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 (Submitted in 2006 for 2008)

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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

TABLE OF CONTENTS

PART A: SUMMARY — ***7***
1. Nominating Party — 7
2. Descriptive Title of Nomination — 7
3. Crop and Summary of Crop System — 7
4. Methyl Bromide Nominated — 8
5. Brief Summary of the Need for Methyl Bromide as a Critical Use — 8
6. Summarize Why Key Alternatives Are Not Feasible — 9
7. Proportion of Crops Grown Using Methyl Bromide — 10
8. Amount of Methyl Bromide Requested for Critical Use — 11
9. Summarize Assumptions Used to Calculate Methyl Bromide Quantity Nominated for Each Region — 11

California - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE — ***12***
California - 10. Key Diseases and Weeds for which Methyl Bromide Is Requested and Specific Reasons for this Request — 12
California - 11. Characteristics of Cropping System and Climate — 12
California - 12. Historic Pattern of Use of Methyl Bromide, and/or Mixtures Containing Methyl Bromide, for which an Exemption Is Requested — 13

CALIFORNIA - PART C: TECHNICAL VALIDATION — ***14***
California - 13. Reason for Alternatives Not Being Feasible — 14
California - 14. List and Discuss Why Registered *(and Potential)* Pesticides and Herbicides Are Considered Not Effective as Technical Alternatives to Methyl Bromide — 18
California - 15. List Present *(and Possible Future)* Registration Status of Any Current and Potential Alternatives — 18
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 — 19
California - 17. Are There Any Other Potential Alternatives Under Development which Are Being Considered to Replace Methyl Bromide? — 21
California - 18. Are There Technologies Being Used to Produce the Crop which Avoid the Need for Methyl Bromide? — 22
California - Summary of Technical Feasibility — 23

Eastern US - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE — ***24***
Eastern US - 10. Key Diseases and Weeds for which Methyl Bromide Is Requested and Specific Reasons for this Request — 24
Eastern US - 11. Characteristics of Cropping System and Climate — 24
Eastern US - 12. Historic Pattern of Use of Methyl Bromide, and/or Mixtures Containing Methyl Bromide, for which an Exemption Is Requested — 26

EASTERN US - PART C: TECHNICAL VALIDATION — ***26***
Eastern US - 13. Reason for Alternatives Not Being Feasible — 26
Eastern US - 14. List and Discuss Why Registered *(and Potential)* Pesticides and Herbicides Are Considered Not Effective as Technical Alternatives to Methyl Bromide: — 29
Eastern US - 15. List Present *(and Possible Future)* Registration Status of Any Current and Potential Alternatives — 30

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 ___ 30
Eastern US - 17. Are There Any Other Potential Alternatives Under Development which Are Being Considered to Replace Methyl Bromide? ___ 30
Eastern US - 18. Are There Technologies Being Used to Produce the Crop which Avoid the Need for Methyl Bromide? ___ 31
Eastern US - Summary of Technical Feasibility ___ 31

Florida - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE ___ ***33***
Florida - 10. Key Diseases and Weeds for which Methyl Bromide Is Requested and Specific Reasons for this Request ___ 33
Florida - 11. Characteristics of Cropping System and Climate ___ 34
Florida - 12. Historic Pattern of Use of Methyl Bromide, and/or Mixtures Containing Methyl Bromide, for which an Exemption Is Requested ___ 35

FLORIDA - PART C: TECHNICAL VALIDATION ___ ***36***
Florida - 13. Reason for Alternatives Not Being Feasible ___ 36
Florida - 14. List and Discuss Why Registered *(and Potential)* Pesticides and Herbicides Are Considered Not Effective as Technical Alternatives to Methyl Bromide: ___ 39
Florida - 15. List Present *(and Possible Future)* Registration Status of Any Current and Potential Alternatives ___ 39
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 ___ 40
Florida - 17. Are There Any Other Potential Alternatives Under Development which Are Being Considered to Replace Methyl Bromide? ___ 41
Florida - 18. Are There Technologies Being Used to Produce the Crop which Avoid the Need for Methyl Bromide? ___ 42
Florida - Summary of Technical Feasibility ___ 42

PART D: EMISSION CONTROL ___ ***43***
19. Techniques That Have and Will Be Used to Minimize Methyl Bromide Use and Emissions in the Particular Use ___ 43
20. If Methyl Bromide Emission Reduction Techniques Are Not Being Used, or Are Not Planned for the Circumstances of the Nomination, State Reasons ___ 44

PART E: ECONOMIC ASSESSMENT ___ ***45***
21. Operating Costs of Alternatives Compared to Methyl Bromide Over 3-Year Period ___ 46
22. Gross and Net Revenue ___ 46
Summary of Economic Feasibility ___ 47

PART F. FUTURE PLANS ___ ***50***
23. What Actions Will Be Taken to Rapidly Develop and Deploy Alternatives for This Crop? ___ 50
24. How Do You Plan to Minimize the Use of Methyl Bromide for the Critical Use in the Future? ___ 52
25. Additional Comments on the Nomination ___ 54
26. Citations ___ 56

APPENDIX A. 2008 Methyl Bromide Usage Numerical Index (BUNI). ___ ***61***

APPENDIX B. List of Treatment Codes/Abbreviations Used For Treatment Applications In The Final Database 64

