UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

OFFICE OF CHEMICAL SAFETY AND POLLUTION PREVENTION

JAN 07 2011

MEMORANDUM

SUBJECT: Assessment of Impacts of a Stay of Food Tolerances for Sulfuryl Fluoride on Selected Post-Harvest Commodities

FROM: Colwell Cook, Entomologist
Biological Analysis Branch

Michelle Ranville, Economist
Economic Analysis Branch
Biological and Economic Analysis Division (7503P)

THRU: Arnet Jones, Chief
Biological Analysis Branch

Timothy Kiely, Chief
Economic Analysis Branch
Biological and Economic Analysis Division (7503P)

TO: Meredith Laws, Chief
Insecticide and Rodenticide Branch
Registration Division (7505P)

Product Review Panel: August 31, 2010

SUMMARY

The Fluoride Action Network, Environmental Working Group, and Beyond Pesticides have filed objections to the tolerances established for sulfuryl fluoride and sought a "stay" of these tolerances as well. Sulfuryl fluoride is a fumigant that was first registered for food uses in 2004, to replace methyl bromide, which was being phased out under the Montreal Protocol on Ozone Depleting Substances. Sulfuryl fluoride was initially registered for use on cereal grains, tree nuts and dried fruits; the commodity list was expanded the following year.

This document assesses the impact of a "stay of tolerance," or cancellation, of sulfuryl fluoride on post-harvest commodities in the United States. Two specific examples, in-shell walnuts and

cocoa beans, will be used to illustrate these impacts. The use of sulfuryl fluoride on in-shell walnuts is an important use and representative, albeit not exactly the same, as use on other tree nuts and dried fruit. Therefore, BEAD expects the impacts to dried fruit to be similar to the impacts on in-shell walnuts. Cocoa beans were chosen as another example because the use is unique; switching to alternatives will be logistically different because of how and where the cocoa beans are fumigated.

BEAD predicts that post-harvest walnut operations will likely switch to phosphine used in chambers. Cocoa bean operations, specifically storage warehouses where fumigation takes place, will also likely switch to phosphine but will also have to erect new structures away from the port warehouses where they currently operate. This is because phosphine fumigation will take as much as five times longer than sulfuryl fluoride fumigation and, therefore, will not fit into the weekend window when the port is closed. Transition to alternatives, in both cases, could take several years.

If there is an immediate revocation of sulfuryl fluoride tolerances (i.e., no transition time), it is possible that adulterated food could enter into the supply chain. Adulterated food products could pose a risk to human health and would have to be destroyed to comply with FDA regulations. This could cause a disruption in the supply chain and may ultimately result in higher prices for consumers.

BACKGROUND

Sulfuryl fluoride was first registered as a termiticide in 1959 under the trade name Vikane®. The first food uses were registered under the trade name Profume® by Dow Agro Sciences in January 2004. Tolerances for sulfuryl fluoride and fluoride (a metabolite of sulfuryl fluoride) were established for cereal grains, tree nuts and dried fruit. The commodities list on the Profume® label was expanded in 2005 to include additional commodities, such as dried legumes, cocoa beans, and coffee beans. Since stored product pests infest not only the foodstuff but also the associated structures, the label also includes structural fumigations of food handling and processing facilities.

Sulfuryl fluoride as Profume® was developed for food uses to replace the fumigant methyl bromide. Methyl bromide, an ozone depleting substance, is banned under the Clean Air Act (CAA) and under the Montreal Protocol in developed nations by 2005, except for special exemptions. The U.S. has been under intense international pressure to reduce and eliminate methyl bromide uses. Of the 17 developed countries that requested CUEs for 2005, only four countries are still requesting exemptions, of which the U.S. is one. In addition, between the 2005 and 2009 CUEs, the U.S. post-harvest CUEs have been reduced by approximately 50 percent by the parties. In the same time period, the methyl bromide stockpile has been reduced by approximately 75 percent. The criteria for a critical use exemption are demanding and not easily met. It is improbable that the parties to the Montreal Protocol will approve any additional production of methyl bromide for 2013. It is also unlikely that there will be enough methyl bromide stockpile, pre-2005 inventories, to cover the needs of the post-harvest industry. Because of these restrictions, methyl bromide will not be considered as an alternative to sulfuryl fluoride in this assessment.

SELECTION OF REPRESENTATIVE COMMODITIES TO ESTIMATE IMPACTS

Two representative commodities, in-shell walnuts and cocoa beans, were selected to estimate the impacts of a stay in sulfuryl fluoride tolerances on post-harvest commodity operations. In-shell walnuts were chosen to represent the impacts because the pests and fumigation practices are similar for all tree nuts and dried fruit. Data available from public databases indicate that about 2.2 percent of in-shell walnuts were treated with sulfuryl fluoride over the three year period from 2006-2008, which is greater than most other tree nuts and dried fruit (CA DPR, 2006-2008; USDA, 2008b and 2010). However, the industries reported to the Methyl Bromide Technical Options Committee (MBTOC) that 90 percent of in-shell walnuts and 90 percent of dried fruit, having transitioned away from methyl bromide, were treated with sulfuryl fluoride in 2009 and the same is expected for 2010 (Meeting between MBTOC and U.S. Dept of State, September 25, 2010)

Cocoa beans were chosen as a second example because the circumstances of when and where fumigation occurs (warehouses at ports) and the fact that 100 percent of cocoa beans are fumigated with sulfuryl fluoride make the potential market disruption much greater than in other commodities.

CONTROL OF POST-HARVEST PESTS IN COMMODITIES

Stored Product Pests

Any food that is stored, processed, or packaged is subject to attack by insects, called stored-product or post-harvest pests. The majority of these insects are beetles and/or moths. They not only feed on the stored product (cereal grains, nuts, fruits, meats, etc.) but also infest the structures in which commodities are processed and housed. Many of these insects occur world wide and will consume a variety of stored products (Highland, 1991).

Walnut fumigations at harvest primarily target codling moth (*Cydia pomonella*) and navel orangeworm (*Amyelois transitella*). Fumigations during storage typically target Indianmeal moth (*Plodia interpunctella*) and sometimes the red flour beetle (*Tribolium castaneum*). The codling moth and the navel orangeworm are pests that attack the nuts in the field and then are consequently brought into facilities when walnuts are harvested. Codling moth larvae are internal feeders and are diapausing within the shell of the walnuts. Navel orangeworm larvae also feed on the nutmeat inside the hull. Most of the control efforts for these two pests are in the field, but countries to which the U.S. exports will not accept commodities containing these insects. Countries, including the U.S., will reject or destroy imported commodities that are infested with insects. To ensure that exported walnuts are pest free, walnuts are fumigated upon harvest and again before they are packaged and shipped.

