why should you adopt good agricultural practices?

AS WITH OTHER FOOD CROPS, almonds are subject to all three major food safety hazard categories—biological, physical and chemical:

- Biological Contamination — Contamination from bacteria, yeasts and molds, including *Salmonella* and *E. coli*.
- Physical Contamination — Contamination from foreign materials that could cause illness or injury, such as stones, glass and metal in food products.
- Chemical Contamination — Contamination from chemicals, including crop protection chemicals, food allergens and aflatoxin.

The threat of contamination in almonds is an important concern, not only to growers, wholesalers and retailers, but also to consumers — your ultimate customers.

Did you know:

- Your neighbor's farming operation can contaminate yours?
- Your irrigation water may be a source of harmful bacteria, such as *Salmonella* and *E. coli*, or it could spread bacteria from another source in your orchard, contaminating your almonds?
- Unhealthy employees, or those with cuts or abrasions, can transmit disease-causing pathogens directly to your almonds?
- Harvest tools, such as tractors and pruning shears, can spread these pathogens?
- Bacterial contamination of nuts shaken to the ground was documented as far back as 1973?
- Business as usual could mean no business?

Food safety is a major concern for all food producers and handlers. Microbial contamination that results in unsafe food is the focus of much of this concern. Contamination can come from many sources: the use of unsanitary harvesting and handling equipment, water, inadequate hand-washing by employees, improper fertilizer and soil amendment use, and a variety of other obvious and not-so-obvious sources.

Prevention of contamination must begin on the farm and continue through to the huller/sheller and handler operations. Current pasteurization technologies cannot eliminate all potential food safety hazards. Therefore, it is critical that Good Agricultural Practices (GAPs) are in place to ensure the contamination load on almonds is at a level low enough to ensure these technologies are effective. The implementation of GAPs in your farming operation is essential to protect your business.

Voluntary industry-wide implementation of GAPs and adherence by all handlers to federal GMP (Good Manufacturing Practices) requirements are necessary to meet the objectives of the Almond Board of California Food Quality and Safety Program (FQSP). Proper implementation of the FQSP requires that each grower utilize GAPs to minimize risk and ensure quality.

documentation and traceability

1

MAINTAINING READILY retrievable records of all almond farm operations is essential and beneficial when it comes to food safety. Although there are many common elements, each farm operation is unique. Specific documentation and record keeping down to the orchard level are optimal to maximize YOUR investment in risk reduction.

Documentation and record keeping are essential for a traceback program. Traceback is the ability to track food items at least one step forward and one step back in the supply chain. Not only should you be able to identify which orchards specific lots were in, but you should also be able to identify which huller/sheller and handler your product was processed through.

There are no off-the-shelf GAP programs, but resources are available to get you started with a written plan and key documentation development. Remember: Don't be intimidated into inaction — your GAP program can evolve in phases, working toward the point where adequate records include (but are not limited to):

- Details of prior farm history and ownership.
- A detailed diagram of facility and orchard layout.
- A detailed flowchart or spreadsheet for variety mix and harvest sequence.
- Lot numbers assigned as loads are harvested and records maintained for all loads of almonds leaving your farm.
- A detailed diagram of adjacent land use, operations and influences.
- A crop management flowchart (prebloom to postharvest).
- Worker-training programs and evidence of training.
- Placement and servicing of sanitary facilities.
- Invoice records for sanitation and personal hygiene supplies.
- Water source information, water-testing plan and results.
- All pesticide and foliar application information.
- All fertility management operations.
- A detailed orchard floor management program.

resources to get started

GAP resources are available at the Almond Board of California website. Additional information and access to GAP planning resources are available from the University of California, Davis, at http://ucfoodsafety.ucdavis.edu.

employee training

2

INFORMED AND TRAINED employees are key assets to your business and are a critical component in effectively executing your GAP program. Preparing for effective awareness and skills training begins with a written employee-training program. Implementing and documenting training sessions are crucial to the success of your food safety risk-reduction program. Written procedures for equipment operation, with food safety in mind, can be simple to get started, but should be comprehensive to include all machines and devices used in crop management and handling high-quality almonds. Written procedures should be available to ensure all individuals who take part in year-round or seasonal orchard management receive training in your expectations and their responsibilities in personal hygiene on the farm. Employee training should include the practices listed here:

