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

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

NOMINATING PARTY:	The United States of America
BRIEF DESCRIPTIVE TITLE OF NOMINATION:	Methyl Bromide Critical Use Nomination for Pre-plant Soil Use for Tomato Grown in Open Fields

NOMINATING PARTY CONTACT DETAILS

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

X Yes ☐ No

CONTACT OR EXPERT(S) FOR FURTHER TECHNICAL DETAILS

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

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

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

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

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PART A: SUMMARY

1. NOMINATING PARTY:

The United States of America (U.S.)

2. DESCRIPTIVE TITLE OF NOMINATION:

Methyl Bromide Critical Use Nomination for Pre-plant Soil Use for Tomato Grown in Open Fields

3. CROP AND SUMMARY OF CROP SYSTEM

Tomato Crops Grown in Open Fields for Fruit. In California, Michigan and South-Eastern United States (Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, South Carolina, Tennessee). These crops are grown in open fields on plastic tarps, often followed by various other crops. Harvested fruit is destined for the fresh market.

4. METHYL BROMIDE NOMINATED:

TABLE 4.1: METHYL BROMIDE NOMINATED

YEAR	NOMINATION AMOUNT (KG)	NOMINATION AREA (HA)
2006	**2,931,879**	**19,839**

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

Currently registered alternatives to methyl bromide do not consistently provide effective control of nutsedge weed species and more time is needed to evaluate relationship between fumigant alternatives, various mulches, and herbicide systems under different growing conditions.

The US nomination is only for those areas where the alternatives are not suitable. In US tomato 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 US is only nominating a CUE for tomato where the key pest pressure is moderate to high such as nutsedge in the Southeastern US.
- regulatory constraints: e.g., telone use is limited in California due to townships caps and in Florida due to the presence of karst geology.
- delay in planting and harvesting: e.g., the plant-back interval for telone+chloropicrin is two weeks longer than methyl bromide+chloropicrin, 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.
- unsuitable topography: e.g., alternatives that must be applied with drip irrigation may not be suitable in areas with rolling or sloped topography due to uneven distribution of the fumigant.

TABLE A.1: EXECUTIVE SUMMARY FOR TOMATOES *

Region		*California Region*	*Michigan Region*	*South-Eastern United States*
AMOUNT OF NOMINATION				
2006	**Kilograms**	102,058	10,745	2,799,236
	Application Rate (kg/ha)	105	48	150
	Area (ha)	971	223	18,645
AMOUNT OF APPLICANT REQUEST				
2005	**Kilograms**	**102,058**	**32,214**	**4,640,896**
	Application Rate (kg/ha)	**105**	**48**	**155**
	Area (ha)	**971**	**668**	**29,959**
2006	**Kilograms**	**102,058**	**31,606**	**4,519,689**
	Application Rate (kg/ha)	**105**	**48**	**150**
	Area (ha)	**971**	**656**	**30,104**
ECONOMICS FOR NEXT BEST ALTERNATIVE				
Technically Feasible Alternative (s)		**METAM SODIUM**	**1,3-D + PIC**	**1,3-D + PIC**
Production Loss (%)		**15%**	**6%**	**6%**
Loss per hectare (US$/ha)		**$ 8,618**	**$ 6,113**	**$ 5,708**
Loss per kg Methyl Bromide (US$/kg)		**$ 82**	**$ 127**	**$ 38**
Loss as % of Gross Revenue (%)		**10%**	**15%**	**14%**
Loss as % of Net Revenue (%)		**26%**	**65%**	**39%**

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

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

Research results confirm that methyl bromide alternatives options provide inconsistent control of nutsedge weed species. Nutsedge is an extremely competitive weed in tomato and can cause significant yield losses in the Southeast. Methyl bromide alternatives also provide incomplete control of soil pathogens in Michigan.

In addition, there is a regulatory prohibition on the use of 1,3-D on karst topography in the South-Eastern United States. In Michigan, 1,3-D can only be used when soil temperature are higher than required for using methyl bromide, and this results in a planting/harvesting/marketing delay. In California, alternatives that must be applied with drip irrigation may not be suitable in areas with rolling or sloped topography due to uneven distribution of the fumigant.

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 AND 2002 (HA)	PROPORTION OF TOTAL CROP AREA TREATED WITH METHYL BROMIDE IN 2002 (%)
California Region	15,479	6
Michigan Region	749	88
South-Eastern United States	31,270	99
NATIONAL TOTAL : *	51,506	63

* National total includes other regions not requesting methyl bromide

7. (*ii*) IF ONLY PART OF THE CROP AREA IS TREATED WITH METHYL BROMIDE, INDICATE THE REASON WHY METHYL BROMIDE IS NOT USED IN THE OTHER AREA, AND IDENTIFY WHAT ALTERNATIVE STRATEGIES ARE USED TO CONTROL THE TARGET PATHOGENS AND WEEDS WITHOUT METHYL BROMIDE THERE.

The primary reason that some tomatoes may be grown without methyl bromide in all three regions is the absence of key target pests (i.e., nutsedge in the Southeast, soil pathogens in Michigan, and pathogens and nematodes in California).

In Florida, areas without karst geology and having low nutsedge pressure can successfully employ a fumigation system relying on 1,3-D and chloropicrin.

In Michigan, the majority of tomato producing acres do not have *Phytopthora spp*., and do not use methyl bromide.

