AIR QUALITY

CALIFORNIA ALMOND **SUSTAINABILITY PROGRAM**

california almonds
Almond Board of California

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INTRODUCTION — SUSTAINABILITY AND AIR QUALITY

One cannot deny that almond production affects air quality. For two to three months during harvest, dust coats trees, cars and homes near orchards and operations involving hulling or shelling. Pillars of airborne dust alert passersby when orchards are being harvested. Although agriculture is not the leading cause of most problematic air emissions, almond growers and handlers can mitigate problems by reducing their contributions.

Two categories of air emissions affected by almond production and processing are 1) U.S. EPA–designated criteria pollutants and 2) greenhouse gases. The key pollutants of concern are particulate matter equal to or less than 10 microns in diameter (PM_{10}) and ground-level ozone. Airborne particulates primarily result from dust stirred up by equipment, motorized vehicles or wind, or from combustion of fuels and wood. Ground-level ozone is formed by atmospheric reactions between nitrogen oxides (NOx) and volatile organic compounds (VOCs) — both associated with fuel use. VOCs also result from the evaporation of petroleum-based products, including pesticides. Airborne particulates and ground-level ozone can adversely affect human health.

Important greenhouse gases associated with almond production and processing are carbon dioxide (CO_2) and nitrous oxide (N_2O). Fuel combustion and soil management practices that increase the breakdown of soil organic matter (e.g., tillage) are key sources of CO_2. Increases in N_2O emissions are generally associated with the use of nitrogen-containing fertilizers and amendments and their decomposition by microbes in soils. Climate change related to greenhouse gases is reported to pose risks ranging from altered crop production to human health issues.

Agriculture is not the only source of air problems in California. Fuel combustion by power utilities and the transportation sector (e.g., cars, trucks, ships and rail) generally is the most significant source. Furthermore, some pollutants affecting air quality in California can come from as far away as China! Within the state, pollutants blown in from coastal urban locations can become trapped in other areas, where they may become a problem (e.g., San Joaquin Valley Air Basin).

On the other hand, it is important to note that agriculture buffers some emissions. Plants absorb ozone. Cropping systems and surrounding landscapes reduce atmospheric CO_2 by sequestering carbon in plant tissues (especially perennials like almonds) and soil. In the near future, almond farmers may be able to sell agricultural carbon offsets in a cap-and-trade economy. Regardless, many agricultural operations likely produce more problematic emissions than they offset.

Almond growers and handlers should be aware of how their activities impact air emissions. Certainly, changes in technology (e.g., replacing older diesel engines) to reduce emissions can incur significant costs. Other efforts that limit emissions can be less expensive or save money. Better use of integrated pest management, for example, can simultaneously limit pesticide use, fuel consumption and associated emissions. This may save money.

The implementation of practices and technologies to reduce problematic air emissions from almond operations may not always be legally required, but is important for showing leadership, being a good neighbor, and enhancing the image of the California Almond community.

	For this orchard, the following practices were used to reduce dust emissions from the orchard floor:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	ORCHARD FLOOR MANAGEMENT — REDUCING PARTICULATES AND ENHANCING CARBON SEQUESTRATION					
1	The entire orchard floor and edges have been disked and/or floated every year. ☐ Yes. (Skip to question 3.) ☐ No.					
2	The entire orchard floor has been disked and/or floated occasionally, but only when soil was moist to minimize dust.	☐	☐	☐	☐	☐
3	Methods other than tillage were used to control weeds (e.g., herbicides, mowing or heat).	☐	☐	☐	☐	☐
4	Organic soil amendments (e.g., compost) were used to stabilize soil by increasing moisture retention and reducing compaction.	☐	☐	☐	☐	☐
5	A plan was implemented to reduce passes by equipment and motorized vehicles in the orchard.	☐	☐	☐	☐	☐
6	Cover cropping was used to stabilize and build soil (increase organic matter) while providing other benefits (reducing weeds, increasing natural enemies of pests, etc.).	☐	☐	☐	☐	☐
7	Natural habitat has been maintained and/or perennial vegetation (hedgerows or trees) has been planted or retained in unfarmed areas within or surrounding the orchard. ☑	☐	☐	☐	☐	☐
8	Other: _____				☐	

☑ This practice may also have food safety implications. Consult ABC GAP recommendations for more information.

