Methyl Bromide Critical Use Nomination for Preplant Soil Use for Peppers Grown in Open Fields on Plastic Tarpaulins

For Administrative Purposes Only:	
Date received by Ozone Secretariat:	
YEAR:	***CUN:***

Nominating Party:	The United States of America (U.S.)
Brief Descriptive Title of Nomination:	Methyl Bromide Critical Use Nomination for Preplant Soil Use for Peppers Grown in Open Fields on Plastic Tarpaulins

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

X Yes ☐ No

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

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

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

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

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PART A: SUMMARY

1. NOMINATING PARTY:

The United States of America

2. DESCRIPTIVE TITLE OF NOMINATION

Methyl Bromide Critical Use Nomination for Preplant Soil Use for Peppers Grown in Open Fields on Plastic Tarpaulins

3. CROP AND SUMMARY OF CROP SYSTEM

Peppers grown in Alabama, Arkansas, California, Florida, Georgia, Kentucky, Louisiana, Michigan, North Carolina, South Carolina, Tennessee, and Virginia. These crops are grown in open fields on plastic tarps, often followed by various other crops. Harvest is destined for the fresh market**.**

4. METHYL BROMIDE NOMINATED

TABLE 4.1: METHYL BROMIDE NOMINATED

YEAR	NOMINATION AMOUNT (KG)	NOMINATION AREA (HA)
2006	**1,572,181**	**10,640**

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

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

- pest control efficacy of alternatives: the efficacy of alternatives may not be comparable to methyl bromide in some areas, making these alternatives technically and/or economically infeasible for use in tomato production.
- geographic distribution of key target pests: i.e., some alternatives may be comparable to methyl bromide as long as key pests occur at low pressure, and in such cases the U.S. is only nominating a CUE for peppers where the key pest pressure is moderate to high such as nutsedge in the Southeastern U.S..
- regulatory constraints: e.g., 1,3 D use is limited in Georgia due to the presence of karst geology.
- delay in planting and harvesting: e.g., the plant-back interval for 1,3 D + chloropicrin is two weeks longer than methyl bromide + chloropicrin, and in Michigan an additional delay would occur because soil temperature must be higher to fumigate with alternatives. Delays in planting and harvesting result in users missing key market windows, and adversely affect revenues through lower prices.

Michigan, California, Florida, Southeastern U.S. (except Georgia and Florida), and Georgia are each presented as separate regions in this nomination to reflect the separate applications from growers in these areas. A brief description of their need for MB follows, also presented on a regional basis.

Michigan

In Michigan peppers, no currently available methyl bromide (MB) alternative exists that is technically feasible for the control of the key target pests, except 1,3-D + chloropicrin. The key pest is the soil fungi *Phytophthora capsici*, which can easily destroy the entire harvest from affected areas if left uncontrolled. While 1,3-D + chloropicrin provided some control in small plot trials with peppers and other vegetable crops in Michigan (Hausbeck and Cortright 2003), the level of control was lower than that afforded by MB. It is also noteworthy that *P. capsici* has recently been shown to occur in irrigation water in Michigan (Gevens and Hausbeck 2003). This will increase the likelihood of spread of this pathogen. It is also not yet clear whether these small-scale results accurately reflect efficacy of MB alternatives in commercial cucurbit production. Furthermore, regulatory restrictions due to concerns over human exposure and ground water contamination, along with technical limitations, result in potential economic infeasibility of this formulation as a practical MB alternative. Key among these factors are a delay in planting as long as 28 days, (which could lead to missing a key market window) due both to label restrictions and low soil temperatures, and a mandatory 30 meter buffer for treated fields near inhabited structures.

Based on the small-plot trial conducted on Michigan peppers (cited above), the best-case yield loss estimate for Michigan using the best available MB alternative (1,3-D + chloropicrin) is estimated to be 6 % typically. In untreated buffer areas, losses could approach 100 % in the worst-case scenario. There may also be unpredictable but potentially significant economic effects created by the planting delays (described above), which will disrupt the schedule of delivery of fresh pepper harvest to wholesale buyers.

California

California peppers are similar to Michigan, in that the critical pest controlled by MB currently is *P. capsici*. The other important pest targeted by MB use in this region is the root knot nematode. California is requesting MB for about 10 % of its pepper area, mainly along the coast. As in Michigan, climatological conditions in these coastal areas - primarily long periods of rainy, cloudy weather – exacerbate problems involving possible methyl bromide alternatives, particularly formulations of 1,3 D, which cannot be used when soils are very wet. Growers are also reporting lack of efficacy against both of these pests at the maximum label rates for this alternative. In addition, California has township caps that limit the amount of 1,3-D that can be used in a given area, as well as 100 meter buffer zones near inhabited structures. Urban encroachment is increasing dramatically in California coastal counties, making the buffer zone requirement more prevalent. These factors are present in the 10% of California pepper area that need MB.

Based on these factors, and studies of yield losses and pest control afforded by likely chemical alternatives to MB, our best-case scenario in the absence of MB is identical to that of Michigan:

we assume 1,3-D + chloropicrin is the best available alternative and will typically result in 6 % yield loss. The worst-case is 100 % loss in infested fields, if the reported lack of efficacy of this MB alternative spreads, and in the buffer areas that remain untreated.

Southeastern United States (Including Florida and Georgia)

In the Southeastern United States, including Florida and Georgia, MB is requested primarily for control of moderate to severe infestations of nutsedge weeds. *P. capsici* is also an important pest targeted currently with MB in these regions. Many growers also use MB against root-knot nematodes. Left uncontrolled, any of these pests could completely destroy the harvests from affected areas.

Of the currently available MB alternatives, metam-sodium offers inconsistent control of nutsedges and nematodes, while 1,3-D + chloropicrin provides adequate control of nematodes (Locascio et al. 1997, Eger 2000, Noling et al. 2000). However, metam-sodium has yield losses of up to 44 % compared to MB where weed infestations are moderate to severe (Locascio et al. 1997). Metam-sodium also creates a planting delay as long as 21 days to avoid risk of phytotoxic injury to crops compared to a 14-day delay for MB. Further, due to regulatory restrictions resulting from groundwater contamination concerns, 1,3-D + chloropicrin cannot be used in large portions of the southeastern United States due to the presence of karst geology, and anywhere in Dade county, Florida, where the majority of that region's peppers are grown. There is also a 28 day planting delay (vs. 14 days for MB) due to regulatory restrictions for 1,3-D + chloropicrin. In Florida particularly, growers are on a tight production schedule where buyers must place pepper transplants in fields at a certain time of the year (see Table 11.2 in the Florida region for details). Thus, if growers have only metam sodium for preplant pest control, they will be forced to fumigate earlier in their season, which in turn will force the fumigation schedule into rainy periods, an untenable situation since rain causes this and all other available fumigants to lose efficacy dramatically (Aerts, 2004).

Furthermore, trials of metam-sodium and 1,3 D + chloropicrin (and various combinations thereof) are based on small plot research trials conducted in the Southeastern United States on crops other than peppers. For fungi and nutsedge, no on-farm, large-scale trials have yet been done. Some researchers have also reported that these MB alternatives degrade more rapidly in areas where they are applied repeatedly due to enhanced metabolism by soil microbes (Dungan and Yates 2003, Gamliel et al. 2003). This may compromise long-term efficacy of these compounds and appears to need further scientific scrutiny.

In sum, neither of these MB alternatives is presently technically and economically feasible for control of key pests, and MB remains a critical use for peppers in the Southeastern United States.

TABLE A.1: EXECUTIVE SUMMARY.

Region		*Michigan*	*Southeastern U.S. except Georgia and Florida*	*Georgia*	*Florida*	*California*
AMOUNT OF NOMINATION*						
2006	**Kilograms**	11,852	82,535	261,804	1,149,588	63,558
	Application Rate (kg/ha)	48	150	150	150	142
	Area (ha)	246	550	1,743	7,654	447
AMOUNT OF APPLICANT REQUEST						
2005	**Kilograms**	16,107	210,911	347,183	1,230,822	181,437
	Application Rate (kg/ha)	48	150	150	150	179
	Area (ha)	334	1404	2312	8195	1012
2006	**Kilograms**	15,803	224,891	347,183	1,230,822	181,437
	Application Rate (kg/ha)	48	150	150	150	179
	Area (ha)	328	1497	2312	8195	1012
ECONOMICS FOR NEXT BEST ALTERNATIVE						
Marginal Strategy		1,3D+Pic	1,3D+Pic	1,3D+Pic	1,3D+Pic	1,3D+Pic
Yield Loss (%)		6%	29%	29%	29%	6%
Loss per hectare (US$/ha)		$2,629	$8,954	$7,368	$6,724	$1,194
Loss per kg Methyl Bromide (US$/kg)		$54	$60	$49	$45	$8
Loss as % of Gross Revenue (%)		11%	29%	21%	23%	6%
Loss as % of Net Revenue (%)		39%	76%	112%	73%	29%

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

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

For Michigan and California pests 1,3 D + chloropicrin is the only key alternative with efficacy comparable to MB. Regulatory restrictions due to human exposure concerns, combined with technical limitations, reduce its use. Key among these factors are a delay in planting as long as 30 days, due both to label restrictions and low soil temperatures, and mandatory 30 to 100 meter buffers for treated fields near inhabited structures.

For the Southeastern United States, including Florida and Georgia, metam-sodium and 1,3 D + chloropicrin are alternatives for nutsedges and nematodes, respectively, the key target pests in these regions. However, peppers treated with metam-sodium, the best available alternative, have an estimated 44 percent yield decrease compared to MB. 1,3 D + chloropicrin is infeasible because it cannot used on karst geology or in Dade county, Florida, and because there is a 28-day planting delay.

There is also evidence that the efficacy of 1,3-D and metam-sodium declines in areas where it is repeatedly applied due to enhanced degradation of methyl isothiocyanate, the active ingredient, by soil microbes (Ashley et al. 1963, Ou et al. 1995, Verhagen et al. 1996, Gamliel et al. 2003).

All other available MB alternatives are currently technically infeasible for U.S. peppers.

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 (AVERAGE OF 2001 & 2002 (HA))	PROPORTION OF TOTAL CROP AREA TREATED WITH METHYL BROMIDE (%)
Michigan	749	44
Southeastern U.S. except Georgia and Florida	3581	25
Georgia	2554	89
Florida	8215	103
California	9854	5
NATIONAL TOTAL*	24954	50

* *Includes States not requesting MB.*

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.

In Michigan, areas not treated apparently do not have any infestation (i.e., zero oospores per unit soil) of the key fungal pests. Applicant states that soil infestation is spreading in the region annually. In California, areas where MB is not used rely on 1,3D + chloropicrin and post-emergence fungicides to control the same pests.

In southeastern U.S., Florida, and Georgia, areas not treated do not have nutsedges or nematodes naturally present in pepper fields. Simple absence of all pests is the only reason these areas are not presently treated with MB.

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?

No. For further discussion of limitations please see Part 5 (above), and the region-specific discussions below.

8. AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

MICHIGAN - TABLE 8.1: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION:	**Michigan**	
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF METHYL BROMIDE	16,107	15,803
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT		
FORMULATION *(ratio of methyl bromide/chloropicrin mixture)* TO BE USED FOR THE CUE	67:33 or 50:50	67:33 or 50:50
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(ha)*	334	328
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	180	180
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	48	48
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	18	18
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	11.99 or 8.95	11.99 or 8.95

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

SOUTHEASTERN U.S. EXCEPT GEORGIA AND FLORIDA- TABLE 8.2: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION:	**Southeastern U.S. except Georgia and Florida**	
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF METHYL BROMIDE	210,911	224,891
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	Strip/Bed	Strip/bed
FORMULATION *(ratio of methyl bromide/Chloropicrin mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(ha)*	1404	1497
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	223	223
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	150	150
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	32 to 50.4	32 to 50.4
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	22.0 to 33.8	22.0 to 33.8

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

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

REGION:	**Georgia**	
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF METHYL BROMIDE	347,183	347,183
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	Strip/bed	Strip/bed
FORMULATION *(ratio of methyl bromide/Chloropicrin mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(m^2 or ha)*	2312	2312
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	224	224
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	150	150
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	**Approximately 58% of each acre is treated and covered with plastic mulch.**	
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE		

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

FLORIDA- TABLE 8.2: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION:	**Florida**	
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF METHYL BROMIDE	1,230,822	1,230,822
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	Strip/Bed	Strip/Bed
FORMULATION *(ratio of methyl bromide/Chloropicrin mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(m^2 or ha)*	8195	8195
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	223.9	223.9
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	150	150
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	24	24
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	16.1	16.1

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

CALIFORNIA - TABLE 8.2: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION:	**California**	
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF METHYL BROMIDE	181,437	181,437
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	Flat	Flat
FORMULATION *(ratio of methyl bromide/Chloropicrin mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(m^2 or ha)*	1012	1012
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	267.2	267.2
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	179	179
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	26.7	26.7
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	17.9	17.9

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

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

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

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

TABLE A.2: 2005 SECTOR REQUEST—PEPPER*

2005 Pepper Sector Request		**Michigan**	**Southeastern U.S. except Georgia and Florida**	**Georgia**	**Florida**	**California**
Applicant Request for 2005	Requested Hectares (ha)	334	1404	2312	8195	1012
	Requested Application Rate (kg/ha)	48	150	150	150	179
	Requested Kilograms (kg)	16,107	210,911	347,183	1,230,822	181,437

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

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

TABLE A.3: 2006 SECTOR NOMINATION--*

2006 (Sector) Nomination		Michigan	Southeastern U.S. except Georgia and Florida	Georgia	Florida	California
Applicant Request for 2006	Requested Hectares (ha)	328	1497	2312	8195	1012
	Requested Application Rate (kg/ha)	48	150	150	150	179
	Requested Kilograms (kg)	15,803	224,891	347,183	1,230,822	181,437
CUE Nominated for 2006	Nominated Hectares (ha)	246	550	1,743	7,654	447
	Nominated Application Rate (kg/ha)	48	150	150	150	142
	Nominated Kilograms (kg)	11,852	82,535	261,804	1,149,588	63,558

2006 Sector Nomination Totals	Overall Reduction (%)	22%
	2006 U.S. CUE Nomination (kg)	**1,569,337**
	Research Amount (kg)	**2,844**
	Total 2006 U.S. Sector Nominated Kilograms (kg)	**1,572,181**

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

MICHIGAN - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

MICHIGAN - 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
Michigan	Crown and root rots caused by the soil-borne fungus *Phytophthora capsici*.	Fumigation practices need to be completed by the first week of May to allow growers to plant early and capture the early market for premium prices, as well as ensuring demand for their crop during the entire growing season (especially during the mid and late season). In addition, yield losses of at least 6 % are possible with the next best alternative available (1,3 D + chloropicrin).

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

MICHIGAN - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	MICHIGAN
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Pepper transplants for fruit production
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual; generally 1 year
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Pepper – usually followed by an eggplant or pepper crop
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy loam; clay loam
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	1 time every 2 years
OTHER RELEVANT FACTORS:	Key marketing opportunities have been established with Michigan's vegetable crop diversification and aims toward stable demands in the late spring and through the summer for Midwestern markets.

MICHIGAN - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE FOR PEPPERS

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA Plant Hardiness zone 5b											
SOIL TEMP. *(°C)*	<10	10 - 15	15-20	20-25	20-25	20-25	20	10-15	<10	<10	<10	<10
RAINFALL *(mm)*	40	72	101	48	47	32	17	31	36	20	6	8
OUTSIDE TEMP. *(°C)*	0.2	7.4	12.1	17.5	20.6	20.9	18.1	8	2.4	-2.9	-8	-7
FUMIGATION SCHEDULE		X										
PLANTING SCHEDULE			X									
KEY MARKET WINDOW					X	X	X	X				

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

Michigan experiences heavy rainfall events across the entire state at any given moment of the growing season. Heavy rain events (over 25 mm) can trigger rapid root and crown rot development, and promote dissemination of *P. capsici* via irrigation sources (Gevens and Hausbeck 2003). Generally, there is no difference in the amount of infection depending on soil type. The pathogen is widespread and indigenous on almost all soil types in Michigan (Cortright 2003, Gevens and Hausbeck 2003).

Significant rainfall events (>25 mm) or cold soil temperatures (<4.4 °C) delay fumigation and planting with the MB alternatives 1, 3 D + chloropicrin and metam-sodium. Also, all fumigation practices need to be completed by the first week of May to allow growers to plant early and capture the early market (July-September).

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

Growers are using anti-drip valves to eliminate loss of MB at the end of rows when the machinery is removed from the ground. Michigan's use of MB for vegetable production has declined steadily since the mid-1990s, when growers switched to different application methods (i.e. from Flat Fumigation to tarped beds) and formulations (from 98 % MB to 67 % MB). Currently, all MB is applied to tarped beds, with 100% of low-density polyethylene sheeting and 95% of the acreage was treated with the 67:33 formulation. Since 2000, about 5% of the acreage has been treated with the 50:50 formulation of methyl bromide and chloropicrin.