In California, areas with flat terrain successfully employ 1,3-D with chloropicrin as a fumigant.

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, areas that use methyl bromide do so because hilly terrain, cold soil temperatures, and heavy pest pressure preclude the use of fumigants that are employed when these conditions are not present.

8. Amount of Methyl Bromide Requested for Critical Use

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

Region:	California Region	
Year of Exemption Request	**2005**	**2006**
Kilograms of Methyl Bromide	102,058	102,058
Use: Broad acre or Strip/Bed Treatment		
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)*	971	971
Application rate *(kg/ha)* for the **active ingredient**	105	105
Application rate *(kg/ha)* for the **formulation**	157	157
Dosage rate* *(g/m^2)* of **active ingredient** used to calculate requested kilograms of methyl bromide	10.5	10.5
Dosage rate* *(g/m^2)* of **formulation** used to calculate requested kilograms of methyl bromide	15.7	15.7

Michigan Region - Table 8.2: Amount of Methyl Bromide Requested for Critical Use

Region:	Michigan Region	
Year of Exemption Request	**2005**	**2006**
Kilograms of Methyl Bromide	32,214	31,606
Use: Broad acre 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)*	668	656
Application rate* *(kg/ha)* for the **active ingredient**	48*	48*
Application rate* *(kg/ha)* for the **formulation**	71.6*	71.6*
Dosage rate* *(g/m^2)* of **active ingredient** used to calculate requested kg of methyl bromide	13.1	13.1
Dosage rate* *(g/m^2)* of **formulation** used to calculate requested kg of methyl bromide	19.5	19.5

**Only 36.7% percent of an hectare receives this amount of methyl bromide formulation.*

SOUTH-EASTERN UNITED STATES* - TABLE 8.3: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION:	**South-Eastern United States**	
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF METHYL BROMIDE	4,640,896	4,519,689
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	Mostly Strip/Bed	Mostly Strip/Bed
FORMULATION *(ratio of methyl bromide/Chloropicrin mixture)* TO BE USED FOR THE CUE	Mostly 67/33	Mostly 67/33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(m^2 or ha)*	29,959	30,104
APPLICATION RATE *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	155	150
APPLICATION RATE *(kg/ha)* FOR THE **FORMULATION**	231	224
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	15.5	15.0
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KG OF METHYL BROMIDE	23.1	22.4

** Includes Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, North Carolina, South Carolina, and Tennessee.*

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

The amount of methyl bromide nominated by the US was calculated as follows:

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

TABLE A.2: 2006 SECTOR NOMINATION *

2006 (Sector) Nomination		California Region	Michigan Region	South-Eastern United States
Applicant Request for 2006	Requested Hectares (ha)	971	656	31,104
	Requested Application Rate (kg/ha)	105	48	150
	Requested Kilograms (kg)	102,058	31,606	4,519,688
CUE Nominated for 2006	Nominated Hectares (ha)	971	223	18,645
	Nominated Application Rate (kg/ha)	105	48	150
	Nominated Kilograms (kg)	102,058	10,745	2,799,236

2006 Sector Nomination Totals	**Overall Reduction (%)**	37
	Total 2006 U.S. CUE Nominated Kilograms (kg)	2,931,879
	Research Amount (kg)	5,501
	Total 2006 U.S. Sector Nominated Kilograms (kg)	**2,937,380**

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

CALIFORNIA REGION - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

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

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY DISEASE(S) AND WEED(S) TO GENUS AND, IF KNOWN, TO SPECIES LEVEL	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
California	*Fusarium* wilt *Verticillium* wilt Root Knot nematodes *Pythium* spp.	Registered alternatives do not provide consistent, efficient and economical control of listed pests.

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

CALIFORNIA REGION - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	CALIFORNIA REGION
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Transplants for tomato fruit production
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Tomato – Strawberry or Barley or fallow
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy to Loam
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Annual
OTHER RELEVANT FACTORS:	No additional information was provided

CALIFORNIA REGION - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE *(Plant Hardiness Zone)*	9A, 9B, 10A											
RAINFALL *(mm)*			0.25	0.00	0.25	3.05	51.8	2.29				
OUTSIDE TEMP. *(℃)**			17.8	20.5	22.2	20.0	14.4	11.7				
FUMIGATION SCHEDULE (DATES)	X	X								X	X	X
PLANTING SCHEDULE (DATES)		X	X	X	X							
KEY MARKET WINDOW (DATES)				X	X	X	X	X	X			

* Norton *et al.,*2000.

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

Telone fumigation controls nematodes. Chloropicrin controls fungal pathogens. A combination of telone and chloropicrin may be a technically feasible alternative for methyl bromide on flat terrain. However, this CUE is only for hilly, rolling terrain where these alternatives would not be uniformly distributed by the irrigation systems.

Metam sodium alone or metam sodium plus chloropicrin will not control root knot nematodes. In addition, rolling field topography having varied soil textures does not allow uniform application of metam sodium. This may result in pockets of high and low concentrations of metam sodium. High concentrations of metam sodium can be phytotoxic to the tomatoes, limiting its usefulness as an alternative in areas of hilly or rolling terrain. The surviving fungal pathogen populations can build up quickly to kill tomato plants (Burnette, 2003).

