METHYL BROMIDE CRITICAL USE NOMINATION FOR PREPLANT SOIL USE FOR STRAWBERRIES GROWN FOR FRUIT IN OPEN FIELDS ON PLASTIC TARPS

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 STRAWBERRIES GROWN FOR FRUIT IN OPEN FIELDS ON PLASTIC TARPS

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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

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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 Strawberries Grown for Fruit in Open Fields On Plastic Tarps

3. CROP AND SUMMARY OF CROP SYSTEM

This nomination covers methyl bromide use in three major strawberry production areas—California, Florida, and states in the Eastern US (Alabama, Arkansas, Georgia, Illinois, Kentucky, Louisiana, Maryland, New Jersey, North Carolina, Ohio, South Carolina, Tennessee, West Virginia and Virginia).

California. California produces more than 80 percent of the fresh market and processed strawberries grown in the U.S. California produces about 20 percent of the world's strawberries. Most strawberries exported from California go to Canada, Japan, and Mexico.

California has two distinct strawberry production areas. The southern region produces both fresh (63 percent) and processed (37 percent) strawberries. The northern region includes both rotated and non-rotated strawberry production regimes, with each producing fresh (84 percent) and processed (16 percent) strawberries. The majority of growers are farming between 4 and 20 hectares of land with strawberry fields in rotation. Because strawberry production in California is concentrated in a small geographic location due to optimal growing conditions, factors that affect this small area can be significant. An example of this, which is discussed later in this chapter, is the regulatory limit on the amount of 1,3-dichloropropene (Telone) that can be used in each township (i.e., 36 square mile area, approximately 95 square km) in California.

Depending on the region, California strawberries are planted in the Summer or Fall. Prior to planting, fumigation is typically performed on flat ground over the entire surface of the field. Immediately after fumigation the field is covered with plastic. At the end of the fumigation period, the plastic is removed and planting beds are formed and covered with fresh plastic. Strawberry plants are transplanted about two weeks after fumigation to ensure that no phytotoxic levels of methyl bromide remain. Harvest begins about 2 to 3 months later. At the end of the first harvest, the strawberry plants are removed and the field is readied for the next crop. Rotational crops that are planted after strawberries, and that benefit from the previous use of methyl bromide include broccoli, celery, lettuce, radish, leeks, and artichokes.

Florida. Florida is the second largest strawberry producing state with 12 percent of the total U.S. production. Nearly all of the domestically produced strawberries harvested in the winter are grown in Florida.

Strawberries are grown as an annual crop in Florida using a raised-bed system. Methyl bromide in combination with chloropicrin is applied to the soil during construction of the raised-beds approximately two weeks prior to planting transplants. Immediately after application, the bed is covered with plastic mulch. Drip or overhead irrigation is used to help establish plants, irrigate plants, and to protect the plants from frost. Many strawberry growers utilize the beds and drip tubes to grow a second crop, such as cucurbits or solanaceous crops.

Eastern U.S. The Eastern U.S. strawberry industry is highly de-centralized and primarily consists of small family farms with several hectares of strawberries that are directly marketed through U-pick, ready-pick, roadside stands, and farmers markets

Strawberry production in the eastern states differs from that in Florida because of soils type (Florida typically has sandy soils; eastern soils are heavier); topography (Florida has much karst topography; much less common in other states), climate (very mild winters in Florida), farm size (farms are larger in Florida), and marketing practices (Florida is typically commercial compared to small U-pick operations) In the Eastern U.S., the vast majority of the strawberry farms use an annual cropping plasti-culture production system where the berries are grown on raised beds similar to Florida strawberry production. Planting time is similar to Florida, but the production peak occurs later in the season, between April and May. About 50 percent of the soils have textures finer than sandy loam. Nutsedge is a primary pest on about 40 percent of the land that typically has coarse-textured soils. Some double cropping of beds occurs.

4. Methyl Bromide Nominated

Table 4.1: Methyl Bromide Nominated

Year	Nomination Amount (kg)	Nomination Area (ha)
2006	**1,615,339**	**8,680**

5. Brief Summary of the Need for Methyl Bromide as a Critical Use

The US nomination is only for those areas where the alternatives are not suitable. In US strawberry fruit 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 strawberry fruit production.
- geographic distribution of key target pests: i.e., some alternatives may be comparable to methyl bromide as long as key pests occur at low pressure, and in such cases the US is only nominating a CUE for strawberry fruit where the key pest pressure is moderate to high such as nutsedge in the Southeastern US.
- regulatory constraints: e.g., telone use is limited in California due to townships caps and in Florida due to the presence of karst geology.
- delay in planting and harvesting: e.g., the plant-back interval for telone+chloropicrin is two weeks longer than methyl bromide+chloropicrin. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.

- unsuitable topography: e.g., alternatives that must be applied with drip irrigation may not be suitable in areas with rolling or sloped topography due to uneven distribution of the fumigant.

The United States (U.S.) nomination for strawberry fruit-field is a critical need for an amount of methyl bromide (MB) in areas with moderate to severe pest pressure, because currently there are no feasible alternatives and farmers would face severe economic hardships in the absence of MB. Where there is moderate to severe pest pressure, the suggested alternatives for strawberry fruit production fail to provide the necessary degree of pest control or their use is not easily adoptable due to state-imposed restrictions. The nomination also notes that applying alternatives is further complicated when plant-back restrictions prevent farmers from meeting marketing windows (e.g., winter or early spring) when strawberry sale prices are as much as 100% higher than during the rest of the year (see Market Window Information). The nomination notes significant progress in adopting emission reduction technologies and changing formulations and application rates to reduce MB dosage rates to some of the lowest in the world, and that further trials are being conducted to evaluate new alternatives, and to test ways of overcoming constraints in further lowering MB formulations and adopting even more impermeable barriers.

TABLE A.1: EXECUTIVE SUMMARY

Region		*California*	*Eastern US*	*Florida*
AMOUNT OF NOMINATION				
2006	**Kilograms**	1,086,777	230,332	295,853
	Application Rate (kg/ha)	196	151	185
	Area (ha)	5,552	1,528	1,600
AMOUNT OF APPLICANT REQUEST				
2006	**Kilograms**	1,632,931	350,534	579,691
	Application Rate (kg/ha)	202	151	202
	Area (ha)	8,094	2,317	2,873
ECONOMICS FOR NEXT BEST ALTERNATIVE				
Marginal Strategy		1,3-D+PIC	1,3-D+PIC	1,3-D+PIC
Yield Loss (%)		14	14	25
Loss per hectare (US$/ha)		11,817	9,319	14,447
Loss per kg Methyl Bromide (US$/kg)		58.57	62.05	77.72
Loss as % of Gross Revenue (%)		16	18	20
Loss as % of Net Revenue (%)		87	42	52

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

Despite use of many alternatives, many of which have already been incorporated into standard strawberry production systems, methyl bromide is believed to be the only currently available treatment that consistently provides reliable control of nutsedge species, nematodes and the disease complex affecting strawberry production. Only acreage with moderate to high pest pressure is included in this nomination.

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

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 (%)
California	11,109	74
Eastern US	Not available	Not available
Florida	2,873	94
NATIONAL TOTAL*:	19,486	65

* National total includes other regions not requesting methyl bromide.

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.

- California has requested enough methyl bromide to treat about 75-85% of the state's strawberry crop with methyl bromide.
- Southeastern states consortium claims that 90% of the total acreage grown in this area is treated with methyl bromide.
- Total acreage grown is 6900 acres and Florida has requested 7100 acres to be treated with methyl bromide.

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?

California has proposed to rigorously test alternatives and is committed to finding alternatives to methyl bromide. The other regions have not proposed reduction in use, however, these regions use significantly less methyl bromide than does California.

8. Amount of Methyl Bromide Requested for Critical Use

California - Table 8.1: Amount of Methyl Bromide Requested for Critical Use

Region: California	**California**
Year of Exemption Request	**2006**
Kilograms of Methyl Bromide	1,632,931
Use: Flat Fumigation or Strip/Bed Treatment	Flat Fumigation
Formulation *(ratio of methyl bromide/chloropicrin mixture)* to be used for the CUE	
Total Area to be treated with the methyl bromide or methyl bromide/Chloropicrin formulation *(m^2 or ha)*	8,094
Application rate* (kg/ha) for the **active ingredient**	202
Dosage rate* (g/m^2) of **active ingredient** used to calculate requested kilograms of methyl bromide	
Application rate* *(kg/ha)* for the **formulation**	
Dosage rate* *(g/m^2)* of **formulation** used to calculate requested kilograms of methyl bromide	

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

Eastern US - Table 8.2: Amount of Methyl Bromide Requested for Critical Use

Region: EASTERN UNITED States	**Eastern U. S.**
Year of Exemption Request	**2006**
Kilograms of Methyl Bromide	350,534
Use: Flat Fumigation or Strip/Bed Treatment	Bed
Formulation *(ratio of methyl bromide/Chloropicrin mixture)* to be used for the CUE	67:33
Total Area to be treated with the methyl bromide or methyl bromide/Chloropicrin formulation *(m^2 or ha)*	2,317
Application rate* (kg/ha) for the **active ingredient**	151
Dosage rate* (g/m^2) of **active ingredient** used to calculate requested kilograms of methyl bromide	30.2
Application rate* *(kg/ha)* for the **formulation**	151
Dosage rate* *(g/m^2)* of **formulation** used to calculate requested kg of methyl bromide	15

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

FLORIDA - TABLE 8.3: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION: FLORIDA	**Florida**
YEAR OF EXEMPTION REQUEST	**2006**
KILOGRAMS OF METHYL BROMIDE	579,691
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT*	Bed
FORMULATION *(ratio of methyl bromide/Chloropicrin mixture)* TO BE USED FOR THE CUE**	98:2
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(m^2 or ha)*	2,873
APPLICATION RATE* (KG/HA) FOR THE **ACTIVE INGREDIENT**	202
DOSAGE RATE* (G/M^2) OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	14
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	206
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	142

** Florida states maximum bed width is 3 feet with 10,100 linear bed feet/acre, which totals 69% of acre treated.*
*** Florida states that growers use 98:2 formulation for sting nematode control.*

9. SUMMARIZE ASSUMPTIONS USED TO CALCULATE METHYL BROMIDE QUANTITY NOMINATED FOR EACH REGION

The amount of methyl bromide nominated by the US 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 three applicants that included growth in their request had the growth amount removed.
- Quarantine and pre-shipment (QPS) hectares is the area in the applicant's request subject to QPS treatments. Not applicable in this sector.
- 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 topography, buffer zones, and unsuitable terrain.