Please see Table 12.1 for further information.

MICHIGAN - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE ON PEPPERS

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	88	96	98	117	126	135
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	No pepper area in Michigan uses flat fumigation application.					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	10,501	11,482	11,747	14,001	15,618	16,230
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)* [A]	67:33	67:33	67:33	67:33 or 50:50	67:33 or 50:50	67:33 or 50:50
METHODS BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Injected 20-25 cm	Injected 20-25 cm	Injected 20-25 cm	Injected 20-25 cm	Injected 20-25 cm	Injected 20-25 cm
APPLICATION RATE (KG/HA)FOR THE FORMULATION	180	180	180	180	180	180
DOSAGE RATE*(G/M^2) OF FORMULATION USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	17.9	17.9	17.9	17.9	17.9	17.9
APPLICATION RATE* (KG/HA) FOR THE ACTIVE INGREDIENT	120	120	120	120 89.6	120 or 89.6	120 or 89.6
APPLICATION RATE OF STRIP/ BED, G MB/ M^2	32.2	32.2	32.2	32.2 or 27.0	32.2 or 27.0	32.2 or 27.0

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

[A] Growers have just started switching to the 50/50 formulation of MB/Chloropicrin since 2000 (about 5% of production acreage) to reduce cost per acre

MICHIGAN - PART C: TECHNICAL VALIDATION -PEPPERS

MICHIGAN - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

MICHIGAN – 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 + chloropicrin	In small plot trials conducted in Michigan, this formulation showed some efficacy against the key pests. It should be noted that these trials had not been completed at the time results were submitted to the EPA. Plant loss was about 6 % as compared to 0 % with MB (Hausbeck and Cortright 2003). While this suggests that it may be technically feasible, large-scale trials have not been conducted to confirm the results. Furthermore, regulatory restrictions and Michigan's cool and wet soils result in a delay of up to 30 days in planting after treatment with this formulation. This results in growers missing key harvest windows, with consequent negative economic impacts (detailed in other sections below).	No
Metam-sodium	Control of the key pest is inconsistent at best (Locascio et al. 1997, Martin 2003). A small plot trial in progress on solanaceous crops in Michigan indicates that plots with metam sodium had higher plant loss than the untreated check plots (Hausbeck and Cortright 2003). It should be noted that these trials had not been completed at the time results were submitted to the EPA. Gilreath et al. (1994) found that metam-sodium treatments did not match MB in terms of plant vigor at the end of the season; *P. capsici* was, however, not present. In the cool conditions of Michigan, metam-sodium is likely to be slow to transform into the active ingredient (methyl isothiocyanate), which also suggests that pest control will not be as effective as with MB (Ashley et al. 1963).	No
NON CHEMICAL ALTERNATIVES		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Soil solarization	Michigan's climate is typically cool (less than 11 °C frequently through May) and cloudy, particularly early in the growing season when control of the key pests is particularly important. In Michigan, the growing season is particularly short (May to September), so the time needed to utilize solarization is likely to render the subsequent growing of crops impossible, even if it did somehow eliminate all fungal pathogens. Since solarization has shown promise in other crops and regions (e.g., tomatoes in Florida), the potential for adoption exists (Schneider et al. 2003). However, because of climate, solarization is not feasible in Michigan.	No
Steam	While steam has been used effectively against fungal pests in protected production systems, such as greenhouses, there is no evidence that it would be effective in open field pepper crops in Michigan. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to sterilize soil down to the rooting depth of field crops (at least 20-50 cm).	No
Biological Control	Biological control agents are not technically feasible alternatives to methyl bromide because they alone cannot control the soil pathogens that afflict peppers in Michigan. The bacterium *Burkholderiaia cepacia* and the fungus *Gliocladium virens* have shown some potential in controlling some fungal plant pathogens (Larkin and Fravel 1998). However, in a test conducted by the Michigan applicants, *P. capsici* was not controlled adequately in summer squash by either of these beneficial microorganisms.	No
Cover crops and mulching	There is no evidence these practices effectively substitute for the control methyl bromide provides against *P. capsici.* Control of *P.capsici* is imperative for pepper production in Michigan. Plastic mulch is already in widespread use in Michigan vegetables, and regional crop experts state that it is not an adequate protectant when used without methyl bromide. The longevity and resistance of *P. capsici* oospores renders cover crops ineffective as a stand-alone management alternative to methyl bromide.	No
Crop rotation and fallow land	The crop rotations available to growers in Michigan region are also susceptible to these fungi, particularly to *P. capsici*. Fallow land can still harbor *P. capsici* oospores (Lamour and Hausbeck 2003). Thus fungi would persist and attack peppers if crop rotation/fallow land was the main management regime.	No
Endophytes	Though these organisms (bacteria and fungi that grow symbiotically or as parasites within plants) have been shown to suppress some plant pathogens in cucumber, there is no such information for the other pepper crops grown in Michigan. Furthermore, the pathogens involved did not include *Phytophthora* species, which are arguably the greatest single threat to Michigan peppers.	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Flooding/Water management	Flooding is not technically feasible as an alternative because it does not have any suppressive effect on *P. capsici* (Allen et al. 1999), and is likely to be impractical for Michigan pepper growers. It is unclear whether irrigation methods in this region could be adapted to incorporate flooding or alter water management for pepper fields. In any case, there appears to be no supporting evidence for its use against the hardy oospores of *P. capsici*.	No
Grafting/resistant rootstock/plant breeding/soilless culture/organic production/substrates/plug plants.	Due to the paucity of scientific information on the utility of these alternatives as methyl bromide replacements in peppers, they have been grouped together for discussion in this document. There are no studies documenting the commercial availability of resistant rootstock immune to the fungal pathogens listed as major pepper pests. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of *Phytophthora* fungi. Soilless culture, organic production, and substrates/plug plants are also not technically viable alternatives to methyl bromide for fungi. One of the fungal pests listed by Michigan can spread through water (Gevens and Hausbeck 2003), making it difficult to keep any sort of area (with or without soil) disease free. Various aspects of organic production – e.g., cover crops, fallow land, and steam sterilization - have already been addressed in this document and assessed to be technically infeasible methyl bromide alternatives.	No
COMBINATIONS OF ALTERNATIVES		
Metam sodium + Chloropicrin	Trials in tomato have shown inconsistent efficacy of this formulation against fungal pests, though it is generally better than metam-sodium alone (Locascio and Dickson 1998, Csinos et al. 1999). Low efficacy in even small-plot trials indicates that this is not a technically feasible alternative for commercially produced peppers at this time. These studies apparently did not measure yield impacts, and did not involve peppers.	No
1,3 D + Metam-sodium	Trials in tomato have shown inconsistent efficacy of this formulation against fungal pests, though it is generally better than metam-sodium alone (Csinos et al. 1999). Low efficacy in even small-plot trials indicates that this is not a technically feasible alternative for commercially produced peppers in Michigan at this time. These studies apparently did not measure yield impacts, and did not involve peppers.	No

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

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

Table 14.1 Technically Infeasible Alternatives Discussion.

NAME OF ALTERNATIVE	DISCUSSION
None	Other than those options discussed elsewhere, no alternatives exist for the control of the key pests when they are present in the soil and/or afflict the belowground portions of pepper plants. A number of effective fungicides are available for treatment of these fungi when they infect aerial portions of crops. However, these infections are not the focus of MB use, which is meant to keep newly planted transplants free of these fungi.

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

MICHIGAN – 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:
Methyl iodide	Not registered in the U.S. for peppers. However, registration is currently being pursued only for tomatoes, strawberries, peppers, and ornamental crops.	Yes	Unknown
Furfural	Not registered in the U.S. for peppers. Registration is currently being pursued only for non-food greenhouse uses.	No (for peppers)	Unknown
Sodium azide	Not registered; no registration requests submitted to U.S.	No (for any crop/commodity)	Unknown
Propargyl bromide	Not registered; no registration requests submitted to U.S.	No (for any crop/commodity)	Unknown

MICHIGAN - 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:

As far as U.S. EPA can ascertain, virtually none of the studies on key MB alternatives has focused on peppers in Michigan's growing conditions. One exception to this situation can be summarized first, although this study was ongoing at the time it was submitted to EPA. This study is a field trial, conducted in small plots in 2003 in Michigan by M.K. Hausbeck and B.D. Cortright of Michigan State University. The study focused on a number of vegetable crops, including bell peppers. As of July 31, 2003, results indicated that 1,3 D + 35 % chloropicrin treatments (shank-injected at 56.7 liters/ha) showed approximately 6 % plant loss (due to *P. capsici*) – less than the 7 % loss seen in the untreated control plots. Metam-sodium (drip-applied at 58.7 kg/ha) showed a 13 % loss. Methyl iodide with either 50 % or 33 % chloropicrin (shank-injected, at either 46.1 or 36.8 kg/ha, respectively) showed only 2 % plant loss. However, methyl iodide is not registered for this crop in the U.S. at present. It should also be noted that (1) since the trial had not yet ended, statistical analysis on these figures was not conducted, (2) plant loss figures are for all vegetable crops combined, and (3) these plots were being carefully monitored and managed with post-plant prophylactic foliar fungicides (e.g., chlorothalonil and myclobutanil) – an optimal management scheme that will require time to enable growers to adopt.

In studies with other vegetable crops, 1,3 D + chloropicrin has generally shown better control of fungi than metam-sodium formulations (though still not as good as control with MB). For example, in a study using a bell pepper/squash rotation in small plots - conducted in the much warmer conditions of Georgia and without *P. capsici* as a component of the pest complex - Webster et al. (2001) found significantly lower fungal populations with 1,3 D + 35 % chloropicrin (drip irrigated or chisel injected, 146 kg/ha of 1,3 D), as compared to the untreated control. However, MB (440 kg/ha, shank-injected) lowered fungal populations even more. Methyl iodide had no significant suppressive effect, as compared to the untreated control. In another study, conducted on tomatoes in Florida, Gilreath et al. (1994) found that metam-sodium treatments did not match MB in terms of plant vigor at the end of the season; *P. capsici* was not present.

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

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3 D + Chloropicrin	*P. capsici*	0 – 6 % PLUS loss of revenue due to planting delays	6 % PLUS loss of revenue due to planting delays
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**6 – 100 % PLUS revenue losses due to planting delays; 6 % likely with the best alternative (1,3 D + chloropicrin)**

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

The critical use exemption applicant states that 1,3 D + chloropicrin, metam-sodium, furfural, propylene oxide, and sodium azide will continue to be the subjects of field studies of utilization and efficacy enhancement where *P. capsici* fungi are the target pests. Most of these alternatives are not currently registered for peppers, and there are presently no commercial entities pursuing registration in the United States. The regulatory restrictions on 1,3-D discussed elsewhere will also remain as negative influences on the economics of this MB alternative. The timeline for developing the above-mentioned MB alternatives in Michigan is as follows:
2003 – 2005: Test for efficacy
2005 – 2007: Establish on-farm demonstration plots for effective MB alternatives
2008 – 2010: Work with growers to implement widespread commercial use of effective alternatives.

Research is also under way to optimize the use of a 50 % MB: 50 % chloropicrin formulation to replace the currently used 67:33 formulation. In addition, field research is being conducted to optimize a combination of crop rotation, raised crop beds, black plastic, and foliar fungicides. Use of virtually impermeable film (VIF) will also be investigated as a replacement for the currently used low-density polyethylene (LDPE).

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

No. Soilless systems and greenhouse production are not in use for peppers in this region, and quick adoption is probably economically infeasible. Growers apply MB on fields with a history of fungal contamination, but it appears that most growing acreage in this region has moderate to severe infestations of *P. capsici* and other soil borne fungi, which thrive in cool and moist climates.

MICHIGAN - SUMMARY OF TECHNICAL FEASIBILITY

Based on the new trials conducted in vegetable crops in Michigan in 2003 (described above in Section 16), EPA has determined that only 1,3 D + chloropicrin has some technical feasibility against the key pest of peppers in this region. However, no large-plot studies have yet been performed to show commercial feasibility. Demonstration studies are planned (see Section 17 above). Important regulatory constraints on 1,3 D must also be kept in mind: a 21 – 30 day planting delay, mandatory 30 m buffers near inhabited structures – both of which will cause negative economic impacts that make the use of these MB alternatives infeasible. There is also potentially lower dissipation (and thus efficacy) of these compounds in the cool, wet soils of this region. These planting restrictions may thus be important factors inhibiting widespread grower adoption of this MB alternative. Potential yield losses associated with plant restrictions could be exacerbated because fumigation practices need to be completed by the first week of May to allow growers to plant early and capture the early market (July – September) and have their product available for premium prices, as well as ensuring demand for their crop during the entire growing season (especially during the mid and late season). Key marketing opportunities have been established with Michigan's vegetable crop diversification and aims toward stable demands in the late spring and through the summer for Midwestern markets.

Currently unregistered alternatives, such as furfural and sodium azide, have shown good efficacy against the key pests involved, although (Cortright, personal communication). However, even if registration is pursued soon (and EPA has no indications of any commercial venture planning to do so), these options will need more research on how to adapt them to commercial pepper production in Michigan.

There are also no non-chemical alternatives that are currently viable for MB replacement for commercial pepper growers. In sum, while the potential exists for a combination of chemical and non-chemical alternatives to replace MB use in Michigan pepper, this goal appears be at least a few years away.

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE ON PEPPERS

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA [U.S. States of Alabama, Arkansas, Kentucky*, Louisiana*, North Carolina, South Carolina, Tennessee and Virginia; *States added for 2005-2007] - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST FOR PEPPERS

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TARGET PESTS (WEED & PLANT-PARASITIC NEMATODES) PATHOGENS, AND [% DEGREE OF INFESTATION, IF REPORTED]	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED *(e.g. Effective herbicide available, but not registered for this crop; mandatory requirement to meet certification for disease tolerance)*
SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA	**1. Yellow and purple nutsedge** (*Cyperus esculentus, C. rotundus*); **[30%]** **2. Plant-parasitic nematodes** (*Meloidogyne incognita; Pratylenchus sp*) **3. Pythium root and collar rots** (*P.irregulare, P. myriotylum, P. ultimum, P. aphanidermatum*) **4. Crown and root rot** (*Phytophthora capsici*)	Only MB can effectively control the target pests found in the southeastern United States where pest pressures commonly exist at moderate to severe levels. Most, if not all of these states are limited in the use of the alternative 1,3-D because of underlying karst topography throughout the region. Halosulfuron, while effective against nutsedge, is only registered for use on row middles in peppers. Metam-sodium has limited pest control capabilities and should never be used as a stand-alone fumigant (Noling, 2003).

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE FOR PEPPERS

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Pepper transplants for fruit production
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual; generally 1 year
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Pepper – usually double-cropped with a high-value cucurbit crop (muskmelon, cucumber, or squash).
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy loam; clay loam
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	1 time per year; (either in spring or fall)
OTHER RELEVANT FACTORS:	There are two distinct pepper-growing systems: 1) a spring crop (fumigation cycle begins in January) and a fall crop (fumigation cycle begins in May). Methyl bromide is applied 1 time per year on an individual field. Pepper does not follow pepper in this rotation; peppers are rotated with another crop, often a high-value cucurbit, which also depends on MB fumigation.

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE – JANUARY FUMIGATION (SPRING, EARLY SUMMER HARVEST)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
CLIMATIC ZONE	U.S. Plant Hardiness Zones 6b, 7a, 7b, 8a, 8b											
FUMIGATION SCHEDULE	X	X	X									
PLANTING SCHEDULE		X	X	X								
KEY HARVEST WINDOW				X	X	X	X					

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - TABLE 11.3 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE – SPRING FUMIGATION (FALL HARVEST)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC
CLIMATIC ZONE	U.S. Plant Hardiness Zones 6b, 7a, 7b, 8a, 8b											
FUMIGATION SCHEDULE					X	X						
PLANTING SCHEDULE						X	X					
KEY HARVEST WINDOW								X	X	X	X	

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA – 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Peppers are generally produced using mechanized practices that involve deep injection (20 – 25 cm) of methyl bromide. Weeds, especially nutsedge, are the most serious concern precipitating MB use in both transplant beds and the field. Nutsedge species grow even under adverse conditions, resist traditional and modern methods of weed control, and are endemic to large tracts of pepper producing area in the Southeastern United States. Herbicides are applied to the row middles between raised production beds to manage grass and broadleaf weeds - but there are no currently registered herbicides that control nutsedges near pepper plants. In addition to weeds, soil-borne fungal pathogens and plant-parasitic nematodes are endemic to the region and nearly all production areas have severe infestations, thereby necessitating annual treatment with a broad-spectrum soil fumigant.

