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

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 (Prepared in 2005)

NOMINATING PARTY CONTACT DETAILS

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Following the requirements of Decision IX/6 paragraph (a)(1), the United States of America has determined that the specific use detailed in this Critical Use Nomination is critical because the lack of availability of methyl bromide for this use would result in a significant market disruption.

☐ Yes ☐ No

____________________ ____________________ _______________
Signature Name Date

Title: _______________________________________

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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 (Prepared in 2005)

3. CROP AND SUMMARY OF CROP SYSTEM

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

California. California produces more than 85% of the fresh market and processed strawberries grown in the U.S. California produces about 20% 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%) and processed (37%) strawberries. The northern region includes both rotated and non-rotated strawberry production regimes, with each producing fresh (84%) and processed (16%) strawberries. The majority of growers are farming between four 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 (1,3-D) 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 (southern California) or fall (northern and southern California). 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 to six weeks after fumigation to ensure that there are no phytotoxic levels of fumigant remaining. Harvest begins about two to four 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 fumigation, include broccoli, celery, lettuce, radish, leeks, and artichokes.

Florida. Florida is the second largest strawberry producing state with 12% of the total U.S. production. All of Florida's production is for fresh market. 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. Typically, MB in combination with chloropicrin is applied to the soil during construction of raised-beds, approximately two weeks prior to planting transplants. Immediately after application, beds are covered with plastic mulch. Drip and overhead irrigation are used to help establish plants, irrigate plants, and protect plants from frost. Many strawberry growers use the existing 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 that directly market strawberries 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 geology; 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 majority of the strawberry farms use an annual cropping plasticulture 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% of the soils have textures finer than sandy loam. Nutsedge is a primary pest on about 40% 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)
2007	**1,733,901**	**9,780**

* Includes research amount of 2,377 kgs.

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

The U.S. nomination for critical use of MB, for 2007, is only for those areas where the alternatives are not suitable, such as constraints due to regulatory, topographical, geological, or soil conditions. U.S. strawberry fruit production will still require MB for 2007, and most likely until protocols are developed from research conducted over several seasons that will provide commercial producers with reliable and economically feasible alternatives. However, the nomination notes significant progress in adopting emission reduction technologies and changing formulations and application rates to reduce MB dosage rates. Research is ongoing to evaluate new alternatives, and to test impermeable films. Constraints on use of alternatives, for 2007, include:

- In areas with heavy pest pressure, the protocols for use of alternatives may not be sufficiently developed, based on research studies, to risk current crop.
- Alternative treatments may be comparable to MB when there is little pressure from key pests. However, the U.S. is only nominating a CUE for strawberry fruit where the key pest pressure is moderate to high, such as nutsedge in the eastern U.S.

- Regulatory constraints: e.g., 1,3-D and virtually impermeable film use is limited in California due to regulations, and in Florida, 1,3-D use is not allowed in areas with karst geology.
- Delay in planting and harvesting: e.g., the plant-back interval for 1,3-D + chloropicrin may be two weeks longer than MB + chloropicrin. In these cases, delays in planting and harvesting will result in users missing key market windows resulting in reduction in revenues due to 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; broadcast fumigation can be impacted by restrictions on 1,3-D.

TABLE A.1: EXECUTIVE SUMMARY

Region	*California*	*Eastern U.S.*	*Florida*
AMOUNT OF APPLICANT REQUEST			
2007 Kilograms	1,451,494	359,841	579,691
AMOUNT OF NOMINATION*			
2007 Kilograms	1,267,880	165,735	297,909

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

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

Only areas with moderate to high pest pressure are included in this nomination for critical use of MB. In several areas MB alternatives have already been incorporated into strawberry production systems. However, in areas where alternatives have not been shown to sufficiently manage major pests economically, MB currently is considered to be the most reliable treatment. MB is used in strawberry production for managing nutsedges and other weeds, nematodes, and pathogens. Some major reasons that MB will continue to be a critical treatment for 2007, are lack of precise protocols for combination treatments (e.g., 1,3-D, chloropicrin, metam-sodium, etc.) that can be applied to commercial operations, physical or regulatory limitations to some important treatments (e.g., 1,3-D, virtually impermeable film), increased costs for some alternative methods, and market issues due to change in crop rotation and time of planting/harvesting.

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 ha (NASS*, 2002 for CA= 11,538 ha)	74% (NASS*, 2002 for CA=55% treated w/MB)
Eastern U.S.	Not available for region (NASS*, 2000 for NC= 729 ha)	Not available for region (region estimate, 80%; Ferguson et al., 2003) (NASS*, 2000 for NC=35% treated w/MB)
Florida	2,873 (NASS*, 2002 for FL= 2,794 ha)	94 (NASS*, 2002 for FL=100% treated w/MB)
NATIONAL TOTAL:**	19,486	65

* National Agricultural Statistics Service, U.S. Department of Agriculture, 2002 Vegetable Crops Report
** 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.

Strawberry producers in the three areas where MB is being requested are faced with different pest problems. In the eastern U.S., other than Florida, the generally small-scale farmers contend with yellow and purple nutsedges, which are significant problems in some areas more than others. Those that are faced with a lower incidence of nutsedge may be able to use other chemicals, chloropicrin, 1,3-D, and metam-sodium, for example, whereas these treatments may not be effective in areas with severe infestations. In Florida, a significant portion of production areas sits above karst geological formations, which proscribes the use of 1,3-D because of ground water contamination. In California, some areas are prevented from using 1,3-D, because of township caps. These areas rely on MB as a critical tool for successful strawberry production. In California, hilly fields impact the application of some alternatives (e.g., drip application of 1,3-D).

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?

Researchers have been testing MB alternatives and are committed to finding effective replacements for MB. Research trials continue to be conducted each season to assess feasibility and consistency of results. Research suggests that there may be some good alternatives on the horizon (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Trout and Damodaran, 2004; Noling and Gilreath, 2004; Hamill et al., 2004; Sydorovych et al., 2004). However, additional research will be required to develop protocols and resolve problems (e.g., application methods for VIF, cost concerns). California researchers are examining the use of various high barrier films to address efficacy and cost issues. VIF manufacturers believe that physical problems associated with applying VIF can be fixed in the near future (Rimini and Wigley, 2004), but California has restrictions on use of VIF, as well as 1,3-D.

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	**2007**
KILOGRAMS OF METHYL BROMIDE	1,451,520
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	Flat Fumigation
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)*	8,097
APPLICATION RATE* (KG/HA) FOR THE **ACTIVE INGREDIENT**	179
DOSAGE RATE* (G/M^2) OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	17.9

** 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	**2007**
KILOGRAMS OF METHYL BROMIDE	359,847
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)*	2,378
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	15.1

** 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	**2007**
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

** A typical strawberry bed in Florida is 71 cm wide and 132 cm from bed center to center; 54% of the area is treated.*

*** Florida growers use a 98:2 formulation for sting nematode control.*

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

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

- The percent of regional hectares in the applicant's request was divided by the total area planted in that crop in the region covered by the request. Values greater than 100% 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 MB, 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. QPS was not applicable in this sector.
- Only the area experiencing one or more of the following impacts were included in the nominated amount: moderate to heavy key pest pressure, regulatory impacts, karst geology, buffer zones, and unsuitable terrain.

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*), **Nematodes**: root knot nematode (*Meloidogyne* spp.) Sting nematode (*Belonolaimus* spp.) **Weeds**: Yellow nutsedge (*Cyperus esculentus*), purple nutsedge (*Cyperus rotundus*), ryegrass, and winter annual weeds.	At moderate to severe pest pressure where MB is not currently used, protocols for commercial application of alternatives have not been sufficiently developed to be implemented for the 2007 season. Uses of some alternatives are limited by regulatory restrictions, such as the township caps on 1,3-D. MB applications in strawberries are typically made using 67:33 or, where feasible, 57:43 mixtures with chloropicrin under plastic mulch. If high barrier tarps becomes available to California growers and technical problems and cost concerns can be resolved, some research suggests that fumigant rates, including MB, might be lowered with near efficacy of current rates under standard films (e.g., Hamill et al., 2004; Noling and Gilreath, 2004; Ajwa et al., 2004; Fennimore et al., 2004).

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	X	X						
PLANTING IN SOUTH**	X		X	X								

*For Fresno, California.
** In Northern California the crop is planted in the fall and harvested from December through June/July. In Northern California rotational crop planting occurs in October/November and harvesting occurs from April thru October; average farm size is 24 ha; rotational crops include lettuce, strawberries, broccoli and cauliflower. In Southern California the crop is planted in both the summer and fall. The rotational crop, often celery, lettuce, or broccoli, is grown from March thru May. Average farm size in this area is about 12 ha, all of which is treated.

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

It is likely that 1,3-D township caps will limit the further adoption of 1,3-D as an alternative. It is possible that use can be reduced, especially in Northern California, by using drip irrigation of 1,3-D—however, move to drip irrigation will result in a 2-3 week delay in schedule. This would be significant for growers who plant long day cultivars such as ‘Diamonte’ (see Appendix B). Hilly terrain also impacts the application of 1,3-D.