California Region - 12. Historic Pattern of Use of Methyl Bromide, and/or Mixtures Containing Methyl Bromide, for which an Exemption Is Requested

California Region - 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)*	994	1,039	1,087	1,089	1,080	900
Ratio of Flat Fumigation use to strip/bed use if strip treatment is used	100% flat fumigation	100% flat fumigation	100% flat fumigation	100% flat fumigation	100% flat fumigation	100% flat fumigation
Amount of methyl bromide active ingredient used *(total kilograms)*	125,359	125,318	125,964	126,236	123,783	97,775
Formulations of methyl bromide *(methyl bromide /chloropicrin)*	67/33	67/33	67/33	67/33	67/33	67/33
Method by which methyl bromide applied *(e.g. injected at 25cm depth, hot gas)*	Mostly Shank at 25-30 cm depth	Mostly Shank at 25-30 cm depth	Mostly Shank at 25-30 cm depth	Mostly Shank at 25-30 cm depth	Mostly Shank at 25-30 cm depth	Mostly Shank at 25-30 cm depth
Application rate of active ingredient in kg/ha*	126	121	116	116	115	109
Application rate of formulations in kg/ha*	188	181	173	173	172	163
Actual dosage rate of active ingredient *(g/m^2)*	12.6	12.1	11.6	11.6	11.5	10.9
Actual dosage rate of formulations *(g/m^2)**	18.8	18.1	17.3	17.3	17.2	16.3

** It is based on formulation containing 67% methyl bromide.*

CALIFORNIA REGION - PART C: TECHNICAL VALIDATION

CALIFORNIA REGION - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

CALIFORNIA REGION – 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		
Telone	Effective against nematodes but not against fungal plant pathogens. Not effective on hilly, rolling terrain.	No
Metam sodium	Effective against fungal plant pathogen if applied uniformly. The petitioner states that metam sodium cannot be applied uniformly because uneven land topography and soil texture. This results in pockets of very high and very low concentration of metam sodium. The surviving fungal pathogen populations can build up quickly to kill tomato plants (Burnette, 2003). In addition, the applicant claims that high concentration can be phytotoxic and low concentration does not control fungal pathogens (data not submitted).	No
Chloropicrin	Chloropicrin is not effective when it is applied alone.	No
NON CHEMICAL ALTERNATIVES		
Soil solarization	The CUE is for tomatoes grown in the coastal areas of California, which have mild weather conditions (15 - 25 C temperatures). The weather conditions restrict soil solarization as alternative to methyl bromide.	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 tomato fields. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to pasteurize 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 and/or nematodes. While biological control may have utility as part of plant pathogen management strategy, it can not be a methyl bromide alternative	No
Cover crops and mulching	There is no evidence that these practices effectively substitute for the control methyl bromide provides against fungal pathogens and nematodes.	No

Crop rotation and fallow land	The land is very expensive and there are not enough hectares in tomato growing areas to rotate. The fungal pathogen survive for many years in soil and therefore it is not a viable option.	No
Endophytes	No information is available on tomato endophytes that will control fungal and plant pathogens.	No
Flooding/Water management	Flooding is not technically feasible as an alternative because it does not have any suppressive effect on fungal plant pathogens and nematodes. In addition, it is prohibitively expensive and there are water management restrictions.	No
Grafting/resistant rootstock/plant breeding/soilless culture/organic production/substrates/plug plants.	There are no studies documenting the commercial availability of resistant rootstock immune to the fungal pathogens listed as target pests. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of fungal pathogens and nematodes.	No

COMBINATIONS OF ALTERNATIVES		
Metam sodium + Chloropicrin	Undulating land topography and variable soil texture will result in uneven concentration of metam sodium through drip irrigation that may affect field performance and can result in phytotoxicity to tomato transplants. This mixture will not control nematodes.	No
Metam sodium + Crop rotation	Same as metam sodium	No
1,3 D + Metam-sodium	This mixture may control fungi and nematodes, but undulating land topography will result in uneven concentration of metam sodium through drip irrigation that may result in phytotoxicity to tomato transplants.	No
1,3-D + Chloropicrin	Telone is effective against nematodes. Chloropicrin is effective against fungal plant pathogens. The combination is a technically feasible alternative to methyl bromide, but undulating topography can reduce its uniformity of application and, hence, its effectiveness.	No
1,3-D + metam sodium + pebulate	This mixture cannot be used as a methyl bromide alternative because pebulate is no longer registered in the United States (during 2002 its registration expired and the manufacturer went out of business).	No

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

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

CALIFORNIA REGION – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
None	Foliar fungicides are not suitable because the key pests are soil borne and afflict the belowground portion of the tomato plant. There are no other alternatives that exist for the control of these key pests on hilly or rolling terrain when they are present in the soil. A number of fungicides are available that may control fungal pathogenss when they attach aerial plant parts. *Fusarium* spp. results in plant wilting and there is no remedy once plant is systemically infected.