TABLE A.2: 2006 SECTOR NOMINATION – STRAWBERRIES*

2006 Strawberries Sector Nomination		California	Eastern US	Florida
Applicant Request for 2006	Requested Hectares (ha)	8,094	2,317	2,873
	Requested Application Rate (kg/ha)	202	151	202
	Requested Kilograms (kg)	1,632,931	350,534	579,691
CUE Nominated for 2006*	Nominated Hectares (ha)	5,552	1,528	1,600
	Nominated Application Rate (kg/ha)	196	151	185
	Nominated Kilograms (kg)	1,086,777	230,332	295,853

2006 Sector Nomination Totals	Overall Reduction (%)	37
	2006 U. S. CUE Nomination (kg)	1,612,962
	Research Amount (kg)	2,377
	Total 2006 U.S. Sector Nominated Kilograms (kg)	**1,615,339**

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

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 IS NEEDED
California	Diseases: Black root rot *(Rhizoctinia* and *Pythium* spp.), crown rot (*Phytophthora cactorum*),	At moderate to severe pest pressure only MB can effectively control the target pests found in California. Uses of alternatives are limited by regulatory restrictions such as the township caps on the amount of 1,3-dichloropropene that can be used. MB applications in strawberries are typically made using 67:33 or, where feasible, 57:43 mixtures with chloropicrin under plastic mulch. Related dosage rates of 202 kg/ha are below the threshold in the MBTOC 2002 Report, making further reduction difficult to achieve without compromising pest management.
California	Nematodes: root knot nematode (*Meloidogyne* spp.) Sting nematode (*Belonolaimus* spp.)	
California	Weeds: Yellow nutsedge (*Cyperus esculentus*), purple nutsedge (*Cyperus rotundus*), ryegrass, and winter annual weeds.	

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)*	Fruiting plants grown from transplants
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Cultured as annual
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Vegetables (e.g. broccoli, celery, lettuce, radish, leeks, cauliflower, artichokes)
SOIL TYPES: *(Sand, loam, clay, etc.)*	Light and medium soils
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Yearly
OTHER RELEVANT FACTORS:	None Identified

CALIFORNIA - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN
CLIMATIC ZONE	9 B											
RAINFALL *(mm)*	trace	1.0	trace	0	44.7	56.9	9.9	30.5	16	72.1	17.3	0
OUTSIDE TEMP. *(℃)**	30.3	27.4	25.1	18.4	13.4	9.6	10.3	10.6	14.4	14.8	20.8	25.7
FUMIGATION SCHEDULE		X										
PLANTING IN NORTH**			X	X								
PLANTING IN SOUTH**	X											

*For Fresno, California.

** In Northern California the crop is planted in September/October and harvested from December through June/July. In Southern California the crop is planted in the summer, generally in July, and harvested from September thru December. The rotational crop, often celery, is grown from March thru May. Average farm size in this area is about 30 acres, 100% of which is treated. Rotational crops include lettuce, celery, and broccoli. In Northern California planting occurs in October/November and harvesting occurs from April thru October; average farm size is 60 acres; rotational crops include lettuce, strawberries, broccoli and cauliflower.

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

To the best of our knowledge none of the following characteristics of the cropping system would affect adoption of a relevant alternative. The US believes that the Telone township caps prevent the further adoption of Telone as an alternative.

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:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	6,808	7,401	8,600	8,248	8,456	7,912
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	All Flat Fumigation					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	1,833,235	1,928,597	2,264,789	1.919,240	1,611,775	1,592,156
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*	Typically 67:33					
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Shank injected 25 to 30 cm deep					
APPLICATION RATE OF FORMULATIONS IN kg/ha*	269	260	275	244	191	201
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	26.9	26	27.5	24.4	19.1	20.1

** 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, CALIFORNIA – 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		
1,3-D Dichloropropene (1,3-D, Telone)	Used alone, 1,3- Dichloropropene does not adequately control diseases and weeds. Buffer zones of 100 feet are too constraining for small fields. Required Protective equipment (protective suits) pose a health risk to workers in hot and humid weather. Long pre-planting intervals affect cultivar selection, Integrated Pest Management practices, timing of harvest, marketing window options, land leasing decisions and crop rotation schedules. In CA, states regulations require township caps, which limits use of 1,3- Dichloropropene.	No
Basamid	Basamid is not registered in the U.S. for strawberry fruit production.	No
Chloropicrin	Chloropicrin alone is not a technically feasible alternative because it provides poor nematode and weed control, although it provides good disease control	No
Metam sodium	Metam-sodium alone is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control. Metam sodium suffers from erratic efficacy most likely due to irregular distribution of the product through soil. Metam sodium if not technically feasible in California because it has limited activity against soilborne pathogens in strawberry fields.	No
Metam sodium, chloropicrin	Metam-sodium with chloropicrin is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control.	No
Methyl iodide	Promising, but it is not currently registered in the U.S. for strawberry fruit production.	No
Nematicides	Addressed individually (e.g., 1,3-D).	No
Ozone	Ozone is not technically feasible alone because it doesn't control diseases and weeds.	No
NON CHEMICAL ALTERNATIVES		

Biofumigation	Biofumigation is not technically feasible because of the quantity of Brassica crop that would be needed to control target pests in strawberries (approximately three hectares would be required for every hectare of strawberry production). Incorporation of Brassica at these levels is likely to have allelopathic effects on the target crop. In addition, field trials growing tomatoes in cabbage residue produced inconsistent and inadequate efficacy, and poor yield in two years out of three.	No
Solarization	Solarization, when used alone for pre-plant fumigation, is not technically feasible because it does not provide adequate control of a wide range of soil-borne diseases and pests. This process is highly weather dependent and works best in combination with IPM for control of pests and diseases.	No
Steam	Although practiced successfully in greenhouse situations, fumigation with steam, when used alone in the field for pre-plant fumigation, is not operationally practical due to low application speeds and high energy requirements (1-3 weeks to treat one hectare). In addition results from field experiments steam treatment have been erratic.	No
Biological Control	Biological control is not technically feasible as a stand alone replacement for methyl bromide because it does not provide adequate control of target pests.	No
Cover Crops and Mulching	Although already in use as part of an Integrated Pest Management Program, cover crops and mulching alone do not provide adequate control of the target pests.	No
Crop rotation/fallow	Crop rotation is already being used in many strawberry production areas, but does not adequately control the target pests.	No
Flooding and water management	Flooding and water management are not feasible due to limited water resources, uneven topography in California, and in the eastern states by sandy soil types that would not retain the flood for an adequate time to control the pests.	No
General IPM	General IPM is already practiced in strawberry production, but it is not technically feasible as a stand-alone replacement for methyl bromide since a combination of IPM methods do not offer adequate pest control by itself.	No
Grafting/Resistant rootstock/plant breeding	Grafting/resistant rootstock/plant breeding is not being used and it is not technically feasible because grafting is not possible given the physical characteristics of strawberry plants. Breeding for resistance to pathogens is valuable as a long-term endeavor and the U.S. continues work in this area. At this point in time, plant breeding has not resulted in a cultivar that is sufficiently resistant to the major target pests.	No
Organic Amendments/Compost	Organic Amendments/Compost is already being used in certain regions of the U.S., but is not technically feasible as a stand-alone replacement for methyl bromide.	No
Organic production	In certain regions of the U.S. some organic production of strawberries occurs. However, as a stand alone replacement for methyl bromide it is not technically feasible because of reduced yields.	No
Resistant cultivars	Resistant cultivars are already being used in certain regions of the U.S., but it is not technically feasible as a stand-alone replacement for methyl bromide.	No

Soil-less culture	Soil-less 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.	No
Substrates/Plug plants	Substrates/plant plugs are currently being used but are not technically feasible as a stand-alone replacement for methyl bromide. Although plug plants have actually proven to be more vigorous than bare root transplants in research trials, it is not known to what extent pathogens are controlled by this method. Weed control would still be an issue. And adopting this use would also require major retooling of the industry.	No
Hand-weeding	Hand-weeding not listed as a standard option. Hand-weeding strawberries is not a desirable practice for controlling weeds because they cannot be removed without damaging the plastic and thereby reducing its effectiveness in excluding weeds, insects, and pathogens.	No
COMBINATIONS OF ALTERNATIVES		
1,3-Dichloropropene/ Chloropicrin	This combination is considered technically feasible as an alternative in certain circumstances. Together they provide good nematicidal and fungicidal capabilities, but would still require a herbicide partner to control weeds. Regulatory restrictions for each of the chemicals may further limit their use.	No, in areas with moderate to severe pest infestation and if not allowed by local regulations.
1,3-Dichloropropene/ Chloropicrin and Metam sodium	These combinations also provide good nematicidal and fungicidal capabilities, but would still require a herbicide partner to control weeds.	No, in areas with moderate to severe pest infestation and if not allowed by local regulations.
Basamid + Chloropicrin	Basamid is not registered in the U.S. for strawberry fruit production.	No

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

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

NAME OF ALTERNATIVE	DISCUSSION
1,3-Dichloropropene	Drip application of 1,3-D in California, are less expensive and require smaller buffer zones than broadcast applications, making it the preferred application method for this alternative (drip, 90%; broadcast, 10%). However, when 1,3-D fumigations by drip are used other production costs are significantly higher due to the need for herbicide applications (i.e. metam sodium) and hand weeding operations. Recent studies in California found that fruit production costs were 20-212% higher than with methyl bromide/chloropicrin (Goldhue), with the smaller cost estimates coming from VIF mulch treatments that are not currently usable due to regulatory and technical issues.

Chloropicrin	Chloropicrin alone is not a technically feasible alternative because it provides poor nematode and weed control, although it provides good disease control
Metam sodium	Metam-sodium alone is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control. Metam sodium suffers from erratic efficacy most likely due to irregular distribution of the product through soil. Metam sodium if not technically feasible in California because it has limited activity against soilborne pathogens in strawberry fields.
Sodium azide	Does not sterilize ground. Yields equal to untreated.
1,3D/chloropicrin	This combination is considered technically feasible as an alternative in certain circumstances. Together they provide good nematicidal and fungicidal capabilities, but would still require a herbicide partner to control weeds. Regulatory restrictions for each of the chemicals may further limit their use.