- Regularly scheduled training and reinforcement sessions.
- Documentation of employees trained at each session.
- Specific training in proper use of portable toilet and hand-washing facilities.
- Specific training in thorough hand-washing techniques.
- Clear understanding of management policies and procedures to prevent ill or injured workers from coming in contact with almonds, and clear expectations for reporting illness and injury.
- Cleaning and sanitation sequence for all equipment and tools used in the management of orchards.

resources for employee training

Visit the Almond Board website for additional resources and almond-specific food safety tools. Farm and ranch worker–friendly videos, in English and Spanish, are available from the national GAPs program at www.gaps.cornell.edu. These short training tools are an easy, informative and uniform way to introduce your employees to critical aspects and needs of personal hygiene on the farm. Though not specific to almonds, the shared responsibility for food safety to protect your business and your employees' source of employment is evident.

fertilizer and soil amendment practices

3

THE IMPROPER HANDLING and use of animal waste (manure, bedding and litter, biosolids, liquid effluent) for soil fertility management, or as part of animal waste disposal-by-land application, is a clear business risk for almond growers. The Almond Board of California does not support the use of manure as fertilizer, but if used, the manure must be applied properly. The intimate and extended contact harvested almonds have with the orchard floor demands that all practical steps to minimize the intentional introduction and survival of human pathogens in soil be taken. Past almond-associated outbreaks of *Salmonella* and detection of *Salmonella* in several orchard floor surveys have elevated the level of concern for raw almonds. Carefully controlled research studies have demonstrated the potential for the almond kernel to be at risk of contamination during windrowing and sweeping. Using noncomposted manure (mixtures of feces, urine and other organic matter) increases microbial risks on the farm and could contribute to foodborne illness. Stacked and aged manure is not the equivalent of well-managed compost, and is known to have a greater potential to harbor surviving pathogens.

Although food safety recommendations generally specify a preharvest interval of at least 60 days between manure application and harvest, there is a lot of uncertainty about the survival potential of pathogens in soil. Some GAP guidelines and certification bodies require a minimum of a 120-day preharvest interval. Research has demonstrated survival of pathogens from manure incorporation, under certain conditions, exceeding 200 days. Recent studies show that under the right conditions, pathogens may survive for several years in an orchard. With this degree of uncertainty, growers are faced with difficult management decisions. If manure application is an integral part of your orchard management, the following steps are highly recommended:

- Store manure away from areas where almonds are grown and handled.
- Erect physical barriers and/or diversion buffers to prevent runoff from the stacked piles into water sources, equipment storage areas, orchard traffic areas or into the orchard.
- Consider using tarps or other barriers to minimize wind-driven drift of particles from manure piles and windrows. Although the outer surfaces of manure piles tend to be dry and have the lowest microbial numbers, these are also the areas that are typically exposed to nonlethal temperatures during aging. Wind-driven movement of pathogenic substances from manure piles alongside fields to adjacent crops has been demonstrated.
- Store manure slurry for at least 60 days in the summer and 90 days in the winter before applying to fields.
- Measure the temperature of stacked manure to ensure it reaches 131° F – 140° F for at least three days at a depth of 18–24 inches. Adding fresh manure to an age-stacked pile is not a good practice; recontamination and growth on residual nutrients are likely to occur.
- If raw manure has not been composted, age the manure to be applied to your field for at least six months prior to application.
- Document the type of manure or compost used, the rates, and the dates and locations of the applications.
- Apply manure at the end of the season, preferably when soils are warm, not saturated and/or cover-cropped. Noncomposted, untreated manure should never be applied fewer than 120 days prior to harvest.
- Do not apply poultry manure, dairy manure or lagoon wastewater during the growing season (after Jan. 1).
- When planting new trees, spread the manure two weeks before planting.
- Do not side-dress with fresh or slurry manure. Do not use biosolids or municipal waste sludge at any time.
- Incorporate manure into the soil immediately after application to minimize wind drift and water runoff. Pathogen die-off is accelerated by incorporation compared with broadcasting to the soil surface alone. If incorporation is not possible or practical under your management plan, it is strongly advised to use only adequately composted materials to minimize potential pathogen contamination.
- Maintain records of suppliers and haulers/spreaders of manure, compost and dates of delivery as well as dates of broadcast or, preferably, incorporation.
- If purchasing compost from a certified supplier, obtain and keep a certificate of analysis for documentation.
- Thoroughly clean tractors, front-end loaders, and other tools and equipment used in manure handling after each use. Prevent wash water from draining to water sources, the orchard floor or any area where harvested almonds are handled or stored.