While there are a variety of pests in cocoa beans the primary post-harvest pests are moths. Indianmeal moth, *Plodia interpunctella* (Hubner), and an *Ephestia* species, usually either *E. elutella* (Hubner), the tobacco moth, or *E. cautella* (Walker), the almond moth, are major pests of cocoa beans (Mabbett, 2002). Indianmeal moths occur worldwide on a variety of commodities as well as in food processing facilities and warehouses. The *Ephestia* moths also occur worldwide on a variety of commodities. These moths are often referred to as pantry pests when

they have been introduced into homes. They are in the same family, Pyralidae, have similar habits, and would respond to the same control tactics; therefore, they will be considered together in this assessment.

Larvae of these moths feed externally on broken pieces and fines (debris) of commodities, including cocoa beans (Mason, 2009). These larvae spin silken webs which contain excreta and exuviae. These webs occur on top as well as inside of the food surface. The moth larvae then feed within the web. This webbing also gives an unpleasant odor to infested commodity (Mohandass et al., 2007). The larvae may have 5-7 instars (Mason, 2009). The last larval instar will leave the food to pupate. A complete life cycle of these moths ranges from 23 to 46 days and depends upon temperature, humidity, and food source (Mohandass et al., 2007).

FDA Regulations

The Federal Food, Drug and Cosmetic Act (FFDCA) provides the Food and Drug Administration (FDA) with the authority to safeguard the U.S. food supply. Under its authority, FDA protects the U.S. food supply by establishing maximum levels of defects, or contaminants, in foods and determines when food is considered adulterated. Contaminants include insect body parts, exuviae, and excretia. Some stored product insects have barbed "hairs" on their bodies and exuviae that are a choking hazard for young children, the elderly, and small pets. In addition, a portion of the population may have allergic reactions to some insects and their body parts. The FDA has set different levels of defects for each commodity; for instance, there is a zero tolerance for live insects in cocoa beans. Nuts are allowed to have a small number of live insects present in storage but not after processing. According to FDA regulations, adulterated products cannot be sold in the U.S. and would likely be destroyed. (Links for FDA are listed in Appendix A).

Primary Post-harvest Fumigants

Historically, methyl bromide was used by the post-harvest community to rapidly kill many insect pests. It is not corrosive to metals so it could be used in many places with electronics and electrical equipment, as well as in warehouses and under tarps. Since methyl bromide is banned under the Montreal Protocol, many of its uses have been replaced with sulfuryl fluoride.

Sulfuryl fluoride can kill insects rapidly and has replaced methyl bromide in many instances. Like methyl bromide, it is not corrosive to metals and can be used in areas that have electronics and electrical equipment. However, the egg stage of most insects is more tolerant than the other life stages requiring either higher concentration or more exposure time for control (Fields and White, 2002; Schneider et al., 2003).

Aluminum phosphide, or phosphine, is the dominant fumigant in the commodity market. It is efficacious, cost-effective, and easy to apply. However phosphine takes four to seven days to work, and at certain times, such as peak harvest, rapid fumigation time is critical. Phosphine is corrosive to silver, copper, and their alloys (label) and is therefore not used in areas with electronic or electrical equipment. If time is not an issue, producers will choose phosphine because it requires much less gas and is less expensive than sulfuryl fluoride.

Current Fumigation Practices

Commercial walnut production in the U.S. occurs almost exclusively in California. Walnuts are harvested from August through November (U.S. Dept of State, 2006). During the peak of the harvest, which lasts for about 30 days, in-shell walnuts are fumigated in eight hours, so three truckloads are fumigated per day per chamber (U.S. Dept of State, 2006). Historically, methyl bromide was the fumigant of choice because it could accommodate the rapid fumigation time needed by the industry to ensure that the harvest time was not impeded. Sulfuryl fluoride has replaced methyl bromide at this critical peak harvest period. Walnuts also have a peak market for holiday baking in the U.S. and Europe during the Christmas season. Phosphine is used to disinfest both shelled and in-shell walnuts during storage when time is not a critical factor.

Dried fruits, raisins, figs, dates, and dried plums are also produced in California. The fruits may be harvested and either dried during processing or may be dried in the field (i.e., raisins). The fruits are cleaned, processed, and placed in storage. Often these dried fruits will become reinfested with insects while in storage; the current practice is to disinfest the fruits with sulfuryl fluoride to kill the insects. Many of the storage facilities have fans to circulate air to prevent hot spots and to reduce moisture. The producers use sulfuryl fluoride to fumigate their stored dried fruit because it will not corrode their electric equipment. Phosphine is often used to disinfest these commodities but only in areas that do not have electric equipment.

Cocoa beans are not produced in the United States; they are imported primarily from Africa and South America. Upon arrival at a port, they are unloaded and placed in a warehouse at the port. Once in the warehouse, cocoa beans are covered with tarpaulin and fumigated with sulfuryl fluoride to meet FDA regulations. To avoid risk to port employees, fumigations typically occur over weekends when the ports and warehouses are closed down (Kip Walk, personal communication, July 2010). The warehouses that cocoa beans are stored in are not dedicated solely to cocoa beans. Even if it were possible to fumigate cocoa beans in a warehouse at the port, it would not be possible to avoid the need for employees to move other products in and out of the warehouse. Furthermore, the warehouses are rented, making it impossible to retrofit them in any way that would enable fumigation throughout the week.

As new cocoa beans arrive they may be stored adjacent to other stored cocoa beans in the warehouse, thus increasing the potential for stored cocoa beans to be re-infested with pests from newly arriving cocoa beans. Cocoa beans may be stored in the warehouses for weeks or months; during this time, the beans may be fumigated several times (Marcotte and Sansone, 2005; Kip Walk, personal communication, July 2010). Today 100 percent of the cocoa beans are fumigated with sulfuryl fluoride.

Alternatives to Sulfuryl Fluoride

Chemical Alternatives

Phosphine is the most widely used fumigant in the commodity market (Cook et al., 2009). It is also the most likely chemical alternative to sulfuryl fluoride. Phosphine is less expensive than sulfuryl fluoride, and less fumigant is needed to kill the same insects. However, phosphine can take longer depending on temperature; at 40°F, the fumigation cycle takes five days to be efficacious compared to two days for sulfuryl fluoride. Since major cocoa bean warehouses are

located in Philadelphia, PA and Camden, NJ, phosphine fumigation would not be able to be conducted in a weekend. In addition, phosphine is corrosive to copper, silver, and their alloys, so fumigators must be aware if these metals are present during fumigation (Phostoxin label). There are also reports of stored product pests being resistant to phosphine (Bauer, 1991; Champ and Highley, 1991).

Another potential chemical alternative is propylene oxide. Commodities and the chamber must be preheated to 95-125°F. Exposure time is 16-48 hours, although exposure time could possibly be reduced to 12 hours at 125°F under vacuum (Propoxide 892 label). However, a major impediment to its use in this market is the size restriction of no greater than a 10,000 cubic foot chamber (USEPA, 2008). According to industry experts, many of the commodity chambers are more than one million cubic feet (Gary Obenauf, personal communication, August 24, 2010). Because of these label restrictions, BEAD does not consider propylene oxide to currently be a viable alternative to sulfuryl fluoride.