Alternatives like 1,3-dichloropropene and metam sodium require a 21 to 28-day interval before planting, compared to 14 days for MB. This interval can cause delays/adjustments in production schedules that could lead to missing specific market windows, thus reducing profits on pepper crops (Kelley, 2003).

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE ON PEPPERS, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE ON PEPPERS

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*[A]	809	830	880	809	809	991
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	Not available					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED [A] *(total kilograms)*	177,808	182,253	132,199	121,563	121,563	148,914
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*	No definitive/substantiated information available				67:33	67:33
METHODS BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	No information available				Injected 15 to 25 cm deep	Injected 15 to 25 cm deep
APPLICATION RATE (KG/HA) FOR THE FORMULATION	No information available					
APPLICATION RATE* (KG/HA) FOR THE ACTIVE INGREDIENT	220	220	150	150	150	150
DOSAGE RATE*(G/M^2) OF FORMULATION USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	No information available				32.0 to 50.4	32.0 to 50.4
APPLICATION RATE OF STRIP/ BED, G MB/M^2	No information available				22.0 to 33.8	22.0 to 33.8

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

[A] An increase in the acreage of peppers produced in the Southeastern U.S. is projected from 2003 through 2007. Although reasons vary from state to state; they include shifts in acreage from tobacco and peanut production to the production of peppers and other high-value vegetable crops. This nomination package also includes two new states (added since 2001): Kentucky and Louisiana.

[B] Based on estimated area: 2,023 to 2,415 m^2 (Lewis, 2003, personal communication).

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - PART C: TECHNICAL VALIDATION FOR PEPPERS

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA – 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 + chloropicrin	This combination will not adequately control nutsedge. 1,3-dichloropropene cannot be used in key pepper growing areas of the U.S. where karst topography exists due to ground-water contamination concerns. Where 1,3-dichloropropene use is allowed, set back restrictions (~ 100 meters from occupied structures; ~ 30 meters for emulsified formulations applied via chemigation) may limit the proportion of the field that can be treated. In addition, because of a 28-day waiting period between application and planting (compared to 14 days for MB), growers could lose half of the harvest season and miss higher-end market windows, mainly for spring fumigations (i.e., fall harvests). (SE Pepper Consortium, CUE # 03-0041).	No
Metam Sodium	Metam sodium provides limited and erratic performance at suppressing all major pepper pathogens and pests. Also, there is a 21-day waiting period at the time of application until planting compared to 14 days for MB. Such a delay causes the higher-end market windows to be missed—particularly for the spring plantings (i.e., fall harvests). Beginning the application cycle earlier is not an option since crops from the previous fumigation cycle must be cleaned up prior to metam application. (Georgia CUE # 03-0049; Kelley, 2003). Repeated applications of MITC (the breakdown product of metam sodium) are known to enhance its biodegradation (and reduce efficacy) as a result of increased populations of adapted microorganisms (Dungan and Yates, 2003).	No
NON CHEMICAL ALTERNATIVES		

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
Soil solarization	For nutsedge control in the southeastern United States, solarization is not technically feasible as a methyl bromide alternative. Response of *Cyperus* species to solarization is sporadic and not well understood; data show solarization to provide, at best, suppression of nutsedge populations (Chase et al. 1999). Research indicates that the lethal temperature for nutsedge tubers is $50^{o}C$ or higher. Trials conducted in mid-summer in Georgia resulted in maximum soil temperatures of 43 ^{o}C at 5 cm depth (Chase et al. 1999). Thus, solarization, even in the warmer months in southern states, did not result in temperatures high enough to destroy nutsedge tubers. Also, tubers lodged deeper in the soil would be completely unaffected. In addition, solarization would take fields out of production since it would be needed during the spring and into the summer months, which are optimal for pepper production.	No
Steam	Steam is not a technically feasible alternative for open field pepper production because it requires sustained heat over a required period of time (UNEP 1998). While steam has been used effectively against fungal pests in protected production systems, such as greenhouses, there is no evidence that it would be effective in open field pepper crops. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to sterilize soil down to the rooting depth of field crops (at least 20-50 cm).	No
Biological Control	Biological control agents alone cannot control nutsedge and/or the soil pathogens that afflict peppers. The bacterium *Burkholderiaia cepacia* and the fungus *Gliocladium virens* have shown some potential in controlling some fungal plant pathogens (Larkin and Fravel 1998). However, no biological control agent has been identified to effectively control nutsedge or *Phytophthora.* Therefore, biological control is not a stand-along replacement for methyl bromide in pepper crops. Only a limited number of biological organisms are effectively used to manage soil borne diseases and pests. Biocontrol agents are usually very specific regarding the organisms they control and their successful establishment is highly dependent on environmental conditions.	No
Cover crops and mulching	Cover crops and mulches have been integrated into solanaceous crop production systems. However there is no evidence these practices effectively substitute for the control methyl bromide provides against nutsedges (Burgos and Talbert 1996). Some cover crops that have been shown to reduce weed populations also reduced or delayed crop maturity and/or emergence, as well as yields (Burgos and Talbert 1996, Galloway and Weston 1996). Mulching has also been shown to be ineffective in controlling nutsedges, which are able to penetrate through both organic and plastic mulches (Munn 1992, Patterson 1998).	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Crop rotation and fallow land	Crop rotation/fallow is not a technically feasible alternative to methyl bromide because it does not provide adequate control of nutsedges or fungal pathogens. The crop rotations available to growers are also susceptible to fungi; fallow land can still harbor fungal oospores (Lamour and Hausbeck 2003). Tubers of the perennial nutsedges provide new plants with larger energy reserves than annual weeds that can be more easily controlled by crop rotations and fallow. (Thullen and Keeley 1975). Furthermore, nutsedge plants can produce tubers within 2 weeks after emergence (Wilen et al. 2003). This enhances their survival across different cropping regimes that can disrupt other plants that rely on a longer undisturbed growing period to produce seeds to propagate the next generation.	No
Flooding/Water management	Flooding has been used effectively to manage various soil borne pest and diseases, especially nematodes and some weeds. However, nutsedges have shown tolerance to this treatment. Submerging nutsedge tubers for 8 days to 4 weeks showed no effect on the sprouting capabilities of the tubers (Horowitz, 1972). Studies in Florida showed ineffective nematode, disease, and nutsedge control after flooding (Allen, 1999). Regulatory issues concerning water management, as well as economic feasibility, also preclude its viability as an alternative to methyl bromide. Land structure, frequent and severe droughts, and the economics of developing and managing flood capabilities prevent flooding from being a viable, cost effective alternative in the Southeastern United States.	No
Grafting/resistant rootstock/plant breeding/soilless culture/organic production/substrates/plug plants.	Due to the paucity of scientific information on the utility of these alternatives as methyl bromide replacements in peppers, they have been grouped together for discussion in this document. The U.S. EPA was unable to locate any studies showing any potential for grafting, resistant rootstock or plant breeding as technically feasible alternatives to methyl bromide control of nutsedges. Plug plants are extensively used on high value vegetable crops like pepper but they do not control competition from nutsedges. There are no studies documenting the commercial availability of resistant rootstock immune to the fungal pathogens listed as major pepper pests. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of *Phytophthora* and *Fusarium* fungi. Soilless culture, organic production, and substrates/plug plants are also not technically viable alternatives to methyl bromide for fungi. Various aspects of organic production – e.g., cover crops, fallow land, and steam sterilization - have already been addressed in this document and assessed to be technically infeasible methyl bromide alternatives.	No
COMBINATIONS OF ALTERNATIVES		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Metam sodium + Chloropicrin	Would possibly be more effective than metam-sodium alone where fungal pests are the only concern (see Michigan sections for more discussion), but this combination may not prevent yield losses due to nutsedges, particularly where the weed pressure is high. U.S. EPA is aware of one vegetable study that showed control of yellow nutsedge with this chemical combination, but weed pressure in that small plot test was low, according to the authors (Csinos et al. 1999).	No
1,3 D + Metam-sodium	Controls nematodes but not nutsedges. U.S. EPA is aware of one vegetable study that showed control of yellow nutsedge with this chemical combination, but weed pressure in that small plot test was low, according to the authors (Csinos et al. 1999). Inconsistently effective against fungal pests (see Michigan sections for more discussion). 1,3-D also subject to regulatory prohibition of use on Karst geology.	No

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

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA- 14. LIST AND DISCUSS WHY REGISTERED *(and Potential)* PESTICIDES AND HERBICIDES ARE CONSIDERED NOT EFFECTIVE AS TECHNICAL ALTERNATIVES TO METHYL BROMIDE:

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
Halosulfuron-methyl	Herbicide: causes potential crop injury; has plant back restrictions. Efficacy is lowered in rainy conditions (common during the period of initial planting of these crops). Also, a 24-month plant back restriction may cause significant economic disruption if growers must rely on this control option. Halosulfuron is only allowed for the row middles for cucurbits, due to its phytotoxicity. This would result in nutsedges surviving close to crop plants. Thus this herbicide is not technically feasible as a stand-alone replacement for MB, and its use in conjunction with other pest management methods has not yet been investigated.
Glyphosate	Herbicide: Is non-selective; like halosulfuron, it will not control nutsedge within the plant rows; does not provide residual control. Thus this herbicide is not technically feasible as a stand-alone replacement for MB, and its use in conjunction with other pest management methods has not yet been investigated.
Paraquat	Herbicide: Is non-selective; will not control nutsedge in the plant rows; does not provide residual control. Thus this herbicide is not technically feasible as a stand-alone replacement for MB, and its use in conjunction with other pest management methods has not yet been investigated.

Other than those options discussed elsewhere, no alternative exists for the control of the key pests and fungi affecting pepper production. Non-chemical alternatives and chemical alternatives to methyl bromide have been or are being investigated and when suitable, are incorporated into current pepper production practices.

Nutsedge management has proven to be difficult due to the perennial growth habit of nutsedge and tubers as primary means of propagation. There are no herbicides which control nutsedge in the crop row. Paraquat and glyphosate will suppress emerged nutsedge, but cannot be used in the crop row because of potential crop injury (SE Pepper Consortium CUE 02-0041.) Research suggests that metam sodium can, in some situations, provide effective pest management for certain diseases and weeds. However, even though there have been nearly 50 years experience with metam sodium, (which breaks down to methyl isothiocyanate) nutsedge control results have been unpredictable.

Since methyl bromide has been used effectively to manage minor crop production, there are limited pesticide alternatives due primarily to the small market share and the high cost associated with pesticide registration. Labeling of these products in minor crops could be more expensive than returns from potential sales, and therefore pesticide manufacturers have been reluctant to register pesticides for minor crop uses. Methyl bromide will be needed until a cost-effective alternative regimen is in place.

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA 15. LIST PRESENT *(and Possible Future)* REGISTRATION STATUS OF ANY CURRENT AND POTENTIAL ALTERNATIVES:

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES FOR PEPPERS

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Methyl iodide	Not registered	Yes	Unknown
Furfural	Not registered.	No	Unknown
Sodium azide	Not registered. No registration application received.	No	Unknown
Propargyl bromide	Not registered. No registration application received.	No	Unknown

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA – 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:

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - TABLE 16.1. FUMIGANT ALTERNATIVES TO METHYL BROMIDE FOR POLYETHYLENE-MULCHED TOMATO (LOCASCIO ET AL. 1997)

Chemicals	Rate (/ha)	Average Nutsedge Density (#/m^2)	Average Marketable Yield (ton/ha)	% Yield Loss (compared to MB)
Untreated (control)	-	300 [ab]	20.1 [a]	59.1
MB + Pic (67-33), chisel-injected	390 kg	90 [c]	49.1 [b]	---
1,3 D + Pic (83-17), chisel-injected	327 l	340 [a]	34.6 [c]	29.5
Metam Na, Flat Fumigation	300 l	320 [a]	22.6 [a]	54.0
Metam Na, drip irrigated	300 l	220 [b]	32.3 [c]	34.2

Notes: (1) Numbers followed by the same letter (within a column) are not significantly different at the 0.05 level of probability, using Duncan's multiple range test.
(2) Data shown are from the Gainesville/Horticultural Unit site, 1994 season (this was one of three sites included in this study). This site had relatively high nutsedge pressure, and data for both pest pressure and marketable yields for all treatments shown.

Locascio et al. (1997) studied MB alternatives on tomatoes grown in small plots at two Florida locations with high nutsedge infestation. The data from this tomato study are being cited because comparable pepper data are not available.

Various treatments were tested on plots that had multiple pests. At the Bradenton site there was moderate to heavy *Fusarium* infestation; heavy purple nutsedge infestation and light root-knot nematode pressure. At Gainesville there was heavy infestation of yellow and purple nutsedge and moderate infestation of root-knot nematode. The treatments at both locations included MB (67%) + chloropicrin (33%) chisel-injected at 390 kg/ha; metam-sodium (chisel-injected) at 300L/ha; metam-sodium drip-irrigated at 300L/ha; and 1,3-D + 17% chloropicrin chisel-injected at 327L/ha. In pairwise statistical comparisons, the yield was significantly lower in metam-sodium treatments compared to MB at both sites. At Bradenton, the average yield from both metam-sodium treatments was 33% of the MB yields, suggesting a 67% yield loss from not using MB. At Gainesville the average yield of the two metam-sodium treatments was 56% of the MB yield, suggesting a 44% yield loss from not using MB. The yield of the 1,3-D treatment at Gainesville was 71% of the MB standard suggesting a 29% loss by not using MB (yield data for 1,3-D were not reported for Bradenton). In considering1,3 D results, one must keep in mind that this MB alternative cannot be used in areas where karst geology exists which is approximately 40% of the Florida pepper production area.

For **root knot nematodes**, both metam-sodium and 1,3 D + 35 % chloropicrin have shown good efficacy in trials with tomato and pepper. For example, Locascio and Dickson (1998) reported that metam-sodium + 35 % chloropicrin (295 l/ha of metam-sodium, shank-injected) reduced nematode galls significantly over untreated control plots, though not as much as did MB + 35 % chloropicrin treatments (500kg MB/ha, shank-injected), in Florida tomatoes. Analysis of 35 tomato and 5 pepper trials conducted from 1993 – 1995 indicated that 1,3 D (with either 17 % or 35 % chloropicrin) provided control of nematodes that was equal or superior to that seen with MB, in 95 % of the tomato and 100 % of pepper trials (Eger 2000). However, it is not clear whether yields were also comparable to those obtained with MB. Noling et al (2000) also studied the effects of metam-sodium (115 l/ha, syringe-injected), 1,3 D + 17 % chloropicrin (53.6 l/ha, soil-injected), and 1,3 D + 35 % chloropicrin (39.8 l/ha), among other treatments, in tomato plots. Galls inflicted by root knot nematodes were reduced significantly by all these MB alternatives, as compared to untreated control plots. Yields were also significantly higher as compared to the control plots; all MB alternatives resulted in similar high yields. However, the effects of MB formulations were not reported in this study. Further, it is the opinion of some U.S. crop experts that metam sodium, in particular, is very inconsistent in its beneficial effects as a nematode control agent (Dr. S. Culpeper, University of Georgia, personal communication).

SOUTHEAST U.S. PEPPER CONSORTIUM - TABLE C.1: ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3 D + chloropicrin	Nutsedges, fungal pathogens	20 - 100	29%
Metam-sodium (with or without chloropicrin)	Nutsedges, fungal pathogens	30 - 55	44%
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**29 % if 1,3 D + pic is used; 44 % if metam-sodium is used**

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA – 17. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE?:

Future plans to minimize MB use include:

1) Optimize use of plastic (VIF) tarps and drip irrigation equipment for applying at-plant herbicides.
2) There are plans to conduct studies on tomato, pepper, and cucurbit crops with combinations of fumigants and herbicides including halosulfuron, metolachlor, rimsulfuron, and dimethenamid. Telone C-35 will be used as a fumigant because of nematode and disease problems.
3) Changing MB:chloropicrin formulations from 98:2 to 67:33

Trials using the alternative fumigants Telone C-35, iodomethane, metam sodium, chloropicrin, and at least two reduced-risk products (Propozone, PlantPro45, DiTera, Deny) are also planned. These trials will incorporate screening of pepper varieties for tolerance/resistance to Phytophthora capsici. The applicant noted that a program to evaluate host resistance to Phytophthora root and crown rot has been implemented. Growers are starting to deploy lines identified with genetic resistance and acceptable horticultural qualities.

SOUTHEAST U.S. PEPPERS CONSORTIUM EXCLUDING FLORIDA AND GEORGIA - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE?:

No. Soilless systems and greenhouse production are not in use for peppers and quick adoption is probably economically infeasible. Grafting has not been evaluated for vegetable production due to the high cost and the large number of plants that would be needed. In addition this alternative is primarily used for nematode and disease management, but there is no evidence that it applies to competition from weeds. Plug plants are extensively used on high value vegetable crops like pepper but they do not control competition from nutsedges.