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	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Basamid	Not registered for use in U.S.	Y	Unknown
Methyl Iodide	Not registered for use in U.S.	Y	Unknown
Propargyl bromide	Registration in US has not yet been requested.	N	Unknown
Sodium azide	Registration in US has not yet been requested.	N	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

California – Table 16.1: Effectiveness of Alternatives – Key Pest 1 Yellow Nutsedge

Key Pest: Key Pest 1	Average disease % or rating and yields in past 3~5 years		
Methyl Bromide formulations and Alternatives	# of Trials	Actual Yields (t/ha)	Citation
MBR: Chloropicrin (67:33) 200 lb Telone: chloropicrin 17.5 gal. drip Chloropicrin EC 100 lb drip Metam sodium 35 gal drip	1	lb/A 14109 15551 14613 15117 (N.S.)	Ferguson, 2001
MBR: Chloropicrin 390kg/ha Telone + 35% chloropicrin (327 L) Telone + 17% chloropicrin (327 L) Metam sodium (300L) Metam NA + chloropicrin (300L +170 kg) Solarization (painted black)	1 of 2	flats/ha 4131 (a) 3541 (ab) 3620 (ab) 2552 (bcd) 2199 (cd) 2710 (bcd)	Locascio, 1999
MBR: Chloropicrin 390kg/ha Telone + 35% chloropicrin (327 L) Telone + 17% chloropicrin (327 L) Metam NA + chloropicrin (300L +170 kg) Metam sodium (300L) Solarization (painted black)	2 of 2	flats/ha 3511 (ab) 3553 (ab) 3333 (ab) 3279 (ab) 2933 (bc) 3210 (b)	Locascio, 1999

California – Table 16.2: Effectiveness of Alternatives – Multiple Pests

EFFECTS OF SOIL FUMIGATION WITH METHYL BROMIDE/CHLOROPICRIN (MB/CP) VS. DICHLOROPROPENE/CHLOROPICRIN (DP/CP) ON YIELDS (GRAMS/PLANT) OF STRAWBERRY IN 10 STUDIES (FROM SHAW AND LARSON 1999).

Study	No Reps.	MB:CP treated		DP:CP treated		Percent Increase[z]	t[y]	p[y]	d[y]
		Mean Yield	SD	Mean Yield	SD				
2	6	992	177	856	109	15.9	1.60	0.070	0.93
5	6	1331	40	1046	55	27.2	10.27	<0.001	5.93
7	5	1096	110	687	62	59.5	6.76	<0.001	4.28
21	6	886	71	914	48	-2.9	-0.78	0.727	-0.45
31	4	655	65	647	54	1.0	0.15	0.443	0.11
58	6	871	56	836	11	4.3	1.52	0.077	0.88
64	36	1381	146	1180	185	17.0	5.12	<0.001	1.21
65	10	1742	131	1489	141	17.0	4.16	<0.001	1.86
66	6	994	88	981	97	1.3	0.37	0.355	0.15
67	4	610	46	591	46	3.2	0.58	0.291	0.41

[z] Unweighted percent increase in yield for the MB:CP treatment over the DP:CP treatment group.
[y] *t* is Student's *t* test value, *p* is a one-tailed probability (requires *P*<0.025 for conventional significance), and d is the standardized effect size.
Average Percent Increase across all studies is 14.35%.

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-Dichloropropene/ Chloropicrin	Weeds, nematodes and diseases	1% gain to 14% loss	14.4% (Shaw and Larson, 1999)
Chloropicrin/Metam sodium	Multiple pests	6.6-47%	27% Locascio, 1999
Metam sodium	Weeds, nematodes and diseases	16%-29.8%	29.8% (Shaw and Larson,1999)
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**14%**

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

Previous research evaluating various chemical alternatives to methyl bromide suggests that the mixture of 1,3-dichloropropene (Telone) with chloropicrin, coupled with separate, but complementary chloropicrin and herbicide treatments for weed control, has a potential an IPM alternative to methyl bromide to manage soil-borne pests and sustain crop yields, but this is only feasible in areas where groundwater concerns could allow the use of Telone. There are no selective herbicides for the control of the wide range of weeds found in strawberries.

Iodomethane plus chloropicrin is a promising alternative. It is actively being researched with promising results and, if registered, would be a viable alternative to methyl bromide, depending on what regulatory restrictions may arise.

California - 18. Are There Technologies Being Used to Produce the Crop which Avoid the Need for Methyl Bromide?:

For chemical alternatives, see above in section 17. Otherwise no, when strawberries are grown in the field for fruit, the growth habit of strawberries (producing runners which take root in the soil) does not lend itself to technologies such as soil-less systems, plug plants, or containerized plants.

California - Summary of Technical Feasibility

Regulatory constraints such as township caps, as well as biological considerations such as heavy pressure from pathogens, nematodes and weeds, increasing nematode damage over time from not using methyl bromide, phytotoxicity, variation in yields, time lost due to delays in planting, and missing early harvest with high strawberry prices contribute to the technical infeasibility of replacing methyl bromide.

The US nomination is only for those areas where the alternatives are not suitable. In US strawberry fruit 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 strawberry fruit production.
- geographic distribution of key target pests: i.e., some alternatives may be comparable to methyl bromide as long as key pests occur at low pressure, and in such cases the US is only nominating a CUE for strawberry fruit where the key pest pressure is moderate to high..
- regulatory constraints: e.g., telone use is limited in California due to township caps.
- delay in planting and harvesting: e.g., the plant-back interval for telone+chloropicrin is two weeks longer than methyl bromide+chloropicrin. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.
- unsuitable topography: e.g., alternatives that must be applied with drip irrigation may not be suitable in areas with rolling or sloped topography due to uneven distribution of the fumigant.

Eastern US - Part B: Crop Characteristics and Methyl Bromide Use

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

Eastern US - 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

Eastern US	Diseases: Black Root Rot (*Pythium, Rhizoctonia*), Crown rot (*Phytopthora cactorum*),	At moderate to severe pest pressure only MB can effectively control the target pests found in the Eastern United States. Related dosage rates of 202 kg/ha are below the threshold in the MBTOC 2002 Report, making further reduction difficult to achieve without compromising pest management.
	Nematodes: Root knot nematode (*Meloidogyne* spp.)	
	Weeds: Yellow nutsedge (*Cyperus escultentus*) Purple nutsedge (*Cyperus rotundus)* Ryegrass (*Lolium* spp.)	

EASTERN US - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

EASTERN US - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	EASTERN US
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Fruiting plants grown from transplants.
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Cultured as annual.
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Varies
SOIL TYPES: *(Sand, loam, clay, etc.)*	50% light, 45% medium, 5% heavy
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Yearly
OTHER RELEVANT FACTORS:	None Identified

EASTERN US - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY
CLIMATIC ZONE	5b – 8b											
RAINFALL *(mm)**	248.2	trace	158	84.3	121.9	108.7	136.9	36.6	131.3	206	107.7	147.8
OUTSIDE TEMP. *(℃)**	25.6	27.2	27.5	25.1	20.0	11.4	7.5	6.2	9.7	15.1	17.7	22.9
FUMIGATION SCHEDULE			X	X								
PLANTING SCHEDULE				X	X							

* Macon, GA

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

To our knowledge the above characteristics would not prevent adoption of any relevant alternative.

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

EASTERN US, SOUTHEASTERN UNITED STATES - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	1421	1446	1593	1694	1823	1879
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	All strip/bed	All strip/bed	All strip/bed	All strip/bed	All strip/bed	All strip/bed
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kg)*	312,231	317,918	239,851	254,689	274,405	283,530
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*	67:33	67:33	67:33	67:33	67:33	67:33
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Pressurized injection at 20 cm depth – two shanks/bed (approximately 76 cm wide bed; 25 cm height at crown of bed)					
APPLICATION RATE OF FORMULATIONS IN kg/ha*	220	220	151	150	151	151
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	45	45	45	45	45	45

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

EASTERN US - PART C: TECHNICAL VALIDATION

EASTERN US - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

EASTERN US – 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		
1,3-D Dichloropropene (1,3-D, Telone)	Used alone, 1,3- Dichloropropene does not adequately control diseases and weeds. Buffer zones of 100 feet are too constraining for small fields. Required Protective equipment (protective suits) pose a health risk to workers in hot and humid weather. Long pre-planting intervals affect cultivar selection, Integrated Pest Management practices, timing of harvest, marketing window options, land leasing decisions and crop rotation schedules	No
Basamid	Basamid is not registered in the U.S. for strawberry fruit production.	No
Basamid, Chloropicrin	Basamid is not registered in the U.S. for strawberry fruit production.	No
Chloropicrin	Chloropicrin alone is not a technically feasible alternative because it provides poor nematode and weed control, although it provides good disease control	No
Metam sodium	Metam-sodium alone is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control.	No
Metam sodium, chloropicrin	Metam-sodium with chloropicrin is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control.	No
Methyl iodide	Promising, but it is not currently registered in the U.S. for strawberry fruit production.	No
Nematicides	Addressed individually.	No
Ozone	Ozone is not technically feasible alone because it doesn't control diseases and weeds.	No
NON CHEMICAL ALTERNATIVES		