Temperature Manipulation

Extreme temperatures are known to affect insect survival. Heat is known to kill insects (Dosland et al., 2006) but is also potentially damaging to various commodities. Heat treatments can be conducted by several different methods, including direct, micro-wave (also called non-ionizing radiation) and radio-frequency (Phillips, 2006). With little data specific to the commodities and pests of interest here, BEAD will not address direct or micro-wave treatments.

Experiments with one type of heat treatment, radio-frequency treatments, have been conducted in in-shell walnuts. The method was demonstrated to be effective for insect control and controlled the insect pests of in-shell walnuts in a short amount of time (Wang et al., 2007a and 2007b). Although these investigations were conducted on a commercial scale for organic walnut production, one of the researchers did not think that this method would be suitable for the non-organic walnuts because of the large scale of production (Judy Johnson, personal communications, Nov 2, 2010). Organic walnuts account for a small fraction (about 2%) of total walnut production.[1] Furthermore, data on start-up costs and efficacy on other commodities of interest (i.e. dried fruit, cocoa beans) are not available. While radio-frequency heat treatments may be a viable option for some commodities, BEAD does not consider this type of heat treatment to be viable at this time because only one study has examined its efficacy outside the laboratory, start-up costs were not available, and the method might be difficult to implement for all conventional in-shell walnuts.

Dosland et al. (2006) notes that low temperatures slow mobility, survivability, and reproduction in stored product pests. Low temperatures will suppress some populations and may actually kill others. In addition, cool temperatures often extend the shelf life of many commodities. Mason and Strait (1997) reviewed suboptimal temperature (i.e. above or below the optimal temperatures for insect pests survival and reproduction) techniques to control pests in grain storage; the authors report populations of Indianmeal moths are significantly reduced with cold treatments in grain, but that many factors, such as humidity, need to be considered.

---

[1] In 2007, there were approximately 5,070 acres of organic walnuts (CDFA, 2007) and 243,000 acres of conventional walnuts (USDA, 2008a) in California.

Mortality of Indianmeal moths has been reported with cold treatments. Johnson et al. (1997) reported 50 percent mortality of Indianmeal moth adults after 49 days and 90 percent mortality after 70 days at 10°C. In addition egg production and hatch were also affected, with 95 percent mortality of eggs at 12 days (Johnson et al., 1997). Disinfestation of product that contains non-diapausing insects may be possible if temperatures are 0-5°C and the product is kept at these low temperatures for three weeks (Johnson, 2007). Dropping the temperature below -15°C worked in less time, 48 hours, and this low temperature is required to control diapausing Indianmeal moth larvae (Johnson, 2007). Based on the scientific literature, low suboptimal temperatures may not be able to rapidly disinfest a commodity, but they are able to prevent insect population growth. Cold storage may be an option to prevent reinfestation, but it could not replace initial fumigation.

Irradiation

Another option for commodities may be irradiation. Marcotte (2006) reports this method is a valid treatment to disinfest many commodities. Gamma, x-ray, or electron beams are used to kill bacteria and food-borne pathogens (Morehouse and Komolprasert, 2004; Fields and White, 2002). While most of the research on ionizing radiation was conducted in the 1970s, the current focus is on sterilization of insect males (Vreysen and Robinson, 2010). Irradiation has the potential to control stored product pests, reduce pathogens, and prolong the shelf-life of fruits and vegetables (Arvanitoyannis et al., 2009). However, Phillips (2006) concludes that ionizing radiation, while highly effective, has high start-up costs and negative public perception in the U.S. Though irradiation is possible, it is not likely to be adopted by the industry in light of other alternatives.

Modified Atmosphere

The term 'modified atmosphere' refers to altering the composition of atmospheric gases to control storage insect pests. The goal is to reduce oxygen to levels that kill or prevent development of stored product pests. Navarro (2006) reports that 95 percent of almond moth eggs are killed in 1.5 days at one percent oxygen; it takes 6.5 days to kill red flour beetle larvae in laboratory studies. The critical component is to have an air-tight structure in which to modify the gases. However, Navarro (2006) reports that modified atmosphere in dried fruits and tree nuts is slow and costly because current equipment does not allow for this technique. If such structures are available, then there is a possibility to combine this technique with reducing pressure (i.e., vacuum sealing).

When cocoa beans are vacuum sealed (i.e., hermetically sealed), they will modify their own atmosphere (C&CI, 2008). For example, Navarro et al. (2007) determined that cocoa beans in a closed jar respired to increase carbon dioxide to 23 percent and dropped oxygen concentration to 1 percent in six days at 26°C. Low pressures can also control insect pests in stored commodities. Eggs of Indianmeal moths in cocoa beans were killed (99 percent mortality) at 50±5 mmHg in 49 hours, whereas phosphine required 5 days (Finkelman et al., 2004). Structures would need to be airtight to modify atmosphere and/or draw a vacuum; this is rarely the case with storage facilities in the United States. The modifications needed to make storage facilities airtight would make it unlikely that modified atmosphere techniques would be selected over other alternatives.

Surface Pesticides

Surface applications of pesticides may also be able to help control some internal feeders. Vick et al. (1985) found methoprene applied to shells of peanuts disrupted the metamorphosis of the almond moth (*Ephestia cautella*). Bullington and Pienkowski (1993) found dichlorvos did not control coleopteran pests infesting cocoa beans. Malathion dust applied at low doses to stored wheat degraded after two weeks and did not control almond moth larvae; at high doses, it controlled both Indianmeal moths and almond moths (Madrid et al., 1983). Although these surface applied pesticides can control stored product pests, they are not able to disinfest a commodity, so they are not a viable alternative to sulfuryl fluoride..

LIKELY ALTERNATIVE SCENARIOS

If food tolerances for sulfuryl fluoride on commodities were "stayed" (i.e., cancelled), BEAD predicts that the most likely alternative scenario for commodity disinfestation would be phosphine fumigation in chambers (in-shell walnuts) or warehouses (cocoa beans). Phosphine is more likely to be chosen as an alternative than propylene oxide because of the chamber size restriction for propylene oxide. Currently, there is not sufficient evidence to suggest that heat treatment would be a viable option for disinfestation of commodities. Cold treatments can suppress or kill insect populations but can take weeks to be effective. Considering FDA requirements, disinfestation needs to be faster so that commodities can be sold. However, cold storage could be an option to prevent reinfestations of stored product insects. Although irradiation could be effective, it is unlikely that firms will choose this option due to negative U.S. public perceptions about radiation. The lack of airtight structures makes modified atmosphere and reduced pressure infeasible at this time.

Because phosphine fumigation takes more time than sulfuryl fluoride fumigation, a transition to phosphine from sulfuryl fluoride would require building more warehouses or building or purchasing more chambers to accommodate the throughput of commodity. The fumigation time is important for post-harvest walnut operations because of the short peak harvest season where commodity must be fumigated quickly to avoid backlog. It is important for cocoa beans because of the short weekend window in which fumigation can take place at the port warehouses. These options were chosen as the alternative scenarios because BEAD deemed them to be more likely than the other options as discussed above.