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

CALIFORNIA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**
AREA TREATED *(hectares)*	7,401	8,600	8,248	8,456	7,912	8,249
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)*	1,928,597	2,264,789	1.919,240	1,611,775	1,592,156	1,651,250
FORMULATIONS OF METHYL BROMIDE	Typically 67:33 *(methyl bromide /chloropicrin)*					
METHOD BY WHICH METHYL BROMIDE APPLIED *)*	Shank injected 25 to 30 cm deep					
APPLICATION RATE OF FORMULATIONS IN kg/ha*	260	275	244	191	201	201
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	26	27.5	24.4	19.1	20.1	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 – 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-Dichloropropene (1,3-D)	Used alone, 1,3- D does not adequately control diseases and weeds. Buffer zones of 30 m are 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, time of harvest, marketing window options, land leasing decisions and crop rotation schedules. In CA, state regulations require township caps, which limits use of 1,3-D.	No
Basamid	Basamid is not registered in the U.S. for strawberry fruit production.	No
Chloropicrin	Chloropicrin alone provides poor nematode and weed control, although it provides good disease control	No
Metam sodium	Metam-sodium alone provides inconsistent nematode and weed control, most likely due to irregular distribution through soil.	No
Methyl iodide	Not currently registered in the U.S.	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 trials. Research is being conducted to determine efficacy against selected pathogens, nematodes, and weeds (e.g., Daugovish et al, 2003).	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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 used 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).	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	Already in use as part of an Integrated Pest Management Program, cover crops and mulching alone do not provide sufficient 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, unsuitable 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 (e.g., Duniway et al., 2003). 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. (e.g., Browne et al., 2003), 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

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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 can be more vigorous than bare root transplants in research trials, disease problems can be severe. One study found significant contamination with *Colletotrichum acutatum* as a result of contaminated nursery stock from Canada and numerous growers lost entire plantings in several states (Sances, 2003). These problems can be overcome (Sances, 2004), but the technology is not ready for widespread commercial application until further studies are conducted. Weed control would still be an issue and adopting this use would also require major retooling of the industry.	No
Tarps	Research on virtually impermeable films (e.g., Ajwa et al., 2003a, 2004; Duniway et al., 2003; Fennimore et al., 2003, 2004; Hamill et al., 2004) shows promise in improving efficacy of chemical fumigants. However, CA currently does not allow the use of VIF due to concerns about worker exposure upon outgassing. In addition, technical issues of application feasibility and costs could hamper implementation.	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 feasible as an alternative in circumstances where weed pressures are low. Together treatment provides good nematicidal and fungicidal capabilities, but would likely require an herbicide partner to control weeds such as nutsedge. Regulatory restrictions for each of the chemicals may further limit their use. Ongoing research indicates that efficacy can be enhanced with use of VIF, but VIF is currently not allowed in California.	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 likely require an herbicide partner (or hand weeding) to control. 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.
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	Township caps restrict the use in California. Where available, if used alone 1,3-D is not a sufficiently effective weed or disease control treatment. Drip applications 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 (not currently available due to regulatory constraints).
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.
1,3-D/chloropicrin/metam-sodium	This combination is being researched as a possible alternative treatment to MB in areas where township caps and label restrictions are not restrictive. Together they provide good nematicidal, weed, and fungicidal capabilities. Research studies are examining the appropriate rates and water amounts required (Ajwa and Trout, 2004). Repeated seasonal trials will be necessary to validate efficacy. Research suggests greater efficacy if VIF is used if regulatory, technological and cost issues are resolved (VIF is not currently allowed in California)..

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 on strawberries.	Yes	Unknown
Methyl Iodide	Not registered in U.S.	Yes	Unknown
Propargyl bromide	Not registered in U.S.	No	Unknown
Furfural	Not registered for use on strawberries.	Unknown	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
		Native weed biomass (kg/ha) w/VIF	Native weed biomass (kg/ha) w/HDPE	
Control (untreated) [1] Chloropicrin (drip): [2] (56 kg/ha) [3] (112 kg/ha) [4] (224 kg/ha) [5] (336 kg/ha) [6] (448 kg/ha) 1,3-D/Chloropicrin (Inline drip): [7] (56 kg/ha) [8] (112 kg/ha) [9] (224 kg/ha) [10] (336 kg/ha) [11] (448 kg/ha) MB/Chloropicrin (shank): [12] 392 kg/ha	2 (4 reps each) (data from Oxnard, CA trial)	[1] 1350 a [2] 600 bcdef [3] 696 bcdef [4] 957 b [5] 398 ef [6] 369 ef [7] 832 bcde [8] 537 bcdef [9] 302 f [10] 319 f [11] 334 f [12] 919 bc *Means within column followed by the same letter do not differ at 0.05 according to Duncan's multiple range test*	[1] 1435 a [2] 822 bcde [3] 658 bcdef [4] 490 cdef [5] 391 ef [6] 520 bcdef [7] 891 bcd [8] 694 bcdef [9] 586 bcdef [10] 565 bcdef [11] 427 ef [12] 440 def *Means within column followed by the same letter do not differ at 0.05 according to Duncan's multiple range test*	Fennimore et al., 2003
		Strawberry yield (%) relative to MB/Pic treatment w/VIF	Strawberry yield (%) relative to MB/Pic treatment w/HDPE	
Control (untreated) [1] Chloropicrin (drip): [2] (56 kg/ha) [3] (112 kg/ha) [4] (224 kg/ha) [5] (336 kg/ha) [6] (448 kg/ha) 1,3-D/Chloropicrin (Inline drip): [7] (56 kg/ha)	3 (data from Oxnard, CA trial) [no pests identified]	[1] 87 [2] 104 [3] 105 [4] 112 [5] 120 [6] 116 [7] 98 [8] 107	[1] 83 [2] 103 [3] 106 [4] 108 [5] 115 [6] 112 [7] 99 [8] 108	Ajwa et al., 2003a

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
[8] (112 kg/ha) [9] (224 kg/ha) [10] (336 kg/ha) [11] (448 kg/ha) MB/Chloropicrin (shank): [12] 392 kg/ha		[9] 117 [10] 120 [11] 120 [12] 111 *No significant difference between chemical trts; untreated significantly different from other trts (P=0.05).*	[9] 105 [10] 121 [11] 115 [12] **100 (=44,751 kg/ha)** *No significant difference between chemical trts; untreated significantly different from other trts (P=0.05).*	
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

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

(From Shaw and Larson, 1999).
[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?

Research evaluating various chemical alternatives to MB suggests that some (e.g., mixture of 1,3-D with chloropicrin—as with Inline product, and possibly coupled with a separate metam-sodium application, use of tolerant germplasm, and use of high barrier films) have the potential to be effective treatments for strawberry pests (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Trout and Damodaran, 2004; Noling and Gilreath, 2004; Hamill et al., 2004; Sydorovych et al., 2004). Research trials must be conducted over several seasons to assess consistency of efficacy (e.g., Ferguson et al., 2003). In addition, for large scale strawberry production technical and cost issues must be resolved, such as high barrier film application and regulatory problems, and consistency of metam-sodium distribution, before these alternatives can be used effectively. Timelines for transition to MB are being considered. Concerns by growers in Northern California include costs associated with shifting from broadcast fumigation to drip application and loss of 2-3 weeks for long-day cultivars (see Appendix B). In some systems, the loss of two or three weeks may be the difference between planting two vegetable crops in rotation, or only one.

Current research priorities include the following:

- Continue to identify and further define optimal conditions and procedures required to maximize performance of 1,3-D, chloropicrin, and other fumigant and herbicide products. Develop a more comprehensive understanding of the possible biologic and economic impacts of implementing the proposed alternatives in commercial strawberry production.
- Continue to identify and resolve implementation constraints to MB alternatives (i.e., costs, efficacy, production or environmental risks, regulatory constraints, and farm profitability) that impact 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, as well as avoid problems of plant phytotoxicity, accidents, and crop loss.
- Continue to evaluate mulch technologies and procedures to minimize emissions of MB and other soil fumigant compounds.
- Continue to identify and evaluate emerging nonchemical alternatives and amendments, such as VIF.

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

As stated in section 17, research is making progress in defining protocols (such as fumigant use rates, tarp types, tolerant cultivars, and optimal water amounts). Additional field trials are necessary to confirm results over a multi-year period. However, due to significant regulatory issues (with 1,3-D and VIF) it has been difficult to formulate an exact timeline for transition to alternatives for many critical uses of MB.

Shank injection of alternatives such as 1,3-D, or 1,3-D with chloropicrin, are feasible on hilly terrain but is greatly affected by township caps. However, research results from California (e.g., Fennimore et al., 2003; Ajwa et al., 2003a, 2003b; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004) have suggested that this type of application is less effective than when applied through drip irrigation equipment. The technical and economic assessment for the eastern U.S. and Florida indicted a 14% yield loss and $ 47 and $ 62 loss per kilogram of MB respectively with the best 1,3-D and chloropicrin application techniques. Because of the lower efficacy, the California strawberry growers would need to use flat fumigation for effective pest control which would require 40% more material to be used than in a typical drip irrigation application to the beds. Growers with weed control problems would need to factor in the additional cost of a companion herbicide. In addition, the township cap restriction requires a different multiplier depending on mode of application.

CALIFORNIA - SUMMARY OF TECHNICAL FEASIBILITY

The U.S. nomination is only for those areas where the alternatives are not suitable. Use of MB for strawberries in California is critical until commercial applications of research findings can be developed. While recent research results (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Trout and Damodaran, 2004; Noling and Gilreath, 2004; Hamill et al., 2004; Sydorovych et al., 2004) indicate that there are potentially effective alternatives to MB, they must be tested for additional seasons to confirm efficacy and especially must be field tested in commercial settings to ensure production will not suffer. Problems facing transition to alternatives include regulatory constraints, such as township caps, biological considerations, such as heavy pressure from pathogens, nematodes and weeds, potential phytotoxic effects, variation in yields, time lost due to delays in planting as a result of drip equipment setup.