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

CALIFORNIA REGION – 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	Application submitted to the US-EPA during February 2002. Not registered	Yes	Unknown
Sodium azide	No application submitted to the US-EPA till date. Not registered	No	Unknown
Propargyl bromide	No application submitted to the US-EPA till date. Not registered	No	Unknown

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

The applicant submitted the results of two field trials conducted in San Diego and Ventura counties on the efficacy of methyl bromide and its alternatives in controlling listed pests (*Fusarium* wilt, *Verticillium* wilt, Root-knot nematode, and *Pythium* spp.). Metam sodium and 1,3-D are both not viable options because of hilly, rolling terrain. Varied soil texture and undulating land topography can create high and low concentration spots of metam sodium and 1,3-D, affecting its efficacy in controlling the pests (Burnette, 2003). Low concentrations may results in lower efficacy and high concentration in phytotoxicity. The growers may suffer 15-20% yield losses. The applicant did not submit any document on the effect of low and high concentration spots of metam sodium on tomato yield. Therefore, we are unable to validate whether or not these losses are reasonable.

CALIFORNIA REGION – TABLE 16.1: EFFECTIVENESS OF ALTERNATIVES – KEY PEST 1

No additional information is available to present.

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

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
Metam sodium	*Fusarium* wilt *Verticillium* wilt Root Knot nematodes *Pythium* spp.	15-20%, based on professional opinion	15-20%
1,3-D	As above	Not a viable option because of hilly, rolling terrain.	
1,3-D + Chloropicrin	As above	Not a viable option because of hilly, rolling terrain.	
1,3-D + metam sodium + Chloropicrin	As above	Not a viable option because of hilly, rolling terrain.	
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**15-20%**

CALIFORNIA REGION - 17. ARE THERE ANY OTHER POTENTIAL ALTERNATIVES UNDER DEVELOPMENT WHICH ARE BEING CONSIDERED TO REPLACE METHYL BROMIDE?: *(If so, please specify.)*

Methyl Iodide, Sodium Azide and Propargyl Bromide

These have not been widely tested in the fields or registered for use in any crop by the United States Environmental Protection Agency. The above fumigants are potential alternatives to methyl bromide that could be used in California to control fungal pathogens and nematodes.

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

Tomatoes are grown in fields. It is neither technically feasible nor economically viable to grow tomatoes in soil-less culture or in containers.

CALIFORNIA REGION - SUMMARY OF TECHNICAL FEASIBILITY

The US EPA has determined that in flat terrain, only 1,3-D + chloropicrin and metam sodium + chloropicrin can be technically feasible against the key pests of tomatoes grown in California. Metam-sodium alone will not control nematodes and may be phytotoxic to plants because of undulating land topography of tomato fields. A mixture of metam sodium and chloropicrin will not control nematodes. In addition, this mixture may also be phytotoxic due to undulating land topography. A mixture of 1,3-D and chloropicrin is unreliable in undulating topography because of uneven distribution of the fumigant through drip irrigation systems. Currently unregistered alternatives, such as methyl iodide, sodium azide or propargyl bromide have shown good efficacy against the key pests. However, even if registration is pursued soon the commercial tomato growers will need transition period for adoption in California.

There are also no non-chemical alternatives that are currently viable for MB replacement for commercial tomato growers.

MICHIGAN REGION - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

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

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY DISEASE(S) AND WEED(S) TO GENUS AND, IF KNOWN, TO SPECIES LEVEL	SPECIFIC REASONS WHY METHYL BROMIDE NEEDED
Michigan Region	1. Crown, root and fruit rot caused by *Phytophthora capsici* 2. *Fusarium oxysporum* wilt	Methyl bromide is currently the only product that can control these soil-borne pathogens and allow MI growers to deliver their produce during premium priced early market windows. Other control measures have plant back restrictions that put MI tomatoes outside the premium priced fresh market. Resistant varieties have not been identified.

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

MICHIGAN REGION - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	MICHIGAN REGION
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Transplant tomatoes to produce fruit
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Squash, cucumber, eggplant and melons. All are susceptible to *Phytpphthora capsici*.
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy to Loam
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Annual
OTHER RELEVANT FACTORS:	Low soil temperatures during late March do not allow effective soil fumigation with telone, telone+ chloropicrin or metam sodium for tomato planting in April.

MICHIGAN REGION - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE *(Plant Hardiness Zone)*	5B											
SOIL TEMP. *(℃)**	<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. *(℃) * **	0.2	7.4	12.1	17.7	20.6	20.9	18.1	8.0	2.4	-2.9	-8.0	-7.0
FUMIGATION SCHEDULE		X										
PLANTING SCHEDULE			X	X								
KEY MARKET WINDOW					X	X	X					

* HAUSBECK AND CORTRIGHT (2003).
** *DATA SOURCE* "http://www.crh.noaa.gov/grr/climate/f6/preliminary.php?site=LAN"

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

Low soil temperatures during late March to early April make the use of in-kind (metam-sodium, 1,3-D + chloropicrin) fumigants impractical because soil temperatures may be below the labeled minimums or plant back restrictions are too long (15 to 30 days) to allow April transplanting of tomato seedlings in the field.

