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2003 NOMINATION FOR A CRITICAL USE EXEMPTION FOR COMMODITY STORAGE FROM THE UNITED STATES OF AMERICA

1. Introduction

In consultation with the co-chair of Methyl Bromide Technical Options Committee (MBTOC), the United States (U.S.) has organized this version of its Critical Use Exemption Nomination in a manner that would enable a holistic review of relevant information by each individual sector team reviewing the nomination for a specific crop or use. As a consequence, this nomination for commodity storage, like the nomination for all other methyl bromide uses included in the U.S. request, includes general background information that the U.S. believes is critical to enabling review of our nomination in a manner that meets the requirements of the Parties' critical use decisions. With that understanding, the fully integrated U.S. nomination for commodity storage follows.

2. Background

In 1997, the Parties to the Montreal Protocol adjusted Article 2H of the Protocol, and agreed to accelerate the reduction in the controlled production and consumption of methyl bromide. This adjustment included a provision calling for a phaseout of methyl bromide by the year 2005 "save to the extent that the Parties decide to permit the level of production or consumption that is necessary to satisfy uses agreed by them to be critical uses." At the same time, the Parties adopted decision IX/6, the critical use exemption decision, which laid out the terms under which critical use exemptions under Article 2H would be granted.

3. Criteria for Critical Uses under the Montreal Protocol

In crafting Decision IX/6 outlining the criteria for a critical use exemption, the Parties recognized the significant differences between methyl bromide uses and uses of other ozone-depleting chemicals previously given scrutiny under the Protocol's distinct and separate Essential Use exemption process. The U.S. believes that it is vitally important for MBTOC to take into account the significant differences between the critical use exemption and the essential use exemption in the review of all methyl bromide critical use nominations.

During the debate leading up to the adoption of the critical use exemption Decision IX/6, an underlying theme voiced by many countries was that the Parties wanted to phase out methyl bromide, but not adversely affect agriculture. This theme was given life in various provisions of the critical use exemption, and in the differences in approach taken between the critical use exemption and the essential use exemption. Those differences are outlined below.

> *The Protocol's negotiated criteria for the Critical Use Exemptions for methyl bromide are much different from the criteria negotiated for "Essential Uses" for other chemicals.*

Under the Essential Use provisions, in order to even be considered for an exemption, it was necessary for each proposed use to be "critical for health, safety or the functioning of society." This high threshold differs significantly from the criteria established for the methyl bromide Critical Use exemption.

Indeed, for methyl bromide, the Parties left it solely to the nominating governments to find that the absence of methyl bromide would create *a significant market disruption.*

For the U.S. nomination for commodity storage, following detailed technical and economic review, the U.S. has determined that some use of methyl bromide in commodity storage is critical to ensuring that there is no significant market disruption. The detailed analysis of technical and economic viability of the alternatives listed by TEAP for use in commodity storage is discussed later in this nomination, as is the basis for the U.S. estimate of the amount of methyl bromide needed within this sector.

> *In the case of methyl bromide, the Parties recognized many agricultural fumigants were inherently toxic, and therefore there was a strong desire not to replace one environmentally problematic chemical with another even more damaging.*

The critical use exemption language explicitly requires that an alternative should not only be technically and economically feasible, it must also be acceptable from the standpoint of human health and the environment. This is particularly important given the fact that most chemical alternatives to methyl bromide are toxic and pose some risk to human health or the environment; in some cases, a chemical alternative may pose risks even greater than methyl bromide.

> *In the case of methyl bromide, the Parties recognized that evaluating, commercializing and securing national approval of alternatives and substitutes is a lengthy process.*

In fact, even after an alternative is tested and found to work against some pests in a controlled setting, adequate testing in large-scale commercial operations in the many regions of the U.S. can take many years before the viability of the alternative can be adequately demonstrated. In addition, the process of securing national and sub-national approval of the use of alternatives requires extensive analysis of environmental consequences and risks to human health. The average time for the national review of scientific information in support of a new pesticide, starting from the date of submission to registration, is approximately 38 months. In most cases, the company submitting the information has spent approximately 7-10 years developing the toxicity data and other environmental data necessary to support the registration request.

> *The Parties to the Protocol recognized that unlike other chemicals controlled under the Montreal Protocol, the use of methyl bromide and available alternatives could be site specific and must take into account the particular needs of the user.*

The Essential Use exemption largely assumed that an alternative used in one place could, if approved by the government, be used everywhere. Parties clearly understood that this was not the case with methyl bromide because of the large number of variables involved, such as crop type, soil types, pest pressure and local climate. That is why the methyl bromide Critical Use exemption calls for an examination of the feasibility of the alternative *from the standpoint of the user*, and *in the context of the specific circumstances of the nomination*, including use and geographic location. In order to effectively implement this last, very important provision, we believe it is critical for MBTOC reviewers to understand the unique nature of U.S. agriculture, as well as U.S. efforts to minimize the use of methyl bromide, to research alternatives, and to register alternatives for methyl bromide.

4. U.S. Consideration/Preparation of the Critical Use Exemption for Commodity Storage

Work on the U.S. critical use exemption process began in early 2001. At that time, the U.S. Environmental Protection Agency (US EPA) initiated open meetings with stakeholders both to inform them of the Protocol requirements, and to understand the issues being faced in researching alternatives to methyl bromide. During those meetings, which were attended by State and association officials representing thousands of methyl bromide users, the provisions of the critical use exemption Decision IX/6 were reviewed in detail, and questions were taken. The feedback from these initial meetings led to efforts by the U.S. to have the Protocol Parties establish international norms for the details to be in submissions and to facilitate standardization for a fair and adequate review. These efforts culminated in decision XIII/11 which calls for specific information to be presented in the nomination.

Upon return from the Sri Lanka meeting of the Parties, the U.S. took a three track approach to the critical use process. First, we worked to develop a national application form that would ensure that we had the information necessary to answer all of the questions posed in decision XIII/11. At the same time, we initiated sector specific meetings. This included meetings with representatives of the post harvest commodity sector across the U.S. to discuss their specific issues, and to enable them to understand the newly detailed requirements of the critical use application. These sector meetings allowed us to fine tune the application so we could submit the required information to the MBTOC in a meaningful fashion.

Finally, and concurrent with our preparation phase, we developed a plan to ensure a robust and timely review of any and all critical use applications we might receive. This involved the assembly of more than 45 PhDs and other qualified reviewers with expertise in both biological and economic issues. These experts were divided into interdisciplinary teams to enable primary and secondary reviewers for each application/crop. As a consequence, each nomination received by the U.S. was reviewed by two separate teams. In addition, the review of these interdisciplinary teams was put to a broader review of experts on all other sector teams to enable a third look at the information, and to ensure consistency in review between teams. The result was a thorough evaluation of the merits of each request. A substantial portion of requests did not meet the criteria of decision IX/6, and a strong case for those that did meet the criteria has been included.

Following our technical review, discussions were held with senior risk management personnel of the U.S. government to go over the recommendations and put together a draft package for submission to the parties. As a consequence of all of this work, it is safe to say that each of the sector specific nominations being submitted is the work of well over 150 experts both in and outside of the U.S. government.

5. Overview of Commodity Storage in the U.S.

Post-harvest commodity storage is a critical component of the food supply system. Critical use exemption applicants in this category represent fruits, nuts, beans, and meat warehouses. Because the growing season is separated from the peak demand season by several months for most of these products, it is imperative for these industries to have reliable means for storing and maintaining the quality of these commodities so they will be marketable.

Dried fruits: California produces almost all of the prunes, raisins and figs in the U.S., and 70 percent, 40 percent and 20 percent of the world's production of these fruits, respectively. This business represents approximately US$350 million in revenue.

Nuts: This sub-sector consists of walnuts and pistachios. The walnut cooperative facility includes approximately 50 percent of the U.S. walnut industry, with an estimated US$280 million in revenues generated for California. The businesses representing the pistachio sector encompass approximately 30 percent of global pistachio production and generate an estimated US$180 million in revenue.

Black-eye and Garbanzo beans: This sub-sector consists of stored black-eyed peas and garbanzo beans, as well as barley, wheat and oats. This business represents an estimated US$7 million in revenues, accounting for 72 percent of domestic black-eyed bean output and 12 percent of domestic garbanzo bean output, along with significant returns from exports.

Meats: This sub-sector consists of stored hams. This nomination is for a single company in this sector represents US$47.8 million in revenues and US$1.7 million in earnings before taxes. The U.S. government is expecting an increased number of applications from this sub-sector next year, as there are currently no alternatives registered for use on hams in the U.S.

6. Results of Review - Determined Need for Methyl Bromide in the Commodity Storage Sector

6a. Target Pests Controlled with Methyl Bromide

Numerous insects infest stored dry fruits, nuts, and beans. Major insect pests of dry fruits include the raisin moth (*Cadra figulilella*), Indian meal moth (*Plodia interpunctella*), dried fruit beetle (*Carpophilus hemipterus*), vinegar flies (*Drosophila* spp.), sawtoothed grain beetle (*Oryzaephilus surinamensis*), and navel orangeworm (*Amyelois transitella*). The main insects attacking walnuts include the codling moth (*Cydia pomonella*), navel orangeworm, sawtoothed grain beetle, merchant grain beetle (*Oryzaephilus mercator*), warehouse beetle (*Trogoderma variabile*), red and confused flour beetles (*Tribolium* spp.), dried fruit beetle, cadelle (*Tenebroides mauritanicus*), Indian meal moth, almond moth (*Ephestia cautella*), and raisin moth. Pests of stored pistachios are primarily the Indian meal moth, navel orangeworm, red flour and confused beetles, and the warehouse beetle. Main pests of dry beans include the cowpea weevil (*Callosobruchus maculatus*), Indian meal moth, sawtoothed grain beetle, bean weevil (*Acanthoscelides obtectus*), confused flour beetle, granary weevil, (*Sitophilus granarius*), and lesser grain borer (*Rhizopertha dominica*). Principal ham pests include the red-legged ham beetle (*Necrobia rufipes*), ham skipper (*Piophila* sp.), dermestid beetles (*Dermestes* spp.), and mites.

In the U.S., the Food and Drug Administration (FDA) regulates the maximum levels of live or dead insects or insect parts that may be present in stored food products. Food commodities that exceed maximum limits allowed are considered adulterated by FDA and thus unfit for human consumption.

An emphasis in the U.S. on maintaining high quality food is codified in several health and consumer safety laws that are implemented by the U.S. Food and Drug Administration (U.S. FDA). These laws ensure that human and animal foods are safe and properly labeled (the Federal Food, Drug and Cosmetic Act (FFDCA). The U.S. FDA defines unacceptable standards for hazards and filth in human and animal foods, called "defect action levels (DALs). These DALs define how much filth is allowed in a food.

Food inspected for filth levels. Filth may include health hazards for children and pets, such as barbed hairs from the dermestid beetle immatures because they are a choking hazard, and contaminants that render the food "adulterated", but are not actually hazardous, such as body parts of pests (legs, wings, scales), as well as their excreta (feces, urine). In addition, U.S. consumers have very high standards for their food, and are likely to sue companies if any flaws are detected. For this reason, food processing and storage companies invest substantial resources in having a clean final product.

The United States' enormous and wide ranging agricultural sector and food production industry has enabled the U.S. to feed its citizens, and meet their high expectations for quality food, as well as meeting the needs of many other countries. The food processing and storage industry in the U.S. prides itself on manufacturing and exporting approximately US$130 billion worth of high quality products. Both domestically and internationally, companies meet stringent standards for food quality by relying of methyl bromide. Therefore, as evidenced by the U.S. nomination for critical uses of methyl bromide, the phaseout of methyl bromide can have a very significant impact on both the technical and economic viability of the food processing and storage sector.

The United States' post-harvest food industry has relied heavily on mechanization and other non- labor inputs to compensate for a high cost of labor. As a result, U.S. post-harvest practices are highly reliant on pesticides such as methyl bromide and other non-labor inputs. The extent of mechanization and reliance on non-labor inputs can be best demonstrated by noting the very low levels of labor inputs. Furthermore, according to estimates by the U.S. Department of Labor's Bureau of Labor Statistics, employment in the commodity storage sector is expected to decrease by approximately 11% between 2000 and 2010, largely due to the increased mechanization of the industry. Total employment is approximately 1.684 million people in the U.S. food processing industry, and approximately 22,000 employees in the preserved fruit and vegetable market.