Township caps are significant for important strawberry areas. There are over 4,000 townships (9,300 ha each) represented in the California township assessment. The information used to develop the estimate of area impacted by township caps in California was from Carpenter, Lynch, and Trout (1999 and 2001), supplemented by discussions with Dr. Trout to ensure that any recent regulatory changes have been properly accounted for.

The current rule in effect for 1,3-D use was used for the this nomination. This is based on 1,3-D usage being allowed at the baseline amount (1X level), not the short term exemption limits (2X). The California Department of Pesticide Regulations (Cal DPR) was contacted for clarification on the 1,3-D township cap question. Cal DPR explained the use of 1,3-D starting in 2005, and beyond, would be based on: current and historic use patterns in each individual township, future enhancements to the air concentration model and health impact models, and assumptions on the use of adjacent land in the models. Because of the uncertainties in all of these parameters they are currently unable to speculate what the future 1,3-D township caps will be in California. Accordingly, we believe that the CUE must cover the level of MB needed to meet the existing 1X regulatory limit.

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 U.S.	**Diseases**: Black root rot (*Pythium, Rhizoctonia*), Crown rot (*Phytopthora cactorum*),	At moderate to severe pest pressure, protocols for commercial application of alternatives have not been sufficiently developed to be implemented for the 2007 season. MB applications in strawberries are typically made using 67:33 or, where feasible, 57:43 mixtures with chloropicrin under plastic mulch. If VIF technical problems and cost concerns can be resolved, research suggests that fumigant rates, including MB, can be lowered with equal efficacy to higher rates under standard films (e.g., Hamill et al., 2004; Noling and Gilreath, 2004; Ajwa et al., 2004; Fennimore et al., 2004).
	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?

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:	1998	1999	2000	2001	2002	2003
AREA TREATED *(hectares)*	1446	1593	1694	1823	1879	2121
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)*	317,918	239,851	254,689	274,405	283,530	320,133
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)					
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)***	22.0	15.1	15.0	15.1	15.1	15.1

** 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-D does not adequately control diseases and weeds, especially nutsedges. Buffer zones of 30 m 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
Methyl iodide	Not currently registered in the U.S.	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

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
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 (e.g., Leandro et al., 2004).	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
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
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

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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 can be more vigorous than bare root transplants in research trials, disease problems can be severe. One study found significant contamination with *Colletotrichum acutatum* as a result of contaminated nursery stock from Canada and numerous growers lost entire plantings in several states (Sances, 2003). These problems can be overcome (Sances, 2004), but the technology is not ready for widespread commercial application until further studies are conducted and analyzed. Weed control would still be an issue and adopting this use would also require major retooling of the industry.	No
Tarps	Research on virtually impermeable films (e.g., Ajwa et al., 2003a, 2004; Duniway et al., 2003; Fennimore et al., 2003, 2004; Hamill et al., 2004) shows promise in improving efficacy of chemical fumigants. However, technical issues of application feasibility and costs could hamper implementation.	No
COMBINATIONS OF ALTERNATIVES		
1,3-Dichloropropene/ Chloropicrin	This combination is considered feasible as an alternative in circumstances where weed pressures are low. Together treatment provides good nematicidal and fungicidal capabilities, but would likely 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 weed 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 likely require an herbicide partner (or hand weeding) to control. Regulatory restrictions for each of the chemicals may further limit their use. VIF may improve efficacy, if technological and cost issues are resolved.	No, in areas with moderate to severe weed 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 MB) and is not very effective on nutsedge.
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	This combination is considered feasible as an alternative where weed pressure is low. Together they provide good nematicidal and fungicidal capabilities, but may require a herbicide partner to control weeds such as nutsedge. Regulatory restrictions may limit their use. Experiments (Gilreath, Motis, Santos, Noling, 2003) with VIF and 1,3-D/chloropicrin indicate nutsedge control may be achievable but rates and formulations are still be investigated for optimal efficacy. VIF may improve efficacy, if technological and cost issues are resolved.
Metam sodium, chloropicrin	Will not effectively control nematodes.
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 on strawberries.	Y	Unknown
Methyl Iodide	Not registered in U.S.	Y	Unknown
Propargyl bromide	Not registered in U.S.	N	Unknown
Furfural	Not registered for use on strawberries.	Unknown	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?

Research evaluating various chemical alternatives to MB suggests that some (e.g., mixture of 1,3-D with chloropicrin—as with Inline product, and possibly coupled with a separate metam-sodium application, use of tolerant germplasm, and use of VIF) have the potential to be effective treatments for strawberry pests (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Trout and Damodaran, 2004; Noling and Gilreath, 2004; Hamill et al., 2004; Sydorovych et al., 2004). Research trials must be conducted over several seasons to assess consistency of efficacy (e.g., Ferguson et al., 2003). In addition, for large scale strawberry production technical and cost issues must be resolved, such as VIF application and regulatory problems, and consistency of metam-sodium distribution, before these alternatives can be used commercially.

Current research priorities include the following:

- Continue to identify and further define optimal conditions and procedures required to maximize performance of 1,3-D, chloropicrin, and other fumigant and herbicide products. Develop a more comprehensive understanding of the possible biologic and economic impacts of implementing the proposed alternatives in commercial strawberry production.
- Continue to identify and resolve implementation constraints to MB alternatives (i.e., costs, efficacy, production or environmental risks, regulatory constraints, and farm profitability) that impact 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 MB and other soil fumigant compounds from soil.
- Continue to identify and evaluate emerging nonchemical alternatives and amendments, such as VIF.

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

As stated in section 17, research is making progress in defining protocols (such as fumigant use rates, tarp types, tolerant cultivars, and optimal water amounts). Additional field trials are necessary to confirm results over a multi-year period.

EASTERN US - SUMMARY OF TECHNICAL FEASIBILITY

The U.S. nomination is only for those areas where the alternatives are not suitable. Use of MB for strawberries in the eastern U.S. is critical until commercial applications of research findings can be developed. While recent research results (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Trout and Damodaran, 2004; Noling and Gilreath, 2004; Hamill et al., 2004; Sydorovych et al., 2004) indicate that there are potentially effective alternatives to MB, they must be tested for additional seasons to confirm efficacy and especially must be field tested in commercial settings to ensure production will not suffer. Problems facing transition to alternatives include regulatory constraints of 30 m buffer zones, biological considerations, such as heavy pressure from pathogens, nematodes and especially nutsedge, potential phytotoxic effects, variation in yields, time lost due to delays in planting.

The U.S. estimates of the area impacted by 30 m buffer zones are 40% for the eastern U.S. and 1% for Florida. These estimates used information from applicants and alternatives manufacturers including: average field size, the density of habitable structures near strawberry fields, population distributions, and surveys of extension agents. For example, the eastern U.S. has many small "pick-your-own" strawberry farms (less than 4 hectares) where the impact of a 30 m buffer is more pronounced than on the larger farms in California or Florida. Because of the significant impact that these estimates have on the overall request for MB, the U.S. EPA is evaluating additional methods to further substantiate and quantify the impacts of buffer zones.

One of the key barriers to adoption of a fumigant and herbicide combination (using fumigants such as chloropicrin, metam sodium with chloropicrin) is the lack of selective herbicides for strawberry weed control. Of the herbicides registered in the U.S., only s-metolachlor will provide suppression of yellow nutsedge, but will provide no control of purple nutsedge at current label rates. However, ongoing work by Noling and Gilreath (2004) indicates that nutsedge control can be achieved with lower rates of MB when used with VIF compared to MB with standard film.

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**: Crown rot, (*Phytophthora citricola, P. cactorum*) **Nematodes**: Sting (*Belonolaimus longicaudatus*); Root-knot (*Meloidogyne* spp.) **Weeds**: Yellow nutsedge (*Cyperus esculentus*); Purple nutsedge (*Cyperus rotundus*); Carolina Geranium (*G. carolinianum*); Cut-leaf Evening Primrose (*Onoethera laciniata*)	At moderate to severe pest pressure, protocols for commercial application of alternatives have not been sufficiently developed to be implemented for the 2007 season. The use of some alternatives are limited in some areas because the soil overlays a vulnerable water table (karst geology). In addition, there are other areas where regulatory restrictions, such as mandatory buffers around inhabited structures make alternatives infeasible. MB applications in Florida strawberries are typically made using 98:2 or 67:33 mixtures with chloropicrin under plastic mulch. If VIF technical problems and cost concerns can be resolved, research suggests that fumigant rates, including MB, can be lowered with equal efficacy to higher rates under standard films (e.g., Hamill et al., 2004; Noling and Gilreath, 2004; Ajwa et al., 2004; Fennimore et al., 2004).

A critical use of MB in this region is to control yellow and purple nutsedge. While it is generally accepted by scientific experts that the incidence of these weeds in the southeastern U.S. is very high, exact figures have been difficult to obtain.