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

MICHIGAN REGION - 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)*	435	476	487	581	648	673
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	100% strip	100% strip	100% strip	100% strip	100% strip	100% strip
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kg)*	21,001	22,964	23,493	28,003	31,235	32,461
FORMULATIONS OF METHYL BROMIDE *(methyl bromide /chloropicrin)*	67/33	67/33	67/33	67/33	67/33	67/33
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	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 OF ACTIVE INGREDIENT IN kg/ha*	48	48	48	48	48	48
APPLICATION RATE OF FORMULATIONS IN kg/ha*	71.6*	71.6	71.6	71.6	71.6	71.6
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	13.1	13.1	13.1	13.1	13.1	13.1
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	19.5	19.5	19.5	19.5	19.5	19.5

**Only 36.7 percent land area is treated in the form of beds and therefore dosage rate (g/m^2) is higher.*

MICHIGAN REGION - PART C: TECHNICAL VALIDATION

MICHIGAN REGION - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

(Give list of all relevant chemical and non chemical alternatives, and their combinations)

MICHIGAN REGION – TABLE 13.1: REASON FOR ALTERNATIVES NOT BEING FEASIBLE

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE + CITATIONS**	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
CHEMICAL ALTERNATIVES		
1,3-D	It is not effective against fungal plant pathogens.	No
Metam sodium	Metam sodium is effective against soil fungi. Michigan soil temperature during April are too low to use this fumigant for an early fresh market tomato crop. Product label states that transplant cannot be planted in the field up to 21 days after fumigation. Technically, it is methyl bromide alternative but economically it is not a viable alternative.	No
Chloropicrin	Chloropicrin is ineffective as soil fumigant when applied alone.	No
NON CHEMICAL ALTERNATIVES		
Soil solarization	Michigan is a northern state with cold weather conditions and therefore it is not a viable option.	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 the open tomato fields. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to pasteurize 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 and/or nematodes. While biological control may have utility as part of plant pathogen management strategy, it can not be a methyl bromide alternative	No
Cover crops and mulching	There is no evidence that these practices effectively substitute for the control methyl bromide provides against fungal pathogens and nematodes.	No
Crop rotation and fallow land	The land is very expensive and there are not enough hectares in tomato growing areas to rotate. The fungal pathogen survive for many years in soil and therefore crop rotation and fallow are not a viable options (Lamour and Hausbeck, 2003*)	No

Endophytes	No information is available on tomato endophytes that will control fungal and plant pathogens.	No
Flooding/Water management	Flooding is not technically feasible because it does not suppress fungal plant pathogens and nematodes.	No
Grafting/resistant rootstock/plant breeding/soilless culture/organic production/substrates/plug plants.	There are no studies documenting the commercial availability of resistant rootstock immune to the fungal pathogens listed as target pests. Grafting and plant breeding are thus also rendered technically infeasible as methyl bromide alternatives for control of fungal pathogens and nematodes.	No
COMBINATIONS OF ALTERNATIVES		
Telone + Chloropicrin	Telone is effective against nematodes. Chloropicrin is effective against fungal plant pathogens. Their combination is a technically feasible alternative, but Michigan's low soil temperature does not allow soil fumigation during April months for early fresh market tomato crop.	No
Metam sodium + Crop rotation	Same as metam sodium	No

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

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

MICHIGAN REGION – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
None	Other than those options discussed above, there are no alternatives that may control the key pest. Registered fungicides (such as azoxystrobin, mefenoxam and mancozeb) may control aerial infections of *Phytophthora capsici*, but are not effective against collar and root rot phase of this pathogen. Soil fumigation with methyl bromide kills soil-borne primary inoculum of this pest and therefore fungicide use is also reduced (Lamour and Hausbeck, 2003*)

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

MICHIGAN REGION – 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.	Yes	Unknown
Sodium azide	Not registered. No registration package has been received.	No	Unknown
Furfural	Not registered	No	Unknown
Propargyl Bromide	Not registered. No registration package has been received.	No	Unknown

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

The applicant submitted the results of one small scale field trial on the efficacy of methyl bromide alternatives in controlling the pest and their effect on tomato yield (Hausbeck and Cortwright, 2003). This study focused on tomato and a number of vegetable crops (cucurbits, winter squash, and melons). As of July 2003, results showed that methyl bromide+ chloropicrin (67/33, shank injected @ 390 Kg/Hectare), metam sodium (drip applied) @ 355 KG ai/ha), 1, 3-D+chloropicrin (65/35, shank injected @ 150 liters/ha) resulted in 0, 12.9, 6.4 percent plant loss. Untreated control suffered 7.1% plant loss.

The fields were treated on May 15 and 16, 2003, and the weather was unusually cooler than normal during May and early June of the year 2003. The results are inconclusive. This study may be repeated during 2004 growing season. The state expert claims that the growers may suffer 6.4 and 12.9 percent yield losses using 1, 3-D + chloropicrin and metam sodium. The expert claims that these losses are expected if the grower fumigate their fields in early May instead of April (using methyl bromide + chloropicrin). In addition, the growers may also suffer revenue losses if they miss early tomato market when prices are higher.

MICHIGAN REGION – TABLE 16.1: EFFECTIVENESS OF ALTERNATIVES – KEY PEST 1

No additional information is available.

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

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS	BEST ESTIMATE OF YIELD LOSS
methyl bromide+ chloropicrin	Phytophthora capsici	0.0 – 0.0	0.0
metam sodium	Phytophthora capsici	0.0 – 12.9	12.9
1, 3-D+chloropicrin	Phytophthora capsici	0.0 –6.4	6.4
chloropicrin	Phytophthora capsici	0.0 –6.4	6.4
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			**0 - 13 % plus revenue losses due to planting; Most likely losses are 6 % using 1,3 D + chloropicrin (the best alternative)**

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

In Michigan the critical use exemption application states that telone + chloropicrin, metam-sodium, methyl iodide, sodium azide, and furfural will continue to be under investigation as methyl bromide alternatives. Most of these alternatives are currently unregistered for use on tomato, and there are presently no commercial entities pursuing registration in the United States. The timeline for developing the above-mentioned MB alternatives in Michigan is as follows:
2003 – 2005: Test for efficacy (particularly against the more prevalent *Phytophthora*)
2005 – 2007: Establish on-farm demonstration plots for effective MB alternatives
2008 – 2010: Work with growers to implement commercial use of effective alternatives.