ECONOMIC IMPACT OF A STAY OF TOLERANCES ON POST-HARVEST COMMODITY OPERATIONS

This section discusses the economic impact of a stay in sulfuryl fluoride tolerances on post-harvest walnut and cocoa bean operations. First, the values of each crop are discussed. Second, the impact on total industry revenues is calculated by comparing the additional cost of the most likely alternative discussed in the previous section (phosphine chambers).

Estimation of Economic Impact on Post-Harvest Walnut Operations

Walnut Production and Value in the United States

On average, approximately, 380,000 tons of walnuts (in-shell basis) are produced each year (See Table 1); nearly 100 percent of walnut production occurs in California (CWC, 2010). At an average price of $1,692 per ton, the average annual value of walnut production is almost $634 million dollars. The value of in-shell walnuts is, however, more pertinent to this analysis since this is the market which may be fumigated with sulfuryl fluoride. The reason that in-shell walnuts may be fumigated with sulfuryl fluoride is that a faster fumigation time is needed to disinfest and ship all of them during the peak holiday season.

Table 1. Walnut Production and Value, in-shell basis, 2005-2009

Year	Tons produced	Tons Sold In-Shell	Price Per Ton	Total Production Value ($000s)	Total Production Value of In-shell ($000s)
2005	355,000	82,000	$ 1,570	$ 557,350	$ 128,740
2006	346,000	71,000	$ 1,630	$ 563,980	$ 115,730
2007	328,000	66,000	$ 2,290	$ 751,120	$ 151,140
2008	436,000	95,000	$ 1,280	$ 558,080	$121, 600
2009	437,000	117,000	$ 1,690	$ 738,530	$ 197,730
5-year avg	**380,400**	**86,200**	**$ 1,692**	**$ 633,812**	**$142,988**

Source: USDA NASS, 2008b and 2010

Estimation of Economic Impact

Table 2 displays the cost analysis including data sources of switching in-shell walnuts that are currently treated with sulfuryl fluoride to phosphine. The logic of the analysis and the results are explained in this section.

If walnut producers can no longer use sulfuryl fluoride to hasten the fumigation process for commodities during peak season, they will need to accommodate the larger volume by building additional phosphine fumigation chambers. Since post-harvest commodity operations are often intertwined with the orchard and harvest operation itself, BEAD was not able to find an operation budget specifically for handling and storing any commodities such as in-shell walnuts or one of the dried fruits. Therefore, impacts are simply expressed in terms of a change in cost per ton.

The number of additional phosphine chambers needed depends on the length of the harvest season, the capacity per fumigation chamber, and the number of days per phosphine fumigation. As mentioned in the previous section, most commodities are currently treated with phosphine. The reason that some portion of in-shell walnuts is treated with sulfuryl fluoride is that a more rapid fumigation time is necessary. The harvest time for walnuts is approximately 75 days long in total, but the need for more rapid fumigation time is due to peak harvest when there is a need to disinfest and ship all in-shell walnuts during the holiday season (U.S. Dept of State, 2006).

With sulfuryl fluoride, a fumigation chamber may be used three times per day (i.e., three truckloads per day); each fumigation cycle takes eight hours (U.S. Dept of State, 2006). The size of a typical dry freight van (the type that may be used for fumigation) is approximately 53' long by 8.5' wide and 9' tall on the inside, or 4,055 cubic feet. If used three times per day (8 hours for each fumigation), each chamber accommodates 12,164 cubic feet of product per day. With phosphine, each chamber is used once every five days because of the longer time needed for the fumigation cycle. Therefore, over a period of five days, each fumigation chamber accommodates 60,818 cubic feet when sulfuryl fluoride is used and 4,055 cubic feet when phosphine is used. Hence, if the current level of throughput is to be maintained, 15 phosphine fumigation chambers will be needed for every one sulfuryl fluoride fumigation chamber.

To increase the number of chambers by 15 fold may require additional Hazardous Air Pollution (HAP) permits to comply with the Clean Air Act (See Appendix B for more details) and may require the purchase of additional land and building permits. The cost of additional land is not included in this analysis because it will not be necessary in all cases and the costs could be highly variable by location.

According to data collected by California's Department of Pesticide Regulation (Cal DPR), approximately 410,000 cubic feet (4,600 tons) of walnuts were treated with sulfuryl fluoride, on average, over the years 2006-2008.[2] However, based on more recent information from industry, around 90 percent of in-shell walnuts are now treated with sulfuryl fluoride, or about 78,000 tons per year (90% of average annual production from Table 1). To avoid underestimation of industry impacts, this is the estimate that will be used in the analysis to find the total impact to industry. Converting the estimate of 78,000 tons of walnuts treated with sulfuryl fluoride to pounds is approximately 155 million pounds. Pounds of in-shell walnuts can be converted to cubic feet using a conversion factor of 22.5 lbs per cubic foot (IT-HULLS, no date), giving about 6.9 million cubic feet treated each year.

Cubic feet of treated commodity is increased by 25 percent to estimate the cubic feet of space needed to fumigate this amount of commodity. In total, 8.6 million cubic feet of space are needed to fumigate 78,000 tons of in-shell walnuts over 30 days.

If a fumigation chamber is 4,055 cubic feet and all fumigation needs to be completed within a 30-day window for the holiday season, about 24 chambers are needed to accommodate the nearly 78,000 tons of throughput of in-shell walnuts that is currently treated with sulfuryl fluoride. To accommodate the same throughput in 30 days with phosphine requires about 355 chambers, 15 times as many. At a cost of $5,000 per chamber, the cost of switching in-shell walnuts treated with sulfuryl fluoride to phosphine is about $1.655 million. Averaged over the total tons treated, this amounts to an increase in production costs of about $21.00 per ton for a single year during

[2] This estimate is based on 820 pounds of sulfuryl fluoride applied to walnuts (Cal DPR, 2006-2008) multiplied by a conversion factor based on pounds of sulfuryl fluoride needed to treat every thousand cubic feet of commodity. Under average temperature conditions, sulfuryl fluoride is typically applied at a rate of approximately two pounds per thousand cubic feet of commodity (2 lbs/1,000 ft^3). At this rate, the 820 pounds applied treated 410,000 cubic feet of commodity. The cubic feet to pounds conversion for walnuts is about 22.5 pounds per cubic foot (IT-HULLS, no date), so 410,000 cubic feet is approximately 9.223 million lbs or 4,600 tons of walnuts treated with sulfuryl fluoride annually, on average, from 2006-2008.

which the additional chambers are built or purchased. The increase in production costs to purchase additional chamber does not recur every year. At a price of $1,692 per ton (Table 1), the increase in production costs amounts to a little more than one percent of the price per ton for one year.

