2003 NOMINATION FOR A CRITICAL USE EXEMPTION FOR FRESH MARKET TOMATOES 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 fresh market tomatoes, like the nomination for all other crops 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. Fresh market tomatoes is one of these uses. With that understanding, the fully integrated U.S. nomination for tomatoes 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 United States believes that it is vitally important for the 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, and not 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 exemption for methyl bromide are much different from the criteria negotiated for "essential uses" for other chemicals.*

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.

For the U.S. nomination for fresh market tomatoes, following detailed technical and economic review, the U.S. has determined that some use of methyl bromide in tomato production is critical to ensuring that there is no significant market disruption. The detailed analysis of technical and economic viability of the alternatives listed by MBTOC for use in growing tomatoes is discussed later in this nomination, and 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 health and 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. where a particular crop is grown can take many cropping seasons 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 risk 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. However, the Parties clearly understood that this was not the case with methyl bromide. 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 in growing fresh market tomatoes, as well as U.S. efforts to minimize the use of methyl bromide, to research alternatives, and to register alternatives for fresh market tomatoes.

4. U.S. Consideration/Preparation of the Critical Use Exemption for Fresh Market Tomatoes

Work on the U.S. critical use exemption process began in early 2001. At that time, the U.S. Environmental Protection Agency (U.S. 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 literally 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 tomato growers 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 Agricultural Production

5a. U.S. Agriculture

The U.S. is fortunate to have a large land expanse, productive soils and a variety of favorable agricultural climates. These factors contribute to and enable the U.S. to be a uniquely large and productive agricultural producer. Indeed, the size and scope of farming in the U.S. is different than in most countries. Specifically, in 2001, U.S. farm land totaled 381 million hectares, a land mass larger than the entire size of many entire countries. Of this, approximately 140 million hectares were devoted to cropland, with the rest devoted to pasture, forest, and other special uses. There were 2.16 million farms, with an average farm size across all farms of 176 hectares (approximately 10 times larger than average farm sizes in the European Union). The availability of land in these regions, and the fact that these U.S. regions are conducive to outdoor cultivation of fruits and vegetables has had an important influence on the way agriculture has developed. Specifically, these factors have meant that greenhouse production has generally proven to be very costly (in relative terms) and has as a consequence, been limited.

Other factors also affected the general development of agriculture in the U.S.. While land for farming is widely available, labor is generally more expensive and less plentiful. As a result, the U.S. has developed a unique brand of highly mechanized farming practices that 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 on U.S. farms: in 2001, only 2.05 million self-employed and unpaid workers operated the 2.16 million U.S. farms, with help from less than 1 million hired workers.

U.S. agriculture is also unique in terms of the broad range of crops produced. For example, the fruit and vegetable sector, the agricultural sector most reliant on methyl bromide, is diverse, and includes production of 107 separate fruit and vegetable commodities or groups of commodities. With this diversity, however, has come a large number of pest problems that methyl bromide has proven uniquely able to address.

Finally, the above factors have contributed to a harvest of commodities that has enabled the U.S. to meet not only its needs, but also the needs of many other countries. The U.S. produced 88.3 million metric tonnes of fruits and vegetables in 2001, up 10 percent from 1990. At the same time, the land planted in fruits and vegetables has remained stable, and individual farm size has increased as the number of farms has fallen. The related yield increases per land area are almost exclusively related to non-labor inputs, like the adoption of new varieties, and the application of new production practices, including plastic mulches, row covers, high-density planting, more effective pesticide sprays, and drip irrigation, as well as increased irrigation practices. Optimization of yields through these and other scientific and mechanized practices make U.S. agricultural output very sensitive to changes in inputs. 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 production of certain crops in certain areas.

5b. Fresh Market Tomato Production

U.S. fresh market tomato production exemplifies many of the characteristics of U.S. agriculture noted above. Fresh market tomatoes are a long-season commodity grown in most of the major vegetable growing areas of the U.S., and Florida and California were the leading producers, accounting for almost two-thirds of the hectares used to grow fresh tomatoes in the United States in 2001. Florida produced about 41 percent of U.S. fresh market tomatoes, while California ranked second with 39 percent. Virginia, Georgia, Michigan, and other Southeastern states (SE) also produced fresh market tomatoes. As a consequence, this nomination covers methyl bromide use in a variety of areas with differing soil and climactic characteristics. Another factor that makes the tomato sector typical of US agriculture is its size. Fresh market tomatoes comprise over $4 billion USD retail value and were harvested from 52,092 hectares (128,720 acres) producing 1,678,000 tonnes (36,964,000 cwt) in 2001.

Seventy percent of U.S. fresh tomatoes are domestically consumed with 30 percent exported to the world market. The U.S. is still a net importer of fresh tomatoes from Canada and Mexico with the total import value of $721 million USD in 2001. Fresh tomatoes are available year-round in the United States. The price of fresh market tomatoes varies during the year. Prices are the lowest during August and September when supplies of locally grown tomatoes in most states are highest.

Finally, tomatoes grown in the U.S. are generally produced using mechanized, scientific practices that involve deep injection of methyl bromide. Tomatoes require intense management, including the use of a broad-spectrum soil fumigant, polyethylene mulch, fertilizers, irrigation and pesticides. Plants are in the field for 4 to 8 months, depending on the season and location. Tomato crops are sometimes double-cropped with a cucurbit crop after harvest (e.g., cucumber, squash, watermelon), and in some areas, specialty peppers (e.g., chili peppers, pimentos, jalapeño peppers) are planted as a second short-season crop.

Tomato growers in Michigan and some areas in Southeastern states have significant pest problems that are currently controlled using methyl bromide, including combinations of fungi, nematodes, and nutsedge (4, 5, 6, 11, 12). In Michigan, the moderate weather (18 to 22° C) with high humidity favors the develop of Phytophthora, which can be a devastating fungal pathogen in tomatoes. There are currently no effective registered alternatives for controlling this pathogen when disease pressure is high, and in Michigan, Phytophthora is a primary reason for using methyl bromide, although weed and nematode control are also important benefits from fumigation. In Southeastern states, methyl bromide is used to control soil-borne fungi, nematodes, and weeds. While these are all important pests, methyl bromide is particularly needed in the Southeastern U.S. to control nutsedge, a weed that can seriously diminish yields in fresh market tomatoes (as well as many other crops). There are currently no registered herbicides that are effective in controlling moderate to high level of nutsedge infestations.

Methyl bromide is typically used in combination with chloropicrin at a rate of 120 to 252 kg per hectare (107 to 225 lbs per acre). The application rate depends on the climatic region, application method (e.g. raised bed vs. full field), soil type, and soil-borne pest pressure. Full field applications and heavy soils tend to increase application rates, while raised bed and light soils tend to decrease application rates. Other things being equal, higher pest pressure, particularly weed pressure, leads to higher application rates. Methyl bromide application rates in Southeastern states tend to be higher than those in Michigan when all these factors are taken into account.

Over the past 30 years, methyl bromide and methyl bromide-chloropicrin combinations have become the standard fumigant in fresh market tomatoes produced with polyethylene mulch. These fumigations are highly effective in controlling wide spectrum of soil-borne pests under different weather conditions, and are particularly important for disease control in Michigan and weed control in Southeastern states. Estimates of the impact of the loss of methyl bromide in vegetable production suggest that without methyl bromide, a significant proportion of U.S. fresh market tomato production will no longer be economically feasible. Results from ongoing research evaluating alternatives to methyl bromide lead to the conclusion that methyl bromide cannot be replaced with a single chemical or cultural tactic.

As a consequence, this nomination covers use in several tomato producing area in the U.S., with differing soil and climactic characteristics. Specifically, the U.S. nominates fresh market tomatoes in the Southeastern U.S. and in the State of Michigan for a critical use exemption. The U.S. is not nominating fresh tomato production in California, because the U.S. has found that it is not a critical need. The U.S. interdisciplinary review team found a critical need for some methyl bromide use in tomato production in the southeastern States (Florida, Georgia, Virginia, Alabama, Arkansas, North Carolina, South Carolina and Tennessee), and Michigan due to significant pest pressure from weeds (specifically, nutsedge) or fungal pathogens (specifically, *Phytophthora*) and/or restrictions on the use of alternatives due to domestic regulations. By consensus, the methyl bromide review group supported the finding that potential yield losses associated with methyl bromide alternatives lead to significant market disruption and economic infeasibility of alternatives in the areas with high pest pressure in the Southeastern states, and in all of Michigan tomato production due to widespread disease potential.

6. Results of Review - Determined Need for Methyl Bromide in the Production of Tomatoes

<u>6a. Target Pests Controlled with Methyl Bromide</u>

In growing fresh market tomatoes, weeds—especially nutsedge—are the most serious concern precipitating methyl bromide use in both transplant beds and in the field. The critical use exemption nomination for the southeastern U.S. is primarily based on the lack of reliable alternatives to control nutsedge species. Nutsedge species grow even under adverse growing conditions and resist traditional and modern methods of weed control and are endemic to large tracts of the fresh market tomato producing area in the Southeast region of the U.S.. Herbicides are applied to the row middles between raised production beds to manage grass and broadleaf weeds - but there are no currently registered herbicides to address high sedge weed pest pressures. Fungal diseases (such as

Phytophthora blight) are also of great concern and are commonly more of a problem than nutsedge in Michigan, the second area covered in this nomination. These pests are expected to become serious problems for fresh market tomato production if methyl bromide were not available for pre-plant fumigation.

In addition to nutsedge, fresh market tomato producers in the Southeastern U.S. have to contend with a variety of other pests, pests currently controlled using methyl bromide. These pests include weeds (nightshades and broad leaf weeds), fungal pathogens (*Phytophthora, Pythium, Verticillium, Fusarium* spp., *Rhizoctonia* spp., *Sclerotium rolfsii*), and nematodes (root-knots caused by *Meloidogyne* spp., *Pratylenchus, Rotylenchus*, *Belonolaimus*). Michigan tomato producers rely on methyl bromide to control *Phytophthora capsici,* but in so doing also achieve control of wilts (*Verticillium* spp., and *Fusarium oxysporum* f. sp. *lycopersicae*). A discussion of these pests follows.