Research is also under way to optimize the use of a 50 % methyl bromide: 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 REGION - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE?: *(e.g. soilless systems, plug plants, containerized plants. State proportion of crop already grown in such systems nationally and if any constraints exist to adoption of these systems to replace methyl bromide use. State whether such technologies could replace a portion of proposed methyl bromide use.)*

Tomatoes are grown in fields. In michigan, it is neither technically feasible nor economically viable to grow tomatoes in soil-less culture or in containers.

MICHIGAN REGION - SUMMARY OF TECHNICAL FEASIBILITY

Although the U.S. E.P.A. determined that metam sodium and a combination of telone + chloropicrin can control the key pest, *Phytophthora,* the planting and harvesting delay due to cold soil temperatures and longer plant-back interval lead to a shorter growing season and missing key market windows when commodity prices are most favorable. These alternatives have plant back restriction of 14-28 days. The plant back restriction delays tomato harvest by 14-28 days. The delayed harvest results in lower net revenues per acre because tomato prices decline as season progresses.

Currently unregistered alternatives, such as methyl iodide, sodium azide, propargyl bromide and furfural have good efficacy against the key pests involved. However, even if registration is pursued, the growers will need transition time to adopt them.

SOUTH-EASTERN UNITED STATES - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

SOUTH-EASTERN UNITED STATES - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY DISEASE(S) AND WEED(S) TO GENUS AND, IF KNOWN, TO SPECIES LEVEL	SPECIFIC REASONS WHY METHYL BROMIDE NEEDED
South-Eastern United States	Nutsedges (*Cyperus rotundus and C. esculentus*) Root-Knot nematodes *Phytophthora* Crown and Root Rot. *Fusarium* Wilt (*F. oxysporum*)	None of the listed MBTOC alternative is effective in controlling the key pests in the South-Eastern United States.

SOUTH-EASTERN UNITED STATES - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE *(Place major attention on the key characteristics that affect the uptake of alternatives):*

SOUTH-EASTERN UNITED STATES - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	SOUTH-EASTERN UNITED STATES
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	Transplant for tomato fruit production
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Annual
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	Tomato. Tomato-Cucumber or Squash or Watermelon or Cantaloupe. Tomato-Cucurbits.
SOIL TYPES: *(Sand, loam, clay, etc.)*	Sandy to loam, over karst geology in many areas
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Annual
OTHER RELEVANT FACTORS:	No other information provided.

SOUTH-EASTERN UNITED STATES - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE *(Plant Hardiness Zone)*	6b, 7a, 7b, 8a, 8b, 9b, 10a, 10b											
SOIL TEMP. *(℃)* **	17-20	17-21	21-24	22-26	25-29	26-29	27-30	28-32	27-29	25-27	21-23	19-21
RAINFALL *(mm)**	51-203	51-203	51-203	51-203	102-203	102-203	51-203	51-203	25-102	25-102	25-102	25-102
OUTSIDE TEMP. *(℃)**	11-22	16-23	21-25	25-28	26-28	25-28	23-25	17-25	10-22	7-19	7-19	8-19
FUMIGATION SCHEDULE	X	X		X	X	X	X				X	X
PLANTING SCHEDULE	X	X	X		X					X	X	X
KEY MARKET WINDOW		X	X	X	X	X	X	X	X			

* *JACOB (1977). ** FLORIDA SOIL TEMPERATUTES SOURCE IS WWW.IMOK.UFL/EDU/WEATHER/ARCHIVES/200/CLIM00*

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

Karst geology inhibits the use of all fumigants that contain 1,3-D.

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

SOUTH-EASTERN UNITED STATES - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	22,269	24,002	25,814	27,831	28,931	28,572
RATIO OF FLAT FUMIGATION USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	Approx. 50% strip	Approx. 50% strip	Approx. 50% strip	Approx. 50% strip	Approx. 50% strip	Approx. 50% strip
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kg)*	4,484,413	4,747,976	4,491,580	4,462,390	4,514,006	4,370,645
FORMULATIONS OF METHYL BROMIDE (*methyl bromide /Chloropicrin)*	67/33	67/33	67/33	67/33	67/33	67/33
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	Mostly Injected at 25-30 cm depth	Mostly Injected at 25-30 cm depth	Mostly Injected at 25-30 cm depth	Mostly Injected at 25-30 cm depth	Mostly Injected at 25-30 cm depth	Mostly Injected at 25-30 cm depth
APPLICATION RATE OF FORMULATIONS IN kg/ha*	201	196	175	163	158	154
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	20.1	19.6	17.5	16.3	15.8	15.4

SOUTH-EASTERN UNITED STATES - PART C: TECHNICAL VALIDATION

SOUTH-EASTERN UNITED STATES - 13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