Post-harvest food storage is a critical component of the food supply system. CUE applicants in this category represent fruits, nuts, beans, and meats warehouses. Because the growing season is separated from the peak demand season by several months for most of these products, it is imperative for these industries to have reliable means for storing and maintaining the quality of these commodities.

6b. Technical and Economic Assessment of Alternatives

Dried Fruit. The state of California is by far the main raisin, prune, and fig producing state in the U.S. In California, raisins are harvested in the fall and dried on paper trays in the field, where they often become infested with various insects. Subsequently, raisins are washed, sorted, graded, and packed into boxes for storage in warehouses, where they may be fumigated several times a year. Raisins are taken from storage throughout the year for processing. Although it takes about three to five days to fumigate these commodities with phosphine and only 12 to 24 hours to fumigate them with methyl bromide, approximately 80 percent of dry fruit fumigation uses phosphine (Throne, 2002a). Methyl bromide is used mainly during the fall, when quick fumigations are needed as production and rush orders peak. Prunes, unlike raisins, are mechanically dried, a process that kills any insect that may be present, and then stored. In storage, prunes are fumigated once or twice during the year to control new infestations. Figs, half of which are usually infested when harvested, are fumigated once, immediately after harvest, and two to three more times during the year. In some cases, figs become re-infested during storage and grading. A substantial portion of the fig market is for the holidays, making the duration of fumigation a time-sensitive issue. Stored dry fruits must be fumigated periodically, otherwise pest populations will build up, affecting their quality and marketability.

Walnuts. California produces over 99 percent of the U.S. walnut crop (NCFAP, 2002). The walnut industry in California is dependent on methyl bromide to disinfest walnuts as they are harvested, to disinfest nuts as they become infested during processing, and as a fumigation treatment for nuts held in storage. A typical walnut facility receives two to eight million pounds (907,184 to 3,628,736 kilograms) of walnuts over a 75 day period, starting in September (Throne, 2002b). As was the case for dried fruits, the industry has replaced most some of their methyl bromide fumigations with phosphine. However, walnuts that are processed for immediate sale are fumigated with methyl bromide in a vacuum fumigation chamber. Walnuts that are to be processed later are placed in storage bins. Packaged walnuts are also fumigated with methyl bromide before sale to meet phytosanitary or quarantine requirements. In the fall, when walnuts need to be moved quickly to European and domestic markets in time for the holidays, phosphine fumigation is too slow to keep up with the rapid turnover required, and methyl bromide is the fumigant of choice during that critical period. Walnuts bound for Europe, especially for the St. Nicholas holiday on December 6, must be on board ship by November 1 (NCFAP, 2002). Methyl bromide is utilized to meet the requirement of having no live insects. The California walnut industry has developed both export and domestic markets that rely on high quality standards.

Pistachios. California produces 99 percent of U.S. pistachios. During peak production season, California processes approximately one million pounds of pistachios per week (Fuentes, 2002). As with walnuts, the large volume and limited silo availability require that fumigation be done rapidly and during this peak season the industry relies on methyl bromide fumigation.

Black-eye and garbanzo beans. California is the main black-eye and garbanzo bean producing state in the U.S. Weevils are found in the harvested crop as it arrives from the field in mid- to late- summer. To ensure that the product is pest-free, it is fumigated with methyl bromide upon arrival, and again as needed during storage, until the commodity is shipped to the packaging facility. Currently, methyl bromide is the only chemical listed by the California Department of Pesticide Regulation for control of the cowpea weevil, one of the major pests of stored beans. Approximately 60 percent to 90 percent of all black-eye beans are consumed during the New Year holiday in the U.S., specifically in the Southeast. Often shipments are based on customers' demand with only a 2- day notification period from the buyer. This very short turnaround time necessitates a completed fumigation within 12-hours. Buyers often request a copy of the fumigation records showing that the product was fumigated just prior to shipment and will not accept a product that cannot verify a recent (15 day) fumigation. It takes 12 hours to complete a fumigation of beans with methyl bromide.

Meats. A single curing and ham storage operation can typically process 10,307,878 kilograms (11,362.5 U.S. tons) of salted hams, jowls, shoulders, and bacon bellies each year. The curing facilities are fumigated with methyl bromide when pests are detected in the product or the smokehouses. This fumigation typically occurs about three to five times during a typical year. During this process, the smokehouse, typically small building (e.g. four stories), is covered with tarp and fumigated while full of hams.

Summary of Technical Feasibility

The results of the U.S. interdisciplinary team review of the MBTOC listed alternatives are summarized in Tables 1 and 2. The best methyl bromide alternative for the control of stored commodity pests is phosphine, alone or in combination. Phosphine is currently being used by the dried fruit and nut industry when production and marketing "timing" conditions allow it. Phosphine is not a feasible replacement for methyl bromide when rapid commodity turnover situations require a faster treatment than 3 to 5 days. Phosphine treatment would also disrupt (i.e. the ham will not cure properly) the ham curing process and for this reason it is not a feasible alternative for this commodity. Furthermore, adoption of phosphine fumigation would require a substantial capital investment for fumigation chambers or gas-tight bins. In addition, pest resistance and corrosion problems (e.g. corrosion of copper alloys, electrical wiring, equipment, and lights) associated with phosphine fumigation for stored commodities would limit the long term usefulness of this fumigant. The corrosion problems and development of resistance in target pests could be reduced by using low phosphine-high carbon dioxide-high temperature combination treatments, but adopting this method would require a high degree of technical skills which is not widely available. This fumigation method requires that the concentrations of carbon dioxide and phosphine and temperature be constantly monitored and adjusted, that the gases be uniformly distributed, that unexposed pockets do not occur, and that the analytical equipment used for these determinations be properly maintained, calibrated, and properly installed. Methyl bromide appears to be the only treatment that consistently provides the high degree of insect and mite control required in stored commodities which depend on rapid fumigation methods.

Table 1. Methyl bromide alternatives identified by the Methyl Bromide Technical Options Committee (MBTOC) for dried fruit, nuts, and stored beans

	Methyl bromide Alternatives	**Technical Feasibility**	**Economic Feasibility**
1	Phosphine, alone	Yes*	No
2	Phosphine, in combination	Yes*	No
3	Propylene oxide	No	No
4	Sulfuryl fluoride	Not registered in the U.S.	N/A
5	Pesticides (contact and low volatility insecticides)	No	No
6	High pressure carbon dioxide	No	No
7	Cold treatment	No	No
8	Heat treatment	No	No
9	Integrated pest management (IPM)	No	No
10	Biological agents	No	No
11	Irradiation	No	No
12	Pest resistant packaging	No	No
13	Controlled and modified atmospheres	No	No
14	Physical removal/cleaning/sanitation	No	No

* Although these alternatives can control pests, practical implementation in many cases is complicated by corrosivity and damage to electronic equipment, building construction, pest resistance and regulatory limitations.

Table 2. Methyl bromide alternatives identified by the Methyl Bromide Technical Options Committee (MBTOC) for fish and meats (ham)

	Methyl bromide Alternatives	**Technical Feasibility**	**Economic Feasibility**
1	Phosphine, alone	Yes	No
2	Phosphine, in combination	Yes	No
3	Propylene oxide	Not registered in the U.S.	N/A
4	Sulfuryl fluoride	Not registered in the U.S.	N/A
5	Pesticides (contact and low volatility insecticides)	No	No
11	Irradiation	No	No

6c. Technical Feasibility of In Kind Alternatives

Phosphine alone is a technically feasible alternative, but cannot be adopted in all cases because: (1) It takes too long to use in some circumstances; (2) it is corrosive of metals; and (3) some pests are developing a resistance. Exposure to phosphine gas will control insects in stored food commodities. However, it takes about three to five days to fumigate with phosphine gas, compared to only 12 to 24 hours with methyl bromide. The U.S. dried fruit industry has already replaced 80 percent of their methyl bromide fumigations with phosphine for situations when rapid commodity turnover is not required (Throne, 2002a). Phosphine does not act fast enough when stored commodities must be moved quickly to meet marketing schedules. The several days required for phosphine fumigation would also interfere with the ham curing process (smoking). Phosphine is corrosive to metals, such as copper in electrical connections, printed circuits, and sensitive equipment, and cannot be used in many warehouses and processing plants. Several stored grain insects have already developed resistance to phosphine (Bell, 2000), and it is likely that resistance will continue to develop in other stored commodity pests, making its use a short-term solution.

Phosphine, in combination may be a technically feasible alternative, but cannot be widely adopted because: (1) This technology is not widely available throughout the country; (2) there are uncertainties as to the effectiveness of this approach for large-scale commodity treatment; (3) it takes too long to use in some circumstances; (4) it is corrosive of metals, although less than phosphine alone; and (5) it may accelerate the development of pest resistance to phosphine.

There is some indication that reduced concentrations of phosphine in combination with carbon dioxide and heat may be able to extend the life of the metals. However, efficacy data for this technique is lacking in the U.S. Studies of the efficacy of this combination, as well as the rate of metal corrosion, are needed. Using lower concentrations of phosphine with resistance already developing in the pest populations will select for resistant populations much quicker and, therefore, is not recommended. Combined treatment (phosphine, heat, carbon dioxide) reduces phosphine corrosion and, if properly calibrated, can be effective against all insect life stages within 24 hours of exposure. Fumigation with this combination requires experience in chemical monitoring, gas movement, and the interaction between temperature and gas concentration and insect mortality. Although this method addresses the corrosion problems associated with phosphine, pest control results can vary widely depending on who is doing the application, thus increasing the risk of total product loss if it cannot be certified as insect free.

Propylene oxide is not technically feasible because: (a) Propylene oxide is not labeled for use on in-shell nuts in the U.S.; (b) it is volatile and flammable and needs to be applied under vacuum conditions for safety; (c) its use would require the construction of large treatment facilities (vacuum chambers); (d) some importing countries will not accept nuts treated with this fumigant; and (e) its use may cause rancidity to nuts. Although complete pest control with this fumigant can be achieved in four hours, it is registered in the U.S. as a package fumigant for treatment of prunes and processed nuts.

Sulfuryl fluoride is not currently registered for use on food products in the U.S. This chemical has been found to be effective against all insects stages, except the eggs (Bell, 2000). Recently, EPA granted temporary tolerances for sulfuryl fluoride for the post-harvest fumigation of stored walnuts and raisins. The temporary tolerances support a three year experimental use permit that expires in March 2005. This fumigant's main efficacy related drawback, assuming full EPA registration is eventually granted, will be its lack of effectiveness against insect eggs, which would limit its utility for routine and pre-export fumigation.

Irradiation is not technically feasible because: (a) Irradiation does not readily kill exposed insects, but rather prevents further feeding and reproduction. Although unable to feed or reproduce, the surviving insects would still create phytosanitary problems. The high doses required to kill exposed insects may affect product quality. (b) Consumer acceptance of irradiated food would further hinder the adoption of this method. (c) Food irradiation is prohibitively expensive, especially for processing large volumes of commodities.

6d. Economic Feasibility of In-Kind Alternatives

The economic assessment of feasibility for *post-harvest uses of methyl bromide* included an evaluation of economic losses due to three major economic measures, with the first measure being sub-divided further into three contributing factors:

(1) absolute losses per facility, are aggregate potential economic losses from:

(1a) direct pest control costs, because alternatives to methyl bromide tend to be more expensive, not only in terms of the price of the fumigant or treatment type, but also for an increased number of treatments.

(1b) capital expenditures, which are often large amounts required to adopt an alternative, such as investments for accelerated replacement of plant and equipment due to corrosive nature of phosphine.

(1c) production delays, which are often related to additional production downtime for the use of alternatives. Many facilities are operating at or near production capacity in "just-in-time" environments. Alternatives that take longer than methyl bromide or require more frequent application can result in manufacturing slowdowns, shutdowns, or shipping delays. Slowing down production will result in additional costs incurred throughout channels of distribution.

(2) Economic loss as a percent of net revenue. This measure is calculated by dividing the absolute loss by the net revenue.

(3) Economic loss as per kilogram of methyl bromide requested. This measure is calculated by dividing the loss per facility by the kilograms active ingredient requested per facility.

These measures represent different ways to assess the economic feasibility of methyl bromide alternatives for methyl bromide use for commodity storage. Because producers (suppliers) represent an integral part of any definition of a market, we interpret the threshold of significant market disruption to be met if there is a significant impact on commodity suppliers using methyl bromide. The economic measures provide the basis for making that determination.

Technically feasible alternatives to methyl bromide in commodity storage are phosphine alone and phosphine in combination. Implementation of these alternatives would have substantial economic implications for the sub-sectors of the commodity storage industry in this initial U.S. nomination. Significant financial impacts likely will result from increased operating costs for materials and labor, capital expenditures, and increased production downtime.

