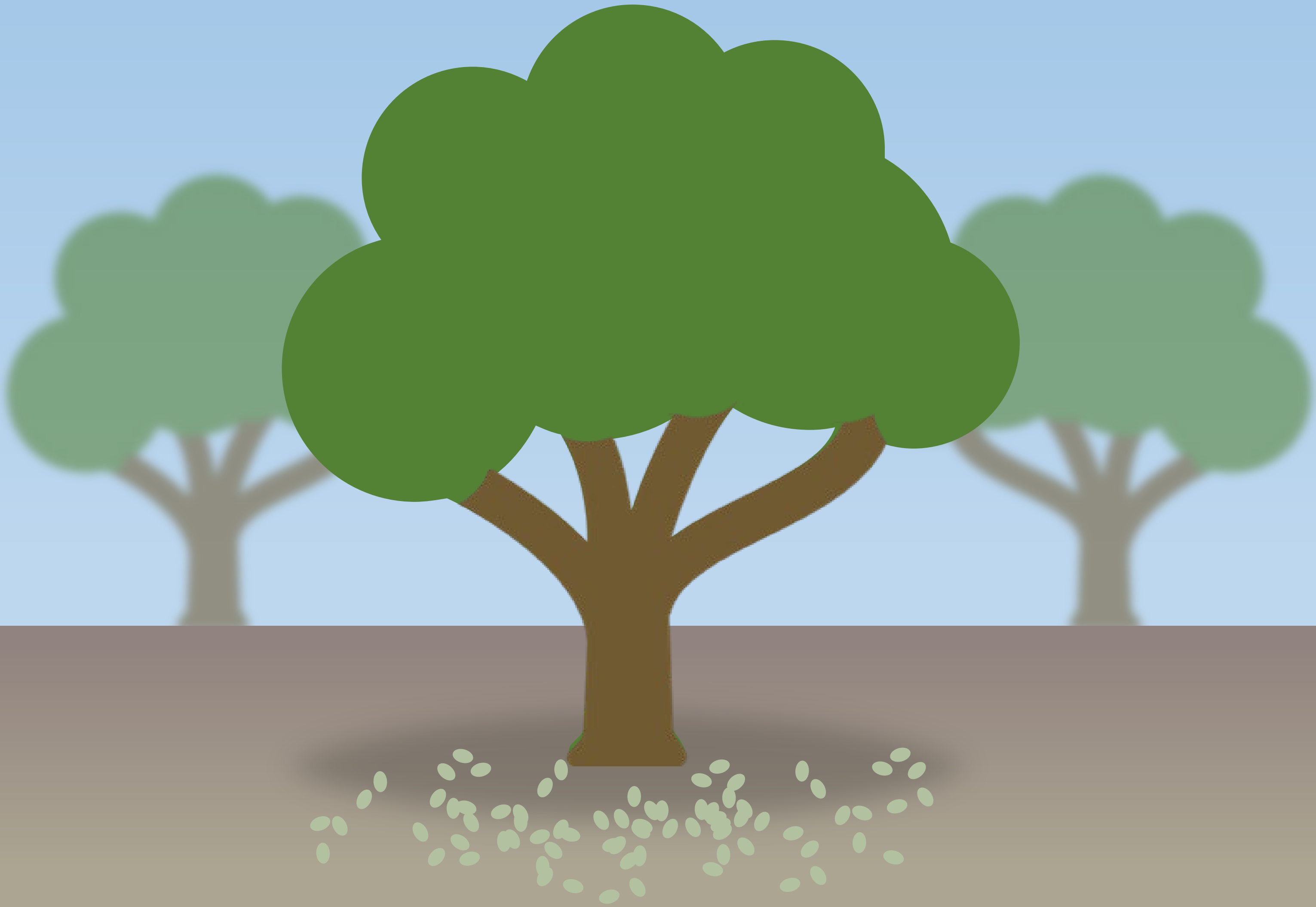


Conventional harvesting

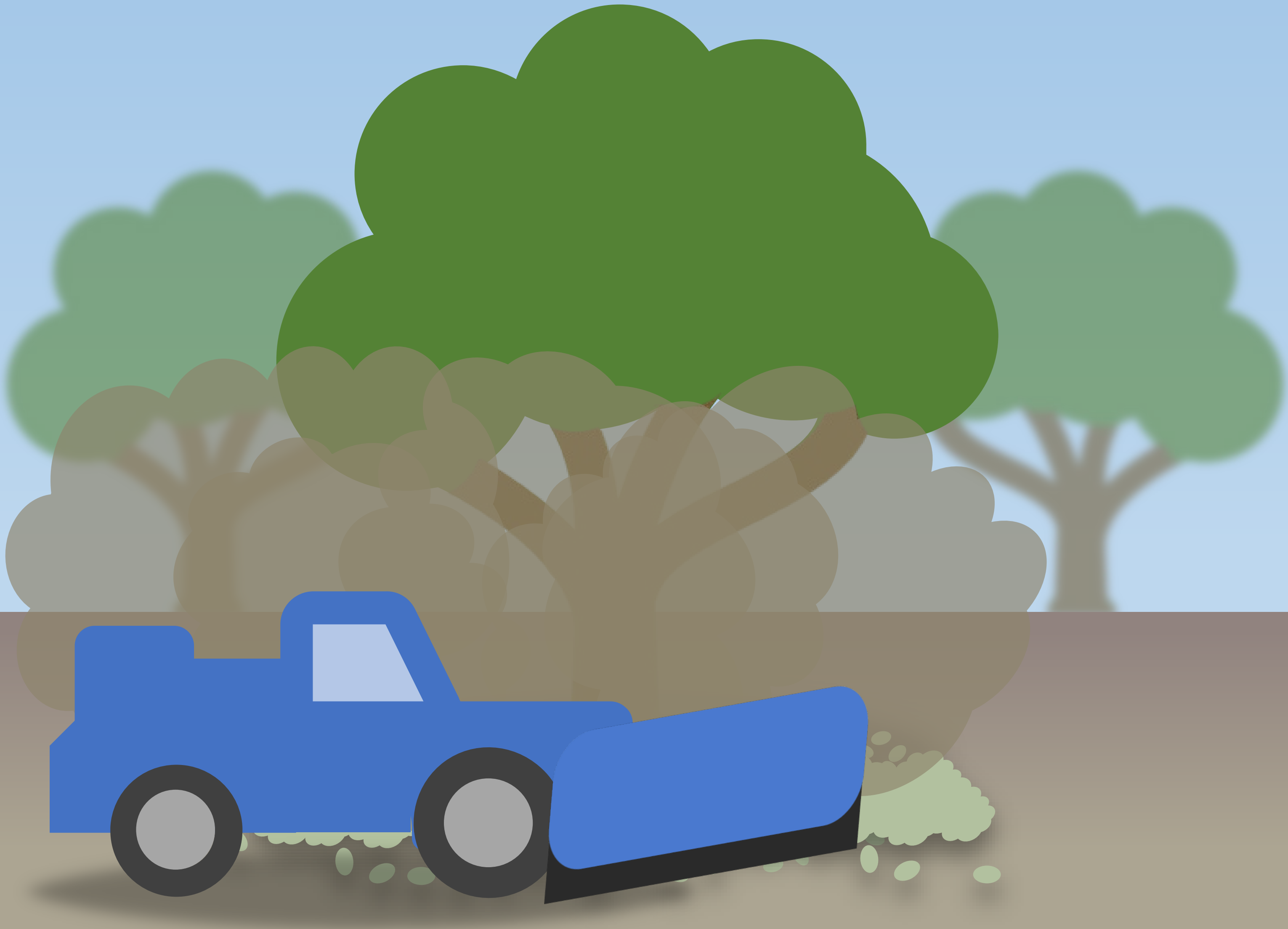


Conventional harvesting

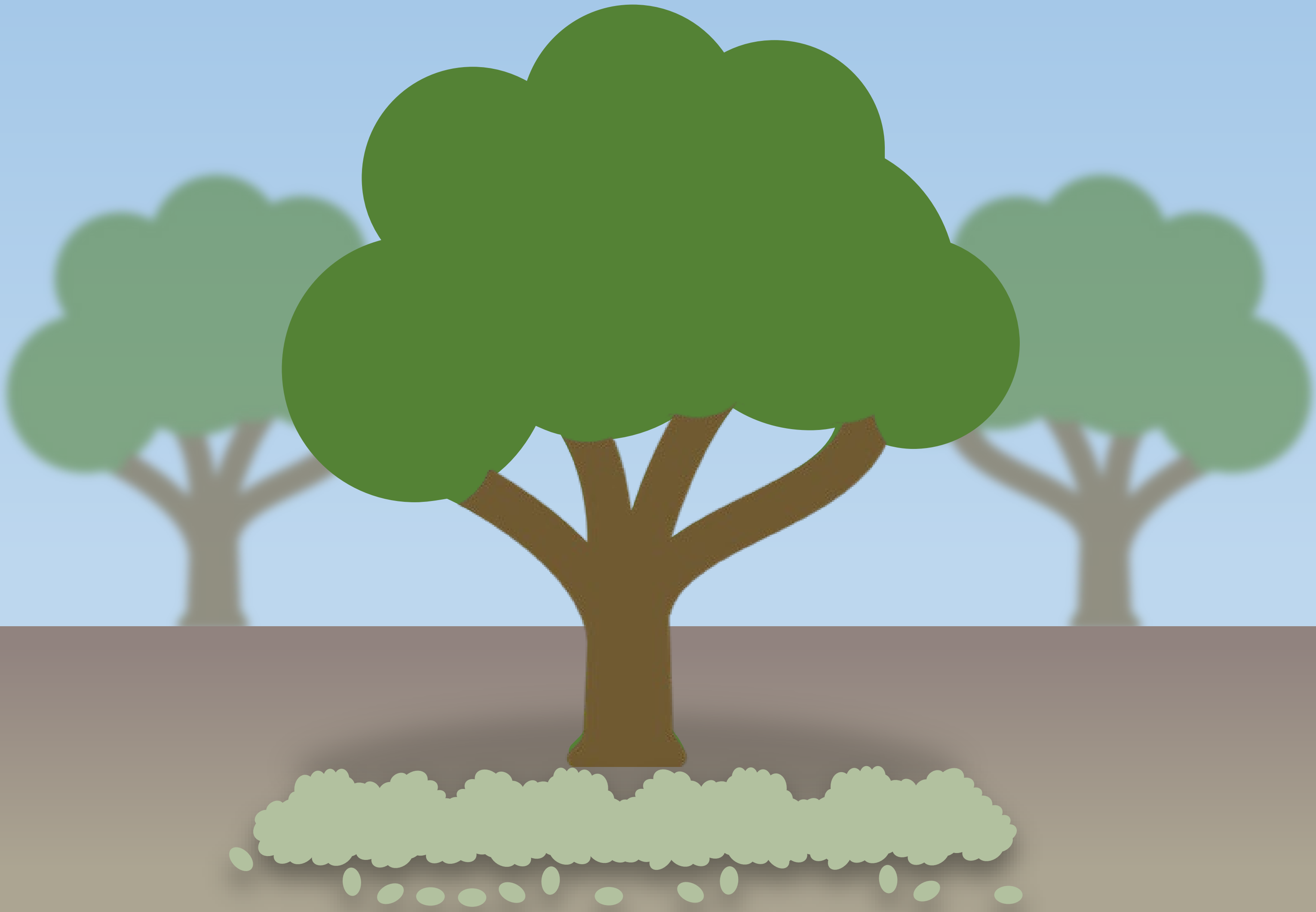
Conventional harvesting

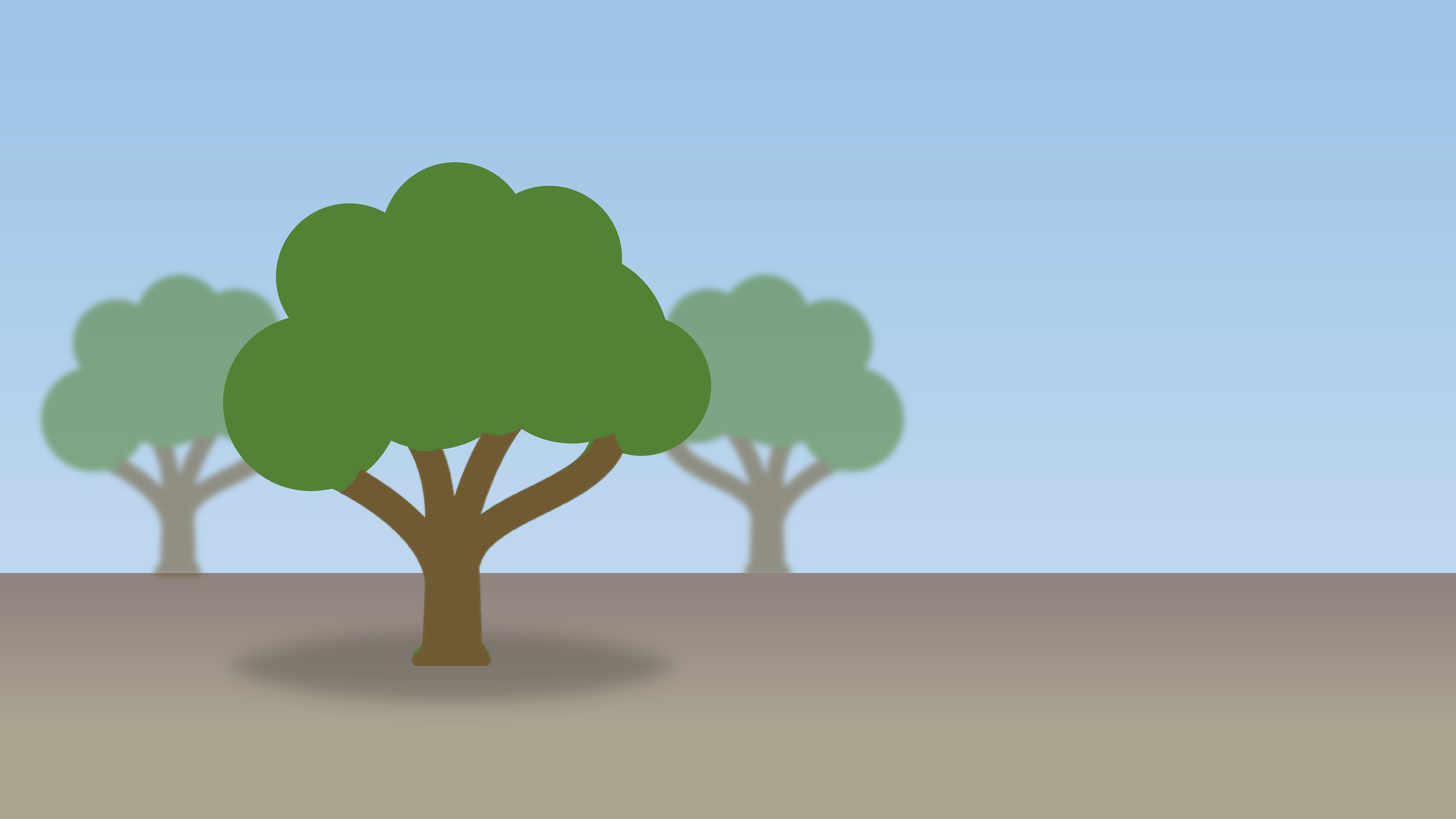


Conventional harvesting