resources for fertilizer and soil amendment practices

To get started on Good Agricultural Practices specifics for soil amendments, go to almondboard.com.

Standards for composting are regulated by CalRecycle (Title 14, California Code of Regulations, Section 17868.3) at www.calrecycle.ca.gov.

water quality and source

4

WATER USED in the production of almonds can be a source of microbial contaminants and a vehicle for spreading contamination. Therefore, maintaining a safe water supply is a top priority. It is well recognized that the quality of water used in irrigation and especially in any foliar applications to almonds may determine the likelihood of introducing and widely disseminating pathogens to the orchard and the crop. To protect your business, become familiar with the sources and quality of your water supply. Identify and document all potential sources of contamination, such as unsafe water routes, shared water conveyance conduits and seasonal influences upon the water supply. Take proactive measures to protect the quality of your water whenever it falls within your ability to control the situation. Coordinate interactions with regional water quality control boards and irrigation districts to ensure a continued safe water supply and timely communication of any potential or known introduction of hazardous levels of contaminants and routine or event-response testing results.

It is highly recommended that all water used for foliar applications comes from a pathogen-free source. Although not a common practice, the use of surface water for a variety of foliar treatments has occurred. Growers should ensure that applicators recharge spray tanks only from well-designed and protected groundwater sources or a municipal water supply. It is always important to inspect all water supplies used for chemical and pesticide mixing and washout to eliminate any chance of improper cross-connections to prevent backflow. Backflow has been the cause of on-farm contamination for pesticide- and pathogen-related illness in foods. Make sure applicators are trained in the proper placement and handling of hoses and equipment to prevent accidental contamination.

- For surface water, including uncapped wells, open canals, reservoirs and collection ponds, conduct bimonthly baseline testing for at least one season. It is recommended that you request analysis of total fecal coliform bacteria and generic *E. coli* from an analytical lab service. Though not ideal for predictive GAP programs, these bacteria are the current practical indicators of the potential for recent fecal contamination above background environmental levels. Use this information to develop a long-term monitoring plan.

- Define an action threshold for your operation in relation to the water-testing guidelines below. While no federal or state regulatory standards for irrigation water exist, based on surveys within California, current recommendations follow a guidance level of 1,000 fecal coliform or 126 generic *E. coli* per 100 mL of water as an action threshold. Although there is currently no established correlation of these levels to the presence of true pathogens in irrigation water, if this level is exceeded, 1) temporarily increase testing frequency; 2) attempt to determine the cause of the change from baseline; and 3) seek professional advice to determine whether a specific corrective action is necessary and feasible. Document and maintain records of all test results and decisions.

- Well water should meet microbiological standards for potable water. If test results are positive (one coliform per 100 mL), testing should be expanded to include fecal coliform and generic *E. coli*.

- For well water, test at least once at the beginning of the season. Monthly testing is highly recommended until sufficient experience with quality over the course of at least two harvest seasons is available. Because properly designed wells should be adequately protected from surface water and runoff effects, a slightly different indicator profile is recommended. Request a microbiological evaluation of total coliform bacteria from your testing lab. This data gives a better overview of potential sources of surface contamination of groundwater.