In 2004, Dr. Stanley Culpepper of the University of Georgia submitted to EPA the results of a survey that characterized the incidence of nutsedge in vegetable operations. In this survey, extension agents in 34 Georgia vegetable producing counties were polled to better understand the level of nutsedge infestation in eggplants and peppers, among other vegetable crops. Their responses are based on their extensive interactions with vegetable growers in their jurisdictions. The portion of the survey data related to eggplants and peppers, used as a surrogate for strawberries, is summarized below (see Tables 10.2 & 10.3).

FLORIDA-TABLE 10.2. PERCENT CURRENT NUTSEDGE INFESTATION IN GEORGIA COUNTIES WHILE METHYL BROMIDE IS AVAILABLE (CULPEPPER, 2004).*

Crop	No Infestation	Light Infestation	Moderate Infestation	Severe Infestation
Pepper	1.3	18.9	65.6	14.2
Eggplant	1.0	40.6	39.0	19.4

*No infestation = no nutsedge infesting production area
*Light infestation = < 5 nutsedge plants per square meter

*Moderate infestation = 5 to 30 nutsedge plants per square meter
*Severe infestations = >30 nutsedge plants per square meter

FLORIDA-TABLE 10.3. PERCENT ANTICIPATED NUTSEDGE INFESTATION THE YEAR AFTER THE INABILITY TO USE METHYL BROMIDE (CULPEPPER, 2004). *

Crop	No Infestation	Light Infestation	Moderate Infestation	Severe Infestation
Pepper	0.0	9.1	31.6	59.3
Eggplant	0.2	11.9	50.3	37.6

*No infestation = no nutsedge infesting production area
*Light infestation = < 5 nutsedge plants per square meter
*Moderate infestation = 5 to 30 nutsedge plants per square meter
*Severe infestations = >30 nutsedge plants per square meter

While this survey focused on Georgia, EPA believes it is reasonable to expect that the levels of nutsedge infestations reported for these crops is likely to be representative of other areas of the southern USA.

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?

Severe weather can impact pest pressure.

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:	1998	1999	2000	2001	2002	2003
AREA TREATED *(hectares)*	2509	2509	2509	2630	2792	2873
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)*	551,205	464,025	471,282	486,477	516,414	708,523
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	Chiseled into soil 30-45 cm below surface of bed					
DOSAGE RATE OF ACTIVE INGREDIENT IN kg/ha*	22.0	18.5	18.8	18.5	18.5	24.7

** 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- D does not adequately control diseases and weeds. Buffer zones of 30 m are 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, time of harvest, marketing window options, land leasing decisions and crop rotation schedules. In Florida, there are regulatory constraints on 1,3-D in fields over karst geology.	No
Basamid	Basamid is not registered in the U.S. for strawberry fruit production.	No
Chloropicrin	Chloropicrin alone is not a 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 feasible alternative because it provides unpredictable disease, nematode, and weed control. Research is ongoing (e.g., Gilreath, Santos, and Noling, 2003) examining issues such as rates and water delivery volume to determine ways to improve consistency.	No
Methyl iodide	Not currently registered in the U.S.	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

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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
Hand-weeding	Hand weeding strawberries is not a desirable practice for controlling nutsedge. Nutsedges reproduce through below-ground tubers or nutlets. When a nutsedge 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 nutsedges 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
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

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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 currently and it is not now technically feasible because it requires a complete transformation of the Florida production system. There are high costs associated with this as compared to current production practices. Research is being conducted to address important concerns (e.g., Paranjpe et al., 2003).	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 can be more vigorous than bare root transplants (Kokalis-Burelle, 2003), diseases must be carefully monitored. One study found significant contamination with *Colletotrichum acutatum* as a result of contaminated nursery stock from Canada and numerous growers lost entire plantings in several states (Sances, 2003). These problems can be overcome (Sances, 2004), but further studies are necessary. Weed control would still be an issue and adopting this use would also require major retooling of the industry.	No
Tarps	Research on virtually impermeable films (e.g., Ajwa et al., 2003a, 2004; Duniway et al., 2003; Fennimore et al., 2003, 2004; Hamill et al., 2004) shows promise in improving efficacy of chemical fumigants. However, technical issues of application feasibility and costs could hamper implementation.	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. Experiments (Gilreath, Motis, Santos, Noling, 2003) with VIF and 1,3-D/chloropicrin indicate nutsedge control may be achievable but rates and formulations are still be investigated for optimal efficacy.	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 provides good nematicidal and fungicidal capabilities, and weed control in some areas, but would likely require a herbicide partner (or hand weeding). Experiments (Gilreath, Motis, Santos, Noling, 2003) with VIF and 1,3-D/chloropicrin indicate nutsedge control may be achievable but rates and formulations are still be investigated for optimal efficacy. VIF may improve efficacy, if technological and cost issues are resolved.	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 drip fumigations are used production costs are increased due to the need for herbicide applications, or metam sodium, or hand weeding. Recent studies in California found that fruit production costs were 20-212% higher than with MB/chloropicrin (Goldhue), with the smaller cost estimates coming from VIF mulch treatments that are not currently available 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 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.
1,3-D/chloropicrin/metam-sodium	This combination is considered feasible as an alternative where weed pressure is low. Together they provide good nematicidal and fungicidal capabilities, but may require a herbicide partner to control weeds such as nutsedge. Regulatory restrictions may limit their use.

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 on strawberries	Y	Unknown
Methyl Iodide	Not registered for use in U.S.	Y	Unknown
Propargyl bromide	Not registered for use in U.S.	N	Unknown
Furfural	Not registered for use on strawberries	Not known	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?

Research evaluating various chemical alternatives to MB suggests that some (e.g., mixture of 1,3-D with chloropicrin—as with Inline product, and possibly coupled with a separate metam-sodium application, use of tolerant germplasm, and use of VIF) have the potential to be effective treatments (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Trout and Damodaran, 2004; Noling and Gilreath, 2004; Hamill et al., 2004; Sydorovych et al., 2004) for strawberry pests if efficacy and economic issues are not problematic. Use of plug plants, rather than bare root transplants, appears to have a significant effect on increased yield (Kokalis-Burelle, 2003). Research trials must be conducted over several seasons to assess consistency of efficacy (e.g., Ferguson et al., 2003). In addition, for large scale strawberry production technical and cost issues must be resolved, such as VIF application and regulatory problems, and consistency of metam-sodium distribution, before these alternatives can be used commercially.

Current research priorities include the following:

- Continue to identify and further define optimal conditions and procedures required to maximize performance of 1,3-D, chloropicrin, and other fumigant and herbicide products. Develop a more comprehensive understanding of the possible biologic and economic impacts of implementing the proposed alternatives in commercial strawberry production.
- Continue to identify and resolve implementation constraints to MB alternatives (i.e., costs, efficacy, production or environmental risks, regulatory constraints, and farm profitability) that impact 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 chemicals 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 MB and other soil fumigant compounds from soil.
- Continue to identify and evaluate emerging nonchemical alternatives and amendments, such as VIF.

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

Researchers are making progress in developing protocols (such as fumigant use rates, tarp types, tolerant cultivars, and optimal water amounts). Additional field trials are necessary to confirm results over a multi-year period.

FLORIDA SUMMARY OF TECHNICAL FEASIBILITY

The U.S. nomination is only for those areas where the alternatives are not suitable. Use of MB for strawberries in Florida is critical until commercial applications of research findings can be developed. While recent research results (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Trout and Damodaran, 2004; Noling and Gilreath, 2004; Hamill et al., 2004; Sydorovych et al., 2004) indicate that there are potentially effective alternatives to MB, they must be tested for additional seasons to confirm efficacy and especially must be field tested in commercial settings to ensure production will not suffer. Problems facing transition to alternatives include regulatory constraints, such as karst geology preventing use of 1,3-D, biological considerations, such as heavy pressure from weeds, especially nutsedge, pathogens, and nematodes, and other factors such as potential phytotoxic effects, variation in yields, time lost due to delays in planting.

The estimates of the area impacted by karst geology in Florida, restricting the use of 1,3-D, were developed and mapped by the Florida Department of Agriculture (1984). The estimates of karst geology for Georgia and the southeast U.S. were developed from applicant and university survey information. In addition see the Reregistration Eligibility Decision (RED) for 1,3-D (U.S. EPA, 1998). A map of the karst geology in the U.S. is available online at http://www2.nature.nps.gov/nckri/map/maps/engineering_aspects/davies_map_PDF.pdf. The proportion of the current Florida strawberry crop that cannot use 1,3-D because of karst geology may be high (even 100%) according to some interpretations of label restrictions due to "karst geology".

Based on research cited above, under moderate to severe pest pressure the alternatives would lead to an overall yield loss of 25%. Chloropicrin alone was not specifically evaluated because it does not provide adequate control of nematodes or weeds. Of the herbicides registered in the U.S. only s-metolachlor will provide suppression of yellow nutsedge, but will provide no control of purple nutsedge at current label rates. One of the key barriers to adoption of a fumigant and herbicide combination is the lack of selective herbicides for strawberry weed control. However, ongoing work by Noling and Gilreath (2004) indicates that nutsedge control can be achieved with lower rates of MB when used with VIF compared to MB with standard film.