LIST OF TABLES

PART A: SUMMARY 7
Table 4.1: Methyl Bromide Nominated 8
Table A.1: Executive Summary 9
Table 7.1: Proportion of Crops Grown Using Methyl Bromide 10
California - Table 8.1: Amount of Methyl Bromide Requested for Critical Use 11
CALIFORNIA - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE 12
California - Table 10.1: Key Diseases and Weeds and Reason for Methyl Bromide Request 12
California - Table 11.1: Characteristics of Cropping System 12
California - Table 11.2: Characteristics of Climate and Crop Schedule 13
California - Table 12.1: Historic Pattern of Use of Methyl Bromide 13
CALIFORNIA - PART C: TECHNICAL VALIDATION 14
California – Table 13.0: Pesticide use data for major strawberry production regions in California 14
California – Table 13.1: Reason for Alternatives Not Being Feasible 15
California – Table 14.1: Technically Infeasible Alternatives Discussion 18
California – Table 15.1: Present Registration Status of Alternatives 18
California – Table 16.1: Effectiveness of Alternatives – Key Pest 1 19
Table 16.2. Effects of Soil Fumigation with Methyl Bromide/Chloropicrin (MB/CP) vs. Dichloropropene/Chloropicrin (DP/CP) on Yields (grams/plant) of Strawberry in 10 Studies 21
California – Table C.1: Alternatives Yield Loss Data Summary 21
EASTERN US - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE 24
Eastern US - Table 10.1: Key Diseases and Weeds and Reason for Methyl Bromide Request 24
Eastern US - Table 11.1: Characteristics of Cropping System 24
Eastern US - Table 11.2 Characteristics of Climate and Crop Schedule 24
Eastern US - Table 12.1 Historic Pattern of Use of Methyl Bromide 26
EASTERN US - PART C: TECHNICAL VALIDATION 26
Eastern US – Table 14.1: Technically Infeasible Alternatives Discussion 29
Eastern US – Table 15.1: Present Registration Status of Alternatives 30
Eastern US – Table C.1: Alternatives Yield Loss Data Summary 30
FLORIDA - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE 33
Florida - Table 10.1: Key Diseases and Weeds and Reason for Methyl Bromide Request 33
Florida - Table 11.1: Characteristics of Cropping System 34
Florida - Table 11.2 Characteristics of Climate and Crop Schedule 34
Florida - Table 12.1 Historic Pattern of Use of Methyl Bromide 35
FLORIDA - PART C: TECHNICAL VALIDATION 36
Florida – Table 15.1: Present Registration Status of Alternatives 39
Florida – Table 16.1: Effectiveness of Alternatives – Field Trials with Virtually Impermeable Films 1 40
Florida – Table C.1: Alternatives Yield Loss Data Summary 41
PART D: EMISSION CONTROL 43

Table 19.1: Techniques to Minimize Methyl Bromide Use and Emissions ____ 44
PART E: ECONOMIC ASSESSMENT ____ 45
Table 21.1: Operating Costs of Alternatives Compared to Methyl Bromide Over 3-Year Period 46
Table 22.1: Year 1 Gross and Net Revenue ____ 46
California - Table E.1: Economic Impacts of Methyl Bromide Alternatives ____ 46
Florida - Table E.2: Economic Impacts of Methyl Bromide Alternatives ____ 47
Eastern United States - Table E.3: Economic Impacts of Methyl Bromide Alternatives ____ 47
PART F. FUTURE PLANS ____ 50
Table 23.1 Summary of Research Results for Methyl Bromide Alternaives on US Strawberry 52
Minimize Use Table 24.1. Base information before implementation of stepwise reductions ____ 54
Minimize Use Table 24.2. Reductions for Step 1 – With adoption of 57:43 by non-nutsedge group. ____ 54
Minimize Use Table 24.3. Reductions for Step 1 – With adoption of 50:50 by non-nutsedge group in 2006 ____ 54
Minimize Use Table 24.4. Reductions for Step 2 – With adoption of High Barrier Films by Nutsedge ____ 54

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 2006 for 2008)

3. CROP AND SUMMARY OF CROP SYSTEM

This nomination is for 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 soil 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)
2008	**1,604,669**	**8,920**

* 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 2008, is 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 require MB for 2008, and until protocols are developed based on 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 2008, 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 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				
2008	**Kilograms**	1,270,058	378,607	579,691
AMOUNT OF NOMINATION*				
2008	**Kilograms**	1,244,656	137,334	220,302

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

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

In areas where alternatives have not been shown to sufficiently manage major pests economically, MB currently is considered to be necessary for acceptable fruit production for the 2008 production year. 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 2008, 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. Economic analyses of the situation in California suggest that "…per acre fumigant and weed-control costs are likely to increase, relative to methyl bromide…Economic viability is also affected by the revenues growers will obtain. This suggests that the field-level economic viability of alternatives cannot be evaluated independently of market-level effects…Acreage declines and price increases are significant for all alternatives in the anticipated 10-15% yield loss range" (Goodhue, et al, 2005). "Under the most likely scenario, industry revenue will decline by 6-17% due to the ban. The effects will differ by region, due to seasonal differences in demand and production, and the possibility of increased foreign competition" (Carter, et al, 2005).

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 small-scale farmers contend with yellow and purple nutsedges, which are significant problems in some areas more than others. Farmers with a lower incidence of nutsedge may be able to use other chemicals, such as chloropicrin, 1,3-D, and metam-sodium, 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 http://www.caves.com/fss/pages/misc/images/karst_map.gif, http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm, and (http://www2.nature.nps.gov/nckri/map/maps/engineering_aspects/davies_map_PDF.pdf). The porous nature of this geology prevents the use of 1,3-D because of risk of ground water contamination. In California, some areas are constrained from using 1,3-D, because of township caps. According to the California Strawberry Consortium approximately 47-67% of strawberry hectares cannot use 1,3-D due to regulatory restrictions. 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). Nevertheless, approximately 35-37% of 13,360 ha of strawberry land is not fumigated with MB, and "…the remaining acreage is being transitioned as quickly as possible without compromising responsible production practices" (California Strawberry Commission, 2005)

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**	**Eastern U. S.**	**Florida**
Year of Exemption Request	**2008**	**2008**	**2008**
Kilograms of Methyl Bromide	1,270,058	378,607	579,691
Use: Flat Fumigation or Strip/Bed Treatment	Flat Fumigation*	Strip / Bed	Strip / Bed**
Formulation *(ratio of methyl bromide/chloropicrin mixture)* to be used for the CUE	67:33	67:33	98:2***
Total Area to be treated with the methyl bromide or methyl bromide/Chloropicrin formulation *(m^2 or ha)*	6,295	2,500	2,873
Application rate* (kg/ha) for the **active ingredient**	202	151	202
Dosage rate* (g/m^2) of **active ingredient** used to calculate requested kilograms of methyl bromide	20.2	15.1	20.2

** For Flat Fumigation treatment application rate and dosage rate may be the same.*
*** 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.
- The use rate has been adjusted for strip treatment in the Eastern Strawberry Fruit Region and the Florida Strawberry Fruit Region. California uses flat fumigation and has not been adjusted.
- The nomination has also been adjusted by 5% for Low Permeability Films.
- Transition to alternatives has been calculated and the nomination has been adjusted to reflect the transition amount.

