METHYL BROMIDE CRITICAL USE NOMINATION FOR PREPLANT SOIL USE ON STRAWBERRY NURSERIES IN OPEN FIELDS OR IN PROTECTED ENVIRONMENTS

FOR ADMINISTRATIVE PURPOSES ONLY:
DATE RECEIVED BY OZONE SECRETARIAT:
YEAR: CUN:

NOMINATING PARTY:	The United States of America
BRIEF DESCRIPTIVE TITLE OF NOMINATION:	Methyl Bromide Critical Use Nomination for Preplant Soil Use for Strawberry Nurseries Grown in Open Fields or in Protected Environments (Prepared in 2005)

NOMINATING PARTY CONTACT DETAILS

Contact Person:	John E. Thompson, Ph. D.
Title:	International Affairs Officer
Address:	Office of Environmental Policy U.S. Department of State 2201 C Street N.W. Room 4325 Washington, DC 20520 U.S.A.
Telephone:	(202) 647-9799
Fax:	(202) 647-5947
E-mail:	ThompsonJE2@state.gov

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.

☐ Yes ☐ No

____________________ ____________________ ____________________

Signature Name Date

Title: ____

CONTACT OR EXPERT(S) FOR FURTHER TECHNICAL DETAILS

Contact/Expert Person:	Steve Knizner
Title:	Acting Division Director
Address:	Biological and Economic Analysis Division Office of Pesticide Programs U.S. Environmental Protection Agency Mail Code 7503C Washington, DC 20460 U.S.A.
Telephone:	(703) 305-6903
Fax:	(703) 308-8090
E-mail:	knizner.steve@epa.gov

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

List all paper and electronic documents submitted by the Nominating Party to the Ozone Secretariat

1. PAPER DOCUMENTS: **Title of Paper Documents and Appendices**	**Number of Pages**	**Date Sent to Ozone Secretariat**

2. ELECTRONIC COPIES OF ALL PAPER DOCUMENTS: **Title of Electronic Files**	**Size of File (kb)**	**Date Sent to Ozone Secretariat**

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PART A: SUMMARY

1. NOMINATING PARTY

The United States of America (U.S.)

2. DESCRIPTIVE TITLE OF NOMINATION

Methyl Bromide Critical Use Nomination for Preplant Soil Use for Strawberry Nurseries in Open Fields or in Protected Environments

3. CROP AND SUMMARY OF CROP SYSTEM

Southeastern (from Maryland, North Carolina, and Tennessee) growers annually produce their transplants in open fields. An individual field is only planted to strawberries once every three years. Approximately 85% of transplants produced are exported to Florida.

California growers produce their transplants over a five year cycle. Screenhouses are used during the first two years and open field plantings are used during the last three years. Methyl bromide (MB) is only needed in production years 2 thru 5. Individual planting sites are only planted to strawberries once every three years. The fourth and fifth production years account for 22% and 77%, respectively, of the current MB nursery usage in California. Transplants produced are distributed widely throughout the U.S. and other countries.

4. METHYL BROMIDE NOMINATED

TABLE 4.1: METHYL BROMIDE NOMINATED

YEAR	NOMINATION AMOUNT (KG)*	NOMINATION AREA (HA)
2007	4,483	13

* Includes research amount of 454 kgs.

5. BRIEF SUMMARY OF THE NEED FOR METHYL BROMIDE AS A CRITICAL USE

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

- Pest control efficacy of alternatives: the efficacy of alternatives may not be comparable to MB in some areas, making these alternatives technically and/or economically infeasible for use in tomato production.
- Quarantine and Pre-Shipment uses are not included in this CUE.

MB is needed in the near future for strawberry nursery production to produce plants free of all damaging diseases and nematodes to meet state and foreign certification standards, as well as prospective buyer expectations. In addition to these certification-related pest control concerns, weed control is also essential to insure maximum runner production and prevent the spread of noxious weeds. The available alternatives, thus far, have not been developed sufficiently to provide acceptable levels of control of the key pests to depths of 1 m. In addition, there are no markets for plants that do not meet the certification standards, which mean that losses up to 100% are possible when less than required levels of pest control occur. Failure to adequately control pests in transplants would jeopardize the viability of the transplant and fruit production industries in the U.S., as well as the viability of fruit production in countries purchasing U.S. plants (e.g., Canada, Mexico, Spain, countries in South America, and some others).

TABLE A.1: EXECUTIVE SUMMARY

Region	*Southeastern States*	*California*
AMOUNT OF NOMINATION*		
2007 Kilograms	2,654	1,375
AMOUNT OF APPLICANT REQUEST		
2007 Kilograms	43,292	137,466

* *See Appendix A for complete description on how nominated amount was calculated.*

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE

The key alternatives are 1,3-dichloropropene (1,3-D)/chloropicrin, 1,3-D/chloropicrin/metam-sodium, and 1,3-D/metam-sodium. Dazomet is also a possible alternative probably in combination with chloropicrin and/or 1,3-D. These chemicals, in addition to other strategies, such as use of high density tarps, may ultimately reduce or replace MB. However, to maintain certification quality protocols for effective use of these alternatives have not been sufficiently developed to provide an adequate level of disease and nematode control throughout the root zone (up to 1 m deep). Additionally, these alternatives will require further study before consistently providing control of yellow and purple nutsedge (*Cyperus esculentus*, *C. rotundus*) (SE states only) and a number of other critical weed pests in California (Table 10.1). The state certification requirements associated with the requesting states are strict (virtually zero tolerance for any damaging diseases and plant-parasitic nematodes) in order to minimize the prospect of spreading these nematode and disease pests to other states and countries where these plants are shipped. Research has been cited (e.g., Kabir et al., 2003) in this review that gives hope for MB replacement or reduction for this sector, but the need for MB for the short term is critical until protocols are developed sufficiently for use in commercial strawberry nursery operations.

7. (*i*) PROPORTION OF CROPS GROWN USING METHYL BROMIDE

All growers in the affected states requesting methyl bromide use are dependent upon its wide pest spectrum and high level of pest control.

TABLE 7.1: PROPORTION OF CROPS GROWN USING METHYL BROMIDE

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TOTAL CROP AREA – 2001-2002 AVERAGE (HA)	PROPORTION OF TOTAL CROP AREA TREATED WITH METHYL BROMIDE (%)
Southeastern States	69	100
California	1,386	100

7. (*ii*) IF ONLY 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.

Pest-free standards for nursery stock make the transition to alternatives difficult.

7. (*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?

Not applicable because the alternatives have not been proven effective for the control of the target pests in nursery conditions.

8. AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

SOUTHEASTERN STATES AND CALIFORNIA- TABLE 8.1: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION:	**SOUTHEASTERN STATES**	**CALIFORNIA**
YEAR OF EXEMPTION REQUEST	**2007**	**2007**
KILOGRAMS OF METHYL BROMIDE	43,292	137,464
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	FLAT FUMIGATION	FLAT FUMIGATION
FORMULATION *(ratio of methyl bromide/chloropicrin mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(ha)*	105	522 (w/o QPS)
APPLICATION RATE *(kg/ha)* FOR THE **FORMULATION**	520	395
APPLICATION RATE *(kg/ha)* FOR **METHYL BROMIDE**	350	263
DOSAGE RATE *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	52.0	39.5
DOSAGE RATE *(g/m^2)* OF **METHYL BROMIDE**	35.0	26.3

9. Summarize Assumptions Used to Calculate Methyl Bromide Quantity Nominated for Each Region

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 two applicants that included growth in their request had the growth amount removed.
- There was a small adjustment for use rate in one of the applications.
- Quarantine and pre-shipment (QPS) hectares is the area in the applicant's request subject to QPS treatments. Both applicants had QPS listed the amount requested and reflects the subtraction of the QPS amount.
- Only the area experiencing one or more of the following impacts were included in the nominated amount: moderate to heavy key pest pressure.

SOUTHEASTERN STATES - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

SOUTHEASTERN STATES - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

SOUTHEASTERN STATES - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY DISEASE(S) AND WEED(S) TO GENUS AND, IF KNOWN, TO SPECIES LEVEL	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
Southeastern States	Weeds: Yellow nutsedge (*Cyperus esculentus*), Purple nutsedge (*Cyperus rotundus*) Diseases: Black root rot (*Rhizoctonia* and *Pythium* spp.); Crown rot (*Phytophthora cactorum*); root-knot nematodes (*Meloidogyne* spp.)	None of the available alternatives currently provides an acceptable or consistent level of control of nutsedge.

SOUTHEASTERN STATES - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

SOUTHEASTERN STATES - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	SOUTHEASTERN STATES
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Strawberry transplants
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual crop, replanted in same site once every three years
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Various crops planted
SOIL TYPES: *(Sand, loam, clay, etc.)*	93% medium and 7% light soils, containing up to 2% organic matter
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Every year
OTHER RELEVANT FACTORS:	None identified

SOUTHEASTERN STATES - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	6a, 6b, 7a, 7b, 8a, 8b											
RAINFALL *(mm)*	163	124	109	87	78	146	113	202	109	116	54	76
OUTSIDE TEMP. *(℃)*	9.4	14.5	17.7	23.4	26	25.9	22.6	14.9	7.7	3.4	2.9	4.2
FUMIGATION SCHEDULE							X	X				
PLANTING SCHEDULE		X	X									
HARVEST SCHEDULE							2X	X				

* Macon, GA

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

None were identified as being limiting factors.