Biofumigation	Biofumigation is not technically feasible because of the quantity of Brassica crop that would be needed to control target pests in strawberries (approximately three hectares would be required for every hectare of strawberry production). Incorporation of Brassica at these levels is likely to have allelopathic effects on the target crop. In addition, field trials of growing tomatoes in cabbage residue produced inconsistent and inadequate efficacy, and poor yield in two years out of three.	No
Solarization	Solarization, when used alone for pre-plant fumigation, is not technically feasible because it does not provide adequate control of a wide range of soil-borne diseases and pests. This process is highly weather dependent and works best in combination with IPM for control of pests and diseases. However, solarization only suppresses nutsedge at best. (Chase et.al. 1998. Egley, 1983)	No
Steam	Steam, although successfully used in greenhouse situations, when used alone in the field for pre-plant fumigation, is not operationally practical due to low application speeds and high energy requirements (1-3 weeks to treat one hectare). In addition results from field experiments steam treatment have been erratic.	No
Biological Control	Biological control is not technically feasible as a stand-alone replacement for methyl bromide because it does not provide adequate control of target pests.	No
Cover Crops and Mulching	Although already in use as part of an Integrated Pest Management Program, cover crops and mulching alone do not provide adequate control of the target pests.	No
Crop rotation/fallow	Crop rotation is already being used in many strawberry production areas, but does not adequately control the target pests.	No
Flooding and water management	Flooding and water management are not feasible due to limited water resources, uneven topography in California, and in the eastern states by sandy soil types that would not retain the flood for an adequate time to control the pests.	No
General IPM	General IPM is already practiced in strawberry production, but it is not technically feasible as a stand-alone replacement for methyl bromide since a combination of IPM methods do not offer adequate pest control by itself.	No
Grafting/Resistant rootstock/plant breeding	Grafting/resistant rootstock/plant breeding is not being used and it is not technically feasible because grafting is not possible given the physical characteristics of strawberry plants. Breeding for resistance to pathogens is valuable as a long-term endeavor and the U.S. continues work in this area. At this point in time, plant breeding has not resulted in a cultivar that is sufficiently resistant to the major target pests.	No
Organic Amendments/Compost	Organic Amendments/Compost is already being used in certain regions of the U.S., but is not technically feasible as a stand-alone replacement for methyl bromide.	No
Organic production	In certain regions of the U.S. some organic production of strawberries occurs. However, as a stand alone replacement for methyl bromide it is not technically feasible because of reduced yields.	No
Resistant cultivars	Resistant cultivars are already being used in certain regions of the U.S., but it is not technically feasible as a stand-alone replacement for methyl bromide.	No

Soil-less culture	Soil-less 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.	No
Substrates/Plug plants	Substrates/plant plugs are currently being used but are not technically feasible as a stand-alone replacement for methyl bromide. Although plug plants have actually proven to be more vigorous than bare root transplants in research trials, it is not known to what extent pathogens are controlled by this method. Weed control would still be an issue. And adopting this use would also require major retooling of the industry.	No
Hand-weeding	Hand weeding strawberries is not a desirable practice for controlling nutsedge. Sedges reproduce through below-ground tubers or nutlets. When a sedge plant is removed by hand the 10 to 30 tubers, which grow 2 to 30 cm (1 to 12 inches) below ground, will rapidly produce new plants. Therefore, had weeding can lead to a rapid 10- to 30-fold increase in weeds. In addition, those sedges that germinate under the plastic mulch cannot be removed by hand without damaging the plastic and reducing its effectiveness in excluding weeds, insects, and pathogens.	No
COMBINATIONS OF ALTERNATIVES		
1,3-Dichloropropene/ Chloropicrin	This combination is considered technically feasible as an alternative in certain circumstances where weed pressures are low. Together they provide good nematicidal and fungicidal capabilities, but would still require an herbicide partner to control weeds such as nutsedge. Regulatory restrictions for each of the chemicals may further limit their use.	No, in areas with moderate to severe pest infestation and if not allowed by local regulations.
1,3-Dichloropropene/ Chloropicrin and Metam sodium	These combinations also provide good nematicidal and fungicidal capabilities, but would still require a herbicide partner (or hand weeding) to control.	No, in areas with moderate to severe pest infestation and if not allowed by local regulations.

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

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

EASTERN US – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
Metam sodium	This potential alternative has an extended time between application and crop planting (compared to methyl bromide) and is not very effective on nutsedge. It also can be inconsistent for disease control.
chloropicrin	The alternative does not give effective control of nutsedge. It also produces objectionable odors (a serious issue in urban fringe areas where strawberries are grown.) Insufficient root knot nematode control.
1,3-D	The alternative does not give effective control of nutsedge. Excessive PPE requirements, and set or buffer space requirements.

1,3-D, chloropicrin	The alternative does not give effective control of nutsedge. Excessive PPE requirements, and set or buffer space requirements. There are occasional phytotoxicity problems associated with this alternative.
1,3-D, chloropicrin, metam sodium	The alternative does not give effective control of nutsedge. Excessive PPE requirements, and set or buffer space requirements.
Metam sodium, chloropicrin	The alternative does not give effective control of nutsedge.
Nematicides	None registered except 1,3-D.

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

EASTERN US – 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:
Basamid	Not registered for use in U.S.	Y	Unknown
Methyl Iodide	Not registered for use in U.S.	Y	Unknown
Propargyl bromide	Registration in US has not yet been requested.	N	Unknown
Sodium azide	Registration in US has not yet been requested.	N	Unknown

EASTERN US - 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

See California region, Section 16, for discussion of studies of relevant alternatives.

EASTERN US – TABLE C.1: ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3-Dichloropropene/ Chloropicrin	Weeds, nematodes and diseases	1% gain to 14% loss	14.4% (Shaw and Larson, 1999)
Chloropicrin/Metam sodium	Multiple pests	6.6-47%	27% Locascio, 1999
Metam sodium	Weeds, nematodes and diseases	16%-29.8%	29.8% (Shaw and Larson,1999)
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**14%**

Eastern US - 17. Are There Any Other Potential Alternatives Under Development which Are Being Considered to Replace Methyl Bromide?

Iodomethane plus chloropicrin is the clear alternative. It is actively being researched with promising results and, if registered, would be a viable alternative to methyl bromide.

Eastern US - 18. Are There Technologies Being Used to Produce the Crop which Avoid the Need for Methyl Bromide?

For chemical alternatives, see above in section 17. Otherwise, no, the growth habit of strawberries (producing runners which take root in the soil) does not lend itself to technologies such as soil-less systems, plug plants, or containerized plants.

Eastern US - Summary of Technical Feasibility

At moderate to severe pest pressure only MB can effectively control the target pests found in the Eastern US. MB applications in strawberries are typically made using 67:33 or, where feasible, 50:50 mixtures with chloropicrin under plastic mulch. Related dosage rates of 202 kg/ha are below the threshold in the MBTOC 2002 Report, making further reduction difficult to achieve without compromising pest management.

The US nomination is only for those areas where the alternatives are not suitable. In US strawberry fruit 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 strawberry fruit production.
- geographic distribution of key target pests: i.e., some alternatives may be comparable to methyl bromide as long as key pests occur at low pressure, and in such cases the US is only nominating a CUE for strawberry fruit where the key pest pressure is moderate to high such as nutsedge in the Southeastern US.
- regulatory constraints: e.g., telone use is limited due to the presence of karst geology.
- delay in planting and harvesting: e.g., the plant-back interval for telone+chloropicrin is two weeks longer than methyl bromide+chloropicrin. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.
- unsuitable topography: e.g., alternatives that must be applied with drip irrigation may not be suitable in areas with rolling or sloped topography due to uneven distribution of the fumigant.

FLORIDA - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

FLORIDA, FLORIDA - 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
Florida	Diseases: Phytophthora, Crown Rot (*P. citricola, P. cactorum*)	At moderate to severe pest pressure only MB can effectively control the target pests found in Florida. In addition, the use of alternatives are limited in some areas because the soil overlays a vulnerable water table (karst topography). Finally, there are other areas where regulatory restrictions such as mandatory buffers around inhabited structures make alternatives infeasible. MB applications in strawberries are typically made using 67:33 or, where feasible, 50:50 mixtures with chloropicrin under plastic mulch. Related dosage rates of 202 kg/ha are below the threshold in the MBTOC 2002 Report, making further reduction difficult to achieve without compromising pest management.
Florida	Nematodes: Sting (*Belonolaimus longicaudatus*) Root-knot (*Meloidogyne* spp.)	
Florida	Weeds: Yellow nutsedge (*Cyperus esculentus*) Purple nutsedge (*Cyperus rotundus*) Carolina Geranium (*G. carolinianum*) Cut-leaf Evening Primrose (*Onoethera laciniata*)	

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

FLORIDA - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	FLORIDA
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Transplants
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Cultured as annual.
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Cucurbits and peppers
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy to loam soil
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Annually
OTHER RELEVANT FACTORS:	None Identified

FLORIDA - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE *(e.g. temperate, tropical)*	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b	9a-10b
RAINFALL *(mm)*	65.5	50	72.6	134.1	175.8	193.3	152.7	65	42.7	158.8	62	66.8
OUTSIDE TEMP. *(℃)*	19.4	22.1	25.3	27.6	28.2	28.2	27.3	24.1	19.2	17.3	16	16.9
FUMIGATION SCHEDULE						X	X					
PLANTING SCHEDULE							X	X				

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

To our knowledge none of these characteristics would prevent the adoption of relevant alternatives.

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

FLORIDA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	2469	2509	2509	2509	2630	2792
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	All strip					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kg)*	542,315	551,205	464,025	471,282	486,477	516,414
FORMULATIONS OF METHYL BROMIDE *(methyl bromide/chloropicrin)*	98:2	98:2	98:2	98:2	98:2	98:2
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Chiseled into soil 30-45 cm below surface of bed					
APPLICATION RATE OF FORMULATIONS IN kg/ha*	220	220	185	188	185	185
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	15	15	13	13	13	13

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

FLORIDA - PART C: TECHNICAL VALIDATION

FLORIDA - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

FLORIDA – 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		
1,3-D Dichloropropene (1,3-D, Telone)	Used alone, 1,3- Dichloropropene does not adequately control diseases and weeds. Buffer zones of 100 feet are too constraining for small fields. Required Protective equipment (protective suits) pose a health risk to workers in hot and humid weather. Long pre-planting intervals affect cultivar selection, Integrated Pest Management practices, timing of harvest, marketing window options, land leasing decisions and crop rotation schedules	No
Basamid	Basamid is not registered in the U.S. for strawberry fruit production.	No
Chloropicrin	Chloropicrin alone is not a technically feasible alternative because it provides poor nematode and weed control, although it provides good disease control	No
Metam sodium	Metam-sodium alone is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control.	No
Metam sodium, chloropicrin	Metam-sodium with chloropicrin is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control.	No
Methyl iodide	Promising, but it is not currently registered in the U.S. for strawberry fruit production.	No
Nematicides	Addressed individually (e.g., 1,3-D).	No
Ozone	Ozone is not technically feasible alone because it doesn't control diseases and weeds.	No
NON CHEMICAL ALTERNATIVES		
Biofumigation	Biofumigation is not technically feasible because of the quantity of Brassica crop that would be needed to control target pests in strawberries (approximately three hectares would be required for every hectare of strawberry production). Incorporation of Brassica at these levels is likely to have allelopathic effects on the target crop. In addition, filed trials on tomatoes grown in cabbage residue produced inconsistent and inadequate efficacy, and poor yield in two years out of three.	No