SOUTH-EASTERN UNITED STATES – TABLE 13.1: REASON FOR ALTERNATIVES NOT BEING FEASIBLE

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
CHEMICAL ALTERNATIVES		
Telone	Effective against nematodes, but not against fungal plant pathogens and nutsedge weeds. Approximately 40% of tomato land has Karst geology. Growers with Karst topography can not use telone because of underground water contamination.	No
Metam sodium	It will control many weeds but control of nutsedge is very inconsistent. It is not very effective against nematode population.	No
Chloropicrin	Chloropicrin controls soil fungi only. It also stimulates nutsedge weed growth and therefore it is not a viable option. It occasionally stimulates nutsedge emergence but also occasionally controls nutsedge as noted in the literature. Again the issue is its inability to get consistent control (Culpepper, 2004).	No
NON CHEMICAL ALTERNATIVES		
Soil solarization	For nutsedge control in the southeastern U.S. states, solarization is unlikely to be technically feasible as a methyl bromide alternative. Research indicates that the lethal temperature for nutsedge tubers is 50^{o}C or higher (Chase et al. 1999). While this may be achieved for some portion of the autumn cropping in southern cucurbit growing regions, it is very unlikely for any portion of the spring crops. Trials conducted in mid-summer in Georgia resulted in maximal soil temperatures of 43^{o}C at 5 cm depth, not high enough to destroy nutsedge tubers, and tubers lodged deeper in the soil would be completely unaffected.	No
Steam	Steam is not a technically feasible alternative for open field tomato 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 tomato fields. Any such system would also require large amounts of energy and water to provide sufficient steam necessary to pasteurize 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, nematodes and nutsedges.	No

Cover crops and mulching	Cover crops and mulches appear to reduce weed population, but not nutsedges (Burgos and Talbert 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
Crop rotation and fallow land	It is not a technically or economically (can not afford to take land out of production) feasible alternative to methyl bromide because it does not, by itself, provide adequate control of fungi and/or nutsedges. The crop rotations available to growers are also susceptible to fungi; fallow land can still harbor fungal oospores. As regards 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. Furthermore, nutsedge plants can produce tubers within 8 weeks after emergence. 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
Endophytes	It is not a technically viable option because it has never been shown to work against the key pests in tomato or similar crops.	No
Flooding/Water management	Flooding has never been shown to control nutsedge species. Nutsedges are much more tolerant of watery conditions than many other weed pests. For example, Horowitz (1972) showed that submerging nutsedge in flowing or stagnant water (for 8 days and 4 weeks, respectively) did not affect the sprouting capacity of tubers. There are also serious practical obstacles to implementing flood management approaches in cucurbit production in the southern and southeastern U.S. states. Droughts are common in many parts of these regions, and the soil composition may not support flooding and still remain productive.	No
Grafting/resistant rootstock/plant breeding/soil-less culture/organic production/substrates/plug plants.	These technologies have never been shown to control listed key pests under field conditions. Resistant root stock or cultivars may control one pest, but not the other. It is almost impossible to breed or genetically engineer tomato cultivars that has all agronomic characters and is resistant to all key pests. This has no effect on managing nutsedge weeds.	No
COMBINATIONS OF ALTERNATIVES		
1,3 D + chloropicrin+ herbicide (such as pebulate)	This combination is the most promising alternative for the control of all key pests in southeastern region. The executive summary of dozens of research trials show that the growers may harvest tomato yield that is near equal to the yield obtained using methyl bromide and chloropicrin. Using this combination the growers may lose an average of 6.2% yield in areas where this combination can be used (Chellemi *et al*., 2001).	May be

Metam sodium + Chloropicrin	This mixture may be more effective than metam sodium alone in controlling fungal pests, but this combination would not prevent yield losses caused by nutsedges and some species of nematodes. This mixture along with a herbicide (for controlling nutsedge weeds) may be a viable methyl bromide alternative in the South-Eastern United States where the growers can not use telone due to karst topography. Further experiments need to be done on this mixture to find out whether or not it is technically and economically viable.	May be
Telone + Chloropicrin	It is effective against nematodes and fungal plant pathogens, but not against nutsedge and other weeds. Approximately 40 and 8.0% of tomato land in Florida and Georgia, respectively, has Karst geology. Growers with Karst topography can not use telone because of state regulations and underground water contamination issues.	No
Telone + metam sodium + herbicide (such as pebulate)	This mixture could provide reasonable control of pests if weed pressure is low to moderate and land does not have Karst geology. Pebulate is no longer registered because the manufacturer went out of business during 2002. Growers will need to use one of the newly registered herbicides if they use this combination, and will be constrained by certain limitations (described below).	No
Metam sodium + Crop rotation	Same as metam sodium.	

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

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

SOUTH-EASTERN UNITED STATES – TABLE 14.1: TECHNICALLY INFEASIBLE ALTERNATIVES DISCUSSION

NAME OF ALTERNATIVE	DISCUSSION
Glyphosate	For nutsedges: Non-selective herbicide that will not control nutsedge. It is not labeled for row middle application. In addition, it does not provide residual control. It is a non-selective herbicide used to control weeds in row middles. Application to the rows would cause injury to the tomato crop. As a preplant treatment glyphosate will not provide season long control of yellow and/or purple nutsedge in tomatoes.
Paraquat	Non-selective; will not control nutsedge in the plant rows; does not provide residual control. Its repetitive applications are required to achieve fair control in the row middle (Culpepper, 2003). Paraquat is a non-selective herbicide that controls annual weeds in row middles. It may also be applied preemergence to the crop. Application to the rows would cause injury to the tomato crop. For perennial weeds, such as nutsedge, it will burn down the top portion of the plant but the tubers remain viable, allowing the weed to grow again. Therefore, paraquat will not provide season long control because the weed can regrow during the growing season.