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

SOUTHEASTERN STATES - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1998	1999	2000	2001	2002	2003
AREA TREATED *(hectares)*	82	82	55	67	71	75
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	Nearly all flat fumigation	Nearly all flat fumigation	Nearly all flat fumigation	Nearly all flat fumigation	Nearly all flat fumigation	Nearly all flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	49,386	33,764	22,900	27,747	29,251	30,923
FORMULATIONS OF METHYL BROMIDE *(methyl bromide/ chloropicrin)*	98:2	67:33	67:33	67:33	67:33	67:33
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection
APPLICATION RATE OF FORMULATIONS IN kg/ha*	616	619	619	619	619	619
APPLICATION RATE OF METHYL BROMIDE IN kg/ha*	604	413	413	413	413	413
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	61.6	61.9	61.9	61.9	61.9	61.9
ACTUAL DOSAGE RATE OF METHYL BROMIDE *(g/m^2)**	60.4	41.3	41.3	41.3	41.3	41.3

** For flat fumigation treatment application rate and dosage rate may be the same.*

SOUTHEASTERN STATES - PART C: TECHNICAL VALIDATION

SOUTHEASTERN STATES - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

SOUTHEASTERN STATES – TABLE 13.1: REASON FOR ALTERNATIVES NOT BEING FEASIBLE

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
CHEMICAL ALTERNATIVES		
Chloropicrin	Objectionable odors in residential areas; little or no efficacy on nutsedge (Locascio 1997 & 1999); in some instances it caused increased emergence of nutsedge (Motis and Gilreath 2002); Unlikely that disease and nematode control required by state certification programs can be attained throughout the 1 m root zone. Chloropicrin is generally considered a good control measure for certain pathogens (*Pythium, Phytophthora, Fusarium, Verticillium*), but is not considered effective for nematode or weed control. [See also chloropicrin issues addressed in the fumigant combination entries in this section.]	No
NON CHEMICAL ALTERNATIVES		
Biofumigation	Lack of adequate data on the activity of biofumigation materials on nutsedge control; Based on studies with other crops, allelochemicals may cause phytotoxic effects (Norsworthy 2002; Johnson et al. 1993); unlikely that the level of disease and nematode control required by state certification programs can be attained throughout the 1 m deep root zone. Biofumigation is not technically feasible because it does not provide adequate, or consistent, control of target pests to produce a certifiable strawberry nursery stock. Research conducted in Florida showed some control of plant pathogens, but no control of nematodes or weeds in the soil. In cases where biofumigation have been shown to control weeds, the data are mostly for small-seeded weed species that have small carbohydrate energy sources compared to nutsedge. The data on biofumigation are too limited to consider it as a practical alternative to methyl bromide, and strategies to incorporate biofumigation with other alternatives have not been adequately developed. It is not clear that Brassica crops can be supplied in such quantity needed to control target pests. Estimates are that the biofumigant would have to occupy approximately 3 hectares for every hectare of strawberry production. Incorporation of Brassica at these levels would be likely to have allelopathic effects on the target crop.	No

Name of Alternative	**Technical and regulatory* reasons for the alternative not being feasible or available**	**Is the alternative considered cost effective?**
Solarization	Even in warmer climates (Georgia) it is difficult to attain temperatures lethal to nutsedge (50-55°C) at depths below 10 centimeters (Miles et. al. 2002). However, research to enhance the efficacy of solarization with tarps is being conducted (e.g., Arbel et al., 2003). Solarization is not feasible alternative by itself because it does not provide adequate control of target pests to produce certifiable strawberry nursery stock. Use of solarization is not practical due to the depth of heating required to eliminate viable weed seed, nematodes, and disease organisms. The time for solarization to raise soil temperatures to the level needed to kill soil pathogens in any strawberry nursery region is likely to also be the time when the crops themselves must complete their growth cycle. Unpredictable, stormy summer weather still creates risks and may damage mulch. In one Southeast field trial, solarization gave poor yields in two years out of three with losses ranging from 0% to 40% (Miles et. al. 2002).	No
General IPM	IPM, the use of pest monitoring activities coupled with chemical and non-chemical management tools, has been adopted already for management of weed, diseases, and nematodes on most crops. General IPM is being used in strawberry nursery stock production, but it is not technically feasible alone to provide adequate pest control. IPM practices include field sanitation to limit inoculum buildup, crop rotation to provide non host periods, and breeding for resistance to pathogens.	No
Cover crops mulching	Cover crops/mulching is currently being used but it is not technically feasible alone as a complete replacement for MB to control the target pest and certify the nursery stock; level of disease and nematode control required by state certification programs cannot be attained. Cover crops/mulching is currently being used but it is not technically feasible as a complete replacement for MB to control the target pests and certify the nursery stock. The use of cover crops is a common practice to improve soil structure and suppress an array of soilborne pathogens. Cover crops and mulches have been integrated into strawberry nursery crop production systems. Some cover crops that have been shown to reduce weed populations also reduced or delayed crop maturity and/or emergence, as well as yields (Burgos et al., 1996; Galloway et al., 1996). Cowpea and sunn hemp have been shown to suppress nutsedge, but the effect is short lived due to the weed's capacity for rapid tuber production. Allelochemicals released by some cover crops or organic mulches can injure crops (Johnson et al., 1993; Norsworthy, 2002).	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Crop rotation/fallow	Growers typically use this practice by growing other crops every two out of three years; this practice has not resulted in a level of disease and nematode control required by state certification programs throughout the 1 m deep root zone; no suitable nutsedge controls are available during production of the rotational crops (Culpepper, 2002). A three-year crop rotation/fallow is being used in strawberry nursery stock production, but it is not technically feasible when used alone to control the key target pests. Strategies for use with other alternatives are being studied, but are not currently developed to use in a commercial nursery at this time. Although such crop rotation and fallow procedures are generally considered useful pest management tools for weeds, diseases and nematodes, they are rarely considered standalone control measures. Significantly longer time frames may produce higher levels of control for most pests, but are generally considered impractical because of limited land availability and high costs. There are registered herbicides that are effective for nutsedge control in agronomic crops. These herbicides are not available for most fruit or vegetable crops, and many of them have 12- to 26-month carryover restrictions for vegetable crops. Crop rotation and fallow will not suppress nutsedge. Johnson & Mullinix (1997) showed that uninterrupted plantings of peanut, corn, or cotton, with moderate levels of weed management suppressed yellow nutsedge in Georgia. Their data also showed an increase in nutsedge densities in fallow plots, likely due to the longevity of nutsedge tubers in soil, mild winters that prevent winter-kill of tubers, and the ability of tubers to regenerate with the long growing season in the southeastern coastal plain. There are also reports of increasing populations of yellow nutsedge in fallowed fields, even when weed control/management is performed. Since there are no herbicides registered for use on strawberry plants that will effectively control nutsedge, management of these weeds during short-term rotations and fallow is not effective.	No
Soilless culture	Soilless culture is not being used and it is not technically feasible because it requires a complete transformation of the U.S. production system. There are high costs associated with this as compared to current production practices. According to data provided by The National Center for Food and Agricultural Policy, a greenhouse typically costs between US$12.5 million and US$20 million per hectare. Although yields obtained through greenhouse production are higher than yields of the best growers, the issue of capitalization for this and other sectors make the alternative not feasible as a near term strategy to reduce reliance on MB.	No

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
Substrates/plug plants grown hydroponically	Substrates/plug plants are currently being produced and sold in the southeast and to a very limited extent in California, but this method alone does not provide pest control and would fail to produce a pest free product. Furthermore, this method would require extensive retooling by the nursery industry, and would be cost prohibitive to change to this technology.	No
Combinations of Alternatives		
1,3-D + chloropicrin	Little or no efficacy on nutsedge (Locascio 1997 & 1999); level of disease and nematode control required by state certification programs cannot be attained throughout the 1 m deep root zone; may be the best alternative where nutsedge is not a problem (50% of production area). The combination of 1,3-D and chloropicrin is not technically feasible because it does not adequately control nematodes and diseases to the level required by various state laws, and results in yield losses in nursery plants. 1,3 D provides good nematode control, moderate disease control, and poor weed control. A 30.5 meter (100 feet) 1,3-D buffer requirement, to mitigate area resident exposure, would be particularly constraining on smaller fields in predominantly urban fringe areas, which is typical for the Southeastern U.S. growers. Personal Protective Equipment (PPE) requirements also limit operations that require workers in the field, particularly given the high temperatures which occur in the southeast, which are exacerbated by high humidity. Workers wearing the required PPE become at risk for possible heat exhaustion or heat stroke. For example, PPE may require applicators to wear fully sealed suits with respirators. Such suits do not have refrigeration components, and under conditions of high heat and humidity, rapidly become unbearable for a typical applicator. Growers believe that the requirements for buffers and PPE may make it impractical to adopt 1,3-D. The buffer requirements, especially for the small farms in the Southeastern U.S., eliminate so much area around the perimeter of a field that there is very little left that can be treated using 1,3-D alone to grow strawberries. Chloropicrin provides good disease control, but poor nematode and weed control. Workers complain about eye and lung irritation when applying chloropicrin, which is used as tear gas.	No