Southeast U.S. Peppers Consortium excluding Florida and Georgia – Summary of Technical Feasibility

There has been extensive research on alternatives for solanaceous crops, and methyl bromide minimizing practices have been incorporated into pepper production systems where possible. However, the effectiveness of chemical and non-chemical alternatives designed to fully replace methyl bromide must still be characterized as preliminary. These alternatives have not been shown to be stand-alone replacements for methyl bromide, and no combination has been shown to provide effective, economical pest control. Methyl bromide is believed to be the only treatment currently available that consistently provides reliable control of nutsedge species and the disease complex affecting pepper production. (Locascio et al., 1997) Nutsedges resist traditional and modern methods of weed control and are endemic to large tracts of pepper producing area in the Southeastern United States. Herbicides are applied to the row middles between raised production beds to manage grass and broadleaf weeds, but there are no currently registered herbicides to address sedge weed pests. Nematodes, especially root knot nematodes (*Meloidogyne* spp.), and fungal diseases (such as *Phytophthora* blight) are also of concern. Fungal pests are expected to become serious problems for pepper production if MB were not available for pre-plant fumigation.

The 1,3-dichloropropene and chloropicrin combination does not effectively control nutsedges. Lack of an effective registered herbicide for control of nutsedge impairs adoption of methyl bromide alternatives in pepper (Banks, 2002). In addition, labeling of 1,3-dichloropropene products restricts its use in key pepper growing areas of the United States where karst topography exists due to ground-water contamination concerns. In areas where 1,3-dichloropropene use is allowed, set back restrictions and 28-day waiting periods between application and planting cause delays/adjustments in production schedules that could lead to missing specific market windows, thus reducing profits on pepper crops. For example, peppers produced during the winter return a higher price than peppers produced during warmer months, and many growers rely on this price premium to maintain profitability.

Metam sodium provides limited and erratic performance at suppressing all major solanaceous pathogens and pests. Data indicate that metam sodium is not an effective alternative to methyl bromide for nutsedge control in bell pepper fields Webster et al., (2002). A 21-day planting delay is also recommended for this chemical. In addition there is evidence that both 1,3-dichloropropene and methyl isothiocyanate (the breakdown product of metam sodium) levels decline more rapidly, thus further compromising efficacy, in areas where these are repeatedly applied (Smelt et al. 1989, Ou et al. 1995, Gamliel et al. 2003). This is due to enhanced degradation of these chemicals by soil microbes (Dungan and Yates 2003).

Research on the effectiveness of non-chemical alternatives to methyl bromide is still in a preliminary stage, particularly for high value, minor-use crops such as peppers.

GEORGIA - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE ON PEPPERS

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

GEORGIA - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST FOR PEPPERS

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TARGET PESTS (WEED & PLANT-PARASITIC NEMATODES) PATHOGENS, AND [% DEGREE OF INFESTATION, IF REPORTED]	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED *(e.g. Effective herbicide available, but not registered for this crop; mandatory requirement to meet certification for disease tolerance)*
GEORGIA	**1. Yellow and Purple Nutsedge** (*Cyperus esculentus, C. rotundus*) ***[100%]*** **2. Crown and Root rot** (*Phytophthora capsici*) ***[40%]*** **3. Plant-parasitic nematodes** (*Meloidogyne incognita; Pratylenchus sp*) ***[70%]*** **4. Southern Blight** (*Sclerotium rolfsii*) ***[70%]*** **5. Pythium root and collar rots** (*P.irregulare, P. myriotylum, P. ultimum, P. aphanidermatum*) ***[100%]***	Only MB can effectively control the target pests found in the southeast U.S. where pest pressures commonly exist at moderate to severe levels. Most, if not all of these states are limited in the use of the alternative 1,3-D because of underlying karst topography throughout the region. Halosulfuron, which is registered only for middle-of-row use, does not control nutsedge near pepper plants where most competition occurs. Metam-sodium has limited pest control capabilities and should never be used as a stand-alone fumigant (Noling, 2003). Refer to Item 13 for additional detail.

GEORGIA - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE FOR PEPPERS

GEORGIA - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	GEORGIA
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Pepper transplants for fruit production
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual; generally 1 year
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Pepper – usually followed by a cucurbit crop (cucumbers or squash). Occasionally eggplants follow pepper crops.
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy loam; clay loam
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	1 time per year; (either in spring or fall)
OTHER RELEVANT FACTORS:	Actual frequency may be between 12 and 15 months depending on the number of crops grown per fumigation cycle.

GEORGIA - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE – JULY FUMIGATION EVENT, PEPPER CROP IS HARVESTED IN FALL.

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	U.S. Plant Hardiness Zones 7a, 7b, 8a, 8b											
SOIL TEMP. *(° F)*	64.1	72.5	80.8	85.9	87.8	86.8	82.2	73.9	34.0	54.0	51.1	55.5
RAINFALL *(inches)*	5.0	3.8	3.5	4.5	5.6	4.8	3.4	2.3	2.3	4.5	4.5	4.2
AVERAGE AIR TEMP. *(℃)*	69.8	77.7	84.7	89.4	90.7	90.5	87.3	79.3	69.8	63.1	61.5	64.0
FUMIGATION SCHEDULE					X							
PLANTING SCHEDULE	**2C**				**P**							
KEY HARVEST WINDOWS			**2C**	**2C**	**2C**		**P**	**P**	**P**			

Methyl bromide applied in July allows the grower to economically produce at least two crops from one annual fumigation event. **P** = planting or harvest of pepper crop; **2C** = planting and/or harvest of 2nd crop.

GEORGIA - TABLE 11.3. CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE – SPRING (LATE FEBRUARY - MARCH) FUMIGATION EVENT, PEPPER CROP IS HARVESTED IN EARLY SUMMER

	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN
CLIMATIC ZONE	U.S. Plant Hardiness Zones 7a, 7b, 8a, 8b											
SOIL TEMP. *(℃)*	Same as above- Table 11.2											
RAINFALL *(mm)*	Same as above- Table 11.2											
AIR TEMP. *(℃)*	Same as above- Table 11.2											
FUMIGATION SCHEDULE[A]	X											
PLANTING SCHEDULE[A,]		**P**				**2C**						
KEY HARVEST WINDOW[A,]				**P**	**P**	**P**		**2C**	**2C**	**2C**		

[A]Fumigation is an early spring event. Two crops are shown as being produced from one fumigation event.
P = planting and/or harvest of pepper crop; **2C** = planting and/or harvest of second crop.

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

Peppers are generally produced using mechanized practices that involve deep injection of methyl bromide. Methyl bromide is being requested only for moderate to severe pest infestations. Approximately 81% of the Georgia pepper area is considered to have moderate to severe infestations of nutsedge (Culpepper, 2004).

Weeds, especially nutsedge, are the most serious concern precipitating methyl bromide use in both transplant beds and in the field. Nutsedge species grow even under adverse conditions, resist traditional and modern methods of weed control, and are endemic to large tracts of pepper producing area in the Southeastern United States. Herbicides are applied to the row middles between raised production beds to manage grass and broadleaf weeds - but there are no currently registered herbicides that control nutsedges near pepper plants. Weeds, when present in crops such as pepper, tomato, and cucurbits for 40 to 60 days may reduce yields by 10 to 50%. In addition to weeds, soil-borne fungal pathogens and plant-parasitic nematodes are endemic to the region and nearly all production areas have severe infestations, thus necessitating annual treatment with a broad-spectrum soil fumigant.

Alternatives like 1,3-dichloropropene and metam sodium require 21 to 28-day interval before planting compared to 14 days for MB. This interval can cause delays/adjustments in production schedules that could lead to missing specific market windows, thus reducing profits on pepper crops (Kelley, 2003).

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

GEORGIA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE ON PEPPERS

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	1,192	1,267	1,767	2,263	2,252	2,312
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	All production acreage is strip/bed fumigation and tarped with LDPE films.					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	294,550	313,053	337,163	347,944	338,248	347,183
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*	98:2	98:2	98:2 (15% acreage) 67:33 (85% Of acreage)	67:33	67:33	67:33
METHODS BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp	Injected, 20.3 to 30.5 cm, under tarp
APPLICATION RATE (KG/HA)FOR THE FORMULATION	252	252	194 or 283	224	224	224
APPLICATION RATE* (KG/HA) FOR THE ACTIVE INGREDIENT	247	247	190	150	150	150
DOSAGE RATE*(G/M^2) OF FORMULATION USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	24.7	24.7	18.1	15.0	15.0	15.0
APPLICATION RATE OF STRIP/ BED, G MB/M^{2+}	Approximately 58% of the field is treated with MB and covered with plastic mulch.					

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

GEORGIA (CUE 03-0049) - PART C: TECHNICAL VALIDATION FOR PEPPERS

GEORGIA - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

GEORGIA – 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 + chloropicrin	This combination will not adequately control nutsedge. 1,3-dichloropropene cannot be used in key pepper growing areas of the U.S. where karst topography exists due to ground-water contamination concerns. Where 1,3-dichloropropene use is allowed, set back restrictions (~ 100 meters from occupied structures; ~ 30 meters for emulsified formulations applied via chemigation) may limit the proportion of the field that can be treated. In addition, because of a 28-day waiting period between application and planting (compared to 14 days for MB), growers could lose half of the harvest season and miss higher-end market windows, mainly for spring fumigations (i.e., fall harvests). (SE Pepper Consortium, CUE # 03-0041).	No
Metam Sodium	Metam sodium provides limited and erratic performance at suppressing all nutsedge weed species and pepper pathogens. Also, there is a 21-day waiting period at the time of application until planting compared to 14 days for MB. Such a delay causes the higher-end market windows to be missed—particularly for the spring plantings (i.e., fall harvests). Beginning the application cycle earlier is not an option since crops from the previous fumigation cycle must be cleaned up prior to metam application. (Georgia CUE # 03-0049; Kelley, 2003). Repeated applications of MITC (the breakdown product of metam sodium) are known to enhance its biodegradation (and reduce efficacy) as a result of increased populations of adapted microorganisms (Dungan and Yates, 2003).	No
NON CHEMICAL ALTERNATIVES		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Soil solarization	For nutsedge control in the southeastern United States, solarization is not technically feasible as a methyl bromide alternative. Response of *Cyperus* species to solarization is sporadic and not well understood; data show solarization to provide, at best, suppression of nutsedge populations (Chase et al. 1999). Research indicates that the lethal temperature for nutsedge tubers is 50 ^{o}C or higher (Chase et al. 1999). Trials conducted in mid-summer in Georgia resulted in maximum soil temperatures of 43 ^{o}C at 5 cm depth. Thus, solarization, even in the warmer months in southern states, did not result in temperatures high enough to destroy nutsedge tubers. Also, tubers lodged deeper in the soil would be completely unaffected. In addition, solarization would take fields out of production since it would be needed during the spring and into the summer months, which are optimal for pepper production.	No
Steam	Steam is not a technically feasible alternative for open field pepper production because it requires sustained heat over a required period of time (UNEP 1998). While steam has been used effectively against fungal pests in protected production systems, such as greenhouses, there is no evidence that it would be effective in open field pepper crops. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to sterilize soil down to the rooting depth of field crops (at least 20-50 cm).	No
Biological Control	Biological control agents alone cannot control nutsedge and/or the soil pathogens that afflict peppers. The bacterium *Burkholderia cepacia* and the fungus *Gliocladium virens* have shown some potential in controlling some fungal plant pathogens (Larkin and Fravel 1998). However, no biological control agent has been identified to effectively control nutsedge or *Phytophthora.* Therefore, biological control is not a stand-along replacement for methyl bromide in pepper crops. Only a limited number of biological organisms are effectively used to manage soil borne plant pathogens and pests. Biocontrol agents are usually very specific regarding the organisms they control and their successful establishment is highly dependent on environmental conditions.	No
Cover crops and mulching	Cover crops and mulches have been integrated into solanaceous crop production systems. However there is no evidence these practices effectively substitute for the control methyl bromide provides against nutsedges (Burgos and Talbert 1996). Some cover crops that have been shown to reduce weed populations also reduced or delayed crop maturity and/or emergence, as well as yields (Burgos and Talbert 1996, Galloway and Weston 1996). Mulching has also been shown to be ineffective in controlling nutsedges, which are able to penetrate through both organic and plastic mulches (Munn 1992, Patterson 1998).	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Crop rotation and fallow land	Crop rotation/fallow is not a technically feasible alternative to methyl bromide because it does not provide adequate control of nutsedges or fungal pathogens. The crop rotations available to growers are also susceptible to fungi; fallow land can still harbor fungal oospores (Lamour and Hausbeck 2003). Tubers of the perennial nutsedges provide new plants with larger energy reserves than annual weeds that can be more easily controlled by crop rotations and fallow. (Thullen and Keeley 1975). Furthermore, nutsedge plants can produce tubers within 2 weeks after emergence (Wilen et al. 2003). This enhances their survival across different cropping regimes that can disrupt other plants that rely on a longer undisturbed growing period to produce seeds to propagate the next generation.	No
Flooding/Water management	Flooding has been used effectively to manage various soil borne pest and plant pathogens, especially nematodes and some weeds. However, nutsedges have shown tolerance to this treatment. Submerging nutsedge tubers for 8 days to 4 weeks showed no effect on the sprouting capabilities of the tubers (Horowitz, 1972). Studies in Florida showed ineffective nematode, plant pathogen, and nutsedge control after flooding (Allen, 1999). Regulatory issues concerning water management, as well as economic feasibility, also preclude its viability as an alternative to methyl bromide. Land structure, frequent and severe droughts, and the economics of developing and managing flood capabilities prevent flooding from being a viable, cost effective alternative in the Southeastern United States.	No
Grafting/resistant rootstock/plant breeding/soilless culture/organic production/substrates/plug plants.	Due to the paucity of scientific information on the utility of these alternatives as methyl bromide replacements in peppers, they have been grouped together for discussion in this document. The United States was unable to locate any studies showing any potential for grafting, resistant rootstock or plant breeding as technically feasible alternatives to methyl bromide control of nutsedges. Plug plants are extensively used on high value vegetable crops like pepper but they do not control competition from nutsedges. There are no studies documenting the commercial availability of resistant rootstock immune to the fungal pathogens listed as major pepper pests. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of *Phytophthora* and *Fusarium* fungi. Soilless culture, organic production, and substrates/plug plants are also not technically viable alternatives to methyl bromide for fungi. Various aspects of organic production – e.g., cover crops, fallow land, and steam sterilization - have already been addressed in this document and assessed to be technically infeasible methyl bromide alternatives.	No
COMBINATIONS OF ALTERNATIVES		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Metam sodium + Chloropicrin	Would possibly be more effective than metam-sodium alone where fungal pests are the only concern (see Michigan sections for more discussion), but this combination may not prevent yield losses due to nutsedges, particularly where the weed pressure is high. U.S. EPA is aware of one vegetable study that showed control of yellow nutsedge with this chemical combination, but weed pressure in that small plot test was low, according to the authors (Csinos et al. 1999).	No
1,3 D + Metam-sodium	Controls nematodes but not nutsedges. U.S. EPA is aware of one vegetable study that showed control of yellow nutsedge with this chemical combination, but weed pressure in that small plot test was low, according to the authors (Csinos et al. 1999). Inconsistently effective against fungal pests (see Michigan sections for more discussion). 1,3-D also subject to regulatory prohibition of use on Karst geology.	No

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

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

GEORGIA – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
Halosulfuron-methyl	For nutsedges: potential crop injury; plant back restrictions. Efficacy is lowered in rainy conditions (which are common in this region). Also, a 24 month plant back restriction may cause significant economic disruption if growers must rely on this control option.
Glyphosate	For nutsedges: Non-selective; will not control nutsedge in the plant rows; does not provide residual control. Repeated applications are required for control even in row middles.
Paraquat	For nutsedges: Non-selective; will not control nutsedge in the plant rows; does not provide residual control

Other than those options discussed in Table 13.1 and elsewhere in this document, no alternative exists for the control of the key pests and fungi affecting pepper production. Non-chemical alternatives and chemical alternatives to methyl bromide have been or are being investigated and when suitable, are incorporated into current pepper production practices.

Nutsedge management has proven to be difficult due to the perennial growth habit of nutsedge and tubers as primary means of propagation. There are no herbicides which control nutsedge in the crop row. Paraquat and glyphosate will suppress emerged nutsedge, but cannot be used in the crop row because of potential crop injury (SE Pepper Consortium CUE 02-0041). Research suggests that metam sodium can, in some situations, provide effective pest management for certain plant pathogens and weeds. However, even though there have been nearly 50 years experience with metam sodium, (which breaks down to methyl isothiocyanate) nutsedge control results have been unpredictable.