Yellow & purple nutsedge: (*Cyperus* spp.) Yellow nutsedge (*Cyperus esculentus* L.) and purple nutsedge *Cyperus rotundus* L.) are perennial species of the Cyperacea family that are widely recognized for their detrimental economic impact on agriculture. Purple nutsedge is considered the world's worst weed due to its widespread distribution and the difficulties in controlling it (16). Purple nutsedge is considered a weed in at least 92 countries and is reported infesting at least 52 different crops. Yellow nutsedge is listed among the top fifteen worst weeds. Yellow nutsedge is found throughout the continental U.S. Purple nutsedge is primarily found in southern coastal U.S. and along the Pacific coast in California and Oregon. A survey conducted in Georgia ranked the nutsedges as the most troublesome weeds in vegetable crops (there are more 30 vegetable crops grown in Georgia) and among the top five most troublesome weeds in corn, cotton, peanut, and soybean (17).

Nutsedge is propagated by tubers formed along underground rhizomes and corms. The parent tuber could be a tuber or a corm from the previous generation. During tillage of the soil, the underground stems are broken and new plants are established from either single or chains of tubers or corms. A single plant is capable of producing 1,200 new tubers within 25 weeks (18). Each tuber is capable of sprouting several times (19). Tuber populations between 1,000 and 8,700 per/m^2 have been reported for purple nutsedge (20). Nutsedge is very difficult to eradicate once it is established because of dormancy factors in the tubers and their ability to survive an array of adverse conditions for long periods of time. Nutsedge species are strong competitors with most vegetable crops for water and nutrients and can dramatically reduce crop yields, even at low plant densities, if not controlled effectively.

Purple and yellow nutsedge are serious problems in polyethylene film mulch vegetable production systems. Most weeds are controlled by these films, but nutsedges are able to penetrate the plastic films and actively compete with the vegetable crops, causing yield losses reported between 41 and 89 percent (21).

There are very few herbicides that provide effective nutsedge control and the only one registered for use on tomatoes, pebulate, is no longer available since the registration expired on December 31, 2002 and the registrant is bankrupt. The herbicides that are available for these crops are generally older chemicals that are marginally effective against the spectrum of weeds that are problematic for solanaceous crops. Among the areas covered by this nomination for continued methyl bromide use in fresh market tomatoes, 15 to 60 percent of production areas are moderately to highly infested with nutsedge, with the majority falling in the 40 to 60 percent range.

Fungal diseases. Phytophthora blight, caused by *Phytophthora capsici*, causes seed rot and seedling blight in many solanaceous crops including eggplants, pepper, and tomato. Phytophthora blight is one of the most destructive diseases and there are few control measures. Resistance to metalaxyl has been documented for *Phytophthora* species. Southern stem blight, caused by *Sclerotium rolfsii*, is also a very common and destructive disease affecting tomatoes, and other solanaceous crops. In Michigan's tomato producing areas, *Phytophthora* is the major problem controlled with methyl bromide, and this disease is endemic to the entire tomato producing areas in Michigan. Other fungal pathogens (*Verticillium, Fusarium* spp., *Rhizoctonia* spp.) can also infect tomatoes and are controlled by methyl bromide soil fumigation.

Root-knot nematode (*Meloidogyne* spp.) Root damage caused by these nematodes leads to reduced rooting systems, which in turn lead to reduced water and nutrient uptake. The gall formation induced by the nematodes at their root feeding sites results in symptoms like stunting, wilting, and chlorosis, and renders the plant more susceptible to secondary infections. Preplant control of nematodes is important because once root damage is done and symptoms are evident, it is very difficult to avoid significant yield losses. Nematodes are found in all tomato producing regions in the U.S..

6b. Overview of Technical and Economic Assessment of Alternatives

Tomato growers rely on fumigation with methyl bromide/chloropicrin within the plastic mulch production system to control soil borne diseases and pests. In the Southeastern states, where methyl bromide is needed to produce fresh market tomatoes, this fumigation system is designed to allow effective sedge control in tomato production. In Michigan, this system is effective in controlling fungal diseases where other controls are ineffective. In both areas, methyl bromide is also effective in controlling nematodes, other weeds, and diseases other than Phytophthora blight.

There has been extensive research on alternatives for the tomato sector, and have been incorporated into production systems where possible. However, the effectiveness of chemical alternatives in fully replacing methyl bromide depends critically on pest pressure: under conditions of low to moderate pest pressure, methyl bromide alternatives may be effective, but are almost invariably technically and economically infeasible when pest pressure is high. For non-chemical alternatives, the effectiveness in controlling key pests must still be characterized as preliminary. These alternatives have not been shown to be stand-alone replacements for methyl bromide, and no combination has been shown to provide effective, economical pest control. Given the variability in pest pressure, and proportion of time that pest pressure can be characterized as heavy, methyl bromide is believed to be the only treatment currently available that consistently provides reliable control of nutsedge species and the disease complex affecting fresh market tomato production.

We begin our technical and economic assessment by presenting in-kind (chemical) alternatives, and then describe the attributes of the not-in-kind alternatives.

6c. Technical Feasibility of In-Kind (Chemical) Alternatives

Table 1 provides a summary of technical and economic assessment of the chemical alternatives to methyl bromide, as identified by MBTOC for fresh tomatoes. As mentioned above, the technical feasibility of some methyl bromide alternatives depend on the level of pest pressure. When pest pressure is low to moderate, some alternatives may be technically (and economically) feasible, but under conditions of high pest pressure, these same alternatives are neither technically nor economically feasible. The discussion below describes these conditions in more detail.

Table 1. Methyl Bromide Alternatives Identified by MBTOC for Tomatoes.

Methyl Bromide Alternative	Assessment of Technical Feasibility	Assessment of Economic Feasibility
1,3-Dichloropropene (Telone)	No	NA[2]
1,3-Dichloropropene, Chloropicrin	Yes/No[1]	Yes/No
1,3-Dichloropropene, Chloropicrin, Pebulate	Yes/No[1]	Yes/No
Basamid	Yes/No[1]	Yes/No
Basamid, Solarization	Yes/No[1]	Yes/No
Chloropicrin	No	NA
Metam Sodium	Yes/No[1]	Yes/No
Metam sodium, Crop rotation	Yes/No[1]	Yes/No
Methyl Iodide	Not registered in the U.S.	NA
Propargyl bromide	Not registered in the U.S.	NA

[1]When nutsedge, nematode and/or fungal disease pressure is very high, which occurs in 40-60% of Southeastern area, and all of the Michigan area, these alternatives are not technically feasible.
[2]Alternatives not found technically feasible were not assessed for economic viability.

1,3-Dichloropropene (Telone): Telone is not a technically feasible stand-alone alternative to methyl bromide for the control of nutsedge and the fungal pathogen complex that affects tomato production. Telone provides good control of nematode populations, with some effect on certain fungal pathogens, but generally offers poor control of diseases and weeds (4, 5, 6). In addition, 1,3-dichloropropene is restricted in key tomato growing areas of the U.S. which have hydrogeological conditions conducive to the transport of chemical to groundwater (specifically, soils underlain by karst topography and sandy sub-soils with short depth to aquifers). Karst topography is irregular topography resulting from solutions of carbonate rock units. Areas where karst topography and certain surface features occur (e.g., sinkholes) are indicative of areas where karst is near the surface and where the potential for groundwater contamination is the highest. Approximately 40 percent of Florida's tomato area is in areas facing this type of hydrogeological constraint. As a consequence, 1,3-dichloropropene use is prohibited in key growing areas like Dade County, Florida where 1335 hectares of tomatoes are grown each year. In areas where 1,3-dichloropropene use is allowed, set back restrictions (~ 100 meters from occupied structures; ~ 30 meters for emulsified formulations applied via chemigation) limit the proportion of the field that can be treated. The set back restrictions are expected to limit 1,3-dichloropropene use in about 1 percent of Florida's tomato production area.

There are also highly restrictive personal protective equipment (PPE) requirements for 1,3-dichloropropene application, which limit the ability of farmers to use the chemical in tropical and subtropical climates. For example, the recommended PPE for 1,3-dichloropropene involves applicators wearing coveralls over short sleeve shirts and shorts, chemical resistant gloves, footwear and socks, an apron and chemical resistant headgear. Under conditions of extreme heat and humidity (which is characteristic of the Southeastern U.S. in the summer), wearing this ensemble rapidly become unbearable for a typical applicator, and could cause heat exhaustion or heat stroke.

Additionally, a 3-week time interval before planting is recommended to avoid phytotoxic levels after 1,3-dichloropropene application. This interval can cause delays/adjustments in production schedules that could lead to missing specific market windows, thus reducing profits on the fresh market tomato crops. For example, tomatoes produced during the winter fetch a higher price than tomatoes produced during warmer months, and many growers rely on this price premium to maintain profitability.

1,3-Dichloropropene and Chloropicrin: The 1,3-dichloropropene and chloropicrin combination is not technically feasible in cases with high/moderate nutsedge pressure because it needs to be coupled with an herbicide to provide season long control. It can be effective for production areas where the nutsedge problem is minimal and there is low disease pressure of fungal and nematode pests. With severe nutsedge infestations, yield losses can be 30 to 40 percent compared to methyl bromide treatment. All constraints described above for 1,3-dichloropropene also apply to this pesticide combination, including soil limitations, buffer constraints, and worker exposure safeguards (PPE). In fact, PPE recommendations for telone C-17 are even more stringent than for 1,3-dichloropropene alone and include a chemical resistant protective suit and a respirator. These issues were taken into account in the level of the U.S. nomination.

Trials comparing broadcast applications with standard in-row applications indicated the need to increase the amount of chloropicrin to compensate for the potential decrease in efficacy of 1,3-dichloropropene applied via broadcast. Applications via micro-irrigation systems have yielded mixed results, probably due to poor lateral distribution of the chemical in the soil. Potential yield losses of 6 to 7 percent were reported, compared to precision methods. Yield increases of up to 2 percent were reported compared to methyl bromide when there was a second application of chloropicrin at the time of bed shaping following a Telone C-35 broadcast application, but once again, this depends on pest pressure.