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 2008 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	9B											
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 (the requesting consortium estimated that 47-67% of strawberry fields cannot use 1,3-D because of restrictions). It is possible that MB use can be reduced, especially in Northern California, by using drip irrigation of 1,3-D—however, a 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:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	8,600	8,248	8,456	7,912	8,245	8,417 (est)
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)*	2,364,789	1,919,240	1,611,775	1,592,156	1,651,220	1,698,248 (est)
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 ACTIVE INGREDIENT (kg/ha)*	275	233	191	201	200	202
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	27.5	23.3	19.1	20.1	20.0	20.2

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

CALIFORNIA - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

According to the California Strawberry Commission (Dan Legard, personal communication; July, 2005):

> "Straight Pic and Pic + metam sodium sequential treatments are used in a small proportion of the strawberry acreage due to a combination of efficacy, regulatory and production system limitations. A review of the 2003 PUR [California Pesticide Use Report] data from Cal DPR [California Department of Pesticide Regulation] reveals that only 902.5 acres [366 ha] were treated with metam sodium compared to 26,480 acres [10,722 ha] treated with Pic combinations. This represents only 3% of the acreage with several counties showing 0 acres treated. Many County Ag Commissions discourage or prohibit metam sodium applications through strict permit conditions, the result of several fumigation accidents in the past. The use of Pic of Pic + metam applications was primarily restricted to Orange County with some use other counties (see Table 13.0). The main production issue with using metam is the need for an extended plant back time that lengthens the time needed to prepare the field for planting by up to 2 weeks. Pic alone applications have been shown to be less efficacious than methyl bromide + Pic, Telone + Pic or Pic + metam sodium. In the northern districts, where 50% (Santa Maria) to 90% (Monterey/Watsonville) of the acreage is planted to day-neutral cultivars, drip fumigation presents significant transitional issues due to the need to switch from broadcast to bed fumigation. This requires a significant increase in setup time for growers prior to fumigation and results in a loss of revenue from a vegetable crop not being able to be grown in rotation with the strawberry crop. Recent research suggests that Pic + high barrier films may prove to be a viable alternative. The California Strawberry Commission is conducting research to verify these results and working with the regulators to allow increased use of straight Pic applications."

Table 13.0: PESTICIDE USE DATA FOR MAJOR STRAWBERRY PRODUCTION REGIONS IN CALIFORNIA

County	Methyl Bromide	Chloropicrin	1,3-D	Metam Sodium	Pic only (= Pic -MB - 1,3-D)*
	Hectares treated with fumigant				
San Diego	188	230	7	0	34
Orange	365	676	25	38	286
Ventura	3003	3467	348	301	116
Santa Barbara	923	1665	672	24	70
San Luis Obispo	17	256	238	0	1
Monterey	2662	3317	596	0	59
Santa Cruz	1006	1111	115	3	-10
total	8164	10722	2001	366	556
% of total (Pic)	76%	100%	19%	3%	

*Negative values are due to recording errors in California Department of Pesticide Regulation database (2003)

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.	Possibly, in some situations
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	Possibly, in some situations
Metam sodium	Metam-sodium alone provides inconsistent nematode and weed control, most likely due to irregular distribution through soil.	Possibly, in some situations
Methyl iodide	Not currently registered in the U.S.	No
Nematicides	Addressed individually (e.g., 1,3-D).	Possibly, in some situations
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
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

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

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
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)	Native weed biomass (kg/ha) w/VIF [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*	Native weed biomass (kg/ha) w/HDPE [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
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)	3 (data from Oxnard, CA trial) [no pests identified]	Strawberry yield (%) relative to MB/Pic treatment w/VIF [1] 87 [2] 104 [3] 105 [4] 112 [5] 120 [6] 116 [7] 98 [8] 107 [9] 117 [10] 120 [11] 120	Strawberry yield (%) relative to MB/Pic treatment w/HDPE [1] 83 [2] 103 [3] 106 [4] 108 [5] 115 [6] 112 [7] 99 [8] 108 [9] 105 [10] 121 [11] 115	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**
[11] (448 kg/ha) MB/Chloropicrin (shank): [12] 392 kg/ha		[12] 111 *No significant difference between chemical trts; untreated significantly different from other trts (P=0.05).*	[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.

The California Strawberry Commission (Dan Legard, personal communication; July, 2005) stated that they are "…working aggressively to verify the suitability of Pic + high barrier films and overcome regulatory barriers to the use of straight Pic applications. The key to improving local permit conditions for the use of Pic may be through reduced emissions. If Pic can be retained within the treated bed for sufficiently long it will degrade (2 day half life), dramatically reducing emissions. Research on the use of high barrier films, salt/water furrow seals and other technology is under consideration by the Commission and should prove helpful in obtaining more permissive local permit conditions for using Pic and other alternatives. The same methods should be useful in reducing emissions of telone, leading to a significant increase in the amount of acres that can be treated with telone within the township cap restrictions."

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 for those areas where the alternatives have not been shown to be 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 (estimated to include 47-67% of strawberry-producing land). 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*), **Nematodes**: Root knot nematode (*Meloidogyne* spp.) **Weeds**: Yellow nutsedge (*Cyperus escultentus*), Purple nutsedge (*Cyperus rotundus*), Ryegrass (*Lolium* spp.)	At moderate to severe pest pressure, protocols for commercial application of alternatives have not been sufficiently developed to be implemented for the 2008 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).

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 (Alabama, Arkansas, Georgia, Illinois, Kentucky, Louisiana, Maryland, Mississippi, Missouri, New Jersey, North Carolina, Ohio, South Carolina, Tennessee, and Virginia)											
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 Southeastern Strawberry Consortium (2003) addressed the issue of the importance of crop schedules and timing of plant-back for their industry:

> "Upper Coastal Plain and Lower Central Piedmont strawberry acreage in North Carolina **must** be planted from 25-Sep to 1-Oct for growers in this area to achieve the kinds of yields that we are representing…(20,600 lb/A) [23,100 kg/ha]. Outsiders to our industry are often surprised to learn that even an extra week of delay in planting for the popular 'short day' type strawberry cultivars Chandler, Camarosa and Sweet Charlie, can result in reductions in yield potential of 15-20%, or more. A two week delay could potentially reduce yields by 50%, especially in a colder than normal fall and winter conditions, such as the in 2000-2001 season. In fact, at the Clayton Central Crops Research Station (Upper Coastal Plain) in a 2002-2003 strawberry plasticulture fumigation study involving Telone C-35 at 30 gal/A [278 L/ha], iodomethane 98:2 at 150 lb/A [168 kg/ha] and iodomethane 98:2 at 120 lb/A [135 kg/ha], it was learned that by planting on 27-Sep-02 we achieved an overall marketable yield of 21,791 lb/A [24,436 kg/ha] vs. 17,492 [19,615 kg/ha] for 4-Oct-02 and 10,287 lb/A [11,536 kg/ha] for planting on 11-Oct-02 (averaged over all 3 fumigants). This represents an actual reduction in yield of nearly 20% for a 1-week delay and 52% for a 2-week delay for Chandler fruit harvested in April-May 2003 (unpublished report –Poling and Schiavone). In addition, iodomethane at 150 lb/A [168 kg/ha] (75 lb/A in the bed) [84 kg/ha] produced a statistically significant higher yield than Telone C-35, and was statistically no different than the 120 lb/A [135 kg/ha] rate (Iodomethane 98:2) – suggesting some important cost savings are possible with shank injection of this fumigant. The anticipated label for Iodomethane 98:2 will permit a 1 week plant-back…At this stage, only MBC-33 (2 week plant-back), or iodomethane 98:2 (1 week plant-back – assuming that this product receives EPA registration in Sep-03) [it did not] will permit growers to achieve a timely planting, assuming that the fumigation is completed in mid-September."

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:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	1593	1694	1823	1879	2121	2166
Hectares and Use Rates presented are for the treated strip.						
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	All strip/bed					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kg)*	239,851	254,689	274,405	283,530	320,133	327,323
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	Pressurized injection at 20 cm depth – two shanks/bed (approximately 76 cm wide bed; 25 cm height at crown of bed)					
APPLICATION RATE OF ACTIVE INGREDIENT **(kg/ha)***	151	151	151	151	151	151
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	15.1	15.1	15.1	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	Possibly, in some situations
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	Possibly, in areas with primarily disease problems

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Metam sodium	Metam-sodium alone is not a technically feasible alternative because it provides unpredictable disease, nematode, and weed control.	Possibly, in some situations
Methyl iodide	Not currently registered in the U.S.	No
Nematicides	Addressed individually.	Generally, nematodes are not the only pests
Ozone	Ozone is not technically feasible alone because it doesn't control diseases and weeds.	No
NON CHEMICAL ALTERNATIVES		
Biofumigation	Biofumigation is not technically feasible because of the quantity of Brassica crop that would be needed to control target pests in strawberries (approximately three hectares would be required for every hectare of strawberry production). Incorporation of Brassica at these levels is likely to have allelopathic effects on the target crop. In addition, field trials of growing tomatoes in cabbage residue produced inconsistent and inadequate efficacy, and poor yield in two years out of three.	No
Solarization	Solarization, when used alone for pre-plant fumigation, is not technically feasible because it does not provide adequate control of a wide range of soil-borne diseases and pests. This process is highly weather dependent and works best in combination with IPM for control of pests and diseases. However, solarization only suppresses nutsedge at best. (Chase et.al., 1998; Egley, 1983)	No
Steam	Steam, although successfully used in greenhouse situations, when used alone in the field for pre-plant fumigation, is not operationally practical due to low application speeds and high energy requirements (1-3 weeks to treat one hectare). In addition results from field experiments steam treatment have been erratic.	No
Biological Control	Biological control is not technically feasible as a stand-alone replacement for methyl bromide because it does not provide adequate control of target pests (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

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
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
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

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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. Restrictive PPE requirements, and set or buffer space requirements.
1,3-D, chloropicrin	The alternative does not give effective control of nutsedge. Restrictive 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 an 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
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

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. In addition, planting schedules must be critical maintained to meet market demands. Use of some alternatives will result in the need for re-evaluating treatments (see Section 11-ii above).

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 for those areas where the alternatives have not been shown to be 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.

Only a small portion of the buffer zone would be available for alternatives, and the MB use for this sector would not be effectively different than the 2007 nomination. According to experts at the Department of Horticulture, North Carolina State University (personal communication): "There is a potential for use of both metham + Pic in approximately 10% of the buffer zones which are not subject to heavy nutsedge, and this option will be pursued by 1-2% of the growers in the Consortium in 2006 under the guidance of North Carolina State University researchers and Extension workers (under a grant from USDA). There is no opportunity to utilize Chloropicrin alone due to its poor control of any weeds."

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

<table>
<tr><th>REGION WHERE METHYL BROMIDE USE IS REQUESTED</th><th>KEY DISEASE(S) AND WEED(S) TO GENUS AND, IF KNOWN, TO SPECIES LEVEL</th><th>SPECIFIC REASONS WHY METHYL BROMIDE NEEDED</th></tr>
<tr><td rowspan="3">Florida</td><td>Diseases: Crown rot, (Phytophthora citricola, P. cactorum)</td><td rowspan="3">At moderate to severe pest pressure, protocols for commercial application of alternatives have not been sufficiently developed to be implemented for the 2008 season. The use of some alternatives are limited in certain 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, preliminary research results suggest that fumigant rates, including MB, might be lowered with similar 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). Larger scale trials for several seasons would have to confirm research trials.</td></tr>
<tr><td>Nematodes: Sting (Belonolaimus longicaudatus); Root-knot (Meloidogyne spp.)</td></tr>
<tr><td>Weeds: Yellow nutsedge (Cyperus esculentus); Purple nutsedge (Cyperus rotundus); Carolina Geranium (G. carolinianum); Cut-leaf Evening Primrose (Onoethera laciniata)</td></tr>
</table>

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											
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. In addition, the proportion of the current Florida strawberry crop that should not use 1,3-D because of karst geology is not known exactly but appears to be high in the major strawberry-growing areas of Florida. These areas are concentrated within a 40 km radius of Plant City, Florida on approximately 2,760 ha (2002 estimate (Rosskopf et al., 2005) in an increasingly populated region between Tampa and Orlando. Much of this area sits on limestone at, or near, the surface (http://www.caves.com/fss/pages/misc/images/karst_map.gif.