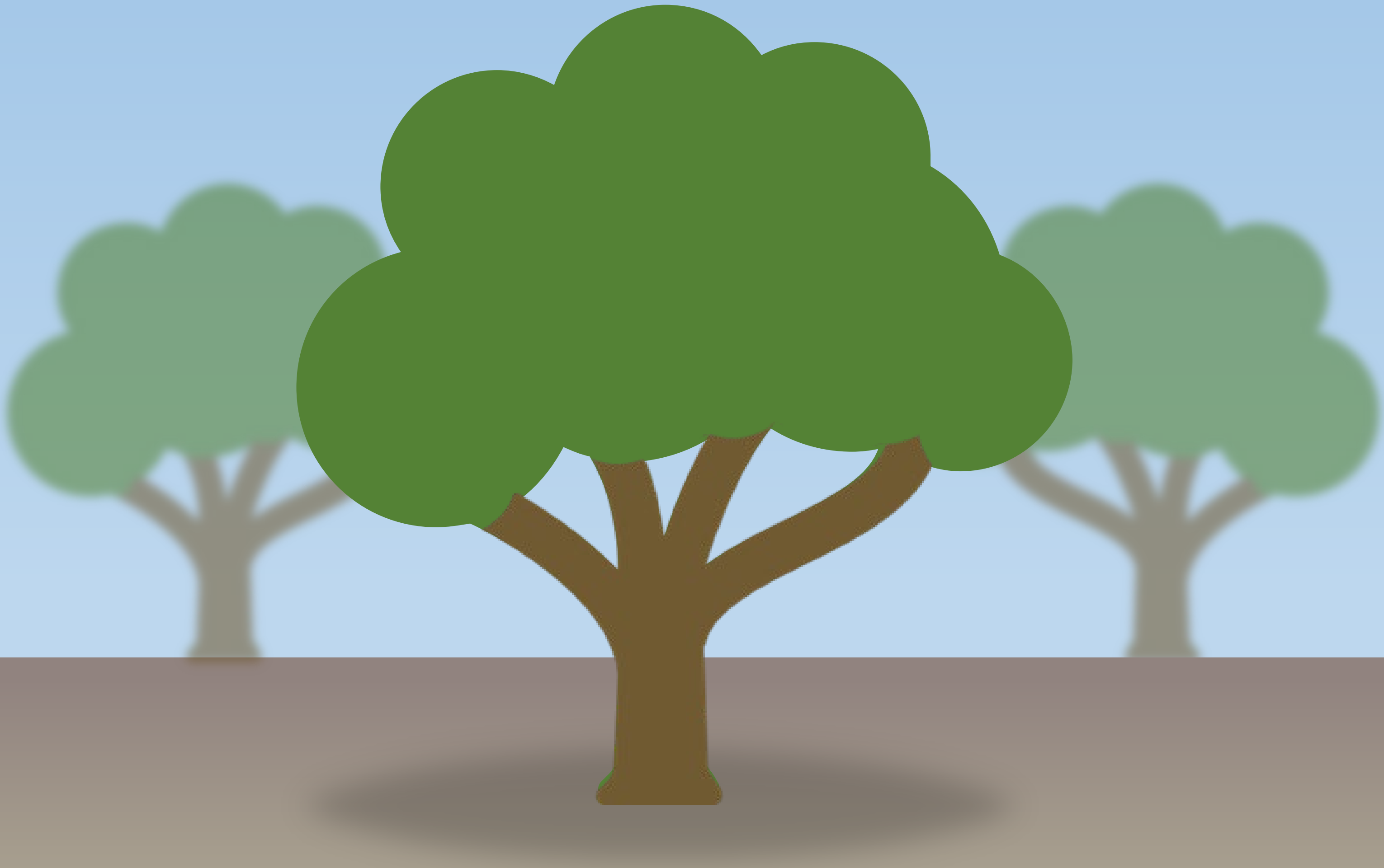


Conventional harvesting





Off-ground harvesting

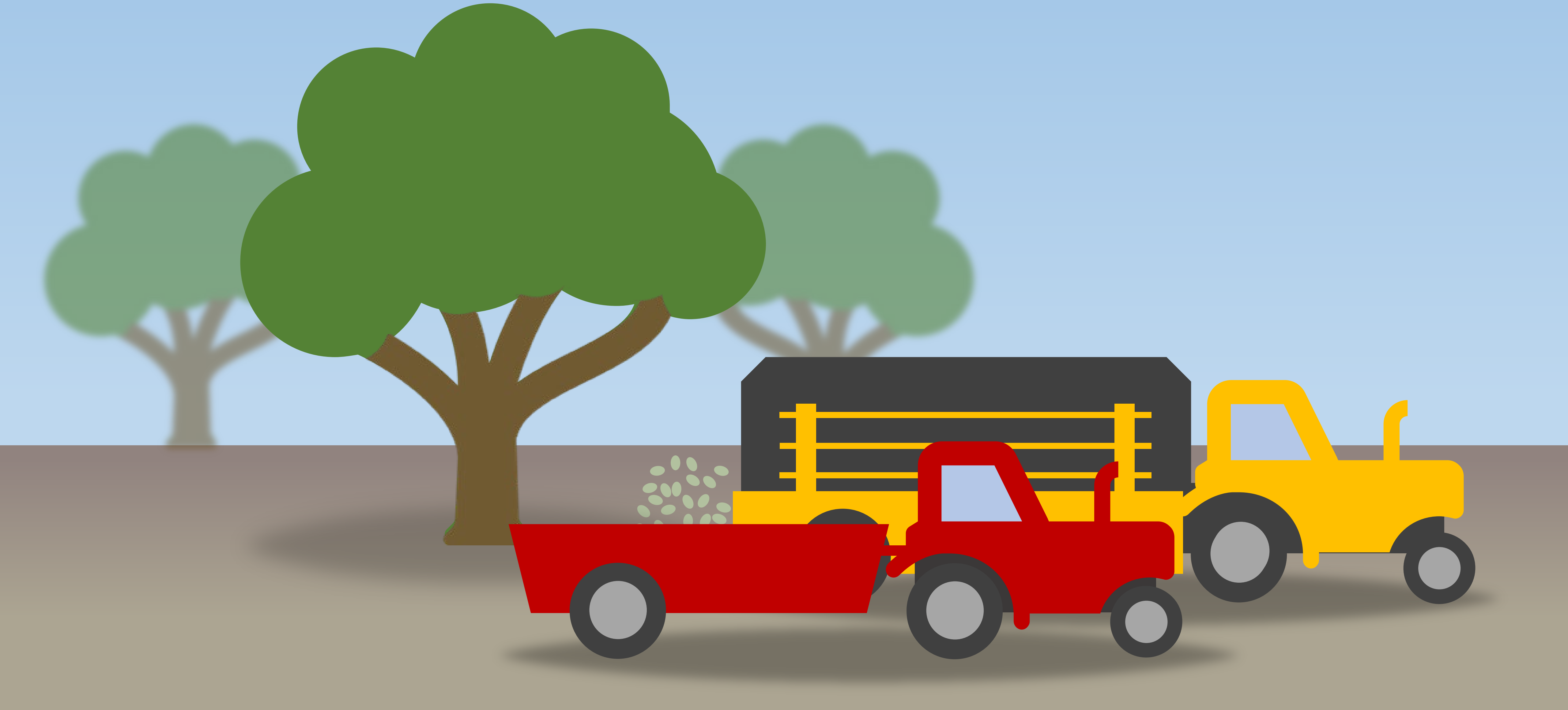


Off-ground harvesting

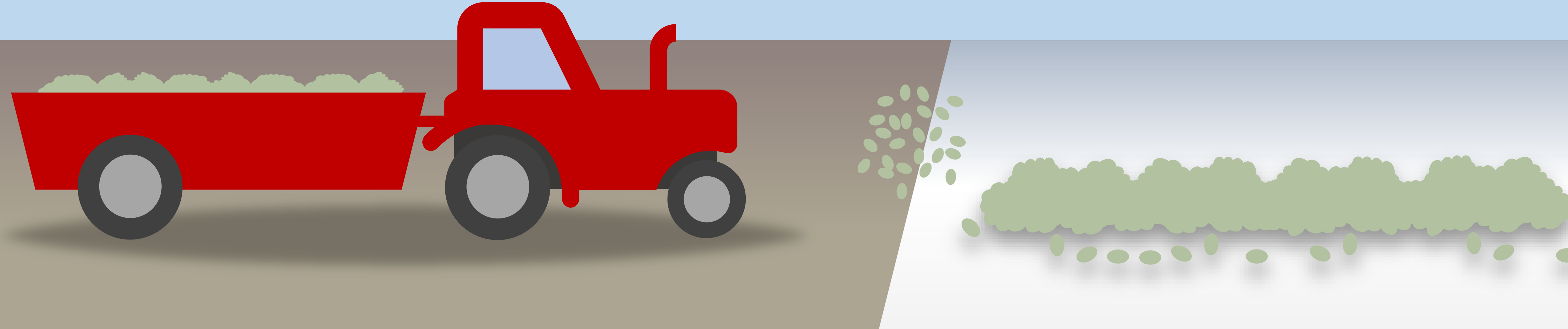
Drying scenario 1

Drying scenario 2

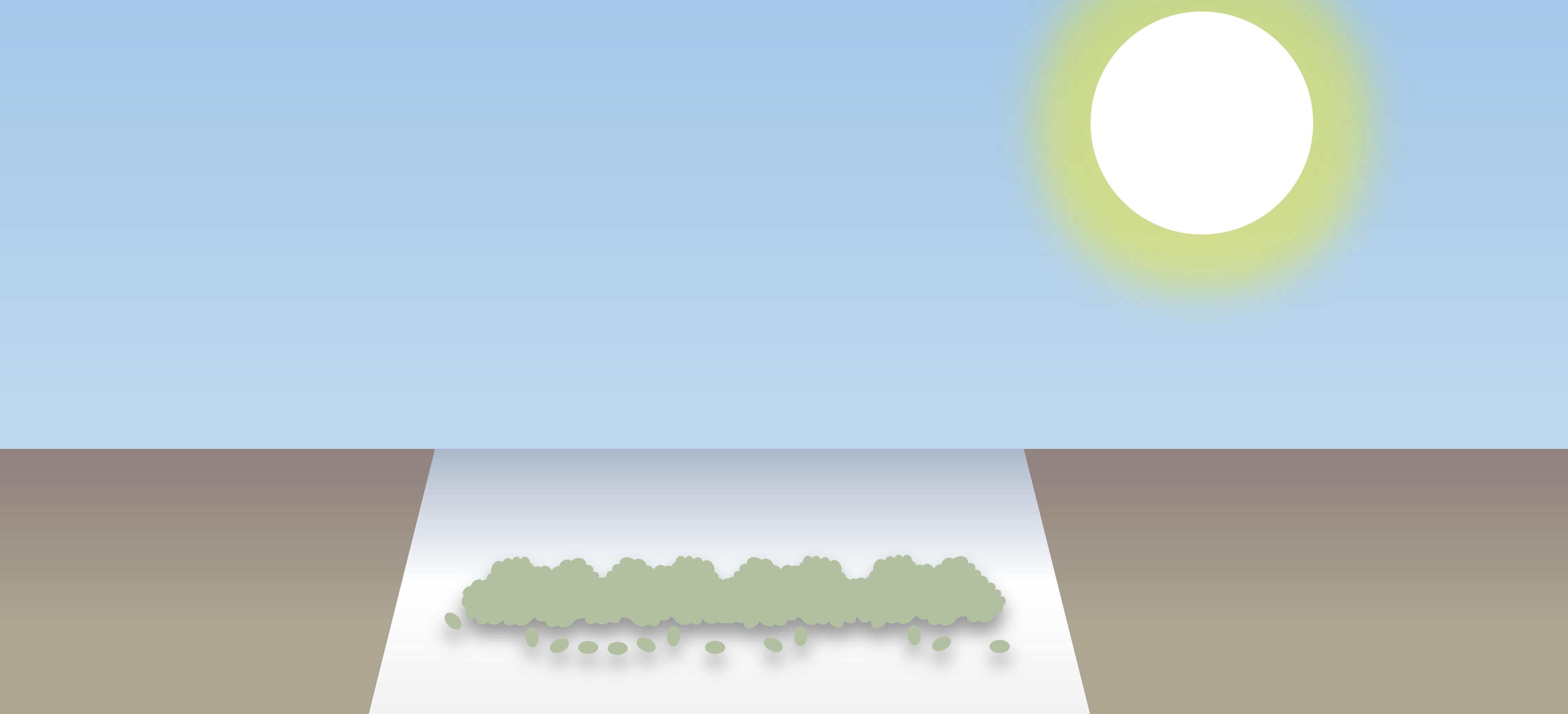
Drying scenario 2



