METHYL BROMIDE CRITICAL USE RENOMINATION FOR PREPLANT SOIL USE (OPEN FIELD OR PROTECTED ENVIRONMENT)

NOMINATING PARTY:
The United States of America

NAME
USA CUN09 SOIL Ornamentals Open Field or Protected Environment

BRIEF DESCRIPTIVE TITLE OF NOMINATION:
Methyl Bromide Critical Use Nomination for Preplant Soil Use for Ornamentals Grown in Open Fields or in Protected Environments (Submitted in 2007 for 2009 Use Season)

CROP NAME (OPEN FIELD OR PROTECTED):
Ornamentals, including cut flowers, cut foliage, herbaceous perennials, bulbs and plant propagative material, in both open fields and protected environments (tunnels, open-ended and closed hoop-houses, shade houses, and permanent greenhouses)

QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION:

TABLE COVER SHEET: QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION

YEAR	NOMINATION AMOUNT (METRIC TONNES)*
2009	137.776

*This amount includes methyl bromide needed for research.

SUMMARY OF ANY SIGNIFICANT CHANGES SINCE SUBMISSION OF PREVIOUS NOMINATIONS:

The US government has determined that caladiums should not have been listed as a crop using methyl bromide under the CUE process. The Florida floriculture industry clarified that caladiums qualify for QPS use of methyl bromide. Therefore, caladiums have been removed from this nomination. Previously it was not clear that Florida was not including caladiums in the requested amount. Once this was clarified, it was determined that the removal of caladiums will not impact the amount nominated.

CA cut flower industry conducted a survey this year and obtained better information on methyl bromide usage. Hot gas in CA greenhouses makes up a larger percentage of usage then previously realized. Hot gas users are using the 98:2 formulation at 487 kg/ha, for a total amount used of approximately 33,603 kg on 69 ha. Greenhouse growers are not permitted to apply methyl bromide with tractor-drawn equipment and must apply methyl bromide from outside of the greenhouse (25). This method involves applying methyl bromide through tubes on the soil surface under the tarp, and higher concentrations are required to get efficacy similar to sub-surface shank-applied broadcast applications. Research on finding ways to decrease this usage is now an industry priority.

REASON OR REASONS WHY ALTERNATIVES TO METHYL BROMIDE ARE NOT TECHNICALLY AND ECONOMICALLY FEASIBLE:

Alternatives do not provide adequate control the full pest spectrum. In addition, use restrictions limit widespread use of alternatives.

(Details on this page are requested under Decision Ex. I/4(7), for posting on the Ozone Secretariat website under Decision Ex. I/4(8).)

This form is to be used by holders of single-year exemptions to reapply for a subsequent year's exemption (for example, a Party holding a single-year exemption for 2005 and/or 2006 seeking further exemptions for 2007). It does not replace the format for requesting a critical-use exemption for the first time.

In assessing nominations submitted in this format, TEAP and MBTOC will also refer to the original nomination on which the Party's first-year exemption was approved, as well as any supplementary information provided by the Party in relation to that original nomination. As this earlier information is retained by MBTOC, a Party need not re-submit that earlier information.

NOMINATING PARTY CONTACT DETAILS:

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Following the requirements of Decision IX/6 paragraph (a)(1) The United States of America has determined that the specific use detailed in this Critical Use Nomination is critical because the lack of availability of methyl bromide for this use would result in a significant market disruption. X Yes ☐ No

_______________________ _______________________ ______________

Signature Name Date

Title: ____

CONTACT OR EXPERT(S) FOR FURTHER TECHNICAL DETAILS:

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LIST OF DOCUMENTS SENT TO THE OZONE SECRETARIAT IN OFFICIAL NOMINATION PACKAGE:

1. PAPER DOCUMENTS: **Title of paper documents and appendices**	**No. of pages**	**Date sent to Ozone Secretariat**
USA CUN09 Soil_ Ornamentals_ Open Field		
2. ELECTRONIC COPIES OF ALL PAPER DOCUMENTS: ***Title of each electronic file (for naming convention see notes above)**	**No. of kilobytes**	**Date sent to Ozone Secretariat**
USA CUN09 Soil_ Ornamentals_ Open Field		

* Identical to paper documents

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Part A: INTRODUCTION
Renomination Part A: SUMMARY INFORMATION

1. (Renomination Form 1.) NOMINATING PARTY AND NAME:
The United States of America
USA CUN09 SOIL Ornamentals Open Field or Protected Environment

2. (Renomination Form 2.) DESCRIPTIVE TITLE OF NOMINATION:
Methyl Bromide Critical Use Nomination for Preplant Soil Use for Ornamentals Grown in Open Fields or in Protected Environments (Submitted in 2007 for 2009 Use Season)

3. CROP AND SUMMARY OF CROP SYSTEM (*e.g. open field (including tunnels added after treatment), permanent glasshouses (enclosed), open ended polyhouses, others (describe)*):

The United States ornamentals industry is characterized by numerous crop species and varieties, with multiple cropping systems in different environments. This nomination is for ornamentals, including cut flowers, cut foliage, herbaceous perennials, bulbs and plant propagative material, in both open fields and protected environments (tunnels, open-ended and closed hoop-houses, shade houses, and permanent greenhouses). This nomination does not include other aspects of the ornamental industry, such as Christmas tree nurseries.

This nomination is for multiple species (see Appendix B). The nomination will describe the issues facing the industry, with crop specific information included when available, but not every cropping system in the industry will be explained. In addition, this industry changes rapidly and therefore, the species and varieties grown also changes. For example, several years ago, sunflowers were not a major crop in Florida but now they are.

In 1997, eight percent of the ornamentals in the United States were grown under cover and 92 percent were grown in the open. There are three basic systems in place for ornamentals in California. Annuals are shallow rooted crops that represent 50 to 60 percent of the industry. They are often planted to a depth of 6 to 8 inches. Fumigants can be shanked into the preformed beds or drip-applied from drip tapes placed on top of beds under plastic mulch. Bulb crops represent about 30 percent of the industry. Fumigants are applied by deep shanking. Bedding up generally occurs after planting the bulbs. Perennials are deep-rooted multi-year crops and represent 10 to 20 percent of the industry in California. Fumigation needs to penetrate to a depth of 2 to 3 feet and may require multi-level shanking.

In California, the nomination includes cut flowers, cut foliage, and perennials. Production occurs in open fields, tunnels, open-ended and closed hoop-houses, shade houses, and permanent greenhouses. Species grown in California include *Ranunculus* and calla lilies (see Appendix B for additional species grown).

Methyl bromide is used in almost all saran house production – snap dragons, asters, gerbera daisies, mums, etc, as a broadcast solid tarp treatment. It is used in field grown statice and gypsophila as an in-bed treatment. In some gladiolus production, methyl bromide is used broadcast solid tarp for increased of cormels and tissue culture stock (4).

Many crops, such as *Ranunculus*, are grown outdoors in open fields. *Ranunculus* is grown as an annual in the field. In fall, seeds are planted on beds. Flowers are harvested in the spring and the tubers are harvested in July and August. These tubers are used in landscaping and are planted in the fall (6). The tubers, which are distributed worldwide, are also used in commercial production.

In Florida, some of the typical cut flowers grown are snapdragons, lilies, gladiolus, lisianthus, delphinium, and sunflowers. Growers rotate to other cut flower species, but not to other crops. Planting occurs between August and March, with harvesting occurring October through May. Two to three plantings occur each year, with only one application of methyl bromide each year.

Several aspects of the California and Florida field grown ornamental industry limit the adoption of methyl bromide alternatives. Land is often in desirable coastal areas, with an ideal climate for ornamental crop production. However, this climate also makes it highly desirable for residential development, resulting in high land prices and proximity of fields to residential areas. As mentioned above, the industry is characterized by numerous crop species and varieties, with variation in pest and chemical susceptibility. To stay competitive, growers often introduce new varieties. When new varieties are introduced, the susceptibility of the plant to pests or to residual pesticide applications is often unknown. (1)

In Michigan, perennial herbaceous nurseries are also requesting methyl bromide to control nematodes and weeds. Some of the species grown are Delphinium, Hosta, and Phlox. Herbaceous perennials are grown in open fields.

4. AMOUNT OF METHYL BROMIDE NOMINATED (*give quantity requested (metric tonnes) and years of nomination*):

(Renomination Form 3.) YEAR FOR WHICH EXEMPTION SOUGHT:

TABLE A 1: QUANTITY OF METHYL BROMIDE REQUESTED IN EACH YEAR OF NOMINATION

YEAR	NOMINATION AMOUNT (METRIC TONNES)*
2009	**137.776**

*This amount includes methyl bromide needed for research.

(Renomination Form 4.) SUMMARY OF ANY SIGNIFICANT CHANGES SINCE SUBMISSION OF PREVIOUS NOMINATIONS (e.g. changes to requested exemption quantities, successful trialling or commercialisation of alternatives, etc.)

The US government has determined that caladiums should not have been listed as a crop using methyl bromide under the CUE process. The Florida floriculture industry clarified that caladiums qualify for QPS use of methyl bromide. Therefore, caladiums have been removed from this nomination. Previously it was not clear that Florida was not including caladiums in the requested amount. Once this was clarified, it was determined that the removal of caladiums will not impact the amount nominated.

CA cut flower industry conducted a survey this year and obtained better information on methyl bromide usage. Hot gas in CA greenhouses makes up a larger percentage of usage then previously realized. Hot gas users are using the 98:2 formulation at 487 kg/ha, for a total amount used of approximately 33,603 kg on 69 ha. Greenhouse growers are not permitted to apply methyl bromide with tractor-drawn equipment and must apply methyl bromide from outside of the greenhouse (25). This method involves applying methyl bromide through tubes on the soil surface under the tarp, and higher concentrations are required to get efficacy similar to sub-surface shank-applied broadcast applications. Research on finding ways to decrease this usage is now an industry priority.

5. (i) BRIEF SUMMARY OF THE NEED FOR METHYL BROMIDE AS A CRITICAL USE (e.g. no registered pesticides or alternative processes for the particular circumstance, plantback period too long, lack of accessibility to glasshouse, unusual pests)**:**

The U.S nomination is only for those areas where the alternatives are not suitable. In U.S. ornamental production there are several factors that make the potential alternatives to methyl bromide unsuitable. These include:

- Pest control efficacy of alternatives: the efficacy of alternatives may not be comparable to methyl bromide in some areas, making these alternatives technically and/or economically infeasible for use in ornamental production.
- Regulatory constraints: e.g., in some areas of the United States 1,3-Dichloropropene use is limited due to township caps in California.
- Delay in planting and harvesting: e.g., the plant-back interval for 1,3-D+chloropicrin is two weeks longer than methyl bromide+chloropicrin, and in the northern parts of the United States an additional delay would occur because soil temperature must be higher to fumigate with alternatives. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.

As part of the overall ornamentals industry, the cut flower, foliage, and bulb industry is very complex. For example, a single grower in California may grow as many as 100 species and/or varieties in a single year. Growers must find methyl bromide alternatives that will control previous crops grown on the site, as well as a diversity of key pests, which vary for each crop variety. For example, in *Ranunculus*, residual tubers, bulbs, and seeds from the previous crop must be killed because they are reservoirs for nematodes and soil pathogens and considered to be weeds themselves as they are off-variety. Along with these issues, there are concerns about phytotoxicity and registration with alternative chemicals (6, 28).

TABLE A 2: EXECUTIVE SUMMARY*

Region		California Cut Flower Commission	Michigan Herbaceous Perennials	Florida Cut Flowers	Sector Total or Average
EPA Preliminary Value	kgs	70,307	4,763	79,379	154,448
EPA Amount of All Adjustments	kgs	(2,361)	(2,224)	(16,146)	(20,732)
Most Likely Impact Value for Treated Area	kgs	67,946	2,539	63,232	133,716
	ha	323	13	181	516
	Rate	211	200	350	259
Sector Research Amount (kgs)		4,060	2009 Total US Sector Nomination		137,776

* *See Appendix A for a complete description of how the nominated amount was calculated.*

(ii) STATE WHETHER THE USE COVERED BY A CERTIFICIATION STANDARD. (*Please provide a copy of the certification standard and give basis of standard (e.g. industry standard, federal legislation etc.). Is methyl bromide-based treatment required exclusively to meet the standard or are alternative treatments permitted? Is there a minimum use rate for methyl bromide? Provide data which shows that alternatives can or cannot achieve disease tolerances or other measures that form the basis of the certification standard).*

In Michigan, growers cannot ship product without a clean inspection and Michigan Department of Agriculture certification. Fumigating is not a regulatory requirement nor is fumigating with methyl bromide mandatory. However, crops need to grow free from nematodes and certain diseases in order to meet trade requirements. Generally growers have found that methyl bromide is the best way to meet these requirements.

6. SUMMARISE WHY KEY ALTERNATIVES ARE NOT FEASIBLE (Summary should address why the two to three best identified alternatives are not suitable, < 200 words)**:**

1. In California, 1,3-D + chloropicrin is considered one of the best currently available alternatives, if use restrictions, such as township caps, were removed and label application rates were increased. However, as currently registered, this alternative does not provide sufficient control of weeds and regulatory restrictions limit use.

2. 1,3-D + chloropicrin, followed by metam sodium, plus herbicides is expensive due to the material cost and the need for multiple applications. Use of the fumigants without herbicides may not adequately control weeds. However, contact herbicides may damage the crop in the field, resulting in yield or quality losses. Damage to the following crop may occur if soil residual herbicides are used.

3. Solarization seems promising in Florida production but would take awhile to adopt. Solarization takes several weeks to control many pests to a depth of 30 cm. This length of time for a treatment is not economically feasible for many growers due to the intensive, year-round production situation of the cut flower industry. In addition, solarization is not feasible under Michigan field conditions. Production areas in California are in mainly coastal regions where solarization is not feasible due to cool temperatures and cloud cover most of the year.

7. (i) PROPORTION OF CROP GROWN USING METHYL BROMIDE *(provide local data as well as national figures. Crop should be defined carefully so that it refers specifically to that which uses or used methyl bromide. For instance processing tomato crops should be distinguished from round tomatoes destined for the fresh market)***:**

Table A 3. PROPORTION OF CROP USING METHYL BROMIDE

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TOTAL CROP AREA IN 2002 (HA)	PROPORTION OF TOTAL CROP AREA TREATED WITH METHYL BROMIDE IN 2002 (%)**
A California Cut Flowers, Cut Greens, and Perennials*	5,795	6%
B Florida Floriculture*	5,402	26%
C Michigan Herbaceous Perennials***	2,019	<1%
National Total (Cut Flowers, Cut Florist Greens, and Bulbs, Corms, Rhizomes and Tubers-Dry):	**15,542**	**11%**
National Total (Floriculture Crops)* **	**36,679**	**Not available**

*2002 USDA Census of Agriculture for cut flowers and cut florist greens, and bulbs, corms, rhizomes and tubers – dry (2002 is the most recent year for which census data are available).
**For proportion of total crop treated, included historical methyl bromide use data from 2002 and 2003. For National Total (Cut Flowers, Cut Florist Greens, and Bulbs, Corms, Rhizomes and Tubers-Dry) included only California and Florida usage.
*** 2002 USDA Census of Agriculture for floriculture crops (includes bedding/garden plants, cut flowers and cut florist greens, foliage plants, and potted flowering plants). These figures include many ornamental crops not included with this sector nomination.