Combinations of 1,3-dichloropropene and chloropicrin are not effective in controlling Phytophthora capsici (22).

1,3-Dichloropropene and Chloropicrin and Pebulate (Tillam): Pebulate is not currently registered in the U.S. and is therefore not available. This combination is not technically feasible where pest pressure is high. Methyl bromide is significantly superior where severe nutsedge, nematode, or pathogen infestations exist. When compared with methyl bromide, average yield losses of 14 percent have been reported (5, 6). Yield losses of approximately 40 percent were experienced in some fields historically not managed for high populations of nematodes and fungal pathogens (5,6).

A major concern with this alternative is the phytotoxicity of pebulate in some fields when used at 3 kg/ha, which is the rate necessary for effective weed control. At lower rates (~1.5 kg/ha) plants are not adversely affected but nutsedge control is significantly reduced. In areas with severe nutsedge infestations, this would not be acceptable for nutsedge management. Also of issue is the label restriction of pebulate prohibiting hand transplant use. Over 85 percent of transplants involve some hand transplanting operations during planting (USDA Crop Profiles—Tomatoes, TN; http://pestdata.ncsu.edu/cropprofiles/docs/tntomatoes.html). Finally, pebulate, is no longer available in the U.S. since the registration expired on December 31, 2002 and the registrant is bankrupt.

Basamid (dazomet): Basamid is not technically feasible where severe nutsedge, nematode, or pathogen infestations exist. It is inconsistent in its efficacy against fungal pests. In addition, it has not been reported to be effective against yellow or purple nutsedge. Yield losses of 30 to 40 percent have been reported in Southeastern areas where nutsedge infestation was heavy (4).

Basamid (dazomet) and Solarization: This combination is not technically feasible where severe nutsedge, nematode, or pathogen infestations exist. It is inconsistent in its efficacy against fungal pests. In addition, it has not been reported to be effective against yellow or purple nutsedge. Yield losses of 30 to 40 percent have been reported in Southeastern areas where nutsedge infestation was heavy (4). Neither Basamid nor solarization has been effective in nematode or nutsedge management (2,4).

Chloropicrin: Chloropicrin alone is not technically feasible because it is not sufficiently efficacious against nematodes and weeds. Chloropicrin provides some control of soilborne pathogens/diseases but is less effective against nematodes and weeds. Most of the research data are for 1, 3-dichloropropene + chloropicrin, and as previously noted, control of nutsedge and nematodes has not been reliable or effective.

Airborne concentrations of chloropicrin must be monitored. Airborne chloropicrin levels of 0.1 ppm require the use of air-purifying respirators and levels exceeding 4 ppm require the use of air-supplying respirators. Furthermore, emission of chloropicrin from agricultural fields into urban areas has been a concern due to lachrymating effects. Increased use of chloropicrin will trigger the need to address these issues.

Metam Sodium: Metam sodium is not technically feasible where severe nutsedge, nematode, or heavy fungal pathogen infestations exist. Metam-sodium used in combination with chloropicrin and/or 1,3-dichloropropene may be effective where severe infestations of nutsedge do not exist (e. g., in Michigan).

Metam sodium has been reported to be inconsistent in its efficacy against soil-borne pests (4). Metam sodium degrades in the soil to form methyl isothiocyanate, which has activity against nematodes, fungi, insects, and weeds. Metam sodium has a lower vapor pressure than methyl bromide, and therefore cannot penetrate and diffuse throughout the soil as effectively as methyl bromide. In addition, the effectiveness of metam sodium is very dependent on the organic matter and moisture content of the soil. Studies to evaluate best delivery systems for metam sodium are being conducted. Some studies have shown that soil injections and drenches are more effective than drip irrigation.

Research trials show that incorporation of metam sodium with a tractor-mounted tillovator provides good results but most growers do not have this equipment. The results of two efficacy trials conducted in 2000 by IR-4 (Inter-regional Initiative 4, a USDA funded organization supporting minor uses) showed control of major pests, however there was very low pest pressure at the test sites.

Moreover, there are some regulatory restrictions on metam sodium that limit its use in Michigan. The metam sodium label recommends a minimum of 21 days of waiting period after application if soil temperatures are below 15 degrees Celsius. Tomato planting may be delayed by 14 days if metam sodium were used as a soil fumigant due to Michigan's cold climate, which may cause loss both from lower yields (shorter growing season) and lower prices (from missing key markets). Therefore, in addition to problems with the spectrum and magnitude of control, metam sodium may not be a viable methyl bromide alternative in Michigan's cold weather conditions that last late into the year.

Metam Sodium and Crop Rotation: The metam sodium and crop rotation combination is not a technically feasible alternative in high pest pressure areas, because research data show metam sodium alone provides limited and erratic performance at suppressing all major solanaceous pathogens and pests, and crop rotation does not address this deficiency. It is not technically feasible where severe nutsedge, nematode, or heavy fungal pathogen infestations exist. Moreover, intensive cultivation (and land prices determined by productivity) leaves little land for crop rotation.

Methyl Iodide: It is not registered for soil fumigation in the United States.

Propargyl Bromide: It is not registered for soil fumigation in the United States.

6d. Economic Feasibility of In-Kind Alternatives

The economic analysis of the tomato application compared data on yields, crop/commodity prices, revenues and costs using methyl bromide and using alternative pest control regimens in order to estimate the loss of methyl bromide availability. The alternatives identified as technically feasible - in cases of low pest infestation - by the U.S. are: (a) 1,3-Dichloropropene and Chloropicrin and Pebulate; (b) 1,3-Dichloropropene and Chloropicrin; (c) Basamid; (d) Basamid and Solarization; (e) Metam sodium; and (f) Metam sodium and crop rotation. Pest control costs for tomatoes are less than 4 percent of total variable costs and therefore changes in pest control costs would have little impact on any of the economic measures used in the analysis. The economic factor that really drives the feasibility analysis is yield loss associated with the alternatives, and in some cases, loss due to missed market windows (lost price premiums).

The economic assessment of feasibility for *pre-plant uses of methyl bromide*, such as for fresh market tomatoes, includes an evaluation of economic losses from three basic sources: (1) yield losses, referring to reductions in the quantity produced, (2) quality losses, which generally affect the price received for the goods, and (3) increased production costs, which may be due to the higher-cost of using an alternative, additional pest control requirements, and/or resulting shifts in other production or harvesting practices.

The economic reviewers then analyzed crop budgets for pre-plant sectors to determine the likely economic impact if methyl bromide were unavailable. Various measures were used to quantify the impacts, including the following:

(1) losses as a percent of gross revenues. This measure has the advantage that gross revenues are usually easy to measure, at least over some unit, *e.g.*, a hectare of land or a storage operation. However, high value commodities or crops may provide high revenues but may also entail high costs. Losses of even a small percentage of gross revenues could have important impacts on the profitability of the activity.

(2) absolute losses per hectare. For crops, this measure is closely tied to income. It is relatively easy to measure, but may be difficult to interpret in isolation.

(3) losses per kilogram of methyl bromide requested. This measure indicates the value of methyl bromide to crop production but is also useful for structural and post-harvest uses.

(4) losses as a percent of net cash revenues. We define net cash revenues as gross revenues minus operating costs. This is a very good indicator as to the direct losses of income that may be suffered by the owners or operators of an enterprise. However, operating costs can often be difficult to measure and verify.

(5) changes in profit margins. We define profit margin to be profits as a percentage of gross revenues, where profits are gross revenues minus all fixed and operating costs. This measure would provide the best indication of the total impact of the loss of methyl bromide to an enterprise. Again, operating costs may be difficult to measure and fixed costs even more difficult.

These measures represent different ways to assess the economic feasibility of methyl bromide alternatives for methyl bromide users, who are tomato producers in this case. 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.

1,3-Dichloropropene with Chloropicrin and Pebulate

The results of the economic evaluation of the 1,3-Dichloropropene/Chloropicrin/Pebulate combination (which assumes that pebulate is available even though the registrant has gone bankrupt and the U.S. registration has expired), relative to methyl bromide, are shown below in Table 2, beginning with the estimates of yield loss, which is also a measure of gross revenue loss. Percent yield losses are estimated to be 25 percent in Michigan, primarily due to losses from failure to control *Phytophthora*. In Southeastern states, yield losses are estimated to range from 5 to 15 percent. Areas with high pest pressure would suffer yield losses higher than 10 percent, and high pest pressure is expected on 50 to 60 percent of tomato growing area in this region.

Economic losses (per hectare) are calculated by adding the expected loss in yield/revenue to the increase in production costs. As mentioned earlier, yield losses are expected to dominate economic losses, with some decline in revenue coming from missing price premiums in key markets due to delayed planting (i.e., these estimates somewhat understate impacts compared to including increases in chemical costs, but the conclusions are the same). These effects are expressed as economic loss per hectare in the second row of Table 2. Under conditions of high pest pressure, significant yield loss would result in substantial economic losses to fresh tomato growers. In areas with high pest pressure in Southeastern states, economic loss was estimated up to $6,721 USD per hectare. Moreover, this alternative might not be technically feasible in some Southeastern states because of the label restriction of pebulate prohibiting hand transplant use, and over 85 percent of transplants actually involve some hand transplanting operations during planting. Putting aside the worker protection issue, if pest pressure were low, the use of 1,3-dichloropropene, chloropicrin, pebulate would result in economic losses closer to $950 USD per hectare. In Michigan, economic losses would be more than $10,000 USD per hectare in areas with heavy pest pressure, based on assuming 25 percent yield losses.

Economic loss per kilogram of methyl bromide is a measure of the marginal contribution of methyl bromide. It is calculated by dividing usage rates (per hectare) into the estimate of economic losses per hectare Comparing these losses provides a rough measure of the loss in economic efficiency associated with adoption of methyl bromide alternatives. Under this measure, tomato production in Michigan suffers high efficiency losses compared to the Southeast region, but it is important to note that in both cases, losses are greater than zero, suggesting efficiency losses in both tomato producing areas.