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
1,3-D + chloropicrin + metam-sodium	Inconsistent control of nutsedges; unlikely to sufficiently control disease and nematode problems as required by state certification programs. The combination of 1,3-D, chloropicrin and metam sodium is not currently technically feasible because it does not consistently control pests and diseases to the level required by various state laws. Research with tarps and other combination strategies may improve efficacy (e.g., Ajwa et al., 2003), but these need to be sufficiently developed for commercial use. 1,3-D is a good nematicide and chloropicrin is a good fungicide. Metam sodium provides moderate, but unpredictable disease, nematode, and weed control since it suffers from erratic efficacy, most likely due to irregular distribution of the product through soil. Metam sodium degrades in the soil to form methylisothiocyanate, which has activity against nematodes, fungi, insects, and weeds. MB has a higher vapor pressure than metam sodium, therefore can penetrate and diffuse throughout the soil more effectively than metam sodium. In addition, the effectiveness of metam sodium is very dependent on the organic matter and moisture content of the soil. Studies to evaluate best delivery systems for metam sodium are being conducted. Some studies have shown that soil injections and drenches are more effective than drip irrigation. Research trials show that incorporation of metam sodium with a tractor-mounted tillovator provides good results but most growers do not have this equipment. A 3-week time interval before planting is required to avoid phytotoxic levels; causing delays in production schedules that could lead to missing specific market windows, thus reducing profit or actually causing a loss for a grower. The combination of the three chemicals would still require a companion herbicide or hand weeding. Failure to control the full spectrum of weeds could lead to increased disease pressure over time because the weeds can be reservoirs for disease or harbors insect vectors of disease. Also, in strawberry fruit production, there is demand for pest free strawberry root stock. The nursery growers who do not supply this type of product will be forced out of the market.	No

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
1,3-D + metam-sodium	1,3-D or metam-sodium possess inconsistent control of nutsedge (Webster et. al. 2001); metam-sodium component is likely to provide inconsistent nematode, weed and disease control due to poor movement within soil; it is unlikely that the disease and nematode control required by state certification programs can be attained with this combination throughout the 1 m. deep root zone. Research examining protocols for combination treatments have the best chance for effective pest control, but strategies must be developed so they are ready for commercial applications. The combination of 1,3-D and metam sodium is not technically feasible because it does not consistently control pests and diseases to the level required by various state laws, and results in yield losses in nursery plants. 1,3-D is a good nematicide and metam sodium provides moderate, but unpredictable disease, nematode, and weed control. As indicated above, metam-sodium also suffers from erratic efficacy, most likely due to irregular distribution of the product through soil. The combination of these chemicals would still require a companion herbicide or hand weeding. Failure to control the weed seed in soil would most likely lead to increased disease pressure over time. Also, in strawberry fruit production, there is demand for pest free strawberry root stock. The nursery growers who do not supply this type of product will be forced out of the market. As with the other suggested combinations (above) there are issues with the use of Personal Protective Equipment (PPE) in the hot or hot and humid climates of California and the southeastern U.S. In addition, the buffer requirement of 90 meters (300 feet) would be particularly constraining on smaller fields in predominantly urban fringe areas. For small strawberry nursery operations in the southeastern U.S., the 1,3-D buffer requirements eliminate a large area around the field perimeter, which impacts the total acreage available for strawberry nursery production. Sequential application of each one of these chemicals requires significantly more time than using MB alone since growers must wait longer after fumigation to put the strawberry root stock in the ground. Growers have a greater planting delay for several weeks, which will extend their production schedule. This delay directly impacts cultivar options, Integrated Pest Management practices, timing of planting and harvest for strawberry fruit production, marketing window options, land leasing decisions, and subsequent crop rotation schedules. Since growers will require rootstock at a fixed time during the year, the nursery plants could be of lower grade and quality (smaller) causing loss to both the nursery grower and the fruit grower.	No

** Regulatory reasons include local restrictions (e.g. occupational health and safety, local environmental regulations) and lack of registration.*

SOUTHEASTERN STATES - 14. LIST AND DISCUSS WHY REGISTERED *(and Potential)* PESTICIDES AND HERBICIDES ARE CONSIDERED NOT EFFECTIVE AS TECHNICAL ALTERNATIVES TO METHYL BROMIDE

SOUTHEASTERN STATES – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
Other fungicides, herbicides, or nematicides.	There are no other pesticides (with the exception of iodomethane) in the registration process that can take the place of MB.

SOUTHEASTERN STATES - 15. LIST PRESENT *(and Possible Future)* REGISTRATION STATUS. OF ANY CURRENT AND POTENTIAL ALTERNATIVES

SOUTHEASTERN STATES – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Iodomethane	Not registered for any crop uses in the US.	Yes	Unknown
Propargyl bromide	Registration in the U.S. has not been requested.	No	Unknown
Sodium azide	Registration in the U.S. has not been requested.	No	Unknown

SOUTHEASTERN STATES - 16. STATE RELATIVE EFFECTIVENESS OF RELEVANT ALTERNATIVES COMPARED TO METHYL BROMIDE FOR THE SPECIFIC KEY TARGET PESTS AND WEEDS FOR WHICH IT IS BEING REQUESTED

The following study was conducted in the southeastern U.S. but with methyl iodide (MI) as the principal treatment comparing to 1,3-D with 35% chloropicrin (Telone C-35) and an untreated control. Based on researchers' opinions from numerous studies, MI when used as a soil fumigant generally provides yields and levels of pest control comparable to MB. Accordingly, we assumed that the results of the available study are representative of previous studies and can be relied upon for assessing the comparative value of the best available alternative (1,3-D + 35% chloropicrin).

Given the soil types present in production areas the root zone required to be protected is generally as deep as 1 m. Although several of the alternatives provided adequate levels of pest control at shallower depths, none consistently provided suitable control levels at 1 m. Failure to provide levels of pest control at the required depth will result in inadequate levels of control, which will result in rejection of the plants produced under these conditions (100% loss in affected fields). Accordingly, the maximum loss estimate is listed as 100% because the various state certification requirements, which equate to a zero tolerance for disease symptoms and nematodes.

SOUTHEASTERN STATES – TABLE 16.1: EFFECTIVENESS OF ALTERNATIVES—CERTAIN WEEDS

Treatment	**Application Rate (kg/ha)**	**% MB Pest Control**			**% MB Yield**	**Comments**
		Nem.	Dis.	Weeds		
Methyl Iodide (100%)	263	NQ	NQ	Assume 100%	Assume 100%	No MB tested
Methyl Iodide/Chloropicrin (75:25)	263/66	NQ	NQ	92%	81%	
1,3-D/Chloropicrin (Telone C-35)	254/139	NQ	NQ	87%	73%	

Source: Gilreath, J.P., E.B. Poling, J.W. Noling, 2001, unpublished study

Key to Table Abbreviations: NQ = not quantified (too low and non-uniform); Nem. = nematodes; Dis. = diseases

MI alone yield was statistically higher than the combination with chloropicrin (CP) and the 1,3-D/CP treatments. There was no statistical difference between these later two treatments, however, they both provided statistically higher yields than the untreated controls. The prominent weeds present were hairy galinsoga (*Galinsoga cillata*), carpetweed (*Mollugo verticillata*), and purslane (*Portulaca oleracea*). The most difficult weed to control was hairy galinsoga, with MI alone providing the highest levels of control of this as well as the other weeds. The post treatment disease and nematode incidence data were too variable and too low in any of the plots to formulate any conclusions. The yield benefit exhibited by MI is likely to be a combination of weed control plus control of other unidentified microbial pests. The comparative weed control percentages are based solely on control of hairy galinsoga.

SOUTHEASTERN STATES – TABLE C.1: ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3-D/chloropicrin (Telone C-35)	Certain Weeds (see above table)	0-27%	10%
Metam Sodium	Certain Weeds (see above table)		50%
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**10%**

SOUTHEASTERN STATES - 17. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE

Iodomethane is in a pending registration status and is being evaluated as an alternative. It is generally considered to be as effective as MB for most preplant crop uses and nearly all pests. Growers could easily transition to this alternative.

Dazomet is also in a pending registration status as a nematicide on strawberries. The efficacy in the southeastern U.S. is unclear.

SOUTHEASTERN STATES - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE

There are no replacements for MB currently because of the strict requirements of producing pest free nursery stock. The technology changeover costs for adopting soilless culture techniques are high. Although yields reportedly obtained through greenhouse production are higher than that of the best conventional growers, capitalization for this and other sectors makes the alternative not feasible as a near term strategy to reduce reliance on MB. No information was presented on the long term viability of this option. The organic strawberry fruit growers are dependent upon MB treated transplants to enable them to grow strawberries with limited pest problems.

SOUTHEASTERN STATES - SUMMARY OF TECHNICAL FEASIBILITY

Protocols for effective use of the alternatives have not been sufficiently developed at this time to provide acceptable control of major pests in commercial strawberry nurseries in the southeastern U.S. The use of these alternatives will require further study before growers can be confident that they are able to effectively control such major pests as yellow and purple nutsedges, which are limiting factors in nursery production in this area. The consortium is currently developing a timeline to describe the transition from MB to alternatives. Research has been cited from California (e.g., Kabir et al., 2003) that gives hope for MB replacement or reduction for this sector, but the need for MB for the short term is critical until protocols are developed sufficiently for use in commercial strawberry nursery operations in both southeastern and California nursery sites.

Key alternatives are 1,3-D)/chloropicrin, 1,3-D/chloropicrin/metam-sodium, and 1,3-D/metam-sodium. Dazomet is also a possible alternative probably in combination with chloropicrin and/or 1,3-D. These chemicals, in addition to developing strategies for use of tarps, such as virtually impermeable films, may ultimately reduce or replace MB. However, after long term MB use, strategies for new treatments must be researched and transferred for commercial applications.