The cost analysis makes the most conservative possible estimate by assuming that all fumigations would still be conducted inside chambers. However, it is possible that fumigation could be conducted under tarps and that the additional number of chambers needed could be reduced.

Table 2. Transition Costs for In-Shell Walnuts to Phosphine Chambers

Item Description	Value
Commodity Pounds Treated with SF per Year (lbs) [1]	**155,160,000**
Commodity Tons Treated with SF per Year (tons)	**77,580**
Commodity Cubic Feet to be Transitioned (cubic feet) [3]	**6,896,000**
Space Needed to Treat Transitioned Commodity (cubic feet) [4]	**8,620,000**
Size of Phosphine Chamber (cubic ft) [5]	**4,055**
Total Capacity of a Chamber Using SF over 30-day window (cubic feet) [6]	**364,950**
Chambers Needed to Accommodate SF-Treated In-shell walnuts in 30 days [7]	**24**
Chambers Needed to Accommodate Throughput with Phosphine [8]	**355**
Price per Chamber [9]	**$ 5,000**
Total Cost of Additional Fumigation Chambers [10]	**$ 1,655,000**
Additional Cost per ton of in-shell walnuts treated [11]	**$ 21.33**

[1] Calculated as [77,580 * 2,000] to convert tons treated to lbs treated
[2] Calculated as [86,200 * 0.9] to get 90 percent of average annual in-shell walnut production from Table 1
[3] Calculated as [155,160,000 / 22.5] to convert lbs of treated in-shell walnuts to cubic feet of treated walnuts
[4] Volume of the commodity treated (6,896,000 cu ft) increased by 25% to allow for extra air space in the fumigation chamber or facility. Source of conversion factor: U.S. Dept of State, 2006; Gary Obenauf, personal communication, August 24, 2010
[5] Source: Penske, Available at http://www.pensketruckrental.com/commercial-truck-rentals/trailer-truck/48-ft.html, Accessed September 2, 2010.
[6] Calculated by multiplying size of a chamber (4,055 cu ft) by harvest period in days (30 days) by the number of times a chamber is used each day (3 times per day).
[7] Calculated by dividing the volume of commodity to be treated (8,620,000 cu ft) by the total capacity of an SF chamber over a 30-day period (364,950 cu ft). The result (23.62) is rounded up to 24 full chambers.
[8] Calculated as chambers needed to treat volume with SF (23.62) multiplied by 15 because each chamber takes 5 days to use with phosphine compared to 1/3 of a day with sulfuryl fluoride. The result (354.295) is rounded up to 355 full chambers.
[9] Source: American Trailer Exchange, See Dry Van Trailers at http://www.amtrex.net/AMTREXsalesinventory.htm, Accessed September 2, 2010.
[10] The cost of 331 additional chambers at $5,000 each.
[11] Total cost ($1,655,000) divided by tons of commodity treated.

Transition Time for In-shell walnuts

Phosphine is considered a hazardous air pollutant; a permit is needed if more than 10 tons are to be used annually. The Hazardous Air Pollutant (HAP) permit needed to release the fumigants is issued annually, but the first one takes anywhere from three months to three years to obtain. Whether a permit will be needed to release the additional phosphine gas and the length of time needed to obtain the permit are two points of uncertainty in the transition time. (See Appendix B for details) If additional land is needed to hold the extra fumigation chambers, it will take time to find and purchase another suitable fumigation site. Fumigation chambers will also need to be rented, purchased, or built. If chambers are built, they will need to obtain building permits.

Depending on the circumstances, securing the extra chambers and any necessary permits could take several years. However, given the high degree of uncertainty, BEAD cannot make a precise prediction as to the number of years needed to make the transition from sulfuryl fluoride to phosphine.

Estimation of Economic Impact on Cocoa Bean Operations

Quantity and Value of Cocoa Bean Imports to the U.S.

Approximately 150 companies in the United States produce more than $4 billion of chocolate confectionary from cocoa beans annually (U.S. Census, 2007). However, the U.S. does not produce cocoa beans domestically; the entire supply is imported. On average, over the past five years, about 441,000 metric tons valued at $861 million are imported annually (See Table 3). More than half of the supply comes from Cote d'Ivoire and about 20 percent comes from Indonesia.

Table 3. U.S. Imports of Cocoa Beans, metric tons and value in $000s, 2005-2009

	Units	2005	2006	2007	2008	2009	05-09 avg
Cote d'Ivoire	MT	334,674	239,497	194,379	219,746	180,197	233,699
	$000s	**$ 384,581**	**$ 360,096**	**$ 534,006**	**$ 499,385**	**$ 206,034**	**$ 461,536**
Indonesia	MT	131,203	139,008	68,701	42,756	104,064	97,147
	$000s	**$ 181,677**	**$ 108,287**	**$ 106,167**	**$ 245,175**	**$ 127,167**	**$ 163,930**
Ecuador	MT	31,565	19,353	25,940	36,746	62,037	35,128
	$000s	**$ 31,793**	**$ 60,639**	**$ 95,212**	**$ 172,484**	**$ 19,975**	**$ 81,331**
Domin. Repub.	MT	14,897	22,016	16,789	10,592	38,252	20,509
	$000s	**$ 32,781**	**$ 31,909**	**$ 28,618**	**$ 99,547**	**$ 25,317**	**$ 42,928**
Ghana	MT	14,138	38,084	17,551	5,258	20,008	19,008
	$000s	**$ 57,655**	**$ 37,967**	**$ 10,033**	**$ 55,204**	**$ 39,652**	**$ 36,082**
Nigeria	MT	31,357	1,109	3,059	12,353	15,402	12,656
	$000s	**$ 1,773**	**$6,960**	**$ 34,326**	**$ 42,507**	**$ 1,034**	**$ 30,037**
Papua New Guinea	MT	11,301	9,996	20,281	17,118	13,545	14,448
	$000s	**$ 15,679**	**$ 36,948**	**$ 42,192**	**$ 38,636**	**$ 12,267**	**$ 26,852**
Rest of World	MT	7,031	4,584	8,434	11,182	8,869	8,020
	$000s	**$8,062**	**$17,399**	**$27,781**	**$25,585**	**$3,758**	**$ 16,517**
Total	MT	576,167	473,645	355,135	355,751	442,375	440,614
	$000s	**$ 872,154**	**$ 714,002**	**$ 660,206**	**$ 878,337**	**$ 1,178,525**	**$ 860,645**

Source: U.S. Census Bureau, Foreign Trade Statistics

Estimation of Economic Impact

Table 4 displays the cost analysis including data sources of switching cocoa beans that are currently treated with sulfuryl fluoride in port warehouses to treatment with phosphine in off-site warehouses. The logic of the analysis and the results are explained in this section. The analysis estimates the cost of building additional off-site fumigation warehouses (i.e., chambers) for cocoa beans that are currently treated with sulfuryl fluoride. The cost of land and any necessary fumigation permits are not included in this analysis.