Expressed as proportion of gross and net revenue, economic losses can also describe the impact on the economic viability of a given production system. Using these measures, one can see that adoption of 1,3-Dichloropropene/Chloropicrin/Pebulate as the methyl bromide alternative would lead to substantial economic impacts. Given the competitive nature of vegetable production in the U.S., these economic impacts would render this alternative economically infeasible for U.S. fresh market tomato producers.

Table 2. Measures of Economic Impact on Fresh Market Tomatoes in the U.S.

Loss Measure	Michigan[1]	Southeast
Direct Yield Loss	20 - 30%	5 - 15%
Economic Loss Per Hectare	$10,550	$950 – $6,721 likely $2,230
Economic Loss Per Kilogram methyl bromide	$97	$11.10 – $30.55 likely $13.70
Economic Loss as % of Gross Revenue	31%	7 - 16% likely 9%
Economic Loss as % of Net Cash Returns	160%	87 - 112% likely 109%

[1]The economic measures were calculated for the projected yield loss of 25%. Analysis for Michigan is based on using 1,3-D and Chloropicrin as the methyl bromide alternative treatment. Analysis for the Southeast region is based on using 1,3-D, chloropicrin, and pebulate as the methyl bromide alternative.

1,3-Dichloropropene with Chloropicrin

Potential economic losses to fresh-market tomato growers in Michigan would be significant because estimated yield losses would be 20 to 30 percent for the 1,3-Dichloropropene/Chloropicrin combination. Michigan does not have a nutsedge infestation problem, and use of Pebulate is not necessary, but the losses from *Phytophthora* would be similar to the scenario presented in Table 2. Price would also be lower due to missed early season premiums and reduced quality of the products. Since the estimated yield impacts are so large, this alternative is not considered economically feasible.

As an alternative treatment in the Southeast region, 1,3-Dichloropropene/Chloropicrin might be feasible for a limited time in areas with low nutsedge pressure, providing an alternative herbicide is available (see earlier discussion). However, this nomination includes the portion of tomato production in the Southeast region where nutsedge pressure is high. In such cases, 1,3-Dichloropropene/Chloropicrin is not a technically feasible alternative and is, therefore, not included in this economic analysis.

Other Alternatives (Basamid; Basamid with Solarization; Metam Sodium; Metam Sodium with Crop Rotation)

Data show that these different alternatives showed the same (or greater) yield losses as 1,3-Dichloropropene/Chloropicrin/Pebulate for the production regions of interest. Once again, yield losses play the major role in determining the size of economic loss for tomatoes growers, and these technically feasible alternatives would have the same (or greater) economic losses as the use of 1,3-Dichloropropene/Chloropicrin/Pebulate.

What is the best alternative regimen to methyl bromide?

Where regulations permit, a combination of 1,3-Dichloropropene/Chloropicrin/Pebulate (assuming that pebulate once again becomes available in the U.S.) may be the best alternative to methyl bromide for fungal, nematode and nutsedge pest control; however, inconsistency in the level of pest control still may exist (4). Among the other alternatives, Telone C-35 (1,3-dichloropropene with 35 percent chloropicrin), metam-sodium, methyl iodide (currently not registered in the U.S.), and chloropicrin may be potential alternatives, but weed (nutsedge) control remains problematic. Pebulate (Tillam), an herbicide labeled for tomatoes (but apparently no longer being produced in the U.S. as of this report date), has shown some success in managing low and moderate infestations of nutsedge. When pebulate is used in combination with 1,3-dichloropropene and chloropicrin, it can be effective against *Verticillium* wilt and nematodes. Crucially, however, it is not labeled for hand transplant, which is the common method of planting fresh market tomatoes in the Southeastern region of the U.S.. Moreover, pebulate has been implicated as phytotoxic when used at rates compatible with effective weed control. Nutsedge does not appear to be a problem in Michigan tomato fields, but Phytophthora can be a major problem. Michigan's cold climate seems to be unfavorable for metam sodium use in a timely manner, due to planting delays after fumigation. This precludes capturing key early markets for tomatoes.

<u>6e. Technical Feasibility of Not-In-Kind (Non-Chemical) Alternatives</u>

This section summarizes the analysis of the remainder of the methyl bromide alternatives identified by

MBTOC for tomatoes, primarily non-chemical alternatives. Table 3 contains a summary of the technical assessment, which is that none of these alternatives were found to be technically feasible. A description of each alternative follows. No economic assessment for these alternatives was conducted because of their technical infeasibility.

Table 3. Methyl Bromide Alternatives Identified by MBTOC for Tomato.

Methyl Bromide Alternative	Assessment of Technical Feasibility	Assessment of Economic Feasibility[1]
Biofumigation	No	NA
Solarization	No	NA
Solarization, fungicides	No	NA
Steam	No	NA
Biological Control	No	NA
Cover Crops and mulching	No	NA
Crop Residue Compost	No	NA
Crop Rotation/ Fallow	No	NA
Flooding and Water management	No	NA
General IPM	No	NA
Grafting/Resistant Root Stock/Plant Breeding	No	NA
Organic Amendments/Compost	No	NA
Planting Time	No	NA
Ploughing and Tillage	No	NA
Resistant Cultivars	No	NA
Soil-less Culture	No	NA
Substrate/Plug Plants	No	NA

[1]Alternatives not found technically feasible were not assessed for economic viability.

Biofumigation. Biofumigation is not technically feasible in the United States because of the large amount of brassica required to alter fumigation practices in the large tomato production area in the U.S.. The efficacy of biofumigation at large has not been extensively tested for tomato production. Four studies were conducted with cabbage residue as a biofumigant for tomato production but these studies did not result in comparable yields to methyl bromide. It is almost impossible to conduct biofumigation across a large scale to obtain commercially acceptable pest control because of the delays in planting times biofumigation would cause and due to the additional costs growers would face.

Solarization is not technically feasible in the U.S. The tomato growers would generally not be able to take advantage of the best timing for solarization, since tomatoes are produced from April until October. Cooler months when plants are not in the ground would not provide the necessary solar heat requirements. In Florida, where solarization may be more effective than other areas, researchers have found that solarization resulted in significantly more weeds, fewer tomato fruit, and more root knot nematodes (2).

Solarization and Fungicides is not technically feasible in the U.S. (see Alternative 12). Fungicides do not control weed or nematode pests.

Steam is not technically feasible to sterilize tomato fields for control of fungal, nematode and weed pests at commercial scale in open field production. Steam sterilization does not typically penetrate deep enough into the associated soil to address target pests associated with tomato production. The only available prototypes have very limited range and speed and can only sterilize approximately half to one hectare (one to 2 acres) a day. Steam can be used as an alternative to methyl bromide soil fumigation in small-scale or closed production areas but has yet to be proven economical and practical for large-scale, open field production systems (UNEP,1998).

Biological Control is not technically feasible because it is not a stand alone replacement to methyl bromide. The USDA's Agricultural Research Service (ARS) conducted a multi-year study of non-pathogenic fusarium to control fusarium wilt. Although the study showed promising results, it requires further examination to determine the frequency and consequences if the biological control organism mutates.

Cover Crops and Mulching: Presently, plastic mulch is largely used in tomato production under field conditions and it does not prevent pathogenic fungal infestations, nematodes and/or weeds.

Crop Residue Compost: There is no research showing that this will significantly affect nutsedge or other pests of concern in plastic culture of tomatoes.

Crop Rotation/Fallow is not feasible technically and/or economically at field level because it does not control nutsedge, nematode, and diseases.

Flooding and Water Management is not feasible technically and/or economically in field production because it does not control nutsedge, nematode, and diseases when pest pressure is high. One researcher in Florida reported that there was no significant difference between flooded and non-flooded treatments concerning marketable yields, numbers of nutsedge, nematode galls, or root rots in tomato.

General IPM is not technically feasible by itself. IPM does not reliably deliver adequate crop protection under condition of high pest pressure, especially for weeds**.** It is not feasible technically and/or economically at the field level because it does not control nutsedge, nematode, and diseases when pest pressure is high.

Grafting; resistant rootstock; plant breeding: Disease, nematode, and heat-resistant cultivars are common in the industry, as well as cultivars for quality characteristics. These do not address weed issues and genetic resistance is never complete against diseases and pests. Plant breeding has always been an integral part of tomato production.

Organic Amendments/Compost: As a part of standard IPM, amendments are frequently used to improve soil fertility to boost yields, however, it is not a stand alone replacement to methyl bromide. In addition, this practice does not address severe nutsedge infestations in production fields.

Planting Time: Planting time is determined by market requirements and will not address pest issues.

Ploughing and Tillage: It is not technically feasible because it does not control diseases, nematodes, or nutsedge weeds.

Resistant Cultivars: There are currently no tomato cultivars with host-plant resistance to all fungal and/or nematodes pests. It may be possible to produce a new tomato cultivar with resistance to a few specific pests. The National Center for Food and Agricultural Policy (Washington, DC) recently estimated that 100 percent of Florida's tomato production already employs fusarium and/or verticillium wilt resistant cultivars. Much research was conducted on the Mi gene to create a nematode resistant tomato variety. Unfortunately, the variety failed as a result of heat instability or apparent temperature sensitivity of the gene rendering it infeasible for certain climates or seasonal plantings.

Soil-less Culture is technically infeasible as a means to grow the bulk of the U.S. national supply of tomatoes, due to the volume of production, despite the fact some farms that have moved their production indoors. In addition, the cost of soil-less culture is very high and requires an initial capital investment for the physical structure to build greenhouses, benches, irrigation systems, etc and the development of new tomato varieties suitable for production in all parts of the U.S. Moreover, there are some risks associated with soil-less culture. A fungal infection, for example, can spread quickly through the growing medium in a greenhouse from one plant to many others with days.

Substrate/Plug Plants: Fungal, nematode and weed infestations are field problems not addressed by substrate/plug methodology.