Since methyl bromide has been used effectively to manage minor crop production, there are limited pesticide alternatives due primarily to the small market share and the high cost associated with pesticide registration. Labeling of these products in minor crops could be more expensive than returns from potential sales, and therefore pesticide manufacturers have been reluctant to register pesticides for minor crop uses. Methyl bromide will be needed until a cost-effective alternative regimen is in place.

The applicant supplied information indicating pepper yield in fields treated with 1,3-D was 43% below MB-treated fields, though these results are as yet unpublished.

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

GEORGIA – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES FOR PEPPERS

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Iodomethane	Not registered	Yes	Unknown
Furfural (Multigard™)	Not registered	No	Unknown
Sodium azide	Not registered. No registration application received.	No	Unknown
Propargyl bromide	Not registered. No registration application received.	No	Unknown

GEORGIA - 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:

GEORGIA - TABLE 16.1. FUMIGANT ALTERNATIVES TO METHYL BROMIDE FOR POLYETHYLENE-MULCHED TOMATO (LOCASCIO ET AL. 1997)

Chemicals	Rate (/ha)	Average Nutsedge Density (#/m^2)	Average Marketable Yield (ton/ha)	% Yield Loss (compared to MB)
UNTREATED (CONTROL)	-	300 ^{ab}	20.1 ^{a}	59.1
MB + Pic (67-33), chisel-injected	390 kg	90 ^{c}	49.1 ^{b}	---
1,3 D + Pic (83-17), chisel-injected	327 l	340 ^{a}	34.6 ^{c}	29.5
Metam Na, Flat Fumigation	300 l	320 ^{a}	22.6 ^{a}	54.0
Metam Na, drip irrigated	300 l	220 ^{b}	32.3 ^{c}	34.2

Notes: (1) Numbers followed by the same letter (within a column) are not significantly different at the 0.05 level of probability, using Duncan's multiple range test.
(2) Data shown are from the Gainesville/Horticultural Unit site, 1994 season (this was one of three sites included in this study). This site had relatively high nutsedge pressure, and data for both pest pressure and marketable yields for all treatments shown.

Locascio et al. (1997) studied MB alternatives on tomatoes grown in small plots at two Florida locations with high nutsedge infestation. The data from the tomato study are being cited because pepper data are not available.

Various treatments were tested on plots that had multiple pests. At the Bradenton site there was moderate to heavy *Fusarium* infestation; heavy purple nutsedge infestation and light root-knot nematode pressure. At Gainesville there was heavy infestation of yellow and purple nutsedge and moderate infestation of root-knot nematode. The treatments at both locations included MB (67%) + chloropicrin (33%) chisel-injected at 390 kg/ha; metam-sodium (chisel-injected) at 300L/ha; metam-sodium drip-irrigated at 300L/ha; and 1,3-D + 17% chloropicrin chisel-injected at 327L/ha. In pairwise statistical comparisons, the yield was significantly lower in metam-sodium treatments compared to MB at both sites. At Bradenton, the average yield from both metam-sodium treatments was 33% of the MB yields, suggesting a 67% yield loss from not using MB. At Gainesville, the average yield of the two metam-sodium treatments was 56% of the MB yield, suggesting a 44% yield loss from not using MB. The yield of the 1,3-D treatment at Gainesville was 71% of the MB standard suggesting a 29% loss by not using MB (yield data for 1,3-D were not reported for Bradenton). { In considering 1,3 D results, one must keep in mind that this MB alternative cannot be used in areas where karst geology exists.}

Georgia - Alternatives Yield Loss Data Summary

Alternative	List Type of Pest	Range of Yield Loss	Best Estimate of Yield Loss
1,3 D + chloropicrin	Nutsedges, fungal pathogens	20 - 100	29
Metam-sodium (with or without chloropicrin)	Nutsedges, fungal pathogens	30 - 55	44
Overall Loss Estimate for All Alternatives to Pests			**29 % if 1,3 D + pic is used; 44 % if metam-sodium is used**

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

There are plans to conduct studies on tomato, pepper, and cucurbit crops with combinations of fumigants and herbicides including halosulfuron, metolachlor, rimsulfuron, and dimethenamid. Telone C-35 will be used as a fumigant because of nematode and plant pathogen problems.

Trials using the alternative fumigants Telone C-35, iodomethane, metam sodium, chloropicrin, and at least two low risk products (Propozone, PlantPro45, DiTera, Deny) are also planned. These trials will incorporate screening of pepper varieties for tolerance/resistance to *P. capsici*. The applicant noted that a program to evaluate host resistance to *Phytophthora* root and crown rot has been implemented. Growers are starting to deploy lines identified with genetic resistance and acceptable horticultural qualities.

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

No. Soilless systems and greenhouse production are not in use for peppers and quick adoption is probably economically infeasible. Grafting has not been evaluated for vegetable production due to the high cost and the large number of plants that would be needed. In addition this alternative is primarily used for nematode and plant pathogen management, but there is no evidence that it applies to competition from weeds. Plug plants are extensively used on high value vegetable crops like pepper but they do not control competition from nutsedges.

GEORGIA - SUMMARY OF TECHNICAL FEASIBILITY

There has been extensive research on alternatives for solanaceous crops, and methyl bromide minimizing practices have been incorporated into pepper production systems where possible. However, the effectiveness of chemical and non-chemical alternatives designed to fully replace methyl bromide must still be characterized as preliminary. These alternatives have not been shown to be stand-alone replacements for methyl bromide, and no combination has been shown to provide effective, economical pest control. Methyl bromide is believed to be the only treatment currently available that consistently provides reliable control of nutsedge species and the plant pathogen complex affecting pepper production. Nutsedges resist traditional and modern methods of weed control and are endemic to large tracts of pepper producing area in the Southeastern United States. Herbicides are applied to the row middles between raised production beds to manage grass and broadleaf weeds, but there are no currently registered herbicides to address nutsedges in the row. Nematodes, especially root knot nematodes (*Meloidogyne* spp.), and fungal diseases (such as Phytophthora blight) are also of concern. These pests are expected to become serious problems for pepper production if methyl bromide were not available for pre-plant fumigation.

The 1,3-dichloropropene and chloropicrin combination does not effectively control nutsedges. Lack of an effective registered herbicide for control of nutsedge impairs adoption of methyl bromide alternatives in pepper (Banks, 2002). In addition, labeling of 1,3-dichloropropene products restricts its use in key pepper growing areas of the U.S. where karst topography exists, due to ground-water contamination concerns. In areas where 1,3-dichloropropene use is allowed, set back restrictions, and 28-day waiting periods between application and planting cause delays/adjustments in production schedules that could lead to missing specific market windows, thus reducing profits on pepper crops. For example, peppers produced during the winter fetch a higher price than peppers produced during warmer months, and many growers rely on this price premium to maintain profitability.

Metam sodium provides limited and erratic performance at suppressing all major solanaceous pathogens and pests. Data indicate that metam sodium is not an effective alternative to methyl bromide for nutsedge control in bell pepper fields Webster et al., (2002 a). A 21-day planting delay is also recommended for this chemical. In addition there is evidence that both 1,3-dichloropropene and methyl isothiocyanate (the breakdown product of metam sodium) levels decline more rapidly, thus further compromising efficacy, in areas where these are repeatedly applied (Smelt et al. 1989, Ou et al. 1995, Gamliel et al. 2003). This is due to enhanced degradation of these chemicals by soil microbes (Dungan and Yates 2003).

Research on the effectiveness of non-chemical alternatives to methyl bromide is still in a preliminary stage, particularly for high value, minor-use crops.

PART B: FLORIDA -CROP CHARACTERISTICS AND METHYL BROMIDE USE ON PEPPERS

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

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

REGION WHERE METHYL BROMIDE USE IS REQUESTED	TARGET PATHOGENS, NEMATODES AND/OR WEED(S) TO GENUS AND, IF KNOWN, TO SPECIES LEVEL	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED *(e.g. Effective herbicide available, but not registered for this crop; mandatory requirement to meet certification for disease tolerance)*
Florida	Yellow & purple nutsedges (*Cyperus rotundus & C. esculentus*) Phytophthora Blight (*Phytophthora* spp.) Root-knot nematodes (*Meloidogyne* spp.) Damping-off Disease (*Rhizoctonia solani*, *Pythium* spp.) Nightshade (*Solanum* spp.)	Only MB can effectively control the target pests found in Florida where pest pressures commonly exist at moderate to severe levels. Use of 1,3-dichloropropene is restricted in key pepper growing areas of Florida underlain by karst geology and sandy (porous) sub-soils, geological features that could lead to ground-water contamination. Approximately 40 % of Florida's pepper production land has these soil constraints. As a consequence, 1,3-dichloropropene is prohibited in key growing areas like Dade County, where 100% of the pepper growing area is affected (U.S. EPA, 2002, Noling, 2003). Metam-sodium has limited pest control capabilities and should never be used as a stand-alone fumigant (Noling, 2003). Halosulfuron, which is effective against nutsedge, is only registered for use in row middles in peppers.

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

FLORIDA - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	REGION A
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Pepper transplants for fruit production
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual (usually 1 yr)
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Eggplants or cucurbits
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy and sandy-loam soils
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	1time per year
OTHER RELEVANT FACTORS:	Double-cropped with cucurbits

FLORIDA - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	Sept	Oct	NOV	DEC	JAN	FEB
CLIMATIC ZONES	Plant Hardiness Zones 9a; 9b; 10a, 10.											
RAINFALL *(mm)*, TAMPA, FL	65.5	50.0	72.5	134.1	175.8	193.3	152.7	65.0	42.7	158.8	62.0	66.8,
OUTSIDE TEMP. *(°C)*; TAMPA, FL	19.4	22.1	25.3	27.6	28.2	28.2	27.3	24.1	19.2	17.3	16.0	16.9
FUMIGATION SCHEDULE[A]						X	X	X	X	X	X	
TRANSPLANTING SCHEDULE; ' NON DOUBLE-CROPPED[B]	X						X	X	X	X	X	X
KEY HARVEST WINDOW; NON DOUBLE-CROPPED[C]	X	X	X	X					X	X	X	X

[A] Non-double cropped.: earliest start date: August 15; cells marked with an "x" represent variation in fumigation initiation amongst pepper growers.
[B] For Non-Double cropped pepper production, transplanting peppers is usually initiated around September 1; cells marked with an "x" represent variation in transplanting dates amongst pepper growers.
.[C] For Non-Double Cropped Peppers; Harvest Period usually begins as early as Nov. 15, and may continue until June 15, depending on when planted and weather conditions.

FLORIDA - TABLE 11.3 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE – PEPPERS DOUBLE CROPPED WITH ANOTHER VEGETABLE (USUALLY CUCURBITS)

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	Oct	NOV	DEC	JAN	FEB
CLIMATIC ZONES	Plant Hardiness Zones 9a; 9b; 10a, 10.											
RAINFALL *(mm)*, TAMPA, FL	65.5	50.0	72.5	134.1	175.8	193.3	152.7	65.0	42.7	158.8	62.0	66.8,
OUTSIDE TEMP. *(°C)*; TAMPA, FL	19.4	22.1	25.3	27.6	28.2	28.2	27.3	24.1	19.2	17.3	16.0	16.9
FUMIGATION SCHEDULE'; DOUBLE-CROPPED[A]						X	X					
TRANSPLANTING SCHEDULE; DOUBLE-CROPPED[B]	**2C**	**2C**					**P**	**P**				**2C**
KEY HARVEST WINDOW; DOUBLE-CROPPED[C]	**P**	**P**	**2C**	**2C**	**2C**				**P**	**P**	**P**	**P**

[A]Double-cropped; assumed to be with cucurbits; earliest start date is August 15; shaded cells represent variation in fumigation initiation amongs pepper growers who double-crop.
[B]For Double-Cropped pepper production, transplanting (**P**) is typically initiated on September 1; variance can be until October 31, as represented by the shaded cell. The second crop of curcurbits (usually) transplants (indicated by "**2C**") would typically be initiated around Feb 15, and may vary until April 30
[C] For Double Cropped peppers, Harvest Period usually begins as early as Nov. 15, (**P**), may continue until April 15, depending on when planted and weather conditions; Harvesting of second crop (**2C**) may start around May and continue until mid-July.

Climate Zone designation (http://www.usna.usda.gov/Hardzone)

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

The sandy soils of Florida are a contributing factor to the erratic performance suppressing nematodes and plant pathogens of the metam sodium + chloropicrin combination, the most promising alternative to methyl bromide currently available for use in Dade County (because of label restrictions for 1,3-D). Methyl bromide has higher vapor pressure than metam sodium, therefore can penetrate and diffuse throughout the soil more effectively than metam sodium.

Several climatic factors appeared to contribute to increases in plant pathogens, e.g., Southern stem blight, caused by the soil-borne fungus (*Sclerotium rolfsii*) across the production area, even with methyl bromide. Variations in rainfall and soil and air temperatures may predispose developing plants to diseases caused by plant-pathogenic fungi. Furthermore, in the fall, temperature and rainfall patterns favor high levels of nematode infestation.

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

FLORIDA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	9,429 ha	8,903 ha	8,903 ha	8,741 ha	8,741 ha	8,195 ha
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	100% strip treatments are used in this region					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	1,727,644	1,630,376	1,644,501	1,431,639	1,406,135	1,315,417
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*[A]	98:2 & 67:33	98:2 & 67:33	98:2 & 67:33	67:33	67:33	67:33
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*[A]	Sweptback chisel-shank, 25-30.5 cm.deep	Sweptback chisel-shank, 25-30.5 cm.deep	Sweptback chisel-shank, 25-30.5 cm.deep	Sweptback chisel-shank, 25-30.5 cm.deep	Sweptback chisel-shank, 25-30.5 cm.deep	Sweptback chisel-shank, 25-30.5 cm.deep
APPLICATION RATE OF FORMULATIONS, **(kg/ha)**[A]	186.7 or 273	186.7 or 273	186.7 or 273	244.8	240.3	240.3
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	Not Available	Not Available	Not Available	Not Available	Not Available	Not Available
DOSAGE RATE*(G/M^2) OF FORMULATION USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	27.3	27.3	27.5	24.5	24	24
APPLICATION RATE OF STRIP/ BED, G MB/M^2	15.9 – 18.2	15.9 – 18.2	15.9 – 18.2	15.9 – 18.2	15.9 – 18.2	15.9 – 18.2

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

[A] Sources: personal communication, Professor J.W. Noling, November 25, 2003; M. Aerts, December 2, 2003.