GREENHOUSE GASES AND CARBON SEQUESTRATION

Greenhouse gases are a worldwide issue because of their association with global warming. Two greenhouse gases produced by almond production and processing are carbon dioxide (CO_2) and nitrous oxide (N_2O). Although more CO_2 likely is produced, N_2O is about 300 times more effective at trapping heat in the atmosphere. On- and off-site (power stations) combustion of fossil fuels is a major CO_2 source. Consequently, improving fuel and electricity use efficiencies, as well as using renewable energy sources (e.g., solar or wind), decrease emissions and may save money. Other than combustion, tillage and other orchard practices that enhance microbial breakdown of soil organic matter also increase CO_2 emissions.

N_2O emissions can increase when nitrogen fertilizers are applied. Microbes in the soil convert a portion of the nitrogen into N_2O. How much is converted and under what soil conditions are the subject of ongoing research, but indications suggest a strong relationship between nitrogen use efficiency and reductions in N_2O emissions. The production of most nitrogen fertilizers is energy intensive. Using them efficiently can decrease production needs and, therefore, decrease off-farm emissions. See the Nutrient Management module for current practices to improve the efficiency of nitrogen use.

Almond orchards and surrounding landscapes offset at least some greenhouse gas emissions by sequestering carbon in plant tissues and soil. Measurable impacts of many agricultural practices on greenhouse gas emissions and carbon sequestration are not fully understood, although the Almond Board of California is funding research to improve industry's understanding of these issues. Current recommended practices include decreased or no tillage, the efficient use of nitrogen fertilizers, and, when practical, maximizing other vegetation in and around the orchard (e.g., cover crops, hedgerows or trees).

	For this orchard or facility, the following practices were used to reduce dust emissions from unpaved surfaces:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	UNPAVED SURFACES — REDUCING PARTICULATES					
9	Unpaved roads had speed limits posted to reduce dust generation.	☐	☐	☐	☐	☐
10	Vehicle access to unpaved roads was restricted physically (e.g., by a gate).	☐	☐	☐	☐	☐
11	Applications of water or organic dust suppressants (e.g., road oil or polymers) or layering of mulches, chips (during winter), sand or gravel was used on unpaved roads and/or on unpaved equipment yards.	☐	☐	☐	☐	☐
12	At least some roads and/or equipment yards were paved or were maintained in an intentionally planted cover crop.	☐	☐	☐	☐	☐
13	Other: _____				☐	

References and more information

Almond Board of California. 2010. Air Quality Web page: http://www.almondboard.com/Growers/lawsandregulations/AirQuality/.

Ludwig, Gabriele. 2008. Almonds and Air Quality. Accessed on July 11, 2011 at http://airquality.ucdavis.edu/pages/events/2008/green_acres/LUDWIG.pdf.

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Dust and particulate matter

Particulate matter is a generic term to describe a complex group of airborne particles that vary in size and composition, depending on the source(s) and geographic location. Particles with a diameter less than or equal to 10 microns are regulated and known as PM_{10}. The PM_{10} spectrum is subdivided into coarse and fine particles. Coarse particles range from 2.5 to 10 microns and can result as a component of fugitive dust stirred up by wind, motorized vehicles or equipment. Although impacts of dust on human health are uncertain, farm dust (with associated coarse particles) is a nuisance and should be minimized to comply with regulations and as part of being a good neighbor. Fine particles ($PM_{2.5}$) are less than or equal to 2.5 microns and are emitted during combustion of fuels (especially petroleum diesel) and wood, or are produced by atmospheric conversion of gaseous pollutants. $PM_{2.5}$ can penetrate deeply into respiratory pathways and is a serious risk to human health.