Phosphine alone

The potential economic losses associated with the use of phosphine alone mostly arise from production delay costs and capital expenditures. Estimated economic losses from a shift to phosphine alone treatment are summarized in Table 3. The estimated economic loss as a percentage of net revenue ranges from 12 percent to 154 percent. The range is particularly large because the commodities analyzed are not homogeneous. The industries that use methyl bromide for storage fumigation are subject to limited pricing power because companies within these industries operate in a highly competitive global marketplace characterized by high sales volume and low profit margins. The potential economic losses of using the phosphine alone for commodity storage would significantly reduce their low profit margins. Four of the five commodity storage uses of methyl bromide occur almost exclusively in California due to the state's unique climate and access to ports for exporting.

For the walnut sector, using phosphine would drastically hinder market demand for the product, especially shipments to Europe during the holiday season. All existing fumigation space is currently used to pack for the pre-Christmas market. It is estimated that for independent handlers, who typically move walnuts through atmospheric methyl bromide fumigation every 24 hours, that packing capacity would be reduced to one-fifth of current levels if five days are required for fumigation. In addition, handlers would lose early-season revenue needed to finance operations, and this cash flow impact would further contribute to market disruptions and losses. Furthermore, if there is a year with excessively high pest pressures, the un-fumigated walnuts could easily sustain so much damage in storage that these lots would not be worth processing, as the yield of useable nuts would be too low to justify sorting costs. Even if all of the walnuts could be stored and processed on a steady basis throughout the year, prices paid to growers would be depressed by the increased supply that would be forced onto the domestic market. The same issue of longer exposure times resulting in lost revenue is also applicable to the pistachio sector.

With regard to the bean sector, rapid turnaround time is essential during peak seasons. An average of 10-15 truckloads of beans are delivered daily to each warehouse. Fumigation with methyl bromide begins at 4:00pm each day, and concludes 12 hours later. The 12-hour time used to fumigate with methyl bromide is critical to keep up with the truckloads of beans arriving from harvest on a daily basis. With a 72-hour fumigant such as phosphine, there would be a tremendous backlog and similar to the walnut case, the high pest pressure would likely deem the crop unfit for consumption, thus resulting in lost revenues. In addition, methyl bromide is the only product listed by the California Department of Pesticide Regulation as suitable for controlling the cowpea weevil, a major pest in bean warehouses.

Phosphine is not economically feasible for use in areas of the dried fruit sector (especially prunes and figs), as current warehouses have too much equipment that would corrode. Higher equipment maintenance costs might require construction of additional chambers, which would be cost-prohibitive. In addition, longer exposure time reduces flexibility of handling figs and prunes, which may lead to worse quality commodities and subsequent lost revenues.

Phosphine in combinations with heat

Phosphine in combination is likely to be even more costly than phosphine alone because implementation of this treatment also require retrofitting the facility for heat. See phosphine alone discussion above for summary of economic impacts of moving to phosphine.

Table 3. Summary of Estimated Economic Losses in the Absence of Methyl Bromide

Economic Loss Measures		Beans in storage (Representative size: 8,495 m^3)	Prunes, figs, & raisins (Representative size: 14,159 m^3)	Pistachios (Representative size: 31,149 m^3)	Walnuts (Representative size: 8,495 m^3)	Ham (Representative size: 5,663 m^3)
Absolute loss per average facility	Direct pest control costs	$38,000	$14,000	($10,000)	($81,000)	NA[1]
	Capital expenditures	$42,000	$32,000	$18,000	$519,000	NA
	Production delays	$8,000	$92,000	$1,510,000	$1,308,000	NA
	Total	$88,000	$141,000	$1,518,000	$1,746,000	NA
Economic loss as a percentage of net revenue		154%	20%	48%	12%	NA
Economic loss as per kilogram of methyl bromide requested		$218	$414	$608	$79	NA

[1]Not available because no alternative is identified as technically feasible.

6e. Technical Feasibility of Not In Kind Alternatives

Carbon dioxide (high pressure) is not technically feasible because: (a) Only small quantities of dry fruits can be treated at a time since only small chambers that can withstand high pressure are available. Unavailability of large scale pressure chambers restrict its widespread use (California Walnut Commission, 2002). b) Carbon dioxide is marginally effective against some insect stages. For example in almond moth *Ephestia cautella* (Walker) the adults are two to four times more sensitive to carbon dioxide concentrations than the eggs and pupae, respectively (Navarro et. al, 1999).

Cold treatment is not technically feasible because this method requires either a long time for treatment at moderately cold temperatures or extreme cold temperatures for a short period of time. Effective treatment requires maintaining a temperature of minus 18_C (0_F) for several hours, minus 10_C (14_F) for between 7 and 62 hours, or between 0 and 10_C (32 to 50_F) for a minimum of two weeks (California Walnut Commission & Walnut Marketing Board, 2002). Cold treatment drawbacks include the following: a) The slowness of the process would interfere with the rapid movement of products, especially during harvest in fall, and would affect the industry's capacity to meet the demands of the European market, delaying shipments by 1-3 weeks. b) The application of this alternative would require major investment of capital for construction of specialized cold chambers or retrofitting of existing facilities. c) Energy costs to quickly cool large masses of commodity would be prohibitive.

Heat treatment is not technically feasible because there is little information on how exposure to heat would affect the treated commodity, considering that the effect of high temperatures on the quality of dried fruit and nuts varies with the commodity, temperature, length of treatment, and other factors. For instance, except for pistachios, there is rapid quality deterioration when nuts are stored above ambient temperatures. Although exposure to extreme heat will control stored food pests in flour mills and food processing facilities, no research has been conducted in the U.S. that demonstrates the effectiveness of this method with large volumes of dry fruit, nuts, or beans. Similarly, In the absence of reliable information on these issues, large-scale heat treatment of stored commodities is not an option at this time.

Integrated pest management (IPM) is not technically feasible by itself because it is not designed to completely eliminate pests from any given commodity nor to ensure that such commodity remains free from infestation. The IPM approach to pest control seeks to manage pests at economically tolerable levels by making use of all available chemical, cultural, biological, and mechanical pest control practices so as to avoid or reduce the frequency of fumigations. IPM techniques, such as sanitation, destruction of infested materials, pest monitoring, trapping, and chemical control are routinely used by the industry. Because of the zero tolerance for insects imposed by market demands and regulatory requirements, IPM is not an acceptable alternative to methyl bromide fumigation.

Biological agents: Biocontrol is not currently designed to provide the degree of pest control that market and regulatory agencies demand in stored food products. Furthermore, the use of biological control agents for control of stored product pests is still in its infancy. Biological agents are slow to act, are species-specific, and would only reduce, not eliminate, pest populations in an infested commodity. Moreover, the use of insect predators and parasitoids would add insect parts to the product, and their presence would be subject to FDA regulations just like other insects.

Pest resistant packaging: This alternative is not feasible for treating bulk commodity.

Controlled and modified atmospheres are not technically feasible by themselves because some combinations, such as carbon dioxide with high heat, have been shown to be effective in disinfesting dried fruit and nuts. However, the adoption of this method requires, depending upon temperature, a minimum of 2-5 days of pest exposure for control, which is too long for the high commodity output in the U.S., especially during harvest. For instance, Diamond Walnut alone processes 3,628,739 kilograms (4,000 tons) at its Stockton plant. In addition, adoption of this method for rapid disinfestation would require major capital investment for equipment and retrofitting of existing structures (California Walnut Commission & Walnut Marketing Board, 2002). In addition, eggs and pupae are less sensitive to this control method than are the adults (Navarro et. al, 1999).

Physical removal/cleaning/sanitation: This technique is already being used. By itself, this approach is not designed to disinfest a commodity, but only to temporarily reduce the build-up of pest populations.

Pesticides (contact and low volatility insecticides): Insecticides are not registered for use on dry fruit or ham in the U.S. and, at present, only pyrethrins - piperonyl butoxide aerosol formulations are registered for use on other stored commodities. These formulations, used as space sprays, fogs, or mists, are designed to control exposed insects and do not penetrate into the treated commodities. Insecticide applications would only temporarily control exposed insects, while having no effect on those feeding inside the infested commodities. Thus, insecticide treatment would not provide the degree of control required to satisfy market and regulatory standards (California Walnut Commission & Walnut Marketing Board, 2002).

7. Critical Use Exemption Nomination for Commodity Storage

The U.S. interdisciplinary review team found a critical need for methyl bromide for commodity storage of dry fruit (raisins, figs, prunes), walnut, pistachios, black-eye and garbanzo beans in California, and for dried/cured pork products in Virginia. These are likely to be only the initial requests for commodity storage. Twelve of fourteen alternatives identified by the Methyl Bromide Technical Options Committee (MBTOC) were regarded by reviewers as technically and economically infeasible for post-harvest management of the main insect pests affecting dried fruit and nuts. Phosphine was the only alternative found to be suitable for use on nuts and beans, except during high production and/or marketing periods, when commodities need to be fumigated rapidly to keep up with production pressures and market demands. Five of five "not-in-kind" alternatives identified by the Methyl Bromide Technical Options Committee (MBTOC) were regarded by reviewers as technically or economically infeasible for post-harvest management of the main insect pests affecting and meats (ham).

The actual amount of methyl bromide requested, the proposed volumes to be treated, and the treatment rates for each commodity are summarized in Tables 4-8.

Table 4. Methyl Bromide Usage and Requests for Stored Black-Eye and Garbanzo Beans in California.

	1997	1998	1999	2000	2001	2005	2006	2007
kg	9,457	8,883	14,734	10,620	4,286	12,088	12,088	12,088
1,000 cu meters	183	178	297	217	178	255	255	255
rate (kg/ 1,000 cu meters)	51.7	50.0	49.5	48.9	24.0	47.4	47.4	47.4

The representative user for this sector is a warehouse operation that handles the crop as it is brought in from the field. Five warehouses represent 42,827 cubic meters of storage for grain crops including black-eye beans, garbanzo beans, black beans, wheat, oats, and barley. The product is typically treated as it arrives from the field, or when the pest is detected. Following the initial fumigation, the commodities are usually fumigated once every 30 days during the months of April to September. In addition, it is common for buyers to request a copy of the fumigation records to show that the product was fumigated prior to shipment; some buyers do not accept a product that cannot verify a recent 15-day fumigant. However, in some cases fumigation can vary according to pest pressure.

Table 5. Methyl Bromide Usage and Requests for Dry Fruits (Prunes, Figs, Raisins) in California.

	1997	1998	1999	2000	2001	2005	2006	2007
kg	8,501	19,862	17,001	16,251	16,251	20,412	20,412	20,412
1,000 cu meters	496	1,614	1,109	684	684	850	850	850
rate (kg/1,000 cu m)	17.1	12.3	15.3	23.8	23.8	24	24	24.0

The above table represents the historical usage for approximately 85% of this industry. Application rates have increased since 1997, but have not fluctuated in recent years. However, raisins are now fumigated with phosphine on a regular basis, which subsequently allows for the use of alternatives requiring a longer exposure time, such as phosphine. Presently, the sector is researching sulfuryl fluoride as a potential replacement for methyl bromide.

Table 6. Methyl Bromide Usage and Requests for Pistachios in California.

	1997	1998	1999	2000	2001	2005	2006	2007
kg	3,031	5,670	4,025	3,946	3,946	4,536	4,536	4,536
1,000 cu meters	57	57	57	57	57	57	57	57
rate (kg/1,000 cu m)	53.5	100.0	71.1	69.7	69.7	80.1	80.1	80.1

Pistachio plants vary somewhat in size; an average was taken in the table above. The largest processor handles over 45,360,000 kg of pistachios per year, as California produces the majority of pistachios for consumption in the U.S. Consortium members use methyl bromide because of particular characteristics in the fumigant that are not present in other registered fumigants, as well as its efficacy. Although the application rate has not fluctuated extensively since 1997, the pistachio industry has reduced its dependence on methyl bromide by using phosphine whenever possible; the sector is also lobbying for the registration of sulfuryl fluoride.