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 98:2 to 67:33– this may have some promise, but nutsedge is a primary pest in the Eastern region and Florida.	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); research is ongoing in CA, FL and other areas (e.g., Gilreath, Motis, Santos, Noling, 2003; Duniway et al., 2003; Ajwa et al., 2003a)	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 promise for disease management, but has to be used with other chemicals for efficacy on weeds. In addition, economic feasibility is a concern with chloropicrin. Multiple field studies and economic evaluation have been conducted by Dr. Frank Louws (frank_louws@ncsu.edu) and Lisa Ferguson (lisa_ferguson@ncsu.edu) and researchers elsewhere (e.g., Stall, 1999, Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004). 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. Also, research in California and Florida continues to explore means of integrating more effective plastic tarps (Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004; Hamill et al., 2004; Noling and Gilreath, 2004). VIF barriers are not currently used in California due to concerns of worker exposure after film removal. This situation may change if regulatory authorities are persuaded that workers would not be exposed unduly to fumigant during outgassing.
3. 1,3-D (Telone-C35/InLine) – extensive work has been conducted with InLine especially in California (e.g., Fennimore et al., 2003, 2004; Ajwa et al., 2003a, 2003b, 2004; Browne et al., 2003; Duniway et al., 2003; Ajwa and Trout, 2004), and yields are frequently comparable to MB, but limitations with use of 1,3-D + Pic have already been described.
4. Iodomethane may be a "drop-in" replacement for MB, when it is available. However, this active ingredient has not been registered in the U.S. and it is unknown when, or if, this will take place.

PART E: ECONOMIC ASSESSMENT

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

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

REGION	ALTERNATIVE	YIELD*	COST IN YEAR 1 *(US$/ha)*	COST IN YEAR 2 *(US$/ha)*	COST IN YEAR 3 *(US$/ha)*
California	**Methyl Bromide**	**100%**	**$65,888**	**$65,888**	**$65,888**
	Chloropicrin + Metam sodium	73%	$65,683	$65,683	$65,683
	1,3-D + chloropicrin	86%	$65,664	$65,664	$65,664
	Metam Sodium	70%	$65,684	$65,684	$65,684
Florida	**Methyl Bromide**	**100%**	**$44,254**	**$44,254**	**$44,254**
	1,3-D + chloropicrin	86%	$43,030	$43,030	$43,030
	Chloropicrin + Metam Sodium	73%	$39584	$39584	$39584
	Metam Sodium	70%	$38,818	$38,818	$38,818
Eastern United States	**Methyl Bromide**	**100%**	**$29,482**	**$29,482**	**$29,482**
	Chloropicrin + Metam sodium	73%	$30,555	$30,555	$30,555
	1,3-D + chloropicrin	86%	$31,658	$31,658	$31,658
	Metam Sodium	70%	$30,270	$30,270	$30,270

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

22. Gross and Net Revenue

TABLE 22.1: YEAR 1, 2, 3 GROSS AND NET REVENUE

Year 1, 2, 3			
Region	**Alternatives** *(as shown in question 21)*	**Gross revenue for last reported year** *(US$/ha)*	**Net Revenue for last reported year** *(US$/ha)*
California	**Methyl Bromide**	**$76,252**	**$10,363**
	Chloropicrin+ Metam sodium	$55,664	($10,020)
	1,3-D chloropicrin	$65,548	($3,840)
	Metam Sodium	$53,376	($12,307)
Florida	**Methyl Bromide**	**$55,168**	**$10,914**
	1,3-D + chloropicrin	$47,224	$4,194
	Chloropicrin + Metam Sodium	$40,273	$689
	Metam Sodium	$38,728	($90)
Eastern United States	**Methyl Bromide**	**$51,892**	**$22,410**
	Chloropicrin+ Metam sodium	$37,881	$7,327
	1,3-D chloropicrin	$44,608	$12,950
	Metam Sodium	$36,624	$6,054

Measures of Economic Impacts of Methyl Bromide Alternatives

California - Table E.1: Economic Impacts of Methyl Bromide Alternatives

CALIFORNIA	Methyl Bromide	Pic+Metam Sodium	1,3-D+pic	Metam Sodium
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	1,3-D+PIC	PIC+METAM SODIUM	METAM SODIUM
YIELD LOSS (%)	0%	14%	27%	30%
YIELD PER HECTARE	5,046	4,319	3,683	3,542
* PRICE PER UNIT (US$)	$10.93	$10.93	$10.93	$10.93
= GROSS REVENUE PER HECTARE (US$)	$55,168	$47,224	$40,273	$38,728
- OPERATING COSTS PER HECTARE (US$)	$44,254	$43,030	$39,584	$38,818
= NET REVENUE PER HECTARE (US$)	$10,914	$4,194	$689	($90)
LOSS MEASURES				
1. LOSS PER HECTARE (US$)	$0	$6,720	$10,225	$11,004
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$33	$51	$55
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	12%	19%	20%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	62%	94%	101%

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

EASTERN UNITED STATES	METHYL BROMIDE	PIC+METAM SODIUM	1,3-D+PIC	METAM SODIUM
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 Eastern United 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. 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. This is also true 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.

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 14%, 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. 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%.

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% of California's strawberry production lands are fumigated with MB, and 35% are fumigated with alternatives (2% of production is organic). Approximately 10% 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 three to four weeks 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 in 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.

Eastern United States:

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?

A specific timeline for implementing alternative strategies for current MB use areas is difficult primarily due to the complex and long term nature of transfer of technological information from research to commercial applications and the uncertainties associated with regulatory constraints for some alternatives. Nevertheless, as described in this document, alternative methodologies are being streamlined to improve efficacy. In California, according to Trout and Damodaran (2004), "…[m]ost growers do not believe that, in the near term with moderate pest pressures, yields with alternatives are less than those with MeBr:chloropicrin mixtures. Some growers are more concerned about loss of chloropicrin (currently under re-registration) than MeBr". Prior to implementation of alternatives for commercial use, research, including treatments with MB, is necessary. The U.S. estimates that strawberry fruit research will require 2377 kg per year of MB for 2005 and 2006. This amount is necessary to conduct research on alternatives and is in addition to the amounts requested in the submitted CUE applications.

Based on preliminary research results, researchers believe that a mix of fumigants together possibly with herbicide treatments is the best possible alternative to MB. In addition, use of impermeable tarps can improve efficacy of fumigants. Combinations of 1,3-D/chloropicrin, and metam-sodium/chloropicrin are being tested for disease and weed control. Future research plans will test combinations of these fumigants with chemicals (not necessarily registered for use, but valuable for research trials for possible future registration) 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 MB 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 an important 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 MB alternative research trials that have 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% of the yield of the crop with a methyl bromide control. However, in some instances, even a 95% yield may involve some profit losses.

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

Alternatives	**Total Number of Studies**	**Number of Studies with Yield at Least 95% of Methyl Bromide**
Basamid (Dazomet) and combinations	27	12
Chloropicrin and combinations	58	36
Compost systems	11	6
Enzone	3	0
Metam sodium (Vapam) and combinations	73	24
Organic production	5	1
Ozone	1	1
Solarization and Combinations	22	6
Tarps	3	1
Telone (1,3-dichloropropene) and combinations	93	41

Registration

The U. S. has invested in efforts to register MB alternatives, as well as efforts to support technology transfer and education activities with the private sector. The U.S. has programs for ensuring that new pesticides are safe for both health and the environment. It can take a new pesticide, or new pesticide use, several years to be registered. This is in addition to the time it takes to perform, draft results, and deliver the health and safety studies that are required for registration. U.S. registration decisions are often the basis for other countries' pesticide regulations.

Since 1997, the U.S. has made the registration of alternatives to MB a high registration priority. By virtue of being a top registration priority, MB alternatives enter the science review process as soon as U.S. EPA receives the application and supporting data. This review process takes an average of 38 months to complete. Additionally, the applicant has spent, in most cases, approximately 7-10 years developing the data necessary to support registration. Iodomethane (methyl iodide) is a promising alternative that is currently under review and may have application for strawberries.

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

The U.S. nomination for critical use of MB, for 2007, is only for those areas where the alternatives are not suitable, such as constraints due to regulatory, topographical, geological, or soil conditions. Furthermore, as in the past, the U.S. nomination subtracts increased area of production from consortia requests. Minimizing the use of MB in the future will be a function of implementing protocols developed in appropriate research studies. The greatest barrier to implementation of new techniques that can reduce or eliminate the use of MB is the time required to adequately test treatments that appear to be effective against the variety of pests that pose problems for commercial strawberry production. Numerous studies have been cited in this nomination indicating the various possibilities that may allow growers to produce their crops with MB alternatives. Positive results have been observed for options such as 1,3-D/chloropicrin, metam-sodium, VIF tarps, etc. However, alternatives can only be commercially viable when economic, regulatory, biological, and geological considerations are factored into strawberry production. Alternatives will become more acceptable in the coming years as research studies consolidate results over multiyear trials and effective fumigation protocols are developed for commercial applications.

As an example to minimize MB use, the eastern strawberry consortium has presented a plan. Research and grower trials in the eastern region suggest that further alterations in the MB:pic formulation offers the 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 MB 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 high strawberry yields in plots treated with 280 kg/ha of 96% chloropicrin (Plymouth, 2000-2001, and 2001-2002). However, this formulation of chloropicrin is also objectionable to workers. Worker protection standards must be high, and because of objectionable odor, it may be impractical to use in “pick-your-own” and ready-pick operations.