It is assumed that all imported cocoa beans, approximately 441,000 metric tons (1.89 billion lbs) of cocoa beans, are fumigated with sulfuryl fluoride. Cocoa beans have completely transitioned from methyl bromide to sulfuryl fluoride as their primary fumigant. Past applications for methyl bromide critical use exemptions (CUEs) were for 100 percent of the imported commodity. EPA no longer receives applications for methyl bromide CUEs from the cocoa bean community. It is assumed that 100 percent are now fumigated with sulfuryl fluoride. These estimates are converted to cubic feet to estimate the cost of additional fumigation warehouses that would be necessary to accommodate these products throughout the season.

For cocoa beans, fumigation occurs all year round because importation of cocoa beans occurs year round. As mentioned earlier, phosphine fumigation takes longer than sulfuryl fluoride fumigation making it infeasible to conduct phosphine fumigations at the port warehouses over the weekend when workers are not present. To continue fumigating to meet FDA regulations, additional cocoa bean warehouses will need to be constructed off-site to accommodate the longer fumigation time. These sites would likely be located somewhere near the major ports in Philadelphia, PA and Camden, NJ. In the case of cocoa beans, fumigation is generally conducted in large warehouses under tarps. A 60,000 cubic foot fumigation chamber could cost from $100,000 to $175,000 to construct, not including the additional cost of land (Neven, 2004).

The cost analysis assumes that fumigation/storage warehouses cost $2.29 per cubic foot to build. However, the fumigation scenario for cocoa beans is different from in-shell walnuts in that the cocoa beans may be stored in the same warehouse in which they are fumigated for a long period of time. The average length of time for cocoa beans to remain in a warehouse is unknown. Industry contacts indicated that cocoa beans may be stored for weeks or months before being transported. BEAD considers three possible scenarios: cocoa beans are stored for an average of 7 days, 30 days, or 60 days. Assuming that cocoa beans will need to be stored for 30 days, on average, the 32.38 million cubic feet of cocoa beans that need to be fumigated will require an additional 2.7 million cubic feet of space. The additional space is estimated to cost the industry a total of $6.18 million or about $14.00 per metric ton. The costs per metric ton for the 7-day and 60-day scenario are $3.00 and $28.00, respectively. Like the in-shell walnuts scenario, the cost of building additional warehouse space for fumigation is not incurred every year; it is a one-time investment. At a price of about $2,000 per metric ton (calculated from average quantity and value from Table 3), the increase in production costs amounts to less than one percent of the value.

Table 4. Transition Costs for Cocoa Beans: Fumigation Warehouses

Item Description	Value
Commodity metric tons treated with SF per year (MT) [1]	440,615
Commodity pounds treated with SF per year (lbs) [2]	971,388,914
Commodity cubic feet to be transitioned (cubic feet) [3]	25,903,704
Space Needed to Treat Transitioned Commodity (cubic feet) [4]	32,379,630
Cost per cubic foot of fumigation/storage space [5]	$ 2.29
Cubic feet of space needed to hold all SF-treated cocoa beans for 7 days [6]	622,685
Total cost of additional space if beans are stored for 7 days [7]	$ 1,426,987
Costs per metric ton of additional space if beans are stored for 7 days [8]	$ 3.24
Cubic feet of space needed to hold all SF-treated cocoa beans for 30 days	2,698,303
Total cost of additional space if beans are stored for 30 days	$ 6,183,610
Costs per metric ton of additional space if beans are stored for 60 days	$ 14.03
Cubic feet of space needed to hold all SF-treated cocoa beans for 60 days	5,396,605
Total cost of additional space if beans are stored for 60 days	$ 12,367,220
Costs per metric ton of additional space if beans are stored for 60 days	$ 28.07

[1] Average of 2005-2009 values; Source: US Census Bureau, Foreign Trade Statistics, See Table 3.
[2] Calculated as [440,615 x 2,204.62] to convert metric tons to lbs.
[3] The pounds per cubic foot (lbs/ft^3) conversion factor for cocoa beans is between 30 and 45 lbs, depending on whether the beans are loose or packed. The average of 37.5 is used to convert lbs to cubic feet. See http://www.lossinweightfeeder.com/standards/documents/1500-C01-2.pdf. Accessed Sept 2, 2010.
[4] Volume of the commodity treated (409,929 cu ft) increased by 25% to allow for extra air space in the fumigation chamber or facility.
[5] This estimate assumes an average cost of $137,500 to build a 60,000 cubic foot warehouse (Neven, 2004: 309).
[6] Calculated as [32,379,630 / 52] to convert cubic feet of space needed to treat by number of time periods per year that space is needed.
[7] Calculated as [622,685 x $2.29] to find total cost of additional pace needed.
[8] Calculated as [$1,426,987 / 440,615] to find average cost per metric ton of additional space needed.

Transition Time for Cocoa Beans

As with transition time for in-shell walnuts, HAP permits may need to be obtained for cocoa beans. However, in the case of cocoa beans, additional time for locating a suitable fumigation site and building a fumigation warehouse is a certainty. The time to locate a site and construct a warehouse could take two to four years depending on market availability. It is also possible that chocolate manufacturers will take up the responsibility of fumigation, but the change in the market infrastructure is not fully understood at this point. In total, the transition could take several years.

It is important to note that transition to off-site phosphine fumigations for cocoa beans is dependent on the availability of space and funding to build the warehouses.

CRITICAL ASSUMPTIONS

This analysis makes some assumptions which are critical to its findings. First, it is assumed that in-shell walnut producers will not need to purchase additional land to accommodate additional fumigation chambers. It is possible that the space they currently have would not be sufficient to accommodate a large number of additional chambers. If more land were needed, it assumes that there will be sufficient time for commodities to transition to alternatives. In the event that there is an immediate removal of tolerances, the impacts to the commodities market would be different than what has been described here. Even though in-shell walnuts currently have a methyl bromide critical use exemption through 2011, the industry has mostly converted to sulfuryl fluoride due to a lack of availability of methyl bromide. Without a rapid fumigant or additional phosphine fumigation chambers, there will be a backlog of in-shell walnuts during harvest. This backlog could result in a delay of shipments during the holiday season, and some walnuts may never be harvested causing a loss of revenue to the growers and an increase in the price of walnuts to the end consumer.

The impacts to other commodities treated with sulfuryl fluoride, other than cocoa beans, would be similar to those described for in-shell walnuts.

In the case of cocoa beans, the consequences of an immediate revocation of tolerances would also be severe. There is no critical use exemption for methyl bromide use in cocoa beans because the industry made a complete transition to sulfuryl fluoride. It would not be possible to transfer responsibility for pest control to the country of origin because the cocoa beans would become reinfested during transit. In addition, they could not be treated with sulfuryl fluoride outside of the country because the U.S. would no longer have an import tolerance. This would lead to either destruction or refusal of shipments by warehouse operators to comply with FDA regulations.