Managing sources of PM_{10}

Sources of dust and PM_{10} from almond farming include the orchard floor, unpaved roads, unpaved equipment yards, and harvest, hulling and shelling operations. Using no tillage, limiting passes through the orchard, cover cropping and retaining appropriate natural vegetation decrease dust from the orchard floor. For unpaved roads and unpaved equipment yards, preventive practices include restricting vehicle access and speed, applying dust suppressants, putting down appropriate materials (e.g., mulch), and paving or seeding with ground cover.

	For this orchard or facility, the following practices were used to minimize dust from harvest, hulling or shelling:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	HARVEST — REDUCING PARTICULATES					
14	Year-round orchard floor management resulted in a smooth and level orchard floor to optimize harvest efficiency and minimize dust.	☐	☐	☐	☐	
15	Operators of sweepers and pickup machines have been trained in techniques to reduce dust.	☐	☐	☐	☐	☐
16	To reduce dust, the sweeper head was set at the manufacturer-recommended height (not lower).	☐	☐	☐	☐	☐
17	The sweeper head used tines made of wire instead of rubber/plastic.	☐	☐	☐	☐	☐
18	Sweepers designed to minimize passes and reduce dust were used.	☐	☐	☐	☐	☐
19	When near sensitive surroundings (roads, homes, etc.), conventional pickup machines were driven at reduced speeds and were positioned to discharge debris into the orchard, away from sensitive surroundings.	☐	☐	☐	☐	☐
20	Speeds for separator fans on conventional pickup machines were lowered (e.g., 910 rpm instead of 1,080 rpm).	☐	☐	☐	☐	☐
21	Pickup machines designed for reduced dust output were used.	☐	☐	☐	☐	☐
22	Other: _____				☐	
	HULLING AND SHELLING — REDUCING PARTICULATES					
23	This operation has hulling or shelling operations. ☐ Yes. ☐ No. (Skip to question 29 on page 11.)					
24	The hulling/shelling facility stockpiled nuts on pavement (not soil) to minimize dust.	☐	☐	☐	☐	☐
25	The hulling/shelling facility implemented practices to reduce airborne dust caused by unloading almonds at receiving pits.	☐	☐	☐	☐	
26	The hulling/shelling facility regularly inspected and serviced the emission-control system (ventilation and air pollution controls) to ensure efficient operation.	☐	☐	☐	☐	
27	Air pollution controls for the hulling/shelling facility included a cartridge filter or fabric filter baghouse.	☐	☐	☐	☐	
28	Other: _____				☐	

DUST AND PM_{10} CONTROL STRATEGIES AT HARVEST

Adapted from California Almonds Outlook, Almond Board of California, August 2010

When harvest approaches, there are simple actions almond growers or their custom harvesters can implement to reduce dust and PM_{10} from harvest activities. The following tips are based on both findings from Almond Board–funded research and equipment manufacturer recommendations.

Sweeper heads should be set at the manufacturer's factory level to keep wire tines 0.125 inch off the ground. If they are set too low, dust from the pickup is increased substantially. Wire tines without rubber flaps on sweeper heads can reduce dust, particularly on softer soils.

Adjusting the blower spouts to match the unique conditions in the field can reduce blower passes. Adding an optional berm brush can also help minimize blower passes under many conditions.

Harvester ground speed should be reduced, depending on field conditions. In orchards with loose soils, slower ground speed allows gravity to drop dirt, which is preferable to depending solely on fans. Fifty percent less dust is produced when conventional pickup machines are driven at 1.5 mph as opposed to 3 mph, for example.

Under clean orchard conditions, suction fan speed can be reduced on pickup machines to dramatically reduce dust in the field without loss of harvest efficiency.

When operating harvesters near roads or homes, use the trees as a natural filter by blowing rows close to the edge into the orchard, to allow the dust to filter and settle out.