Solarization	Solarization, when used alone for pre-plant fumigation, is not technically feasible because it does not provide adequate control of a wide range of soil-borne diseases and pests. This process is highly weather dependent and works best in combination with IPM for control of pests and diseases. However, solarization only suppresses nutsedge at best. (Chase et.al. 1998. Egley, 1983)	No
Steam	Steam, when used alone for pre-plant fumigation, is not operationally practical due to low application speeds and high energy requirements (1-3 weeks to treat one hectare). In addition results from field experiments steam treatment have been erratic.	No
Biological Control	Biological control is not technically feasible as a stand alone replacement for methyl bromide because it does not provide adequate control of target pests.	No
Cover Crops and Mulching	Although already in use as part of an Integrated Pest Management Program, cover crops and mulching alone do not provide adequate control of the target pests.	No
Crop rotation/fallow	Crop rotation is already being used in many strawberry production areas, but does not adequately control the target pests.	No
Flooding and water management	Flooding and water management are not feasible due to limited water resources, uneven topography in Florida, and in the eastern states by sandy soil types that would not retain the flood for an adequate time to control the pests.	No
General IPM	General IPM is already practiced in strawberry production, but it is not technically feasible as a stand alone replacement for methyl bromide since even a combination of IPM methods do not offer adequate pest control by itself.	No
Grafting/Resistant rootstock/plant breeding	Grafting/resistant rootstock/plant breeding is not being used and it is not technically feasible because grafting is not possible given the physical characteristics of strawberry plants. Breeding for resistance to pathogens is valuable as a long-term endeavor and the U.S. continues work in this area. At this point in time, plant breeding has not resulted in a cultivar that is sufficiently resistant to the major target pests.	No
Organic Amendments/Compost	Organic Amendments/Compost is already being used in certain regions of the U.S., but is not technically feasible as a stand-alone replacement for methyl bromide.	No
Organic production	In certain regions of the U.S. some organic production of strawberries occurs. However, as a stand alone replacement for methyl bromide it is not technically feasible because of reduced yields.	No
Resistant cultivars	Resistant cultivars are already being used in certain regions of the U.S., but it is not technically feasible as a stand-alone replacement for methyl bromide.	No
Soil-less culture	Soil-less 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.	No

Substrates/Plug plants	Substrates/plant plugs are currently being used but are not technically feasible as a stand-alone replacement for methyl bromide. Although plug plants have actually proven to be more vigorous than bare root transplants in research trials, it is not known to what extent pathogens are controlled by this method. Weed control would still be an issue. Adopting this use would also require major retooling of the industry.	No
Hand-weeding	Hand weeding strawberries is not a desirable practice for controlling nutsedge. Sedges reproduce through below-ground tubers or nutlets. When a sedge plant is removed by hand the 10 to 30 tubers, which grow 2 to 30 cm (1 to 12 inches) below ground, will rapidly produce new plants. Therefore, had weeding can lead to a rapid 10- to 30-fold increase in weeds. In addition, those sedges that germinate under the plastic mulch cannot be removed by hand without damaging the plastic and reducing its effectiveness in excluding weeds, insects, and pathogens.	No
COMBINATIONS OF ALTERNATIVES		
1,3-Dichloropropene/ Chloropicrin	This combination is considered technically feasible as an alternative in certain circumstances where weed pressure is low. Together they provide good nematicidal and fungicidal capabilities, but would still require a herbicide partner to control weeds such as nutsedge. Regulatory restrictions for each of the chemicals may further limit their use.	No, in areas with moderate to severe pest infestation and if not allowed by local regulations.
1,3-Dichloropropene/ Chloropicrin and Metam sodium	This combination also provides good nematicidal and fungicidal capabilities, but would still require a herbicide partner (or hand weeding) to control.	No, in areas with moderate to severe pest infestation and if not allowed by local regulations.

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

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

FLORIDA – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
1,3-Dichloropropene	Drip application of 1,3-D in Florida are less expensive and require smaller buffer zones than broadcast applications, making it the preferred application method for this alternative (drip, 90%;broadcast, 10%). However, when 1,3-D fumigations by drip are used other production cots are significantly higher due to the need for herbicide applications (i.e. metam sodium) and hand weeding operations. Recent studies in California found that fruit production costs were 20-212% higher than with methyl bromide/chloropicrin (Goldhue), with the smaller cost estimates coming from VIF mulch treatments that are not currently usable due to technical issues.
Chloropicrin	Chloropicrin alone is not a technically feasible alternative because it provides poor nematode and weed control, although it provides good disease control

Metam sodium	Metam-sodium alone is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control. Metam sodium suffers from erratic efficacy most likely due to irregular distribution of the product through soil. Metam sodium if not technically feasible in California because it has limited activity against soilborne pathogens in strawberry fields.
Sodium azide	Does not sterilize ground. Yields equal to untreated.
1,3D/chloropicrin	This combination is considered technically feasible as an alternative in certain circumstances where weed pressure is low. Together they provide good nematicidal and fungicidal capabilities, but would still require a herbicide partner to control weeds such as nutsedge. Regulatory restrictions for each of the chemicals may further limit their use. Not economically feasible.

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

FLORIDA – 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:
Basamid	Not registered for use in U.S.	Y	Unknown
Methyl Iodide	Not registered for use in U.S.	Y	Unknown
Propargyl bromide	Registration in US has not yet been requested.	N	Unknown
Sodium azide	Registration in US has not yet been requested.	N	Unknown

FLORIDA - 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

See California Region, Section 16, for discussion of studies of relevant alternatives.

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

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3-Dichloropropene/ Chloropicrin	Weeds, nematodes and diseases	1% gain to 14% loss	14.4% (Shaw and Larson, 1999)
Chloropicrin/Metam sodium	Multiple pests	6.6-47%	27% Locascio, 1999
Metam sodium	Weeds, nematodes and diseases	16%-29.8%	29.8% (Shaw and Larson,1999)
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**25%**

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

Previous research evaluating various chemical alternatives to methyl bromide suggests that the mixture of 1,3-dichloropropene (Telone) with chloropicrin, coupled with separate , but complementary chloropicrin and herbicide treatments for weed control, has a potential an IPM alternative to methyl bromide to manage soil-borne pests and sustain crop yields. There are no currently registered herbicides for the control of sedges in strawberries.

Current research priorities include the following:
-Continue to identify and further define optimum conditions and procedures required to maximize performance of Telone, chloropicrin, and other fumigant and herbicide products. -Develop a more comprehensive understanding of the possible biologic and economic impacts of implementing the proposed alternatives to methyl bromide in commercial Florida agriculture.
-Continue to identify and resolve implementation constraints to methyl bromide alternatives (i.e., high costs, lower efficacy, increased production or environmental risks, regulatory constraints, and/or reduced farm profitability) that negatively impact future widespread adoption of such alternatives.
-Continue to develop effective multi-crop, IPM based systems, including characterization of impacts and residual effects within current double cropping systems.
-Maintain technology transfer projects to educate growers to learn how to effectively choose, apply, and incorporate alternative chemical so as to maximize pest control, crop response and to avoid problems of plant phytotoxicity and crop loss.
-Continue to evaluate mulch technologies and procedures to minimize emissions of methyl bromide and other soil fumigant compounds from soil.
- Continue to identify and evaluate emerging nonchemical alternatives.

FLORIDA – 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE?

For chemical alternatives, see above in section 17. Otherwise, no, the growth habit of strawberries (producing runners which take root in the soil) does not lend itself to technologies such as soil-less systems, plug plants, or containerized plants.

FLORIDA SUMMARY OF TECHNICAL FEASIBILITY

Karst topography, as well as biological considerations such as heavy pest pressure (especially with nutsedge), increasing nematode damage over time from not using methyl bromide, phytotoxicity, variation in yields, time lost due to delays in planting, and missing early harvest with high strawberry prices contribute to the technical infeasibility of replacing methyl bromide.

The US nomination is only for those areas where the alternatives are not suitable. In US strawberry fruit 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 strawberry fruit production.
- geographic distribution of key target pests: i.e., some alternatives may be comparable to methyl bromide as long as key pests occur at low pressure, and in such cases the US is only nominating a CUE for strawberry fruit where the key pest pressure is moderate to high such as nutsedge in the Southeastern US.
- regulatory constraints: e.g., telone use is limited due to the presence of karst geology.
- delay in planting and harvesting: e.g., the plant-back interval for telone+chloropicrin is two weeks longer than methyl bromide+chloropicrin. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.
- unsuitable topography: e.g., alternatives that must be applied with drip irrigation may not be suitable in areas with rolling or sloped topography due to uneven distribution of the fumigant.

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?	Although research appears to be promising, early adoption has come upon serious logistical and practical limitations such as: 1. Unreliable supplies of the VIF film since no US source of VIF film exists (only European sources); 2. US requires season long UV protection in film vs. Europe's 2 weeks; and 3. Difficulty applying VIF under US production systems without damaging film.	Between 1997 and 2000 the US has reduced the use of methyl bromide in strawberries grown for fruit production by 24%.	Reduction of MB/Pic in mixtures, i.e. changes from 67:33 to 57:43 – this may have some promise, but nutsedge is a primary pest on 40% of the land in Eastern region (890 ha), and below 30.2 g/m2 a.i. dosage, nutsedge cannot be controlled successfully.	The US anticipates that the decreasing supply of methyl bromide will motivate growers to try less frequent applications.
WHAT FURTHER USE/EMISSION REDUCTION STEPS WILL BE TAKEN FOR THE METHYL BROMIDE USED FOR CRITICAL USES?	Investigations are going to be initiated in 2004-2005 with VIF in Eastern region (North Carolina)	None identified	None identified	None identified
OTHER MEASURES	None identified	None identified	None identified	None identified

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

1. Chloropicrin (drip AND shank) shows great promise in Eastern Region, but economic feasibility is a concern with Pic. Multiple Field studies and economic evaluation have been conducted by Dr. Frank Louws (frank_louws@ncsu.edu) and Lisa Ferguson (lisa_ferguson@ncsu.edu) Also, the USDA-Methyl Bromide Alternatives Research/Extension interdisciplinary working group at NCSU (contact Lisa Ferguson) is preparing an important summary of multiple years of alternatives research for several Eastern Region States and a manuscript is now being written by

Dr. Charles Safley, NCSU, Economist, "O. Sydorovych, C. D. Safley, L. M. Ferguson, F. J. Louws, G. E. Fernandez, and E. B. Poling, *Economic Evaluation of the Methyl Bromide Alternatives for the Production of Strawberries in the Southeastern United States*

2. VIF OR HIGH BARRIER FILMS –E.B. POLING is initiating work in late summer 2004 with harvest in Spring 2005 – reports available in summer 2005.
3. Telone-C35/InLine – extensive work has been conducted with InLine by our interdisciplinary group (see Word Document attachment), and yields are comparable to MB, but important limitations with use of 1,3-D + Pic in the Eastern Region have already been presented in the Narratives for 2002 and 2003.
4. Iodomethane is an excellent replacement for MB (it has been tested extensively by NCSU researchers), and if there is EPA registration in late 2004, there could be widespread industry adoption by the 2005-2006 season. Two years of unpublished studies at NCSU (2002-2003, 2003-2004) are indicating potential of using relatively low application rates with Iodomethane -- the cost savings associated with these lower rates will potentially speed the adoption of Iodomethane in the Eastern Region. Studies in 2004-2005 will be initiated with tank mixes of Methyl Bromide + Iodomethane, to further reduce MB needs in 2005-2006.