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	1,3-D provides control of nematode populations, but poor control of plant pathogens and weeds. Control of nematodes is erratic, due to poor distribution of the fumigant in the sandy soils of Florida. 1,3-D's use is prohibited due to groundwater contamination in key pepper growing areas with karst geology, which is estimated to be about 40% in of FL pepper area in 2002. In Dade County, a major pepper production area, 100% of pepper acreage is affected by a label prohibition put in place due to groundwater contamination concerns. In areas where 1,3-dichloropropene use is allowed, set back restrictions (~ 100 meters from occupied structures; ~ 30 meters for emulsified formulations applied via chemigation) may limit the proportion of the field that can be treated. In addition, the 28-day waiting period between application and planting can cause delays/adjustments in production schedules that could lead to missing specific higher-end market windows .	No
Metam-sodium	Provides limited and erratic performance at suppressing all major pepper pathogens and pests. Does not work under high pest pressure. Considered the best available alternative for Dade County only, where 1,3 D use is prohibited (Aerts, 2003). However, this is at best a treatment complementary to other fumigants and herbicides, and not as a stand-alone option (Noling, 2003). Metam sodium has a lower vapor pressure than methyl bromide, and therefore cannot penetrate and diffuse throughout the soil as effectively as methyl bromide. In addition, the effectiveness of metam sodium is very dependent on the organic matter and moisture content of the soil.	No
NON CHEMICAL ALTERNATIVES		

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Solarization	Solarization is not technically feasible as a methyl bromide alternative for control of nutsedges. Research indicates that the lethal temperature for nutsedge tubers is 50 ^{o}C or higher (Chase et al. 1999. Trials conducted in mid-summer in Georgia resulted in maximal soil temperatures of 43 ^{o}C at 5 cm depth. Thus, solarization, even in the warmer months in southern states, did not result in temperatures reliably high enough to destroy nutsedge tubers, and tubers lodged deeper in the soil would be completely unaffected. Response of *Cyperus* species to solarization is sporadic and not well understood and data show solarization to provide, at best, suppression of nutsedge populations (Chase et al. 1999). In addition, solarization will take fields out of production since it would be needed during the spring and into the summer months, which are optimal for pepper production.	No
Steam	Steam is not a technically feasible alternative for open field pepper production because it requires sustained heat over a required period of time (UNEP 1998). While steam has been used effectively against fungal pests in protected production systems, such as greenhouses, there is no evidence that it would be effective in open field pepper crops. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to sterilize soil down to the rooting depth of field crops (at least 20-50 cm).	No
Biological Control	Biological control agents alone cannot control nutsedge and/or the soil pathogens that afflict peppers. The bacterium *Burkholderia cepacia* and the fungus *Gliocladium virens* have shown some potential in controlling some fungal plant pathogens (Larkin and Fravel 1998). However, no biological control agent has been identified to effectively control nutsedge or *Phytophthora.* Therefore, biological control is not a stand-along replacement for methyl bromide in pepper crops. Only a limited number of biological organisms are effectively used to manage soil borne plant pathogens and pests.	No
Cover crops and mulching	Cover crops and mulches have been integrated to solanaceous crop production management. However there is no evidence these practices effectively substitute for the control methyl bromide provides against nutsedges (Burgos and Talbert 1996). Some cover crops that have been shown to reduce weed populations also reduced or delayed crop maturity and/or emergence, as well as yields (Burgos and Talbert 1996, Galloway and Weston 1996). Mulching has also been shown to be ineffective in controlling nutsedges, since these plants are able to penetrate through both organic and plastic mulches (Munn 1992, Patterson 1998).	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Crop rotation and fallow land	Crop rotation/fallow is not a technically feasible alternative to methyl bromide because it does not provide adequate control of nutsedges or fungal pathogens. The crop rotations available to growers are also susceptible to fungi; fallow land can still harbor fungal oospores (Lamour and Hausbeck 2003). As regards to nutsedges, tubers of these perennial species provide new plants with larger energy reserves than the annual weeds that can be frequently controlled by crop rotations and fallow land (Thullen and Keeley 1975). Furthermore, nutsedge plants can produce tubers within 2 weeks after emergence (Wilen et al. 2003). This enhances their survival across different cropping regimes that can disrupt other plants that rely on a longer undisturbed growing period to produce seeds to propagate the next generation.	No
Flooding/Water management	South Florida is generally subject to natural flooding during summer months, but other areas cannot be flooded because of lack of a shallow, impermeable layer. Although flooding is a pest management tool that has been used effectively to manage various soil borne pest and plant pathogens, nutsedges have shown tolerance to this treatment. Submergence of nutsedge tubers for periods of 8 days to 4 weeks showed no effect on the sprouting capabilities of the tubers (Horowitz, 1972). Studies in Florida (Allen, 1999) showed ineffective nematode, plant pathogen, and nutsedge control. Regulatory issues concerning water management, as well as economic feasibility, also preclude its viability as an alternative to methyl bromide. Land structure, frequent and severe droughts, and the economics of developing and managing flood capabilities will prevent flooding from being a viable, cost effective alternative in the Southeastern states.	No
Grafting/resistant rootstock/plant breeding/soilless culture/organic production/substrates/plug plants.	Due to the paucity of scientific information on the utility of these alternatives as methyl bromide replacements in peppers, they have been grouped together for discussion in this document. The U.S. was unable to locate any studies showing any potential for grafting, resistant rootstock or plant breeding as technically feasible alternatives to methyl bromide control of nutsedges. Plug plants are extensively used on high value vegetable crops like pepper but they do not control competition from nutsedges. There are no studies documenting the commercial availability of resistant rootstock immune to the fungal pathogens listed as major pepper pests. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of *Phytophthora* and *Fusarium* fungi. Soilless culture, organic production, and substrates/plug plants are also not technically viable alternatives to methyl bromide for fungi. Various aspects of organic production – e.g., cover crops, fallow land, and steam sterilization - have already been addressed in this document and assessed to be technically infeasible methyl bromide alternatives.	No

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
Combinations of Alternatives		
Metam sodium + Chloropicrin	This combination has been used in Florida since the 1970s. It is being investigated as a leading alternative to methyl bromide in Dade County because of label restrictions for 1,3-D, which is not registered for use in Dade County. However, it has shown erratic performance suppressing weeds, nematodes, and plant pathogens in the sandy soils of Florida. Methyl bromide has higher vapor pressure than metam sodium, therefore can penetrate and diffuse throughout the soil more effectively than metam sodium. Trials in tomato have shown inconsistent efficacy of this formulation against fungal pests, though it is generally better than metam-sodium alone (Locascio and Dickson 1998, Csinos et al. 1999). Low efficacy in even small-plot trials indicates that this is not a technically feasible alternative for commercially produced peppers at this time.	No
1,3 D + chloropicrin	This combination is not effective in cases with high/moderate nutsedge pressure because it needs to be coupled with an herbicide to provide season long control. Trials comparing Flat Fumigation applications with standard in-row applications indicated the need to increase the amount of chloropicrin to compensate for the potential decrease in efficacy of 1,3-dichloropropene applied via Flat Fumigation. Applications via micro-irrigation systems have yielded mixed results, probably due to poor lateral distribution of the chemical in the soil (Martin 2003; Dungan and Yates, 2003). In addition, 1,3-D's use is prohibited due to groundwater contamination in key pepper growing areas with karst geology which is estimated to be about 40% in of FL pepper area in 2002. In Dade County this formulation cannot be used at all, due to a label prohibition.	No
1,3 D + Metam-sodium	Trials in tomato have shown inconsistent efficacy of this formulation against fungal pests, though it is generally better than metam-sodium alone (Csinos et al. 1999). Low efficacy in even small-plot trials indicates that this is not a technically feasible alternative for commercially produced peppers at this time. In addition, 1,3-D's use is prohibited due to groundwater contamination in key pepper growing areas with karst geology which is estimated to be about 40% in of FL pepper area in 2002. In Dade County 100% of pepper acreage is affected by this limitation.	No

** 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
Halosulfuron-methyl	For nutsedges: potential crop injury; plant back restrictions. Efficacy is lowered in rainy conditions (which are common in this region). Also, a 24-month plant back restriction may cause significant economic disruption if growers must rely on this control option. Halosulfuron is registered for use in row middles only.
Glyphosate	For nutsedges: Non-selective; will not control nutsedge in the plant rows; does not provide residual control
Paraquat	For nutsedges: Non-selective; will not control nutsedge in the plant rows; does not provide residual control. Another weed, nightshade, has shown resistance to paraquat, a dangerous development since this plant serves as a reservoir for many insects (e.g., whiteflies), that are vectors of pepper diseases (Aerts, 2004)

Other than those options discussed in Table 13.1 and elsewhere in this document, no alternative exists for the control of the key pests and fungi affecting pepper production. Non-chemical alternatives and chemical alternatives to methyl bromide have been or are being investigated and when suitable, incorporated into current pepper production practices.

Nutsedge management has proven to be difficult due to the perennial growth habit of nutsedge and tubers as primary means of propagation. There are no herbicides which control nutsedge in the crop row. Paraquat and glyphosate will suppress emerged nutsedge, but cannot be used in the crop row because of potential crop injury (SE Pepper Consortium CUE 02-0041). Research suggests that metam sodium can, in some situations, provide effective pest management for certain plant pathogens and weeds. However, even though there have been nearly 50 years experience with metam sodium, (which breaks down to methyl isothiocyanate) nutsedge control results have been unpredictable.

Since methyl bromide has been used effectively to manage minor crop production, there are limited pesticide alternatives due primarily to the small market share and the high cost associated with pesticide registration. Labeling of these products in minor crops could be more expensive than returns from potential sales, and therefore pesticide manufactures have been reluctant to register pesticides for minor crop uses. Methyl bromide will be needed until a cost-effective alternative regimen is in place.

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:
Iodomethane	Pre-plant soil fumigant. Not registered yet	Yes	Unknown
Trifloxysulfuron sodium	Herbicide - recently registered for tomato in FL only. Crop injury potential exist	No	Unknown
Fosthiazate	Not registered	No	Unknown
Furfural (Multigard™)	Not registered	No	Unknown
Sodium azide	Not registered. No registration application received.	No	Unknown
Propargyl bromide	Not registered. No registration application received.	No	Unknown
Paecilomyces lilacinus	Biological nematicide; not registered	Yes	Unknown

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

FLORIDA - TABLE 16.1. FUMIGANT ALTERNATIVES TO METHYL BROMIDE FOR POLYETHYLENE-MULCHED TOMATO (LOCASCIO ET AL. 1997)-)

Chemicals	Rate (/ha)	Average Nutsedge Density (#/m^2)	Average Marketable Yield (ton/ha)	% Yield Loss (compared to MB)
Untreated (control)	-	300 [ab]	20.1 [a]	59.1
MB + Pic (67-33), chisel-injected	390 kg	90 [c]	49.1 [b]	---
1,3 D + Pic (83-17), chisel-injected	327 l	340 [a]	34.6 [c]	29.5
Metam Na, Flat Fumigation	300 l	320 [a]	22.6 [a]	54.0
Metam Na, drip irrigated	300 l	220 [b]	32.3 [c]	34.2

Notes: (1) Numbers followed by the same letter (within a column) are not significantly different at the 0.05 level of probability, using Duncan's multiple range test.

(2) Data shown are from the Gainesville/Horticultural Unit site, 1994 season (this was one of three sites included in this study). This site had relatively high nutsedge pressure, and data for both pest pressure and marketable yields for all treatments shown.

All fumigants were injected 15-20 cm deep, with three chisels per bed, 30 cm apart

Locascio et al. (1997) studied MB alternatives on tomatoes grown in small plots at two Florida locations with high nutsedge infestation. The data from the tomato study are being cited because pepper data are not available.

Various treatments were tested on plots that had multiple pests. At the Bradenton site there was moderate to heavy *Fusarium* infestation; heavy purple nutsedge infestation and light root-knot nematode pressure. At Gainesville there was heavy infestation of yellow and purple nutsedge and moderate infestation of root-knot nematode. The treatments at both locations included MB (67%) + chloropicrin (33%) chisel-injected at 390 kg/ha; metam-sodium (chisel-injected) at 300L/ha; metam-sodium drip-irrigated at 300L/ha; and 1,3-D + 17% chloropicrin chisel-injected at 327L/ha. In pairwise statistical comparisons, the yield was significantly lower in metam-sodium treatments compared to MB at both sites. At Bradenton, the average yield from both metam-sodium treatments was 33% of the MB yields, suggesting a 67% yield loss from not using MB. At Gainesville, the average yield of the two metam-sodium treatments was 56% of the MB yield, suggesting a 44% yield loss from not using MB. The yield of the 1,3-D treatment at Gainesville was 71% of the MB standard suggesting a 29% loss by not using MB (yield data for 1,3-D were not reported for Bradenton). In considering 1,3 D results, one must keep in mind that this MB alternative cannot be used in areas where karst geology exists, or anywhere in Dade county, a major production area.

FLORIDA - ALTERNATIVES YIELD LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3 D + chloropicrin	Nutsedges, fungal pathogens	20 - 100	29
Metam-sodium (with or without chloropicrin)	Nutsedges, fungal pathogens	30 - 55	44
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**29 % if 1,3 D + pic is used; 44 % if metam-sodium is used**

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

Iodomethane is being considered for registration as a methyl bromide replacement. Its registration date is not known. Please refer to Table 15.1 for details.

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

The U.S. EPA is unaware of large- scale, commercial greenhouse operations for peppers or other technologies that could reduce methyl bromide use. There may be local or small community organic or hothouse pepper production that targets fresh market and/or temporal (seasonal) sectors.

Grafting has not been evaluated for vegetable production due to the high cost and the large number of plants that would be needed. In addition this alternative is primarily used for nematode and plant pathogen management, but there is no evidence that it applies to competition from weeds. Plug plants are extensively used on high value vegetable crops like pepper but they do not control competition from nutsedges.

There has been extensive research on alternatives for solanaceous crops, and methyl bromide minimizing practices have been incorporated into pepper production systems where possible. However, the effectiveness of chemical and non-chemical alternatives designed to fully replace methyl bromide must still be characterized as preliminary.
Weeds, particularly nutsedge, are the major pests of Florida peppers that drive the need for methyl bromide. There are no registered herbicides compatible with pepper production. Although s-metolachlor (Dual Magnum) and napropamide (Devrinol) were cited as herbicides with some potential to control nutsedges, the efficacy of these herbicides in sub-tropical Florida is inconsistent (Noling, 2003). When nutsedge pressure is moderate to severe, 1,3-D + chloropicrin is not technically feasible because it needs to be coupled with an effective herbicide to provide control for the entire growing season (U.S. EPA, 2002). Frank et al (1992) reported that weeds in pepper for 40 to 60 days could reduce yields by 10 to 50 percent. Stall and Morales-Payan reported that tomato must be nutsedge-free for 2 to10 weeks to keep yield reductions below 5 percent. There are no herbicides which control nutsedge in the crop row. Paraquat and glyphosate will suppress emerged nutsedge, but cannot be used in the crop row because of potential crop injury (SE Pepper Consortium CUE 02-0041).

In addition, labeling of 1,3-dichloropropene products restricts its use in key pepper growing areas of the U.S. where karst topography exists due to ground-water contamination concerns. In areas where 1,3-dichloropropene use is allowed, set back restrictions and 28-day waiting periods between application and planting cause delays/adjustments in production schedules that could lead to missing specific market windows, thus reducing profits on pepper crops. For example, peppers produced during the winter fetch a higher price than peppers produced during warmer months, and many growers rely on this price premium to maintain profitability.

Metam sodium provides limited and erratic performance at suppressing all major solanaceous pathogens and pests. Data indicate that metam sodium is not an effective alternative to methyl bromide for nutsedge control in bell pepper fields (Webster et al. (2002). A 21-day planting delay is also recommended for this chemical. In addition there is evidence that both 1,3-dichloropropene and methyl isothiocynate (the breakdown product of metam sodium) levels decline more rapidly, thus further compromising efficacy, in areas where these are repeatedly applied (Smelt et al. 1989, Ou et al. 1995, Gamliel et al. 2003). This is due to enhanced degradation of these chemicals by soil microbes (Dungan and Yates 2003).

Diseases caused by soil-borne plant pathogenic fungi, (e.g., *Phytophthora* spp., *Verticillium* spp., *Pythium* spp. and *Rhizoctonia solani*) commonly reside in many production areas, since many pepper production areas are old tomato production fields. Fungicides such as chlorothalonil, and azoxystrobin are considered to be only prophylactic, and may not offer sufficient pest management. Resistance of *Phytophthora* spp to metalaxyl and mefanoxem (Ridomil and Ridomil Gold, respectively) has been reported in tomato crop areas, and most recently pepper (Lamour and Hausbeck 2003).

Nematodes, such as the root knot nematode species of *Meloidogyne* were third, following weeds and fungal pathogens, in order of causing yield and economic losses in Florida peppers. Pre-plant control of nematodes is very important because root feeding and damage may predispose the plant tissues to fungal pathogens or bacterial wilt which can lead to significant yield loss. Fumigant alternatives such as metam-sodium (Vapam, K-pam) have proven inconsistent. (Noling, 2003; CUE #03-0017).

Research on the effectiveness of non-chemical alternatives to methyl bromide is still in a preliminary stage, particularly for high value, minor-use crops.

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 *(e.g. Effective herbicide available, but not registered for this crop; mandatory requirement to meet certification for disease tolerance)*
California	Crown and root rots caused by soil-borne fungi – particularly *Phytophthora capsici.* Plant-parasitic nematodes, primarily root knot (*Meloidogyne* spp.)	Registered alternative fumigants, fungicides, and nematicides are not as cost-effective and do not provide the same level of pest control as methyl bromide. One application of methyl bromide can last more than a year (within a particular field), whereas alternative chemicals must be applied annually.

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)*	Pepper transplants for fruit production
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual; generally 1 year
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Pepper may be followed by pepper, celery, broccoli or leafy vegetables
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy loam; clay loam
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	1 time every 2 years
OTHER RELEVANT FACTORS:	High land costs and urban encroachment increasing near production areas. Very few crops can be rotated with peppers that will provide an economic return.

CALIFORNIA - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA Plant Hardiness Zone 9b											
RAINFALL *(mm)*[A,B]	16.0 29.7	72.1 112.3	17.3 16.0	0 0	T 17.2	1.0 T	T 0	0 T	44.7 74.9	56.9 273.1	9.9 36.3	30.5 62.2
OUTSIDE TEMP. *(℃)*[A]	14.4 13.2	14.8 12.4	20.8 14.9	25.7 17.1	30.3 17.2	27.4 19.1	25.1 18.2	18.4 16.3	13.4 14.2	9.6 11.4	10.3 2.1	10.6 11.2
FUMIGATION SCHEDULE[C]								X*	X*	X*		
PLANTING SCHEDULE[C]											X	X
KEY MARKET WINDOW				X	X	X	X	X				

Notes:

* Fumigation occurs in these months, but only every other year, typically.

[A] Air temperatures and rainfall data were collected from weather stations in Fresno (top number) and at the San Francisco Airport (bottom number) from September to December 2002 and January to August, 2003.