Planting schedule can be affected by another alternative, VIF tarp technology, which is being actively researched. Recently, Noling and Gilreath (2004) reported on demonstration trials comprising 17 commercial strawberry fields that were conducted by growers from 2000-2004. Results of these trials allowed the evaluation of the use of VIF and its efficacy when used in combination with reduced rates of MB. Results were promising, but conclusions reached concerning the technical aspects of VIF are consistent with the Party's contention that for the 2007 season, MB is critical for strawberry farmers in Florida. According to Noling and Gilreath:

> At many of the demonstration sites, problems were incurred during the plastic laying operation, in that tractor speeds needed to be reduced as low as 2 to 3 mph [3-5 kph], rather than 4 to 5 mph [6.4-8 kph], to properly install the plastic. Since the VIF plastics are not embossed, they have a tendency to slip from under the rear press wheels during installation causing stoppages in the plastic laying operation. Since the VIF mulch lack 'stretch' characteristics, utilizing marginally wider spool widths of plastic than typically used have improved laying characteristics in the field. There is also no question that these new VIF mulches will be more expensive (2x) in terms of material and labor costs to install, but use of VIF plastic mulches may become more cost effective as methyl bromide availability decreases and pricing increases in future years, and as growers acquire necessary skills in which to lay them. Clearly, growers intent on using VIF in the future will have to adapt to change by acquiring a more patient and problem solving attitude to utilize the new technology. It should also be recognized that these slower tractor speeds can also create a flow metering problem for accurate, uniform dispensing of methyl bromide; thereby requiring some possible changes in application equipment

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:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	2509	2509	2630	2792	2873	2873
Hectares and use rate presented are for the treated strip.						
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	All strip treatments					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kg)*	464,025	471,282	486,477	516,414	708,511	694,340
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					
APPLICATION RATE OF ACTIVE INGREDIENT (kg/ha)*	185	188	185	185	247	242
DOSAGE RATE OF ACTIVE INGREDIENT IN kg/ha*	18.5	18.8	18.5	18.5	24.7	24.2

** 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.	Possibly, in some situations, if use is allowed
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.	Probably not in Florida
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.	Possibly, in some situations
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; Noling and Gilreath, 2004) with VIF and 1,3-D/chloropicrin indicate nutsedge control may be achievable but rates and formulations are still be investigated for optimal efficacy.	Possibly in some situations but not in areas with moderate to severe pest infestation; may not be 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; Noling and Gilreath, 2004) 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.	Possibly in some situations but not in areas with moderate to severe pest infestation; may not be 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	Yes	Unknown
Methyl Iodide	Not registered for use in U.S.	Yes	Unknown
Propargyl bromide	Not registered for use in U.S.	N0	Unknown
Furfural	Not registered for use on strawberries	Not known	Unknown
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

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

FLORIDA – TABLE 16.1: EFFECTIVENESS OF ALTERNATIVES – FIELD TRIALS WITH VIRTUALLY IMPERMEABLE FILM

Summary[1] of the effect of reduced soil application rates of methyl bromide (MB) and chloropicrin used concurrently with virtually impermeable plastic mulch film (VIF) on subsequent plant growth, mortality, and pest control in 17 strawberry field demonstration trials from Fall 2000 through Fall 2004.

FARM LOCATION	MB FORMULATION	% MB RATE REDUCTION FROM TYPICAL RATE (392 kg/ha) w/LDPE[2]	NUMBER DEAD PLANTS/15 m ROW	NUMBER PLANT DECLINE/15 m ROW	WEED DENSITY/15 m ROW	NUMBER CROWN DIAMETER (cm)
Fall 2000						
1	67/33	0	0.640	0.325	0.737	0.425
2	67/33	50	ns[3]	ns	ns	nvd
3	67/33	50,100	0.281	0.441	0.001	0.001
4	98/0	0	ns	ns	ns	nvd[4]
5	98/2	0	--	--	0.508	0.379
6	67/33	50	ns	ns	ns	nvd
7	67/33	50	ns	ns	0.662	nvd
Fall 2001						
8	67/33	30,50	0.648	0.867	0.340	0.327
9	67/33	50,66	0.238	0.557	0.056	0.262
10	67/33	50	ns	ns	0.011	nvd
11	67/33	20,40	--	--	0.006	0.118
Fall 2002						
12	67/33	50	ns	ns	0.347	0.664
13	67/33	40	0.606	0.543	ns	nvd
14	67/33	50	0.389	0.717	0.808	nvd
Fall 2003						
15	67/33	45	0.804	0.559	0.371	nvd
16	67/33	25	0.292	0.156	ns	0.500
17	67/33	50	0.587	0.441	0.001	0.623

[1] From Noling, J. W., and Gilreath, J. P. 2004. Use of virtually impermeable plastic mulches (VIF) in Florida strawberry. Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions, 2004. http://www.mbao.org/2004/Proceedings04/001%20Noling%20paper.pdf.

[2] Low Density Polyethylene film

[3] NS-not statistically significant (probabilities could not be calculated), with no recorded incidence for measured plant parameter.

[3] NVD-general observation recorded for site visit to indicate no visual difference between rate and mulch treatments apparent.

Also, 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 (e.g., Noling and Gilreath, 2004).

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. Noling and Gilreath (2004) have conducted research trials with VIF and in research trials found significant effects of VIF use to reduce rates of MB. If further tests confirm these findings and if technical problems can be resolved, such as tractor speed of laying the film, potential metering issues, and cost and availability, VIF may have the potential to reduce rates of MB and possibly other fumigants, while maintaining or increasing efficacy.

FLORIDA SUMMARY OF TECHNICAL FEASIBILITY

The U.S. nomination is for those areas where the alternatives have not been shown to be 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). The use of 1,3-D is restricted as an alternative to MB in areas with karst geology. Maps showing areas of karst geology in Florida are available online (http://www.caves.com/fss/pages/misc/images/karst_map.gif, http://www.dep.state.fl.us/geology/geologictopics/sinkhole.htm, and http://www2.nature.nps.gov/nckri/map/maps/engineering_aspects/davies_map_PDF.pdf). The proportion of the current Florida strawberry crop that should not use 1,3-D because of karst geology is not known precisely, but appears to be high in the major strawberry-growing areas of Florida (see map). These areas are concentrated within a 40 km radius of Plant City, Florida on approximately 2,760 ha (2002 estimate) in an increasingly populated region between Tampa and Orlando(Rosskopf et al., 2005). Much of this area sits on limestone at, or near, the surface (http://www.caves.com/fss/pages/misc/images/karst_map.gif.