California - Part B: Crop Characteristics and Methyl Bromide Use

California - 10. Key Diseases and Weeds for which Methyl Bromide Is Requested and Specific Reasons for this Request

California - Table 10.1: Key Diseases and Weeds and Reason for Methyl Bromide Request

Region where methyl bromide use is requested	Key disease(s) and weed(s) to genus and, if known, to species level	Specific reasons why methyl bromide needed
California	Diseases: Phytophthora Crown and Root Rots (*Phytophthora spp.*); Red Stele (*Phytophthora fragariae*); Verticillium Wilt (*Verticillium dahliae*); Nematodes: Root-knot (*Meloidogyne spp.*); sting (*Belonolaimus spp.*); dagger (*Xiphinema spp.*); lesion (*Pratylenchus spp.*); foliar (*Aphelenchoides spp.*); needle (*Longidorus spp.*); stem (*Ditylenchus spp.*) Weeds: numerous weeds listed (e.g., annual bluegrass, bur clover, carpetweed, chickweed, field bindweed, goat grass, hairy nightshade, lambsquarter, malva, nutsedge, pig weed, portulaca, prostate spurge, puncture vine, purslane, vetch)	The state mandatory certification program has strict requirements for control of diseases and nematodes, which amount to near complete control of the key pests. Given the growing situations encountered over the course of the 5-year transplant production cycle (a different growing location is used each year), none of the alternatives have thus far been shown to consistently perform with sufficient efficacyl at soil depths to 1 m. There is research being conducted that hints at acceptable alternatives to MB (e.g., Kabir et al., 2003) but currently there is a critical need for MB until commercial application of research findings are instituted. Methyl iodide is considered by most researchers to be a potentially effective alternative, but it is currently not registered in the US.

California – 11. (*i*) Characteristics of Cropping System and Climate

California - Table 11.1: Characteristics of Cropping System

Characteristics	California
Crop Type: *(e.g. transplants, bulbs, trees or cuttings)*	Strawberry transplants
Annual or Perennial Crop: *(# of years between replanting)*	Annual crop, only planted in the same location once every three years
Typical Crop Rotation *(if any)* **and use of methyl bromide for other crops in the rotation:** *(if any)*	The principal rotational crops are endive, garlic, onion, horseradish, mint, alfalfa, sugarbeets, and potatoes.
Soil Types: *(Sand, loam, clay, etc.)*	80 % light soils, 10% medium soils and 10% heavy soils; 70% with 2% or less organic matter
Frequency of methyl bromide Fumigation: *(e.g. every two years)*	Every year
Other relevant factors:	No

California (low elevation areas; years 3 & 4) -Table 11.2 Characteristics of Climate and Crop Schedule

	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Climatic Zone	6a, 6b, 7a, 9a, 9b											
Rainfall *(mm)*	16	72.1	17.3	0	trace	1.0	trace	0	44.7	56.9	9.9	30.5
Outside Temp. *(℃)*	14.4	14.8	20.8	25.7	30.3	27.4	25.1	18.4	13.4	9.6	10.3	10.6
Fumigation Schedule		X										
Planting Schedule			X	X								
harvest schedule											X	

*For Fresno, California.

California (high elevation areas; year 5) -Table 11.3 Characteristics of Climate and Crop Schedule

	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Climatic Zone	6a, 6b, 7a, 9a, 9b											
Fumigation Schedule						X	X					
Planting Schedule		X										
harvest schedule							X	X	X			

California – 11. (*ii*) Indicate if any of the above characteristics in 11. (*i*) prevent the uptake of any relevant alternatives?

Legal restrictions of some alternatives and certain soil moisture conditions can have an impact on use.

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

CALIFORNIA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
AREA TREATED *(hectares)*	1,153	1,267	1,283	1,295	1,477	1,551
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	All Flat fumigation	All Flat fumigation	All Flat fumigation	All Flat fumigation	All Flat fumigation	All Flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kg)*	313,200	341,230	337,604	341,022	389,069	408,530
FORMULATIONS OF METHYL BROMIDE *(e.g. methyl bromide 98:2; methyl bromide /chloropicrin 70:30)*	67:33	67:33	67:33	67:33	67:33	
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection	Flat fumigation soil injection
APPLICATION RATE OF FORMULATIONS IN kg/ha*	408	404	395	395	395	395
APPLICATION RATE OF METHYL BROMIDE IN kg/ha*	272	269	263	263	263	263
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	40.8	40.4	39.5	39.5	39.5	39.5
ACTUAL DOSAGE RATE OF METHYL BROMIDE *(g/m^2)**	27.2	26.9	26.3	26.3	26.3	26.3

** For Flat fumigation treatment application rate and dosage rate may be the same.*

CALIFORNIA - PART C: TECHNICAL VALIDATION

CALIFORNIA - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

CALIFORNIA – TABLE 13.1: REASON FOR ALTERNATIVES NOT BEING FEASIBLE

Please see the description above under the Southeastern U.S. (Southeastern U.S. Table 13.1).

CALIFORNIA - 14. LIST AND DISCUSS WHY REGISTERED *(and Potential)* PESTICIDES AND HERBICIDES ARE CONSIDERED NOT EFFECTIVE AS TECHNICAL ALTERNATIVES TO METHYL BROMIDE

CALIFORNIA – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

Please see the description in the Southeastern U.S. above (Southeastern U.S. Table 14.1).

CALIFORNIA - 15. LIST PRESENT *(and Possible Future)* REGISTRATION STATUS OF ANY CURRENT AND POTENTIAL ALTERNATIVES

CALIFORNIA – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS *State if registered for this crop, registered for crop but use restricted, registered for other crops but not target crop, or not registered*	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Iodomethane	Not registered for any crop uses in the U.S.	Yes	Unknown
Sodium Azide	Not submitted for registration.	No	Unknown
Propargyl bromide	Not submitted for registration.	No	Unknown

CALIFORNIA - 16. STATE RELATIVE EFFECTIVENESS OF RELEVANT ALTERNATIVES COMPARED TO METHYL BROMIDE FOR THE SPECIFIC KEY TARGET PESTS AND WEEDS FOR WHICH IT IS BEING REQUESTED

Numerous studies have been referenced (see section 26) in the two applications (Southeastern States [Maryland, North Carolina, Tennessee], and California). Several studies suggest that alternatives (most likely combination of alternatives) have potential as MB replacements, but not in the immediate future. This is because after so many years of reliance on MB, protocols for alternative treatments have to go through the long process of research and development before they are commercially available. This is especially true for managing pests subject to the rigorous requirements of California's nursery certification program. Table 16.4 exemplifies the difficulty in transtioning to alternatives, given their variability. Even though some studies have shortcomings, in terms of the procedures used or the information reported, the overall conclusion is that none of the chemical and/or non-chemical alternatives can immediately be substituted for MB. Therefore, for the current nomination, MB is considered critical for the strawberry nursery sector. Consortia are currently developing timelines to detail their schedules for transition from MB to alternatives.

While no immediate replacements are currently available to address the most severe pest problems, research from California (e.g., Kabir et al., 2003) (see Tables 16.5a and 16.5b, below), suggests that strawberry nurseries may have alternatives to MB that will result in healthy nursery stock that will be comparable to MB treated plants, even in terms of fruit yield after field planting. Small scale research results suggested that the use of chloropicrin followed by dazomet produced yields (during some years of the study) at least as high as MB treated soil. The issues of consistency and scale-up to commercial use are still outstanding, and this study did not evaluate specific pests, use of tarps, or consider California certification requirements. Therefore, there is a critical need for MB until the efficacy of alternative treatments can be confirmed.

When one takes into account that the five-year production system involves new planting sites each year, consistency is important in satisfying the needs of their international, interstate and intrastate customers. The inconsistency in performance of the alternatives most likely results from the application methods, application rates, formulations of alternatives, soil and weather conditions, and pest species and levels present in tests. Experience with techniques in application of alternatives, and interactions of several alternatives, should improve efficacy.

The root zone to be protected is as deep as 1 m. Although several of the alternatives provide adequate levels of pest control at shallower depths, none consistently provide suitable control levels at 1 m. Failure to provide levels of pest control at the required depth will result in inadequate levels of control, which will result in rejection of the plants produced under these conditions (100% loss in affected fields).

CALIFORNIA – TABLE 16.1: EFFECTIVENESS OF ALTERNATIVES – CHEMICAL ALTERNATIVES TO METHYL BROMIDE FUMIGATION – HOW WELL DO THEY WORK?

Treatment	Application Method & Rate (kg/ha)	Pest Control (% of MB)		Yield (% of MB)	Comments
		NEM	**DIS.**		
MB/CP (67:33)	MB: 246kg/ha; CP: 121 kg/ha; chisel injection & tarped	+	+	100	
1,3-D/CP (70:30)	1,3-D: 361 kg/ha; CP: 155 kg/ha; chisel injection & tarped	+	+	96	
Chloropicrin (CP)	95-189; and 190 and higher; chisel injection & tarped	+	+	89 (< 190kg/ha); 103 (>190 kg/ha)	Evaluated both low and high dosage rates
Metam Sodium	950 kg/ha; surface drench and tarped	+	+	92	
Dazomet	340 kg/ha; broadcast, tilled into soil, and tarped	+	+	95	
Enzone (sodium tetra thiocarbonate)	2.85 kg/ha tarped	+	+	80	Not registered for use on strawberries
UTC		+	+	70	

Source: Gubler, W.D., J.M. Duniway, and N. Welch. 1996. Chemical Alternatives to Methyl Bromide Fumigation – How Well Do They Work?