7. Critical Use Exemption Nomination for Tomatoes.

As noted above, this nomination is for a critical use exemption for methyl bromide for fresh market tomato production in Michigan and a collection of states in the Southeastern region of the U.S.. The U.S. interdisciplinary review team found a critical need for methyl bromide for tomato growers in Michigan and the Southeastern states in the U.S.. The alternatives identified by the MBTOC were, as reviewed in detail above, regarded by reviewers as technically and economically infeasible for acceptable management of the major tomato pests under high pest pressure situations. Because such pest pressure conditions are known to be endemic on a significant proportion of tomato production area in Michigan and the Southeastern U.S., these areas form the basis for the nomination.

Table 4 and 5 summarize methyl bromide historical usage, including area treated, and the actual amount requested for 2005 thru 2007 for tomato.

Table 4. Methyl Bromide Usage and Request for Tomatoes in Southeastern States.

	1997	1998	1999	2000	2001	2005	2006	2007
tonne	3,704	4,005	3,574	3,360	5,076	5,045	5,045	5,045
hectares*	16,780	18,410	18,980	19,410	31,490	32,080	32,160	32,240
rate (kg/ha)	230	230	200	180	175	160	160	160

* The information used to determine tomato production area changed in 2001 in Florida based on methods for counting specialty varieties of tomatoes.

Table 5. Methyl Bromide Usage and Request for Tomatoes in Michigan.

	1997	1998	1999	2000	2001	2005	2006	2007
tonne	51	49	49	34	34	34	34	34
hectares	427	410	410	284	284	284	284	284
rate (kg/ha)	120	120	120	120	120	120	120	120

The use rate is lower than elsewhere is the U.S. due to differences in pest pressure that are controlled with a lower concentration of methyl bromide. The total area requested for Michigan equal only 3% of all solanaceous hectares in the state which are the acres with *Phytophthora capsici* infestations.

The hectares and tonnes associated with Michigan's historic use on tomatoes also include some hectares of pepper and eggplant crops because Michigan substituted pepper and eggplant on small amounts of tomato production land to respond to local conditions and market demands. For the purposes of the nomination, only the tomato portion of this cropping system is included (284 hectares).

It is also important to note that critical use exemption requests for fresh market tomatoes were submitted by tomato growers association, growers or tomato commission in Southeast regions of the U.S., and Michigan. There is a tremendous amount of variation in the use of chemicals across these agricultural systems, and this variation is the result of heterogeneous market conditions for a commodity, hectares planted, weather events, financial position of the industry, pest pressures etc. Because of the variation due to biologic, climatic, and economic conditions, it is difficult to predict the precise amount of methyl bromide that may be necessary for a specific use (see discussion below under section 9).

The U.S. nomination has been determined based first 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 (buffer zones, township caps), environmental concerns such as soil based restrictions due to potential groundwater contamination, and historic use rates, among other factors.

Table 6. Methyl Bromide Critical Use Exemption Nomination for Tomatoes.

Year	Total Request by Applicants (kilograms)	U.S. Sector Nomination (kilograms)
2005	5,233,521	**2,865,262**

8. Minimizing Use/Emissions of Methyl Bromide in the United States/Stockpiles

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 keeping with both local requirements to avoid “drift” of methyl bromide into inhabited areas, as well as to preserve methyl bromide and keep related emissions to the lowest level possible, methyl bromide is machine injected into soil to specific depths. In addition, as methyl bromide has become more scarce, users in the United States have, where possible, experimented with different mixes of methyl bromide and chloropicrin. Specifically, in the early 1990s, methyl bromide was typically sold and used in methyl bromide mixtures made up of 98% methyl bromide and 2% chloropicrin, with the chloropicrin being included solely to give the chemical a smell enabling those in the area to be alerted if there was a risk. However, with the outset of very significant controls on methyl bromide, users have been experimenting with significant increases in the level of chloropicrin and reductions in the level of methyl bromide. While these new mixtures have generally been effective at controlling target pests, it must be stressed that the long term efficacy of these mixtures is unknown. Reduced methyl bromide concentrations in mixtures, more mechanized soil injection techniques, and the extensive use of tarps to cover land treated with methyl bromide has resulted in reduced emissions and an application rate that we believe is among the lowest in the world.

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 2003 and 2004 70% reduction. 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.

9. 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 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, climate, soil type, and target pests, which change from region to region and even 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 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.

In addition to federally supported research, applicants for methyl bromide critical use exemptions have reported that they have expended in excess of $17 million USD conducting their own research into the use of alternatives to methyl bromide since the announcement of the phaseout in 1992.

Table 7. 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

Major areas of research have included preplant soil applications and post-harvest commodity storage over a wide range of commodities, including but not limited to tomatoes, strawberries, eggplants, melons and other cucurbits, sweet potato, citrus, dried fruits and nuts, grain, stone fruits, fresh fruits and vegetables, forestry seedlings, raspberries, ornamental and nursery crops, vineyard crops, and turfgrasses. While much research has been targeted for support of crops such as tomatoes and strawberries, the primary users of methyl bromide in the U.S., most of the pre-plant soil applied alternatives work has had implications for disease and nematode control across many other crops. Logical groupings for such transfer of research information include annual fruit and vegetable crops (e.g. solanaceous crops, strawberries, and melons), perennial tree and vine crops (e.g. citrus, grapes, avocado, stone fruits, almonds, walnut, and raspberry), and stored commodities (e.g. walnuts, dried fruits, grains, and processed foods). Research objectives for ongoing and proposed research by Federal and private sources to determine the potential efficacy of methyl bromide alternatives and their implementation in commercial agricultural and food processing operations are described below.

The USDA 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 USDA 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.

Government funded studies related to U.S. tomato production that are currently on-going include the following:

a. Multi-Tactic Approach to Pest Management for Methyl Bromide Dependent Crops in Florida (Sep 2000 - Aug 2003)

To evaluate the use of reduced risk pesticides applied through drip irrigation for nematode, fungal pathogen control and yield; to evaluate vegetable transplants grown in mixes amended with plant growth-promoting rhizobacteria (PGPR) in a production system that includes the most promising alternatives for methyl bromide. Tomato or pepper seed will be placed in a standard 70 percent peat, 30 percent vermiculite medium. Medium amendment(s) consisting of formulations of plant growth promoting rhizobacteria (PGPR) will be applied as formulations of BioYield 213 before seeding. A subsample of 5 to 6 week old seedlings, depending on time of year, will be assessed for height, root and shoot dry weight, leaf area, stem caliper, chlorophyll density, and associated calculated ratios. Both treated and untreated plants will be transplanted to field plots treated with a variety of alternative soil treatments and application methodologies including the reduced risk chemical Plantpro applied through drip irrigation. Natural incidences of soilborne pathogens will be assessed throughout the growing season. Disease incidence ratings will be made and confirmed where necessary by plating on appropriate media. Marketable yield will be assessed for treated and untreated plots. These treatments will be evaluated in four field trials conducted over 24 months. Trials will utilize split plot designs.

b. Field Scale Demonstration/validation Studies of Alternatives for Methyl Bromide in Plastic Mulch (Apr 2000 - Jun 2003)
Evaluate and validate the effectiveness and economic viability of alternatives to methyl bromide soil fumigation for nematode disease and weed control in plastic mulch vegetable production systems in Florida. Establish alternative treatments on grower fields at a scale sufficient to allow their evaluation as components of production systems; Establish paired subplots in alternative treatments and adjacent grower standard treatments; Diagnose and monitor nematodes, soil-borne diseases, and practice including grading fruit and recording weights conduct a comparative cost/benefit analysis of the alternative treatments using the whole enterprise budget analysis method.

c. Potential Uses of Mi Gene Resistance As a Component of Integrated Nematode Management in Tomato (Sep 2001 - Aug 2002)
Determine the host status of Mi gene resistant tomatoes to 15 field populations of *Meloidogyne* spp.; determine if first crop chemical rates can be reduced when using this resistance; observe the effects of Mi gene resistance from a first crop on root-knot nematode population densities and damage in a second crop; determine utility of the resistance and yield potential of resistant varieties under large-scale grower conditions. Greenhouse trials will be performed on fifteen field populations of root-knot nematodes to determine presence of Mi gene resistance-breaking biotypes. A small plot tomato field trial will be conducted in the spring followed by a fall cantaloupe crop at the same site. The spring trial will consist of the following chemical treatments as main plots-control: methyl bromide (67-33 350 lbs./A), Telone II (18 gals./A), Telone II (24 gals./ A), Telone C-17 (35 gals./A), Telone C-35 (35 gals./A) and an untreated control. Main plots will consist of chemical treatments and sub-plots shall include resistant and susceptible tomato varieties. The trial will be followed by a fall cantaloupe crop without further treatment. Data collection in both the spring and fall crops will include fruit weight, number, grade, root galling and plant vigor ratings.

d. Efficacy of Cultural Practices, Organic Amendments & Fumigants on Tomato Production, Soil Thermal Properties & Soil Water (Sep 2001 - Aug 2003)
The objective of this study is to develop a cropping system that combines the beneficial effects of several systems in a replicated design demonstrated in a grower's field for tomato production and compare it to methyl bromide system. Fourteen treatments will be evaluated in a grower's field for their effectiveness on plant growth, production and conservation of water. Treatments will include fallow, Sunn hemp 'Tropic Sun', co-compost, solarization, K-pam, chloropicrin, and methyl bromide.

e. Field Demo and Scale-Up of Soilless Culture As An Alternative to Soil/Methyl Bromide for Tomato and Pepper (Sep 2001 - Aug 2002)
The objective of this research will be to field test the practicality and economics of outdoor soilless culture of tomato and pepper, and to determine solutions to scale-up problems. A soilless system will be field tested on a commercial farm operation using tomato and pepper. Inputs and crop production

will be monitored and compared to conventional crop production practices.

f. Field Evaluation Studies of Dactylaria Higginsii As a Component in An Integrated Approach to Pest Management (Sep 2001 - Aug 2003)
The objective of this cooperative research agreement is to evaluate the nutsedge biological control agent, *Dactylaria higginsii*, as a component in an integrated pest management program for vegetables. Large-scale field experiments will be conducted to include multiple off-season nutsedge management tools including tillage, herbicide applications and the biological control agent *Dactylaria higginsii*. A fall tomato crop will then be produced using a conventional system and the biologically based system.

g. Biological Control of Fusarium Wilt and Other Soilborne Plant Pathogenic Fungi (Nov 2002 - Nov 2007)
Assess the potential of microbes to control soil-borne plant pathogenic fungi and determine biological, environmental and ecological factors affecting performance of these microbes. Characterize biological, ecological and genetic relationships among and within pathogenic, saprophytic and biocontrol soil-borne microorganisms. Elucidate mechanisms of action of biocontrol agents used against soil-borne plant pathogens, and, where previous work identified a general mechanism of action, identify the specific underlying basis of the mechanism. Work will include, but is not limited to, the nature of resistance to Fusarium wilt in tomato induced by *Fusarium oxysporum* strain CS-20.

h. Replacement of Methyl Bromide by Integrating the Use of Alternative Soil Fumigants, Cultural Practices, and Herbicides for Tomato, Pepper (University of Georgia/CSREES Sep 2001 - Sep 2003)
Evaluate soil fumigant alternatives to methyl bromide for management of weeds, diseases, and nematodes in cooperation with growers in tomato, pepper, and watermelon. Evaluate the most effective application methods for soil fumigant alternatives in tomato, pepper and watermelon. Evaluate the need and efficacy of herbicides applied in combination with methyl bromide alternative soil fumigants in tomato, pepper and watermelon. Additionally, evaluate crop tolerance to these herbicides. To determine a systems approach of managing weeds, diseases, and nematodes that can be effectively and economically adopted by growers in tomato, pepper and watermelon.