Another alternative, VIF tarp technology, is being actively researched. Recently, Noling and Gilreath (2004) reported on demonstration trials comprising 17 commercial strawberry fields that were conducted by growers from 2000-2004. Results were promising from a pest management perspective but their conclusions concerning the technical aspects of VIF are consistent with the Party’s contention that for the 2008 season, MB is critical for strawberry farmers in Florida. According to Noling and Gilreath:

> “At many of the demonstration sites, problems were incurred during the plastic laying operation, in that tractor speeds needed to be reduced as low as 2 to 3 mph [3-5 kph], rather than 4 to 5 mph [6.4-8 kph], to properly install the plastic. Since the VIF plastics are not embossed, they have a tendency to slip from under the rear press wheels during installation causing stoppages in the plastic laying operation. Since the VIF mulch lack ‘stretch’ characteristics, utilizing marginally wider spool widths of plastic than typically used have improved laying characteristics in the field. There is also no question that these new VIF mulches will be more expensive (2x) in terms of material and labor costs to install, but use of VIF plastic mulches may become more cost effective as methyl bromide availability decreases and pricing increases in future years, and as growers acquire necessary skills in which to lay them. Clearly, growers intent on using VIF in the future will have to adapt to change by acquiring a more patient and problem solving attitude to utilize the new technology. It should also be recognized that these slower tractor speeds can also create a flow metering problem for accurate, uniform dispensing of methyl bromide; thereby requiring some possible changes in application equipment.”

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. Ongoing work by Noling and Gilreath (2004) indicates that weed control might be achieved with lower rates of MB if used with VIF compared to MB with standard film. However, these findings must be confirmed on large scale plots and technical problems that were described in their report must first be resolved.

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 (e.g., Noling and Gilreath, 2004), 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 two weeks; and 3. Difficulty applying VIF under US production systems without damaging film.	Where VIF can be implemented, MB rates should decrease. 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, if it becomes 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

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.

Table 23.1 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 2008, is for those areas where the alternatives are not suitable, such as constraints due to regulatory, topographical, geological, or soil conditions. Furthermore, 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.

Noling and Gilreath (2004) found that "…with VIF it was possible to reduce the rate of methyl bromide to 196 kg ha^{-1} without a significant loss of weed control compared with methyl bromide applied at 392 kg ha^{-1} under LDPE". However, they found that at several of the field sites there were problems with laying the film and required reducing tractor speed for installation, lengthening the time of land preparation and potentially causing flow metering problems reducing "…accurate, uniform dispensing of methyl bromide". These problems may require the redesign of equipment. Adaptations to accommodate the lack of VIF stretch properties have been made by using wider spool widths, but costs are a significant issue for broad use in commercial applications. 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)

Minimize Use 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

Minimize Use 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

Minimize Use 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

Minimize Use 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

For further details regarding the transition plans for this sector please consult the national management strategy.

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 2008, 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. 2008 Methyl Bromide Usage Newer Numerical Index (BUNNI).

2008 Methyl Bromide Usage Newer Numerical Index - BUNNI					Strawberry Fruit	
January 24, 2006	Region	CA Strawberry Commission	Eastern Strawberry	Florida FFVA Strawberry	Sector Total or Average	Notes
Dichotomous Variables	Strip or Bed Treatment?	Flat Fumigation	Strip	Strip		
	Currently Use Alternatives?	Yes	Yes	Yes		
	Tarps / Deep Injection Used?	Tarp	Tarp	Tarp		
Most Likely Combined Impacts (%)	Karst -1,3-D Limitation (%)	0%	0%	40%		
	100 ft Buffer Zones (%)	0%	40%	1%		
	Key Pest Distribution (%)	100%	37%	37%		
	Regulatory Issues (%)	50%	0%	0%		
	Unsuitable Terrain (%)	15%	0%	0%		
	Cold Soil Temperature (%)	0%	0%	0%		
	Total Combined Impacts (%)	**100%**	**62%**	62%		
Most Likely Baseline Transition	(%) Able to Transition	0%	33%	33%		
	Minimum # of Years Required	0	7	7		
	(%) Able to Transition / Year	**0%**	**5%**	**5%**		
EPA Adjusted Use Rate (kg/ha)		202	130	130		
EPA Adjusted Strip Dosage Rate (g/m2)		20	20	20		
2008 Applicant Requested Usage	*Amount - Pounds* (Pounds)	*2,800,000*	*834,686*	*1,278,000*	*4,912,686*	
	Area - Acres (Pounds)	*15,555*	*6,178*	*7,100*	*28,833*	
	Rate (lb/A) (Pounds)	*180.01*	*135.11*	*180.00*	*170*	
	Amount - Kilograms (Metric)	**1,270,058**	**378,607**	**579,691**	**2,228,355**	
	Treated Area - Hectares (Metric)	6,295	2,500	2,873	11,668	
	Rate (kg/ha) (Metric)	202	151	202	191	
EPA Preliminary Value	**kgs**	**1,270,058**	**272,908**	**579,691**	**2,122,656**	
EPA Baseline Adjusted Value has been adjusted for:		MBTOC Adjustments, Double Counting, Growth, Use Rate/Strip Treatment, LPF Transition, and Combined Impacts				
EPA Baseline Adjusted Value	kgs	1,270,058	144,114	231,181	1,645,353	
EPA Transition Amount	kgs	(25,401)	(6,780)	(10,879)	(43,061)	
Most Likely Impact Value (kgs)	kgs	**1,244,656**	**137,334**	**220,302**	**1,602,292**	
	ha	**6,169**	**1,056**	**1,695**	**8,920**	
	Rate	**202**	**130**	**130**	**180**	
Sector Research Amount (kgs)		**2,377**	**2008 Total US Sector Nomination**		**1,604,669**	

1 Pound = 0.453592 kgs 1 Acre = 0.404686 ha

* ALL OF THE APPLICANTS HAVE BEEN ADJUSTED FOR STRIP TREATMENTS EXCEPT MICHIGAN WHO ADJUSTED ON THEIR OWN

Footnotes for Appendix A:

Values may not sum exactly due to rounding.