Table 7. Methyl Bromide Usage and Requests for Walnuts in California

	1997	1998	1999	2000	2001	2005	2006	2007
kg	77,018	64,992	81,025	68,428	65,022	97,704	87,362	108,046
1,000 cu meters	762	643	801	677	864	1,220	1,091	1,349
rate (kg/1,000 cu m)	101.1	101.1	101.1	101.1	75.3	80.1	80.1	80.1

A typical walnut facility processes approximately 113,400,000 kg of walnuts every year. Independent handlers process a slightly smaller volume, but all product must clear fumigation before the following day's shipment arrives, during peak seasons. The average handlers receive approximately 907,200- 3,628,800 kg of walnuts per day, for 75 days, beginning in September. During this peak season methyl bromide must be used in order to keep up with market demand. However, during off-seasons, several processors have switched to Phosphine in combination, which takes three days to affect an insect kill.

Table 8. Methyl Bromide Usage and Requests for Meats in Virginia.

	1997	1998	1999	2000	2001	2005	2006	2007
kg	726	726	363	544	726	907	907	907
1,000 cubic meters	62	62	62	62	62	62	62	62
rate (kg/1,000 cu m)	11.6	11.6	5.8	8.7	11.6	14.6	14.6	14.6

This facility produces 10,308,060 kg of the following products per year: dry cured salted hams, shoulders, jowls, and bacon bellies. The facilities are only treated when pests are present through the inspection of the product and of the smokehouses. As demonstrated in the above table, application frequency fluctuates according to pest growth and pest pressure during any given season.

Typically, methyl bromide is applied 3-5 times throughout the year, but this operation has attempted to reduce dependence on methyl bromide by using pyrethrins, traps for flies, and pheromone jars.

The U.S. nomination has been determined based on consideration of the requests we received and an evaluation of the supporting material. This evaluation, which resulted in a reduction in the amount being nominated, included careful examination of issues including the area infested with the key target (economically significant) pests for which methyl bromide is required, the extent of regulatory constraints on the use of registered alternatives, and historic use rates, among other factors.

Table 9. Methyl Bromide Critical Use Exemption Nomination for the Commodity Sector.

Year	Total Request by Applicants (kilograms)	U.S. Sector Nomination (kilograms)
2005	135,828	87,753

8. Availability of Methyl Bromide from Recycled or Stockpiled Sources

In accordance with the criteria of the critical use exemption, the Parties must discuss the potential that the continued need for methyl bromide can be met from recycled or stockpiled sources. With regard to recycling of methyl bromide, it is fair to say that the U.S. concurs with earlier TEAP conclusions that recycling of methyl bromide used in commodity storage facilities is not currently feasible. Facilities in the U.S. are very large and not able to be sealed tightly enough to allow methyl bromide to be captured and recycled. Recycling systems are under development for port fumigation but the issues of: trapping efficacy, worker and bystander safety, liability for the captured fumigant, and design of facilities to extract the captured methyl bromide have slowed the development of this approach. The U.S. has been investigating the level of the existing stockpile, and we believe that whatever stock pile may now exist will likely be fully depleted by 2005 when the need for the critical use exemption will start.

9. Minimizing Use/Emissions of Methyl Bromide in the U.S.

In accordance with the criteria of the critical use exemption, we will now describe ways in which we strive to minimize use and emissions of methyl bromide. While each sector based nomination includes information on this topic, we thought it would be useful to provide some general information that is applicable to most methyl bromide uses in the country

The use of methyl bromide in the United States is minimized in several ways. First, because of its toxicity, methyl bromide is regulated as a restricted use pesticide in the United States. As a consequence, methyl bromide can only be used by certified applicators who are trained at handling these hazardous pesticides. In practice, this means that methyl bromide is applied by a limited number of very experienced applicators with the knowledge and expertise to minimize dosage to the lowest level possible to achieve the needed results.

In terms of compliance, in general, the United States has used a combination of tight production and import controls, and the related market impacts to ensure compliance with the Protocol requirements on methyl bromide. Indeed, over the last – years, the price of methyl bromide has increased substantially. As Chart 1 in Appendix D demonstrates, the application of these policies has led to a more rapid U.S. phasedown in methyl bromide consumption than required under the Protocol. This accelerated phasedown on the consumption side may also have enabled methyl bromide production to be stockpiled to some extent to help mitigate the potentially significant impacts associated with the Protocol's 70 percent reduction in 2003 and 2004. We are currently uncertain as to the exact quantity of existing stocks going into the 2003 season that may be stockpiled in the U.S. We currently believe that the limited existing stocks are likely to be depleted during 2003 and 2004. This factor is reflected in our requests for 2005 and beyond.

At the same time we have made efforts to reduce emissions and use of methyl bromide, we have also made strong efforts to find alternatives to methyl bromide. The section that follows discusses those efforts.

10. U.S. Efforts to Find, Register and Commercialize Alternatives to Methyl Bromide

Over the past ten years, the United States has committed significant financial and technical resources to the goal of seeking alternatives to methyl bromide that are technically and economically feasible to provide pest protection for a wide variety of crops, soils, and pests, while also being acceptable in terms of human health and environmental impacts. The U.S. pesticide registration program has established a rigorous process to ensure that pesticides registered for use in the United States do no present an unreasonable risk of health or environmental harm. Within the program, we have given the highest priority to rapidly reviewing methyl bromide alternatives, while maintaining our high domestic standard of environmental protection. A number of alternatives have already been registered for use, and several additional promising alternatives are under review at this time. Our research efforts to find new alternatives to methyl bromide and move them quickly toward registration and commercialization have allowed us to make great progress over the last decade in phasing out many uses of methyl bromide. However, these efforts have not provided effective alternatives for all crops, soil types and pest pressures, and we have accordingly submitted a critical use nomination to address these limited additional needs.

Research Program

When the United Nations, in 1992, identified methyl bromide as a chemical that contributes to the depletion of the ozone layer and the Clean Air Act committed the U.S. to phase out the use of methyl bromide, the U.S. Department of Agriculture (USDA) initiated a research program to find viable alternatives. Finding alternatives for agricultural uses is extremely complicated compared to replacements for other, industrially used ozone-depleting substances because many factors affect the efficacy such as: crop type, climate, soil type, and target pests, which change from region to region and among localities within a region.

Through 2002, the USDA Agricultural Research Service (ARS) alone has spent US$135.5 million to implement an aggressive research program to find alternatives to methyl bromide (see Table 1 below). Through the Cooperative Research, Education and Extension Service, USDA has provided an additional $11.4m since 1993 to state universities for alternatives research and outreach. This federally supported research is a supplement to extensive sector specific private sector efforts, and that all of this research is very well considered. Specifically, the phaseout challenges brought together agricultural and forestry leaders from private industry, academia, state governments, and the federal government to assess the problem, formulate priorities, and implement research directed at providing solutions under the USDA's Methyl Bromide Alternatives program. The ARS within USDA has 22 national programs, one of which is the Methyl Bromide Alternatives program (Select Methyl Bromide Alternatives at this web site: http://www.nps.ars.usda.gov). The resulting research program has taken into account these inputs, as well as the extensive private sector research and trial demonstrations of alternatives to methyl bromide. While research has been undertaken in all sectors, federal government efforts have been based on the input of experts as well as the fact that nearly 80 percent of preplant methyl bromide soil fumigation is used in a limited number of crops. Accordingly, much of the federal government pre-plant efforts have focused on strawberries, tomatoes, ornamentals, peppers and nursery crops, (forest, ornamental, strawberry, pepper, tree, and vine), with special emphasis on tomatoes in Florida and strawberries in California as model crops.

Table 1: Methyl Bromide Alternatives Research Funding History

Year	Expenditures by the U.S. Department of Agriculture (US$ Million)
1993	$7.255
1994	$8.453
1995	$13.139
1996	$13.702
1997	$14.580
1998	$14.571
1999	$14.380
2000	$14.855
2001	$16.681
2002	$17.880

The USDA/ARS strategy for evaluating possible alternatives is to first test the approaches in controlled experiments to determine efficacy, then testing those that are effective in field plots. The impact of the variables that affect efficacy is addressed by conducting field trials at multiple locations with different crops and against various diseases and pests. Alternatives that are effective in field plots are then tested in field scale validations, frequently by growers in their own fields. University scientists are also participants in this research. Research teams that include ARS and university scientists, extension personnel, and grower representatives meet periodically to evaluate research results and plan future trials.

Research results submitted with the CUE request packages (including published, peer-reviewed studies by (primarily) university researchers, university extension reports, and unpublished studies) include trials conducted to assess the effectiveness of the most likely chemical and non-chemical alternatives to methyl bromide, including some potential alternatives that are not currently included in the MBTOC list.

As demonstrated by the table above, U.S. efforts to research alternatives for methyl bromide have been substantial, and they have been growing in size as the phaseout has approached. The United States is committed to sustaining these research efforts in the future to continue to aggressively search for technically and economically feasible alternatives to methyl bromide. We are also committed to continuing to share our research, and enable a global sharing of experience. Toward that end, for the past several years, key U.S. government agencies have collaborated with industry to host an annual conference on alternatives to methyl bromide. This conference, the Methyl Bromide Alternatives Outreach (MBAO), has become the premier forum for researchers and others to discuss scientific findings and progress in this field.

The post-harvest commodity sector has invested substantial time and funding into research and development of technically and economically feasible alternatives to methyl bromide. Past and current research focuses on the biology and ecology of the pests, primarily insects. To implement non-chemical controls and reduce methyl bromide use requires a thorough understanding of the pests in order to exploit their weaknesses. Some of these studies have focused on the effects of temperature and humidity on the fecundity, development, and longevity of a specific species. Other studies have addressed the structural preferences and microhabitat requirements of a species. Studies of factors affecting population growth (interactions within and among species) have been conducted. IPM and sanitation methods are also under investigation. This includes storage facility design and engineering modifications for pest exclusion. Another area of study is insect-resistant packaging. In fact, new research is demonstrating a potential to incorporate chemical repellents into packaging materials (Arthur and Phillips 2003). Further studies with pheromones and trapping strategies are helping to improve IPM in commodity storage facilities.

The number of available insecticides that can be used in commodity storage facilities in the U.S. has declined in recent years. Sulfuryl fluoride is toxic to stored-product pests but requires long exposures to kill insect eggs (Arthur and Phillips 2003). The research and development of chemical alternatives to be used by this sector is a critical need in the U.S.

The resulting research program has taken into account these inputs, as well as an estimated US$20 million spent by the private sector to fund research and trial demonstrations of alternatives to methyl bromide. For the post-harvest commodity storage sector, the following studies are government-funded:

Biology and Management of Food Pests (Oct 2002- Sep 2007) – The objectives of this study are to: 1) Examine the reproductive biology and behavior of storage weevils, Indian meal moth, and red and confused flour beetles. 2) Determine the influence of temperature on the population growth, mating and development of storage pests, specifically storage weevils, Indian meal moth, and red and confused flour beetles. 3) Examine the use of CO_2 concentrations within a grain mass to predict storage weevils and flour beetle population growth. 4). Examine the use of alternative fumigants on insect mortality (ozone, sagebrush, Profume).

Postharvest Pest Management with Novel Heating Techniques (Sep 2000 - Sep 2004) - This study aims to replace postharvest fumigation by scientifically sound, environmentally friendly, economically feasible, consumer acceptable pest control methods for US agriculture products. Goals include studying fundamental kinetics for thermal mortality of most commonly encountered pest arthropods in nuts and fruits, such as codling moths, navel orangeworms, Indian meal moths and spider mites, in order to develop a practical thermal method to replace chemical fumigation by using electromagnetic energy at radio and microwave frequencies.

Chemically Based Alternatives to Methyl Bromide for Postharvest and Quarantine Pests (Jul 2000 - Dec 2004) – This study will focus on developing quarantine/postharvest control strategies using chemicals to reduce arthropod pests in durable and perishable commodities. Objectives include: 1) Develop new fumigants and/or strategies to reduce methyl bromide use. 2) Develop technology and equipment to reduce methyl bromide emissions to the atmosphere. 3) Develop system approaches for control using chemicals combined with non-chemical methodologies which will yield integrated pest control management programs. 4) Develop methods to detect insect infestations.

Indian Meal Moth Granulosis Virus As An Alternative to Mb for Protection of Dried Fruits and Nuts (Mar 2001 - Oct 2002) – This study will determine the efficacy and persistence of the Indian meal moth granulosis virus applied topically or with complete coverage as a protectant for walnuts, raisins, almonds, pistachios and dried lima beans. Determine inactivation by high temperatures and existing/candidate fumigants. Determine attractancy and survival of larvae to the complete formulation and components.

Vacuum-Hermetic Fumigation As An Alternative to Methyl Bromide for Control of Postharvest Pests (Oct 2001 - Dec 2002) – The objective of this study is to determine the effectiveness of vacuum-hermetic fumigation for controlling Post-harvest pests by developing a treatment schedule that is lethal to pests and innocuous to Post-harvest commodities.