PART E: ECONOMIC ASSESSMENT

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 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.

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

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

ALTERNATIVE	YIELD*	COST IN YEAR 1 *(US$/ha)*	COST IN YEAR 2 *(US$/ha)*	COST IN YEAR 3 *(US$/ha)*
Methyl Bromide	100	1,248	1,248	1,248
Chloropicrin+ metam sodium	73	964	964	964
1,3-d chloropicrin	86	1,416	1,416	1,416
Metam Sodium	70	849	849	849

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

22. Gross and Net Revenue

TABLE 22.1: YEAR 1 GROSS AND NET REVENUE

Year 1		
Alternatives *(as shown in question 21)*	**Gross revenue for last reported year** *(US$/ha)*	**Net Revenue for last reported year** *(US$/ha)*
Methyl Bromide	$29,818	$5484
Chloropicrin+ metam sodium	$20,679	$-1,716
1,3-d chloropicrin	$24,362	$702
Metam Sodium	$19,829	$-2,396

TABLE 22.2: YEAR 2 GROSS AND NET REVENUE

Year 2		
Alternatives *(as shown in question 21)*	**Gross revenue for last reported year** *(US$/ha)*	**Net Revenue for last reported year** *(US$/ha)*
Methyl Bromide	$29,818	$5484
Chloropicrin+ metam sodium	$20,679	$-1,716
1,3-d chloropicrin	$24,362	$702
Metam Sodium	$19,829	$-2,396

TABLE 22.3: YEAR 3 GROSS AND NET REVENUE

Year 3		
Alternatives *(as shown in question 21)*	**Gross revenue for last reported year** *(US$/ha)*	**Net Revenue for last reported year** *(US$/ha)*
Methyl Bromide	$29,818	$5484
Chloropicrin+ metam sodium	$20,679	$-1,716
1,3-d chloropicrin	$24,362	$702
Metam Sodium	$19,829	$-2,396

MEASURES OF ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

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

CALIFORNIA	METHYL BROMIDE	ALTERNATIVE PIC+MS	ALTERNATIVE 1,3-D+PIC	ALTERNATIVE MS
YIELD LOSS (%)	0	27%	14%	30%
YIELD PER HECTARE (FRESH)	48,438	35,359	41,639	33,906
* PRICE PER UNIT (US$)	$1.71	$1.62	$1.62	$1.62
= GROSS REVENUE PER HECTARE (US$)	$73,683	51,099	60,173	48,999
- OPERATING COSTS PER HECTARE (US$)	$60,131	55,339	58,438	54,921
= NET REVENUE PER HECTARE (US$)	$13,552	(4,240)	(1,735)	(5,922)
LOSS MEASURES				
1. LOSS PER HECTARE (US$)	$0	17,792	11,817	19,474
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	88.19	58.57	96.52
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	24%	16%	26%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	131%	87%	144%

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

FLORIDA	METHYL BROMIDE	ALTERNATIVE 1,3-D+PIC
YIELD LOSS (%)	0	25
YIELD PER HECTARE	3,138	2,353
* PRICE PER UNIT (US$)	23.10	23.10
= GROSS REVENUE PER HECTARE (US$)	72,511	54,360
- OPERATING COSTS PER HECTARE (US$)	44,459	40,795
= NET REVENUE PER HECTARE (US$)	28,012	13,565
LOSS MEASURES		
1. LOSS PER HECTARE (US$)	$0	14,447
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	77.72
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	20%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	52%

EASTERN UNITED STATES - TABLE E.3: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

EASTERN UNITED STATES	METHYL BROMIDE	ALTERNATIVE PIC+MS	ALTERNATIVE 1,3-D+PIC	ALTERNATIVE MS
YIELD LOSS (%)	0%	27%	14%	30%

Yield per Hectare	22,417	16,364	19,270	15,692
*** Price per Unit (US$)**	2.59	2.59	2.59	2.59
= Gross Revenue per Hectare (US$)	51,892	37,881	44,608	36,324
- Operating Costs per Hectare (US$)	29,623	30,555	31,658	30,270
= Net Revenue per Hectare (US$)	22,269	7,327	12,950	6,054
Loss Measures				
1. Loss per Hectare (US$)	$0	14,942	9,319	16,215
2. Loss per Kilogram of Methyl Bromide (US$)	$0	99.49	62.05	107.96
3. Loss as a Percentage of Gross Revenue (%)	0%	29%	18%	31%
4. Loss as a Percentage of Net Revenue (%)	0%	67%	42%	73%

SUMMARY OF ECONOMIC FEASIBILITY

The economic analysis evaluated methyl bromide alternative control scenarios for strawberry production of fruit in Southeastern states, Florida, and California by comparing the economic outcomes of methyl bromide oriented production systems to those using alternatives.

The economic factors that most influence the feasibility of methyl bromide alternatives for fresh market strawberry 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 tomato producers in this case. Because producers (suppliers) represent an integral part of any definition of a market, we interpret the threshold of significant market disruption to be met if there is a significant impact on commodity suppliers using methyl bromide. The economic measures provide the basis for making that determination.

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 strawberries 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 fumigation scenarios for the Eastern States and California, relative to methyl bromide: 1) metam sodium + chloropicrin; 2) 1,3-d + chloropicrin; and 3) metam sodium. Yield loss estimates were based on data from the CUE's and EPA data, as well as expert opinion.

For Florida, three scenarios were compared to the methyl bromide baseline: 1) 1,3-d plus chloropicrin; 2) Iodomethane; and 3) Iodomethane + chloropicrin. Because Iodomethane **is not registered**, it is not considered a feasible alternative but the analysis is provided for comparative purposes.

Florida

In 2002, Florida had 2,792 hectares (6,900 acres) or 100% of harvested area treated with an average of 75 kilograms (166 pounds) of methyl bromide per hectare (acre). The closest chemical alternative to methyl bromide is 1,3-d plus chloropricrin (as Telone C-35). However, US-EPA estimates that approximately 40% of Florida's strawberry growing areas overlay Karst geology, which prohibits the use of 1,3-d because of the potential for groundwater contamination. The use of 1,3-d also requires a 100-foot buffer around inhabited structures. This would reduce the strawberry producing acreage by about 10%. Nematodes and nutsedge are key pests in Florida strawberry controlled with methyl bromide. Chloropicrin is not as effective in controlling weeds as methyl bromide. Using chloropicrin adds to production costs through increased weeding and labor costs (to search for and pick the fruit).

The least-loss scenario for Florida in the absence of methyl bromide is for growers to use 1,3-d plus chloropicrin. Under that scenario, yield loss would be approximately 27%, not including increases in labor costs for hand weeding, drip irrigation costs, or changes in market prices due to later harvests missing early market price-premiums. A delay in planting occurs due to the longer plant-back interval for 1,3-d, which means delayed harvesting. According to U.S. Department of Agriculture data, market prices for Florida strawberries decline approximately 18% between December and January. Yield and price impacts together make up impacts on gross revenues.

Under Alternative 1 (1,3-d plus chloropicrin), the yield loss was estimated to be 25% with operating costs in US dollars per hectare of $40,795. The estimated net revenue was $13,565 per hectare. The estimated loss per hectare is estimated to be $14. The loss per kilogram of methyl bromide in US dollars is estimated to be $77.72 per kilogram. If growers miss the December market window, a loss of approximately one month's revenue would reduce grower gross revenues by about 22% in addition to the yield loss of 25%.

The following alternatives are presented for comparative purposes only as the products are not registered. Under alternative 2 (Iodomethane), the yield loss was estimated to be 14%. Operating costs in US dollars per hectare are $40,795. The estimated net revenue was $21,538 per hectare. The loss per hectare is estimated to be $6,474. The loss per kilogram of methyl bromide in US dollars is estimated to be $34.83 per kilogram.

Under alternative 3 (Iodomethane + chloropicrin), the yield loss was estimated to be 30%. Operating costs in US dollars per hectare are $40,795. The estimated net revenue was $9,963 per hectare. The loss per hectare is estimated to be $18,049. The loss per kilogram of methyl bromide in US dollars is estimated to be $97.11 per kilogram.

California

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). Approximately 63 percent of California's strawberry acreage is fumigated with methyl bromide, and 31 percent is fumigated with alternatives. Approximately 15 percent of the strawberry acreage is on hillsides with slopes severe enough to make drip irrigation impractical.

Increased production preparation time would delay planting in the Southern Region and reduce the harvest period in the Northern Region, leading to decreases in the prices farmers receive. Ground preparation between crops takes 30 days longer using 1,3-d and chloropicrin because of the time required to prepare drip irrigation. According to U.S. Department of Agriculture data, market prices for strawberries California decline 5% between January and February. If using the alternatives delays the harvest period, US-EPA estimates there will be a market price decline in addition to a yield loss. The following paragraphs illustrate the estimated losses with three alternatives for California.

Alternative 1 (chloropicrin+metam sodium), yield loss was estimated to be 27%, and gross revenues are expected to decline 24%. The estimated net revenue is estimated to decline more than 131%. The loss per kilogram of methyl bromide in US dollars is estimated to be $88.19 per kilogram.

Under alternative 2 (1,3-d plus chloropicrin), the yield loss was estimated to be 14% and prices by 05%, if growers miss key market windows. Gross revenue is expected to decline 16%. The net revenue is expected to decline by more than 87%. The loss per kilogram of methyl bromide in US dollars is estimated to be $58.57 per kilogram.