- Closed, underground or capped well systems should be tested annually at the beginning of the season.

resources on developing a water quality plan

Additional background information on irrigation water quality standards, GAP microbial testing and access to water quality planning resources are available from the University of California, Davis, at http://ucgaps.ucdavis.edu and the Water Quality and Technical Assistance Program for California Agriculture at http://waterquality.ucanr.org.

- If you use water from a water district, obtain copies of water quality reports from the district (monthly, quarterly or annually).

- If wells or water sources are found to be contaminated with fecal coliform/ *E. coli*, take corrective measures such as disinfecting, filtering or chlorinating the well or water source.

- Evaluate and document the source of water used for dust reduction in the orchard.

- Use only a protected well source or municipal water to clean equipment surfaces and foliar-spray tanks, lines and nozzles. Minimize the potential for water used to clean orchard soil from equipment to reach food contact surfaces of the equipment.

- Identify and document nearby landfill sites, sewage treatment facilities, leach fields, potential runoff, leaching or storm-related discharge from adjacent or upstream farming operations (such as concentrated animal operations or compost producers), and resident or seasonal concentrations of domestic animals or wildlife that may influence water quality.

- Take corrective actions and document these actions, such as construction of physical barriers, disinfecting wells and use of a catch pond.

- Using recycled or reclaimed water, unless documented as having received tertiary treatment (which includes a terminal pathogen disinfection step) as a source of irrigation water, is not recommended.

orchard floor management

5

THE PRACTICAL REALITIES of modern almond harvest management result in direct contact of nuts with the orchard floor. Whenever almonds come in direct contact with soil or are brought into intimate contact with soil surface materials, some level of microbial contamination is ensured, and the potential for contamination with pathogens greatly increases. Some level of intermixing of harvested almonds, soil and organic debris during windrowing is unavoidable. Recent surveys have undeniably shown that low levels of pathogens, such as *Salmonella*, may be present in sporadic locations on the orchard floor surface. Dust aerosols generated during harvest operations can spread these highly localized hot spots within a windrow section and, potentially, across large sections of an orchard block. University research has demonstrated that when free moisture combines with contaminated almond hulls or exposed shells, transfer of pathogens from the exterior of the nut to the interior is possible. Following passive infiltration, pathogens such as *Salmonella* can grow quickly on the residual nutrients in all parts of the almond.

As the numbers of the pathogen increase, two elements of concern for growers and handlers also increase. First, growth of the contaminating pathogen elevates the potential for foodborne illness by sheer numbers, and elevates the chance of cross-contamination within a lot and among lots during further handling and processing. And second, as pathogens grow on the almond hull, their potential to resist environmental stress (such as drying and sunlight), as well as to better tolerate disinfection treatments during processing, are increased. The bottom line is that the risk to your consumers goes up under these conditions.

Mandatory pasteurization of California Almonds has been in place since September 2007. While pasteurization processes are considered a “kill” step for pathogens such as *Salmonella*, these processes significantly reduce, but do not eliminate, all pathogens. For this reason, orchard floor management is a key prerequisite to ensuring pasteurization processes are effective.

resources for pest and wildlife management

Dealing with wildlife in an open farm environment is one of the most difficult challenges growers of all crops have to face in managing food safety risks. There are no sure cures or easy and effective methods. While the potential for contamination is undeniable, there is no known specific role of wildlife in past *Salmonella* outbreaks on almonds. If you have identified some potential problems in your orchard, contact your county agricultural commissioner to access California Department of Food and Agriculture (CDFA) expertise and obtain permits for vector and predator management.

The USDA APHIS Wildlife Services is increasingly involved in issues related to human pathogens in animal populations, especially bird control (www.aphis.usda.gov/wildlife_damage/).

Guidance for managing vertebrate pests in the orchard can be found at the University of California IPM Online site, www.ipm.ucdavis.edu.

Although some practical, recommended steps to minimize the potential for contamination are listed below, harvest operations cannot completely eliminate nut contact with soil and orchard debris or dust aerosols. During late harvest season, there is potential for rainfall, which increases potential for microbial contamination. Under these conditions, it is essential to do everything possible to minimize contamination. All stakeholders in the almond industry must participate in minimizing the sources of contamination.