(ii) IF PART OF THE CROP AREA IS TREATED WITH METHYL BROMIDE, INDICATE THE REASON WHY METHYL BROMIDE IS NOT USED IN THE OTHER AREA, AND IDENTIFY WHAT ALTERNATIVE STRATEGIES ARE USED TO CONTROL THE TARGET PATHOGENS AND WEEDS WITHOUT METHYL BROMIDE THERE.

There are numerous cut flower, foliage, bulb, and herbaceous perennial species. It is beyond the scope of this document to describe the pest control practices for all species. However, the USG is able to provide a couple of examples of alternatives that have been found for some species.

Steam sterilization has been adopted by some greenhouse and shade house producers of lilies (asiatic and longiflorum types). The USG does not have an estimate for the proportion of the nomination in which steam is a feasible alternative. Given that the majority of the nomination is for outdoor use, it is expected that a minimal proportion of the nomination could switch to steam.

Steam can also be an effective alternative but it is very expensive to heat soil uniformly to an adequate depth (0.3 to 0.9 meters) for the length of time required to be effective. There are also costs associated with setting up steam systems, especially in older/established greenhouses.

Some crops have had success with substrates in greenhouses. These crops include roses, gerbera, lilies and tulips. For a couple of crops using substrates, lilies and tulips, the soil used in production needs to be fumigated. After a year or two the soil in the greenhouse under the crate becomes contaminated with diseases like *Pythium* and *Phytophthora*. Growers using this system need to reuse the soil in order for the system to be cost effective. Methyl bromide is used in this system to eliminate diseases, old bulbs and weeds.

In the case of roses and gerberas, substrate production is more feasible than for other crops because these crops are perennial and production in substrates results in increased yield and quality. In perennial systems, infrastructure costs can be amortized over several years. However, due to the high production costs, cut rose production is decreasing.

Lilies and tulips are also often grown in substrates. These crops are "forced", which means that that the bulbs are planted in crates and actually grown in very large cooler/growth chambers. They are stacked floor to ceiling in these growing rooms for the first 4 to 8 weeks after planting and then taken into the greenhouse where they are spread out 2 dimensionally for finishing the last 4 to 6 weeks. This results in a lower cost of production and a faster turn on space in the greenhouse, which is very costly.

There are challenges associated with substrate production. Generally, for most crops, there isn't an offsetting yield or quality increase to defer the costs associated with substrate production. Costs include a large increase in inputs, capital expenditures for the systems coupled with high costs of potting mix or substrates, plus the labor to move crates or install the system. In addition, growers must be very careful in substrate systems when it comes to water quality management, fertility management and disease containment. Yield losses can be very high if mistakes are made. Soil has a buffering capacity that limits some of the problems that are associated with substrate production. In addition, substrates may cause significant increases in the cost of production. Some growers that have tried substrates ended up going back to ground production for the reasons described above. For example, Gerbera flowers are sensitive to fertility and water issues in the substrate system. Some growers have even moved back to ground production due the risks that are involved.

Easter lily growers in northern California and southern Oregon are using 1,3-D and metam sodium, applied sequentially instead of methyl bromide. These growers have a very long fallow growth policy where they will rotate onto ground after 10 to 12 years, which is feasible because most of the lily growers are also cattle ranchers. In the major floriculture growing regions in California, production occurs in close proximity to the coast to get the proper environment to be able to farm outdoors. California coastal land prices and availability preclude 10 year fallow periods**.** There is limited land available in addition to competition with other specialty growers, such as berries, for the same land.

Many berry growers farm with plasticulture. These growers bed up, plastic mulch the beds with drip irrigation set up underneath, then drip fumigate with methyl bromide alternatives such as 1,3-D/chloropicrin followed by metam sodium one week later. The growers then aerate when they put the holes in the mulch for planting. In floriculture and bulb, corm, tuber and rhizome production, the planting densities are so dense, such as in callas, planting into plastic is not possible because the plants are so close together that the plastic essentially has to be removed to facilitate the close spacing of the seedlings.

Methyl bromide is not being requested for the ornamental crop acreage that has had success with substrates or other alternatives.

(iii) WOULD IT BE FEASIBLE TO EXPAND THE USE OF THESE METHODS TO COVER AT LEAST PART OF THE CROP THAT HAS REQUESTED USE OF METHYL BROMIDE? WHAT CHANGES WOULD BE NECESSARY TO ENABLE THIS?

No. In this industry, the fumigation situation and need for methyl bromide varies by species. Although there are some potential alternatives, there is not enough scientific or grower experience for all crop species to switch to alternatives at this time. One major difficulty is that market desires require a high degree of flexibility in scheduling certain species and new cultivars. Therefore, the information on the sensitivity of each crop to fumigant alternatives as well as the pests is not known until crops have been in production for at least a few cycles.

Current research trials are aimed at alternatives. Chloropicrin, metam sodium and the other alternatives are being researched as both drip applied as well as broadcast applications. However, so far research using the best currently registered alternative, i.e. 1,3-D/chloropicrin followed by metam one week later, has yet to demonstrate that this alternative is effective and will result in adequate yields. In addition, regulatory restrictions (e.g., township caps) may limit the use of this alternative.

Methyl bromide is not being requested for those crops that have alternate control strategies, such as other fumigants, substrates, or other alternatives. Instead, this nomination is for those species where suitable alternatives have not been found. Research to find alternatives to methyl bromide is ongoing in all of the regions.

8. AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE (*Duplicate table if a number of different methyl bromide formulations are being requested and/or the request is for more than one specified region*):

TABLE A 4. AMOUNT OF METHYL BROMIDE REQUESTED

REGION	A California Cut Flowers, Cut Greens, and Perennials	B Florida Floriculture	C Michigan Herbaceous Perennials
YEAR OF EXEMPTION REQUEST	**2009**		
QUANTITY OF METHYL BROMIDE NOMINATED (METRIC TONNES)	See Appendix A	See Appendix A	See Appendix A
TOTAL CROP AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION (M^2 OR HA) (NOTE: IGNORE REDUCTIONS FOR STRIP TREATMENT)	See Appendix A	See Appendix A	See Appendix A
METHYL BROMIDE USE: **BROADACRE OR STRIP/BED** TREATMENT?	Broadcast	Broadcast	Broadcast
PROPORTION OF BROADACRE AREA WHICH IS TREATED IN STRIPS; E.G. 0.54, 0.67	1.0	1.0	1.0
FORMULATION (RATIO OF METHYL BROMIDE/CHLOROPICRIN MIXTURE) TO BE USED FOR CALCULATION OF THE CUE E.G. 98:2, 50:50	Varies[1]	98:2	98:2
APPLICATION RATE* (KG/HA) FOR THE FORMULATION	Varies[1]; See Appendix A	See Appendix A	See Appendix A
DOSAGE RATE* (G/M^2) (I.E. ACTUAL RATE OF FORMULATION APPLIED TO THE AREA TREATED WITH METHYL BROMIDE/CHLOROPICRIN ONLY)	See Appendix A	See Appendix A	See Appendix A

[1]Formulation is dependent on the pest pressure, application method, and rotation scheme. Greenhouse fumigations applied as hot gas require the highest concentration (98:2 formulation at 487 kg/ha) due to the need to get adequate penetration into the soil profile. Field fumigations, if following strawberries, use the reduced concentration of 57:43 at 252 kg/ha. Normal field fumigations use the 67:33 formulation at 252 kg/ha.

Strip treatments are not used for several reasons. According to the University of Florida, treating in strips may be dangerous to crop production. In a snapdragon test from the 2003 fall season there was an untreated strip next to the plots. A heavy rain washed soil from this untreated area into the plots, spreading soilborne disease through the plots and causing heavy damage (8). These data show the danger of using an untreated strip in or near the production site. Usually growers will treat the whole site to avoid such problems. An additional concern when using strip treatments is that there are more seams and edges with strip or bed fumigation that can result in methyl bromide escape.

Strip treatments often used in field tomato and pepper production are not readily, if ever, done in California. For vegetable crops, the crop is planted with a wide walkway/furrow between beds. In California floriculture growers plant as many units as possible in per hectare in order to be profitable. Therefore, although the exact proportion of the area treated with methyl bromide is not available, in floriculture production the beds are larger than the spaces between beds. Strip fumigation also lends itself to plasticulture which lends itself to individual plants that grow relatively big and need space between plants within the beds, such as vegetable crops. Floriculture and bulb, corm, tuber and rhizome crops such as calla, gladiolus, *Ranunculus*, sunflower, stock, *Liatris*, chrysanthemum, snapdragon and others, are planted very densely, at close spacing, in beds. The spacing is so close that the plastic is essentially removed in order to plant or allow seedlings and transplants to grow.

Researchers are addressing strip treatments in research.   Much of the research in California is aimed at drip fumigation which, in a sense, is strip fumigation since only the beds are fumigated and not the furrows. Even though there have been failures with strip/bed treatments, growers/researchers are trying to make the technique work, as well as other alternative broadcast/shank treatments.

9. SUMMARISE ASSUMPTIONS USED TO CALCULATE METHYL BROMIDE QUANTITY NOMINATED FOR EACH REGION *(include any available data on historical levels of use):*

The amount of methyl bromide nominated by the U.S. was calculated as follows:

- The percent of regional hectares in the applicant's request was divided by the total area planted in that crop in the region covered by the request. Values greater than 100 percent are due to the inclusion of additional varieties in the applicant's request that were not included in the USDA National Agricultural Statistics Service surveys of the crop.
- Hectares counted in more than one application or rotated within one year of an application to a crop that also uses methyl bromide were subtracted. There was no double counting in this sector.
- Growth or increasing production (the amount of area requested by the applicant that is greater than that historically treated) was subtracted. The applicant that included growth in their request had the growth amount removed.
- Only the acreage experiencing one or more of the following impacts were included in the nominated amount: moderate to heavy key pest pressure, regulatory impacts, karst topographic features, buffer zones, unsuitable terrain, and cold soil temperatures.

Renomination Form Part G: CHANGES TO QUANTITY OF METHYL BROMIDE REQUESTED

This section seeks information on any changes to the Party's requested exemption quantity.

(Renomination Form 16.) CHANGES IN USAGE REQUIREMENTS

Provide information on the nature of changes in usage requirements, including whether it is a change in dosage rates, the number of hectares or cubic metres to which the methyl bromide is to be applied, and/or any other relevant factors causing the changes.

The amount nominated reflects reductions based on transition to alternatives.

(Renomination Form 17.) RESULTANT CHANGES TO REQUESTED EXEMPTION QUANTITIES

QUANTITY (KG) REQUESTED FOR PREVIOUS NOMINATION YEAR:	138,538
QUANTITY (KG) APPROVED BY PARTIES FOR PREVIOUS NOMINATION YEAR:	138,538
QUANTITY (KG) REQUIRED FOR YEAR TO WHICH THIS REAPPLICATION REFERS:	137,776
TREATED AREA (HA) FOR YEAR TO WHICH THIS REAPPLICATION REFERS:	See Appendix A

Part B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASON FOR THIS REQUEST IN EACH REGION (*List only those target weeds and pests for which methyl bromide is the only feasible alternative and for which CUE is being requested*):

TABLE B 1. KEY PESTS

Region where methyl bromide use is requested	**Key disease(s) and weed(s) to species and, if known, to level of race**[1]	**Specific reasons why methyl bromide needed** (e.g. Effective herbicide available, but not registered for this crop; mandatory requirement to meet certification for disease tolerance; no host resistance for a specific race**)**
A: California Cut Flowers, Cut Greens and Perennials	*Verticillium* spp., *Fusarium* spp., *Pythium* spp., *Meloidogyne* spp., Nutsedge (*Cyperus* spp.), *Malva* spp., *Poa* spp., and previous crop propagules. Specific pest problems vary by individual crop and variety.	Due to the diversity and complexity of the cut flower and foliage industry, additional time is needed to complete ongoing research into implementation of methyl bromide alternatives and to allow time for registering materials. It is difficult to control all of these root pathogens and weeds with commercially available crop management materials or methods. Some of the alternatives that have been found for other crops may not be feasible for floriculture because of high cost, phytotoxicity issues, difficulties with quickly treating and replanting fields for multi-cropping, township caps, and buffer zone requirements (5).
B: Florida Floriculture	All soil borne diseases, weeds, and nematodes. Includes *Fusarium* spp., *Rhizoctonia* spp., *Phytoplithora*, Stromatinia, *Pythium* spp., *Erwinia*, and most soil nematodes i.e. *Meliodogyne* spp., and previous crop propagules. Specific pest problems vary by individual crop and variety.	These diseases are common, abundant, and spread through/by water. Florida has areas of tropical and sub-tropical climate, which is conducive to the spread of these diseases. Alternatives have not been found for all species. Some of the alternatives that have been found for other crops may not be feasible for floriculture because of high cost, difficulties with quickly treating and replanting fields for multi-cropping, and buffer zone requirements (5). Due to the diversity and complexity of the cut flower and foliage industry, additional time is needed to complete ongoing research into implementation of methyl bromide alternatives and to allow time for registering materials.
C: Michigan Herbaceous Perennials	**Nematodes:** *Meloidogyne hapla*, *Pratylenchus* spp., *Ditylenchus* spp.; **Fungi:** *Pythium* (damping-off, root rot), *Fusarium* (damping-off, root rot), *Phytophthora, Rhizoctonia;* **Weeds**: *Cyperus esculentus* (yellow nutsedge), *Inula brittanica*, *Oxalis stricta*, *Cirsium arvense*, *Rorippa sylvestri*	Until field-tested alternatives can be identified and protocols developed for them, methyl bromide will be critical to pest management for this industry.

[1]A list of key pests of select cut flower species is included in Appendix B.