Growers will achieve further reductions in MB use where nutsedge is not a primary pest (representing about 60% of the industry, or 1333 ha) by changing the formulation to 57:43; this change can result in a 9% reduction in MB use by 2005(Table 24.2). By 2006, it may be feasible to use 50:50 mixtures with chloropicrin under plastic mulch beds to achieve further reductions (Table 24.1). Increasing the percentage of Pic can occur with the fewest obstacles to implementation, and can potentially reduce MB use by 15% in 2006 and 2007 (Table 24.3). It is more difficult to accomplish comparable reductions by formulation changes in nutsedge infested regions, as experience has shown that MB dosages below 30.2 g/m2 do not provide satisfactory nutsedge control. These growers will likely implement alternative methods, such as VIF or high barrier films that could reduce MB by one third. Ongoing research will help define the best approach. If the use of VIF or high barrier tarps proves effective, there is potential, in 2006 and 2007, to significantly reduce MB use from 140,216 kg to 93,947 kg (Table 24.4). 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 the current request), and a lowering of the average application rate for the region to 108 kg/ha.

Stepwise Reductions Proposed for the Eastern Region (January 2004)

Table 24.1. 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 24.2. 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 Consortium	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 24.3. 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 Consortium	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

Table 24.4. 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?

For the current nomination, the U. S. believes that MB is a critical treatment for strawberry producers until research protocols are developed that can describe effective soil treatments for the key pests. In the absence of heavy pest pressure and regulatory constraints, 1,3-D with chloropicrin, and metam sodium, may be feasible, and the U.S. request has been reduced to take into account areas that meet these circumstances. However, the following factors could make the alternatives inappropriate for commercial application:

- Regulatory constraints such as township caps, buffer zones, and karst geology
- Heavy pest pressure such as nutsedge where tests can not confirm reliability of alternative
- Phytotoxicity from alternatives
- Significant variation in yields from season to season
- Significantly increased costs due to delays in planting with alternatives
- Increased costs due to change of harvest time and missing optimal market window
- Reduced vigor of starter plants if strawberry nurseries cannot use MB

U.S. researchers are continuing their efforts to find and commercialize alternatives.
In addition, significant efforts have been made to reduce the use and emissions of MB associated with strawberries. For example, strawberry producers in California have routinely integrated sustainable and environmentally compatible techniques into their production system. These strategies include the use of insects for biological control, and many techniques that limit losses to disease, including use of crop rotation, alternating fungicides to limit resistance buildup, clean tillage, water management and field sanitation. Still, soil treatments are required. For 2007, in the absence of defined methods for MB alternatives that can effectively be used in commercial production, MB is critical for strawberry production.

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

Methyl Bromide Critical Use Exemption Process

2007 Methyl Bromide Usage Numerical Index (BUNI)

Date: 1/28/2005

Sector: STRAWBERRIES

Average Hectares in the US: 20,356

% of Average Hectares Requested: 66%

	2007 Amount of Request			2001 & 2002 Average Use*			Quarantine and Pre-Shipment	Regional Hectares**		Research Amount (kgs)
REGION	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)		2003 Hectares	Requested %	
CALIFORNIA	1,451,494	8,094	179	1,601,966	8,184	196	0%	11,979	68%	2377
EASTERN US	359,841	2,377	151	278,967	1,851	151	0%	2,469	96%	
FLORIDA	579,691	2,873	202	501,446	2,711	185	0%	2,873	100%	
TOTAL OR AVERAGE	2,391,026	13,344	179	2,382,379	12,747	187	0%	17,321	77%	

2007 Nomination Options	Subtractions from Requested Amounts (kgs)					Combined Impacts Adjustment (kgs)		MOST LIKELY IMPACT VALUE		
REGION	2007 Request	(-) Double Counting	(-) Growth	(-) Use Rate Adjustment	(-) QPS	HIGH	LOW	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)
CALIFORNIA	1,451,494	-	-	-	-	1,378,920	1,233,770	1,267,880	7,070	179
EASTERN US	359,841	-	80,873	-	-	178,539	161,801	165,735	1,100	151
FLORIDA	579,691	-	78,245	-	-	320,925	290,839	297,909	1,611	185
Nomination Amount	2,391,026	2,391,026	2,231,908	2,231,908	2,231,908	1,878,384	1,686,410	1,731,524	9,780	177
% Reduction from Initial Request	0%	0%	7%	7%	7%	21%	29%	28%	27%	1%

Adjustments to Requested Amounts	Use Rate (kg/ha)		(%) Karst (Telone)		(%) 100 ft Buffer Zones[1]		(%) Key Pest Distribution		Regulatory Issues (%)[2]		Unsuitable Terrain (%)		Cold Soil Temp (%)		Combined Impacts (%)[3]	
REGION	Low	EPA	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	HIGH	LOW
CALIFORNIA	179	179	0	0	0	0	0	0	94	82	15	15	0	0	95%	85%
EASTERN US	151	151	0	0	40	40	40	30	0	0	0	0	0	0	64%	58%
FLORIDA	185	185	40	40	1	1	40	30	0	0	0	0	0	0	64%	58%

Other Considerations	Dichotomous Variables (Y/N)						Other Issues			Economic Analysis				Quality/ Time/ Market Window/ Yield Loss (%)	Marginal Strategy
REGION	Strip Bed Treatment	Currently Use Alternatives?	Research / Transition Plans	Tarps / Deep Injection Used	Pest-free Cert. Requirement	Adopt New Fumigant	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 Operating Revenue		
CALIFORNIA	No	Yes	Yes	Tarp	No		-	Yes	1/year	$ 11,817	$ 59	16%	87%	14% Yield Loss	1,3-d+pic
EASTERN US	Yes	Yes	Yes	Tarp	No		+	Yes	1/year	$ 9,319	$ 62	18%	42%	14% Yield Loss	1,3-d+pic
FLORIDA	Yes	Yes	Yes	Tarp	No		0	Yes	1/year	$ 6,720	$ 33	12%	62%	14% Yield Loss	1,3-d+pic

1 Buffer Zones were reduced from 300 feet to 100 feet, therefore the impact estimate has been reduced from 90% to 40%.

2 The Regulatory Issues impact estimate has been adjusted for California. Their original request already reflected Regulatory Issues impacts.

3 Combined Impacts were revised on 3/31/04 due to the above mentioned adjustments.

Most Likely Impact Value: High 24% Low 77%

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. **<u>Average Hectares in the US</u>** – 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. **<u>% of Average Hectares Requested</u>** - 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. **<u>2007 Amount of Request</u> –** The 2007 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. **<u>2001 & 2002 Average Use</u> –** 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. **<u>Quarantine and Pre-Shipment</u> –** Quarantine and pre-shipment (QPS) hectares is the percentage (%) of the applicant's request subject to QPS treatments.
6. **<u>Regional Hectares, 2001 & 2002 Average Hectares</u>** – 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. **<u>Regional Hectares, Requested Acreage %</u>** - 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. **<u>2007 Nomination Options</u> –** 2007 Nomination Options are the options of the inclusion of various factors used to adjust the initial applicant request into the nomination figure.
9. **<u>Subtractions from Requested Amounts</u>** – Subtractions from Requested Amounts are the elements that were subtracted from the initial request amount.
    10. **<u>Subtractions from Requested Amounts, 2007 Request</u> –** Subtractions from Requested Amounts, 2007 Request is the starting point for all calculations. This is the amount of the applicant request in kilograms.
    11. **<u>Subtractions from Requested Amounts, Double Counting</u>** - 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. **<u>Subtractions from Requested Amounts, Growth or 2002 CUE Comparison</u>** - 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 2007 request from an applicant's 2002 CUE application compared with the 2007 request from the applicant's 2003 CUE application.
    13. **<u>Subtractions from Requested Amounts, QPS</u>** - 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 2007 Request minus Double Counting, minus Growth or 2002 CUE Comparison then

multiplied by the percentage subject to QPS treatments. *Subtraction from Requested Amounts, QPS = (2007 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 2007 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 geology** – Percent karst geology 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 geology.

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 geology, 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 geology.

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 2007 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 B. Transitional Issues for Strawberry growers in Northern California

December 17, 2004
By Dan Legard, California Strawberry Commission

There are two options for using methyl bromide alternatives in northern California. The first is broadcast applications of Telone C35 or straight chloropicrin. This option is attractive because it fits into the current production practices (i.e. fumigation method) that growers use with methyl bromide. However, neither of these options currently provides sufficient savings on the cost of the fumigation to offset the increase weeding costs and higher risk associated with using the alternatives for many growers. For chloropicrin, the County Agricultural Commissions are currently hesitant to allow growers to broadcast fumigate in Monterey and Santa Cruz Counties due to concerns that this would result in an increase in public complaints relating to fumigants since a majority currently are associated with exposure to chloropicrin. There is not a similar concern with fumigations using Telone C35 or methyl bromide even thought chloropicrin is also a major component of those fumigations. This is probably an education issue and we are planning to work with the chloropicrin task force on educating growers and Ag Commissions in the safe use of straight Pic.

The main concern associated with broadcast fumigation with Telone C35 is related to the Telone township cap. There are different emission ratios used for the different application methods that adjust the amount of Telone applied to the township cap. The lbs used are “adjusted” by the following factors (1x for deep shank, 1.1x for drip applied, 1.8x for shallow shank). Hopefully, most growers would use deep shank where possible for broadcast Telone applications. However, broadcast applications still involve treating approximately 40% more acreage than drip (2 row bed and slightly lower for 3 and 4 row beds, which are becoming more popular in the North).