- Develop a farm policy to exclude domestic animals from free access to the orchard. Work to minimize wild animal and bird traffic through your orchard.
- Clearly identify adjacent and surrounding concentrated animal production operations in orchard layout maps. Include any drainage potential to the orchard floor from free stalls, manure piles and lagoon overflow during storm events. Include patterns of prevailing and seasonal wind-gust direction that could carry particulates and aerosols from animal operations to your orchard blocks. Take a similar approach with any adjacent manure-holding and compost operations.
- Develop a clear plan of action in the event of storm-related flooding of the orchard from any up-flow source that may potentially carry hazardous chemicals or pathogens. For example, determine whether municipal storm drains have had an impact on the surface water drainage system for your orchard.
- Minimize all sources of habitat, nesting and hiding places for rodents and other vermin in and around the orchard and farm operational areas. Control weeds along drainage ditches, on berms and in related areas. Maintain a wide, plant-free buffer between canals and adjacent natural, undeveloped land and your orchard. Rodents and other small animals are less likely to cross open ground. Keeping a lightly disked buffer smoothed periodically also helps identify hot spots for nocturnal animal movement by their tracks.
- Keep equipment “boneyards” and debris piles away from orchards, and inspect unused buildings for possible issues with pest nesting.
- Identify and document the common and seasonal presence of wildlife adjacent to and within your orchard. Identify and document patterns of wildlife movement from surrounding natural habitats and from neighboring crops, especially following their harvest, into your orchard blocks. Controlling rodents, reptiles, birds and other wildlife is very challenging and varies among the diverse almond production regions. Seeking the assistance of agricultural pest specialists is highly recommended.
- Keep all food and beverage containers or other metallic and glass materials out of the orchard, since these materials represent potential sources of foreign-material contamination.
- Evaluate suitable methods to keep dust to a minimum. Minimizing dust helps reduce the spread of contamination, and is one additional benefit of meeting or exceeding air quality objectives.

To minimize the potential for growth of pathogens on windrowed almonds:

- Keep your orchard floor as level, smooth and dry as practical during the season. Although the ability of pathogens, such as *Salmonella*, to somehow survive on the inhospitable environment of a dry, bare-soil orchard floor has been clearly demonstrated, all expectations are that persistence is very low.
- Prevent the development of uneven areas within inter-row spaces, where almonds will be windrowed, that could result in pooling of rainfall. Pooling water increases the risk of foodborne illness due to pathogen infiltration of the hulls and shells and subsequent growth under the warm temperatures during the harvest period.
- Consider the necessity and practicality of forming temporary shallow diversion channels to prevent rainfall accumulation draining from the undisturbed tree-line soil surface to the drying windrows.

field sanitation and worker hygiene

6

WORKER HYGIENE plays a critical role in minimizing potential contamination of produce that is consumed fresh and that has multiple "touch points" with human hands during harvest and postharvest handling. Almonds do not fall in the category of high concern with regard to touch points; however, it is always important to build awareness of the role of personal hygiene and responsibility among management and all employees. Individual attention to the needs of proper field sanitation and hygiene should not be taken for granted. Ensuring that proper hygiene will be practiced starts with the quality and adequacy of supplies and placement of facilities. The enforceable requirements for this are mandated by federal and state regulations.