11. (i) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

TABLE B 2. CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

CHARACTERISTICS	Region where methyl bromide is requested		
	A: California Cut Flower, Cut Greens, and Perennials	B: Florida Floriculture	C: Michigan Herbaceous Perennials
Crop type, e.g. transplants, bulbs, trees or cuttings	Cut Flowers, Cut Greens, and Perennials	Cuttings, Bulbs	Herbaceous perennials
Annual or perennial crop (state number of years between replanting)	Annual and Perennial	Annual and Perennial	Perennial: 2-year seeded (6% of treated area) and 2-year transplants (29% of treated area) are on a 2 year replant/fumigation cycle; 3-year transplants (65% of treated area) are on a 3 year replant/fumigation cycle

CHARACTERISTICS	Region where methyl bromide is requested		
	A: California Cut Flower, Cut Greens, and Perennials	B: Florida Floriculture	C: Michigan Herbaceous Perennials
Typical crop rotation (if any) and use of methyl bromide for other crops in the rotation (if any)	A California cut flower producer may grow many ornamental species and hundreds of individual varieties. Crops are grown in rotation on an 8 to 16 week interval per year on the same parcel of land. Although species are rotated, the complex nature of this crop makes a *typical* crop rotation difficult to identify. Instead, an example of a rotation will be described here. A crop rotation system for a grower may involve several annuals. The first annual crop is planted and then harvested 90 to 180 days later. A different species is planted immediately after the first harvest. Harvest follows approximately 90 to 180 days later. A third crop is then planted. Fumigation would occur when the production starts to decline, which may be an interval of one to two years. Most growers produce numerous species, including annuals, perennials, and bulbs, throughout the farm. The rotation involving all of these species would be more complex than the example.	A production system for a grower may involve several species. The typical cut flowers grown are snapdragons, lilies, gladiolus, lisianthus, delphinium, and sunflowers. Growers rotate to other cut flower species but not to other crops. Planting occurs between August and February, with harvesting occurring October through May. Two to three plantings occur each year, with only one application of methyl bromide each year. Most growers produce numerous species, including annuals, perennials, and bulbs, throughout the farm. The rotation involving all of these species would be more complex than described above.	None
Soil types: (Sand loam, clay, etc.)	All. Cut flowers in California are primarily produced in the coastal environment where nearly all types of soil are present.	All	Various, light to heavy

CHARACTERISTICS	Region where methyl bromide is requested		
	A: California Cut Flower, Cut Greens, and Perennials	B: Florida Floriculture	C: Michigan Herbaceous Perennials
Typical dates of planting and harvest	Throughout year.	Planting: August – February Harvest: October – May	Varies (Planting occurs in the spring and fall)
Typical dates of methyl bromide fumigation	Throughout year.	June - December	Varies (Before planting)
Frequency of methyl bromide fumigation (e.g. every two years)	One time per year, although it may occur less often on the portion of the acreage in this sector that produces perennials and gladiolus.	One time per year	Perennial: 2-year seeded (6% of treated area) and 2-year transplants (29% of treated area) are on a 2 year replant/fumigation cycle; 3-year transplants (65% of treated area) are on a 3 year replant/fumigation cycle
Typical soil temperature range during methyl bromide fumigation (e.g. 15-20°C)	10 – 15.6°C	13.9 – 30.6°C	15.6 – 26.7°C
Climatic zone (e.g. temperate, tropical)	Temperate	Subtropical	Temperate
Annual and seasonal rainfall (mm)*	Annual: 571.8 Spring (Mar - May): 144.0 Summer (Jun - Aug): 16.8 Fall (Sep - Nov): 108.5 Winter (Dec - Feb): 302.5	Annual: 1,372.1 Spring (Mar - May): 269.7 Summer (Jun - Aug): 551.9 Fall (Sep - Nov): 327.7 Winter (Dec - Feb): 223.5	Annual: 793.0 Spring (Mar - May): 198.6 Summer (Jun - Aug): 236.0 Fall (Sep - Nov): 218.4 Winter (Dec - Feb): 139.5
Range in average temperature variations in mid winter and mid summer (e.g. min/max °C) (e.g. Jan 5-15°C, July 10-30°C**	Jan: 0.78 – 10.4°C July: 22.2 – 26.6 °C	Jan: 9.5 – 20.5°C July: 26.4 – 28.6°C	Jan: -14.1 – -1.1°C July: 17.2 – 24.5°C
Other relevant factors:	None identified	None identified	No other relevant factors identified.

*State level precipitation averages (1901-2000). Local precipitation may vary. Seasonal rainfall may not add up to annual rainfall due to rounding.
http://www.ncdc.noaa.gov/oa/climate/research/cag3/state.html = used state level data from this website for annual and seasonal rainfall
** Used highest and lowest average recorded temperature (between 1895 and 2006) for January and July.

(ii) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11.(i) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Cut flowers are often marketed for a certain time of year or holiday. Missing specific dates can be detrimental to the grower and cause severe economic impacts.

12. HISTORIC PATTERN OF USE OF METHYL BROMIDE, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

(*Add separate table for each major region specified in Question 8*):

TABLE B 3A: HISTORIC PATTERN OF USE IN CALIFORNIA CUT FLOWER, CUT GREENS, AND PERENNIALS

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004	2005
AREA TREATED (HECTARES)	552	576	332	364	281	272	257
RATIO OF BROADACRE METHYL BROMIDE USE TO STRIP/BED USE	Nearly all flat fumigation						
AMOUNT OF METHYL BROMIDE **ACTIVE INGREDIENT USED** (TOTAL KG)	163,506	157,401	85,211	65,079	70,813	63,555	65,840
FORMULATIONS OF METHYL BROMIDE. (E.G. METHYL BROMIDE/CHLOROPICRIN 98:2, 70:30)	67:33; or 98:2						
METHOD BY WHICH METHYL BROMIDE APPLIED	Chiseled or shanked						
APPLICATION RATE OF FORMULATIONS IN KG/HA*	296	273	256	179	252	233	256
ACTUAL **DOSAGE RATE** OF FORMULATIONS (G/M^2)*							

*For broadacre treatment application rate and dosage rate may be the same

TABLE B 3B: HISTORIC PATTERN OF USE IN FLORIDA FLORICULTURE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
AREA TREATED (HECTARES)	1,416	1,416	1,416	1,416	1,416	1,416
RATIO OF BROADACRE METHYL BROMIDE USE	Nearly all flat fumigation					
AMOUNT OF METHYL BROMIDE **ACTIVE INGREDIENT USED** (TOTAL KG)	622,328	622,328	622,328	622,328	622,328	622,328
FORMULATIONS OF METHYL BROMIDE. (E.G. METHYL BROMIDE/CHLOROPICRIN 98:2, 70:30)	98 : 2					
METHOD BY WHICH METHYL BROMIDE APPLIED	Chiseled or shanked					
APPLICATION RATE OF FORMULATIONS IN KG/HA*	439	439	439	439	439	439
ACTUAL **DOSAGE RATE** OF FORMULATIONS (G/M^2)*						

*For broadacre treatment application rate and dosage rate may be the same

TABLE B 4C: HISTORIC PATTERN OF USE IN MICHIGAN HERBACEOUS PERENNIALS

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
AREA TREATED (HECTARES)	248	228	129	130	110	110	110
RATIO OF BROADACRE METHYL BROMIDE USE TO STRIP/BED USE	Flat fumigation						
AMOUNT OF METHYL BROMIDE **ACTIVE INGREDIENT USED** (TOTAL KG)	97,477	89,539	50,485	50,961	41,153	41,153	42,349
FORMULATIONS OF METHYL BROMIDE.	98 : 2						
METHOD BY WHICH METHYL BROMIDE APPLIED	injected						
APPLICATION RATE OF FORMULATIONS IN KG/HA*	392	392	392	392	375	375	386
ACTUAL **DOSAGE RATE** OF FORMULATIONS (G/M^2)*							

*For broadacre treatment application rate and dosage rate may be the same

Part C: TECHNICAL VALIDATION
Renomination Form Part D: REGISTRATION OF ALTERNATIVES

13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE (Provide detailed information on a minimum of the best two or three alternatives as identified and evaluated by the Party, and summary response data where available for other alternatives (for assistance on potential alternatives refer to MBTOC Assessment reports, available at *http://www.unep.org/ozone/teap/MBTOC* , other published literature on methyl bromide alternatives and Ozone Secretariat alternatives when available):

TABLE C 1. REASON FOR ALTERNATIVES N OT BEING FEASIBLE

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE
1,3-Dichloropropene (1,3-D)	Controls nematodes but will not provide adequate control of diseases and weeds at label rates. Buffer zones make using this alternative difficult because often flowers are produced on small parcels of land, often near homes. (1) Township caps are in place for 1,3-D that limit its use in California and use restrictions are in place in some Florida counties (1). Many crops are grown in coastal areas, where cut flowers are also grown. This number would be higher with the standard (1X) caps. Affecting some rotations are plant back times, which can be 1 to 2 weeks longer with 1,3-D. Combined regulatory and plant back limitations could restrict use of 1,3-D in California to less than 50 percent of the current fumigated area (4, 9). Some growers have found adequate control when 1,3-D is combined with other fumigants or herbicides.
Chloropicrin	Controls diseases but does not provide adequate control of weeds and nematodes. Weed control is poorer than with methyl bromide (4). Adequate efficacy for the pest complex cannot be achieved with lower use rates (1). There are also concerns about phytotoxicity to nearby plantings if greater than 2 percent chloropicrin is used in a combination (1).
Metam sodium	Performance with metam sodium is erratic and inconsistent, depending on soil type, moisture content, and temperature. Soil texture can have an affect on efficacy, with greater efficacy in light sandy soil compared to loams (27). Many years of research have indicated difficulty achieving consistent efficacy with metam sodium on high value crops. Also, pest populations tend to build up over time with metam sodium. Repeat use results in an increase in the population of bio-degraders of the active ingredient. Problematic for bulb growers is the fact that it suppresses active nematodes, and not the eggs. Similar issues with other MITC generators, such as metam potassium and dazomet.
1,3-D + chloropicrin	In California, 1,3-D + chloropicrin is considered one of the best currently available alternatives, if use restrictions, such as township caps, were removed and label application rates were increased. However, as currently registered, this alternative does not provide sufficient control of weeds and regulatory restrictions limit the use of this combination.

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE
Metam sodium + chloropicrin	This combination does not provide adequate control of nematodes and weeds, and performance is inconsistent. Nutsedge is not adequately controlled with this combination (1). In addition, this combination is expensive. Studies conducted on snapdragon by McSorley and Wang (2003 and 2004) in Florida showed that this combination provided comparable control to methyl bromide (7, 8). However, the first study contained soils with light pest pressure because it had previously been treated with methyl bromide + chloropicrin. In addition, this site had sandy soils, and different results could be obtained with other soil types. In the second year, the sites were contaminated with weeds seeds and *Fusarium* spp., so the results are more difficult to interpret. Snapdragons reproduce by seed, so it is not clear if this combination is effective for bulb crops, especially over the long term. Additional research is needed on this alternative. Restrictions for the individual chemicals also apply for the combination.
1,3-D + metam sodium	Regulatory restrictions limit use. In addition, performance is inconsistent. Restrictions for the individual chemicals also apply for the combinations.
1,3-D + chloropicrin + metam sodium	Although 1,3-D + chloropicrin followed by metam sodium will control diseases and nematodes, weed control is not adequate, requiring the use of herbicides. This treatment is expensive due to the cost of the materials and the need for at least two separate applications. (1) Restrictions for the individual chemicals also apply for the combinations.
1,3-D + chloropicrin + herbicides	In Michigan, 1,3-D or 1,3-D + chloropicrin under tarp combined with post emergence herbicides is considered the best currently available alternative. Additional limitations for herbicides are described below. Restrictions for the individual chemicals also apply for the combinations.
Metam sodium + crop rotation	Use of this combination may reduce methyl bromide use. Instead of applying methyl bromide at every planting, crops less susceptible to pests in the fields are planted after the initial crop, with metam sodium used between plantings. However, pest populations increase over time so methyl bromide applications are still needed periodically to reduce populations to below damaging levels. (1) A discussion of crop rotation is included below.
Steam	Field steam sterilization is cost prohibitive, in part because of the high cost of fuels. Installation of pipes is labor intensive and must be removed after steaming to accommodate cultural practices. In Florida, some soils prevent burial of pipes to an adequate depth. (1)
Biological control agents	No biological controls are developed to cover all of the pests. Results with biological control agents may vary with field or environmental conditions (19). Even in small containers, biological control is not reliable for soil-borne pathogens.
Crop rotation	Rotation with other cut flower species is used extensively in cut flower production. However, in annual cropping they are generally too short for the full effects of rotating schemes to be effective. The previous crop (bulbs, corms) often contaminate the following crop or may harbor pathogens. In addition, crop rotation is not really a solution to pest problems in floriculture because either the crop cycle is too long (perennials) or the pests persist in the soil for a long time (19). Most cut flower species are sensitive to the same pathogens. Flower rotations are generally not a true rotation in the pest control sense. Some growers have had success with crop rotation. In California, some gladiolus growers are leasing land to strawberry growers. The strawberry growers fumigate the land with methyl bromide, and a crop of gladiolus can follow without additional methyl bromide fumigation. This practice is most feasible for large growers and requires flexibility. This arrangement is not feasible for calla lily growers because calla lilies are very susceptible to the root disease complex supported by strawberries and raspberries. This type of arrangement is not guaranteed to be available to growers in the future and relies on continued availability of methyl bromide. (1)

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE
Herbicides	Weed control is a difficult problem for many cut flower producers. Contact herbicides may damage the crop in the field, resulting in yield or quality losses. Damage to the following crop may occur if soil residual herbicides are used. (1) Herbicides were evaluated for Michigan herbaceous perennials between 2004 and 2006. Oryzalin + isoxaben and flumioxazin both provided greater than 70 percent weed. However, flumioxazin caused unacceptable crop injury. Methyl bromide performed better than the herbicides. (30)
Solarization	Seems promising in FL production but would take awhile to adopt. It must be adapted to work in a broadcast system. It may also not control pests to an adequate depth (1). Pest pressures may build during the first crop preventing a second crop from being planted (1). Solarization takes several weeks to control many pests to a depth of 30 cm. This length of time for a treatment is not economically feasible for many growers due to the intensive, year-round production situation of the cut flower industry (19). In a study conducted in Florida on snapdragon, McSorley and Wang (2004) showed that this option had similar yields to the other treatments but the plants were shorter (8). The site was treated with methyl bromide/chloropicrin the previous crop season, so it is not clear if this could have impacted results. The site also had sandy soils, and different results could be obtained with other soil types. In addition, the sites were contaminated with weeds seeds and *Fusarium* spp. after fumigation and before planting, so the results are difficult to interpret. Snapdragons reproduce by seed, so it is not clear if this combination is effective for bulb crops, especially over the long term. Additional research is needed. The study mentioned in the above paragraph also referred to another study in which solarization in Florida has been successful with impatiens and vinca. (8) Another recent study in Florida found that solarization may effectively suppress winter weeds but may not adequately control other weeds (29) In addition, double cropping may not be possible with solarization because pests efficacy does not last as long as fumigation (29). Solarization is not feasible under Michigan field conditions. Some considerations include: not able to generate acceptable heat to allow spring planting; most effective time for solarization is not compatible with timing for production; uses solar radiation to heat soil under clear plastic, and under certain conditions in some locations in the summer, soil can be heated to as high as 60 C to a depth of 7.5 cm. Effective solarization would likely require several months of covered bed treatments, to heat soil to a sufficient depth (25-30 cm) in order to affect soil-borne pathogens. Seeds of some weed species are resistant even to higher temperatures obtained with solarization. Nutsedges, *Fusarium* spp., *Macrophomina* spp. are not controlled, or unpredictably controlled, by solarization (20). Production areas in California are mainly coastal where solarization is not feasible due to cool temperatures and cloud cover most of the year. Therefore, this alternative is not considered technically feasible.
Furfural	As of October 2006, this chemical is now registered for greenhouse ornamentals to control nematodes and fungal pathogens. The label describes a greenhouse as “any enclosed structure type with a nonporous covering and is large enough to allow a person to enter” (18). Some growers producing in protected structures may not be able to use this material if the structure is not completely enclosed or if the protected covering is made up of a porous material. This alternative cannot be used on field grown ornamentals (18). According to the label, about 23 species are listed and described has showing tolerance of post-plant drench applications (18). The label also mentions that furfural may injure celosia, coleus, new guinea impatiens, lisianthus, petunia, and leather leaf fern and that not all species and cultivars have been tested (18).

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE
Biofumigation	This is a process where mustard species (*Brassica* spp.) are grown and ultimately disked into soils. A bioactive breakdown product of some of these species is MITC. Biofumigation is still largely in the experimental stages. (19) Specific brassicas as well as specific years yield variable amounts of activity. While this alternative may provide some control, the control of all target pests is not sufficient. Also, brassica waste must be available in huge quantities to provide at best minor effects.
Soilless culture / Substrates /plug plants	Container production may be possible in higher value cut flower crops but it is not generally feasible, especially for deeper rooted crops and on large acreage.