Key to Abbreviations: 1,3-D = 1,3-dichloropropene; MB = methyl bromide; CP = chloropicrin; MS = metam sodium; UTC = untreated control; Nem. = nematodes; Dis. = diseases

Watsonville, CA 1993 study using large-scale plots; low levels of Phytophthora crown and root rots, Verticillium wilt, and nematodes; one-year evaluation only

CALIFORNIA – TABLE 16.2: EFFECTIVENESS OF ALTERNATIVES CHLOROPICRIN EFFECT ON WEED SEED VIABILITY.

Control Measures Evaluated	Application Method & Rate (kg/ha)	Weed Control (% of MB)	Comments
MB/CP (67:33)	MB: 225 kg/ha CP: 111 kg/ha; soil injection	100	Very good control of 3 weeds; no control of 2 weeds (mallow & filaree)
Metam Sodium (MS)	MS: 197 kg/ha; drip irrigation	Comp.	Very good control of 3 weeds; no control of 2 weeds (mallow & filaree)
MS plus CP	MS: 197kg /ha drip irrigation; CP: 83 – 220 kg/ha soil injection	Very Comp.	produced a slight increase in weed control over MS alone = best available treatment for the weed species present
Chloropicrin (CP)	CP: 83 – 220 kg/ha soil injection	Comp.	good control of 3 weeds at the higher rates; no control of 2 weeds (mallow & filaree)
UTC		none	

Source: Haar, M.J., S.A. Fennimore, H.A. Ajwa, C.Q. Winterbottom. 2003. Chloropicrin Effect on Weed Seed Viability.

Key to Abbreviations: CP = chloropicrin; MS = metam sodium; 1,3-D = 1,3-dichloropropene; UTC = untreated controls; Comp = comparable.

The study was conducted over two years near Santa Maria, CA. Primary weed pests: *Polygonum aviculare* (knot-grass), *Portulaca oleracea* (common purslane) and *Malva parviflora* (little mallow) were introduced in both years, whereas, *Stellaria media* (chickweed) and *Erodium cicutarium* (red-stem filaree) were introduced in the second year; similar weed seed sensitivity for CP and MS; no yield data obtained.

CALIFORNIA – TABLE 16.3: EFFECTIVENESS OF ALTERNATIVES - SOIL FUMIGATION AND RUNNER PLANT PRODUCTION.

Treatment	Application Method & Rate (kg/ha)	Yield (% of MB)	Comments
Methyl bromide	Chisel	100 (4 trials)	
Chloropicrin	140-191 kg/ha , chisel	73-92 (3 trials)	
Chloropicrin	≥300 kg/ha, Chisel;	86 – 100 (4 trials)	Appeared to be the best of the alternatives evaluated
1,3-D/Chloropicrin (70:30)	Chisel;	84 (1 trial)	Did not rank very high as an alternative due to reduced plant growth and runner production
1,3-D/Chloropicrin (30:70)	Chisel	91 (1 trial)	Appeared to perform similar to the high rate of chloropicrin
UTC	Not Applicable	38-55 (4 trials)	

Source: Larson, K.D. and D.V. Shaw, 2000, Soil Fumigation and Runner Plant Production: A Synthesis of Four Years of Strawberry Nursery Field Trials, Hort Sci. 35 (4):642-646.
Key to Abbreviations: 1,3-D = 1,3-dichloropropene; UTC = untreated controls.

This study was conducted on former strawberry nursery soils, however, other crops were planted in these soils prior to initiating this study; fumigants chiseled into soil at a 36 cm depth and covered with a tarp for 7 days; pest types and pressures uncertain, however, Verticillium wilt (*V. albo-atrum*) was detected in some locations and roots were examined for decay and discoloration, with the untreated plants (UTC) exhibiting most of the disease symptoms; nematodes were not considered to be a problem in any of the test locations. It should be noted that the main focus of this study was to evaluate yield responses and that quantification of the various pest organisms was beyond the scope of this study.

CALIFORNIA – TABLE 16.4: EFFECTIVENESS OF ALTERNATIVES - EVALUATION OF ALTERNATIVES TO METHYL BROMIDE FOR SOIL FUMIGATION AT COMMERCIAL FRUIT AND NUT TREE NURSERIES

Treatment	Application Method & Rate (kg/ha)	Nematode Control (% of MB)
Methyl bromide /chloropicrin (75:25)	MB: 448 kg/ha; CP: 151 kg/ha	100
1,3-D/CP	1,3-D: 518 kg/ha; CP: 283 kg/ha	83-100
1,3-D + Metam Sodium	Sequential application; 1,3-D: 518 kg/ha; MS: (?) kg/ha.	16-100
1,3-D/dazomet	Sequential application; 396 kg/ha; 224 kg/ha DZ	28-100

Source: McKenry, M.V., 2001. Evaluation of Alternatives to Methyl Bromide for Soil Fumigation at Commercial Fruit and Nut Tree Nurseries, California Department of Pesticide Regulation (Contract # 99-0218).

Key to Abbreviations: 1,3-D = ; CP = ; MB = ;DZ = dazomet; Prominent nematode pests present: lesion (*Pratylenchus* spp.), spiral (*Helicotylenchus dihystera*), dagger (*Xiphinema americanum*) and some root-knot (*Meloidogyne* spp.)

CALIFORNIA – TABLE 16.5a and 16.5b: EFFECTIVENESS OF ALTERNATIVES - EVALUATION OF ALTERNATIVES TO METHYL BROMIDE FOR THE CONTROL OF SOIL PESTS: STRAWBERRY AS A MODEL SYSTEM

Table 16.5a. FRUIT YIELD (GRAMS PER PLANT) OF STRAWBERRY AT WATSONVILLE, CA IN 2002. [The 'nursery' column indicates the treatment of nursery plants grown in 2001; the 'field' column indicates the fumigation treatment in the field.]

Nursery treatment (high elevation, MacDoel, CA)	Field treatment (Watsonville)	Marketable yield (g/plant)	Unmarketable yield (g/plant)	Total yield (g/plant)
control	Pic	1301.7	535.6	1837.3
MB/Pic	Pic	1235.8	550.9	1786.6
MI/Pic	Pic	1278.2	525.0	1803.3
Pic followed by dazomet	Pic	1388.4	575.1	1963.4
Telone C35 followed by dazomet	Pic	1346.4	553.3	1899.7
control	MB/Pic	1520.3	600.1	2120.4
MB/Pic	MB/Pic	1474.0	596.3	2070.3
MI/Pic	MB/Pic	1526.8	625.0	2151.8
Pic followed by dazomet	MB/Pic	1634.5	640.6	2275.1
Telone C35 followed by dazomet	MB/Pic	1434.1	634.0	2068.1
ANOVA		------------------------P values----------------------		
Nursery		0.04*	0.24	0.07
Field		<0.0001*	<0.0001*	<0.0001*
Nursery (field)		0.47	0.74	0.73
		* indicates significance		

Source: Kabir, Z., Fennimore, S., Martin, F., Ajwa, H., Duniway, J., Browne, G., Winterbottom, C., Westerdahl, B., Goodhue, R., Guerrero, L., Haar, M. 2003. Alternative[s] Fumigants for the Control of Soil Pests: Strawberry as a Model System. Methyl Bromide Alternatives Conference (2003). www.mbao.org.

Key to Abbreviations: For **nursery treatments**: **control**= no fumigation; **methyl bromide/chloropicrin (MB/Pic)** = 57:43, 450 kg/ha; **methyl iodide/chloropicrin (MI/Pic)** = 50:50, 392 kg/ha; **1,3-D/chloropicrin (Telone C35)** (300 liters/ha) followed by **dazomet (280 kg/ha)**; **chloropicrin (Pic)** (336 kg/ha) followed by **dazomet** (280 kg/ha).

For **field treatments**: **control**= no fumigation; **MB/Pic**, 67:33 (392 kg/ha); **Pic** (224 kg/ha).

Table 16.5b. FRUIT YIELD (GRAMS PER PLANT) OF STRAWBERRY AT WATSONVILLE, CA IN 2003. [The 'nursery' column indicates the treatment of nursery plants grown in 2002; the 'field' column indicates the fumigation treatment in the field.]

Nursery treatment (high elevation, MacDoel, CA)	Field treatment (Watsonville)	Marketable yield (g/plant)	Unmarketable yield (g/plant)	Total yield (g/plant)
control	Pic	1270.2	1092.5	2362.7
MB/Pic	Pic	1244.2	1070.5	2314.7
MI/Pic	Pic	1153.7	992.9	2146.6
Pic followed by dazomet	Pic	1324.6	1059.4	2384.0
Telone C35 followed by dazomet	Pic	1220.2	1069.7	2289.9
control	MB/Pic	1177.2	1216.1	2393.3
MB/Pic	MB/Pic	1132.2	1179.8	2311.9
MI/Pic	MB/Pic	1050.8	1106.2	2157.0
Pic followed by dazomet	MB/Pic	1166.9	1249.2	2416.0
Telone C35 followed by dazomet	MB/Pic	1111.0	1176.9	2287.9
ANOVA		------------------------P values---------------------		
Nursery		0.001*	0.003*	0.0001*
Field		<0.0001*	<0.0001*	0.70
Nursery (field)		0.92	0.60	0.99
		* indicates significance		

Source: Kabir, Z., Fennimore, S., Martin, F., Ajwa, H., Duniway, J., Browne, G., Winterbottom, C., Westerdahl, B., Goodhue, R., Guerrero, L., Haar, M. 2003. Alternative[s] Fumigants for the Control of Soil Pests: Strawberry as a Model System. Methyl Bromide Alternatives Conference (2003). www.mbao.org.