Drying scenario 2

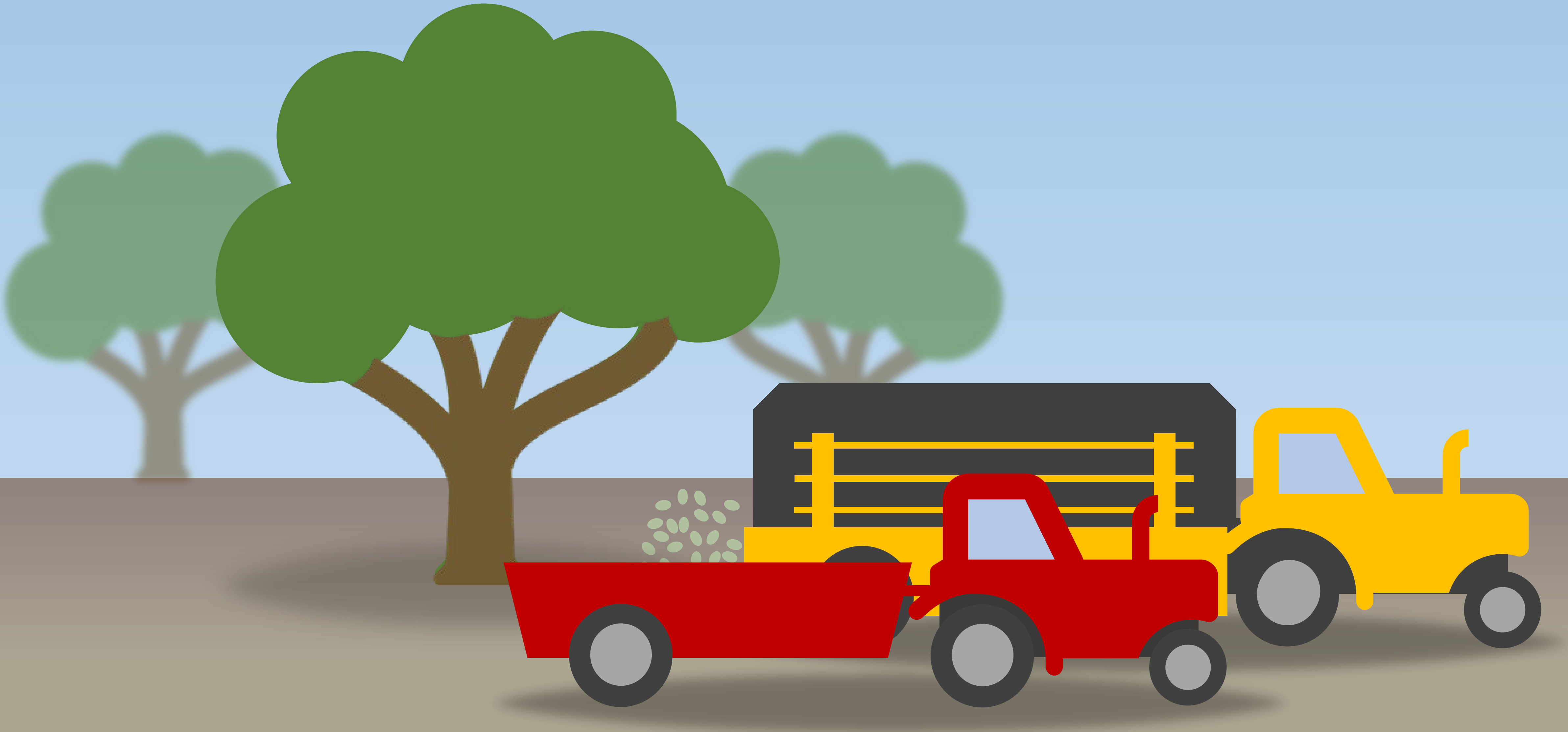


Drying scenario 2

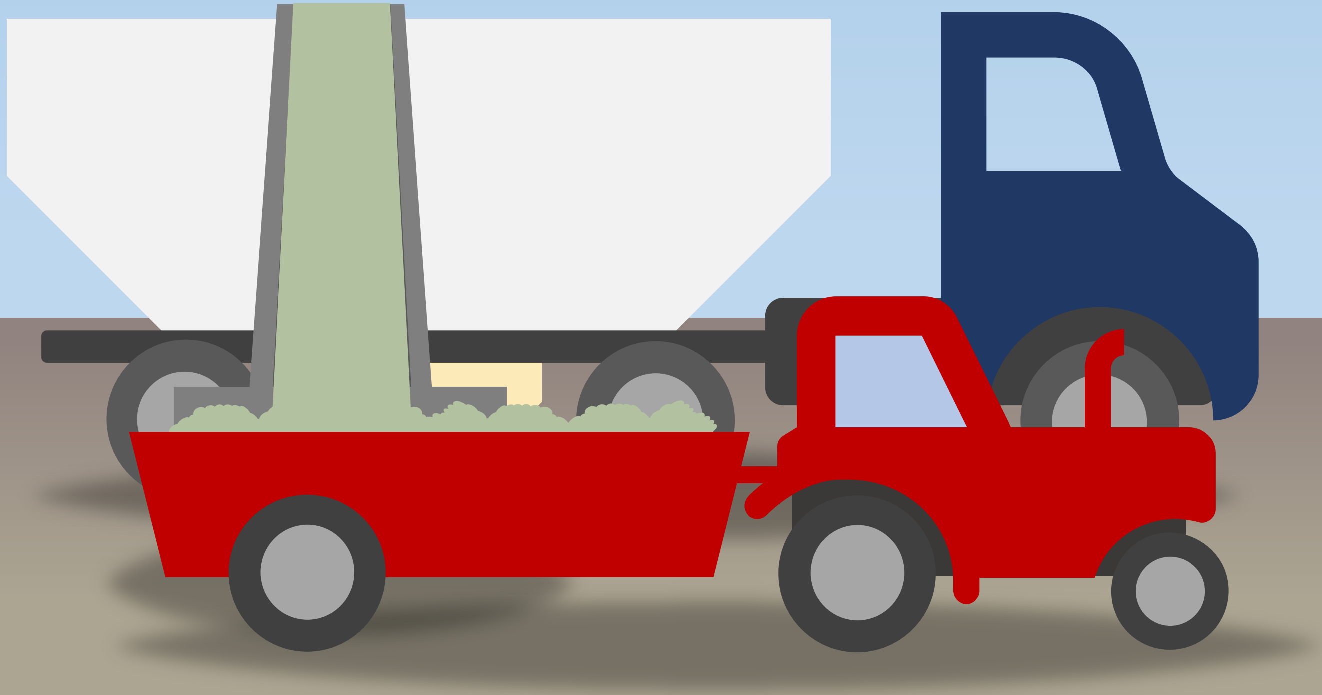


Drying scenario 3

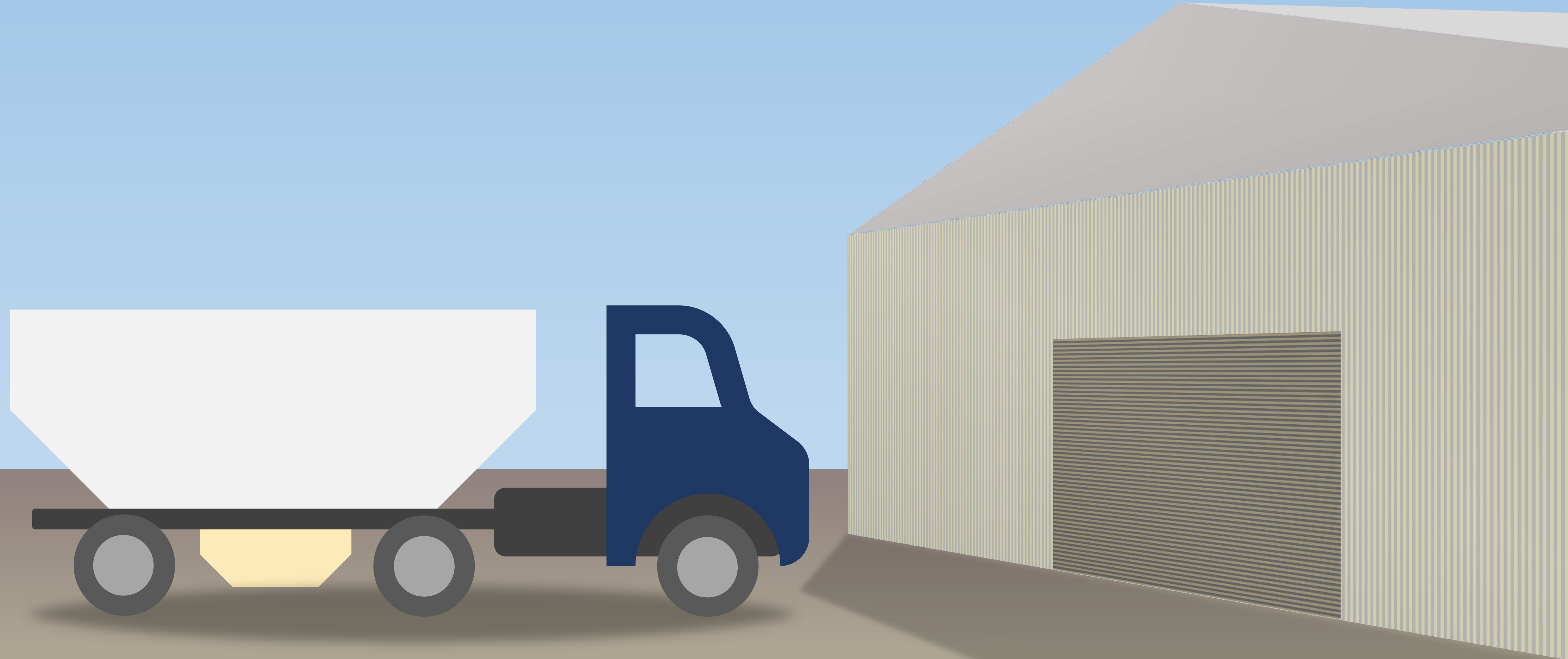
Drying scenario 3



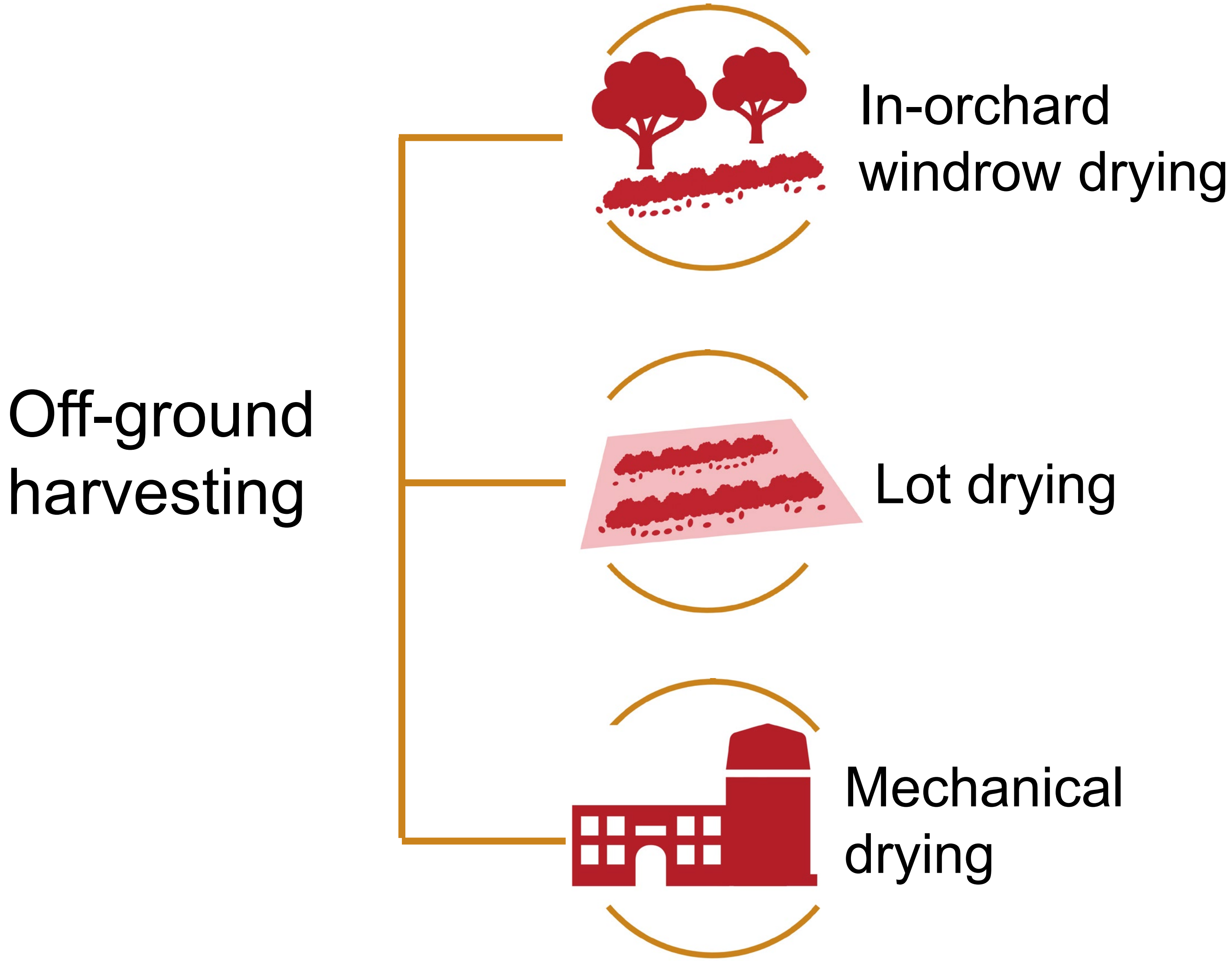
Drying scenario 3



Drying scenario 3