Hullers and shellers can limit PM_{10} by taking action to decrease dust while unloading almonds at receiving pits; regularly inspecting and servicing emission-control systems; and using a cartridge filter or fabric filter baghouse.

To reduce dust, adjust sweeper heads and blower spouts, and reduce speeds. When operating near roads, blow rows close to the edge into the orchard, to allow dust to filter and settle out.

Sweepers can generate dangerous amounts of dust, which creates both an air quality problem and a safety hazard when alongside public roads.

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	For this orchard or facility, the following practices and technologies were used to reduce emissions from combustion:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	COMBUSTION (FUEL AND WOOD) AND ALTERNATIVES — REDUCING PARTICULATES, OZONE PRECURSORS AND GREENHOUSE GASES					
29	Prunings were not burned, but were used productively (e.g., chipped or composted and used on-site, or used for energy generation).	☐	☐	☐	☐	☐
30	Manufacturer-recommended maintenance of engines was completed.	☐	☐	☐	☐	☐
31	Low-emission motorized vehicles (i.e., flex fuel, hybrids or biodiesel) were used by the business.	☐	☐	☐	☐	☐
32	Selection of stationary power equipment was based, in part, on emissions ratings (e.g., electric motors instead of diesel engines for pumping systems).	☐	☐	☐	☐	☐
33	Engine emissions have been reduced by retrofitting/replacing diesel engines to Tier 3 or 4 standards.	☐	☐	☐	☐	☐
34	Diesel engines have been replaced (or retrofitted) with technology relying on cleaner-burning fuel (e.g., propane, natural gas or biodiesel) or electricity.	☐	☐	☐	☐	☐
35	On-site renewable energy sources (e.g., solar or wind) supplied at least some electricity requirements.	☐	☐	☐	☐	☐
36	Other: _____				☐	

SMOG-FORMING POLLUTANTS

Smog includes a mixture of pollutants, mostly ground-level ozone and ozone precursors (nitrogen oxides [NOx] and volatile organic compounds [VOCs]), which form ozone in sunlight. The U.S. Clean Air Act mandates states to meet federal air quality standards. Unfortunately, the San Joaquin Valley has failed to meet ozone standards since 1989. Besides causing human respiratory problems, ozone can decrease crop production. Some yield losses for the San Joaquin Valley are estimated to exceed 30 percent.

Smog also includes fine particulates ($PM_{2.5}$). The key source for all smog-forming pollutants is the combustion or handling of fuels (especially petroleum diesel). Smog-forming pollutants can be emitted during any almond farming or processing activity involving fuel. Pesticides (VOCs) and burning organic wastes ($PM_{2.5}$) are other farm sources of smog-forming pollutants.

Almond farmers and handlers can implement practices to reduce pollutants from combustion. These include replacing or retrofitting older diesel engines with cleaner-burning technology; using lower-emission fuels; or installing electric motors. Low-emission motorized vehicles are also beneficial. After taking action to improve energy efficiency (see the Energy Efficiency module), zero-emission solar- or wind-powered systems for supplying electricity should be considered. Instead of burning on-site, prunings can be chipped for use as mulch or compost, or for powering cogeneration (co-gen) plants.

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Linking water use, energy use and air emissions

Significant energy is used in pumping water for irrigation and other needs. A properly designed and maintained irrigation system reduces emissions of NOx and VOC ozone precursors, $PM_{2.5}$ and greenhouse gases. Recommended practices include tracking water use, regular testing and maintenance of system components (e.g., pumps, lines, filters and emitters), and use of drip or micro sprinklers. More information is found in the Irrigation Management module.