In addition to the research that is ongoing under the USDA, applicants to the U.S. government for inclusion in the nomination for critical uses have cited the following research plans as ones they are funding or otherwise participating in. Many of the studies are the same ones conducted for tomatoes and eggplant. They are:

<u>Michigan Solanaceous Crops Consortium (including Tomatoes):</u>

> In 2003 and 2004, university researchers will trial the following alternatives on test plots owned by commercial growers: Telone C-35; Multigard FFA; Multigard Protect with Vapam HL; CX-100 (applied as drip or preplant); Chloropicrin (100%); Iodomethane (67%/33%); and composted chicken manure. These trials will analyze the ability of these alternatives to

control Verticillium, Fusarium and Phytophthora.

Southeastern U.S. Tomatoes Consortium:

A study on fumigation alternatives will be conducted on the Eastern Shore of Virginia. Treatments will include Telone C-35 with herbicide; Telone II with chloropicrin and/or herbicide; and Vapam with chloropicrin, with or without herbicide. This study will measure crop yield. A study entitled, Methyl Bromide Alternatives for Tomato, Pepper and Cucurbit Crops, conducted by David Monks and Frank Louis will be conducted in North Carolina. Herbicides such as metolachlor, halosulfuron, rimsulfuron, and dimehenamid will be tested in combination with certain fumigants. Yield will be measured. A study entitled "Combinations of fumigants and herbicide replacements for methyl bromide" will be conducted in 2003-2004 for watermelon, pepper and tomato crops by A.S. Culpepper, D.B. Langston, Jr., W.T. Kelley and G. Fonash. Treatments will include chloropicrin; 1,3-D; halosulfuron; metam sodium; metam potassium; sulfentrazone and combinations of the above. This study will measure yield.

In addition, a summary table that captures the results of alternative trials is shown below (Table 5). This table summarizes the results of studies with quantitative yield data presented at the Methyl Bromide Alternatives Conferences, The National Center for Food and Agricultural Policy (NCFAP) "The Economic Impact of the Scheduled Phaseout of Methyl Bromide," 2000 and the applications for Critical Use Exemptions.

As the table aptly summarizes, even among studies that demonstrate significant yields using the alternatives, there is still variation in the performance of the alternative. Thus, while it may perform well in one study, it may also perform below acceptable standards in another study. It is true that some of the older studies may skew this result, but nonetheless, the result still shows inconsistency to some degree even with the tremendous strides made to date in optimizing application and use of the alternatives. The standard used to characterize success in the analysis presented here is if the alternative produced crops with at least 95 percent of the yield of the crop with a methyl bromide control. However, in some instances, even a 95 percent yield may involve some profit losses.

Table 8: Summary of Research Results for U.S. Tomatoes

Alternatives	**Total Number of Studies**	**Number of Studies with Yield Greater than 95% Compared to Methyl Bromide**
Basamid (Dazomet) and combinations	41	11
Cabbage Residue	4	2
Chloropicrin and combinations	45	15
Compost and combinations	3	0
Metam sodium (Vapam) combinations	132	25
Solarization	13	4
1,3-dichloropropene (1,3-D) and combinations	128	47
Tetrathiocarbonate	5	0
XRM 5053	1	0

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.

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.

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, U.S. EPA registers pesticides provided its use does not pose unreasonable adverse effects to humans or the environment. Under FFDCA, the U.S. EPA is responsible for setting tolerances (maximum permissible residue levels) for any pesticide used on food or animal feed. With the passage of FQPA, the U.S. EPA 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 U.S. EPA examines the ingredients of a pesticide to determine if they are safe is called the registration process. The U.S. EPA evaluates the pesticide to ensure that it will not have any unreasonable 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 U.S. EPA, unless it has an exemption from regulation under FIFRA.

Since 1997, the U.S. EPA has made the registration of alternatives to methyl bromide a high registration priority. Because the U.S. EPA currently has more applications for all types of pesticides pending in its review than resources to evaluate them, U.S. EPA prioritizes the applications in its registration queue. By virtue of being a high 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. A methyl bromide alternative is still likely to go through the average processing time. Once review process begins, it takes an average processing time of 38 months from date of submission to issuance of a registration decision. Even for methyl bromide alternatives, the registrant (the pesticide applicant) has, in most cases, spent approximately 7-10 years developing the data necessary to support registration.

As one incentive for the pesticide industry to develop alternatives to methyl bromide, the U.S. EPA has worked to reduce the burdens on data generation, to the extent feasible while still ensuring that the U.S. EPA’s registration decisions meet the Federal statutory safety standards. Where appropriate from a scientific standpoint, the U.S. EPA 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, U.S. EPA 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 groundwater concerns) being directly addressed through USDA's Agricultural Research Service's $13.5 million per year research program conducted at more than 20 field evaluation facilities across the country. Also EPA's participation in the evaluation of research grant proposals submitted to the USDA's Cooperative State Research, Education, and Extension Service methyl bromide alternatives research program of US$ 2.5 million per year has further ensured that critical registration issues are being addressed by the research community.

Since 1997, EPA has registered the following chemical/use combinations as part of its commitment to expedite the review of methyl bromide alternatives:

1999: Pebulate to control weeds in tomatoes
2000: Phosphine to control insects in stored commodities
2001: Indian Meal Moth Granulosis Virus to control Indian meal moth in stored grains
2001: Terrazole to control pathogens in tobacco float beds
2001: Telone applied through drip irrigation - all crops
2002: Halosulfuron-methyl to control weeds in melons and tomatoes

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

– Iodomethane as a pre-plant soil fumigant for various crops
– Fosthiazate as a pre-plant nematocide for tomatoes
– Sulfuryl fluoride as a post-harvest fumigant for stored commodities
– Trifloxysulfuron sodium as a pre-plant herbicide for tomatoes
– Dazomet as a pre-plant soil fumigant for strawberries and tomatoes

Again, while these activities appear promising, it must be noted that issues related to toxicity, ground water contamination, and the release of air pollutants may pose significant problems with respect to some alternatives that may lead to use restrictions since many of the growing regions are in sensitive areas such as those in close proximity to schools and homes. Ongoing research on alternate fumigants is evaluating ways to reduce emission under various application regimes and examining whether commonly used agrochemicals, such as fertilizers and nitrification inhibitors, could be used to rapidly degrade soil fumigants. For example, if registration of iodomethane or another alternative occurs in the near future, commercial availability and costs will be factors that must be taken into consideration.

It must be emphasized, however, that finding potential alternatives, and even registering those alternatives is not the end of the story. Those alternatives must be tested by users and must be technically and economically feasible before wide-spread adoptions. 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 for speedy adoption, the United States government has also been involved in these steps by promoting technology transfer, experience transfer, and private sector training.

10. Conclusion and Policy Issues Associated with the Nomination

On the basis of an exhaustive review of a large, multi-disciplinary team of sector and general agricultural experts, we have determined that the TEAP listed potential alternatives for the specific crops and areas covered in this nomination are not currently technically or economically viable from the standpoint of United States growers covered by this exemption request. We have also determined that the absence of methyl bromide for the nominated uses will result in a significant market disruption to the effected sectors. We have and continue to expend significant efforts to find and commercialize alternatives, and that potential alternatives to the use of methyl bromide for many important uses are under investigation and may be on the horizon. Based on this analysis, we believe those requests included in this nomination meet the criteria set out by the Parties in Decision IX/6.

In accordance with those Decisions, we believe that the U.S. nomination contained in this document for the use of methyl bromide for fresh market tomato production in Michigan and the southeastern U.S. 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 TEAP listed potential alternatives for tomatoes are not currently technically or economically feasible from the standpoint of United States tomato growers covered by this nomination. Specifically, we have determined that a switch from methyl bromide to an alternative fumigant will impact Michigan and southeastern U.S. fresh market tomato production largely due to yield losses associated with inadequate control of pests in areas of high pest pressures. These applicants have generally made a strong case that the alternatives reduce yield significantly and the resulting financial and economic impacts are large enough to affect the profitability and competitiveness of Michigan and southeastern U.S. fresh tomato production.

In Michigan, the U.S. has made a strong case that the alternatives may not be consistent in controlling soil-borne pests, particularly *Phytophthora capsici,* when pest pressures are high and soil-temperatures are low at preplant fumigation time. Accordingly, areas in Michigan that meet these criteria are included in this nomination. It is worth noting that this happens to be a small percentage of the total solanaceous growing area in Michigan.

In the southeastern U.S., the U.S. has made a strong case that there is a critical need for the use of methyl bromide in areas where alternatives are not sufficient to allow production of acceptable yields of marketable tomatoes. Methyl bromide is a necessary component for proper pest management and for acceptable production needs when pest infestations, particularly nutsedge pressures, are severe. However, economic measures showed that fresh-tomato growers in areas of the southeastern U.S. without high pest pressure are not likely to suffer heavy losses because yield losses associated with methyl bromide alternatives are moderate when pest pressures are low to moderate.