Under alternative 3 (metam sodium), the yield loss was estimated to be 30%, and the gross revenue loss was estimated to by 26%. The loss per kilogram of methyl bromide in US dollars is estimated to be $96.52 per kilogram.

Eastern United States:
Under Alternative 1 (chloropicrin+metam sodium), yield loss was estimated to be 27%, with gross revenues decline 29%, and a loss in estimated net revenue of 67%. The loss per kilogram of methyl bromide in US dollars is estimated to be $99.49 per kilogram.

Under alternative 2 (1,3-d + chloropicrin), the yield loss was estimated to be 14%, with gross revenues declining 18%, and net revenues expected to decline by 42%. The loss per kilogram of methyl bromide in US dollars is estimated to be $62.05 per kilogram.

Under alternative 3 (Metam Sodium), the yield loss was estimated to be 30%, with gross revenues declining 31%, and net revenues expected to decline by 73%. The loss per kilogram of methyl bromide in US dollars is estimated to be $107.96 per kilogram.

Note: Market price data was not available for the Eastern United States but it is assumed that the net effect of shifting from methyl bromide to any of the alternatives would result in additional revenue reductions due 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. FUTURE PLANS

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

The amount of methyl bromide requested for research purposes is considered critical for the development of effective alternatives. Without methyl bromide 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 estimates that strawberry fruit research will require 2377 kg per year of methyl bromide for 2005 and 2006. This amount of methyl bromide 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 field study testing the comparative performance of methyl bromide, host resistance, cultural practices, pest management approaches for control of root-knot nematodes. Another example is a five year field study comparing methyl bromide to 1,3-D combined with biologically based materials including transplant treatments for control of weeds, root-knot nematodes and soil borne fungal pathogens.

Research for a methyl bromide alternative for strawberry production continues to be a very active area of research. USDA, University of Florida Institute of Food and Agricultural Sciences, and the Florida Fruit and Vegetable Association are currently conducting research in this area. Over 100 peer-reviewed articles have been published to date based on trials conducted by the above groups. Control of nutsedge and winter annual weeds is crucial to successful berry production in Florida. Control of nutsedge is also extremely important to 40 percent of the Eastern strawberry production land where nutsedge is a problem. In the near term, research is needed to find a suitable pre-emergent herbicide, or to find ways to get better herbicidal efficacy from currently available fumigants. In the long term, efforts should be continued to find non-chemical means to suppress nutsedge damage. Some additional research to fine-tune use of alternative fumigants to maximize efficacy and yield is also needed.

Research studies submitted with the critical use exemption request packages include trials conducted to assess the effectiveness of the most likely chemical and non-chemical alternatives to methyl bromide, including some potential alternatives that are not currently included in the MBTOC list. Based on preliminary results from research conducted in this area and largely in the area of tomatoes and strawberries, researchers believe that a mix of fumigants together with an herbicide treatment is the best possible alternative to methyl bromide. Combinations of 1,3-dichloropropene/chloropicrin, and metam-sodium/chloropicrin are being tested for disease and weed control. Future research plans will test combinations of these fumigants with chemicals such as halosulfuron, metolachlor, and sulfentrazone. A program to evaluate host resistance to *Phytophthora* root and crown rot has been implemented. Growers are starting to deploy lines identified as having both genetic resistance and acceptable horticultural qualities.

As demonstrated by the chart and description below, U.S. efforts to research alternatives for methyl bromide have been substantial, and they have been growing in size as the phase out has approached. The U.S. is committed to sustaining its research efforts out into the future until technically and economically viable alternatives are found for each and every controlled use of methyl bromide. The U.S. is also committed to continuing to share our research, and enable a global sharing of experience. Toward that end, for the past several years, key U.S. government agencies have collaborated with industry to host an annual conference on alternatives to methyl bromide. This conference, the Methyl Bromide Alternatives Outreach (MBAO), has become the premier forum for researchers and others to discuss scientific findings and progress in this field.

Methyl Bromide Alternatives Research Funding History

Year	Amount (Million)
1993	US$ 7.255 M
1994	US$ 8.453 M
1995	US$ 13.139 M
1996	US$ 13.702 M
1997	US$ 14.580 M
1998	US$ 14.571 M
1999	US$ 14.380 M
2000	US$ 14.855 M
2001	US$ 16.681 M
2002	US$ 17.880 M

The numerous methyl bromide alternative research trials that have been produced quantitative yield data are summarized in the table below. This table shows that, even among studies that demonstrate significant yields using the alternatives, there is significant variation in the performance of the alternative. Thus, while a given alternative may perform well in one study, it may also perform below acceptable standards in another study. The standard used to characterize success in the analysis presented here is if the alternative produced crops with at least 95 percent of the yield of the crop with a methyl bromide control. However, in some instances, even a 95 percent yield may involve some profit losses.

Summary of Research Results for Methyl Bromide Alternatives on U.S. Strawberry.

Organic production	5	1
Ozone	1	1
Solarization and Combinations	22	6
Tarps	3	1
Telone (1,3-dichloropropene) and combinations	93	41

Registration

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

The U.S. has one of the most rigorous programs for ensuring that new pesticides are safe for both health and the environment. These safeguards, however, come at a cost of both money and time. It can take a new pesticide, or new pesticide use, several years to be registered by the U.S. EPA. This is in addition to the time it takes to perform, draft results, and deliver the very large number of health and safety studies that are required for registration. Few countries, particularly in the developing world, have the resources to conduct and review these studies or the market power to leverage chemical companies to perform and submit the necessary data. Thus, U.S. registration decisions are often the basis for other countries' pesticide regulations, which means that the benefits from assuring human and environmental safety accrue globally.

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

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

Since 1997, the U.S. EPA has made the registration of alternatives to methyl bromide a high registration priority. Because the U.S. EPA currently has more applications for all types of pesticides pending in its review process than resources to evaluate them, U.S. EPA prioritizes the applications in its registration queue. By virtue of being a top registration priority, methyl bromide alternatives enter the science review process as soon as U.S. EPA receives the application and supporting data rather than waiting in turn for the EPA to initiate its review. This review process takes an average of 38 months to complete. Additionally, the registrant (the pesticide applicant) has, in most cases, spent approximately 7-10 years developing the data necessary to support registration.

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

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

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

Several additional, promising alternatives are under review at EPA that may be able to be used on strawberries in the future. These include: iodomethane (methyl iodide) and propargyl bromide, which currently look very promising in field studies. Although iodomethane is chemically similar to methyl bromide, it photodegrades before it reaches the stratosphere, and therefore is not a significant ozone depleter. While iodomethane and propargyl bromide are not currently registered for use as pesticides in the U.S., research on combinations of pesticides with chemicals like methyl iodide are also planned. Some of these trials will incorporate screening of strawberry varieties for tolerance/resistance to *Phytophthora capsici*. Again, while these activities appear promising, it must be noted that concerns about toxicity, drinking water contamination, and the release of air pollutants regarding some alternatives presents another difficulty that may restrict use since many of the growing regions are in sensitive areas such as those in close proximity to schools and homes. Ongoing research on alternate fumigants is evaluating ways to reduce emission under various application regimes and examining whether commonly used agrochemicals, such as fertilizers and nitrification inhibitors, could be used to rapidly degrade soil fumigants. If registration of iodomethane or propargyl bromide occurs in the near future, commercial availability and costs will be factors that must be taken into consideration.

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

First, the Eastern region strawberry growers *already apply fumigants in the strip/bed*, and this accounts for 50% lower methyl bromide (MB) use compared to strawberry growing regions (e.g. CA) using broadcast applications.

Second, in 1999 the industry switched to the 67:33 formulation from 98:2, and this is the main factor accounting for the fact that while total plasticulture acreage in our consortium has increased 32 percent since 1997, total methyl bromide usage has decreased from 312,236 kg (a.i.) in 1997 to 283,535 kg (a.i.) in 2002.

Third, an extensive number of research and grower trials in the Eastern Region would suggest that further alterations in the MB:pic formulation offers our best near term strategy to achieve significant reductions in MB dependency without creating significant market disruption. Chloropicrin is expected to be a very important part of pest control practices in the Eastern Region when methyl bromide is no longer available. Either alone or in combination with other materials, chloropicrin has performed well in research trials, and two years of recent research has demonstrated very high strawberry yields in plots treated with a stand alone rate of 250 lb/acre of 96% chloropicrin (Plymouth, 2000-2001, and 2001-2002). But, this formulation of chloropicrin is also a very objectionable chemical to work with – causing severe eye irritation and potential acute breathing problems. Worker protection standards must be high. Because of very objectionable odor, it may be impractical to use by farmers in this consortium, most of whom have their strawberry pick-your-owns and ready-pick operations on the fringe of urban and suburban populations. Drift could also be a serious problem.

Nonetheless, we wish to achieve further reductions in MB use in areas of the Eastern Region where nutsedge is not a primary pest (representing about 60% of the industry, or 1333 ha) by actively pursuing a change in formulation to 57:43 for the non-nutsedge areas -- this one change can result in a 9% reduction methyl bromide use in 2005 (Table 2). By 2006, it may be feasible to use 50:50 mixtures with chloropicrin under plastic mulch beds to achieve further reductions – shown in Table 3.

Stepwise Reductions Proposed for the Eastern Region (January 2004)

Table 1. Base information before implementation of stepwise reductions

Eastern Region (hectares)	Year	Nutsedge areas = 40% Consortium	Non-nutsedge areas = 60% of Consortium	Total MB a.i.	Application rate for the a.i. (kg/ha)
2222	2005	134,278	201,418	335,696	151
2317	2006	140,216	210,324	350,841	151
2376	2007	143,936	215,905	359,841	151

Table 2. Reductions for Step 1 – With adoption of 57:43 by non-nutsedge group

Eastern Region (hectares)	Year	Nutsedge areas = 40% Consortium	Non-nutsedge areas = 60% of Cons.	Table 1 MB Kg (a.i.)	Adjusted MB Kg (a.i.)	Ave. Appl. Rate (kg/h)
2222	2005	134,278	171,356	335,696	305,634	138
2317	2006	140,216	178,932	350,841	319,148	138
2376	2007	143,936	183,680	359,841	327,616	138

Table 3. Reductions for Step 1 – With adoption of 50:50 by non-nutsedge group in 2006

Eastern Region (hectares)	Year	Nutsedge areas = 40% Consortium	Non-nutsedge areas = 60% of Cons.	Table 1 MB Kg (a.i.)	Adjusted MB Kg (a.i.)	Ave. Appl. Rate (kg/h)
2222	2005	134,278	171,356	335,696	305,634	138
2317	2006	140,216	156,958	350,841	297,174	128
2376	2007	143,936	161,122	359,841	305,058	128

Step 1 (increasing the percentage of Pic) can occur with the fewest obstacles to implementation, and can potentially reduce MB use by 9% in 2005, 15% in 2006 and 15% in 2007 (Table 3).
It is more difficult to accomplish comparable reductions in MB use for growers in nutsedge regions by formulation changes, as our experience has shown that MB dosages below 30.2 g/m2 do not provide satisfactory nutsedge control. Therefore, for growers in nutsedge areas, we wish to investigate, in cooperation with VIF or High Barrier film manufacturers, the potential of growers in these areas to cut MB usage by at least 1/3rd with these films.