* Regulatory reasons include local restrictions (e.g. occupational health and safety, local environmental regulations) and lack of registration.
** Citations should be recorded by a number only, to indicate citations listed in Question 22.

14. LIST AND DISCUSS WHY REGISTERED PESTICIDES AND HERBICIDES ARE CONSIDERED NOT EFFECTIVE AS TECHNICAL ALTERNATIVES TO METHYL BROMIDE (*Provide information on a minimum of two best alternatives and summary response data where available for other alternatives)*:

In general, registered pesticides do not provide adequate control the full pest spectrum and/or use restrictions limit widespread use of alternatives. See section 6 for information specifically on 1,3-D + chloropicrin, 1,3-D + chloropicrin, followed by metam sodium, plus herbicides, solarization. See section 12 for more information on a variety of alternatives.

15. STATE RELATIVE EFFECTIVENESS OF RELEVANT ALTERNATIVES COMPARED TO METHYL BROMIDE FOR THE SPECIFIC KEY TARGET PESTS AND WEEDS FOR WHICH IT IS BEING REQUESTED (*Use the same regions as in Section 10 and provide a separate table for each target pest or disease for which methyl bromide is considered critical. Provide information in relation to a minimum of the best two or three alternatives.*):

This section only includes new research results submitted this year, with some exceptions. Previous research summaries can be found in previous nominations.

In Florida, studies are being done to evaluate the susceptibility of various cut flower crops to certain pests (10, 11). The results are described below, in part, to demonstrate the unique susceptibility of crop species, and even culitvars of the same species, to plant pests.

In one study (10), fungal pathogens were identified from a field with declining snapdragon seedlings. *Fusarium* spp. were more prevalent in the field soil then *Pythium* spp. and *Rhizoctonia* spp. Four cut flower species were transplanted into soil infested with *Fusarium* spp., *Pythium aphanidermatum*, and *Rhizoctonia* spp. (soil from the field) or autoclaved soil from the same field. These plants were 'Echo Pink lisianthus (*Eustoma grandiflorum*(Raf.) Shinn), 'Potomac Rose' snapdragon (*Antirrhinum majus* L.), 'Qis White Cut' larkspur (*Consolida ajacis* (L.) Schur.), and 'Queen of Africa' white dill (*Ammi majus* L.). Plants were grown in a greenhouse in a randomized complete block design. There were four replications.

After 12 weeks, plant height, fresh weight of roots and shoots, number of blooms, number of flower buds, and number of total flowers were analyzed, and root systems were rated.

The results indicated that lisianthus, snapdragon and larkspur were susceptible to the pathogens (with the snapdragon and larkspur cultivars particularly susceptible) whereas white dill was tolerant (white dill shoot weight was reduced but flower yield was not significantly different between the autoclaved and non-autoclaved soils.). Since three different genera of pathogens were included in the non-autoclaved soil, the study noted that it was not clear which affected the flower species.

In another greenhouse study (11), the following seven cultivars were evaluated to determine their host status and their tolerance to two races of the southern root knot nematode (*Meloidogyne incognita*): 'Potomac Royal' snapdragon (*Antirrhinum majus*), 'Madonna Blue' blue lace flower (*Didiscus caeruleus*), 'Green Mist' and 'Queen of Africa' white dill (*Ammi majus*), 'Qis White Cut' larkspur (*Consolida ajacis*), and 'Avila Rose Rim' and 'Echo Pink' lisianthus (*Eustoma grandiflorum*). An uninoculated control was also included. Each treatment had 4 replications. Thirteen weeks after inoculation, shoot and root fresh weights, number of flower buds, number of blooms, root gall indices, and plant height were determined. The number of nematodes was also determined. 'Qis white Cut' larkspur and the two lisianthus cultivars were poor hosts of the southern root knot nematodes. 'Potomac Royal' snapdragon, 'Madonna Blue' blue lace flower, and 'Green Mist' white dill were good hosts of the nematodes. The other white dill cultivar, 'Queen of Africa', was also a host but was not as susceptible as the 'Green Mist' cultivar. 'Madonna Blue' blue lace flower was not tolerant of the nematodes.

A preliminary progress report was submitted to the California Cut Flower Commission for the project "Evaluation of Alternatives to Methyl Bromide for Floriculture Crops" (22). This study evaluated various treatments on *Fusarium oxysporum* and *Pythium* spp. Preliminary findings included the following: 1) pre-plant application of methyl iodide: chloropicrin (50:50) at 448 kg/ha performed as well as methyl bromide: chloropicrin (50:50) at 336 kg/ha; 2) use of VIF did not improve pathogen control when compared to the standard film; and 3) post-plant treatments, such as furfural, 2-bromoethanol, and dimethyl disulfide, did not affect pathogen control.

Another update, an annual report to the California Cut Flower Commission, also included preliminary results from ongoing trials (23). A shank trial compared methyl bromide/chloropicrin at 392 kg/ha to methyl iodide/chloropicrin (50:50) at 392 kg/ha and an untreated control under standard high density polyethylene tarp and virtually impermeable film. The crop grown was calla lily (*Zantedeschia* spp.). Both pathogens (*Pythium* spp. and *Fusarium oxysporum*) and weeds (such as *Cyperus esculentus* and volunteer crop plants) were evaluated. The results showed that methyl bromide /chloropicrin under VIF was the only treatment that provided adequate control of yellow nutsedge. Both methyl bromide/chloropicrin and methyl iodide/chloropicrin were more effective at controlling weeds than the untreated control. This trial also includes a number of post-plant treatments that had not been evaluated at the time of the report. The second trial included the following treatments: untreated control, methyl iodide/chloropicrin (33:67) at 224 kg/ha, chloropicrin at 224 kg/ha, methyl bromide /chloropicrin at 224 kg/ha, and 1,3-D/chloropicrin at 336 kg/ha. These treatments also included treatments with and without metam sodium at 468 L/ha applied 6 days after the other fumigants were applied. For weed control, no statistical differences were determined for all treatments compared to the untreated control. This was due to a lot of variation in the data. Additional results are expected in the future.

A study was conducted on field grown *Ranunculus* in California (26). Both shank fumigation and drip fumigation experiments were done. Treatments in the shank fumigation trial included the following: methyl bromide /chloropicrin (67:33) at 392 kg/ha and methyl iodide/chloropicrin (50:50) at 336 kg/ha. Treatments in the drip fumigation trial included the following: 1,3-D/chloropicrin at 336 kg/ha, Pic at 224 kg/ha, methyl iodide/chloropicrin (33:67) at 224 kg/ha, and methyl bromide /chloropicrin at 224 kg/ha. These treatments also included treatments with and without metam potassium at 280.5 L/ha one week later. It also appears that there was an untreated control, with and without the addition of metam potassium. In the shank trial, the two fumigation treatments showed similar control of pathogens and weeds. Comparisons between virtually impermeable film (VIF), semi-impermeable film (SIF) and high density polyethylene mulch (HDPE) revealed no significant differences between VIF and SIF and HDPE. In the drip trial, the methyl iodide/chloropicrin, chloropicrin and 1,3-D/chloropicrin treatments produced greater bulb yields than methyl bromide /chloropicrin (not clear if the results were statistically significant). The application of metam potassium improved control of weeds (e.g. little mallow and clover) and pathogens (e.g. *Fusarium* and *Pythium* spp.), and increased total yields. Again, it is not clear if the results were statistically significant, except when compared to the unfumigated plots.

In a grower education document, trial results were summarized and described (24). These results appear to bee similar to results that have been described above. This document is also a good example of the effort going on to educate growers. It should also be noted that research for methyl bromide alternatives is ongoing in the ornamental industry.

A trial evaluating the effectiveness of methyl iodide on ornamental cockscomb in Florida included the following treatments: untreated check, methyl iodide+PIC 50:50 224 kg/ha, and methyl bromide +Pic 98:2 224 kg/ha, all with metalized film (31). There were four replicates. Weed count, weed dry weight, *Fusarium* and *Pythium* colony forming units, wilted and dead plants, cockscomb stem diameters, cockscomb plant height, total cockscomb stems, and marketable cockscomb stems were evaluated. Treatments with methyl iodide+PIC and methyl bromide/chloropicrin were comparable, and statistically different from the untreated check.

A: KEY PATHOGENS: Pythium spp., Phytophthora spp., Fusarium oxysporum

TABLE C 2. SUMMARY OF RESEARCH TRIALS FOR CONTROL OF PATHOGENS

METHYL BROMIDE AND ALTERNATIVES (INCLUDE DOSAGE RATES AND APPLICATION METHOD)	COMPARATIVE DISEASE % OR RATING AND YIELDS OF CROPS WITH ALTERNATIVES AND METHYL BROMIDE TREATMENTS IN TRIALS SINCE 1995						
	YEAR	REP	CROP	DISEASE (% OR RATING)	ACTUAL YIELDS (T/HA)	STATISTICAL SIGNIFICANCE	CITATION **
All drip applied Methyl iodide+Pic (50:50) 336 kg/ha Methyl iodide+Pic (33:67) 448 kg/ha 1,3-D 224 L/ha 1,3-D+Pic 468 L/ha Chloropicrin 448 kg/ha Furfural+metam sodium (67:33) 784 kg/ha Sodium azide 112 kg/ha Untreated control	2002 (Pub. 2006)	6	Calla lily rhizome	Diseased plants (%) 55 c 45 c 86 ab 47 c 51 c 50 c 96 ab 100 a	# Salable rhizomes harvested 110 ab 129 ab 98 bc 130 ab 124 ab 149 a 66 c 60 c	Both weeds and diseases were evaluated in this trial	2[1]
All drip applied Methyl iodide+Pic (50:50) 168 kg/ha Methyl iodide+Pic (50:50) 336 kg/ha Methyl iodide+Pic (33:67) 224 kg/ha Methyl iodide+Pic (33:67) 448 kg/ha 1,3-D+Pic 187 L/ha 1,3-D+Pic 355 L/ha Chloropicrin 224 kg/ha, followed by metham sodium 701 L/ha Chloropicrin 336 kg/ha, followed by metham sodium 701 L/ha Untreated control	2003 (Pub. 2006)	6	Calla lily rhizome	Diseased plants (%) 40 b 37 b 40 b 43 b 46 b 46 b 40 b 46 b 92 a	# Salable rhizomes harvested 1593 abc 2143 a 1713 abc 1875 ab 1192 c 1513 bc 1752 abc 1930 a 406 d	Both weeds and diseases were evaluated in this trial	2[1]
All drip applied 1,3-D:chloropicrin (60.8:33.3) 187 L/ha 1,3-D:chloropicrin (60.8:33.3) 281 L/ha 1,3-D:chloropicrin (60.8:33.3) 374 L/ha 1,3-D:chloropicrin (60.8:33.3) 468 L/ha 1,3-D:chloropicrin (60.8:33.3) 524 L/ha Untreated control LSD	2003 (Pub. 2005)	6	Freesia	Pythium spp (cfu/g soil) 1 0 2 0 0 133 33	Plant height (cm) / Vigor rating (1-5 scale) 57.7 / 3.9 55.0 / 4.1 55.9 / 4.3 58.2 / 4.3 55.9 / 4.0 51.5 / 3.0 2.6 / 0.4	Both weeds and diseases were evaluated in this trial	3[2]

Methyl Bromide and Alternatives (include dosage rates and application method)	Comparative Disease % or Rating and Yields of crops with Alternatives and methyl bromide treatments In Trials since 1995						
	Year	Rep	Crop	Disease (% or rating)	Actual yields (t/ha)	Statistical significance	Citation **
All drip applied Methyl iodide:chloropicrin (50:50) 448 kg/ha 1,3-D:chloropicrin 524 L/ha Furfural 1075 kg/ha Furfural 538 kg/ha + Metam sodium 235 kg/ha Untreated control LSD	2003 (Pub. 2005)	5	Freesia	*Pythium* (cfu/g soil) 1 6 97 27 171 58 For *Fusarium oxysporum* treatment results not statistically different from control.	Plant height (cm) 91.4 89.9 87.0 90.4 87.1 2.7	Both weeds and diseases were evaluated in this trial	3[2]
All drip applied Methyl iodide:chloropicrin (50:50) 336 kg/ha Methyl iodide:chloropicrin (50:50) 448 kg/ha Methyl iodide:chloropicrin (33:67) 336 kg/ha Methyl iodide:chloropicrin (33:67) 448 kg/ha Methyl bromide:chloropicrin (50:50) 448 kg/ha Untreated control LSD	2004 (Pub. 2005)	6	Freesia	*Pythium* (cfu/g soil) 68 55 55 2 55 182 67	Vigor rating (1-5 scale) / Spikes (#) 3.2 / 25 3.5 / 35 3.3 / 38 3.3 / 24 2.8 / 35 1.3 / 16 0.9	Both weeds and diseases were evaluated in this trial	3

Methyl Bromide and Alternatives (include dosage rates and application method)	Comparative Disease % or Rating and Yields of crops with Alternatives and methyl bromide treatments In Trials since 1995						
	Year	Rep	Crop	Disease (% or rating)	Actual Yields (t/ha)	Statistical significance	Citation **
Drip application methyl bromide:chloropicrin (50:50) 336 kg/ha + metham sodium 355 kg/ha 2-bromoethanol 448 kg/ha + metham sodium 355 kg/ha DMDS 448 kg/ha + metham sodium 355 kg/ha Furfural 672 kg/ha + metham sodium 355 kg/ha Propylene oxide 448 kg/ha + metham sodium 355 kg/ha Sodium azide 168 kg/ha + metham sodium 355 kg/ha Untreated + metham sodium 355 kg/ha Untreated control	2006 (Trial 1)	6	Not Specified	*Pythium* spp. (cfu/g) 0.67 b 2.67 b 0.67 b 0.00 b 0.00 b 3.33 b 0.00 b 124.00 a	*F. oxysporum* (cfu/g) 19.0 b 16.8 b 0.0 b 22.3 b 11.2 b 5.6 b 1.1 b 704.6 a	Crop growth data were not collected.	27
Drip application methyl bromide:chloropicrin (50:50) 336 kg/ha + metham sodium 355 kg/ha 2-bromoethanol 448 kg/ha + metham sodium 355 kg/ha DMDS 448 kg/ha + metham sodium 355 kg/ha Furfural 672 kg/ha + metham sodium 355 kg/ha Propylene oxide 448 kg/ha + metham sodium 355 kg/ha Sodium azide 168 kg/ha + metham sodium 355 kg/ha Untreated + metham sodium 355 kg/ha Untreated control	2006 (Trial 2)	6	Not Specified	*Pythium* spp. (cfu/g) 3.33 d 4.00 d 7.33 cd 10.00 cd 1.33 d 34.00 b 23.33 cb 106.00 a	*F. oxysporum* (cfu/g) 38.0 c 17.0 c 22.3 c 20.2 c 11.2 c 46.8 c 128.5 b 253.3 a	Crop growth data were not collected.	27

[1] methyl bromide:chloropicrin treatment not included because appropriate formulation for drip application was not available. Plots were too small for a shank application.
[2] methyl bromide:chloropicrin control not used.