Begin with a written employee-training program. Brief but frequent training and reinforcement of training are required to maximize compliance. A number of resources are available to get started (see Resources box). Proper hand-washing has been identified as the single most important factor in reducing the microbiological risk to individuals and food. Document all training and steps taken to ensure compliance with local, state and federal worker hygiene practices. With regard to toilet facilities, the following key guidelines apply to all situations and locations:

- Workers should have ready access to toilets and fully stocked hand-washing stations at all times. This helps reduce the incidence of workers relieving themselves in the field, a practice that greatly increases the possibility of microbial contamination. Toilets must be placed within one-quarter of a mile from the fieldwork area. In California, an exemption to this rule is provided if workers are in the field for less than two hours.
- Avoid locating facilities near sources of irrigation. Stay away from areas that are subject to water runoff, which has the potential to contaminate soil, water sources, almonds, animals and workers.
- Do not clean portable toilets in the orchard. Sewage transport trucks need direct access to toilet facilities to ensure proper collection and disposal of wastes through a municipal sewage system or a subsurface septic tank system. Use special caution when servicing portable toilets to prevent leaking into the fields. You should have a pre-established plan for waste containment in the case of such leakage, using appropriate barriers or physical containment, definition of the affected area, and the segregation and disposal of all affected almonds.
- For permanent or hard-plumbed facilities, be aware of any potential for cross-connections to other water sources, such as foliar makeup water. Ensure that adequate backflow protection is in place. Backflow has been the cause of on-farm contamination for pesticide- and pathogen-related illness in foods. Make sure applicators are trained in the proper placement and handling of hoses and equipment to prevent accidental contamination.

resources on field sanitary facilities and worker hygiene training

There are a number of simple-to-use resources related to regulatory requirements and training tools to teach owners, supervisors and farmworkers about the need and how to's of personal hygiene and hand-washing techniques. Straightforward fact sheets and checklists on all aspects of farm labor safety (including portable toilets and hand-washing) from Cal/OSHA are available at www.dir.ca.gov/dosh. Additional training material, including worker-training DVDs (in English and Spanish) that focus on employee hygiene as well as laminated posters, may be ordered from the national Good Agricultural Practices program at Cornell University at www.gaps.cornell.edu.

pest control

7

- Develop a regular program for inspection of all buildings, structures and fields to check for evidence of pest populations or deposits of animal droppings. The program should include regular and frequent monitoring of affected and treated areas to accurately assess the program's effectiveness. Document the inspections on a simple site-identified checklist.
- Prevent the accumulation of pest and vector attractants, including water, cull piles and any food source. Collect and remove garbage, trash and related debris frequently. All waste receptacles should have tight-fitting covers.
- Preventing insect pest buildup can prevent the attraction of birds, reptiles and amphibians. Preventing rodent and small-mammal population buildup can reduce the presence of predators (although land-based predators and raptors are often encouraged in some pest management systems).
- Promptly remove dead or trapped birds, insects, rodents and other pests from traps and property to ensure clean and sanitary facilities and to avoid attracting additional pests.
- Ensure that potential nesting, roosting and hiding places for pests have been minimized.
- Regularly inspect all equipment and almond-handling or contact surfaces for evidence of animal droppings or deposits. Clean and sanitize soiled surfaces with approved disinfectants.
- Carefully follow all government regulations and pesticide label instructions.
- Document your pest control program.

ALL ANIMALS, wild and domestic, including mammals, birds, reptiles and insects are potential sources of contamination. They are also capable of vectoring (transferring) contamination from any form of waste or contaminated point source to the crop, the orchard environment, water, equipment and any almond contact surface. They can harbor and shed a variety of pathogenic agents, such as *Salmonella* or infectious and toxigenic forms of *E. coli*. Animals, especially birds, can also passively transfer human pathogens from concentrated animal production operations to adjacent farm operations. Insects create the conduit that introduces mold spores into almond kernels that can result in aflatoxin contamination. In addition to understanding the issues of animal and insect management in the orchard, it is important to minimize attraction, harborage and potential for contamination by all animals at all operational facilities and sites.

resources for pest control

There are many model and template audits to guide you in prioritizing and developing a pest management plan. The USDA Fresh Produce Audit Verification Program (www.ams.usda.gov/AMSv1.0/) has an extensive checklist that can be consulted for guidance in combination with the GAP resources on the Almond Board website.

harvest and delivery sanitation

8

HARVEST IS A CRITICAL TIME, and careful attention should be paid to eliminating potential sources of contamination or conditions that could result in the proliferation of microorganisms such as molds that produce aflatoxin or bacteria such as *Salmonella*, which can cause illness. In addition, steps should be taken to prevent the introduction of foreign objects or materials into the crop during the harvest process and delivery to the processing facility.