Scenarios

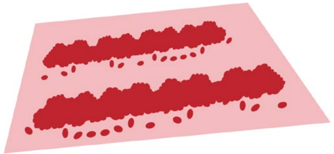

Off-ground harvesting
In-orchard windrow drying
Lot drying
Mechanical drying

Scenarios

Off-ground harvesting

In-orchard windrow drying

- Conventional vs low-dust pickup
- Soil stabilization vs bare soil



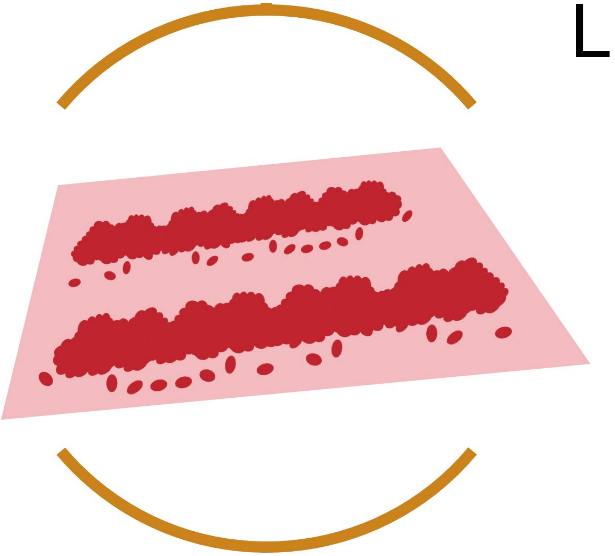
Lot drying

Mechanical drying

Scenarios

Off-ground harvesting

In-orchard windrow drying



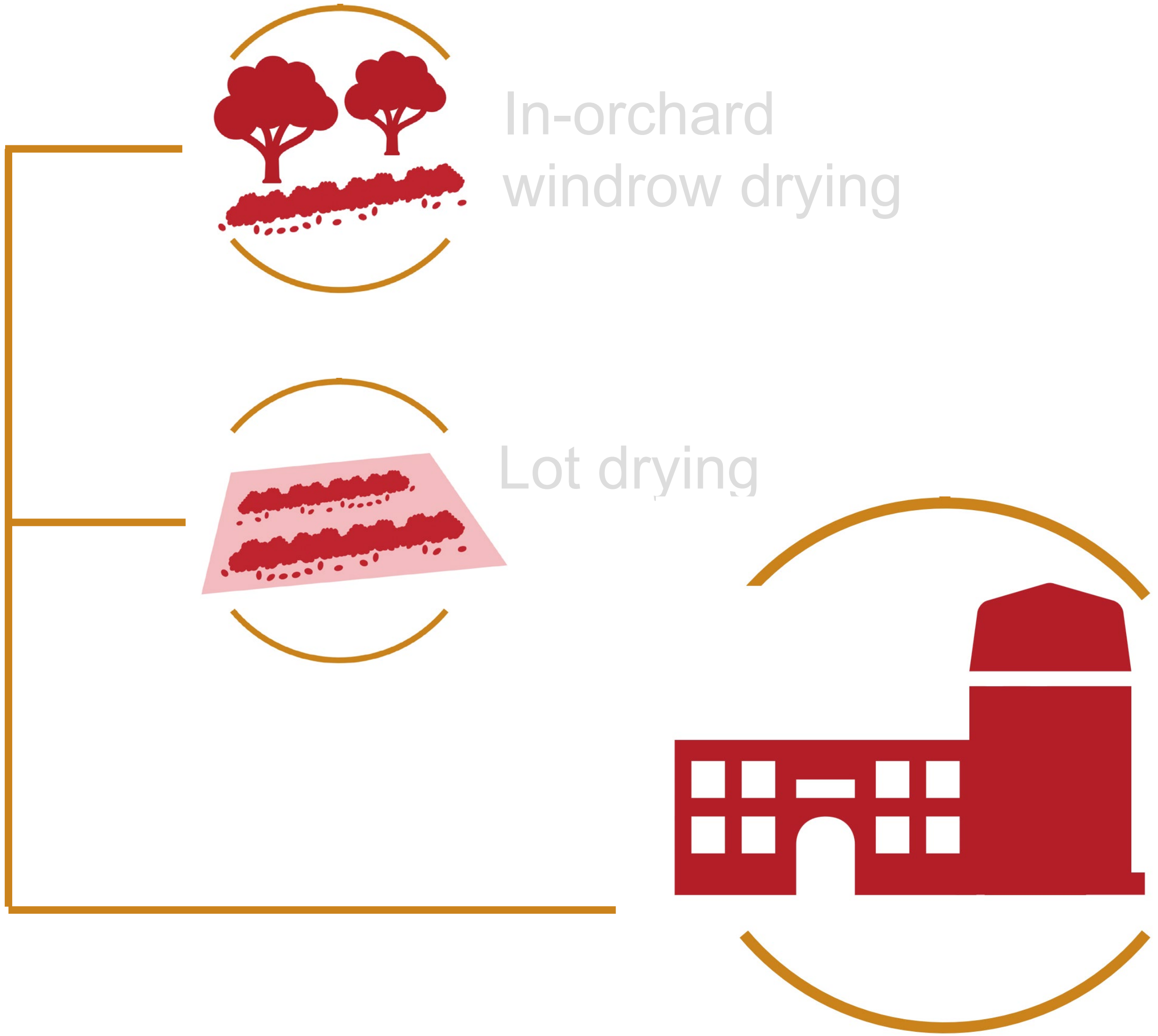
Lot drying

- Land availability and cost
- Lot size
- Soil stabilization vs bare soil
- Possibility of turning almonds