B: KEY WEEDs: Includes nutsedge, Off-variety propagative material, mustard (*Brassica* spp.), chickweed, bittercress (varies by trial)

TABLE C 3. SUMMARY OF RESEARCH TRIALS FOR CONTROL OF WEEDS

METHYL BROMIDE AND ALTERNATIVES (INCLUDE DOSAGE RATES AND APPLICATION METHOD)	COMPARATIVE WEED NUMBER, BIOMASS AND YIELDS OF CROPS WITH ALTERNATIVES AND METHYL BROMIDE TREATMENTS IN TRIALS SINCE 1995						
	YEAR	REP	CROP	CONTROL OF TARGET WEED (NO. PER M^2), BIOMASS	ACTUAL YIELDS (T/HA)	STATISTICAL SIGNIFICANCE	CITATION **
All drip applied Methyl iodide+Pic (50:50) 336 kg/ha Methyl iodide+Pic (33:67) 448 kg/ha 1,3-D 224 L/ha 1,3-D+Pic 468 L/ha Chloropicrin 448 kg/ha Furfural+metam sodium (67:33) 784 kg/ha Sodium azide 112 kg/ha Untreated control	2002 (Pub. 2006)	6	Calla lily rhizome	Nutsedge (% mortality) 100 a 100 a 33.3 bc 100 a 97.2 a 49.5 b 17.4 cd 8.1 d Other weeds evaluated: mustard, calla (off bulbs), mallow, common groundsel, clover	# Salable rhizomes harvested 110 ab 129 ab 98 bc 130 ab 124 ab 149 a 66 c 60 c	Both weeds and diseases were evaluated in this trial	2[1]
All drip applied Methyl iodide+Pic (50:50) 168 kg/ha Methyl iodide+Pic (50:50) 336 kg/ha Methyl iodide+Pic (33:67) 224 kg/ha Methyl iodide+Pic (33:67) 448 kg/ha 1,3-D+Pic 187 L/ha 1,3-D+Pic 355 L/ha Chloropicrin 224 kg/ha, followed by metham sodium 701 L/ha Chloropicrin 336 kg/ha, followed by metham sodium 701 L/ha Untreated control	2003 (Pub. 2006)	6	Calla lily rhizome	Nutsedge emeregence from weed bank (#) 3.2 1.0 11.3 1.0 4.5 0.0 1.2 0.7 2.5 No statistical difference amount treatments	# Salable rhizomes harvested 1593 abc 2143 a 1713 abc 1875 ab 1192 c 1513 bc 1752 abc 1930 a 406 d	Both weeds and diseases were evaluated in this trial	2[1]

Methyl Bromide and Alternatives (include dosage rates and application method)	Comparative Weed Number, Biomass and Yields of Crops with Alternatives and methyl bromide treatments In Trials since 1995						
	Year	Rep	Crop	Control of target weed (No. per m^2), Biomass	Actual yields (t/ha)	Statistical significance	Citation **
All drip applied 1,3-D:chloropicrin (60.8:33.3) 187 L/ha 1,3-D:chloropicrin (60.8:33.3) 281 L/ha 1,3-D:chloropicrin (60.8:33.3) 374 L/ha 1,3-D:chloropicrin (60.8:33.3) 468 L/ha 1,3-D:chloropicrin (60.8:33.3) 524 L/ha Untreated control LSD	2003 (Pub. 2005)	6	Freesia	Total Weeds (#/m^2) Jan. 7 2004 17 38 17 29 18 124 55	Plant height (cm) / Vigor rating (1-5 scale) 57.7 3.9 55.0 4.1 55.9 4.3 58.2 4.3 55.9 4.0 51.5 3.0 2.6 0.4	Both weeds and diseases were evaluated in this trial	3[2]
All drip applied Methyl iodide:chloropicrin (50:50) 448 kg/ha 1,3-D:chloropicrin 524 L/ha Furfural 1075 kg/ha Furfural 538 kg/ha + Metam sodium 235 kg/ha Untreated control LSD	2003 (Pub. 2005)	5	Freesia	Bittercress (#) 0 1 8 0 30 11 Chickweed was also evaluated in this trial.	Plant height (cm) 91.4 89.9 87.0 90.4 87.1 2.7	Both weeds and diseases were evaluated in this trial	3[2]
All drip applied Methyl iodide:chloropicrin (50:50) 336 kg/ha Methyl iodide:chloropicrin (50:50) 448 kg/ha Methyl iodide:chloropicrin (33:67) 336 kg/ha Methyl iodide:chloropicrin (33:67) 448 kg/ha Methyl bromide:chloropicrin (50:50) 448 kg/ha Untreated control LSD	2004 (Pub. 2005)	6	Freesia	Total weeds (#/m^2) Aug. 11, 2004 76 77 94 62 68 273 99	Vigor rating (1-5 scale) / Spikes (#) 3.2 25 3.5 35 3.3 38 3.3 24 2.8 35 1.3 16 0.9	Both weeds and diseases were evaluated in this trial	3

Methyl Bromide and Alternatives (include dosage rates and application method)	Comparative Weed Number, Biomass and Yields of Crops with Alternatives and methyl bromide treatments In Trials since 1995							
	Year	Rep	Crop	Control of target weed (No. per m^2), Biomass	Actual yields (t/ha)		Statistical significance	Citation **
Drip application				Yellow Nutsedge	Broadleaf*	Grass**		
methyl bromide:chloropicrin (50:50) 336 kg/ha + metham sodium 355 kg/ha				1 b	21 b	11 b		
2-bromoethanol 448 kg/ha + metham sodium 355 kg/ha				4 b	18 b	14 b		
DMDS 448 kg/ha + metham sodium 355 kg/ha				3 b	85 b	17 b		
Furfural 672 kg/ha + metham sodium 355 kg/ha	2006 (Trial 2)	6	Not Specified	11 ab	56 b	17 b	Crop growth data were not collected.	27
Propylene oxide 448 kg/ha + metham sodium 355 kg/ha				2 b	23 b	9 b		
Sodium azide 168 kg/ha + metham sodium 355 kg/ha				6 b	26 b	39 b		
Untreated + metham sodium 355 kg/ha				13 ab	43 b	29 b		
Untreated control				25 a	266 a	120 a		
				* Mostly knotweed and ragweed ** Mostly annual bluegrass				

** Citations should be recorded by a number only, to indicate citations listed in Question 22.

Some following research was included with the previous nomination. Please note that this does not include all of the research submitted previously.

Ornamentals – Liatris - Effectiveness of Alternatives – Diseases and Weeds

In this study, all fumigants were applied through drip irrigation tapes and high-density polyethylene was used. A methyl bromide + chloropicrin comparison was not used because the plots were too small to use a shank application. Near harvest, there was no significant difference in the percent weed cover in all treatments, although weed control was not considered adequate. In addition, the number of inflorescences was not significantly different among the treatments, although longer stems were observed with some treatments. (See results below)

TABLE C 4. RESEARCH ON LIATRIS

Key Pest: Diseases and Weeds	**Average disease or Weed % or rating and yields in 2003**					
Methyl Bromide formulations and Alternatives	**# of Reps**	**Disease Control (CFU/g dry soil)**		**Weed Control (mean # weeds/m^2)**	**LIatris Plant Vigor**	**Liatris Avg Height**
		Pythium ultimum	***Fusarium oxysporum***	Total Weeds	**rating 1-5**	**cm**
Methyl iodide (213 kg/ha) + chloropicrin (213 kg/ha)	6	0	1,113	78	3.8	93
Metham sodium (356 kg/ha)	6	5	1,160	90	3.1	92
Chloropicrin (355 kg/ha), followed by metham sodium (356 kg/ha)	6	1	1,217	50	3.1	93
1,3-Dichloropropene (153 kg/ha) + chloropicrin (83.6 kg/ha)	6	8	1,205	109	3.4	92
1,3-Dichloropropene (153 kg/ha) + chloropicrin (83.6 kg/ha), followed by metham sodium (178kg/ha)	6	7	1,559	112	3.9	93
1,3-Dichloropropene (153 kg/ha) + chloropicrin (83.6 kg/ha), followed by metham sodium (356 kg/ha)	6	21	1,420	172	3.9	96
Sodium azide (112 kg/ha)	6	40	1,900	139	3.8	95
Furfural (674 kg/ha)	6	53	775	128	3.0	86
Fufural (337 kg/ha) + metham sodium (337 kg/ha)	6	2	749	219	3.7	91
DMDS (473 kg/ha)	6	57	620	95	3.1	89
DMDS (237 kg/ha) + chloropicrin ()237 kg/ha)	6	34	1,489	154	3.3	93
Untreated control	6	59	562	78	3.0	88
LSD		37	ns	ns	0.6	4

Source:21

Ornamentals – Snapdragon – Effectiveness of Alternatives – Weeds

This study was conducted with soils consisting of 96 percent sand. Also, this study was conducted in an area with low pest pressure because it had been treated with methyl bromide for several years. The researchers stated the need to conduct additional tests to determine long term control with the alternative fumigants, because methyl bromide may have reduced pest populations for all sites.

TABLE C 5. RESEARCH ON SNAPDRAGON

Key Pests: Weeds in Snapdragon	**Weed rating and yields**				
Methyl Bromide formulations and Alternatives *(include dosage rates and application method)*	**# of Reps**	**Weed Rating**		**# of Reps**	**Harvested Plants per m of row**
		Total Weeds/ 7.6 m of row (9 Oct.)	**Total Weeds/ 7.6 m of row (14 Nov.)**		
Methyl bromide/chloropicrin (98:2) broadcast injection, 504 kg/ha	4	1.25 b	4.75 b	4	117.8 a
Metam sodium, drenched + rototilled, 701 L/ha	4	1.50 b	3.75 b	4	118.0 a
Metam sodium, drenched + rototilled, 701 L/ha +chloropicrin, injected, 168 kg/ha	4	0.50 b	2.00 b	4	116.8 a
Untreated	4	16.25 a	37.00 a	4	109.6 b

Source: 7

Ornamentals – Snapdragon – Effectiveness of Alternatives – Weeds

This study was conducted at the same site discussed above. Except for solarization, the fields received the same treatment as the year before. The solarization plots were treated with methyl bromide + chloropicrin the previous season. In this study, a rain event washed weed seeds and *Fusarium* spp. from untreated border areas into the site, after fumigation had taken place. Plots showed effects from this event during November and plots in two of the replications were destroyed due to the high number of dead plants (these were the areas most affected by the rain). All plots had substantial losses from this event and also caused yields for methyl bromide + chloropicrin yields to be intermediate. The solarized plants also had shorter plants compared to the best fumigation treatment.

TABLE C 6. WEED RESEARCH ON SNAPDRAGON

Key Pest: Weeds in Snapdragon	**Weed Rating and Yields**				
Methyl Bromide formulations and Alternatives *(include dosage rates and application method)*	**# of Reps**	**Weed Rating**		**# of Reps**	**Harvested Plants Per m of Row**
		Total Weeds/m^2(2 Oct. 2003)	**Total Weeds/m^2 (20 Nov. 2003)**		
Methyl bromide/chloropicrin (98:2) broadcast injection, 504 kg/ha	4	0.0 b	9.0 a	2	62.0 bc
Metam sodium, drenched + rototilled, 701 L/ha	4	0.0 b	10.2 a	2	84.6 ab
Metam sodium, drenched + rototilled, 701 L/ha +chloropicrin, injected, 168 kg/ha	4	0.0 b	15.0 a	2	92.3 a
Solarization	4	0.0 b	19.2 a	2	77.4 ab
Untreated	4	79.8 a	23.5 a	2	39.2 c

Source: 8

MICHIGAN HERBACEOUS PERENNIALS – HOSTA – EFFECTIVENESS OF ALTERNATIVES

Currently, limited research is available for herbaceous perennials because long term research with USDA is ongoing. This research is due to be analyzed and reported after 2006 studies end. However, some preliminary research is available and is described below. It should be noted that these herbicides are currently not registered for control of this weed. Some limitations to this study include no methyl bromide control treatment and no data from an untreated control.

TABLE C 7. RESEARCH ON HOSTA

KEY PEST: *INULA BRITTANNICA*	AVERAGE PERCENT WEED CONTROL AND AVERAGE PERCENT CROP INJURY				
METHYL BROMIDE FORMULATIONS AND ALTERNATIVES	**# OF REPS**	**OCTOBER 15, 2001**		**JUNE 20, 2002**	
		Percent Weed Control	**Percent Crop Injury**	**Percent Weed Control**	**Percent Crop Injury**
Triclopyr + clopyralid (1.68 kg ai/ha)	n/a	100	19	89	89
Dicamba (2.24 kg ai/ha)	n/a	100	41	67	78
Clopyralid (0.28 kg ai/ha)	n/a	100	19	67	26
Clopyralid (0.56 kg ai/ha)	n/a	100	22	81	33
2,4-D + clopyralid (1.5 kg ai/ha)	n/a	100	22	78	37
2,4-D (3.36 kg ai/ha)	n/a	97	37	74	56
Triclopyr (2.24 kg ai/ha)	n/a	89	3	70	81
Glyphosate (4.48 kg ai/ha)	n/a	48	41	26	89
Diquat (1.5 kg ai/ha)	n/a	52	97	26	14
Dicamba + diflufenzopyr (0.196 kg ai/ha)	n/a	89	26	8	78
LSD		10	23	30	16

Source: 12

16. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT THAT THE PARTY IS AWARE OF WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE? (*If so, please specify*):

Studies continue to include methyl iodide, which is considered a potential replacement for methyl bromide. However, it is not clear when methyl iodide may be registered in the United States. There are a number of possibilities, including both chemical and non-chemical alternatives, which are being investigated for use as possible methyl bromide replacements.

Until a chemical is registered, and only when efficacy against key pests is demonstrated in repeated trials at commercial scales, does the USG consider that a chemical or technology is a *bona fide* replacement for methyl bromide.

Methyl iodide: Only has an 'experimental use permit' that allows field trials on about 2,000 acres (combined) of several crops (none of which are cucurbits). Under development for future registration submission

Propargyl bromide: Under proprietary development for future registration submission.

Sodium azide: Under proprietary development for future registration submission.

Furfural: registered for greenhouse ornamentals only. Under proprietary development for other registration submission.

DMDS (dimethyl disulfide): Under proprietary development for future registration submission.

Muscador albus Strain QST 20779. Registered but no commercially available formulation.

17. (i) ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WITHOUT METHYL BROMIDE? (e.g. soilless systems, plug plants, containerised plants. State proportion of crop already grown in such systems nationally and if any constraints exist to adoption of these systems to replace methyl bromide use. State whether such technologies could replace a proportion of proposed methyl bromide use):

Some crops have had success with substrates in greenhouses. These crops include roses, gerbera, lilies and tulips.

In the case of roses and gerberas, substrate production is more feasible than for other crops because these crops are perennial and production in substrates results in increased yield and quality. In perennial systems, infrastructure costs can be amortized over several years. However, due to the high costs cut rose production is decreasing.

Lilies and tulips are also often grown in substrates. These crops are "forced", which means that that the bulbs are planted in crates and actually grown in very large cooler/growth chambers. They are stacked floor to ceiling in these growing rooms for the first 4 to 8 weeks after planting and then taken into the greenhouse where they are spread out 2 dimensionally for finishing the last 4 to 6 weeks. This results in a lower cost of production and a faster turn on space in the greenhouse which is very costly. However, methyl bromide is still used in these systems.