Key to Abbreviations: For **nursery treatments**: **control**= no fumigation; **methyl bromide/chloropicrin (MB/Pic)** = 57:43, 450 kg/ha; **methyl iodide/chloropicrin (MI/Pic)** = 50:50, 392 kg/ha; **1,3-D/chloropicrin (Telone C35)** (300 liters/ha) followed by **dazomet (280 kg/ha)**; **chloropicrin (Pic)** (336 kg/ha) followed by **dazomet** (280 kg/ha).

For **field treatments**: **control**= no fumigation; **MB/Pic**, 67:33 (392 kg/ha); **Pic** (224 kg/ha).

This strawberry yield research study was conducted at three strawberry runner nurseries. Plants were grown for three years at two high elevation nurseries (HEN) or for two years at a low elevation nursery (LEN). Plants were then placed in two different field locations (Watsonville and Oxnard) for marketable yield assessments. Plants received various fumigation treatments at both nursery and field locations (results from two trials, conducted in 2002 and 2003, are presented in Tables 16.5a and 16.5b, above).

Pests were not identified and only yields were evaluated. In the 2002 test, "…fruit yield was significantly greater under the on-site MBPic treatment than in Pic treatment alone" (Table 16.5a). The fumigants used at the nursery had "…positive carryover effects on marketable fruit yield when the treatment was Pic [followed by] Basamid".

The results at the Watsonville location for the 2003 test showed "…marketable fruit yield was increased (9%) in on-site Pic treatments compared to MBPic treatments. In contrast, non-marketable fruit yield was significantly greater (4%) under MBPic than under Pic (Table 16.5b). The authors again noted that the nursery treatments had significant carryover effects on the fruit yield. They "…suggest that application of Pic fb [followed by] Basamid [dazomet] at the HEN increased runner plant production, which eventually improved fruit yield with Pic in the fruiting field. Pic could be a viable alternative to MBPic". No interaction was found between the fumigations at the nursery and field, therefore, the effects were considered additive.

CALIFORNIA – TABLE C.1: ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3-D/Chloropicrin	Certain weeds	0-27%	10%
1,3-D + Metam Sodium	Certain weeds	---	13%
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**10-13%**

CALIFORNIA - 17. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE?

California-Table 15.1 for status of iodomethane. This fumigant is unregistered, but is reported to be a potential suitable alternative for all key pests.

Dazomet is also in a pending registration status as a nematicide on strawberries and may be an effective alternative, especially when combined with other treatments (e.g., Kabir et al., 2003).

CALIFORNIA - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE

Because of strict requirements for pest free nursery stock, only in limited areas can strawberry nursery plants be produced safely without MB. A shift to soilless cultivation would require a major shift in production and would result in a significant market disruption for the near term.

CALIFORNIA - SUMMARY OF TECHNICAL FEASIBILITY

Strict requirements for pest free nursery plants make MB a critical tool for nursery growers, at least for the near future. Protocols for effective use of the alternatives that were discussed above, have not been sufficiently developed at this time to provide sufficient control of such major pests as nematodes and root rot pathogens in commercial strawberry nurseries in California. The use of these alternatives will require further study before growers can be confident that they are able to effectively control these pests, which are limiting factors in nursery production. Research has been cited from California (e.g., Kabir et al., 2003) that gives hope for MB replacement or reduction for this sector, but the need for MB for the short term is critical until protocols are developed sufficiently for use in commercial strawberry nursery operations in both California and southeastern nursery sites. Timelines are being developed to outline the industry's transition to alternatives.

Key alternatives are 1,3- D/chloropicrin, 1,3-D/chloropicrin/metam-sodium, and 1,3-D/metam-sodium. Dazomet is also a possible alternative probably in combination with chloropicrin and/or 1,3-D. These chemicals, in addition to developing strategies for use of tarps, such as VIF, may ultimately reduce or replace MB. Currently, high barrier films are in use in California and have helped to reduce the rates of MB.VIF are restricted in California and there are concerns about acceptable off-gassing rates. Strategies for new treatments must be researched and transferred for commercial applications.

PART D: EMISSION CONTROL

19. TECHNIQUES THAT HAVE AND WILL BE USED TO MINIMIZE METHYL BROMIDE USE AND EMISSIONS IN THE PARTICULAR USE

TABLE 19.1: TECHNIQUES TO MINIMIZE METHYL BROMIDE USE AND EMISSIONS

TECHNIQUE OR STEP TAKEN	VIF OR HIGH BARRIER FILMS	METHYL BROMIDE DOSAGE REDUCTION	INCREASED % CHLOROPICRIN IN METHYL BROMIDE FORMULATION	LESS FREQUENT APPLICATION
WHAT USE/EMISSION REDUCTION METHODS ARE PRESENTLY ADOPTED?	Currently, most growers use HDPE tarps; VIF is restricted in California.	Between 1997 and 2002 the dosage rate of methyl bromide has dropped by one eighth.	All use 67:33	For certification of nursery stock, fumigation must occur prior to every planting
WHAT FURTHER USE/EMISSION REDUCTION STEPS WILL BE TAKEN FOR THE METHYL BROMIDE USED FOR CRITICAL USES?	Research is underway to develop use in commercial production systems	Possible changeover from broadcast to raised bed band treatments,	Unidentified	For certification of nursery stock, fumigation must occur prior to every planting
OTHER MEASURES *(please describe)*	Examination of promising but presently unregistered alternative fumigants with non-chemical methods.	Unidentified	Unidentified	For certification of nursery stock, fumigation must occur prior to every planting

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

Tarpaulins (high density polyethylene, mostly experimental use of virtually impermeable film) are used to minimize use and emissions of MB. In addition, practices such as deep injection are used by strawberry nursery growers to reduce the MB rates required for growing nursery stock.

PART E: ECONOMIC ASSESSMENT

The following economic analysis is organized by MeBr critical use application. Cost of MeBr and alternatives are given first in table 21.1. This is followed in table 22.1 by a listing of net and gross revenues by applicant. Expected losses when using MeBr alternatives are then decomposed in tables E1 and E2.

Reader 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 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. We did not include fixed costs because it is often difficult to measure and verify.

21. COSTS OF ALTERNATIVES COMPARED TO METHYL BROMIDE OVER 3-YEAR PERIOD:

TABLE 21.1: OPERATING COSTS WITH ALTERNATIVES COMPARED TO METHYL BROMIDE OVER 3-YEAR PERIOD

REGION	ALTERNATIVE	YIELD*	COST IN YEAR 1 *(US$/ha)*	COST IN YEAR 2 *(US$/ha)*	COST IN YEAR 3 *(US$/ha)*
SOUTHEASTERN STATES	**Methyl Bromide**	**100**	**$ 30,245**	**$ 30,245**	**$ 30,245**
	Metam Sodium	50	$ 29,927	$ 29,927	$ 29,927
	1,3-P+Pic	90	$ 31,513	$ 31,513	$ 31,513
CALIFORNIA	**Methyl Bromide**	**100**	**$ 37,831**	**$ 37,831**	**$ 37,831**
	1,3-D+Metam Sodium	87	$ 40,157	$ 40,157	$ 40,157
	1,3-D+Pic	90	$ 37,664	$ 37,664	$ 37,664

** As percentage of typical or 3-year average yield, compared to methyl bromide*

SOUTHEASTERN STATES-22. GROSS AND NET REVENUE

SOUTHEASTERN STATES-TABLE 22.1: YEARS 1, 2, AND 3 GROSS AND NET REVENUE

ALTERNATIVES *(as shown in question 21)*	GROSS REVENUE FOR LAST REPORTED YEAR *(US$/ha)*	NET REVENUE FOR LAST REPORTED YEAR *(US$/ha)*
Methyl Bromide	**$ 42,008**	**$ 11,763**
Metam Sodium	$ 21,004	$ (8,923)
1,3-d+pic	$ 37,807	$ 6,294

CALIFORNIA-22. GROSS AND NET REVENUE

CALIFORNIA-TABLE 22.1: YEARS 1, 2, AND 3 GROSS AND NET REVENUE

ALTERNATIVES *(as shown in question 21)*	**GROSS REVENUE FOR LAST REPORTED YEAR** *(US$/ha)*	**NET REVENUE FOR LAST REPORTED YEAR** *(US$/ha)*
Methyl Bromide	**$ 47,741**	**$ 9,909**
1,3-D+ Metam Sodium	$ 41,773	$ 1,616
1,3-D+ Pic	$ 42,967	$ 5,303

SOUTHEASTERN STATES - TABLE E.1: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

SOUTHEASTERN STATES	METHYL BROMIDE	ALTERNATIVE METAM	ALTERNATIVE 1,3-D+PIC
YIELD LOSS (%)	0%	50%	10%
YIELD PER HECTARE (PLANTS)	211,715	105,857	190,543
* PRICE PER UNIT (US$)	$ 0.20	$ 0.20	$ 0.20
= GROSS REVENUE PER HECTARE (US$)	$ 42,008	$ 21,004	$ 37,807
- OPERATING COSTS PER HECTARE (US$)	$ 30,245	$ 29,927	$ 31,513
= NET REVENUE PER HECTARE (US$)	$ 11,763	$ (8,923)	$ 6,294
LOSS MEASURE			
1. LOSS PER HECTARE (US$)	$0	$ 20,686	$ 5,469
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$ 50.15	$ 13.26
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	49%	13%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	176%	46%

CALIFORNIA - TABLE E.2: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

CALIFORNIA	METHYL BROMIDE	ALTERNATIVE 1,3-D METAM	ALTERNATIVE 1,3-D+PIC
YIELD LOSS (%)	0%	13%	10%
YIELD PER HECTARE (BOXES)	796	696	716
* PRICE PER UNIT (US$)	$ 60.00	$ 60.00	$ 60.00
= GROSS REVENUE PER HECTARE (US$)	$ 47,741	$ 41,773	$ 42,967
- OPERATING COSTS PER HECTARE (US$)	$ 37,831	$ 40,157	$ 37,664
= NET REVENUE PER HECTARE (US$)	$ 9,909	$ 1,616	$ 5,303
LOSS MEASURES			
1. LOSS PER HECTARE (US$)	$0	$ 8,293	$ 4,606
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$ 31.49	$ 17.49
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	17%	10%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	84%	46%

SUMMARY OF ECONOMIC FEASIBILITY

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

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

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

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

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

(4) Losses as a percent of net revenues. We define net 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.