Non-Chemical Pest Control in Fruits and Nuts Using Electromagnetic Energy (Sep 2000 - Sep 2004) -- The objective of this study is to develop an economical system using microwaves or radio-frequency heating to disinfest post-harvest walnuts of insect pests. Project also will demonstrate the efficacy of the system to processors, and document the effect of the method on product quality.

Research results submitted with the CUE request packages, including published, peer-reviewed studies, university extension reports, and unpublished studies include trials conducted to assess the effectiveness of the most likely chemical and non-chemical alternatives to methyl bromide, including potential alternatives not currently included in the MBTOC list.

Modern studies on stored-product fumigant efficacy entail more than simply establishing a mortality dosage. For example, with regard to improving fumigant efficacy, topics researchers are presently investigating include minimizing dosages and studying the manner in which compounds work, how they are affected by physical conditions, and how to avoid or counter pest resistance. Resistance is also a pertinent topic, as many pests have recently begun to develop resistance to phosphine, a technically feasible alternative to methyl bromide. For phosphine, the tolerance spectrum among susceptible strains is quite wide. While there has been substantial industry-wide research to improve and maintain safe storage practices, consumer demands for food safety and quality are very high in the U.S. Further, technology upgrades require substantial capital outlays. Although fumigation is still heavily relied upon in order to combat and prevent pest outbreaks and infestations in stored commodities, the U.S. commodity storage industries are committed to further investigations for alternatives to methyl bromide.

Recent research has shown that combination methods of fumigation involving low phosphine levels, high temperatures, and high carbon dioxide levels for 24 hour periods in sealed structures have the potential for replacing some methyl bromide treatments of stored food products.

Studies carried out at the University of Purdue in the mid 1990s by David K. Mueller revealed that exposure to low phosphine levels (65-100 parts per million or 9% - 19% of standard phosphine concentration), heat (32-37EC), and 4% - 6% carbon dioxide produced 100% mortality in test stored product insects (eggs, larvae, and pupae of Angoumois grain moth, red flour beetle, warehouse beetle, and rice weevil). The process relies on heat and carbon dioxide to increase the susceptibility of insects to phosphine by interfering with insect metabolism. Using low concentrations of phosphine reduces the chance of corrosion of copper in electric connections and equipment, a common problem associated with phosphine use. Heat and carbon dioxide help reduce moisture, which tends to contribute to corrosion. This treatment requires a high level of precision in order to maintain the desired phosphine and carbon dioxide concentrations and heat levels. This area of research continues.

Additional proceedings from the 6th International Working Conference on Stored-product Protection claim that carbon dioxide with high pressure followed by sudden pressure loss provides a safe means of insect control leaving no residues, however, further research is needed to determine the relationship between time and pressure, the efficacy of this technique on immature stages of different species, and quality effects on various commodities, specifically walnuts. (Appendix 1).

The California walnut industry has spent US$958,000 since 1992 researching alternatives to methyl bromide. Industry leadership meets several times annually to determine future directions for research, as well as to discuss general trends with respect to post harvest alternatives. Numerous studies on alternatives such as controlled atmospheres, Phosphine in combination, magtoxin, phostoxin, the IMM granulosis virus, and sulfuryl fluoride have been financed and conducted since 1992. Magtoxin has proven to be more effective that phostoxin, as phostoxin creates odors in walnuts due to absorption; phosphine "may not be an effective commodity disinfestation treatment on certain whole nuts because it is highly and rapidly sorbed by the nuts and results in insufficient phosphine concentration for insect control".

Within the next two years, radio frequence waves will be tested, and according to Mitcham et al, "if this method can be economically integrated into the packing process, it would appear to have excellent potential as a disinfestation method for in-shell walnuts." This treatment requires only a few minutes of exposure, does not involve chemical applications, and there are no foreseen consumer marketing issues. However, studies to date have not yet been conducted on commercial production scales, and economic analysis of the additional cost per unit mass basis is warranted to determine this alternative's economic feasibility. A demonstration of radio frequency waves to industry leaders is scheduled for February 2002, to further determine the possibility of implementation on a commercial scale.

The walnut industry has also reduced its reliance on methyl bromide using Phosphine in combination where possible, once the receiving process has been complete. Phosphine in combination takes three days to effect insect kill. One other helpful alternative, also relevant to the pistachio sector, is the increased availability of the contact pesticide granulosis virus, to control outbreaks of the Indian meal moth. Additionally, the walnut industry collaborates extensively with the USDA, is supportive of efforts of chemical companies to conduct more trials using sulfuryl fluoride on foods, and pending the registration of sulfuryl fluoride.

The California pistachio industry has also funded efficacy and residue studies for sulfuryl fluoride, a fumigant that effectively controls many adult insect pests of stored products. However, its low effectiveness against insect eggs will limit its potential as a methyl bromide replacement. Like the walnut sector, the pistachio industry also collaborates extensively with the USDA in Parlier, CA and the University of California at Davis in order to research alternatives to methyl bromide, specifically sulfuryl fluoride. Although sulfuryl fluoride is effective against adult pests and de-gasses rapidly, it does not kill eggs and is not yet registered for use on food products in the U.S. Presently, the pistachio sector has spent US$20,000 on this research. In addition, the industry is currently testing the biological control agent IMM granulosis virus; laboratory tests have demonstrated positive results but efficacy in a commercial setting has not yet been demonstrated. However, this biological control agent is expected to be used extensively by organic growers. The applicant also donated 1 ton of pistachios to USDA for this research, and the tests are expected to be completed by approximately September 2003. Scientists from UC Davis are presently developing a proposal to research radio frequency waves as another alternative. This research is expected to conclude in approximately two years.

In order to further research alternatives to methyl bromide, the pistachio sector plans to investigate the following options:

- Improve fumigant efficacy
- Develop cost-effective gas application technology
- Improve the feasibility and economic viability of controlled atmospheres, heat and cold treatments, and other physical control techniques
- Further develop potential for recapture/recovery systems for methyl bromide which could eliminate or substantially reduce the release of methyl bromide into the atmosphere.
- Reducing the dosage of methyl bromide, phosphine, and other alternative chemical treatments through the addition of synergists or displaced fumigation techniques.

Obviously further research into the above-mentioned alternatives will warrant significant funding, but the California pistachio industry continues to support technically and economically feasible alternatives.

The California bean industry intends to collaborate extensively with the University of California Agricultural Extension program in the near future. The industry also tends to follow recommendations of the Dried Bean Board when deciding what effective alternatives to implement. Presently, the industry uses phostoxin when time is not a critical factor, but because of the extreme need for a 12-hour fumigant during harvest time, future research must focus on the need for a fast-acting fumigant that achieves a 100% mortality rate.

California's dried fruit industry has spent approximately US$1,000,000 on researching alternatives to methyl bromide. Industry also supplies commodities, facilities, equipment, and labor as needed, though some of the research is carried out by the USDA. The following studies are planned for 2003:

- Physical treatments for postharvest insects: Determine heat tolerance for moth species, identify stage and pest species most tolerant to vacuums, describe response of cowpea weevil eggs to commercial cold storage temperatures.
- Navel orangeworm phenology and movement: Determine seasonal prevalence and spatial variation during the first crop year.
- Pheromone-based control methods in the orchard: Begin navel orangeworm mating destruction and nitidulid attract-and-kill.
- Low temperature storage as a component of integrated postharvest systems: Complete low temperature studies for eggs of Indian meal moth and navel orangeworm
- Potential of insect pathogens: Continue walnut GMO work; begin gregarine studies; identify multi-host pathogens.
- Parasitoids as stored-product insects: Document reduction of insect fragments with parasitoids.
- Optimization of Indian meal moth pheromone trapping: Obtain purified components of sex pheromone, begin comparison of trap baits.
- Efficacy of chemicals of alternative fumigants: Determine the efficacy of propylene oxide and carbon dioxide mixtures against a variety of stored product insects.
- Trapping of fumigants: Determining the load of methyl bromide on activated carbon after repeated use and the effect of high moisture of the sorption process.
- Insect/plant volatiles and chemical detection of infestations: Test and calibrate various adsorbents for collection efficiencies for commodity and insect volatiles. Begin analyzing volatiles for signature patterns from insects and commodity.
- Integration of chemical/non-chemical techniques: Integrate technologies developed with non-chemical alternatives to form a systems approach.

The California dried fruit industry also funds pre-plant studies for fruit, nut, and vine crops.

While the U.S. government's role to find alternatives is primarily in the research arena, we know that research is only one step in the process. As a consequence, we have also invested significantly in efforts to register alternatives, as well as efforts to support technology transfer and education activities with the private sector.

Registration Program

The United States has one of the most rigorous programs in the world for safeguarding human health and the environment from the risks posed by pesticides. While we are proud of our efforts in this regard, related safeguards do not come without a cost in terms of both money and time. Because the registration process is so rigorous, it can take a new pesticide several years (3-5) to get registered by EPA. It also takes a large number of years to perform, draft results and deliver the large number of health and safety studies that are required for registration.

U.S. registration decisions are often the basis for other countries' pesticide regulations, which means that the benefits from assuring human and environmental safety accrue globally. Few countries, particularly in the developing world, have the resources to conduct and review these studies nor the market power to leverage chemical companies to perform and submit the necessary data. In recognition of this factor the USDA has provided some funding to help enable registration, and the U.S. EPA has introduced an accelerated review process for chemicals that are potential alternatives to uses of methyl bromide. This has involved a significant commitment of resources, and has resulted in fast track review of methyl bromide alternatives, such as sulfuryl fluoride. However, much work remains to be done.

The U.S. EPA regulates the use of pesticides under two major federal statutes: the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Federal Food, Drug, and Cosmetic Act (FFDCA), both significantly amended by the Food Quality Protection Act of 1996 (FQPA). Under FIFRA, EPA registers pesticides provided its use does not pose unreasonable risks to humans or the environment. Under FFDCA, the Agency is responsible for setting tolerances (maximum permissible residue levels) for any pesticide used on food or animal feed. With the passage of FQPA, the Agency is required to establish a single, health-based standard for pesticides used on food crops and to determine that establishment of a tolerance will result in a "reasonable certainty of no harm" from aggregate exposure to the pesticide.

The process by which EPA examines the ingredients of a pesticide to determine if they are safe is called the registration process. The Agency evaluates the pesticide to ensure that it will not have any adverse effects on humans, the environment, and non-target species. Applicants seeking pesticide registration are required to submit a wide range of health and ecological effects toxicity data, environmental fate, residue chemistry and worker/bystander exposure data and product chemistry data. A pesticide cannot be legally used in the U.S. if it has not been registered by EPA, unless it has an exemption from regulation under FIFRA.

Since 1997, the Agency has made the registration of alternatives to methyl bromide a high registration priority. Because the Agency currently has more applications pending in its review than the resources to evaluate them, EPA prioritizes the applications in its registration queue. By virtue of being a top registration priority, methyl bromide alternatives enter the science review process as soon as U.S. EPA receives the application and supporting data rather than waiting in turn for the EPA to initiate its review. Once the review process begins, it takes an average of 38 months to complete the registration.

As one incentive for the pesticide industry to develop alternatives to methyl bromide, the Agency has worked to reduce the burdens on data generation, to the extent feasible while still ensuring that the Agency's registration decisions meet the Federal statutory safety standards. Where appropriate from a scientific standpoint, the Agency has refined the data requirements for a given pesticide application, allowing a shortening of the research and development process for the methyl bromide alternative. Furthermore, Agency scientists routinely meet with prospective methyl bromide alternative applicants, counseling them through the preregistration process to increase the probability that the data is done right the first time and rework delays are minimized

The U.S. EPA has also co-chaired the USDA/EPA Methyl Bromide Alternatives Work Group since 1993 to help coordinate research, development and the registration of viable alternatives. The work group conducted six workshops in Florida and California (states with the highest use of methyl bromide) with growers and researchers to identify potential alternatives, critical issues, and grower needs covering the major methyl bromide dependent crops and post harvest uses.