If VIF or High Barrier Research and Extension Demonstrations in High Pressure Nutsedge Areas of the Eastern Region in 2004-2005 and 2005-2006 are successful, there is potential in 2006 and 2007 to significantly reduce methyl bromide use further: the current projected amount of MB a.i. needed in Eastern Region nutsedge areas for 2006 is calculated to be 140,216 kg (350,540 x .4), and this research has the potential to lower this region's dependency from 140,216 kg to 93,947 kg (Table 4). The net effect of implementing steps 1 and 2 on the Eastern

Region would be a 28.4 % reduction in 2006, and 28.4% reduction in 2007 (relative to our current request), and a lowering of the average application rate for our region to 108 kg/ha.

Table 4. Reductions for Step 2 – With adoption of High Barrier Films by Nutsedge

Eastern Region (hectares)	Year	Nutsedge areas = 40% Consortium	Non-nutsedge areas = 60% of Cons.	Table 1 MB Kg (a.i.)	Adjusted MB Kg (a.i.)	Ave. Appl. Rate (kg/h)
2222	2005	134,278	171,356	335,696	305,634	138
2317	2006	93,947	156,958	350,841	250,905	108
2376	2007	96,437	161,122	359,841	257,559	108

25. ADDITIONAL COMMENTS ON THE NOMINATION?

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

In accordance with those Decisions, we believe that the U.S. nomination contained in this document provides all of the information that has been requested by the Parties. On the basis of an exhaustive review of a large, multi-disciplinary team of sector and general agricultural experts, we have determined that the MBTOC listed potential alternatives for the strawberry sector are not currently technically or economically feasible from the standpoint of U.S. strawberry growers covered by this critical use exemption nomination. Under certain circumstances in the absence of heavy pest pressure and regulatory constraints, 1,3-dichloropropene with chloropicrin, and possibly also with metam sodium, may be economically feasible, and indeed, the U.S. request has been reduced to take into account possible use in areas that may meet such ideal circumstances. However, any of the following factors would or could make the alternatives economically infeasible:

- Regulatory constraints such as township caps, buffer zones, and karst topology,
- Heavy pest pressure such as nutsedge,
- Increasing nematode damage over time from not using methyl bromide,
- Phytotoxicity,
- Variation in yields,
- Time lost due to delays in planting,
- Missing early harvests with high strawberry prices, and
- Less vigorous starter plants if strawberry nurseries cannot use methyl bromide.

We have demonstrated that we have and continue to expend significant efforts to find and commercialize alternatives, and that potential alternatives to the use of methyl bromide in strawberries may be on the horizon. The registration process, which is designed to ensure that new pesticides do not pose an unacceptable risk, is long and rigorous. The U.S. need for methyl bromide for strawberries will be maintained for the period being requested.

In addition, significant efforts have been made to reduce the use and emissions of methyl bromide associated with strawberries. It is particularly valuable to note that the strawberry production industry in California has done a good job of integrating more sustainable and environmentally compatible techniques into their current production system. These currently employed strategies include the use of insects for biological control, and many techniques that limit losses to disease including use of crop rotation, alternation of chemicals fungicides to limit resistance buildup, clean tillage, water management and field sanitation. Unfortunately the continued success of their well constructed IPM system is dependent on the use of methyl bromide as a pre-plant soil fumigant. Initial reductions in populations of the entire pest complex achieved with methyl bromide make it feasible to use more environmentally sound control measures throughout the season to keep reduced pest populations in check. Without a replacement capable of controlling all of the pests that methyl bromide controls, the entire IPM strategy must be reconstructed. Research on alternatives for this commodity has been progressive and productive. There have been promising advances towards the development of alternative fumigants and application methodologies. The regulatory constraints for employment of the currently available alternatives remain as the largest obstacle to their adoption for strawberry production.

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APPENDIX A. 2006 Methyl Bromide Usage Numerical Index (BUNI).

Methyl Bromide Critical Use Exemption Process — Date: 26-Feb-2004 — Average Hectares in the US: 19,486

2006 Methyl Bromide Usage Numerical Index (BUNI) — Sector: STRAWBERRIES — % of Average Hectares Requested: 68%

REGION	2006 Amount of Request: Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	2001 & 2002 Average Use*: Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	Quarantine and Pre-Shipment	Regional Hectares**: 2001 & 2002 Average	% of 2001 & 2002 Average	Requested Hectares %
CALIFORNIA	1,632,931	8,094	202	1,601,966	8,184	196	0%	11,109	74%	73%
EASTERN US	350,534	2,317	151	278,967	1,851	151	0%	not available	not available	not available
FLORIDA	579,691	2,873	202	501,446	2,711	185	0%	2,873	94%	100%
TOTAL OR AVERAGE	2,563,155	13,284	185	2,382,379	12,747	177	0%	13,982	91%	95%

2006 Nomination Options	Subtractions from Requested Amounts (kgs)					Combined Impacts Adjustment (kgs)		MOST LIKELY IMPACT VALUE			
REGION	2006 Request	(-) Double Counting	(-) Growth or 2002 CUE Comparison	(-) Use Rate Difference	(-) QPS	HIGH	LOW	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	% Reduction
CALIFORNIA	1,632,931	-	-	48,709	-	1,140,640	871,322	1,086,777	5,552	196	33%
EASTERN US	350,534	-	104,977	-	-	230,823	228,368	230,332	1,528	151	34%
FLORIDA	579,691	-	32,659	45,586	-	300,868	275,795	295,853	1,600	185	49%
Nomination Amount	2,563,155	2,563,155	2,425,520	2,331,225	2,331,225	1,672,331	1,375,485	1,612,962	8,680	177	37%
% Reduction from Initial Request	0%	0%	5%	9%	9%	35%	46%	37%	35%		

Adjustments to Requested Amounts	Use Rate (kg/ha)		(%) Karst Topography		(%) 100 ft Buffer Zones		(%) Key Pest Distribution		Regulatory Issues (%)		Unsuitable Terrain (%)		Cold Soil Temp (%)		Combined Impacts (%)	
REGION	2006	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	HIGH	LOW
CALIFORNIA	202	196	0	0	0	0	0	0	67	47	15	15	0	0	72%	55%
EASTERN US	151	151	0	0	90	90	40	30	0	0	0	0	0	0	94%	93%
FLORIDA	202	185	40	40	1	1	40	30	0	0	0	0	0	0	60%	55%

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	No	-	Yes	1/year	$ 10,732	$ 53	15%	79%	14% Yield Loss	Metam-Sodium + Pic
EASTERN US	Yes	Yes	Yes	Tarp	No	+	Yes	1/year	$ 8,661	$ 47	14%	-128%	14% Yield Loss	1,3-d+pic/Metam+Pic
FLORIDA	Yes	Yes	Yes	Tarp	No	0	Yes	1/year	$ 9,319	$ 62	18%	42%	14% Yield Loss	1,3-d+pic

Notes * SE Strawberry Consortium (AL, AR, GA, NC, SC, TN, OH, NJ, VA) requested a greater quantity of Methyl Bromide from their 2002 CUE application, due to the inclusion of 4 new states (Illinois, Kentucky, Louisiana, and Maryland) in the 2003 CUE Application, it has been adjusted by growth figures only.

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

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.

APPENDIX C. SUMMARY OF NEW APPLICANTS

A number of new groups applied for methyl bromide for 2005 during this application cycle, as shown in the table below. Although in most cases they represent additional amounts for sectors that were already well-characterized sectors, in a few cases they comprised new sectors. Examples of the former include significant additional country (cured, uncooked) ham production; some additional request for tobacco transplant trays, and very minor amounts for pepper and eggplant production in lieu of tomato production in Michigan.

For the latter, there are two large requests: cut flower and foliage production in Florida and California ('Ornamentals') and a group of structures and process foods that we have termed 'Post-Harvest NPMA' which includes processed (generally wheat-based foods), spices and herbs, cocoa, dried milk, cheeses and small amounts of other commodities. There was also a small amount requested for field-grown tobacco.

The details of the case that there are no alternatives which are both technically and economically feasible are presented in the appropriate sector chapters, as are the requested amounts, suitably adjusted to ensure that no double-counting, growth, etc. were included and that the amount was only sufficient to cover situations (key pests, regulatory requirements, etc.) where alternatives could not be used.

The amount requested by new applicants is approximately 2.5% of the 1991 U.S. baseline, or about 1,400,000 pounds of methyl bromide, divided 40% for pre-plant uses and 60% for post-harvest needs.

The methodology for deriving the nominated amount used estimates that would result in the lowest amount of methyl bromide requested from the range produced by the analysis to ensure that adequate amounts of methyl bromide were available for critical needs. We are requesting additional methyl bromide in the amount of about 500,000 Kg, or 2% or the 1991 U.S. baseline, to provide for the additional critical needs in the pre-plant and post-harvest sector.

Applicant Name	2005 U.S. CUE Nomination (lbs)
California Cut Flower Commission	400,000
National Country Ham Association	1,172
Wayco Ham Company	39
California Date Commission	5,319
National Pest Management Association	319,369
Michigan Pepper Growers	20,904
Michigan Eggplant Growers	6,968
Burley & Dark Tobacco Growers USA - Transplant Trays	2,254
Burley & Dark Tobacco Growers USA - Field Grown	28,980
Virginia Tobacco Growers - Transplant Trays	941
Michigan Herbaceous Perennials	4,200

Ozark Country Hams	240
Nahunta Pork Center	248
American Association of Meat Processors	296,800
Total lbs	**1,087,434**
Total kgs	**493,252**