These measures represent differ MB users, who are forest seedling 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 MB. The economic measures provide the basis for making that determination.

The economic analysis compared the costs of MB alternative control scenarios for the Southeastern Strawberry Consortium and the California Strawberry Growers Association to the baseline costs for MB. The economic estimates were first calculated in pounds and acres and then converted to kilograms and hectares. The costs for the alternatives are based on market price for the control products multiplied by the number of pounds of active ingredient that would be applied. The baseline costs were based on the average number of applications to treat strawberry plants (boxes) with MB per year. The loss per hectare measures the value of MB based on changes in operating costs and changes in yield. The loss expressed as a percentage of the gross revenue is based on the ratio of the loss to the gross revenue using MB. Likewise for the loss as a percentage of net revenue. These losses are shown in Tables E.1 and

E.2.

The values to derive gross revenue and the operating costs for each alternative were derived from the baseline MB costs compared to the costs of changes under two fumigation scenarios in the Southeastern States: 1) metam sodium; and 2) 1,3-d + chloropicrin.

For California, the baseline MB costs were compared to two scenarios: 1) 1,3-d + metam sodium; and 2) 1,3-d + chloropicrin. The differences in the cost of production were primarily attributable to changes in fumigation costs.

One of the issues facing nursery growers is that pest infestation can wipe out production for the season. If there are quality concerns such as disease, weeds, or insect infestation, nursery growers will not be able to market their seedlings. Fruit producers are not willing to purchase plants that have any visual symptoms of disease and may hold the nursery responsible for any disease that shows up during fruiting in the field in the first weeks after planting. A small amount of contamination in nursery stock could be multiplied many times in strawberry fruit production. Nearly a billion plants are produced by the California strawberry nursery system alone each year and this production is distributed world-wide. There are approximately 13 seedling/runner producers in California that must manage disease incidence over the 4 year production cycle of the strawberry stock.

PART F. FUTURE PLANS

23. WHAT ACTIONS WILL BE TAKEN TO RAPIDLY DEVELOP AND DEPLOY ALTERNATIVES FOR THIS CROP?

Results of ongoing research suggest that there are treatments for strawberry nurseries that have the potential to replace MB in the future. However, because nursery stock is so important to the strawberry fruit industry, effective alternatives will be difficult to identify. The industry supports research to identify the most effective methods to treat soil, and as noted, some are promising (e.g., Kabir et al., 2003). After possibly five years of research trials, scale-up trials on a commercial level will be done to confirm the most effective treatments found in research trials. Combinations of several chemical and non-chemical controls are likely to be the most effective alternative to MB.

The amount of MB requested for research purposes is considered critical for the development of effective alternatives. Without MB for use as a standard treatment, the research studies can never address the comparative performance of alternatives. This would be a serious impediment to the development of alternative strategies. The U.S. government estimated that strawberry nurseries research will require 454 kg per year of MB for 2005 and 2006. This figure will be revised for use after that time. That amount of MB is necessary to conduct research on alternatives and is in addition to the amounts requested in the submitted CUE applications. One example of the research is a three year study testing the comparative performance of MB, alternative fumigants, preplant fungicide dips, post plant fungicides, germplasm, microbial inoculants, and cultural practices.

24. HOW DO YOU PLAN TO MINIMIZE THE USE OF METHYL BROMIDE FOR THE CRITICAL USE IN THE FUTURE?

As described in Section 23.

25. ADDITIONAL COMMENTS ON THE NOMINATION?

The MB critical use exemption nomination for Strawberry Nurseries has been reviewed by the U. S. Environmental Protection Agency and the U. S. Department of Agriculture and meets the guidelines of The *Montreal Protocol on Substances That Deplete the Ozone Layer*. This use is considered critical because there are conditions in some nurseries within this sector with high pest pressure where no feasible alternatives or substitutes are currently effective. While some alternatives appear to offer an alternative to MB for some pests in some research trials, the high production nursery industry demands a consistent and reliable pre-plant fumigation treatment that can allow production goals to be met. Currently MB is the only consistent provider of this requirement. The loss of MB, therefore, would result in a significant market disruption. The effort to avoid market disruption provides the basis for nomination of this sector for critical use exemption of MB.

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APPENDIX A. 2007 Methyl Bromide Usage Numerical Index (BUNI).

Methyl Bromide Critical Use Exemption Process

2007 Methyl Bromide Usage Numerical Index (BUNI)

Date: 1/28/2005

Sector: STRAWBERRY NURSERY

Average Hectares in the US: Not Available

% of Average Hectares Requested: Not Available

	2007 Amount of Request			2001 & 2002 Average Use*				Regional Hectares**		
REGION	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	Quarantine and Pre-Shipment	2001 & 2002 Average	Requested %	Research Amount (kgs)
CALIFORNIA	137,464	522	263	365,045	1,386	263	99%	Not Available		454
SOUTHEASTERN US	43,292	105	413	28,499	69	413	89%			
TOTAL OR AVERAGE	180,756	627	288	393,544	1,455	270	94%			

2007 Nomination Options	Subtractions from Requested Amounts (kgs)					Combined Impacts Adjustment (kgs)		MOST LIKELY IMPACT VALUE		
REGION	2007 Request	(-) Double Counting	(-) Growth*	(-) Use Rate Adjustment	(-) QPS	HIGH	LOW	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)
CALIFORNIA	137,464	-	-	-	136,089	1,375	1,375	1,375	5	263
SOUTHEASTERN US	43,292	-	14,793	4,370	21,475	2,654	2,654	2,654	8	350
Nomination Amount	180,756	180,756	165,963	161,593	4,029	4,029	4,029	4,029	13	315
% Reduction from Initial Request	0%	0%	8%	11%	98%	98%	98%	98%	98%	-9%

Adjustments to Requested Amounts	Use Rate (kg/ha)		(%) Karst (Telone)		(%) 100 ft Buffer Zones		(%) Key Pest Distribution		Regulatory Issues (%)		Unsuitable Terrain (%)		Cold Soil Temp (%)		Combined Impacts (%)	
REGION	Low	EPA	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	HIGH	LOW
CALIFORNIA	263	263	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
SOUTHEASTERN US	413	350	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%

Other Considerations	Dichotomous Variables (Y/N)					Other Issues			Economic Analysis					
REGION	Strip Bed Treatment	Currently Use Alternatives?	Research / Transition Plans	Tarps / Deep Injection Used	Pest-free Cert. Requirement	Change from Prior CUE Request (+/-)	Verified Historic MeBr Use / State	Frequency of Treatment	Loss per Hectare (US$/ha)	Loss per Kilogram of MeBr (US$/kg)	Loss as a % of Gross Revenue	Loss as a % of Net Revenue	Quality/ Time/ Market Window/ Yield Loss (%)	Marginal Strategy
CALIFORNIA	No	Yes	Yes	Tarp	Yes	+	Yes	2~5 years	$ 4,606	$ 17	10%	46%	10%	1,3-D + Pic
SOUTHEASTERN US	No	Yes	Yes	Tarp	Yes	+	Yes	2~5 years	$ 5,469	$ 13	13%	46%	10%	1,3-D + Pic

* Growth calculated after subtracting QPS

Conversion Units: 1 Pound = 0.453592 Kilograms; 1 Acre = 0.404686 Hectare

Most Likely Impact Value: High 24% Low 77%

Footnotes for Appendix A:

Values may not sum exactly due to rounding.