[B] A "T" in the column denotes trace amount of rainfall recorded

[C] The above cycle is if another pepper crop followed the first planting of peppers. If other crops follow pepper, then planting of the other crops (e.g.,a leafy vegetable) would begin in October and harvest would be in in December, January and February.

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

Urban encroachment and concomitant buffer zones and local (township) caps restrict the use of the MB alternative 1,3 D (with or without chloropicrin). Essentially this prevents the use of this alternative on approximately 10 % of the pepper growing area in California, according to the applicant. The applicant is requesting MB only for this proportion of their total pepper acreage.

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

In California, the soil injection of MB under tarps has increased from approximately 68% of the area using this fumigant in 1997 to 93% in 2003. The depth of methyl bromide application varies from 15 to 36 cm centimeters below tarps. The low MB dosage rate is due in large part to a shift by all growers to formulations lower than the 98:2 ratio that was used in the mid-1990s. The formulations most commonly in use currently are 75:25 or 67:33 mixture of methyl bromide: chloropicrin. (Melban 2003). Please see Table 12.1 for further information.

CALIFORNIA- TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	726	864	1,226	995	447	Not available
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	Ratio of Flat Fumigation treatments versus bed applications is not known. Two methods of application are used: Flat-fumed type, and methyl bromide is injected, and sealed with plastic ground cover. If buffer zones are strict (e.g., in southern Santa Clara County), then almost all applications are flat-fumed, Flat Fumigation. The second type of application involves bed-fumed (~0.67 A, or 29,000 sq. ft)					
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	184.4	211.6	201.6	171.7	142.0	Not available
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*	75:25 or 67:33	75:25 or 67:33	75:25 or 67:33	75:25 or 67:33	75:25 or 67:33	75:25 or 67:33
METHODS BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Flat-fumed or bed fumed, injected 16-36 cm deep	Flat-fumed or bed fumed, injected 16-36 cm deep	Flat-fumed or bed fumed, injected 16-36 cm deep	Flat-fumed or bed fumed, injected 16-36 cm deep	Flat-fumed or bed fumed, injected 16-36 cm deep	Flat-fumed or bed fumed, injected 16-36 cm deep
APPLICATION RATE OF FLAT FUMIGATION ; FLAT-FUMED; KG A.I./ha*	336.3	336.3	336.3	336.3	336.3	336.3
APPLICATION RATE OF FLAT FUMIGATION ; BED-FUMED; KG A.I./ha*	224.0	224.0	224.0	224.0	224.0	224.0
DOSAGE RATE*(G/M^2) OF FORMULATION USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	27.4	27.4	27.4	27.4	27.4	27.4
APPLICATION RATE OF STRIP/ BED, G MB/M^2						

California - Part C: Technical Validation

California - 13. Reason for Alternatives Not Being Feasible

California– Table 13.1: Reason for Alternatives Not Being Feasible

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available	Is the alternative considered cost effective?
Chemical Alternatives		
1,3-D + chloropicrin	In small plot trials conducted in Michigan, this formulation showed some efficacy against the *P. capsici*. It should be noted that these trials had not been completed at the time results were submitted to the EPA. Plant loss was about 6 % as compared to 0 % with MB (Hausbeck and Cortright 2003). While this suggests that it may be technically feasible against fungal pests, large-scale trials have not been conducted to confirm the results. This formulation has shown effectiveness equivalent to that of MB against nematodes, the other type of key pest cited by California (Eger 2000). California also has township caps on the amount of 1, 3 D and chloropicrin that can be used near urban areas and a mandatory buffer (approx. 100 m) around treated areas, factors that may result in significant areas remaining untreated	no
Metam Sodium	Control of the key fungal pest is inconsistent at best (Martin 2003). A small plot trial in progress on solanaceous crops in Michigan indicates that plots with metam sodium had higher plant loss than the untreated check plots (Hausbeck and Cortright 2003). It should be noted that these trials had not been completed at the time results were submitted to the EPA. Gilreath et al. (1994) found that metam-sodium treatments did not match MB in terms of plant vigor at the end of the season; *Fusarium* was one of several pests present	no
Non Chemical Alternatives		
Soil solarization	California's coastal climate is typically cool (less than 16 ^{o}C frequently through December), rainy, and cloudy, particularly early in the pepper-growing season when control of the key pests is particularly important. Since solarization has shown some potential in other crops and regions (e.g., tomatoes in Florida), the potential for adoption exists (Schneider et al. 2003). However, at this time it is technically infeasible for California coastal peppers.	No

Name of Alternative	**Technical and regulatory* reasons for the alternative not being feasible or available**	**Is the alternative considered cost effective?**
Steam	While steam has been used effectively against fungal pests in protected production systems, such as greenhouses, there is no evidence that it would be effective in open field pepper crops in California. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to sterilize soil down to the rooting depth of field crops (at least 20-50 cm).	No
Biological Control	Biological control agents are not technically feasible alternatives to methyl bromide because they alone cannot control the soil pathogens that afflict peppers in California. The bacterium *Burkholderia cepacia* and the fungus *Gliocladium virens* have shown some potential in controlling some fungal plant pathogens (Larkin and Fravel 1998). However, in a test conducted in Michigan, *P. capsici* was not controlled adequately in summer squash by either of these beneficial microorganisms. Tests in California peppers have apparently not been conducted.	No
Cover crops and mulching	There is no evidence these practices effectively substitute for the control methyl bromide provides against *P. capsici.* Plastic mulch is already in widespread use in California vegetables, and regional crop experts state that it is not an adequate protectant when used without methyl bromide. The longevity and resistance of *P. capsici* oospores renders cover crops ineffective as a stand-alone management alternative to methyl bromide.	No
Crop rotation and fallow land	The crop rotations available to growers in the coastal California region are also susceptible to these fungi, particularly to *P. capsici*. Fallow land can still harbor *P. capsici* oospores (Lamour and Hausbeck 2003). Thus fungi would persist and attack peppers if crop rotation/fallow land was the main management regime. The same phenomenon applies to nematodes, another important soil pest in this region.	No
Endophytes	Though these organisms (fungi that grow symbiotically or as parasites within plants) have been shown to suppress some plant pathogens in cucumber, there is no such information for the pepper crops grown in California. Furthermore, the pathogens involved did not include *Phytophthora* species, which are arguably the greatest single threat to California peppers.	No
Flooding/Water management	Flooding is not technically feasible as an alternative because it does not have any suppressive effect on *P. capsici* (Allen et al. 1999), and is likely to be impractical for California pepper growers. It is unclear whether irrigation methods in this region could be adapted to incorporate flooding or alter water management for pepper fields. In any case, there appears to be no supporting evidence for its use against the hardy oospores of *P. capsici*.	No

Name of Alternative	**Technical and regulatory* reasons for the alternative not being feasible or available**	**Is the alternative considered cost effective?**
Grafting/resistant rootstock/plant breeding/soilless culture/organic production/substrates/plug plants.	Due to the paucity of scientific information on the utility of these alternatives as methyl bromide replacements in peppers, they have been grouped together for discussion in this document. There are no studies documenting the commercial availability of resistant rootstock immune to the fungal pathogens listed as major pepper pests. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of *Phytophthora* and *Fusarium* fungi. Soilless culture, organic production, and substrates/plug plants are also not technically viable alternatives to methyl bromide for fungi. *P.capsici* can spread through water (Gevens and Hausbeck 2003), making it difficult to keep any sort of area (with or without soil) plant pathogen free. Various aspects of organic production – e.g., cover crops, fallow land, and steam sterilization - have already been addressed in this document and assessed to be technically infeasible methyl bromide alternatives.	No
Combinations of Alternatives		
Metam sodium + Chloropicrin	Trials in tomato have shown inconsistent efficacy of this formulation against fungal pests, though it is generally better than metam-sodium alone (Locascio and Dickson 1998, Csinos et al. 1999). Low efficacy in even small-plot trials indicates that this is not a technically feasible alternative for commercially produced cucurbits at this time. These studies apparently did not measure yield impacts, and did not involve cucurbits.	No
1,3 D + Metam-sodium	Trials in tomato have shown inconsistent efficacy of this formulation against fungal pests, though it is generally better than metam-sodium alone (Csinos et al. 1999). Low efficacy in even small-plot trials indicates that this is not a technically feasible alternative for commercially produced cucurbits in Michigan at this time. These studies apparently did not measure yield impacts, and did not involve cucurbits.	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:

Name of Alternative	**Discussion**
	Other than those options discussed elsewhere, no alternatives exist for the control of the key pests when they are present in the soil and/or afflict the belowground portions of pepper plants. A number of effective fungicides are available for treatment of these fungi when they infect

	aerial portions of crops. However, these infections are not the focus of MB use, which is meant to keep newly planted transplants free of these fungi.

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

CALIFORNIA – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS *State if registered for this crop, registered for crop but use restricted, registered for other crops but not target crop, or not registered*	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Methyl iodide	Not registered	Yes	Unknown
Furfural	Not registered	No	Unknown
Sodium azide	Not registered. No registration application received.	No	Unknown
Propargyl bromide	Not registered. No registration application received.	No	Unknown

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

As far as EPA can ascertain, virtually none of the studies on key MB alternatives has focused on peppers in coastal California's growing conditions. One exception to this situation can be summarized first, although this study was ongoing at the time it was submitted to EPA. This study is a field trial, conducted in small plots in 2003 in Michigan by M.K. Hausbeck and B.D. Cortright of Michigan State University. The study focused on a number of vegetable crops, including bell peppers. As of July 31, 2003, results indicated that 1,3 D + 35 % chloropicrin treatments (shank-injected at 56.7 liters/ha) showed approximately 6 % plant loss (due to *P. capsici*) – less than the 7 % loss seen in the untreated control plots. Metam-sodium (drip-applied at 58.7 kg/ha) showed a 13 % loss. Methyl iodide with either 50 % or 33 % chloropicrin (shank-injected, at either 46.1 or 36.8 kg/ha, respectively) showed only 2 % plant loss. However, methyl iodide is not registered for this crop in the U.S. at present. It should also be noted that (1) since the trial had not yet ended, statistical analysis on these figures was not conducted, (2) plant loss figures are for all vegetable crops combined, and (3) these plots were being carefully monitored and managed with post-plant prophylactic foliar fungicides (e.g., chlorothalonil and myclobutanil) – an optimal management scheme that will require time to enable growers to adopt.

In studies with other vegetable crops, 1,3 D + chloropicrin has generally shown better control of fungi than metam-sodium formulations (though still not as good as control with MB). For example, in a study using a bell pepper/squash rotation in small plots - conducted in the much warmer conditions of Georgia and without *P. capsici* as a component of the pest complex - Webster et al. (2001) found significantly lower fungal populations with 1,3 D + 35 % chloropicrin (drip irrigated or chisel injected, 146 kg/ha of 1,3 D), as compared to the untreated control. However, MB (440 kg/ha, shank-injected) lowered fungal populations even more. Methyl iodide had no significant suppressive effect, as compared to the untreated control. In another study, conducted on tomatoes in Florida, Gilreath et al. (1994) found that metam-sodium treatments did not match MB in terms of plant vigor at the end of the season; *Fusarium* was one of several pests present.

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

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
1,3 D + Chloropicrin	Soil borne fungal plant pathogens	0 – 6 %	6 %
Metam sodium (with or without chloropicrin)	Soil borne fungal diseases	0-100 %	100 %
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**6 – 100 %; 6 % likely with the best alternative (1,3 D + chloropicrin)**

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

Work underway in Michigan peppers (summarized in Table 17 for Michigan) will produce results likely to be applicable to coastal California pepper production. However, it should be noted that the many of the MB alternatives under study under study are not yet registered for peppers in the U.S., and it is unclear when (if ever) commercial entities will pursue such registration (see table 15.1, California or Michigan regions, for registration status).

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

No. Soilless systems and greenhouse production are not in use for peppers in this region, and quick adoption is probably economically infeasible. Growers apply MB on fields with a history of pest contamination, but it appears that most growing acreage in this region has moderate to severe infestations, particularly of *P. capsici* and other soil borne fungi, which thrive in cool and moist climates.

CALIFORNIA - SUMMARY OF TECHNICAL FEASIBILITY

Without methyl bromide, pepper producers in cool weather climates of Ventura and Santa Clara Counties would most likely use a mixture of 1,3-D and chloropicrin (Telone C-35) to manage the nematode and fungal pathogen populations prior to transplanting pepper. There is evidence from numerous small plot and large-scale trials to indicate that these MB alternatives, in combination, will control nematodes to the extent that MB does nematodes.(e.g. Eger 2000). However, EPA believes that there is no comparable set of research results to indicate that fungal pests, particularly *P. capsici*, will be controlled to a similar extent.
To wit, no large-plot studies have yet been performed to show commercial feasibility against fungal pests in coastal California peppers. Important regulatory constraints on 1,3 D and chloropicrin must also be kept in mind: township caps on the amounts used (which may affect the use rate and hence efficacy), mandatory 100 m buffers near inhabited structures – both of which will cause negative economic impacts that are likely to make the use of these MB alternatives infeasible for the near future. These planting restrictions may thus be important factors inhibiting widespread grower adoption of this MB alternative.

Currently unregistered alternatives, such as furfural and sodium azide, have shown good efficacy against the key pests involved. However, even if registration is pursued soon (and the EPA has no indications of any commercial venture planning to do so) these options will need more research on how to adapt them to commercial pepper production in California.
There are also no non-chemical alternatives that are currently viable for MB replacement for commercial pepper growers. In sum, while the potential exists for a combination of chemical and non-chemical alternatives to replace MB use in California pepper, this goal appears be at least a few years away.

PART D: EMISSION CONTROL

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

TABLE 19.1: TECHNIQUES TO MINIMIZE METHYL BROMIDE USE AND EMISSIONS

TECHNIQUE OR STEP TAKEN	VIF OR HIGH BARRIER FILMS	METHYL BROMIDE DOSAGE REDUCTION	INCREASED % CHLOROPICRIN IN METHYL BROMIDE FORMULATION	LESS FREQUENT APPLICATION
WHAT USE/EMISSION REDUCTION METHODS ARE PRESENTLY ADOPTED?	Currently some growers use HDPE tarps.	Growers have switched from a 98% MB formulation to a 67 % formulation. Between 1997 and 2001, the U.S. has achieved a 36 % reduction in use rates.	From 2 % to 33 %	No
WHAT FURTHER USE/EMISSION REDUCTION STEPS WILL BE TAKEN FOR THE METHYL BROMIDE USED FOR CRITICAL USES?	Research is underway to develop use in commercial production systems	Research is underway to develop use of a 50 % MB formulation in Michigan commercial production systems. Not known if other regions are planning similar work.	Research is underway to develop use of a 50 % MB formulation in Michigan commercial production systems. Not known if other regions are planning similar work.	The U.S. anticipates that the decreasing supply of methyl bromide will motivate growers to try less frequent applications.
OTHER MEASURES *(please describe)*	Examination of promising but presently unregistered alternative fumigants and herbicides, alone or in combination with non-chemical methods, is planned in all regions (Please see Section 17 for each region for details)	Measures adopted in Michigan will likely be used in the other regions when fungi are the only key pests involved	Measures adopted in Michigan will likely be used in the other regions when fungi are the only key pests involved	Unknown

20. If Methyl Bromide Emission Reduction Techniques Are Not Being Used, or Are Not Planned for the Circumstances of the Nomination, State Reasons

In accordance with the criteria of the critical use exemption, each party is required to describe ways in which it strives to minimize use and emissions of methyl bromide. The use of methyl bromide in the growing of peppers in the United States is minimized in several ways. First, because of its toxicity, methyl bromide has, for the last 40 years, been regulated as a restricted use pesticide in the United States. As a consequence, methyl bromide can only be used by certified applicators who are trained at handling these hazardous pesticides. In practice, this means that methyl bromide is applied by a limited number of very experienced applicators with the knowledge and expertise to minimize dosage to the lowest level possible to achieve the needed results. In keeping with both local requirements to avoid "drift" of methyl bromide into inhabited areas, as well as to preserve methyl bromide and keep related emissions to the lowest level possible, methyl bromide application for cucurbits is most often machine injected into soil to specific depths.

As methyl bromide has become scarce, users in the United States have, where possible, experimented with different mixes of methyl bromide and chloropicrin. Specifically, in the early 1990s, methyl bromide was typically sold and used in methyl bromide mixtures made up of 95% methyl bromide and 5% chloropicrin, with the chloropicrin being included solely to give the chemical a smell enabling those in the area to be alerted if there was a risk. However, with the outset of very significant controls on methyl bromide, users have been experimenting with significant increases in the level of chloropicrin and reductions in the level of methyl bromide. While these new mixtures have generally been effective at controlling target pests, at low to moderate levels of infestation, it must be stressed that the long-term efficacy of these mixtures is unknown.