Mechanical drying

Scenarios

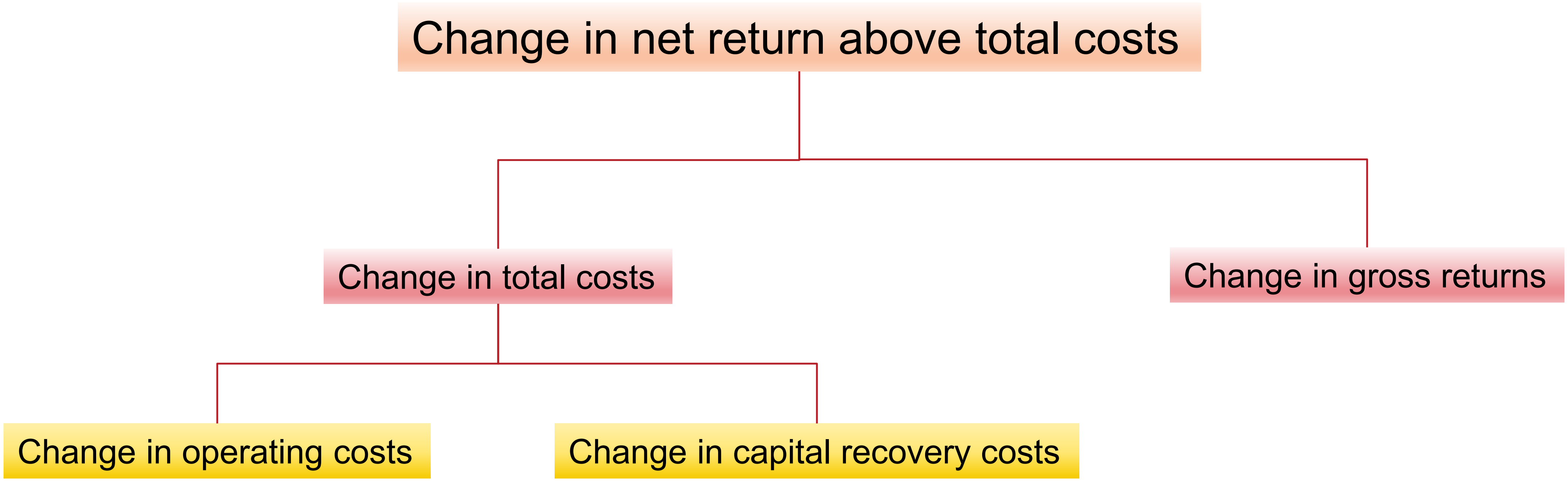
Off-ground harvesting



Mechanical drying

- Dryer format and cost
- Drying losses

Economic metrics



Expected effects

Losses due to windfall; may be affected by
- Region
- Variety
- Harvest schedule

Harvesters; effect currently unknown; rental cost will be affected by
- Capital cost
- Fuel/labor demand/cost
- Lifespan/depreciation
- Maintenance cost

Cultural practices
- Fewer pest control measures needed
- Less stringent leveling needed

Harvest operations
- Blowing/sweeping are avoided
- Pickup may be avoided

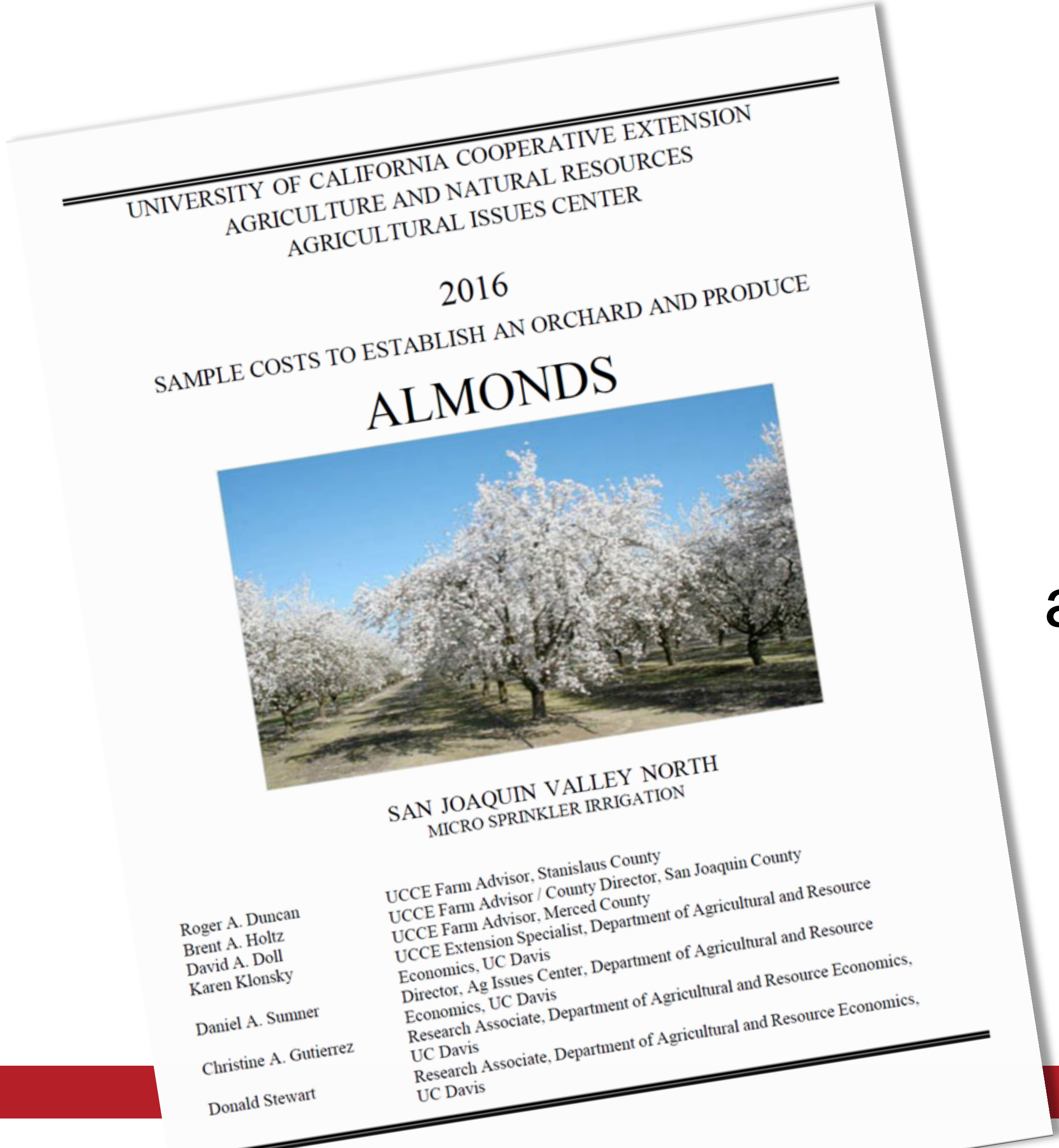
?