This coordination has resulted in key registration issues (such as worker and bystander exposure through volatilization, township caps and drinking water concerns) being directly addressed through USDA's Agricultural Research Service's US$15 million per year research program conducted at more than 20 field evaluation facilities across the country. Also EPA's participation in the evaluation of research grant proposals each year for USDA's US$2.5 million per year methyl bromide alternatives research has further ensured close coordination between the U.S. government and the research community.
Since 1997, the U.S. EPA has registered the following chemical/use combinations as part of its commitment to expedite the review of methyl bromide alternatives:

- 2000: Phosphine in combination to control stored product insect pests
- 2001: Indian Meal Moth Granulosis Virus to control Indian meal moth in stored grains

EPA is currently reviewing several additional applications for registration as methyl bromide alternatives, with several registration eligibility decisions expected in the next several years, including:

- Sulfuryl fluoride as a post-harvest fumigant for stored commodities

While these activities appear promising, it must be noted that concerns about toxicity, drinking water contamination, and the release of air pollutants regarding some alternatives presents another difficulty that may restrict use since some of the affected facilities may be in sensitive areas such as those in close proximity to schools and homes.

It must be emphasized, however, that finding potential alternatives, and even registering those alternatives is not the end of the process. Alternatives must be tested by users and found technically and economically feasible before widespread adoption will occur. As noted by TEAP, a specific alternative, once available may take two or three cropping seasons of use before efficacy can be determined in the specific circumstance of the user. In an effort to speed adoption the U.S. government has also been involved in these steps by promoting technology transfer, experience transfer, and private sector training.

11. Conclusion and Policy Issues Associated with the Nomination

In summary, a review of the critical use exemption criteria in Decision IX/6 demonstrates that the Parties clearly understood the many issues that make methyl bromide distinctly different from the industrial chemicals previously addressed by the Parties under the essential use process. It is now the challenge of the MBTOC, TEAP and the Parties to consider the national submission of critical use nominations in the context of that criteria, and the information requirements established under Decision XIII/11.

In accordance with those Decisions, we believe that the U.S. nomination contained in this document provides all of the information that has been requested by the Parties. On the basis of an exhaustive review of a large, multi-disciplinary team of sector and general agricultural experts, we have determined that the MBTOC listed potential alternatives for the commodity sector are not currently technically or economically feasible from the standpoint of the U.S. commodity industry covered by this exemption nomination.

In addition, we have demonstrated that we have and will continue to expend significant efforts to find and commercialize alternatives to the use of methyl bromide for treating stored commodities. It must be stressed that the registration process, which is designed to ensure that new pesticides do not pose an unreasonable adverse effect to human health and the environment, is long and rigorous. The U.S. need for methyl bromide for the protection of stored commodities will be maintained for the period being requested.

In reviewing this nomination, we believe that it is important for the MBTOC, the TEAP and the Parties to understand some of the policy issues associated with our request. A discussion of those follows:

a. Request for Aggregate Exemption for All Covered Methyl Bromide Uses: As mandated by Decision XIII/11, the nomination information that is being submitted with this package includes information requested on historic use and estimated need in individual sectors. That said, we note our agreement with past MBTOC and TEAP statements which stress the dynamic nature of agricultural markets, uncertainty of specific production of any one crop in any specific year, the difficulty of projecting several years in advance what pest pressures might prevail on a certain crop, and, the difficulty of estimating what a particular market for a specific crop might look like in a future year. We also concur with the MBTOC's fear that countries that have taken significant efforts to reduce methyl bromide use and emissions through dilution with chloropicrin may be experiencing only short term efficacy in addressing pest problems. On the basis of those factors, we urge the MBTOC and the TEAP to follow the precedent established under the essential use exemption process for Metered Dose Inhalers (MDIs) in two key areas.

First, because of uncertainties in both markets and the future need for individual active moieties of drugs, the TEAP has never provided a tonnage limit for each of the large number of active moieties found in national requests for a CFC essential use exemption for MDIs, but has instead recommended an aggregate tonnage exemption for national use. This has been done with an understanding that the related country will ensure that the tonnage approved for an exemption will be used solely for the group of active moieties/MDIs that have been granted the exemption. We believe that the factors of agricultural uncertainty surrounding both pest pressures in future year crops, and efficacy of reduced methyl bromide application provide an even stronger impetus for using a similar approach here. The level of unpredictability in need leads to a second area of similarity with MDIs, the essential need for a review of the level of the request which takes into account the need for a margin of safety.

b. Recognition of Uncertainty in Allowing Margin for Safety: With MDIs, it was essential to address the possible change in patient needs over time, and in agriculture, this is essential to address the potential that the year being requested for could be a particularly bad year in terms of weather and pest pressure. In that regard, the TEAP's Chart 2 in Appendix D demonstrates the manner in which this need for a margin of safety was addressed in the MDI area. Specifically, Chart 2 in Appendix D tracks national CFC requests for MDIs compared with actual use of CFC for MDIs over a number of years.

Chart 2 in Appendix D demonstrates several things. First, despite the best efforts of many countries to predict future conditions, it shows that due to the acknowledged uncertainty of out-year need for MDIs, Parties had the tendency to request, the TEAP recommended, and the Parties approved national requests that turned out to include an appreciable margin of safety. In fact, this margin of safety was higher at the beginning – about 40% above usage – and then went down to 30% range after 4 years. Only after 5 years of experience did the request come down to about 10% above usage. While our experience with the Essential Use process has aided the U.S. in developing its Critical Use nomination, we ask the MBTOC, the TEAP and the Parties to recognize that the complexities of agriculture make it difficult to match our request exactly with expected usage when the nomination is made two to three years in advance of the time of actual use.

Chart 2 in Appendix D also demonstrates that, even though MDI requests included a significant margin of safety, the nominations were approved and the countries receiving the exemption for MDIs did not produce the full amount authorized when there was not a patient need. As a result, there was little or no environmental consequence of approving requests that included a margin of safety, and the practice can be seen as being normalized over time. In light of the similar significant uncertainty surrounding agriculture and the out year production of crops which use methyl bromide, we wish to urge the MBTOC and TEAP to take a similar, understanding approach for methyl bromide and uses found to otherwise meet the critical use criteria. We believe that this too would have no environmental consequence, and would be consistent with the Parties aim to phaseout methyl bromide while ensuring that agriculture itself is not phased out.

c. Duration of Nomination: It is important to note that while the request included for the use above appears to be for a single year, the entire U.S. request is actually for two years – 2005 and 2006. This multi-year request is consistent with the TEAP recognition that the calendar year does not, in most cases, correspond with the cropping year. This request takes into account the facts that registration and acceptance of new, efficacious alternatives can take a long time, and that alternatives must be tested in multiple cropping cycles in different geographic locations to determine efficacy and consistency before they can be considered to be widely available for use. Finally, the request for multiple years is consistent with the expectation of the Parties and the TEAP as evidenced in the Parties and MBTOC request for information on the duration of the requested exemption. As noted in the Executive Summary of the overall U.S. request, we are requesting that the exemption be granted in a lump sum of 9,920,965 kilograms for 2005 and 9,445,360 kilograms for 2006. While it is our hope that the registration and demonstration of new, cost effective alternatives will result in even speedier reductions on later years, the decrease in our request for 2006 is a demonstration of our commitment to work toward further reductions in our consumption of methyl bromide for critical uses. At this time, however, we have not believed it possible to provide a realistic assessment of exactly which uses would be reduced to account for the overall decrease.

12. Contact Information

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14. Appendices

Appendix A. List of Critical Use Exemption (CUE) requests for the Commodity Sector in the U.S.

CUE 02-0002, California Bean Shippers Associations in Storage

CUE 02-0015, California Dry Prune Board

CUE 02-0019, California Pistachio Processors

CUE 02-0030, California Walnut Commission

CUE 02-0033, Gwaltney of Smithfield (Ham)

Appendix B: Spreadsheets Supporting Economic Analyses

This appendix presents the calculations, for each sector, that underlie the economic analysis presented in the main body of the nomination chapter. As noted in the nomination chapter, each sector is comprised of a number of applications from users of methyl bromide in the United States, primarily groups (or consortia) of users. The tables below contain the analysis that was done for each individual application, prior to combining them into a sector analysis. Each application was assigned a unique number (denoted as CUE #), and an analysis was done for each application for technically feasible alternatives. Some applications were further sub-divided into analyses for specific sub- regions or production systems. A baseline analysis was done to establish the outcome of treating with methyl bromide for each of these scenarios. Therefore, the rows of the tables correspond to the production scenarios, with each production scenario accounting for row and the alternative(s) accounting for additional rows.

The columns of the table correspond to the estimated impacts for each scenario. (The columns of the table are spread over several pages because they do not fit onto one page.) The impacts for the methyl bromide baseline are given as zero percent, and the impacts for the alternatives are given relative to this baseline. Loss estimates include analyses of yield and revenue losses, along with estimates of increased production costs. Losses are expressed as total losses, as well as per unit treated and per kilogram of methyl bromide. Impacts on profits are also provided.

After the estimates of economic impacts, the tables contain basic information about the production systems using methyl bromide. These columns include data on output price, output volume, and total revenue. There are also columns that include data on methyl bromide prices and amount used, along with data on the cost of alternatives, and amounts used. Additional columns describe estimates of other production (operating) costs, and fixed/overhead costs.

The columns near the end of the tables combine individual costs into an estimate of total production costs, and compare total costs to revenue in order to estimate profits. Finally, the last several columns contain the components of the loss estimates.

Commodity (CM) Part A

Sector Summary of Economic Estimates					***Absolute Loss Per Representative Facility***						
CUE # 02-00	**Sector**	**Applicant**	**Alternative**	Technically Feasible?	Representative Facility Size	Direct Pest Control Costs ($ USD)	Capital Expenditure ($ USD)	Production Delays ($ USD)	**Total ($ USD)**	**Loss as a Percentage of Net Revenue**	**Loss as per Kilogram of Methyl Bromide Requested ($ USD)**
2	CM	Bean Shippers Assn	methyl bromide		0.3 million cubic feet						
2	CM	Bean Shippers Assn	Phosphine	Y	0.3 million cubic feet	$38,000	$42,000	$8,000	$88,000	154%	$218
15	CM	CA Dried Plum Board	methyl bromide		0.5 million cubic feet						
15	CM	CA Dried Plum Board	Phosphine	Y	0.5 million cubic feet	$14,000	$32,000	$92,000	$141,000	20%	$414
19	CM	CA Pistachio	methyl bromide		1.1 million cubic feet						
19	CM	CA Pistachio	Phosphine	Y	1.1 million cubic feet	-$10,000	$18,000	$1,510,000	$1,518,000	48%	$607
30	CM	CA Walnut	methyl bromide		0.3 million cubic feet						
30	CM	CA walnut	Phosphine	Y	0.3 million cubic feet	-$81,000	$519,000	$1,308,000	$1,746,000	12%	$80
33	CM	Gwaltney (Ham)	methyl bromide								
			Phosphine	N							

Commodity (CM) Part B															
Sector Summary of Economic Estimates					***Methyl Bromide or Alternative Costs***										
CUE # 02-00	**Sector**	**Applicant**	**Alternative**	Revenue per facility ($ USD)	Kg ai that would be applied per facility	Units of product applied per facility	Unit	Methyl Bromide cost per facility ($ USD)	Methyl Bromide cost per kgs ($ USD)	Appli-cation & other costs ($ USD)	Annual cost per facility ($ USD)	Cost of Goods Sold ($ USD)	Net Revenue ($ USD)	Loss as a % of Net Revenue	Loss per kilograms of Methyl Bromide ($ USD)
2	CM	Bean Shippers Assn	methyl bromide	$2,174,000	888	404	kg ai	$3,019.20	$7.47	$112,211	$115,230	$2,001,602	$57,168	0%	$0
2	CM	Bean Shippers Assn	Phosphine	$2,174,000							$153,000	$2,001,602	-$30,832	154%	$218
15	CM	CA Dried Plum Board	methyl bromide	$11,300,000	750	341	kg ai	$2,250.00	$6.60	$8,150	$10,400	$10,599,400	$690,200	0%	$0
15	CM	CA Dried Plum Board	Phosphine	$11,300,000							$20,800	$10,599,400	$549,200	20%	414
19	CM	CA Pistachio	methyl bromide	$178,200,000	5,500	2,500	kg ai	$16,500.00	$6.60	$80,025	$96,525	$174,992,400	$3,111,075	0%	$0
19	CM	CA Pistachio	Phosphine	$178,200,000							$86,525	$174,992,400	$1,593,075	49%	$607
30	CM	CA Walnut	methyl bromide	$237,700,000	48,221	21,919	kg ai	$65,755.91	$3.00	$646,244	$712,000	$222,249,500	$14,738,500	0.00%	$0
30	CM	CA walnut	Phosphine	$237,700,000							$631,000	$222,249,500	$12,992,500	12%	$80
33	CM	Gwaltney (Ham)	methyl bromide												
			Phosphine												

Appendix C: U.S. Technical and Economic Review Team Members

Christine M. Augustyniak (Technical Team Leader). Christine has been with the U.S. Environmental Protection Agency since 1985. She has held several senior positions, both technical and managerial, including Special Assistant to the Assistant Administrator for Prevention, Pesticides, and Toxic Substances, Chief of the Analytical Support Branch in EPA's office of Environmental Information and Deputy Director for the Environmental Assistance Division in the Office of Pollution Prevention and Toxics. She earned her Ph. D. (Economics) from The University of Michigan (Ann Arbor). Dr. Augustyniak is a 1975 graduate of Harvard University (Cambridge) *cum laude* (Economics). Prior to joining EPA, Dr. Augustyniak was a member of the economics faculty at the College of the Holy Cross (Worcester).