There are challenges associated with substrate production. Generally, for most crops, there isn't an offsetting yield or quality increase to defer the costs associated with substrate production. Costs include a large increase in inputs, capital expenditures for the systems coupled with high costs of potting mix or substrates, plus the labor to move crates or install the system. In addition, growers must be very careful in substrate systems when it comes to water quality management, fertility management and disease containment. Yield losses can be very high if mistakes are made. Soil has a buffering capacity that limits some of the problems that are associated with substrate production. In addition, substrates may cause significant increases in the cost of production. Some growers that have tried substrates ended up going back to ground production for the reasons described above. For example, gerberas are sensitive to fertility and water issues in the substrate system. Some growers have even moved back to ground production due the risks that are involved.

Methyl bromide is not being requested for the ornamental crop acreage that has had success with substrates or other alternatives.

(ii) IF SOILLESS SYSTEMS ARE CONSIDERED FEASIBLE, STATE PROPORTION OF CROP BEING PRODUCED IN SOILLESS SYSTEMS WITHIN REGION APPLYING FOR THE NOMINATION AND NATIONALLY:

The proportion of crops/area in the ornamentals industry using soilless systems is not clear. Soilless systems are not considered feasible for the nominated area. Methyl bromide is not being requested for the ornamental crop acreage that has had success with substrates or other alternatives.

(iii) WHY ARE SOILESS SYSTEMS NOT A SUITABLE ALTERNATIVE TO PRODUCE THE CROP IN THE NOMINATION?

Soilless systems are not a feasible alternative for the crop in the nomination due to high costs and the risks involved. See description above (16 (i)). Methyl bromide is not being requested for the ornamental crop acreage that has had success with substrates or other alternatives.

Progress in registration of a product will often be beyond the control of an individual exemption holder as the registration process may be undertaken by the manufacturer or supplier of the product. The speed with which registration applications are processed also can falls outside the exemption holder's control, resting with the nominating Party. Consequently, this section requests the nominating Party to report on any efforts it has taken to assist the registration process, but noting that the scope for expediting registration will vary from Party to Party.

(Renomination Form 11.) PROGRESS IN REGISTRATION

Where the original nomination identified that an alternative's registration was pending, but it was anticipated that one would be subsequently registered, provide information on progress with its registration. Where applicable, include any efforts by the Party to "fast track" or otherwise assist the registration of the alternative.

USG has no legal authority to compel registrations; it can only act on registrations requested by private entities. The timely submission of data to support a registration decision is at the sole discretion of the registrant. Please see table above for additional detail.

TABLE C 8. PROGRESS UPDATE

Name of Alternative	Present Registration Status	Progress Toward Registration / Updates	Additional Comments
Furfural	Registered	Registered for use on greenhouse ornamentals	As described above in section 12, the registered use of furfural is limited to specific situations and species.
Methyl iodide	Not registered	Experimental Use Permit (EUP) for use from Fall 2006 through Fall 2007.	The EUP allows a total of 810 ha of ornamentals, strawberries and tomatoes in the US to be treated with a 50:50 methyl iodide/chloropicrin formulation. Applications will be made to approximately 0.5 to 1 ha fields. This use shows the commitment of the US to working toward alternatives. However, this EUP will not impact the nomination given the small area involved. A full registration is pending.
Sodium azide	Not registered	Registration package not submitted	
Propargyl bromide	Not registered	Registration package not submitted	
Muscador albus strain QST 20799	Registered	Registered	These registrations will expire in March, 2008 (30 months after registration) unless the registrant meets certain conditions. No commercial formulation is available for testing or sale.

Additional notes on specific herbicides listed:

Halosulfuron-methyl

In December 2002, halosulfuron-methyl (Sandea®) was registered for weed control (including nutsedge) in tomatoes, peppers, eggplant, and cucurbits

Halosulfuron-methyl has a number of limitations which may affect its widespread adoption, that include: (1) phyto-toxicity with moderate rainfall immediately after application; (2) cool temperatures, (3) susceptible varieties, and (4) plant back restrictions. Specifically:

- Rainfall or sprinkler irrigation greater than 2.5 cm, soon after a pre-emergent application of halosulfuron-methyl, may cause crop injury. Sudden storms with greater than 2.5 cm of rainfall are common in Florida and other areas of the southeastern United States. In addition, rainfall within four hours after a post-emergence application of halosulfuron-methyl may reduce effectiveness and cause crop injury.
- Under cool temperatures that can delay early seedling emergence or growth, halosulfuron methyl can cause injury or crop failure. This is especially likely to occur during the first planting of the season. In addition, not all hybrids/varieties of tomatoes have been tested for sensitivity to halosulfuron-methyl. Halosulfuron may also delay maturity of treated crops.
- Halosulfuron methyl plant back restrictions are up to 36 months. Many of the vegetable crops fall within the 4 to 12 month range, although some are longer. There are label limitations for halosulfuron methyl. As per product label, halosulfuron methyl should not

be applied if the crop or target weeds are under stress due to drought, water saturated soils, low fertility, or other poor growing conditions. This herbicide can not be applied to soil that has been treated with organophosphate insecticides. Foliar applications of organophosphate insecticides may not be made within 21 days before or 7 days after halosulfuron methyl application.

Note: All the limitations above are listed in the US registration label for halosulfuron, which in turn is based on proprietary data submitted to EPA by the registrant company.

S-metolachlor

It was registered for use in tomatoes in April 2003. However, it is not registered in states of concern, and does not control purple nutsedge or nightshade species. Further, it does not provide commercially acceptable weed control in plasticulture systems.

Rimsulfuron

There is evidence that rimsulfuron only provides suppressive control of yellow nutsedge (40 to 70 percent control) (Nelson *et al*, 2002). In addition, the label warns against tank mixing with organophosphate insecticides because injury to the crop may occur. Also, for most of the vegetable crops besides tomatoes there is a 12-month plant back restriction. This plant back restriction can seriously compromise the rotational interval needed for second crop production and IPM programs.

USG endeavors to identify methyl bromide alternatives in order to move them forward in the registration queue. However USG has no legal authority to compel registrations; it can only act on registrations requested by private entities. The timely submission of data to support a registration decision is at the sole discretion of the registrant.

(Renomination Form 12.) DELAYS IN REGISTRATION

Where significant delays or obstacles have been encountered to the anticipated registration of an alternative, the exemption holder should identify the scope for any new/alternative efforts that could be undertaken to maintain the momentum of transition efforts, and identify a time frame for undertaking such efforts.

USG has no legal authority to compel registrations; it can only act on registrations requested by private entities. The timely submission of data to support a registration decision is at the sole discretion of the registrant. Please see table above for additional detail.

The industry expects that many growers could switch to methyl iodide once it is registered. Since the registration of methyl iodide has been delayed, the industry is continuing to research currently registered chemicals, such as metam sodium, and available practices to determine whether combinations of these other control methods or modifying application techniques would allow growers to transition to these methods. Growers will transition to alternatives as effective control methods are found.

(Renomination Form 13.) DEREGISTRATION OF ALTERNATIVES

Describe new regulatory constraints that limit the availability of alternatives. For example, changes in buffer zones, new township caps, new safety requirements (affecting costs and feasibility), and new environmental restrictions such as to protect ground water or other natural resources. Where a potential alternative identified in the original nomination's transition plan has subsequently been deregistered, the nominating Party would report the deregistration, including reasons for it. The nominating Party would also report on the deregistration's impact (if any) on the exemption holder's transition plan and on the proposed new or alternative efforts that will be undertaken by the exemption holder to maintain the momentum of transition efforts.

Six fumigants are undergoing a review of risks and benefits at present. A likely outcome of this review will be the imposition of additional restriction on the use of some or all of these chemicals. This process will not lead to proposed restrictions until 2008, at which point the notice and comment rulemaking process will start. No final decision will be reached until the completion of the rule-making process, generally one to two years after it's start.. It is not possible to forecast the outcome of the rulemaking-process at this time.

An additional complication in forecasting changes in the registration of alternatives is that under our Federal system States may impose restrictions above those imposed at the Federal level. Examples of these additional restrictions include the township caps on Telone® in California and the "SLN" (Special Local Needs) restrictions on the same chemical in 31 Florida counties.

In addition, the California Department of Pesticide Regulation (DPR) may impose use restrictions and water seal requirements on all soil fumigants to reduce their contributions to volatile organic compounds as part of the efforts to meet the Federal Clean Air Standards for ground level ozone. DPR plans to finalize regulations in the next 2-3 months to meet a deadline imposed by a lawsuit concerning compliance with the 1994 pesticide component of the State Implementation Plan (SIP) on ozone. They are also in the process of devising what measures will be included in the next SIP (for June, 2007) to meet the new lower ozone standards.

Part D: EMISSION CONTROL
Renomination Form Part E: IMPLEMENTATION OF MBTOC/TEAP RECOMMENDATIONS

18. TECHNIQUES THAT HAVE AND WILL BE USED TO MINIMISE METHYL BROMIDE USE AND EMISSIONS IN THE PARTICULAR USE (*State % adoption or describe change*):

19.

TABLE D 1A: CALIFORNIA CUT FLOWERS, CUT GREENS, AND PERENNIALS; TECHNIQUES TO MINIMIZE EMISSIONS

Technique or step taken	Low permeability barrier films	Methyl bromide dosage reduction	Increased % chloropicrin in methyl bromide formulation	Deep injection	Less frequent application
What use/emission reduction methods are presently adopted?	Growers are using high barrier films in field applications (and 75 percent of greenhouse growers are using high barrier films)	5% rate reductions (273 kg/ha to 256 kg/ha)			
What further use/emission reduction steps will be taken for the methyl bromide used for critical uses?	Continue to increase use of high barrier films until all growers are using them. Experiments ongoing with VIF; state regulations will determine usage.	Additional rate reductions dependent on trial data (viability of low rate), VIF regulations, and drip fumigation trials			
Other measures (please describe)	See Worksheet 4 Cultural practices: Rotate with strawberry growers. Other pesticides: Rotating with 1,3-D/chloropicrin and Metam. Estimates that have reduced usage of methyl bromide (in kilograms used) by 58 percent since 1999.				

TABLE D 1B: FLORIDA FLORICULTURE; TECHNIQUES TO MINIMIZE EMISSIONS

Technique or step taken	Low permeability barrier films	methyl bromide dosage reduction	Increased % chloropicrin in methyl bromide formulation	Deep injection	Less frequent application
What use/emission reduction methods are presently adopted?		No	No		
What further use/emission reduction steps will be taken for the methyl bromide used for critical uses? (Projected by 2011)	*	Reduce rates in half (from 448 kg/ha to 224 kg/ha)*	Use 67:33 formulation		
Other measures (please describe)	High barrier films, pest resistant cultivars, and solarization are other measures that are expected to be used in the future to reduce methyl bromide use. *There have been problems getting the glue to stick to high barrier films in broadcast applications. Research has shown promising results when using half rates of methyl bromide under metallized film, but it was necessary to strip fumigate and 1/4 of production was lost.				

TABLE D 1C: MICHIGAN HERBACEOUS PERENNIALS; TECHNIQUES TO MINIMIZE EMISSION

Technique or step taken	Low permeability barrier films	Methyl bromide dosage reduction	Increased % chloropicrin in methyl bromide formulation	Deep injection	Less frequent application
What use/emission reduction methods are presently adopted?	Yes (high barrier films but not VIF)	No	No		No
What further use/emission reduction steps will be taken for the methyl bromide used for critical uses?	Yes (high barrier films but not VIF)	No	No		No
Other measures (please describe)	Other measures used and planned include handweeding, other pesticides, using longer crop rotations, and planting crops that are less susceptible to nematodes.				

20. IF METHYL BROMIDE EMISSION REDUCTION TECHNIQUES ARE NOT BEING USED, OR ARE NOT PLANNED FOR THE CIRCUMSTANCES OF THE NOMINATION, STATE REASONS:

Techniques to minimize emission include the use of low-permeability films, the application of water seals, and the "top dressing" application of fertilizer. In California, however, there is a performance standard for films that require a minimum level of permeability to methyl bromide to protect workers so low barrier films cannot be used with methyl bromide.

In Michigan, growers have found that the 67:33 and 50:50 formulations cannot be used because they are ineffective on nematode populations and weed control and would not be adequate to allow crops to pass Michigan Department of Agriculture inspection and certification.

The application of water seals is dependent on the availability of adequate supplies of water and a lack of restrictions on water use as well as irrigation systems that will allow the application of sufficient quantities of water to effect the seal.

The Methyl Bromide Technical Options Committee and the Technology and Economic Assessment Panel may recommended that a Party explore and, where appropriate, implement alternative systems for deployment of alternatives or reduction of methyl bromide emissions.

Where the exemptions granted by a previous Meeting of the Parties included conditions (for example, where the Parties approved a reduced quantity for a nomination), the exemption holder should report on progress in exploring or implementing recommendations.

Information on any trialling or other exploration of particular alternatives identified in TEAP recommendations should be addressed in Part C.

(Renomination Form 14.) USE/EMISSION MINIMISATION MEASURES

Where a condition requested the testing of an alternative or adoption of an emission or use minimisation measure, information is needed on the status of efforts to implement the recommendation. Information should also be provided on any resultant decrease in the exemption quantity arising if the recommendations have been successfully implemented. Information is required on what actions are being, or will be, undertaken to address any delays or obstacles that have prevented implementation.

In accordance with the criteria of the critical use exemption, each party is required to describe ways in which it strives to minimize use and emissions of methyl bromide. The use of methyl bromide in the growing of tomato in the United States is minimized in several ways. First, because of its toxicity, methyl bromide has, for the last 40 years, been regulated as a restricted use pesticide in the United States. As a consequence, methyl bromide can only be used by certified applicators that 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 application for tomatoes is most often machine injected into soil to specific depths.

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, at low to moderate levels of infestation, it must be stressed that the long term efficacy of these mixtures is unknown.

Tarpaulin (high density polyethylene) is also used to minimize use and emissions of methyl bromide. In addition, cultural practices are utilized by tomato growers.

Reduced methyl bromide concentrations in mixtures, cultural practices, and the extensive use of tarpaulins 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 for the uses described in this nomination.

USDA has several grant programs that support research into overcoming obstacles that have prevented the implementation of methyl bromide alternatives. In addition, USEPA and USDA jointly fund an annual meeting on methyl bromide alternatives. At th8is year’s meeting (held in November in Orlando, Florida) sessions were to assess and prioritize research needs and to develop a use/emission minimization agenda for methyl bromide alternatives research.

Part E: ECONOMIC ASSESSMENT

20. (Renomination Form 15.) ECONOMIC INFEASIBILITY OF ALTERNATIVES – METHODOLOGY *(METHYL BROMIDETOC will assess economic infeasibility based on the methodology submitted by the nominating Party. Partial budget analysis showing per hectare gross and net returns for methyl bromide and the next best alternatives is a widely accepted approach. Analysis should be supported by discussions identifying what costs and revenues change and why. The following measures may be useful descriptors of the economic outcome using methyl bromide or alternatives. Parties may identify additional measures. Regardless of the measures used by the methodology, it is important to state why the Party has concluded that a particular level of the measure demonstrates a lack of economic feasibility):*

The following measures or indicators may be used as a guide for providing such a description:

(a) The purchase cost per kilogram of methyl bromide and of the alternative;
(b) Gross and net revenue with and without methyl bromide, and with the next best alternative;
(c) Percentage change in gross revenues if alternatives are used;
(d) Absolute losses per hectare relative to methyl bromide if alternatives are used;
(e) Losses per kilogram of methyl bromide requested if alternatives are used;
(f) Losses as a percentage of net cash revenue if alternatives are used;
(g) Percentage change in profit margin if alternatives are used.