\- (undesirable)

\+ (desirable)

Change in net return per acre above total costs relative to conventional practices ($/acre)

Sources


UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION
AGRICULTURE AND NATURAL RESOURCES
AGRICULTURAL ISSUES CENTER

2016

SAMPLE COSTS TO ESTABLISH AN ORCHARD AND PRODUCE

ALMONDS

SAN JOAQUIN VALLEY NORTH
MICRO SPRINKLER IRRIGATION

Roger A. Duncan	UCCE Farm Advisor, Stanislaus County
Brent A. Holtz	UCCE Farm Advisor / County Director, San Joaquin County
David A. Doll	UCCE Farm Advisor, Merced County
Karen Klonsky	UCCE Extension Specialist, Department of Agricultural and Resource Economics, UC Davis
Daniel A. Sumner	Director, Ag Issues Center, Department of Agricultural and Resource Economics, UC Davis
Christine A. Gutierrez	Research Associate, Department of Agricultural and Resource Economics, UC Davis
Donald Stewart	Research Associate, Department of Agricultural and Resource Economics, UC Davis

Prior cost study by UC Davis and UC Cooperative Extension

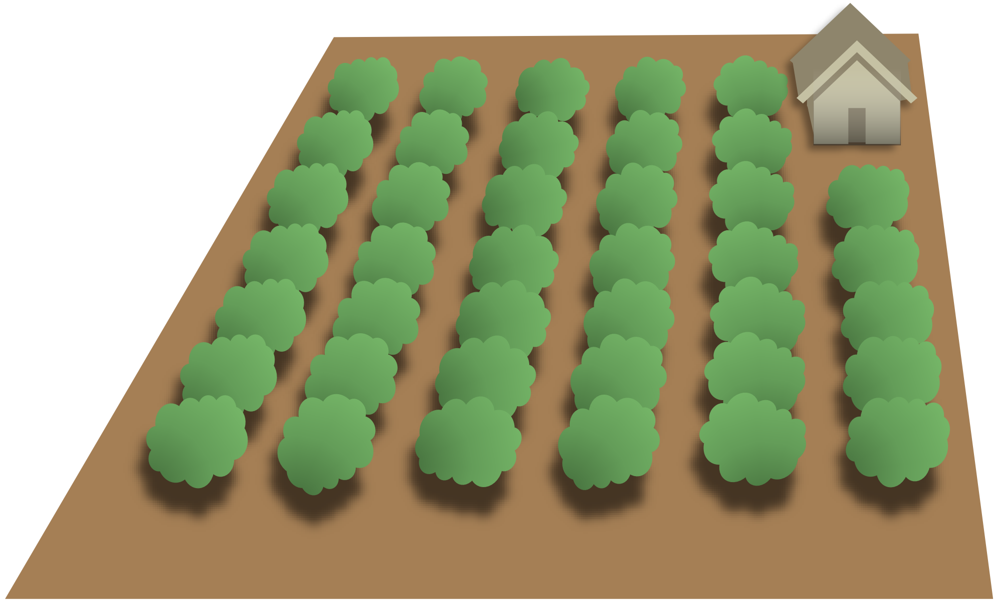
Sources

Experts from

…along with cost data from additional vendors and service providers

Assumptions

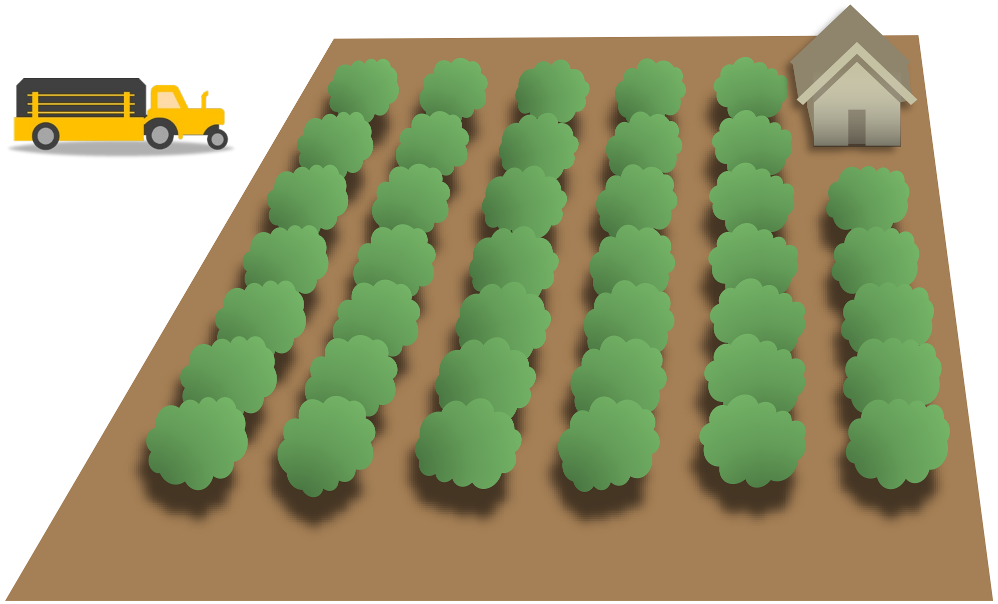
Model developed for a hypothetical orchard



- 100 acre orchard
- >4 years old
- 2200 lb/acre yield
- $2.50/lb selling price
- 1% windfall
- Conventional sanitation, fertilization, irrigation, pest management, pruning, pollination etc. agree with existing cost study

Assumptions

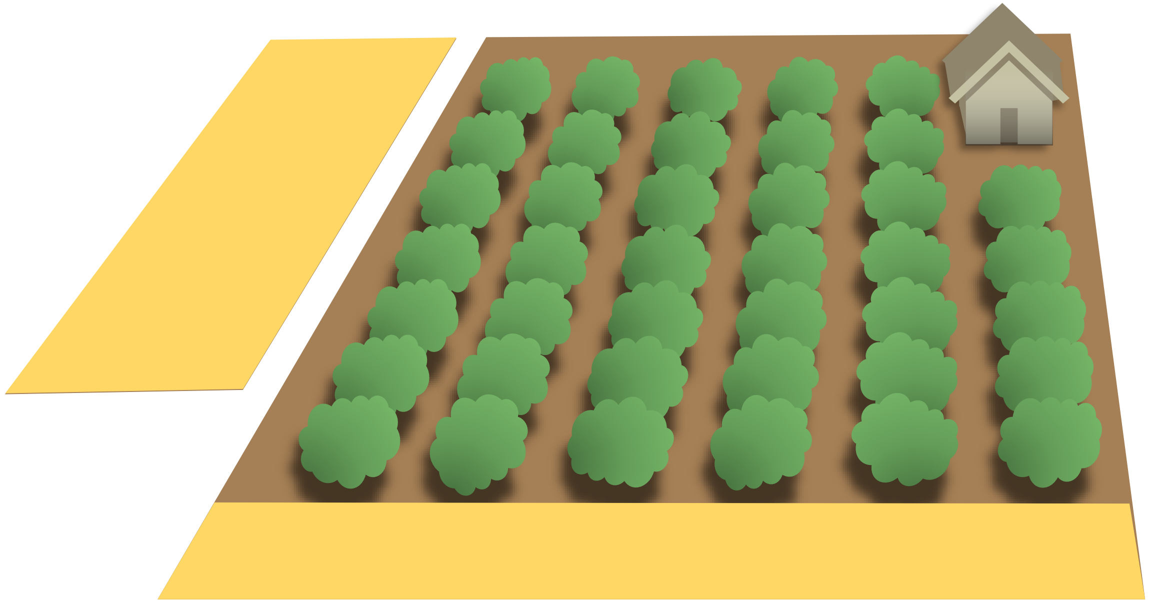
Off-ground harvesters



- Off-ground harvesters can be utilized at a cost similar to conventional harvesters
- Off-ground harvesters have no loss

Assumptions

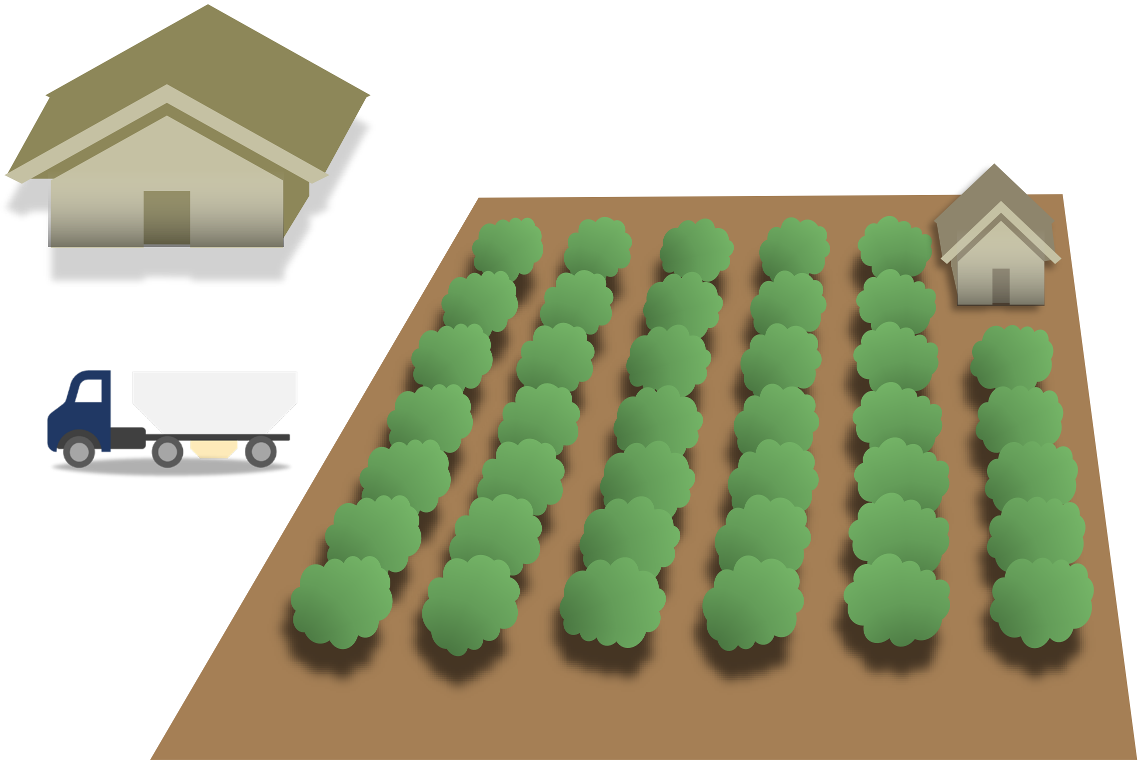
Drying lot scenario



- Drying lot sized 5-7 acres
- Land not currently used for production
- Land either owned by grower or leased near orchard
- Hand raking is required