1. **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.
2. **Strip Bed Treatment** – Strip bed treatment is 'yes' if the applicant uses such treatment, no otherwise.
3. **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.
4. **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.
5. **Pest-free cert. Required** - This variable is a 'yes' when the product must be certified as 'pest-free' in order to be sold
6. **Other Issues**.- Other issues is a short reminder of other elements of an application that were checked
7. **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.

8. **<u>Quarantine and Pre-Shipment Removed?</u>** – This indicates whether the Quarantine and pre-shipment (QPS) hectares subject to QPS treatments were removed from the nomination.
9. **<u>Most Likely Combined Impacts (%)</u>** – 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.
10. **<u>(%) Karst geology</u>** – 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.
11. **<u>(%) 100 ft Buffer Zones</u>** – 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.
12. **<u>(%) Key Pest Impacts</u>** - 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.
13. **<u>Regulatory Issues (%)</u>** - 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.
14. **<u>Unsuitable Terrain (%)</u>** – 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.
15. **<u>Cold Soil Temperatures</u>** – 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.
16. **<u>Total Combined Impacts (%)</u>** - 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.
17. **<u>Most Likely Baseline Transition</u>** – Most Likely Baseline Transition amount was determined by the DELPHI process and was calculated by determining the maximum share of industry that can transition to existing alternatives.
18. **<u>(%) Able to Transition</u>** – Maximum share of industry that can transition
19. **<u>Minimum # of Years Required</u>** – The minimum number of years required to achieve maximum transition.
20. **<u>(%) Able to Transition per Year</u>** – The Percent Able to Transition per Year is the percent able to transition divided by the number of years to achieve maximum transition.
21. **<u>EPA Adjusted Use Rate</u>** - Use rate is the lower of requested use rate for 2008 or the historic average use rate or is determined by MBTOC recommended use rate reductions.
22. **<u>EPA Adjusted Strip Dosage Rate</u>** – The dosage rate is the use rate within the strips for strip / bed fumigation.
23. **<u>2008 Amount of Request</u>** – The 2008 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.
24. **<u>EPA Preliminary Value</u>** – The EPA Preliminary Value is the lowest of the requested amount from 2005 through 2008 with MBTOC accepted adjustments (where necessary) included in the preliminary value.
25. **<u>EPA Baseline Adjusted Value</u>** – The EPA Baseline Adjusted Value has been adjusted for MBTOC adjustments, QPS, Double Counting, Growth, Use Rate/ Strip Treatment, Miscellaneous adjustments, MBTOC recommended Low Permeability Film Transition adjustment, and Combined Impacts.

26. **EPA Transition Amount** – The EPA Transition Amount is calculated by removing previous transition amounts since transition was introduced in 2007 and removing the amount of the percent (%) Able to Transition per Year multiplied by the EPA Baseline Adjusted Value.
27. **Most Likely Impact Value** – The qualified amount of the initial request after all adjustments have been made given in total kilograms of nomination, total hectares of nomination, and final use rate of nomination.
28. **Sector Research Amount** – The total U.S. amount of methyl bromide needed for research purposes in each sector.
29. **Total US Sector Nomination** - Total U.S. sector nomination is the most likely estimate of the amount needed in that sector.

APPENDIX B. LIST OF TREATMENT CODES/ABBREVIATIONS USED FOR TREATMENT APPLICATIONS IN THE FINAL DATABASES

E-Mail Message from Ian Porter Dated December 23, 2005

As discussed during the bilaterals in Senegal, we undertook to provide you with a list of treatments that MBTOC would like some evaluation on as possible alternatives to replace methyl bromide in future CUN's. Allthough the list appears extensive often treatments are very similar and could be discussed this way if necessary although the more detail we get on individual treatments the better!! The treatments in bold are the highest priority (ie have shown good results in international studies) but I have indicated against the crop type other treatments for which we are aware of studies that shows their performance relative to MB.

#	Treatment Code	Treatment Description	Straw-berries	Comments
1	Cad	Cadusafos 2 + 1		Not registered in the United States.
2	DazNap	Dazomet; Napropamide	Yes	Combinations containing dazomet are not functionally possible due to the 30 – 50 day planting restrictions into plastic mulch, plus the 7 day off-gassing, followed by the 2-3 week *in situ* bioassay label requirements in the United States.
3	DazSol	Dazomet; Solarization	Yes	Solarization is not considered a viable alternative because of the loss of a crop while solarizing the soil (economic feasibility). Also see #2.
4	DMDS	Dimethyl Disulfide	Yes	Not registered in the United States.
5	Fen	Fenamiphos		Voluntary cancellation of all product registrations for fenamiphos, effective as of May 31, 2007
6	Fos	Fosthiazate 900 EC		Registered in March 2004 on Tomatoes Only not strawberries.
7	MI	MI (100)	Yes	MI 100 - Chemical not yet identified by MBTOC.
8	MNa	Metam Sodium	Yes	Referred to in Tomato and Strawberry CUN as chemical alternative.
9	**MNaCad**	Metam Sodium; Cadusafos		Refer to #1
10	**MNaFos**	Fosthiazate 500 EC; Metam Sodium		Refer to #6
11	MNaMes	Metam Sodium; *Erwinia amylovora* HrpN harpin protein (Messenger ™)	Yes	Harpin protein (Messenger ™); is registered on fruiting vegetables and berries but the U.S. has not found data from replicated trials under heavy pest pressure to evaluate.
12	**MNaNap**	Metam Sodium; Napropamide (Devrinol™)	Yes	Napropamide is registered on tomatoes and strawberries. Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
13	MNaPP	Metam Sodium; PlantPro 45	Yes	IR-4 "Minor crops registration group" dropped research on PlantPro 45, and PlantPro EC because of excessive crop injury and/or poor efficacy after 2003 (IR-4. 2003).
14	MNaPPFos	Metam Sodium; PlantPro 45; PlantPro 45; Fosthiazate 500 EC	Yes	Refer to #13.
15	MNaPPO	Metam Sodium; PPO	Yes	PPO - Chemical not yet identified by MBTOC.
16	MNaRootshld	Metam Sodium; fungus Trichoderma harzianum strain T-22 (Rootshield™)	Yes	Registered on fruiting vegetable crops but not strawberries. The U.S. has not found data from replicated trials under heavy pest pressure to evaluate.
17	MNaSol	Metam Sodium, Solarization	Yes	Refer to #3.
18	MNaTel	Metam Sodium; 1,3-dichloropropene (Telone™)	Yes	Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
19	**MNaTelNap**	Metam Sodium; Telone; Napropamide	Yes	Registered on tomatoes not strawberries. Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).