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

Reduced methyl bromide concentrations in mixtures, cultural practices, and the extensive use of tarpaulins to cover land treated with methyl bromide has resulted in reduced emissions and an application rate that we believe is among the lowest in the world for the uses described in this nomination.

PART E: ECONOMIC ASSESSMENT

The following economic assessment is organized by MB critical use application. Cost of MB and alternatives are given first in table 21.1. This is followed in table 22.1 by a listing of net and gross revenues by applicant. Expected losses when using MB alternatives are then further decomposed in tables E1 through E5.

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

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

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

ALTERNATIVE	YIELD*	COST IN YEAR 1 (US$/ha)	COST IN YEAR 2 (US$/ha)	COST IN YEAR 3 (US$/ha)
California				
Methyl Bromide	100%	$5,903	$5,903	$5,903
1,3-D + Chloropicrin	94%	$5,903	$5,903	$5,903
Florida				
Methyl Bromide	100%	$2,656	$2,656	$2,656
1,3-D + Chloropicrin	71%	$3,501	$3,501	$3,501
Metam-Sodium	56%	$3,326	$3,326	$3,326
Georgia				
Methyl Bromide	100%	$3,642	$3,642	$3,642
1,3-D + Chloropicrin	71%	$3,242	$3,242	$3,242
Metam-Sodium	56%	$3,027	$3,027	$3,027
Michigan				
Methyl Bromide	100%	$1,475	$1,475	$1,475
1,3-D + Chloropicrin	94%	$1,772	$1,772	$1,772
Southeast U.S.				
Methyl Bromide	100%	$2,214	$2,214	$2,214
1,3-D + Chloropicrin	71%	$2,585	$2,585	$2,585
Metam-Sodium	56%	$2,585	$2,585	$2,585

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

22. GROSS AND NET REVENUE:

TABLE 22.1: PEPPERS – YEAR 1, 2, AND 3 GROSS AND NET REVENUES

YEAR 1, 2, AND 3		
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	$21,344	$4,098
1,3-D + Chloropicrin	$20,063	$2,903
Florida		
Methyl Bromide	$29,498	$9,158
1,3-D + Chloropicrin	$20,944	$2,433
Metam-Sodium	$16,519	- $479
Georgia		
Methyl Bromide	$35,176	$6,553
1,3-D + Chloropicrin	$24,975	- $816
Metam-Sodium	$19,698	- $3,900
Michigan		
Methyl Bromide	$24,056	- $6,751
1,3-D + Chloropicrin	$20,916	- $9,379
Southeastern U.S.		
Methyl Bromide	$30,579	$11,822
1,3-D + Chloropicrin	$21,711	$2,867
Metam-Sodium	$17,124	$393

NOTE: Year 1 equals year 2 and 3.

MEASURES OF ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

CALIFORNIA PEPPER - TABLE E1: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

CALIFORNIA PEPPER	METHYL BROMIDE	1, 3-D + CHLOROPICRIN
YIELD LOSS (%)	0%	6%
YIELD PER HECTARE	787	739
* PRICE PER UNIT (US$)	$27	$27
= GROSS REVENUE PER HECTARE (US$)	$21,344	$20,063
- OPERATING COSTS PER HECTARE (US$)	$17,246	$17,160
= NET REVENUE PER HECTARE (US$)	$4,098	$2,903
LOSS MEASURES		
1. LOSS PER HECTARE (US$)	$0	$1,194
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$8
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	6%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	29%

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

FLORIDA PEPPER	METHYL BROMIDE	1, 3-D + CHLOROPICRIN	METAM-SODIUM
YIELD LOSS (%)	0%	29%	44%
YIELD PER HECTARE	2,922	2,074	1,636
* PRICE PER UNIT (US$)	$10	$10	$10
= GROSS REVENUE PER HECTARE (US$)	$29,498	$20,944	$16,519
- OPERATING COSTS PER HECTARE (US$)	$20,341	$18,510	$16,999
= NET REVENUE PER HECTARE (US$)	$9,158	$2,433	- $479
LOSS MEASURES			
1. LOSS PER HECTARE (US$)	$0	$6,724	$9,637
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$45	$64
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	23%	33%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	73%	105%

GEORGIA PEPPER - TABLE E.3: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

GEORGIA PEPPER	METHYL BROMIDE	1, 3-D + CHLOROPICRIN	METAM-SODIUM
YIELD LOSS (%)	0%	29%	44%
YIELD PER HECTARE	4,440	3,152	2,486
* PRICE PER UNIT (US$)	$8	$8	$8
= GROSS REVENUE PER HECTARE (US$)	$35,176	$24,975	$19,698
- OPERATING COSTS PER HECTARE (US$)	$28,623	$25,790	$23,598
= NET REVENUE PER HECTARE (US$)	$6,553	- $816	- $3,900
LOSS MEASURES			
1. LOSS PER HECTARE (US$)	$0	$7,368	$10,453
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$49	$70
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	21%	30%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	112%	160%

MICHIGAN PEPPER- TABLE E.4: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

MICHIGAN PEPPER	METHYL BROMIDE	1, 3-D + CHLOROPICRIN
YIELD LOSS (%)	0%	6%
YIELD PER HECTARE	4,530	4,258
* PRICE PER UNIT (US$)	$5	$5
= GROSS REVENUE PER HECTARE (US$)	$24,056	$20,916
- OPERATING COSTS PER HECTARE (US$)	$30,807	$30,296
= NET REVENUE PER HECTARE (US$)	- $6,751	- $9,379
LOSS MEASURES		
1. LOSS PER HECTARE (US$)	$0	$2,629
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$54
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	11%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	39%

SOUTHEASTERN U.S. (EXCEPT FLORIDA & GEORGIA) PEPPER - TABLE E.5: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

SOUTHEASTERN U.S. (EXCEPT FLORIDA & GEORGIA) PEPPER	METHYL BROMIDE	1, 3-D + CHLOROPICRIN	METAM-SODIUM
YIELD LOSS (%)	0%	29%	44%
YIELD PER HECTARE	3,707	2,632	2,076
* PRICE PER UNIT (US$)	$8	$8	$8
= GROSS REVENUE PER HECTARE (US$)	$30,579	$21,711	$17,124
- OPERATING COSTS PER HECTARE (US$)	$18,758	$18,844	$16,731
= NET REVENUE PER HECTARE (US$)	$11,822	$2,867	$393
LOSS MEASURES			
1. LOSS PER HECTARE (US$)	$0	$8,954	$11,429
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$0	$60	$76
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	29%	37%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	76%	97%

SUMMARY OF ECONOMIC FEASIBILITY

There are currently few alternatives to methyl bromide for use in peppers. Furthermore, there are factors that limit existing alternatives' usability and efficacy from place to place. These include pest complex, climate, and regulatory restrictions. As described above, the two most promising alternatives to methyl bromide in Florida, Georgia, and the Southeastern U.S. for control of nutsedge in peppers (1,3-D + chloropicrin and metam-sodium) are considered not technically feasible. This derives from regulatory restrictions and the magnitude of expected yield losses when they are used. Economic data representing the Florida, Georgia, and Southeastern U.S. pepper growing conditions are included in this section as a supplement to the biological review to illustrate the impacts of using MB alternatives, not to gauge them with respect to economic feasibility. However, in California and Michigan 1,3-D + chloropicrin is considered technically feasible.

California

Yield loss in California pepper production is expected to be 6% when using MB alternatives. Growers will experience loss on a per hectare basis of approximately $1,200 and 6% and 29% losses in gross and net revenues, respectively. However, these measures do not clearly indicate that 1,3-D + chloropicrin an economically infeasible alternative to MB.

The economic conditions facing pepper growers were quantified as best as possible but, primarily due to limited data availability, every aspect of the economic picture was not included in the numeric assessment. Factors not accounted for are distribution of yield loss across individual growers and the yield risk associated with using MB alternatives.

Michigan

The U.S. concludes that, at present, no economically feasible alternatives to MB exist for use in Michigan pepper production. Two factors have proven most important in this conclusion. These are yield loss and missed market windows, which are discussed individually below.

1. Yield Loss

Expected yield losses of 6% are anticipated throughout Michigan pepper production.

2. Missed Market Windows

The U.S. agrees with Michigan's assertion that growers will likely receive significantly lower prices for their produce if they switch to 1,3-D + chloropicrin. This is due to changes in the harvest schedule caused by the above described soil temperature complications and extended plant back intervals when using 1,3-D + chloropicrin.

The analysis of this effect is based on the fact that prices farmers receive for their peppers vary widely over the course of the growing season. Driving these fluctuations are the forces of supply and demand. Early in the growing season, when relatively few peppers are harvested, the supply is at is lowest and the market price is at its highest. As harvested quantities increase, the price declines. In order to maximize their revenues, pepper growers manage their production systems with the goal of harvesting the largest possible quantity of peppers when the prices are at their highs. The ability to sell produce at these higher prices makes a significant contribution toward the profitability of pepper operations.

To describe these conditions in Michigan pepper production, weekly pepper sales data from the U.S. Department of Agriculture for the previous three years was used to gauge the impact of early season price fluctuations on gross revenues. Though data availability is limiting, it is assumed that if pepper growers adjust the timing of their production system, as required when using 1,3-D + Chloropicrin, that they will, over the course of the growing season, receive gross revenues reduced by approximately 7.5%. The season average price was reduced by 7.5% in the analysis of the alternatives to reflect this. Based on currently available information, the U.S. believes this reduction in gross revenues serves as a reasonable indicator of the typical effect of planting delays resulting when MB alternatives are used in Michigan pepper production.

Florida

No technically (and thus economically) feasible alternatives to MB are presently available to the effected pepper growers. As such, the U.S. concludes that use of MB is critical in Florida pepper production.

Georgia

No technically (and thus economically) feasible alternatives to MB are presently available to the affected pepper growers. As such, the U.S. concludes that use of MB is critical in Georgia pepper production.

Southeastern U.S. Except Georgia

No technically (and thus economically) feasible alternatives to MB are presently available to the effected pepper growers. As such, the U.S. concludes that use of MB is critical in Southeastern U.S. pepper production.

PART F. FUTURE PLANS

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

Since 1997, the United States EPA has made the registration of alternatives to methyl bromide a high registration priority. Because the EPA currently has more applications pending in its registration review queue than the resources to evaluate them, EPA prioritizes the applications. By virtue of being a top registration priority, methyl bromide alternatives enter the science review process as soon as U.S. EPA receives the application and supporting data rather than waiting in turn for the EPA to initiate its review.

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

The U.S. EPA has also co-chaired the U.S.DA/EPA Methyl Bromide Alternatives Work Group since 1993 to help coordinate research, development and the registration of viable alternatives. This coordination has resulted in key registration issues (such as worker and bystander exposure through volatilization, township caps and drinking water concerns) being directly addressed through USDA's Agricultural Research Service's U.S.$15 million per year research program conducted at more than 20 field evaluation facilities across the country. Also EPA's participation in the evaluation of research grant proposals each year for USDA's U.S.$2.5 million per year methyl bromide alternatives research has further ensured close coordination between the U.S. government and the research community.

The amount of methyl bromide requested for research purposes is considered critical for the development of effective alternatives. Without methyl bromide for use as a standard treatment, the research studies can never address the comparative performance of alternatives. This would be a serious impediment to the development of alternative strategies. The U.S. government estimates that peppers research will require 2844 kg per year of methyl bromide for 2005 and 2006. This amount of methyl bromide is necessary to conduct research on alternatives and is in addition to the amounts requested in the submitted CUE applications. One example of the research is a field study testing the comparative performance of methyl bromide, host resistance, cultural practices, pest management approaches for control of root-knot nematodes. Another example is a five year field study comparing methyl bromide to 1,3-D combined with biologically based materials including transplant treatments for control of weeds, root-knot nematodes and soil borne fungal pathogens.

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

The U.S. wants to note that our usage rate is among the lowest in the world in requested sectors and represents efforts of both the government and the user community over many years to reduce use rates and emissions. We will continue to work with the user community in each sector to identify further opportunities to reduce methyl bromide use and emissions.

25. Additional Comments on the Nomination?

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

Methyl Bromide Critical Use Exemption Process	Date:	26-Feb-2004	Average Hectares in the US:	36,007
2006 Methyl Bromide Usage Numerical Index (BUNI)	Sector:	PEPPERS	% of Average Hectares Requested:	37%

REGION	2006 Amount of Request: Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	2001 & 2002 Average Use*: Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	Quarantine and Pre-Shipment	Regional Hectares**: 2001 & 2002 Average	% of 2001 & 2002 Average	Requested Hectares %
CALIFORNIA	181,437	1,012	179	63,558	447	142	0%	9,854	5%	10%
SOUTHEASTERN US	224,891	1,497	150	135,238	900	150	0%	3,581	25%	42%
GEORGIA	347,183	2,312	150	342,716	2,282	150	0%	2,554	89%	90%
FLORIDA	1,230,822	8,195	150	1,360,776	8,468	161	0%	8,215	103%	100%
MICHIGAN	15,803	328	48	15,924	330	48	0%	749	44%	44%
TOTAL OR AVERAGE	2,000,136	13,343	136	1,918,212	12,428	130	0%	24,954	50%	53%

2006 Nomination Options	Subtractions from Requested Amounts (kgs)					Combined Impacts Adjustment (kgs)		MOST LIKELY IMPACT VALUE			
REGION	2006 Request	(-) Double Counting	(-) Growth or 2002 CUE Comparison	(-) Use Rate Difference	(-) QPS	HIGH	LOW	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	% Reduction
CALIFORNIA	181,437	-	101,191	16,688	-	63,558	63,558	63,558	447	142	65%
SOUTHEASTERN US	224,891	-	112,445	-	-	89,956	52,849	82,535	550	150	63%
GEORGIA	347,183	-	8,935	-	-	284,128	172,507	261,804	1,743	150	25%
FLORIDA	1,230,822	-	-	-	-	1,230,822	824,651	1,149,588	7,654	150	7%
MICHIGAN	15,803	-	-	-	-	11,852	11,852	11,852	246	48	25%
Nomination Amount	2,000,136	2,000,136	1,777,564	1,760,876	1,760,876	1,680,317	1,125,417	1,569,337	10,640	147	22%
% Reduction from Initial Request	0%	0%	11%	12%	12%	16%	44%	22%	20%		

Adjustments to Requested Amounts	Use Rate (kg/ha)		(%) Karst Topography		(%) 100 ft Buffer Zones		(%) Key Pest Distribution		Regulatory Issues (%)		Unsuitable Terrain (%)		Cold Soil Temp (%)		Combined Impacts (%)	
REGION	2006	Low	High	Low	High	Low	High	Low	High	Low	High	Low	High	Low	HIGH	LOW
CALIFORNIA	179	142	0	0	0	0	100	100	26	17	0	0	0	0	100%	100%
SOUTHEASTERN US	150	150	0	0	0	0	80	47	0	0	0	0	0	0	80%	47%
GEORGIA	150	150	8	8	0	0	80	47	0	0	0	0	0	0	84%	51%
FLORIDA	150	150	40	40	1	0	80	47	0	0	0	0	0	0	100%	67%
MICHIGAN	48	48	0	0	0	0	75	75	0	0	0	0	75	75	75%	75%

Other Considerations	Dichotomous Variables (Y/N)					Other Issues			Economic Analysis					
REGION	Strip Bed Treatment	Currently Use Alternatives?	Research / Transition Plans	Tarps / Deep Injection Used	Pest-free Cert. Requirement	Change from Prior CUE Request (+/-)	Verified Historic MeBr Use / State	Frequency of Treatment	Loss per Hectare (US$/ha)	Loss per Kilogram of MeBr (US$/kg)	Loss as a % of Gross Revenue	Loss as a % of Net Revenue	Quality/ Time/ Market Window/ Yield Loss (%)	Marginal Strategy
CALIFORNIA	Yes	Yes	Yes	Tarp	No	0	Yes	1/year	$1,194	$ 8	6%	29%	6%	1,3-D + Pic
SOUTHEASTERN US	Yes	Yes	Yes	Tarp	No	+	Yes	1/year	$8,954	$ 60	29%	76%	29% or 44%	1,3-D + Pic or Metam-Sodium
GEORGIA	Yes	Yes	Yes	Tarp	No	+	Yes	1/year	$7,368	$ 49	21%	112%	29% or 44%	1,3-D + Pic or Metam-Sodium
FLORIDA	Yes	Yes	Yes	Tarp	No	-	Yes	1/year	$6,724	$ 45	23%	73%	29% or 44%	1,3-D + Pic or Metam-Sodium
MICHIGAN	Yes	Yes	Yes	Tarp	No	N/A	Yes	1/year	$ 933	$ 19	4%	-14%	6%	1,3-D + Pic

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

Footnotes for Appendix A:

Values may not sum exactly due to rounding.

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

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

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

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

APPENDIX B. SUMMARY OF NEW APPLICANTS

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

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

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

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

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

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

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