Bacterial cross-contamination of harvested almonds can occur if the harvest equipment or transportation vehicles used have not been cleaned and inspected prior to use. In order to minimize the potential for cross-contamination, it is sometimes necessary to sanitize the equipment and transport container prior to use during harvest operations. It is important to implement cleaning and sanitation programs for equipment that you own and use in your operation. For contract services, it is important that you receive documentation verifying that the equipment and transport vehicles/containers used have been properly cleaned, and sanitized when necessary, prior to use in your operation.

resources for harvest and delivery sanitation

More detailed information is available in the complete Good Agricultural and Good Manufacturing Practices online at the Almond Board website.

- After nuts have been shaken from the tree, they should remain spread out on the orchard floor to properly dry.
- If the nuts are exposed to rain while they are drying on the orchard floor, extra time should be given to ensure they are properly dried prior to sweeping up, and windrows should be fully spread out and/or turned to allow proper drying of the nuts.
- Be sure your pickup machine was not previously used in an orchard where manure or compost was applied after Jan. 1.
- Make every effort to be sure the pickup machine was cleaned and sanitized prior to picking up your almonds.
- Stockpiling can lead to conditions that allow some molds to grow and produce aflatoxin; almonds with a total fruit (in-shell nut and hull) moisture content over 9% may lead to mold growth and aflatoxin contamination.
- If you have excessive condensation, visual mold growth, or are stockpiling higher-moisture almonds, stockpiles should be ventilated.
- Inspect trailers/containers to be sure they are clean of all visible debris, dirt and other nutmeat, and are dry and free of odors.
- Verify that the trailers and cargo containers have not previously been used to transport materials from animal operations such as dairy or poultry farms, and specifically that they have not been used to haul waste or manure.
- Do not permit employees or transport workers to walk on or make direct contact with almonds in trailers when tarping or at any other time.
- Inspect the delivery area at the huller/sheller to ensure the area is free from signs of rodents and birds. Especially check eaves of the delivery area roof for possible bird and rodent nesting areas.
- Ensure that your huller/sheller and your handler follow almond industry-recommended Good Manufacturing Practices (GMPs) and have a traceback system in place.

stockpile management

9

WHEN IN-HULL ALMONDS ARE STOCKPILED, moisture in the almonds combined with hot days and cooler nights may lead to condensation formation under the tarps used to cover the stockpiles, and at the top layers of product in the stockpile. Elevated moisture may provide ideal conditions for the *Aspergillus* mold to grow and produce aflatoxins, which are a food-safety risk.

Aflatoxins are a major concern for the almond industry because of stringent maximum limits for aflatoxin contamination in key export markets.

Aflatoxins are produced by the *Aspergillus* mold species. The *Aspergillus* species *A. flavus* and *A. parasiticus*, which produce alfatoxin, are widely found in almond orchards, although in small amounts. The mold can grow on nutmeats, the hull and/or the shell. Insects, particularly navel orangeworm, can serve as vectors for mold contamination and also promote mold growth resulting from their activity and feeding. Moreover, insect-damaged nuts have been shown to have higher levels of aflatoxin contamination than non-insect–damaged nuts.

Once in the crop, the mold can grow and produce aflatoxins under moist conditions. Moisture in the crop may also lead to reduced quality known as "concealed damage," which is caused by nut exposure to heat and moisture in the field. The interior of affected nuts turns dark after roasting, and they may develop a bitter flavor.