William John Chism (Lead Biologist). Bill has been with the U.S. Environmental Protection Agency since 2000. He evaluates the efficacy of pesticides for weed and insect control. He earned his Ph. D. (Weed Science) from Virginia Polytechnic Institute and State University (Blacksburg), a Master of Science (Plant Physiology) from The University of California (Riverside) and a Master of Science (Agriculture) from California Polytechnic State University (San Luis Obispo). Dr. Chism is a 1978 graduate of The University of California (Davis). For ten years prior to joining the EPA Dr. Chism held research scientist positions at several speciality chemical companies, conducting and evaluating research on pesticides.

Technical Team

Jonathan J. Becker (Biologist) Jonathan has been with the U.S. Environmental Protection Agency since 1997. He has held several technical positions and currently serves as a Senior Scientific Advisor within the Office of Pesticides Programs. In this position he leads the advancement of scientific methods and approaches related to the development of pesticides use information, the assessment of impacts of pesticides regulations, and the evaluation of the benefits from the use of pesticides. He earned his Ph. D. (Zoology) from The University of Florida (Gainesville) and a Masters of Science (Biology/Zoology) from Idaho State University (Pocatello). Dr. Becker is a graduate of Idaho State University. Prior to joining EPA, Dr. Becker worked as a senior environmental scientist with an environmental consulting firm located in Virginia.

Diane Brown-Rytlewski (Biologist) Diane is the Nursery and Landscape IPM Integrator at Michigan State University, a position she has held since 2000. She acts as liaison between industry and the university, facilitating research partnerships and cooperative relationships, developing outreach programs and resource materials to further the adoption of IPM. Ms. Rytlewski holds a Master of Science (Plant Pathology) and a Bachelor of Science (Entomology), both from the University of Wisconsin (Madison). She has over twenty year experience working in the horticulture field, including eight years as supervisor of the IPM program at the Chicago Botanic Garden.

Greg Browne (Biologist). Greg has been with the Agricultural Research Service of the U.S. Department of Agriculture since 1995. Located in the Department of Plant Pathology of the University of California (Davis), Greg does research on soilborne diseases of crop systems that currently use methyl bromide for disease control, with particular emphasis on diseases caused by *Phytophthora* species. He is the author of numerous articles on the use of alternatives to methyl bromide for the control of diseases in fruit and nut crops He earned his Ph. D. (Plant Pathology) from the University of California (Davis) and a Master of Science (Plant Pathology) from the same institution. Dr. Browne is a graduate of The University of California (Davis). Prior to joining USDA was a farm advisor in Kern County.

Nancy Burrelle (Biologist). Nancy Burelle is a Research Ecologist with USDA's Agricultural Research Service, currently working on preplant alternatives to methyl bromide. She earned both her Ph. D. and Master of Science degrees (both in Plant Pathology) from Auburn University (Auburn).

Linda Calvin (Economist). Linda Calvin is an agricultural economist with USDA's Economic Research Service, specializing in research on topics affecting fruit and vegetable markets. She earned her Ph. D. (Agricultural Economics) from The University of California (Berkeley).

Kitty F. Cardwell (Biologist). Kitty has been the National Program Leader in Plant Pathology for the U.S. Department of Agriculture Cooperative State Research, Extension and Education Service since 2001. In this role she administrates all federally funded research and extension related to plant pathology, of the Land Grant Universities throughout the U.S. She earned her Ph.D. (Phytopathology) from Texas A&M University (College Station). Dr. Cardwell is a 1976 graduate of The University of Texas (Austin) *cum laude* (Botany). For twelve years prior to joining USDA Dr. Cardwell managed multinational projects on crop disease mitigation and food safety with the International Institute of Tropical Agriculture in Cotonou, Bénin and Ibadan, Nigeria.

William Allen Carey (Biologist). Bill is a Research Fellow in pest management for southern forest nurseries , supporting the Auburn University Southern Forest Nursery Management Cooperative. He is the author of numerous articles on the use of alternative fumigants to methyl bromide in tree nursery applications. He earned his Ph. D. (Forest Pathology) from Duke University (Durham) and a Master of Science (Plant Pathology) from The University of Florida (Gainesville). Dr. Carey is a nationally recognized expert in the field of nursery pathology.

Margriet F. Caswell (Economist). Margriet has been with the USDA Economic Research Service since 1991. She has held both technical and managerial positions, and is now a Senior Research Economist in the Resource, Technology & Productivity Branch, Resource Economics Division. She earned her Ph.D. (Agricultural Economics) from the University of California (Berkeley). Dr. Caswell also received a Master of Science (Resource Economics) and Bachelor of Science (Natural Resource Management) from the University of Rhode Island (Kingston). Prior to joining USDA, Dr. Caswell was a member of both the Environmental Studies and Economics faculties at the University of California at Santa Barbara.

Tara Chand-Goyal (Biology). Tara has been with the U.S. Environmental Protection Agency since 1997. He serves in the Office of Pesticide Programs as a plant pathologist and specializes in analyzing the efficacy of pesticides with emphasis on risk reduction. He earned his Ph. D. (Mycology and Plant Pathology) from The Queen's University (Belfast) and a Master of Science (Plant Pathology and Mycology) from Punjab University (Ludhiana). Dr. Chand-Goyal is a graduate of Punjab University. Prior to joining EPA Dr. Chand-Goyal was a member of the faculty of The Oregon State University (Corvallis) and of The University of California (Riverside). His areas of research and publication include: the biology of viral, bacterial and fungal diseases of plants; biological control of plant diseases; and, genetic manipulation of microorganisms.

Daniel Chellemi (Biologist). Dan has been a research plant pathologist with the U.S. Department of Agriculture since 1997. His research speciality is the ecology, epidemiology, and management of soilborne plant pathogens. He earned his Ph.D. (Plant Pathology) from The University of California (Davis) and a Master of Science (Plant Pathology) from The University of Hawaii (Manoa). Dr. Chellemi is a 1982 graduate of the University of Florida (Gainesville) with a degree in Plant Science. He is the author of numerous articles in the field of plant pathology. In 2000 Dr. Chellemi was awarded the ARS "Early Career Research Scientist if the Year". Prior to joining USDA, Dr. Chellemi was a member of the plant pathology department of The University of Florida (Gainesville).

Angel Chiri (Biologist). Angel has been with the U.S. Environmental Protection Agency since 1997. He serves in the Office of Pesticide Programs as an entomologist and specializes in analyzing the efficacy of pesticides with emphasis on benefits of pesticide use. He earned his Ph. D. (Entomology) from The University of California (Riverside) and a Master of Science (Biology/Entomology) from California State University (Long Beach). Dr. Chiri is a graduate of California State University (Los Angeles). Prior to joining EPA Dr. Chiri was a pest and pesticide management advisor for the U.S. Agency for International Development working mostly in Latin America on IPM issues.

Colwell Cook (Biologist). Colwell has been with the U.S. Environmental Protection Agency since 2000. She serves in the Office of Pesticide Programs as an entomologist and specializes in analyzing the efficacy of pesticides with emphasis on benefits of pesticide use. She earned her Ph. D. (Entomology) from Purdue University (West Lafayette) and has a Master of Science (Entomology) from Louisiana State University (Baton Rouge). Dr. Cook is a 1979 graduate of Clemson University. Prior to joining EPA Dr. Cook held several faculty positions at Wabash College (Crawfordsville) and University of Evansville (Evansville).

Julie B. Fairfax (Biologist) Julie has been with the U.S. Environmental Protection Agency since 1989. She currently serves as a senior biologist in the Biological and Economics Analysis Division, and has previously served as a Team Leader in other divisions within the Office of Pesticides Programs. She has held several technical positions specializing in the registration, re-registration, special review and regulation of fungicidal, antimicrobial, and wood preservative pesticides. Ms. Fairfax is a 1989 graduate of James Madison University (Harrisonburg, VA) where she earned her degree in Biology. Prior to joining EPA, Julie worked as a laboratory technician for the Virginia Poultry Industry.

John Faulkner (Economist) John has been with the U. S . Environmental Protection Agency since 1989. He serves in the Office of Pesticide Programs analyzing the costs imposed by the regulation of pesticides. He earned his Ph. D. (Economics) from the University of Colorado (Boulder) and holds a Master's of Business Administration from The University of Michigan (Ann Arbor). Dr. Faulkner is a 1965 graduate of the University of Colorado (Boulder). Prior to joining EPA was a member of the economics faculty of the Rochester Institute of Technology (Rochester), The University of Colorado (Boulder) and of the Colorado Mountain College (Aspen).

Clara Fuentes (Biologist). Clara has been with the U.S. Environmental Protection agency since 1999, working in the Philadelphia, Pennsylvania (Region III) office. She specializes in reviewing human health risk evaluations to pesticides exposures and supporting the state pesticide programs in Region III. She earned her Ph. D. (Entomology) from The University of Maryland (College Park) and a Master of Science (Zoology) from Iowa State University (Ames). Prior to joining EPA, Dr. Fuentes worked as a research assistant at U.S. Department of Agriculture, Agricultural Research Service (ARS) (Beltsville), Maryland, and as a faculty member of the Natural Sciences Department at InterAmerican University of Puerto Rico. Her research interest is in the area of Integrated Pest Management in agriculture.

James Gilreath (Biologist). Jim has been with the University of Florida Gulf Coast Research and Education Center since 1981. In this position his primary responsibilities are to plan, implement and publish the results of investigations in weed science in vegetable and ornamental crops. One main focus of the research is the evaluation and development of weed amangement programs for specific weed pests. He earned his Ph.D. (Horticulture) from The University of Florida (Gainesville) and a Master of Science, also in Horticulture, from Clemson University (Clemson). Dr. Gilreath is a 1974 graduate of Clemson University (Clemson) with a degree in Agronomy and Soils.

Arthur Grube (Economist). Arthur has been with the U.S. Environmental Protection Agency since 1987. He is now a Senior Economist in the Biological and Economics Analysis Division, Office of Pesticide Programs. He earned his Ph.D. (Economics) from North Carolina State University (Raleigh) and a Masters of Arts (Economics) also from North Carolina State University. Dr. Grube is a 1970 graduate of Simon Fraser University (Vancouver) where his Bachelor of Arts degree (Economics) was earned with honors. Prior to joining EPA Dr. Grube conducted work on the costs and benefits of pesticide use at the University of Illinois (Urbana). Dr. Grube has been a co-author of a number of journal articles in various areas of pesticide economics

LeRoy Hansen (Economist). LeRoy Hansen is currently employed as an Agricultural Economist for the USDA Economic Research Service, Resource Economics Division in the Resources and Environmental Policy Branch.

He received his Ph.D. in resource economics from Iowa State University (Ames) in 1986. During his 16 years at USDA, Dr. Hansen has published USDA reports, spoken at profession meetings, and appeared in television and radio interviews.

Frank Hernandez (Economist). Frank has been with the U.S. Environmental Protection Agency since 1991. He is a staff economist at the Biological and Economic Analysis Division of the Office of Pesticide Programs. He holds degrees in Economics and Political Science from the City University of New York.

Arnet W. Jones (Biologist). Arnet has been with the U.S. Environmental Protection Agency since 1990. He has had several senior technical and management positions and currently serves as Chief of the Herbicide and Insecticide Branch, Biological and Economic Analysis Division, Office of Pesticide Programs. Prior to joining EPA he was Senior Agronomist at Development Assistance Corporation, a Washington, D.C. firm that specialized in international agricultural development. He holds a Master of Science (Agronomy) from the University of Maryland (College Park).