Please note that in this study net revenue is calculated as gross revenue minus operating costs. This is a good measure as to the direct losses of income that may be suffered by the users. It should be noted that net revenue does not represent net income to the users. Net income, which indicates profitability of an operation for an enterprise, is gross revenue minus the sum of operating and fixed costs. Net income is smaller than the net revenue measured in this study, often substantially so. We did not include fixed costs because they are difficult to measure and verify.

TABLE E.1: CALIFORNIA CALLA LILY & BULBS - ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

California Cut Flowers – Calla Lily & Bulbs	METHYL BROMIDE	Dazomet	1,3-D + Pic	Metam Sodium
YIELD LOSS (%)	0	25 %	25%	20%
YIELD PER HECTARE	236,630	177,473	177,473	189,304
* PRICE PER UNIT (U.S.$)	$0.72	$0.72	$0.72	$0.72
= GROSS REVENUE PER HECTARE (U.S.$)	$171,286	$128,465	$128,465	$137,029
- OPERATING COSTS PER HECTARE (U.S.$)	$149,035	$149,035	$149,035	$149,035
= NET REVENUE PER HECTARE (U.S.$)	$22,251	($20,570)	($20,570)	($12,006)
1. LOSS PER HECTARE (U.S.$)	$0	$42,822	$42,822	$34,257
2. LOSS PER KILOGRAM OF METHYL BROMIDE (U.S.$)	$0	$170	$170	$136
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	25%	25%	20%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	192%	192%	154%

TABLE E.2: FLORIDA CUT FLOWERS - LILIES - ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

Florida Cut Flowers - Lilies	METHYL BROMIDE	Dazomet	1,3-D + Pic	Metam Sodium
YIELD LOSS (%)	0	25 %	25%	20%
YIELD PER HECTARE	30,806	23,104	23,104	24,645
* PRICE PER UNIT (U.S.$)	$7.50	$7.50	$7.50	$7.50
= GROSS REVENUE PER HECTARE (U.S.$)	$231,043	$173,283	$173,283	$184835
- OPERATING COSTS PER HECTARE (U.S.$)	$159,506	$159,506	$159,506	$159,506
= NET REVENUE PER HECTARE (U.S.$)	$71,537	$13,776	$13,776	$25,328
1. LOSS PER HECTARE (U.S.$)	$0	$57,761	$57,761	$46,209
2. LOSS PER KILOGRAM OF METHYL BROMIDE (U.S.$)	$0	$131	$131	$105
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	25%	25%	20%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	81%	81%	65%

TABLE E.3: FLORIDA - CALADIUM - ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

Florida - Caladium	METHYL BROMIDE	Dazomet	1,3-D + Pic	Metam Sodium
YIELD LOSS (%)	0	25 %	25 %	25 %
YIELD PER HECTARE	111,197	83,398	83,398	88,958
* PRICE PER UNIT (U.S.$)	$0.25	$0.25	$0.25	$0.25
= GROSS REVENUE PER HECTARE (U.S.$)	$27,799	$20,850	$20,850	$22,239
- OPERATING COSTS PER HECTARE (U.S.$)	$24,340	$24,340	$24,340	$24,340
= NET REVENUE PER HECTARE (U.S.$)	$3,459	($3,490)	($3,490)	($2,100)
1. LOSS PER HECTARE (U.S.$)	$0	$6,950	$6,950	$5,560
2. LOSS PER KILOGRAM OF METHYL BROMIDE (U.S.$)	$0	$23	$23	$19
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	25%	25%	20%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	201%	201%	161%

TABLE E.4: MICHIGAN HERBACEOUS PERENNIALS ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

Michigan Herbaceous Perennials	Methyl Bromide	Various Alternatives**
Yield Loss (%)	0%	5%
Yield per Hectare Conifer Seedlings	144,920	137,674
* Price per Unit (U.S. $/seedling)	$ 0.97	$ 0.97
= Gross Revenue per Proportion (60%)	$ 140,956	$ 133,908
- Operating Cost per Hectare (U.S. $)	$ 37,311	$ 58,414
= Net Revenue per Hectare (U.S. $)	$ 103,645	$ 75,494
Loss Measures		
1. Loss per Hectare (U.S. $)	$0	$ 28,151
2. Loss per Kilogram of Methyl Bromide (U.S. $)	$0	$ 143.52
3. Loss as a Percentage of Gross Revenue (%)	0%	21%
4. Loss as a Percentage of Net Revenue (%)	0%	37%

** The category Various Alternatives includes physical removal and sanitation, the use of artificial media, and soil treatment with 1,3-D +chloropicrin.

Summary of Economic Feasibility

The economic analysis evaluated methyl bromide alternative control scenarios for cut flower production for Florida, California, and Michigan by comparing the economic outcomes of methyl bromide oriented production systems to those using alternatives. However, due to the fact that there are over 100 species of ornamentals grown in all regions of the country, the data from these examples are used to derive a proxy estimate for the entire industry.

The economic factors that most influence the feasibility of methyl bromide alternatives for fresh cut flower production are: (1) yield losses, referring to reductions in the quantity produced, (2) 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, and (3) missed market windows due to plant back time restrictions, which also affect the quantity and price received for the goods.

The economic reviewers 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) Loss 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.

(2) Loss per Kilogram of Methyl Bromide. This measure indicates the nominal marginal value of methyl bromide to crop production.

(3) Loss as a Percentage of Gross Revenue. 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.

(4) Loss as a Percentage of Net Operating Revenue. 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) Operating Profit Margin. We define operating profit margin to be net operating revenue divided by gross revenue per hectare. 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, therefore fixed costs were not included in the analysis.

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

Several methodological approaches will help interpret the findings. Economic estimates were first calculated in pounds and acres and then converted to kilograms and hectares. Costs for alternatives are based on market prices for the control products multiplied by the number of pounds of active ingredient that would be applied. Baseline costs were based on the average number of annual applications necessary to treat cut flowers with methyl bromide.

Net revenue is calculated as gross revenue minus operating costs. This is a good measure as to the direct losses of income that may be suffered by the users. It should be noted that net revenue does not represent net income to the users. Net income, which indicates profitability of an operation of an enterprise, is gross revenue minus the sum of operating and fixed costs. Net income should be smaller than the net revenue measured in this study. Fixed costs were not included because they are difficult to measure and verify.

Loss per hectare measures the value of methyl bromide based on changes in operating costs and/or changes in yield. Loss expressed as a percentage of the gross revenue is based on the ratio of the revenue loss to the gross revenue. Likewise for the loss as a percentage of net revenue. The profit margin percentage is the ratio of net revenue to gross revenue per hectare. The values to estimate gross revenue and the operating costs for each alternative were derived for three alternative control scenarios for Florida and California, relative to methyl bromide: 1) Dazomet; 2) 1,3-d + chloropicrin; and 3) metam sodium. Yield loss estimates were based on data from the CUEs and U.S. EPA data, as well as expert opinion.

Regulatory constraints

In California, 1,3-d plus chloropicrin would also be the primary replacement for methyl bromide. California restricts total use of 1,3-d, at the local level (township cap). In Florida, the use of 1,3-d also requires a 100-foot buffer around inhabited structures. This would reduce the production acreage an estimated 10%. Nematodes and weeds and pathogens are key pests in Florida and California bulb grower and are controlled with methyl bromide. Chloropicrin is not as effective in controlling weeds as methyl bromide. Using chloropicrin adds to production costs through increased chemical, weeding and labor costs.

Tables E.1 - E.4 provides a summary of the estimated economic losses. A measure of net revenue loss may not be completely accurate partly because some nurseries are publicly owned and seedling prices or production costs are subsidized. The range of losses in the studies is rather large because both dazomet and metam-sodium provide inconsistent pest control. Indirect losses arising from shifts in the production cycle were not quantified. Changes in production costs arise due to differences between the costs of methyl bromide and the alternatives, shifts in the production cycle (increasing the frequency of fumigation or lengthening the fallow period) and additional expenses such as supplementary irrigation. These costs vary across regions

Michigan Herbaceous Perennials

Michigan herbaceous perennials, labeled Region H above, comprise three categories of production systems with numerous plant varieties grown within each category. These categories are 2-year seeded (6% of plants), 2-year transplanted (29% of plants), and 3-year transplanted (65% of plants). To represent growing conditions on a typical hectare of production, and to account for the fact that each category has different revenues and costs of production, the above measures were calculated using representative revenues and costs for each category; these were weighted by the proportion of total production. In addition, various combinations of alternative pest control measures would need to be employed to accomplish the most effective and lowest cost pest control without methyl bromide. These various alternative pest control measures include physical removal and sanitation, the use of artificial media, and soil treatment with 1,3-D +chloropicrin.

Note: Market price data was not available for the United States cut flower industry but it is assumed that the net effect of shifting from methyl bromide to any of the alternatives other than metam sodium would result in additional revenue reductions due to fluctuations in market price due to changes in production and harvesting times.

It should be noted that the applicants do not consider any alternative to be feasible and that these estimates are an attempt to measure potential impacts.

Part F: NATIONAL MANAGEMENT STRATEGY FOR PHASE-OUT OF THIS NOMINATED CRITICAL USE
Renomination Form Part B: TRANSITION PLANS

Provision of a National Management Strategy for Phase-out of Methyl Bromide is a requirement under Decision Ex. I/4(3) for nominations after 2005. The time schedule for this Plan is different than for CUNs. Parties may wish to submit Section 21 separately to the nomination.

21. DESCRIBE MANAGEMENT STRATEGIES THAT ARE IN PLACE OR PROPOSED TO PHASE OUT THE USE OF METHYL BROMIDE FOR THE NOMINATED CRITICAL USE, INCLUDING:

1. Measures to avoid any increase in methyl bromide consumption except for unforeseen circumstances;
2. Measures to encourage the use of alternatives through the use of expedited procedures, where possible, to develop, register and deploy technically and economically feasible alternatives;
3. Provision of information on the potential market penetration of newly deployed alternatives and alternatives which may be used in the near future, to bring forward the time when it is estimated that methyl bromide consumption for the nominated use can be reduced and/or ultimately eliminated;
4. Promotion of the implementation of measures which ensure that any emissions of methyl bromide are minimized;
5. Actions to show how the management strategy will be implemented to promote the phase-out of uses of methyl bromide as soon as technically and economically feasible alternatives are available, in particular describing the steps which the Party is taking in regard to subparagraph (b) (iii) of paragraph 1 of Decision IX/6 in respect of research programmes in non-Article 5 Parties and the adoption of alternatives by Article 5 Parties.

Please refer to the U.S. National Management Strategy that was previously submitted.

Renomination Form Part C: TRANSITION ACTIONS

Responses should be consistent with information set out in the applicant's previously-approved nominations regarding their transition plans, and provide an update of progress in the implementation of those plans.

In developing recommendations on exemption nominations submitted in 2003 and 2004, the Technology and Economic Assessment Panel in some cases recommended that a Party should explore the use of particular alternatives not identified in a nomination' transition plans. Where the Party has subsequently taken steps to explore use of those alternatives, information should also be provided in this section on those steps taken.

Questions 5 - 9 should be completed where applicable to the nomination. Where a question is not applicable to the nomination, write "N/A".

(Renomination Form 6.) TRIALS OF ALTERNATIVES
Where available, attach copies of trial reports. Where possible, trials should be comparative, showing performance of alternative(s) against a methyl bromide-based standard

(i) DESCRIPTION AND IMPLEMENTATION STATUS:

See Section 15 above. Many research projects are ongoing and considerable funding is being used in this effort.

(ii) OUTCOMES OF TRIALS: (*Include any available data on outcomes from trials that are still underway. Where applicable, complete the table included at Appendix I identifying comparative disease ratings and yields with the use of methyl bromide formulations and alternatives.*)

See Section 15 above.

(iii) IMPACT ON CRITICAL USE NOMINATION/REQUIRED QUANTITIES: *(For example, provide advice on any reductions to the required quantity resulting from successful results of trials.)*

During the preparation of this nomination the USG has accounted for all identifiable means to reduce the request. Specifically, approximately 15 million kilograms of methyl bromide were requested by methyl bromide users. After careful scrutiny and subtraction so that no growth, double counting, inappropriate use rates on a treated hectare basis, or use when the requestor qualified under some other provision (QPS, for example) and after appropriate transition given yields obtained by alternatives and the associated cost differentials, was factored in, the USG is requesting roughly 1/3 of that amount.

The USG feels that no additional reduction in methyl bromide quantities is necessary.

(iv) ACTIONS TO ADDRESS ANY DELAYS/OBSTACLES IN CONDUCTING OR FINALISING TRIALS:

The USG has the ability to authorize Experimental Use Permits (EUPs) for large scale field trials for methyl bromide alternatives, as has been done for methyl iodide. A recent change ahs been to allow the EUP for methyl iodide without the previously required destruction of the crop, thus encouraging more growers to participate in field trials. As with other activities connected with registration of a pesticide, the USG has no legal authority either to compel a registrant to seek an EUP or to require growers to participate.

As noted in our previous nomination, the USG provides a great deal of funding and other support for agricultural research, and in particular, for research into alternatives for methyl bromide. This support takes the form of direct research conducted by the Agricultural Research Service (ARS) of USDA, through grants by ARS and CSREES, by IR-4 programs (which provides research opportunities for specialty crops such as tomatoes), through funding of conferences such as MBAO, and through the land grant university system

(RENOMINATION FORM 7.) TECHNOLOGY TRANSFER, SCALE-UP, REGULATORY APPROVAL FOR ALTERNATIVES

The USDA maintains an extensive technology transfer system, the Agricultural Extension Service. This Service is comprised of researchers at land grant universities and county extension agents in addition to private consultants. In addition to these sources of assistance for technology transfer, there are trade organizations and grower groups, some purly voluntary but most with some element of compulsion, that that exist to conduct research, provide marketing assistance, and to disseminate “best practices”. The California Strawberry Commission is one example of such a grower group.

(i) DESCRIPTION AND IMPLEMENTATION STATUS:

Furfural was recently registered (October 2006) for use in greenhouse ornamentals, but not on field grown ornamentals. The impact of this recent registration has not yet been determined pending the review of relevant research data.

(ii) OUTCOMES ACHIEVED TO DATE FROM TECHNOLOGY TRANSFER, SCALE-UP, REGULATORY APPROVAL:

It is too soon to know what the outcomes of this registration. Discussion of this chemical is included in section 12.

(iii) IMPACT ON CRITICAL USE NOMINATION/REQUIRED QUANTITIES: (*For example, provide advice on any reductions to the required quantity resulting from successful progress in technology transfer, scale-up, and/or regulatory approval.*)

The USG feels that no additional change in methyl bromide quantity requested is necessary. The US nomination for this sector reflects the commitment by this sector and the US to reduce methyl bromide use to only the most critical needs. See Appendix A.

(iv) ACTIONS TO ADDRESS ANY DELAYS/OBSTACLES:

Ongoing field trials require results to be validated for commercial application. Therefore, some period of time after publication of field trials is needed for commercial testing and implementation.