Proper moisture control before stockpiling is a crucial step in prevention of mold growth. Prior to stockpiling, a field sample should be taken either before sweeping or in the windrow, using these guidelines:

- Take a representative sample across the orchard floor, from trunks to the middle of the drive row, and along the tree row.
- Take a worst-case sample from the north side of the canopy adjacent to the trunk, where moisture is typically 2 percent higher than in the crop in drive rows and middles.
- In the windrow, a representative sample would include nuts from the top to the bottom of the windrow, and a worst-case sample would be from the bottom, which can be 2 percent higher moisture content.
- Do not stockpile if any one of the following moisture content conditions exist:

  1. The total fruit (kernels + hulls) moisture content exceeds 9 percent;
  2. The hull moisture content exceeds 12 percent; or
  3. The in-shell kernel moisture content exceeds 6 percent.

resources for stockpile management

Rain at harvest increases the risk of mold growth and concealed damage. Follow these guidelines to reduce the risk:

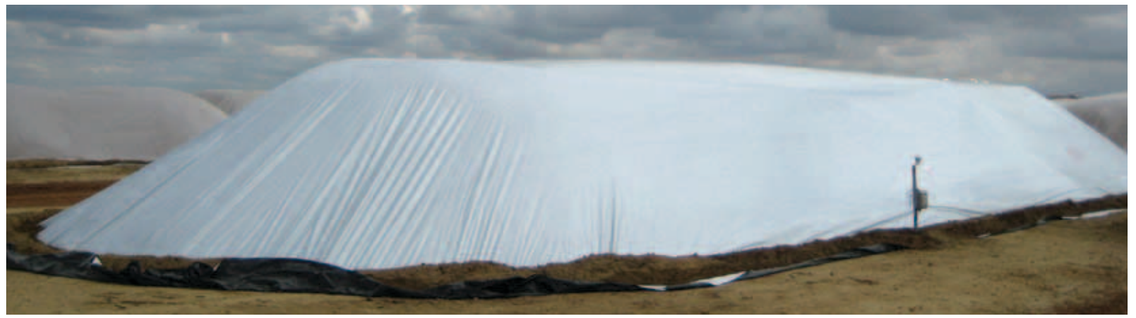
- If rain is forecast, don't shake. After a rain, wet nuts dry faster on the tree than on the wet orchard floor.
- If rain is forecast and the nuts are harvested but still too wet to pick up, blow them away from the tree trunks, but don't windrow.
- Condition (Drop-chute) windrowed nuts after a rain. Removing leaves and other trash helps nuts dry faster. Conditioning the crop before and after rains produces the most rapid drying, with the greater benefit seen with conditioning after rain.
- More information and guidelines are available on the Almond Board website. See "Coping with Rain at Harvest."

If the total fruit (in-hull almond) moisture is more than 9 percent, the relative humidity (rH) may exceed 65 percent in the pile, which is the maximum recommended rH for almond storage.

If moisture is too high for stockpiling, the crop can be taken to a dry area, where nuts may be turned and spread, or, machine drying may be necessary. See "Coping with Rain at Harvest" on the Almond Board website.

The orientation (direction) and shape of the stockpile can also play an important role in minimizing the risk of *Aspergillus* mold growth, black molds on hulls, and the appearance of concealed damage in kernels. To reduce chances of mold growth in the stockpile:

- Place stockpiles on a firm surface, preferably one that is slightly raised to allow moisture to run off rather than puddle around the edges.
- Orient the long axis of piles from north to south as much as possible. Condensation and mold growth tend to be worse on the north side of piles, where the long axis is oriented from east to west.
- Smooth the tops of the piles to help minimize the concentration of moisture from condensation that would occur in any low spots.
- Use a white-on-black tarp which is best at minimizing temperature fluctuations that lead to condensation and mold growth. Clear tarps allow the greatest temperature fluctuations, but are fine for dry, in-hull product, which is well below the moisture threshold. White is intermediate between clear and white-on-black in terms of temperature fluctuations.



Manage stockpiles during storage to maintain even moisture. If piles are stacked too wet, open up the tarps in the daytime when the relative humidity is lower, and close them at night when the relative humidity is high.

Monitor rH during the storage period, paying particular attention to the outside of piles, where there can be significant temperature fluctuations, condensation on tarps and moisture accumulation. Relative humidity can be correlated to moisture content of product by using the chart in the article "Stockpile Management to Prevent Aflatoxin and Concealed Damage," which can be found on the Almond Board website.