	For this orchard or facility, the following practices were used to reduce emissions associated with water use:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	WATER USE — REDUCING PARTICULATES, OZONE PRECURSORS AND GREENHOUSE GASES					
37	The annual amount of water used was monitored and tracked to manage water use efficiency, thereby reducing pumping-related air impacts.	☐	☐	☐	☐	
38	Irrigation system infrastructure (e.g., pumps, lines, filters and emitters) was regularly tested and, if necessary, corrected to maintain optimal efficiency. (See the Irrigation Management module for detailed information.)	☐	☐	☐	☐	☐
39	Irrigation generally was done during off-peak hours, when ozone formation and water evaporation are lower.	☐	☐	☐	☐	☐
40	Irrigation efficiency was maximized through scheduling based on crop evapotranspiration and/or soil and/or plant moisture monitoring. (See the Irrigation Management module for detailed information.)	☐	☐	☐	☐	☐
41	Drip or micro sprinklers were used to reduce use of water and associated energy.	☐	☐	☐	☐	☐
42	The irrigation system for this orchard had zero direct emissions (e.g., solar-powered pumping system or gravity-fed flood/furrow system).	☐	☐	☐	☐	
43	Other: _____				☐	

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	For this orchard, the following practices were used to reduce emissions related to pest management:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	PEST MANAGEMENT AND SPRAY OPERATIONS — REDUCING PARTICULATES, OZONE PRECURSORS AND GREENHOUSE GASES					
44	Integrated pest management (IPM) techniques were used to eliminate the unnecessary use of pesticides and fuel for insect, disease and weed control. (See the Pest Management module for detailed information.)	☐	☐	☐	☐	
45	When choosing pesticides, low-VOC formulations (e.g., not emulsifiable concentrates) were used when available and practical for application.	☐	☐	☐	☐	
46	Extra effort was made to reduce VOCs during the peak ozone period (May 1 to October 31) by avoiding use of fumigants (if practical) during this peak ozone interval.	☐	☐	☐	☐	☐
47	Other: _____				☐	

AIR EMISSIONS FROM PEST MANAGEMENT

Pest management activities can produce problematic emissions. Integrated strategies that emphasize biological and cultural tactics to maintain pests at tolerable levels will generally reduce passes and pesticide applications. By making fewer tractor and sprayer passes, almond growers limit dust and PM_{10} from soil disturbance, as well as reduce emissions of $PM_{2.5}$, NOx, VOCs and greenhouse gases from fuel use.

The highest-profile air quality issue related to pest management is VOCs from pesticides. Pesticide formulations differ in their capacity to volatilize and produce VOCs, and each VOC differs in its potential to form ozone. Volatilization and/or reactivity is influenced by climatic factors (e.g., air temperature, light intensity and relative humidity). Despite this complexity, California Almond growers can take preventive steps, such as avoiding high-VOC formulations like emulsifiable concentrates, as well as minimizing applications, rates and areas treated, especially between May 1 and October 31 (peak ozone interval).

Potential VOC emissions for non-fumigant products can be viewed and compared on the California Department of Pesticide Regulation website (http://www.cdpr.ca.gov). Detailed information on pest and spray management is available at the University of California Statewide Integrated Pest Management Program website (http://www.ucipm.ucdavis.edu).

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	For this orchard, the following practices were used to reduce greenhouse gases from use of nitrogen fertilizers:	Not familiar with this	I haven't tried it	I have tried it	My current practice	Not applicable
	NITROGEN FERTILIZATION — REDUCING GREENHOUSE GASES					
48	Amounts of nitrogen fertilizer applied were guided by plant tissue and/or soil tests, as well as yield goals, to ensure efficient use. (See the Nutrient Management module for detailed information.)	☐	☐	☐	☐	☐
49	Split or multiple applications of nitrogen were made to optimize root uptake by coinciding with key stages of almond growth and development.	☐	☐	☐	☐	☐
50	Variable-rate fertilizer applications and practices ensuring irrigation efficiency were used to maintain desired nitrogen in the root zone, and reduce losses from N_2O emissions, nitrate leaching or runoff.	☐	☐	☐	☐	☐
51	Other: _____				☐	

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