#	Treatment Code	Treatment Description	Straw-berries	Comments
20	MNaTelSol	Metam Sodium; 1,3-dichloropropene (Telone™), Solarization	Yes	Referred to in Tomato CUN as Non-chemical control (South-Eastern United States – Part C Technical Validation). Also see #3.
21	MycCom	Mycorrhizal, compost	Yes	The U.S. has not found data from replicated trials under heavy pest pressure to evaluate.
22	NaN3	Sodium Azide		Not registered in the United States
23	Oxa	Oxamyl (Vydate ™ n-methyl carbamate insecticide, nematicide)		As a nematicide this may be an effective alternative to 1,3-dichloropropene in multichemical combinations.
24	Pic	Chloropicrin	Yes	Referred to in Strawberry CUN in chemical alternative (Part C Technical Validation).
25	PicDazEnz	Dazomet; Dazomet; Sodium tetrathiocarbonate (Enzone ™); Chloropicrin	Yes	Sodium tetrathiocarbonate (Enzone ™) is registered but the U.S. has not found data from replicated trials under heavy pest pressure to evaluate. Also see #2.
26	PicDMDS	DMDS; Chloropicrin	Yes	Refer to # 4.
27	PicEC	Chloropicrin EC	Yes	Referred to in Strawberry CUN in chemical alternative (Part C Technical Validation).
28	PicECDaz	Chloropicrin EC, Dazomet	Yes	Combinations containing dazomet are not functionally possible due to the 30 – 50 day planting restrictions into plastic mulch, plus the 7 day off-gassing, followed by the 2-3 week *in situ* bioassay label requirements in the United States.
29	**PicECDazEnz**	Dazomet; Dazomet; Chloropicrin EC, Sodium tetrathiocarbonate (Enzone ™);	Yes	Refer to #2.
30	**PicECMNa**	Chloropicrin EC; Metam Sodium	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
31	**PicECMNa DiTera**	Metam Sodium; Chloropicrin EC; *Myrothecium verrucaria (*DITera ES ™)	Yes	*Myrothecium verrucaria (*DITera DF ™) is registered but the U.S. has not found data from replicated trials under heavy pest pressure to evaluate.
32	**PicECMNaEnz**	Metam Sodium; Chloropicrin EC; Sodium tetrathiocarbonate (Enzone ™)	Yes	Refer to # 29.
33	**PicECMNaFos**	Metam Sodium; Chloropicrin EC; Fosthiazate 500 EC	Yes	Refer to #6
34	**PicFosDev**	Devrinol 50WG; Chloropicrin; Fosthiazate 500 EC	Yes	Refer to #6
35	**PicMNa**	Metam Sodium; Chloropicrin	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
36	**PicMNaDiTera**	Metam Sodium; Chloropicrin; *Myrothecium verrucaria (*DITera DF ™)	Yes	*Myrothecium verrucaria (*DITera DF ™) is registered but the U.S. has not found data from replicated trials under heavy pest pressure to evaluate.
37	**PicMNaEnz**	Metam Sodium, Chloropicrin; Sodium tetrathiocarbonate (Enzone ™);	Yes	Refer to # 25.
38	**PicMNaFos**	Fosthiazate 500 EC; Chloropicrin; Metam Sodium		Refer to #6
39	**PicMNaNap**	Metam Sodium; Chloropicrin; Napropamide	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
40	**PicMNaSol**	Chloropicrin, Metam Sodium; Solarization	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation). Also see #3.
41	**PicNap**	Chloropicrin; Napropamide	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).

#	Treatment Code	Treatment Description	Straw-berries	Comments
42	**PicTel**	Chloropicrin ,Telone	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
43	**PicTelDev**	Telone; Chloropicrin; Napropamide (Devrinol™)	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
44	PPDev	PlantPro 45B EC; PlantPro 45B EC (3% iodine compound), Napropamide (Devrinol™ 50WG)	Yes	Refer to # 13.
45	PPFosDev	PlantPro 45B; PlantPro 45B; Fosthiazate 500 EC, Napropamide (Devrinol™ 50WG)	Yes	Refer to # 13.
46	TC17	1,3-dichloropropene (Telone™) plus Chloropicrin (17%)	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
47	TC17MNa	1,3-dichloropropene (Telone™); Metam Sodium		Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
48	TC17Nap	1,3-dichloropropene (Telone™); Napropamide (Devrinol™ 50WG)	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
49	TC17PicDev	1,3-dichloropropene (Telone™) plus Chloropicrin (17%); Napropamide (Devrinol™ 50WG)	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
50	**TC35**	1,3-dichloropropene (Telone™) plus Chloropicrin (35%)	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
51	**TC35Daz**	TC35, Dazomet	Yes	Refer to #2.
52	**TC35Dev**	TC35; Napropamide (Devrinol™)	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
53	**TC35EC**	TC35 EC	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
54	**TC35ECDaz**	Dazomet; TC35 EC	Yes	Refer to #2.
55	**TC35ECMNa**	Metam Sodium; TC35 EC	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
56	**TC35EC PicECDaz**	TC35 EC; Chloropicrin EC, Dazomet	Yes	Refer to #2.
57	**TC35ECTref Dev**	TC35 EC; Trifluralin (Treflan™), Napropamide (Devrinol™)		Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
58	**TC35MesTre f**	TC35; Harpin protein (Messenger ™); Trifluralin (Treflan™)		Refer to # 11.
59	**TC35MNa**	TC35, Metam Sodium	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
60	**TC35Nap**	TC35; Napropamide (Devrinol™)	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
61	**TC35Pic**	TC35; Chloropicrin	Yes	Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
62	**TC35PicTref Dev**	TC35; Treflan; Napropamide (Devrinol™); Chloropicrin		Referred to in Strawberry CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).

#	Treatment Code	Treatment Description	Straw-berries	Comments
63	**TC35Sol**	Solarization; TC35	Yes	See #3.
64	Vrlx	Vorlex CP	Yes	Registered cancelled in the United States.

Footnote: TC17 and TC17 are considered to be Telone™ (1,3-dichloropicrin) with 17% chloropicrin or Telone™ with 35% chloropicrin.