In addition to finding alternatives infeasible, we have demonstrated that we have and continue to expend significant efforts to find and commercialize alternatives, and that potential alternatives to the use of methyl bromide in tomatoes may be on the horizon. That said, it must be stressed that the registration process, which is designed to ensure that new pesticides do not pose an unreasonable adverse effects to human health and the environment, is a long and rigorous process. The U.S. need for methyl bromide for tomatoes will be maintained for the period being requested for an exemption in this nomination.

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.

11. Contact Information

For further general information or clarifications on material contained in the U.S. nomination for critical uses, please contact:

John E. Thompson, Ph.D.
Office of Environmental Policy
US Department of State
2201 C Street NW Rm 4325
Washington, DC 20520
tel: 202-647-9799
fax: 202-647-5947
e-mail: ThompsonJE2@state.gov

Alternate Contact:
Denise Keehner, Director
Biological and Economic Analysis Division
Office of Pesticides Programs
US Environmental Protection Agency, 7503C
Washington, DC 20460
tel: 703-308-8200
fax: 703-308-8090
e-mail: methyl.bromide@epa.gov

12. References

1. Agricultural Statistics. 2001. United States Department of Agriculture. National Agricultural Statistics Service. United States Government Printing Office, Washington, DC 20402.

2. Carpenter, Janet, Leonard Gianessi, and Lori Lynch. The Economic Impact of the Scheduled U.S. Phaseout of Methyl Bromide. National Center for Food and Agricultural Policy. 2000.

3. Deepak, M.S., Thomas H. Spreen, and John J. Van Sickle. An Analysis of the Impact of a Ban of Methyl Bromide on the U.S. Winter Fresh Vegetable Market. Journal of Agricultural and Applied Economics v28, n2 (December 1996): 433-443.

4. Gilreath, J. P., Noling, J. W., Locascio, S. J., and Chellemi, D. O. 1999. Effect of methyl bromide, 1,3-dichloropropene +chloropicrin with pebulate and soil solarization on soilborne pest control in tomato followed by double-cropped cucumber. Proc. Fla. State Hort. Soc. 112:292-297.

5. Locascio, S. J., Dickson, D. W., and Kucharek, T. A. 1994. Nutsedge, root-knot nematode, and fungal control with fumigant alternatives to methyl bromide in polyethylene mulched tomato.

Annual International Research Conference on Methyl Bromide (1994).

6. Locascio, S. J., Gilreath, J. P., Dickson, D. W., Kucharek, T. A., Jones, J. P., and Noling, J. W. 1997. Fumigant alternatives to methyl bromide for polyethylene-mulched tomato. HortScience 32:1208-1211.

7. Lynch, Lori and Janet Carpenter. The Economic Impact of Banning Methyl Bromide: Where Do we Need More Research. in Proceedings of the 1999 Annual Research Conference on Methyl Bromide Alternatives and Emissions Reduction.

8. Lynch, Lori and Bruce McWilliams, and David Zilberman. Economic Implications of Banning Methyl Bromide: How have They Changed with Recent Development?. in Proceedings of the 1997 Annual Research Conference on Methyl Bromide Alternatives and Emissions Reduction.

9. NASS-USDA, Agricultural Chemical Use (Vegetables) 2000 (July, 2001). http://usda.mannlib.cornell.edu/reports/nassr/other/pcu-bb/agcv0701.txt

10. National Agricultural Statistics Service. U.S. Tomato Statistics. 1960 - 2001. http://usda.mannlib.cornell.edu/data-sets/specialty/92010.

11. Nelson, S. D., Locascio, S. J., Allen, L. H., Dickson, D. W., and Mitchell, D. J. 1999. Soil flooding and chemical alternatives to methyl bromide in tomato production. Annual International Research Conference on Methyl Bromide (1999).

12. Stall, W. M. and Morales-Payan, J. P. The critical period of nutsedge interference in tomato. http://www.imok.ufl.edu/LIV/groups/IPM/weed_con/nutsedge.htm

13. United States Department of Agriculture. Economic Implications of the Methyl Bromide Phaseout. An Economic Research Report. Economic Research Service. 2000.

14. University of California Cooperative Extension. Sample Costs to Produce Fresh Market Tomatoes - San Joaquin County: Furrow Irrigated. 2000.

15. VanSickle, John J., Chalene Brewster, and Thomas H. Spreen. Impact of a Methyl Bromide Ban on the U.S. Vegetable Industry. University of Florida, 2000.

16. Holm, L.G., D.L. Plucknett, J.V. Pancho, and J.P. Herberger. 1977. The world's worst weeds: distribution and biology. Honolulu, HI: University of Hawaii Press, pp.8-24.

17. Webster, T.M. and G.E. Macdonald. 2001(b). A survey of weeds in various crops in Georgia. Weed Technol. 15:771-790.

18. Gilreath, J.P., J.W. Noling, and P.R. Gilreath. 1999. Nutsedge management with cover crop for

tomato in the absence of methyl bromide. Research summary., USDA Specific Cooperative Agreement 58-6617-6-013.

19. Thullen, R.J. and P.E. Keeley. 1975. Yellow nutsedge sprouting and resprouting potential. Weed Sci. 23:333-337.

20.Gamini,S. and R.K. Nishimoto. 1987. Propagules of purple nutsedge (*Cyperus rotundus*) in soil. Weed Technol. 1:217-220.

21. Patterson, D.T. 1998. Suppression of purple nutsedge (*Cyperus rotundus*) with polyethylene film mulch. Weed Technol.12:275-280.

22. UNEP, Report of the Methyl Bromide Technical Options Committee, 1998 Assessment of Alternatives to Methyl Bromide, United Nations Environment Programme, 1998. (B83, B-28, B281, B87, B287)

13. Appendices

Appendix A. List of critical use exemption (CUE) applications for the Tomato sector in the U.S.

CUE 02-0004, Michigan Solanaceous

CUE 02-0006, California Tomato Commission

CUE 02-0012, Virginia Tomato Growers

CUE 02-0040, Southeastern Tomato Consortium

CUE 02-0046, Florida Fruit and Vegetable Association - Tomato

CUE 02-0047, Georgia Fruit and Vegetable Growers Association - Tomato

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.

Tomato Metric						Loss Estimates							Profit Impacts	
Sector Summary of Economic Estimates				28-Jan-03			as a % of Gross Revenue							
CUE # 02-00	Applicant/Site	Alternative	Notes	Brief Description of Estimate	Techically Feasible ?	Percent Yield Loss	Revenue Loss	Increased Costs	All Losses Thresholds: Strong > 15% Weak < 5%	$ Loss/ Hectare/ Fumi-gation	$ Loss per kg ai of MeBr Thresholds: Strong > $13 Weak < $7	% Operating Profit Loss Thresholds: Strong > 100% Weak < 50%	Profit Margin Threshold: >0 w/ MBr <0 w/o MBr >10% less
4	MI tomato	bromide		tomatoes	Y	0%	0%	0%	0%	$0	$0.00	0%	17%
4	MI tomato	chloropicrin	1	loss estimate	Y	25%	48%	-17%	30%	$11,205	$95.96	158%	-26%
6	CA tomato	methyl bromide		baseline	Y	0%	0%	0%	0%	$0	$0.00	0%	50%
6	CA tomato	1,3 D + pic + metam		max yield loss scenario	Y	10%	6%	6%	12%	$3,337	$24.77	23%	40%
12	VA tomato	methyl bromide		baseline	Y	0%	0%	0%	0%	$0	$0.00	0%	23%
12	VA tomato	1,3-D+ herbicide		biologist yield estimate	Y	10%	13%	0%	14%	$4,983	$29.59	32%	11%
40	SE tomato	methyl bromide		baseline	Y	0%	0%	0%	0%	$0	$0.00	0%	10%
40	SE tomato	1,3 D +pic+ pebulate		biologist yield estimate	Y	10%	10%	2%	12%	$3,511	$23.34	65%	-1%

Tomato Metric						Loss Estimates						Profit Impacts	
Sector Summary of Economic Estimates				28-Jan-03			as a % of Gross Revenue						
CUE # 02-00	Applicant/Site	Alternative	Notes	Brief Description of Estimate	Techically Feasible ?	Percent Yield Loss	Revenue Loss	Increased Costs	All Losses Thresholds: Strong > 15% Weak < 5%	$ Loss/ Hectare/ Fumi-gation	$ Loss per kg ai of MeBr Thresholds: Strong > $13 Weak < $7	% Operating Profit Loss Thresholds: Strong > 100% Weak < 50%	Profit Margin Threshold: >0 w/ MBr <0 w/o MBr >10% less
46	FL-Dade tomato	methyl bromide		baseline	Y	0%	0%	0%	0%	$0	$0.00	0%	-10%
46	FL-Dade tomato	metam sodium	2	applicant's	Y	10%	10%	-4%	6%	$1,677	$8.68	43%	-18%
46	FL-N tomato	methyl bromide		baseline	Y	0%	0%	0%	0%	$0	$0.00	0%	1%
46	FL-N tomato	1,3-D/ chloropicrin		applicant's	Y	5%	5%	-1%	4%	$810	$4.05	52%	-3%
46	FL-Ruskin tomato	methyl bromide		baseline	Y	0%	0%	0%	0%	$0	$0.00	0%	-10%
46	FL-Ruskin tomato	1,3-D/ chloropicrin		applicant's	Y	5%	5%	-1%	4%	$807	$5.57	25%	-15%
46	FL-S tomato	methyl bromide		baseline	Y	0%	0%	0%	0%	$0	$0.00	0%	-28%
46	FL-S tomato	1,3-d/ chloropicrin		applicant's	Y	5%	5%	-1%	4%	$1,017	$6.25	398%	-34%
47	GA tomato	methyl bromide		baseline--dbl cropping	Y	0%	0%	0%	0%	$0	$0.00	0%	9%
47	GA tomato	1,3 D +pic+ pebulate		double cropping	Y	9%	10%	-2%	8%	$3,618	$23.52	61%	2%
47	GA tomato	methyl bromide		baseline-- tomatoes only	Y	0%	0%	0%	0%	$0	$0.00	0%	-59%
47	GA tomato	1,3 D +pic+ pebulate		tomatoes only	Y	9%	10%	-3%	7%	$1,948	$12.67	-14%	-74%

#	Notes
1	Assumed alternative cost the same as MeBr. If it costs more, then it is less economically feasible.
2	1,3 D cannot be used in Dade County FL.
*	kg ai that would be applied/hectare = application rate for the alternatives or requested application rate for methyl bromide.