The US government endeavours to identify methyl bromide alternatives to move them forward in the registration queue. However, it has no legal authority to compel registrations, it can only act on registrations requested by private entities.

(Renomination Form 8.) COMMERCIAL SCALE-UP/DEPLOYMENT, MARKET PENETRATION OF ALTERNATIVES

(i) DESCRIPTION AND IMPLEMENTATION STATUS:

These issues are discussed in the US Management plan for methyl bromide submitted previously.

(ii) IMPACT ON CRITICAL USE NOMINATION/REQUIRED QUANTITIES: (*For example, provide advice on any reductions to the required quantity resulting from successful commercial scale-up/deployment and/or market penetration*.)

The USG feels that no additional change in methyl bromide quantity requested is necessary. The U.S. nomination for this sector reflects the commitment by this sector and the U.S. to reduce methyl bromide use to only the most critical needs. See Appendix A.

(iii) ACTIONS TO ADDRESS ANY DELAYS/OBSTACLES:

USG endeavors to identify methyl bromide alternatives to move them forward in the registration queue. However USG has no legal authority to compel registrations; it can only act on registrations requested by private entities. The timely submission of data to support a registration decision is at the sole discretion of the registrant.

The USDA maintains an extensive technology transfer system, the Agricultural Extension Service. This Service is comprised of researchers at land grant universities and county extension agents in addition to private pest management consultants. In addition to these sources of assistance for technology transfer, there are trade organizations and grower groups, some of which are purely voluntary but most with some element of institutional compulsion, that exist to conduct research, provide marketing assistance, and to disseminate “best practices”. The California Strawberry Commission is one example of such a grower group.

(Renomination Form 9.) CHANGES TO TRANSITION PROGRAM

If the transition program outlined in the Party's original nomination has been changed, provide information on the nature of those changes and the reasons for them. Where the changes are significant, attach a full description of the revised transition program.

See Appendix A.

(Renomination Form 10.) OTHER BROADER TRANSITION ACTIVITIES

Provide information in this section on any other transitional activities that are not addressed elsewhere. This section provides a nominating Party with the opportunity to report, where applicable, on any additional activities which it may have undertaken to encourage a transition, but need not be restricted to the circumstances and activities of the individual nomination. Without prescribing specific activities that a nominating Party should address, and noting that individual Parties are best placed to identify the most appropriate approach to achieve a swift transition in their own circumstances, such activities could include market incentives, financial support to exemption holders, labelling, product prohibitions, public awareness and information campaigns, etc.

In California, the transit timeframe will depend on the results of ongoing trials. Nutsedge is difficult to control using alternatives (except methyl iodide, which is currently not registered). It is expected that the greenhouse hot gas treatments (using 98:2 MB:chloropicrin at 487 kg/ha) has the potential for significant reduction in gas consumption if trials can demonstrate that lower methyl bromide rates are viable for control of target pests. It is expected that transition will occur as rates are refined to target specific pests, growers move to application methods that require less fumigant/ha, and as repeatable, viable control is demonstrated from methyl bromide alternatives.

Part G: CITATIONS

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3 Gerik, J. S., 2005, Drip-applied Soil Fumigation for Freesia Production, HortTechnology 15(4), p. 820-824.

4 Ragsdale, N., USDA-ARS National Program Staff, 2004, Personal communication.

5 Elmore, C., J. MacDonald, H. Ferris, I. Zasada, S. Tsjvold, K. Robb, C. Wilen, L. Bolkin, L. Yahaba, J. Roncoroni, 2003a, Alternatives to Methyl Bromide for Control of Weeds, Nematodes, and Soil-Borne Fungi, Bacteria in Coastal Ornamental Crops – Draft.

6 Elmore, C., J. Roncoroni, K. Robb, C. Wilen, and H. Ajwa, 2003b, Preplant Pest Production in *Ranunculus* Production, Proceeding from the 2003 Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions, Web address: www.mbao.org

7 McSorley, R. and K.-H. Wang., 2003, Fumigant Alternatives to Methyl Bromide for Managing Nematodes and Weeds in Snapdragon, Proc Fla State Hort Soc.

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9 Trout, T., 2003, Impact of Township Caps on Telone Use in California, Proc. Annual International Research Conference on Methyl Bromide Alternatives and Emission Reductions, p. 109.

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12 Richardson, R., B. Zandstra, and T. Dudek. Evaluation of Herbicidal Controls for *Inula brittannica.* ee CUE-0066 request Michigan Field Grown Herbaceous Perennial Growers consortium in 2004 submission

13 Foliage, Floriculture, and Cut Greens. May 2003. Florida Agricultural Statistics Service. Web address: http://www.nass.usda.gov/fl

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15 Prince & Prince, Inc. Survey, 2003. Conducted for California Cut Flower Commission

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19 Pizano, M., 2001, Floriculture and the Environment: Growing Flowers without Methyl Bromide, United Nations Environment Programme.

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APPENDIX A 2009 METHYL BROMIDE USAGE NUMERICAL INDEX EXTRACTED (BUNNIE)

2009 Methyl Bromide Usage Newer Numerical Index - BUNNIE						Ornamentals	
December 18, 2006	Region		California Cut Flower Commission	Michigan Herbaceous Perennials	Florida Cut Flowers	Sector Total or Average	Notes
Dichotomous Variables	Strip or Bed Treatment?		No	No	No		
	Currently Use Alternatives?		Yes	Yes	Yes		
	Tarps / Deep Injection Used?		Tarps	Tarps	Tarps		
	Pest-free Cert Requirements?		No	No	No		
Other Issues	Frequency of Treatment (x/ yr)		1x/ year	1x/ year	1x/ year		*
	QPS Removed?		Yes	Yes	Yes		
Most Likely Combined Impacts (%)	Florida Telone Restrictions (%)		0%	0%	40%		
	100 ft Buffer Zones (%)		0%	0%	0%		
	Key Pest Distribution (%)		100%	100%	100%		
	Regulatory Issues (%)		21%	0%	0%		
	Unsuitable Terrain (%)		0%	0%	0%		
	Cold Soil Temperature (%)		0%	0%	0%		
	Total Combined Impacts (%)		**100%**	**100%**	100%		
Most Likely Baseline Transition	(%) Able to Transition		0%	0%	0%		
	Minimum # of Years Required		0	0	0		
	(%) Able to Transition / Year		**0%**	**0%**	**0%**		
EPA Adjusted Use Rate (kg/ha)			**211**	**200**	**350**		
EPA Adjusted Strip Dosage Rate (g/m2)			21.1	20.0	35.0		
2009 Requested Usage	*Amount - Pounds*	*Pounds*	*155,000*	*11,941*	*1,372,000*	*1,538,941*	
	Area - Acres		*656*	*30*	*3,500*	*4,186*	
	Rate (lb/A)		*236.28*	*398.03*	*392.00*	*368*	
	Amount - Kilograms	Metric	**70,307**	**5,416**	**622,328**	**698,051**	
	Treated Area - Hectares		265	12	1,416	1,694	
	Rate (kg/ha)		265	446	439	412	
EPA Preliminary Value		**kgs**	**70,307**	**4,763**	**79,379**	**154,448**	
EPA Baseline Adjusted Value has been adjusted for:			MBTOC Adjustments, QPS, Double Counting, Growth, Use Rate/Strip Treatment, Miscellaneous, and Combined Impacts				
EPA Baseline Adjusted Value		kgs	67,946	2,539	63,232	133,716	
EPA Transition Amount		kgs	-	-	-	-	
EPA Amount of All Adjustments		kgs	**(2,361)**	**(2,224)**	**(16,146)**	**(20,732)**	
Most Likely Impact Value for Treated Area		kgs	**67,946**	**2,539**	**63,232**	**133,716**	
		ha	**323**	**13**	**181**	**516**	
		Rate	**211**	**200**	**350**	**259**	
Sector Research Amount (kgs)			**4,060**	**2009 Total US Sector Nomination**		**137,776**	

APPENDIX B ORNAMENTAL SPECIES GROWN AND TARGET PESTS

California Species Grown

It is difficult to determine acreage information for cut flowers. However, production data for the major cut flower and bulb species grown is available and estimates of the acreage have been made (See Tables below).

APPENDIX B TABLE 1. CALIFORNIA ORNAMENTALS - PRODUCTION OF MAJOR SPECIES

Species	# Flower Bunches in 2003
Alstroemeria	892,789
Carnations	1,694,870
Delphinium	3,617,186
Gladiolus	Data not released
Gerbera	62,638,650
Iris	5,823,242
Lilium	6,247,027
Chrysanthemums	1,273,742
Pompons	6,350,127
Roses	7,360,729
Snapdragons	2,976,219

Source: 15

This survey is the only source of information but may under report data. Also, the number of stems/bunch is not the same for all crops.

APPENDIX B TABLE 2 CALIFORNIA ORNAMENTALS - PARTIAL LISTING AND ESTIMATE OF CUT FLOWER AND FOLIAGE AREA PRODUCED IN CALIFORNIA IN 2002

Crop	Area (usually field) - ha	Area (usually greenhouse) – m^2
Alstroemeria	8 (0.3%)	47,100 (3.2 %)
Antirrhinum (snapdragon)	126 (5%)	164,898 (11.3%)
Aster		57,598 (4%)
Calla lily	16 (0.6%)	
Carnation	30 (1.2%)	21,739 (1.5%)
Chrysanthemum	88 (3.3%)	281,023 (19 %)
Delphinium	22 (0.8%)	
Eucalyptus	54 (2%)	
Gerbera		214,413 (14.7%)
Gypsophila	55 (2%)	
Iris (Dutch)	18 (0.7%)	
Larkspur	6 (0.2%)	
Lilium	32 (1.2%)	205,959 (14.2%)
Limonium spp.	13 (0.5%)	
Lisianthus	13 (0.5%)	
Protea	190 (7.3%)	
Rose	41 (1.6% - all greenhouse)	123,557 (8.5%)
Stock (*Matthiola*)	26 (1%)	
Wax flower	317 (12%)	
Other	791 (30%)	59,177 (4%)
Greenhouse misc.	70 (2.7%)	278,700 (19%)
Field misc.	303 (11.6%)	
Cut greens misc.	389 (15%)	
Total	2609	1,454,164 (145 ha)

Florida Species Grown

According to the 2002 Census of Agriculture, cut flowers and florist greens were grown on 3,402 ha (outdoors) and foliage plants were grown on 1,198 ha (outdoors). Approximately 2,511 additional ha of cut flowers, florist greens, and foliage plants were grown indoors (under glass) (17).

Although it would be useful to have more accurate acreage information for each species this has been difficult to obtain for several reasons. 1) There are hundreds of species of cut flowers, foliage, and bulb crops grown, and often several species are grown in the same field in the same year. 2) The species grown are constantly changing and fluctuations may occur at any time. For example, several years ago sunflowers were not a major commercial crop in Florida but currently it is a major crop. 3) There are no records available that show which crops are grown at any one time. Due to the sheer number of species, and the constant fluctuation in the industry, the acreage of each species is unable to be determined. The Table below shows a few of the major crops grown and the numberof spikes or stems produced, although acreage information was not available. This information indicates that gladioli are another major crop grown in Florida, and would be expected to be grown on more acreage than some of the other crops.

The only three cut flower species identified by the Florida Agricultural Statistics Service are gladioli, lilies and snapdragon. These are assumed to have the highest acreage (See Table below for production information). These crops have also been identified by the applicant as using methyl bromide.

APPENDIX B TABLE 3. FLORIDA ORNAMENTALS - CROP PRODUCTION FOR CERTAIN CUT FLOWER SPECIES[2] 3.

	2001		2002		2003	
Crop	# of producers	Quantity sold (1000 spikes)[1]	# of producers	Quantity sold (1000 spikes)[1]	# of producers	Quantity sold (1000 spikes)
Gladioli	4	40,331	4	49,581	4	39,444
Snapdragons	5	6,806	4	4,415	4	4,757
Lilies	4	3,031	3	2,257	-	-
Other cut flowers	-	-	9	-	10	-

[1] Quantity of lilies sold 1000 stems.
[2] This table only includes data for growers with sales over $100,000.
Source: 13, 14

Using several data sources, a rough estimate of the number of acres of gladioli grown can be obtained. The quantity sold, shown in the Table above, was averaged and divided by an average yield, which was calculated using data from 1991 to 1998. This method resulted in approximately 638 ha of gladioli. This number does not take into account the variability in yield in an individual year or if yields have changed since 1998 (16).

APPENDIX B TABLE 4. FLORIDA ORNAMENTALS - OTHER CUT FLOWER SPECIES GROWN IN FLORIDA4.

Crop	Crop Rotation Limitation
Delphinium	These species are often sensitive to the same insects and pests as the other cut flower, foliage and bulb species.
Larkspur	
Gerbera	
Lisianthus	
Sunflower	
Aster	
Chrysanthemum	

Key Pests of Select Cut Flower Species

The following list is not comprehensive, but is intended to demonstrate the complexity of the industry. In addition to the diseases and nematodes listed below, there are numerous weed species that are major problems in cut flower production. These species include the bulbs, tubers, or cormlets from a previous crop, yellow nutsedge (*Cyperus esculentus*), little mallow (*Malva parviflora*), and common sow thistle (*Sonchus oleracea*).

APPENDIX B TABLE 5. DISEASES AND NEMATODES OF CUT FLOWER CROPS CURRENTLY CONTROLLED WITH METHYL BROMIDE.

Crop	Key Pests	Scientific name
Antirrhinum	Nematodes Pythium root rot	*Belanolaimus longidorus, Criconomella* spp., *Dolichodorus heterocephalus* *Pythium irregulare* (documented resistance to mefenoxam is 25-50%)
Calla lily	Erwinia soft rot Pythium root rot	*Erwinia carotovora* *Pythium* spp. (resistance to mefenoxam suspected to be widespread
Delphinium	Sclerotinia stem rot	*Sclerotinia* spp.
Dianthus	Fusarium wilt	*Fusarium oxysporum* fsp. *dianthii*
Eustoma	Fusarium wilt, root rot, and stem rot	*Fusarium oxysporum, F. solani,* and *F. avenaceaum*
Freesia	Fusarium wilt	*Fusarium* spp.
Gladiolus	Fusarium wilt Stromatinia neck rot	*Fusarium oxysporum* fsp. *gladioli* *Stromatinia gladioli*
Helianthus	Downy mildew	*Plasmopara halstedii* (this is a soil-borne pathogen)
Hypericum	Root knot nematode Pythium root rot	*Meloidogyne* spp. *Pythium* spp.
Iris	Fusarium wilt	*Fusarium oxysporum* fsp. *iridis*
Larkspur	Sclerotinia stem rot	*Sclerotinia sclerotiorum*
Liatris spicata	Sclerotinia stem rot	*Sclerotinia sclerotiorum*
Lilium	Pythium root rot	*Pythium* spp.
Matthiola	Sclerotinia stem rot Xanthomonas leaf spot	*Sclerotinia sclerotiorum* *Xanthomonas campestris* pv. *campestris*
Ranunculus	Pythium root rot Xanthomonas leaf spot	*Pythium* spp. *Xanthomonas campestris*

Similar information was provided in a recent grower education document (24). In addition to the crops described in the table above, Gerbera was described as susceptible to *Sclerotinia* stem rot.