1. **Average Hectares in the US** – Average Hectares in the US is the average of 2001 and 2002 total hectares in the US in this crop when available. These figures were obtained from the USDA National Agricultural Statistics Service.
2. **% of Average Hectares Requested** - Percent (%) of Average Hectares Requested is the total area in the sector's request divided by the Average Hectares in the US. Note, however, that the NASS categories do not always correspond one to one with the sector nominations in the U.S. CUE nomination (e.g., roma and cherry tomatoes were included in the applicant's request, but were not included in NASS surveys). Values greater than 100 percent are due to the inclusion of these varieties in the U.S. CUE request that were not included in the USDA NASS: nevertheless, these numbers are often instructive in assessing the requested coverage of applications received from growers.
3. **2006 Amount of Request** – The 2006 amount of request is the actual amount requested by applicants given in total pounds active ingredient of methyl bromide, total acres of methyl bromide use, and application rate in pounds active ingredient of methyl bromide per acre. U.S. units of measure were used to describe the initial request and then were converted to metric units to calculate the amount of the US nomination.
4. **2001 & 2002 Average Use** – The 2001 & 2002 Average Use is the average of the 2001 and 2002 historical usage figures provided by the applicants given in total pounds active ingredient of methyl bromide, total acres of methyl bromide use, and application rate in pounds active ingredient of methyl bromide per acre. Adjustments are made when necessary due in part to unavailable 2002 estimates in which case only the 2001 average use figure is used.
5. **Quarantine and Pre-Shipment** – Quarantine and pre-shipment (QPS) hectares is the percentage (%) of the applicant's request subject to QPS treatments.
6. **Regional Hectares, 2001 & 2002 Average Hectares** – Regional Hectares, 2001 & 2002 Average Hectares is the 2001 and 2002 average estimate of hectares within the defined region. These figures are taken from various sources to ensure an accurate estimate. The sources are from the USDA National Agricultural Statistics Service and from other governmental sources such as the Georgia Acreage estimates.
7. **Regional Hectares, Requested Acreage %** - Regional Hectares, Requested Acreage % is the area in the applicant's request divided by the total area planted in that crop in the region covered by the request as found in the USDA National Agricultural Statistics Service (NASS). Note, however, that the NASS categories do not always correspond one to one with the sector nominations in the U.S. CUE nomination (e.g., roma and cherry tomatoes were included in the applicant's request, but were not included in NASS surveys). Values greater than 100 percent are due to the inclusion of these varieties in the U.S. CUE request that were not included in the USDA NASS: nevertheless, these numbers are often instructive in assessing the requested coverage of applications received from growers.
8. **2006 Nomination Options** – 2006 Nomination Options are the options of the inclusion of various factors used to adjust the initial applicant request into the nomination figure.
9. **Subtractions from Requested Amounts** – Subtractions from Requested Amounts are the elements that were subtracted from the initial request amount.
10. **Subtractions from Requested Amounts, 2006 Request** – Subtractions from Requested Amounts, 2006 Request is the starting point for all calculations. This is the amount of the applicant request in kilograms.
11. **Subtractions from Requested Amounts, Double Counting** - Subtractions from Requested Amounts, Double Counting is the estimate measured in kilograms in situations where an applicant has made a request for a CUE with an individual application while their consortium has also made a request for a CUE on their behalf in the consortium application. In these cases the double counting is removed from the consortium application and the individual application takes precedence.
12. **Subtractions from Requested Amounts, Growth or 2002 CUE Comparison** - Subtractions from Requested Amounts, Growth or 2002 CUE Comparison is the greatest reduction of the estimate measured in kilograms of either the difference in the amount of methyl bromide requested by the applicant that is greater than that historically used or treated at a higher use rate or the difference in the 2006 request from an applicant's 2002 CUE application compared with the 2006 request from the applicant's 2003 CUE application.
13. **Subtractions from Requested Amounts, QPS** - Subtractions from Requested Amounts, QPS is the estimate measured in kilograms of the request subject to QPS treatments. This subtraction estimate is calculated as the 2006 Request minus Double Counting, minus Growth or 2002 CUE Comparison then

multiplied by the percentage subject to QPS treatments. *Subtraction from Requested Amounts, QPS = (2006 Request – Double Counting – Growth)*(QPS %)*

14. **Subtraction from Requested Amounts, Use Rate Difference** – Subtractions from requested amounts, use rate difference is the estimate measured in kilograms of the lower of the historic use rate or the requested use rate. The subtraction estimate is calculated as the 2006 Request minus Double Counting, minus Growth or 2002 CUE Comparison, minus the QPS amount, if applicable, minus the difference between the requested use rate and the lowest use rate applied to the remaining hectares.
15. **Adjustments to Requested Amounts** – Adjustments to requested amounts were factors that reduced to total amount of methyl bromide requested by factoring in the specific situations were the applicant could use alternatives to methyl bromide. These are calculated as proportions of the total request. We have tried to make the adjustment to the requested amounts in the most appropriate category when the adjustment could fall into more than one category.
16. **(%) Karst topography** – Percent karst topography is the proportion of the land area in a nomination that is characterized by karst formations. In these areas, the groundwater can easily become contaminated by pesticides or their residues. Regulations are often in place to control the use of pesticide of concern. Dade County, Florida, has a ban on the use of 1,3D due to its karst topography.
17. **(%) 100 ft Buffer Zones** – Percentage of the acreage of a field where certain alternatives to methyl bromide cannot be used due the requirement that a 100 foot buffer be maintained between the application site and any inhabited structure.
18. **(%) Key Pest Impacts** - Percent (%) of the requested area with moderate to severe pest problems. Key pests are those that are not adequately controlled by MB alternatives. For example, the key pest in Michigan peppers, *Phytophthora* spp. infests approximately 30% of the vegetable growing area. In southern states the key pest in peppers is nutsedge.
19. **Regulatory Issues (%)** - Regulatory issues (%) is the percent (%) of the requested area where alternatives cannot be legally used (e.g., township caps) pursuant to state and local limits on their use.
20. **Unsuitable Terrain (%)** – Unsuitable terrain (%) is the percent (%) of the requested area where alternatives cannot be used due to soil type (e.g., heavy clay soils may not show adequate performance) or terrain configuration, such as hilly terrain. Where the use of alternatives poses application and coverage problems.
21. **Cold Soil Temperatures** – Cold soil temperatures is the proportion of the requested acreage where soil temperatures remain too low to enable the use of methyl bromide alternatives and still have sufficient time to produce the normal (one or two) number of crops per season or to allow harvest sufficiently early to obtain the high prices prevailing in the local market at the beginning of the season.
22. **Combined Impacts (%)** - Total combined impacts are the percent (%) of the requested area where alternatives cannot be used due to key pest, regulatory, soil impacts, temperature, etc. In each case the total area impacted is the conjoined area that is impacted by any individual impact. The effects were assumed to be independently distributed unless contrary evidence was available (e.g., affects are known to be mutually exclusive). For example, if 50% of the requested area had moderate to severe key pest pressure and 50% of the requested area had karst topography, then 75% of the area was assumed to require methyl bromide rather than the alternative. This was calculated as follows: 50% affected by key pests and an additional 25% (50% of 50%) affected by karst topography.
23. **Qualifying Area** - Qualifying area (ha) is calculated by multiplying the adjusted hectares by the combined impacts.
24. **Use Rate** - Use rate is the lower of requested use rate for 2006 or the historic average use rate.
25. **CUE Nominated amount** - CUE nominated amount is calculated by multiplying the qualifying area by the use rate.
26. **Percent Reduction** - Percent reduction from initial request is the percentage of the initial request that did not qualify for the CUE nomination.
27. **Sum of CUE Nominations in Sector** - Self-explanatory.
28. **Total US Sector Nomination** - Total U.S. sector nomination is the most likely estimate of the amount needed in that sector.
29. **Dichotomous Variables** – dichotomous variables are those which take one of two values, for example, 0 or 1, yes or no. These variables were used to categorize the uses during the preparation of the nomination.
30. **Strip Bed Treatment** – Strip bed treatment is ‘yes’ if the applicant uses such treatment, no otherwise.
31. **Currently Use Alternatives** – Currently use alternatives is ‘yes’ if the applicant uses alternatives for some portion of pesticide use on the crop for which an application to use methyl bromide is made.

32. **Research/ Transition Plans** – Research/ Transition Plans is 'yes' when the applicant has indicated that there is research underway to test alternatives or if applicant has a plan to transition to alternatives.
33. **Tarps/ Deep Injection Used –** Because all pre-plant methyl bromide use in the US is either with tarps or by deep injection, this variable takes on the value 'tarp' when tarps are used and 'deep' when deep injection is used.
34. **Pest-free cert. Required** - This variable is a 'yes' when the product must be certified as 'pest-free' in order to be sold
35. **Other Issues**.- Other issues is a short reminder of other elements of an application that were checked
36. **Change from Prior CUE Request**- This variable takes a '+' if the current request is larger than the previous request, a '0' if the current request is equal to the previous request, and a '-' if the current request is smaller that the previous request.
37. **Verified Historic Use/ State**- This item indicates whether the amounts requested by administrative area have been compared to records of historic use in that area.
38. **Frequency of Treatment** – This indicates how often methyl bromide is applied in the sector. Frequency varies from multiple times per year to once in several decades.
39. **Economic Analysis** – provides summary economic information for the applications.
40. **Loss per Hectare** – This measures the total loss per hectare when a specific alternative is used in place of methyl bromide. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars.
41. **Loss per Kilogram of Methyl Bromide** – This measures the total loss per kilogram of methyl bromide when it is replaced with an alternative. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars.
42. **Loss as a % of Gross revenue** – This measures the loss as a proportion of gross (total) revenue. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars.
43. **Loss as a % of Net Operating Revenue** -This measures loss as a proportion of total revenue minus operating costs. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars. This item is also called net cash returns.
44. **Quality/ Time/ Market Window/Yield Loss (%)** – When this measure is available it measures the sum of losses including quality losses, non-productive time, missed market windows and other yield losses when using the marginal strategy.
45. **Marginal Strategy** -This is the strategy that a particular methyl bromide user would use if not permitted to use methyl bromide.