This would cause an interruption in supply of cocoa beans to chocolate manufacturers. Some jobs (e.g., truck drivers, manufacturing workers) are completely dependent on the receiving, shipping, and processing of cocoa beans for the chocolate industry. The termination of cocoa bean imports could lead to job loss in the industry and a disruption in the supply of chocolate resulting in higher prices for the end consumer.

CONCLUSIONS

Sulfuryl fluoride is the primary chemical replacement for methyl bromide, which is banned under the Montreal Protocol. If the food tolerances for sulfuryl fluoride are revoked, industries that currently use sulfuryl fluoride will be affected. BEAD examined the effects of cancellation on post-harvest walnut operations and cocoa bean warehouse operations and predicts that these commodities will likely switch to phosphine. Because phosphine takes four to five times longer depending on temperature, additional phosphine chambers will be needed for in-shell walnuts and off-site phosphine fumigation warehouses will be needed for cocoa beans. BEAD estimates that the cost to construct chambers for in-shell walnuts will increase production costs by approximately $22.00 per ton and that the transition could require several years to complete depending on whether air permits and additional land are needed. The cost to construct off-site

fumigation warehouses for cocoa beans will range from $3.00 to $28.00 per metric ton (not including the cost of land) depending on how long cocoa beans are stored on average; this transition could also take several years to complete depending on the need for air permits and the suitability of available land. In both cases, immediate cancellation of sulfuryl fluoride would create a severe disruption in the supply chain and would likely increase the costs for consumers.

REFERENCES

Arvanitoyannis, I. S., A. Ch. Stratakos, and P. Tsarouhas. 2009. Irradiation applications in vegetables and fruits: a review. Critical Reviews in Food Science and Nutrition 49:427-462.

Baur, F. J. 1991. Chemical methods to control insect pests of processed foods. In: J. R. Gorham, ed. Ecology and Management of Food-Industry Pests. Association of Official Analytical Chemists. Arlington, VA. Pp. 427-440.

Bullington, S. W. and R. L. Pienkowski. 1993. Dichlorvos and plastic covers affect insects infesting stored cocoa beans in dockside warehouses. J. Econ. Entomol. 86(4): 1151-1156.

California Department of Food and Agriculture (CDFA). 2007. Organic Sales Reports. Accessed Dec 1, 2010. Available at http://www.cdfa.ca.gov/is/i_&_c/organic.html

California Department of Pesticide Regulation (Cal DPR). 2006-2008. Pesticide Use Reports. Available at http://www.cdpr.ca.gov/docs/pur/purmain.htm

California Walnut Commission. 2010. http://www.walnuts.org/walnuts/index.cfm/industry-resources/ Accessed August 19, 2010

C&CI. 2008. Cocoon storage keeps cocoa in condition in the Tropics—Shipping. Pg 33-35. Available at http://www.grainpro.com/pdf/C&C-Intern-March08.pdf. Accessed June 24, 2010.

Cocoa Federation http://www.cocoafederation.com/education/produce.jsp. Accessed 7/6/2010.

Champ, B. R. and E. Highley. 1991. Pest resistance to pesticides. In: J. R. Gorham, ed. Ecology and Management of Food-Industry Pests, pp. 385-398. Arlington, VA: Association of Official Analytical Chemists.

Cook, C. A, J. Becker, E. Rim. 2009. Revised assessment of percent commodity treated values used in the registrant's dietary exposure assessment for fluoride (DP# 361041). Memorandum submitted to Health Effects Division. May 1, 2009.

Dosland, O., B. Subramanyam, K. Sheppard, and R. Mahroof. 2006. Temperature modification for insect control. In: Jerry Heaps, ed. Insect Management for Food Storage and Processing, 2nd ed. Am. Assoc. Cereal Chem. Pp 89-103.

Fields, P. and N. D. G. White. 2002. Alternatives to methyl bromide treatments for stored-product and quarantine insects. Annual Review of Entomology 47:331-59.

Finkelman, S., S. Navarro., M. Rindner, R. Dias, and A.Azrieli. 2004. Effect of low pressures on the survival of three cocoa pests at 30°C. Journal of Stored Products Research 40:499-506.

Highland, H. A. 1991. Protecting packages against insects. In: J. R. Gorham, ed. Ecology and Management of Food-Industry Pests. Association of Official Analytical Chemists. Arlington, VA. Pp. 345-350.

IT-HULLS. no date. Walnut Dryer Bin Kits. [online] Available at http://www.ithulls.com/walnutbin.html. Accessed September 12, 2010.

Johnson, J. A. 2007. Survival of Indianmeal moth and navel orangeworm (Lepidoptera: Pyralidae) at low temperatures. J. Econ. Entomol. 100(4):1482-1488.

Johnson, J. A., K. A. Valero, and M. M. Hannel. 1997. Effect of low temperature storage on survival and reproduction of Indianmeal moth (Lepidoptera: Pyralidae). Crop Protection 16(6): 519-523.

Mabbett, T. 2002. Storing up problems? Coffee and Cocoa International. [online]. Available at http://www.vicam.com/pdf/tp_cci_sept2002.pdf. Accessed June 24, 2010.

Madrid, F. J., N.D. G. White, and R. N. Sinha. 1983. Effects of malathion dust on indianmeal moth and almond moth (Lepidoptera: Phycitidae) infestation of stored wheat. J. Econ. Entomol. 76:1401-1404.

Marcotte, M. 2006. Irradiation. In: Jerry Heaps, ed. Insect Management for Food Storage and Processing, 2nd ed. Am. Assoc. Cereal Chem. Pp 147-152.

Marcotte, M. and J. Sansone. 2005. Disinfestation of Cocoa Beans in Warehouses in the United States. http://www.mbao.org/2005/05Proceedings/mbrpro05.html

Mason, L. J. 2009. Stored product pests: indianmeal moth. Purdue University Extension E-223_w. Found at: http://extension.entm.purdue.edu/eseries3/view.php?article=articles/indianmeal_moth.txt&id=1&section=Stored%20Product%20Pests. Accessed: July 27, 2010.

Mason, L. J. and C. A. Strait. 1997. Stored product integrated pest management with extreme temperatures. In: G. Hallman and D. Denlinger, eds. Lethal Temperatures in Integrated Pest Management. Westview Press, Denver. Pp. 139-175. Available at: http://cipm.ncsu.edu/IPMtext/chap6.pdf. Accessed: August 12, 2010.

Mohandass, S., F. H. Arthur, K. Y. Zhu, and J. E. Throne. 2007. Biology and management of Plodia interpunctella (Lepidoptera: Pyralidae) in stored products. Journal of Stored Products Research 43:302-311.

Morehouse, K. M. and V. Komolprasert. 2004. Irradiation of food and packaging: an overview. ACS Symposium series 875. Available online: http://www.fda.gov/Food/FoodIngredientsPackaging/IrradiatedFoodPackaging/ucm081050.htm. Accessed 8/18/2010.