Tomato Metric				Revenue or Value			MeBr or Alternative Costs						
Sector of Economic Estimates			28-Jan-03	P	Y	R	Q	Qp		Pp	Ca	Ap	Cp
CUE # 02-00	Applicant/Site	Alternative	Brief Description of Estimate	average crop price per 11.4 kg box	yield # of 11.4 kg boxes per hectare	revenue or value per hectare = PxY	kg ai that would be applied* per hectare	units of product applied per hectare	unit	price per unit of product	appli-cation & other costs	# of appl/ year	Cost per hectare= (Q x Pp + Ca) x Ap
4	MI tomato	methyl bromide	baseline-tomatoes	$9.93	3,705	$36,791	117	117	kg ai	$4.84	$519	1	$1,084
4	MI tomato	chloropicrin	loss estimate	$6.95	2,779	$19,312						1	$1,084
6	CA tomato	methyl bromide	baseline	$7.15	3,920	$28,027	135	135	kg ai	$6.60	$885	1	$1,775
6	CA tomato	1,3 D + pic + metam	max yield loss scenario	$7.50	3,528	$26,459	336	935	liters	$0.79	$2,803	1	$3,544
12	VA tomato	methyl bromide	baseline	$7.30	4,940	$36,062	168	2,104	liters	$0.66	$642	1	$2,032
12	VA tomato	1,3-D+herbicide	biologist yield estimate	$7.02	4,446	$31,211						1	$2,164
40	SE tomato	methyl bromide	baseline	$8.00	3,705	$29,640	150	150	kg ai			1	$1,556
40	SE tomato	1,3 D +pic+ pebulate	biologist yield estimate	$8.00	3,335	$26,676		327	liters	$3.46	$514	1	$1,647

* Other pest control costs are those other than methyl bromide or its alternatives.

Tomato Metric				Revenue or Value			MeBr or Alternative Costs						
Sector of Economic Estimates			28-Jan-03	P	Y	R	Q	Qp		Pp	Ca	Ap	Cp
CUE # 02-00	Applicant/Site	Alternative	Brief Description of Estimate	average crop price per 11.4 kg box	yield # of 11.4 kg boxes per hectare	revenue or value per hectare = PxY	kg ai that would be applied* per hectare	units of product applied per hectare	unit	price per unit of product	appli-cation & other costs	# of appl/ year	Cost per hectare= (Q x Pp + Ca) x Ap
46	FL-Dade tomato	methyl bromide	baseline	$7.50	3,458	$25,935	193	193	kg ai			1	$1,545
46	FL-Dade tomato	metam sodium	applicant's	$7.50	3,112	$23,342						1	$1,775
46	FL-N tomato	methyl bromide	baseline	$7.00	3,705	$25,935	225	225	kg ai	$5.94		1	$1,334
46	FL-N tomato	1,3-D/ chloropicrin	applicant's	$7.00	3,520	$24,638						1	$1,188
46	FL-Ruskin tomato	methyl bromide	baseline	$7.00	3,631	$25,416	163	163	kg ai			1	$1,417
46	FL-Ruskin tomato	1,3-D/ chloropicrin	applicant's	$7.00	3,448	$24,137						1	$1,188
46	FL-S tomato	methyl bromide	baseline	$7.00	3,458	$24,206	163	163	kg ai			1	$1,328
46	FL-S tomato	1,3-d/chloropicrin	applicant's	$7.00	3,285	$22,996						1	$1,188
47	GA tomato	methyl bromide	baseline--dbl cropping	$7.26	6,291	$45,692	154	154	kg ai	$5.83	$1,606	1	$2,502
47	GA tomato	1,3 D +pic+ pebulate	double cropping	$7.22	5,710	$41,218		327	liters	$3.46	$514	1	$1,647
47	GA tomato	methyl bromide	baseline--tomatoes only	$6.60	3,952	$26,083	154	154	kg ai	$5.83	$1,606	1	$2,502
47	GA tomato	1,3 D +pic+ pebulate	tomatoes only	$6.53	3,582	$23,387		327	liters	$3.79	$514	1	$1,755

Tomato Metric				Other Op Costs per Hectare			xed & OH Costs/Hecta			Total	Profits per Hectare		Loss Estimates per Hectare			
Sector of Economic Estimates			28-Jan-03	Cc	Co	Cop	Ce	Cf	Coh	C	Nop	N	Lr	Lp	Lo	L
CUE # 02-00	Applicant/ Site	Alternative	Brief Description of Estimate	other pest control costs*	other operating costs	total operating costs = Cp +Cc+Co	equip-ment	fixed costs	over-head costs	Total Costs / Hectare Cop+Ce+ Cf+Coh	Operating = R-Cop	Profit = R-C	revenue or value	additional cost of alterna-tives	add. other costs	all losses = Lr+Lp+Lo
4	MI tomato	bromide	tomatoes	$1,183	$27,444	$29,711		$847		$30,558	$7,080	$6,232	$0	$0	$0	$0
4	MI tomato	chloropicrin	estimate	$1,183	$21,170	$23,437		$847		$24,285	($4,125)	($4,972)	$17,478	$0	($6,274)	$11,205
6	CA tomato	methyl bromide	baseline		$11,587	$13,361	$128		$632	$14,122	$14,666	$13,905	$0	$0	$0	$0
6	CA tomato	1,3 D + pic + metam	max yield loss scenario		$11,587	$15,131	$128		$632	$15,891	$11,329	$10,568	$1,568	$1,769	$0	$3,337
12	VA tomato	methyl bromide	baseline	$1,754	$16,703	$20,488	$2,905	$661	$3,600	$27,654	$15,574	$8,408	$0	$0	$0	$0
12	VA tomato	1,3-D+ herbicide	biologist yield estimate	$1,754	$16,703	$20,620	$2,905	$661	$3,600	$27,786	$10,591	$3,425	$4,851	$132	$0	$4,983
40	SE tomato	methyl bromide	baseline	$458	$22,231	$24,245	$523	$62	$1,963	$26,792	$5,395	$2,848	$0	$0	$0	$0
40	SE tomato	1,3 D +pic+ pebulate	biologist yield estimate	$458	$22,231	$24,335	$523	$62	$1,963	$26,883	$2,341	($207)	$2,964	$90	$457	$3,511

Tomato Metric				Other Op Costs per Hectare			xed & OH Costs/Hecta			Total	Profits per Hectare		Loss Estimates per Hectare			
Sector of Economic Estimates			28-Jan-03	Cc	Co	Cop	Ce	Cf	Coh	C	Nop	N	Lr	Lp	Lo	L
CUE # 02-00	Applicant/ Site	Alternative	Brief Description of Estimate	other pest control costs*	other operating costs	total operating costs = Cp +Cc+Co	equip-ment	fixed costs	over-head costs	Total Costs / Hectare Cop+Ce+ Cf+Coh	Operating = R-Cop	Profit = R-C	revenue or value	additional cost of alterna-tives	add. other costs	all losses = Lr+Lp+Lo
46	FL-Dade tomato	methyl bromide	baseline	$2,092	$18,380	$22,017	$343	$1,112	$4,951	$28,422	$3,918	($2,487)	$0	$0	$0	$0
46	FL-Dade tomato	metam sodium	applicant's	$2,129	$17,081	$20,985	$374	$1,112	$5,034	$27,505	$2,356	($4,164)	$2,594	$230	($1,147)	$1,677
46	FL-N tomato	methyl bromide	baseline	$470	$22,365	$24,169	$440	$383	$725	$25,716	$1,766	$219	$0	$0	$0	$0
46	FL-N tomato	1,3-D/ chloropicrin	applicant's	$470	$22,124	$23,782	$440	$383	$725	$25,329	$856	($691)	$1,297	($146)	($241)	$910
46	FL-Ruskin tomato	methyl bromide	baseline	$1,650	$18,737	$21,804	$627	$741	$4,877	$28,049	$3,612	($2,633)	$0	$0	$0	$0
46	FL-Ruskin tomato	1,3-D/ chloropicrin	applicant's	$1,650	$18,697	$21,535	$627	$741	$4,774	$27,677	$2,602	($3,540)	$1,279	($229)	($143)	$907
46	FL-S tomato	methyl bromide	baseline	$1,825	$20,798	$23,951	$504	$1,081	$5,393	$30,928	$255	($6,722)	$0	$0	$0	$0
46	FL-S tomato	1,3-d/ chloropicrin	applicant's	$1,825	$20,792	$23,805	$504	$1,081	$5,345	$30,735	($809)	($7,739)	$1,210	($140)	($53)	$1,017
47	GA tomato	methyl bromide	baseline--dbl cropping	$3,165	$34,117	$39,784	$173	$30	$1,420	$41,407	$5,908	$4,285	$0	$0	$0	$0
47	GA tomato	1,3 D +pic+ pebulate	double cropping	$3,165	$34,117	$38,928	$173	$30	$1,420	$40,551	$2,290	$667	$4,474	($856)	$0	$3,618
47	GA tomato	methyl bromide	baseline--tomatoes only	$3,165	$34,117	$39,784	$173	$30	$1,420	$41,407	($13,701)	($15,324)	$0	$0	$0	$0
47	GA tomato	1,3 D +pic+ pebulate	tomatoes only	$3,165	$34,117	$39,036	$173	$30	$1,420	$40,659	($15,649)	($17,272)	$2,696	($748)	$0	$1,948

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 ar 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 Master's 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:

See separate electronic file for charts 1 and 2.