The second option for growers switching from methyl bromide is the use of drip applied Inline or chloropicrin. The main issue for drip applied fumigants is that the entire field and irrigation equipment must be set up before you can apply the fumigants. Growers here have told me that this requires at least an additional 2-3 weeks longer than with broadcast fumigation. The extension of this time is not a serious problem on fields with short day cultivars like Camarosa, however, it is an important problem on fields with day-neutral cultivars like Diamonte (a majority of the acreage in the Watsonville / Salinas area).

On ranches growing predominantly day-neutral (long day) cultivars the production season overlaps with the next crops planting season, so fields of day-neutral cultivars are typically rotated with vegetable crops (i.e. half the ranch is planted in strawberry and the other half is rotated out each year). The normal cycle is strawberry (September 04 – November 05) followed by two vegetable crops (November 05 – September 06) then back to strawberry (September 06 – November 07). The value of the October / November fruit harvests from the day-neutral cultivars is so high that growers cannot shorten the length of their season (not economically possible since this is when most ranches breakeven and make their profit). The need for an additional 2-3 weeks to prepare a field for drip fumigation forces strawberry growers to take back the land from the rotation vegetable growers 2-3 weeks earlier. Normally, vegetable growers can produce two crops between the strawberry rotations. However, the shortening of the season by 2-3 weeks would cause result in only one vegetable crop on 80% of the land instead of two. Land sublease rates to vegetable growers are approximately $1000 for one crop and $1800 for two (the land leases for $2200 for full year). Therefore, strawberry growers would need to absorb the $800 increase in rent on 80% of their crop acreage due to the loss of one of the two vegetable crops.

A second issue with the transition to drip applied fumigants is the need to setup the entire irrigation system before they fumigate. In the traditional production system (i.e. broadcast fumigation), growers migrate most of their irrigation headers and other main line pipes over from the previous season's crop to the new after the end of that season (in November/December/January). However, with drip applied fumigants growers will need two sets of this equipment, an increased cost that is difficult for many growers to absorb. It is difficult to get firm prices on this but I have an estimate of $500 / acre for the additional equipment. Another related issue is that growers cannot use drip applied fumigants on land that has not had strawberries on it before due to a similar issue. The main valves and pipes for the irrigation system need to be setup for strawberry, and this can't be done while another crop is in the ground, and there is insufficient time put this equipment in and setup for drip applied fumigation. Growers in this situation will have to use broadcast fumigation for the first year on new non-strawberry ground.

APPENDIX C. 2006 Methyl Bromide Reconsideration for Strawberry Fruit.

Overview of the U.S. Nomination

The U.S. is requesting 1,918.4 metric tons of methyl bromide for use on field grown strawberries in California (1,452.732 metric tons), Florida (310.997 metric tons) , and the southeastern U.S. (152.294 metric tons).

The U.S. nomination is only for those areas where the alternatives are not suitable. In U.S. 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 U.S. 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.

MBTOC recommended that 1,520.803 metric tons of methyl bromide be allocated to this use as follows: Florida, 224.142 metric tons, the southeastern U.S. 134.476 metric tons, and California 1162.186 metric tons.

MBTOC reasons that the amount calculated by the USG was predicated on a 1X township cap but that the ‘Ornamental’ portion of the U.S. nomination indicates that a greater availability of 1,3-D is expected for 2006. MBTOC further argues that there are available substitutes for methyl bromide and cites “Porter, in press”, to justify a 20% reduction in the nominated amount. MBTOC states that Pic EC® or metam and pic are ‘technically suitable’ for Florida and the southeastern US. MBTOC also states that reduced dosage is appropriate because the treated portion of the beds can be held to 200kg/ha and because dosages can be reduced when higher density films (including VIF) are used, citing Fennimore et al 2005 and Gilreath et al 2003.

The U.S. nomination for strawberry field grown strawberry fruit is a critical need for an amount of methyl bromide 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 methyl bromide. 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 methyl bromide 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 methyl bromide formulations and adopting even more impermeable barriers.

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.

a. Township caps

MBTOC indicates their understanding that the nomination was based on 1X township caps. In fact, a weighted average of expected probability of 1X and 2X cap was used in developing the U.S. request, so the MBTOC assumption on this issue is incorrect[1]. MBTOC reasons that the availability of 1,3,-D for strawberry production will be greater than the 1X township cap but this is by no means certain (see footnote below). MBTOC cites the 'Ornamentals' section of the nomination to bolster their assertion. The 'Ornamentals' section was in error, and the USG thanks MBTOC for noting this discrepancy (which has now been corrected).

b. Alternatives are technically and economically feasible so a 20% reduction for phase-in of alternatives such as 1,3-D/Pic or metam sodium was used: alternatives can be used in areas where 1,3-D is not appropriate

MBTOC appears to disagrees with the U.S. assessments of yield loss.

The U.S. assessments of yield loss were developed from technically appropriate studies relevant to the specific circumstances of the U.S. situation. Technically appropriate studies are those which:

- Included an untreated control for comparison purposes
- Included information on the (key) pests present in the treated area
- Give estimates of yield changes (differences)
- Include methyl bromide as a standard

[1] In practice, the weights applied were 1/3 of the 2X cap and 2/3 of the 1X cap. In the current judgment of USG experts this places too much likelihood on an increased township cap. In repeated conversations with State of California pesticide regulators, USG has been given no indication that the township caps would be raised beyond the temporary increase in the cap except as negotiated in individual agreements. In order to be eligible for an increased cap amount under these agreements, a township must have an unused (banked) amount available to increase the cap. As the program currently stands, only townships with banked amounts can increase their use of 1,3-D above the 1X cap. As townships exceed the 1X cap they lose their ability to increase the caps by depleting their 'banked' amount.

The U.S. nomination was restricted to those situations where ‘key’ pest pressure was moderate to severe[2] and where these pests could not be controlled by alternatives and, therefore, would result in yield loss.

MBTOC used what they describe, interchangeably as a “meta analysis” or an ‘average’. The procedure MBTOC used was not a meta analysis in the sense thata meta analysis includes only studies which are similar enough from a statistical standpoint that they can be combined and analyzed as if they comprised one study, and the studies need to be identified, appraised and summarized according to an explicit and reproducible methodology that is designed to answer a specific research question. In this case, the appropriate research question would be the performance of alternatives to methyl bromide under the conditions of the U.S. nomination (i.e. with moderate to severe pressure from key pests). The null hypothesis would be that alternatives work as well as methyl bromide in the circumstances of the U.S. nomination. The U.S. nomination is specifically for the use of methyl bromide where key pests (pests not adequately controlled by alternatives to methyl bromide) are present at moderate to severe levels and/or soil, climate, terrain, or regulatory conditions are such that alternatives to methyl bromide either cannot be used or result in significant economic losses when used. These economic losses must be of sufficient magnitude that they render the alternative “not economically feasible”.

Although it is difficult to be certain how the MBTOC analysis was conducted and what it includes because it has not been reviewed and published and was not provided to the U.S. experts to evaluate[3], U.S. experts were able to make some educated guesses about the analysis[4]. The analysis for strawberry fruit is described in a paper is listed as being “in press” as conference proceedings with a date after the MBTOC recommendations on the U.S. nomination were tendered.

A version of the paper was presented by Dr. Ian Porter at the Methyl Bromide Alternatives Organization meeting in San Diego, November 2003 and the subject of considerable controversy and questioning among participants. Dr. Porter’s paper included a number of papers which U.S. experts believe are not representative of the specific conditions included in the U.S. nomination in determining the usefulness of alternatives because the research was carried out under conditions of no pest pressure[5]. If no pests are present any alternative, or indeed not using any pesticide at all, will all work equally well. By including situations where there is no pest

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[2] In the judgment of U.S. experts pressure was such that yield losses of the magnitude of those used in the economic assessment would be sustained.

[3] The U.S. requested two of the authors of the paper for references so that the studies included could be evaluated against the circumstances of the U.S. nomination, but to date the references have not been provided.

[4] Some of this material with references had been previously presented at the Methyl Bromide Alternatives Organization 2003 meeting (San Diego). At that time U.S. experts expressed their view that many if not most of the studies were not an appropriate application of the information.

[5] For example, some trials are used for residue tests. These tests are likely to be carried out in conditions of little or no pest pressure in order to have enough harvested fruit to to test for residue. The Porter paper does not indicate which of the studies that were used (but not cited) were for the purposes of examining pesticide residues.

pressure one in effect adds (many) "0" to the equation[6] describing the differences in yield between crops grown using methyl bromide and those grown using an alternative. This has the effect of lowering the average difference between yields using methyl bromide and yields using an alternative. If a sufficient number of "0" are added, the result will be to (falsely) eliminate the yield differences between methyl bromide and the alternative treatments.

In other studies, pests were present but they were not the same pests that were present in all of the U.S. circumstances. Taking the case of the southeastern U.S., for example, weeds, diseases, fungi, and nematodes all infest the crops. Some of these pests can be controlled with alternatives, but some of the weeds, in particular nutsedges (nut grasses), nightshades, and some hard seed coated weeds, cannot. Situations without weeds will show small or no yield losses when alternatives are used while the true situation when (key) weeds are present is that there are large yield losses[7]. Including these factors has the effect of adding "0" yield difference as many times as there are papers.

If the issue had been to average all results, describing an "average" worldwide situation, the procedure would be correct. However, The U.S. submitted requests for continued methyl bromide use only for situations with sufficiently high pest pressure (not average), which cannot be controlled by alternatives to methyl bromide.