Hong-Jin Kim (Economist). Jin has been an economist at the National Center for Environmental Economics at the U.S. Environmental Protection Agency (EPA) since 1998. His primary areas of research interest include environmental cost accounting for private industries He earned his Ph.D. (Environmental and Resource Economics) from The University of California (Davis) and holds a Master of Science from the same institution. Dr. Kim is a 1987 graduate of Korea University (Seoul) with a Bachelor of Arts (Economics). Prior to joining the U.S. EPA, Dr. Kim was an assistant professor at the University of Alaska (Anchorage) and an economist at the California Energy Commissions. Dr. Kim is the author of numerous articles in the fields of resource and environmental economics.

James Leesch (Biologist). Jim has been a research entomologist with the Agricultural Resarch Service of the U.S. Department of Agriculture since 1971. His main area of interest is post-harvest commodity protection at the San Joaquin Valle. He earned his Ph.D. (Entomology/ Insect Toxicology) from The University of California (Riverside) Dr. Leesch received a B.A. degree in Chemistry from Occidental College in Los Angeles, CA in 1965. He is currently a Research entomologist for the Agricultural Research Service (USDA) researching Agricultural Sciences Center in Parlier, CA. He joined ARS in June of 1971.

Sean Lennon (Biologist). Sean is a Biologist interning with the Office of Pesticide Programs of the U.S. Environmental Protection Agency. He will receive his M.S. in Plant and Environmental Science in December 2003 from Clemson University (Clemson). Mr. Lennon is a graduate of Georgia College & State University (Milledgeville) where he earned a Bachelor of Science (Biology). Sean is conducting research in Integrated Pest Management of Southeastern Peaches. He has eight years of experience in the commercial peach industry.

Nikhil Mallampalli (Biologist). Nikhil has been with the U.S. Environmental Protection Agency since 2001. He is an entomologist in the Herbicide and Insecticide Branch of the Biological and Economic Analysis Division. His primary duties include the assessment of pesticide efficacy in a variety of crops, and analysis of the impacts of risk mitigation on pest management. Dr. Mallampalli earned his Ph.D. (Entomology) from The University of Maryland (College Park) and holds a Master of Science (Entomology) from the samr institution. Prior to joining the EPA, he worked as a postdoctoral research fellow at Michigan State University (East Lansing) on IPM projects designed to reduce reliance on pesticides in small fruit production.

Tom Melton (Biologist). Tom has been a member of the Plant Pathology faculty at North Carolina State University since 1987. Starting as an assistant professor and extension specialist, Tom has become the Philip Morris Professor at North Carolina State University. His primary responsibilities are to develop and disseminate disease management strategies for tobacco. Dr. Melton earned his Ph.D. (Plant Pathology) from The University of Illinois (Urbana-Champaign) and holds a Master of Science (Pest Management) degree from North Carolina State University (Raleigh). He is a 1978 graduate of Norht Carolina State University (Raleigh)

Prior to joining the North Carolina State faculty, Dr. Melton was a member of the faculty at The University of Illinois (Urbana- Champaign).

Richard Michell (Biologist). Rich has been with the U.S. Environmental Protection Agency since 1972. He is a nematologist/plant pathologist in the Herbicide and Insecticide Branch of the Biological and Economic Analysis Division. His primary duties include the assessment of pesticide efficacy in a variety of crops, with special emphasis on fungicide and nematicide use and the development of risk reduction options for fungicides and nematicides. Dr. Michell earned his Ph.D. (Plant Pathology/Nematology) from The University of Illinois (Urbana-Champaign) and holds a Master of Science degree (Plant Pathology/Nematology) from The University of Georgia (Athens).

Lorraine Mitchell (Economist). Lorraine has been an agricultural economist with the U.S. Department of Agriculture, Economic Research Service since 1998. She works on agricultural trade issues, particularly pertaining to consumer demand in the EU and emerging markets. Dr. Mitchell earned her Ph.D. (Economics) from The University of California (Berkeley). Prior to joining ERS, Dr. Mitchell was a member of the faculty of the School of International Service of The American University (Washington) and a research assistant at the World Bank.

Thuy Nguyen (Chemist). Thuy has been with the U.S. Environmental Protection Agency since 1997, as a chemist in the Office of Pesticides Program. She assesses and characterizes ecological risk of pesticides in the environment as a result of agricultural uses. She earned her degrees of Master of Science (Chemistry) from the University of Delaware and Bachelor of Science (Chemistry and Mathematics) from Mary Washington College (Fredericksburg, VA). Prior to joining the EPA, Ms Nguyen held a research and development scientist position at Sun Oil company in Marcus Hook, PA, then managed the daily operation of several EPA certified laboratories for the analyses of pesticides and other organic compounds in air, water, and sediments.

Jack Norton(Biologist). Jack has worked for the U.S. Department of Agriculture Interregional research Project #4 (IR-4) as a consultant since 1998. The primary focus of his research is the investigation of potential methyl bromide replacement for registration on minor crops. He is an active member of the USDA/EPA Methyl Bromide Alternatives Working Group. Dr, Norton earned his Ph.D. (Horticulture) from Texas A&M University (College Station) and holds a Master of Science (Horticultural Science) from Oklahoma State University(Stillwater). He is a graduate of Oklahoma State University (Stillwater). Prior to joining the IR-4 program, Dr. Norton worked in the crop protection industry for 27 years where he was responsible for the development and registration of a number of important products.

Olga Odiott (Biologist) Olga has been with the U.S. Environmental Protection Agency since 1989. She has held several technical positions and currently serves as a Senior Biologist within the Office of Science Coordination and Policy. In this position she serves as Designated Federal Official and liaison on behalf of the Office of Pesticide Programs and the FIFRA Scientific Advisory Panel, an independent peer review body that provides advice to the Agency on issues concerning the impact of pesticides on health and the environment. She holds a Masters of Science (Plant Pathology) from the University of Puerto Rico (San Juan). Prior to joining EPA, Ms. Odiott worked for the U.S. Department of Agriculture.

Craig Osteen(Economist). Craig has been with the U.S. Department of Agriculture for over 20 years. He currently is with the Economic Research Service in the Production Management and Technology Branch, Resource Economics Division. He primary areas of interest relate to issues of pest control, including pesticide regulation, integrated pest management, and the methyl bromide phase out. Dr. Osteen earned his Ph.D. (Natural Resource Economics) from Michigan State University (East Lansing).

Elisa Rim (Economist). Elisa is an Agricultural Economist interning with the Office of Pesticide Programs of the U.S. Environmental Protection Agency. She earned her Master of Science (Agricultural Economics) from The Ohio State University (Columbus) and holds a Bachelor of Arts (Political Science) from the same institution. She has conducted research in environmental economics and developed a cost analysis optimization model for stream naturalization projects in northwest Ohio.

Erin Rosskopf (Biologist). Erin received her PhD from the Plant Pathology Department, University of Florida, Gainesville in 1997. She is currently a Research Microbiologist with the USDA, ARS and has served in this position for 5 years.

Carmen L. Sandretto (Agricultural Economist). Carmen has been with the Economic Research Service of the U.S. Department of Agriculture for over 30 years in a variety of assignments at several field locations, and since 1985 in Washington, DC. He has worked on a range of natural resource economics issues and in recent years on soil conservation and management, pesticide use and water quality, and small farm research studies. Mr. Sandretto holds a Master of Arts degree (Economics) from Harvard University (Cambridge) and a Master of Science (Agricultural Economics) from The University of Wisconsin (Madison). Mr Sandretto is a graduate of Michigan State University (East Lansing). Prior to serving in Washington, D.C. he was a member of the economics faculty at Michigan State University and at the University of New Hampshire (Durham).

Judith St. John (Biologist). Judy has been with the USDA's Agricultural Research Service since 1967. She currently serves as Associate Deputy Administrator and as such she is responsible for the Department's intramural research programs in the plant sciences, including those dealing with pre- and post-harvest alternatives to methyl bromide. Dr. St. John earned her Ph.D. (Plant Physiology) from The University of Florida (Gainesville).

James Throne (Biologist). Jim is a Research Entomologist with the U.S. Department of Agriculture's Agricultural Research Service and Research Leader of the Biological Research Unit at the Grain Marketing and Production Research Center in Manhattan, Kansas. He conducts research in insect ecology and development of simulation models for improving integrated pest management systems for stored grain and processed cereal products. Other current areas of research include investigating seed resistance to stored-grain insect pests and use of near-infrared spectroscopy for detection of insect-infested grain. Jim has been with ARS since 1985. Dr. Throne earned his Ph.D. (Entomology) in 1983 from Cornell University (Ithaca) and earned a Master of Science Degree (Entomology) in 1978 from Washington State University (Pullman). Dr. throne is a 1976 graduate (Biology) of Southeastern Massachusetts University (N. Dartmouth).

Thomas J. Trout (Agricultural Engineer). Tom has been with the U.S. Department of Agriculture, Agricultural Research Service since 1982. He currently serves as research leader in the Water Management Research Laboratory in Fresno, CA. His present work includes studying factors that affect infiltration rates and water distribution uniformity under irrigation, determining crop water requirements, and developing alternatives to methyl bromide fumigation. Dr. Trout earned his Ph.D. (Agricultural Engineering) from Colorado State University (Fort Collins) and holds a Master of Science degree from the same institution, also in agricultural engineering. Dr. Trout is a 1972 graduate of Case Western Reserve University (Cleveland) with a degree in mechanical engineering. Prior to joining the ARS, Dr. trout was a member of the engineering faculty of Colorado State University (Fort Collins). He is the author of numerous publications on the subject of methyl bromide alternatives.

J. Bryan Unruh (Biologist). Bryan is Associate Professor of Environmental Horticulture at The University of Florida (Milton) and an extension specialist in turfgrass. He leads the statewide turfgrass extension design team. Dr. Unruh earned his Ph.D. (Horticulture) from Iowa State University (Ames) and holds a Master of Science degree (Horticulture) from Kansas State University (Manhattan). He is a 1989 graduate of Kansas State University.

David Widawsky (Chief, Economic Analysis Branch). David has been with the U.S. Environmental Protection Agency since 1998. He has also served as an economist and a team leader. As branch chief, David is responsible for directing a staff of economists to conduct economic analyses in support of pesticide regulatory decisions. He earned his Ph.D. (Development and Applied Economics) from Stanford University (Palo Alto), and a Master of Science (Agricultural Economics) from Colorado State University (Fort Collins). Dr. Widawsky is a 1987 graduate (Plant and Soil Biology, Agricultural Economics) of the University of California (Berkeley). Prior to joining EPA, Dr. Widawsky conducted research on the economics of integrated pest management in Asian rice production, while serving as an agricultural economist at the International Rice Research Institute (IRRI) in the Philippines.

TJ Wyatt (Economist). TJ has been with the U. S. Environmental Protection Agency since 2001. He serves in the Office of Pesticide Programs analyzing the costs and benefits of pesticide regulation. His other main area of research is farmer decision-making, especially pertaining to issues of soil fertility and soil conservation and of pesticide choice. Dr. Wyatt earned his Ph.D. (Agricultural Economics) from The University of California (Davis). Dr. Wyatt holds a Master of Science (International Agricultural Development) from the same institution. He is a 1985 graduate of The University of Wyoming (Laramie). Prior to joining the EPA, he worked at the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) and was based at the Sahelian Center in Niamey, Niger.

Leonard Yourman (Biologist). Leonard is a plant pathologist with the Biological and Economic Analysis Division of the U. S. Environmental Protection Agency. He currently conducts assessments of pesticide use as they relate to crop diseases. He earned his Ph. D. (Plant Pathology) from Clemson University (Clemson) and holds a Master of Science (Horticulture/ Plant Breeding) from Texas A&M University (College Station). Dr. Yourman is a graduate (English Literature) of The George Washington University (Washington, DC).. Prior to joining EPA, he conducted research on biological control of invasive plants with USDA at the Foreign Disease Weed Science Research Unit (Ft. Detrick, MD). He has also conducted research on biological control of post harvest diseases of apples and pears at the USDA Appalachian Fruit Research Station (Kearneysville, WV). Research at Clemson University concerned the molecular characterization of fungicide resistance in populations of the fungal plant pathogen *Botrytis cinerea.*

Istanbul Yusuf (Economist). Istanbul has been with the U. S. Environmental Protection Agency since 1998. She serves in the Office of Pesticide Programs analyzing the costs imposed by the regulation of pesticides. She earned her Masters degree in Economics from American University (Washington). Ms Yusuf is a 1987 graduate of Westfield State College (Westfield) with a Bachelor of Arts in Business Administration. Prior to joining EPA Istanbul worked for an International Trading Company in McLean, Virginia.

Appendix D: CHARTS

Charts 1 and 2 attached as separate electronic file.