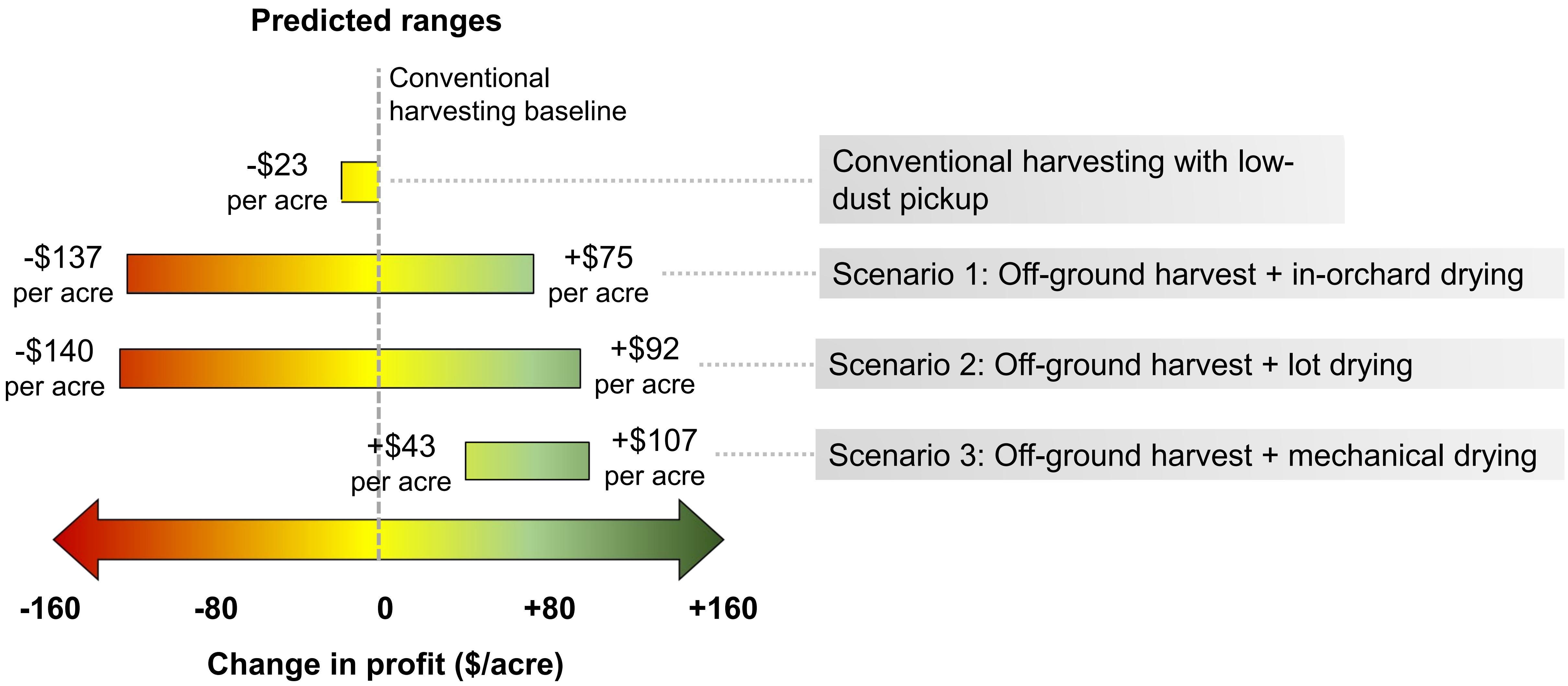
Assumptions

Mechanical drying scenario



- Mechanical drying of almonds can scale to accommodate all off-ground harvesting

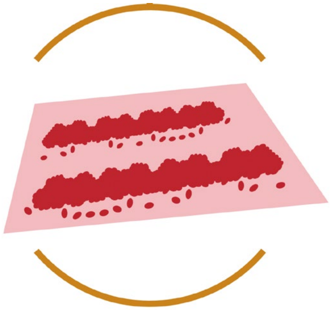
Results - Overview



Results - Detailed

OFF-GROUND HARVESTING

In-orchard windrow drying



Lot drying

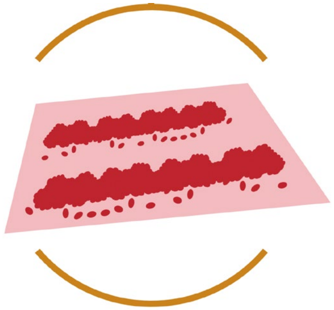
Mechanical drying

Results

OFF-GROUND HARVESTING

In-orchard windrow drying

		Change in profit
No soil stabilization	Conventional pick-up	+$75 per acre
	Low-dust pick-up	+$53 per acre
Soil stabilization	Conventional pick-up	-$115 per acre
	Low-dust pick-up	-$137 per acre



Lot drying

Mechanical drying

Results

OFF-GROUND HARVESTING

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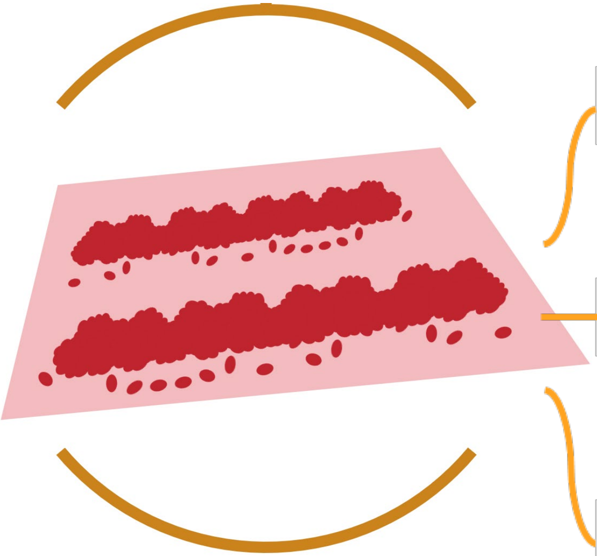
Lot drying



		Change in profit
5-acre lot	Tarped soil	+$77 per acre
5-acre lot	Soil stabilization	+$91 per acre
6-acre lot	Tarped soil	-$27 per acre
6-acre lot	Soil stabilization	-$17 per acre
7-acre lot	Tarped soil	-$140 per acre
7-acre lot	Soil stabilization	-$124 per acre

Mechanical drying

Results

OFF-GROUND HARVESTING

In-orchard windrow drying

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7-acre lot	Tarped soil	-$140 per acre
	Soil stabilization	-$124 per acre

Mechanical drying

		Change in profit
+10% price adjustment	1% over-drying loss	+$43 per acre
	No over-drying	+$98 per acre
No price adjustment	1% over-drying loss	+$53 per acre
	No over-drying	+$107 per acre

Results

OFF-GROUND HARVESTING

In-orchard windrow drying

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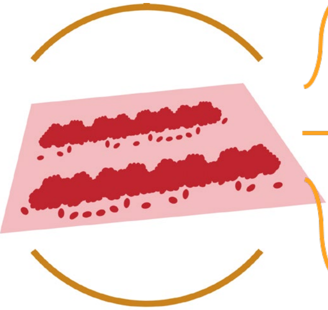

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+10% price adjustment	1% over-drying loss	+$43 per acre
	No over-drying	+$98 per acre
No price adjustment	1% over-drying loss	+$53 per acre
	No over-drying	+$107 per acre

Results

MORE DUST CONTROL

EXPECTED DUST MITIGATION

	Predicted change in profit ($/acre)
Off-ground harvest + mechanical drying	+$107
Off-ground harvest + lot drying with tarping	+$77
Off-ground harvest + lot drying with soil stabilization	+$91
Off-ground harvest + soil stabilization + in-orchard windrow drying + low dust pickup	-$137
Off-ground harvest + in-orchard windrow drying + low dust pickup	+$53
Off-ground harvest + soil stabilization + in-orchard windrow drying	-$115
Off-ground harvest + in-orchard windrow drying	+$77
Conventional harvest + soil stabilization	-$190
Conventional harvest + low-dust pickup	-$23
Conventional harvest	-$0

LESS DUST CONTROL

Research targets

- How much windfall occurs? What is the quality of windfall almonds?
- Can drying on tarped soil reduce dust during pickup? Can tarps withstand pickup machines?
- Can soil stabilizers reduce dust during almond pickup? Do such stabilizers affect almond quality?
- What are the optimal drying conditions for almonds in various mechanical dryer formats?
- What are appropriate drying lot conditions (layer thickness, turning, duration)?

Acknowledgements

University of California
- Kaiwen (Kevin) Wang
- Patrick Brown
- Mae Culumber

Almond Board of California
- Guangwei Huang
- Karen Lapsley
- Gabriele Ludwig
- Sebastian Saa
- Harvest Workgroup

Rory Crowley, Nicolaus Nut Co., Chico, CA
Scott Hermann, Tol Inc, Tulare, CA
Yaron Michelson, Afron, Pardess Hanna, Israel
Mayo Ryan, North State Hulling, Chico,CA