Navarro, S. 2006. Modified atmospheres. In: Jerry Heaps, ed. Insect Management for Food Storage and Processing, 2nd ed. Am. Assoc. Cereal Chem. Pp 105-145.

Navarro, S., T. deBruin, A. R. Montemayor, S. Finkelman, M. Rindner, and R. Dias. 2007. Use of biogenerated atmosheres of stored commodities for quality preservation and insect control, with particular reference to cocoa beans. Integrated Protection of Stored Products IOBC/wprs Bulletin Vol. 3(2): 197-204. [online] Available at http://www/ftic.info/pdf/cocoabeans%20Navarro%20etal%101007.pdf. Accessed July 28, 2010.

Neven, L. G. 2004. Disinfestation of Fresh Horticultural Commodities by Using Hot Forced Air With Controlled Atmospheres. In: R. Dris and S. Homan Jain, eds. *Production Practices and Quality Assessment of Food Crops*, pp. 297-315. Netherlands: Kluwer Academic Publishers.

Phillips, T. W. 2006. The science and technology of postharvest insect control: challenges, accomplishments, and future directions. In Jerry Heaps, ed. Insect Management for Food Storage and Processing, 2nd ed. (pp. 211-222). Am. Assoc. Cereal Chem.

Schneider, S.M., E.N. Rosskopf, J.G. Leesch, D.O. Chellemi, C.T. Bull, and M.Mazzola. 2003. United States Department of Agriculture – Agricultural Research Service research on alternatives to methyl bromide: pre-plant and post-harvest. Pest Manag. Sci. 59:814-826.

U.S. Census Bureau. 2007. Economic Census. NAICS Code: 311320, Chocolate and confectionery manufacturing from cacao beans. Available at http://www.census.gov/econ/census07/

U.S. Department of State. 2006. Methyl Bromide Critical Use Nomination for Post Harvest Use for Commodities. Available at http://www.epa.gov/ozone/mbr/CUN2006/2006_USCommodities.pdf

U.S. Department of Agriculture (USDA). 2008a. 2007 California Walnut Acreage Report. Available at http://www.nass.usda.gov/Statistics_by_State/California/Publications/Fruits_and_Nuts/200805walac.pdf

U.S. Department of Agriculture (USDA). 2008b. Noncitrus Fruits and Nuts, 2007 Summary. National Agricultural Statistics Service. Available at

http://usda.mannlib.cornell.edu/usda/nass/NoncFruiNu//2000s/2008/NoncFruiNu-07-08-2008_revision.pdf

U.S. Department of Agriculture (USDA). 2010. Noncitrus Fruits and Nuts, 2007 Summary. National Agricultural Statistics Service. Available at http://usda.mannlib.cornell.edu/usda/current/NoncFruiNu/NoncFruiNu-07-07-2010.pdf

U.S. Environmental Protection Agency (USEPA). 2008. Addendum to the propylene oxide reregistration eligibility decision. Available at http://www.epa.gov/oppsrrd1/REDs/propylene-oxide-red-addendum.pdf.

Vreysen, M. J. B. and A. S. Robinson. 2010. Ionising radiation and area-wide management of insect pests to promote sustainable agriculture: A review. Agron. Sustain. Dev. [online] Available at http://www. Agronomy-journal.org. Accessed August 25, 2010.

Vick, K. W., J. A. Coffelt, D. L. Silhacek,and H. Oberlander. 1985. Methoprene and sex pheromone as control agents for the almond moth (Lepidoptera: Phycitidae) on peanuts stored in shell. J. Econ. Entomol. 78:258-262.

Wang, S., M. Monzon, J.A. Johnson, E. J. Mitcham, and J. Tang. 2007a. Industrial-scale radio frequency treatments for insect control in walnuts I: heating uniformity and energy efficiency. Postharvest Biology and Technology 45: 240-246.

Wang, S., M. Monzon, J.A. Johnson, E. J. Mitcham, and J. Tang. 2007b. Industrial-scale radio frequency treatments for insect control in walnuts II: insect mortality and product quality.. Postharvest Biology and Technology 45: 247-253.

Appendix A. Some Food and Drug Administration Links

Due to presence of live insects in cocoa beans from Brazil, Indonesia and Malaysia FDA requires fumigation of cocoa beans from these countries (http://www.accessdata.fda.gov/cms_ia/importalert_106.html).

"Title 21, Code of Federal Regulations, Part 110.110 allows the Food and Drug Administration (FDA) to establish maximum levels of natural or unavoidable defects in foods for human use that present no health hazard. These "Food Defect Action Levels" listed in this booklet are set on this premise--that they pose no inherent hazard to health." (http://www.fda.gov/Food/GuidanceComplianceRegulatoryInformation/GuidanceDocuments/Sanitation/ucm056174.htm).

Microanalytical Procedures Manual for cocoa beans:
http://www.fda.gov/Food/ScienceResearch/LaboratoryMethods/MacroanalyticalProceduresManualMPM/ucm084382.htm

Food Storage Compliance 580.100:
http://www.fda.gov/ICECI/ComplianceManuals/CompliancePolicyGuidanceManual/ucm074613.htm.

Compliance Guidelines:
http://www.fda.gov/Food/ScienceResearch/LaboratoryMethods/MacroanalyticalProceduresManualMPM/ucm084382.htm

Compliance Policy Guideline: CPG Sec. 560.350 Coffee and Cocoa Bean Sweeps: authority (http://www.fda.gov/ICECI/ComplianceManuals/CompliancePolicyGuidanceManual/ucm074570.htm)

Appendix B. General HAP Information

The definition for a "major source" of hazardous air pollutants (HAP) can be found in Section 112 (a)(1) of the Clean Air Act .

This definition also serves as the basis for defining a "major source" of HAP for our Title V Operating Permitting Program - Section 501 (2)(A). Additional information regarding Title V Operating Permits can be found at: http://www.epa.gov/oar/oaqps/permits/basic.html. This website includes a guide on the operating permit program, frequently asked questions and answers, and who must obtain a Title V permit.

Information regarding time to obtain a permit comes from the following website: http://www.epa.gov/region9/air/permit/pmfaq.html#faq5

The amount of time it takes to get a permit varies according to many factors, including what type of permit it is, its complexity, who the permitting authority is, how controversial the project is, and whether the permit is appealed after issuance. A New Source Review (NSR) permit issued by EPA takes between six months and one year. The time frame for NSR permits issued by state and local air pollution control agencies varies and is often specified in local regulations. In California, state law requires agencies to issue NSR permits within 180 days.

For Title V, federal regulations require that a permitting authority must issue all of its permits within three years of the date that the agency's Title V program became effective. One third of the total number of permits is supposed to be issued each year. However, most agencies are behind schedule. In addition, issuance can be delayed if EPA, on its own initiative or as a result of a citizen request, objects to a permit. Thus the amount of time it takes to get a Title V permit depends on agency-specific time frames and circumstances that are often beyond the applicant's control.