The U.S. disagrees with the MBTOC assessment of yield loss in the specific circumstances of the U.S. nomination.

Market Windows

As to the component of economic loss that is a consequence of market timing, we believe that MBTOC has not accounted for losses arising from market windows.

Experts are familiar with the occurrence of high prices for fresh produce early in the season, prices which decline as the produce becomes abundant (and more familiar) later in the season. The U.S. has provided marketing data documenting the existence of these market windows and their effects on the revenue and profits earned by farmers. Farmers tell us that nearly all of their net revenue (approximately 90%) above cost is earned during the short period of high prices. For some crops, 75% of the economic loss is due to missing a market window rather than through smaller crops, lower fruit quality, or higher costs.

Many of the alternatives will cause farmers to miss the market window. For some alternatives, for example, the "plant-back" interval is 2-4 weeks longer, relative to methyl bromide plant back

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[6] The actual procedure was to add in yields expressed as a percentage of (anticipated) yield using methyl bromide. How this yield was estimated is puzzling as many of the studies did not include a methyl bromide control. Because there was no indication of pest pressure in many instances, many of the entries indicated yields of approximately 100%, obviating the differences between methyl bromide and the alternatives.

[7] So, for example, studies conducted in California, where there is less pressure for weeds will not give an accurate picture of the situation in the southeastern U.S. where nutsedge, nightshades, and hard seed-coated weeds are a major problem.

times. Requiring a longer interval before a crop can be planted will delay the harvesting, causing a farmer to miss a market window. Some alternatives also require a different bed preparation, which will also delay the planting time. The strawberry crop in California is one example of this situation.

> The main issue for drip applied fumigants is that the entire field and irrigation equipment must be set up before you can apply the fumigants. Growers here have told me that this requires at least an additional 2-3 weeks longer than with broadcast fumigation. The extension of this time is not a serious problem on fields with short day cultivars like Camarosa, however, it is an important problem on fields with day-neutral cultivars like Diamonte (a majority of the acreage in the Watsonville / Salinas area).
>
> On ranches crowing predominantly day-neutral (long day) cultivars the production season overlaps with the next crops planting season, so fields of day-neutral cultivars are typically rotated with vegetable crops (i.e. half the ranch is planted in strawberry and the other half is rotated out each year). The normal cycle is strawberry (September 04 – November 05) followed by two vegetable crops (November 05 – September 06) then back to strawberry (September 06 – November 07). The value of the October / November fruit harvests from the day-neutral cultivars is so high that growers cannot shorten the length of their season (not economically possible since this is when most ranches break even and make their profit). The need for an additional 2-3 weeks to prepare a field for drip fumigation forces strawberry growers to take back the land from the rotation vegetable growers 2-3 weeks earlier. Normally, vegetable growers can produce two crops between the strawberry rotations. However, the shortening of the season by 2-3 weeks would cause result in only one vegetable crop on 80% of the land instead of two. Land sublease rates to vegetable growers are approximately $1000 for one crop and $1800 for two (the land leases for $2200 for full year). Therefore, strawberry growers would need to absorb the $800 increase in rent on 80% of their crop acreage due to the loss of one of the two vegetable crops.
>
> A second issue with the transition to drip applied fumigants is the need to setup the entire irrigation system before they fumigate. In the traditional production system (i.e. broadcast fumigation), growers migrate most of their irrigation headers and other main line pipes over from the previous season's crop to the new after the end of that season (in November/December/January). However, with drip applied fumigants growers will need two sets of this equipment, an increased cost that is difficult for many growers to absorb. It is difficult to get firm prices on this but I have an estimate of $500 / acre for the additional equipment. Another related issue is that growers cannot use drip applied fumigants on land that has not had strawberries on it before due to a similar issue. The main valves and pipes for the irrigation system need to be setup for strawberry, and this can't be done while another crop is in the ground, and there is insufficient time put this equipment in and setup for drip applied fumigation. Growers in this situation will have to use broadcast fumigation for the first year on new non-strawberry ground.[8]

Losses result not only from missing market windows but also from the inability to plant other crops in rotation with strawberries, losing the revenue from these crops

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[8] Daniel Legard, PhD, personal communication, January 3, 2005.

USG experts have examined a “Porter paper in press”[9] and have a number of concerns with the applying the results of this paper in the context of the specific circumstances of the U.S. nomination. Although it has a ‘publication date” of one year later than the San Diego presentation, we find thatour concerns on this issue remain the same. The studies used in the meta analysis are not listed and no indication is given of the criteria used to include or exclude a study from the analysis.

A specific requirement of the Montreal Protocol findings is that they be made “in the circumstances of the nomination”. There is no indication that MBTOC considered the specific circumstances of the U.S. nomination (which are that methyl bromide is requested only for situations where regulatory concerns preclude use of an alternative or where there are ‘key’ pests present at moderate to severe levels, or where terrain conditions (temperature, topography) result in no alternative being technically and economically feasible). MBTOC has not cited research findings to support their contention that alternatives are both technically and economically feasible.The U.S. has relied upon and presented specific results in the circumstances of the nomination to support our request.

California

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-D 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.

Florida

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 geography). 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.

Southeastern U.S.

At moderate to severe pest pressure only MB can effectively control the target pests found in the southeastern U.S. In addition, the use of alternatives are limited in some areas because the soil overlays a vulnerable water table (karst geography). Finally, there are other areas where

[9] Porter,I., S. Mattner, R. Mann, R. Gounder, J. Banks, and P. Fraser. 1994. Strawberry Fruit Production and results from trials in Different Geographic Regions. A Presentation to the Methyl Bromide Alternatives Conference, Lisbon, September 1994.

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.

A requirement for obtaining a critical use exemption for methyl bromide under the Montreal Protocol is that there are no alternatives that are both technically and economically feasible. In making its assessment, MBTOC has ignored the issue of economic feasibility. Presented below are economic considerations for each of the regions applying for a critical use exemption.

TABLE 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.*

TABLE 2: 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 3: 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 4: 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

CALIFORNIA - TABLE 5: 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 6: 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 7: 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 as 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, strawberry farmers 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 strawberry fields 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 chloropicrin (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 30 m 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 labor costs for weeding and harvesting.

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 U.S. 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 U.S. 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 U.S. 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 U.S. 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 U.S. 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 U.S. 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% of California's strawberry areas are fumigated with methyl bromide, and 31% are fumigated with alternatives. Approximately 15% of the strawberry areas are on hillsides with slopes severe enough to make drip irrigation impractical.

Increased production preparation time would delay planting in the southern region of California 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 delay 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 U.S. 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 U.S. 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 U.S. dollars is estimated to be $96.52 per kilogram.

Southeastern 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 U.S. 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 U.S. 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 U.S. 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.

c. use of methyl bromide can be reduced because soil pests can be controlled with a use rate of 200kg/ha and because use of higher density films (including VIF) will allow pest control at lower dosages.

In making this assertion MBTOC has relied on the work cited in two papers, Fennimore et al, 2003 and Gilreath et al, 2003. Fennimore was contacted to determine whether, in his opinion, his work could be appropriately used to support lower application rates. His reply, reproduced below, indicates that he is very uncomfortable with this interpretation of his results[10].

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[10] From: Steven Fennimore [mailto:safennimore@ucdavis.edu]
Sent: Fri Jan 07 16:24:43 2005
To: Dan Legard
Cc: jmduniway@ucdavis.edu; haajwa@ucdavis.edu
Subject: MBTOC VIF stance

Hi Dan
I am a bit disturbed to learn from you that the some in MBTOC may have come to the conclusion that VIF will allow reduced rates of methyl bromide. While I stand behind my research that indicates clearly that the weed control efficacy of drip-applied chloropicrin and Inline are improved under VIF compared to standard film, these fumigants are used to control many other pests besides weeds. For example, results do not necessarily suggest that VIF improves phytopthora cactorum control. Our research results presented at MBAO are preliminary and we are currently preparing peer reviewed publications. When those are written we will have a more clear understanding of the potential benefits and limitations of VIF than we have now. I do believe that VIF offers real potential benefits, however I caution anyone to make policy decisions about VIF based on my preliminary results presented at MBAO

Steve Fennimore
Extension Specialist
University of California, Davis
1636 East Alisal St
Salinas, CA 93905
831-755-2896

Technical and Economic Assessment of MBTOC/TEAP Report.

We have not been provided by MBTOC with information on their technical assessment of the performance of alternatives, ortheir economic assessment on the impact of converting to alternatives. To support the MBTOC's recommended change in the U.S. request citations of the research references and economic assessments that led to the MBTOC conclusions are needed so we can understand the justification. The technical references should describe the species tested, pest numbers, concentrations, times, and commodity volumes. Economic references should describe the costs of converting from methyl bromide to alternatives, the impact of higher yield losses, longer plant back intervals, the economic feasibility if key market windows are missed, and the economic impact of a 20% transition to alternatives including estimates of management costs for more intensive programs and how the impact of less reliable alternatives is calculated. The sources of estimates of the extent of pest pressure should describe the rationale for using other estimates, a complete description of the questions, species being surveyed and quantitative levels used.

U.S. 2006 nomination

In summary, the USG strongly disagrees with MBTOC's contention that the U.S. request can be reduced and reiterates its request for an additional 397.597 metric tons of methyl bromide for a total of 1,918.4 metric tons of methyl bromide.

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