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

SOUTH-EASTERN UNITED STATES – TABLE 15.1: PRESENT REGISTRATION STATUS OF ALTERNATIVES

NAME OF ALTERNATIVE	PRESENT REGISTRATION STATUS	REGISTRATION BEING CONSIDERED BY NATIONAL AUTHORITIES? (Y/N)	DATE OF POSSIBLE FUTURE REGISTRATION:
Halosulfuron-methyl	There are a number of restrictions limiting the potential to use this herbicide in tomatoes in the Southeast (see additional notes below). Among these are potential crop injury and plant back restrictions for rotational crops. Efficacy is lowered in rainy conditions (which are common in this region). Need more time to experiment under field conditions.	Yes	Recently registered
Pebulate	For nutsedges: Was registered for use in tomatoes only, its registration expired during December, 2002 (the manufacturer went out of business)	No	Unknown
S-metolachlor	For nutsedges: Not registered in some states of concern. It is effective against yellow nutsedge and not effective against purple nutsedge (Culpepper, 2004).	Yes	Already registered
Terbacil	For nutsedges: Registered ONLY in strawberries. The manufacturer claims that it is partially effective against yellow nutsedge and does not control purple nutsedge.	No	Unknown
Rimsulfuron	Registered for the control of nutsedge weeds in tomatoes. The product label states that it is partially effective against nutsedges.	Y	Already registered
Trifloxysulfuron	For nutsedges: Newly Registrated for use in tomato. Efficacy needs to be tested under large scale field trials. Labeled for use in Florida only. It provides good control of nutsedge but rotational restrictions may limit its large scale adoption.	Y	Already registered
Methyl Iodide	Not yet registered in the United States	Y	unknown
Sodium azide	Not registered in the United States	No	unknown
Sulfuryl Floride	It is not registered for preplant soil treatment. It is registered for postharvest treatment of agricultural produce (tomato not included)	The registrant has not contacted US-EPA for its use as a preplant soil fumigant.	unknown

Additional notes on specific herbicides listed:

Halosulfuron-methyl

In December 2002, halosulfuron-methyl (Sandea®) was registered for weed control (including nutsedge) in tomatoes, peppers, eggplant, and cucurbits. This recent registration was not on the list of alternatives from

MBTOC and several years are needed to see if it will be adopted. Historically, in the United States it has taken three to five years for an herbicide to be adopted by a significant number of vegetable crop growers.

Halosulfuron-methyl has a number of limitations which may affect its widespread adoption, that include: (1) phyto-toxicity with moderate rainfall immediately after application; (2) cool temperatures, (3) susceptible varieties, and (4) plant back restrictions. Specifically:

- Rainfall or sprinkler irrigation greater than 2.5 cm, soon after a pre-emergent application of halosulfuron-methyl, may cause crop injury. Sudden storms with greater than 2.5 cm of rainfall are common in Florida and other areas of the southeastern United States. In addition, rainfall within four hours after a post-emergence application of halosulfuron-methyl may reduce effectiveness and cause crop injury.
- Under cool temperatures that can delay early seedling emergence or growth, halosulfuron methyl can cause injury or crop failure. This is especially likely to occur during the first planting of the season. In addition, not all hybrids/varieties of tomatoes have been tested for sensitivity to halosulfuron-methyl. Halosulfuron may also delay maturity of treated crops.
- Halosulfuron methyl plant back restrictions are up to 36 months. Many of the vegetable crops fall within the 4 to 12 month range, although some are longer. There are label limitations for halosulfuron methyl. As per product label, halosulfuron methyl should not be applied if the crop or target weeds are under stress due to drought, water saturated soils, low fertility, or other poor growing conditions. This herbicide can not be applied to soil that has been treated with organophosphate insecticides. Foliar applications of organophosphate insecticides may not be made within 21 days before or 7 days after halosulfuron methyl application.

  Note: All the limitations above are listed in the US registration label for halosulfuron, which in turn is based on proprietary data submitted to EPA by the registrant company.

S-metolachlor

It was registered for use in tomatoes in April 2003. However, it is not registered in states of concern, and does not control purple nutsedge or nightshade species. Further, it does not provide commercially acceptable weed control in plasticulture systems.

<u>Rimsulfuron</u>

There is evidence that rimsulfuron only provides suppressive control of yellow nutsedge (40 to 70 percent control) (Nelson *et al*, 2002). In addition, the label warns against tank mixing with organophosphate insecticides because injury to the crop may occur. Also, for most of the vegetable crops besides tomatoes there is a 12-month plant back restriction. This plant back restriction can seriously compromise the needed rotational interval needed for IPM programs.

South-Eastern United States - 16. State Relative Effectiveness of Relevant Alternatives Compared to Methyl Bromide for the Specific Key Target Pests and Weeds for which It Is Being Requested

Telone C35 (1,3 D + 35 % chloropicrin) plus pebulate herbicide has been found to be the best alternative to methyl bromide in controlling listed key pests under Florida growing conditions (Chellemi *et al*., 2001). Pebulate is no longer registered in the U.S., however, so another herbicide would have to be substituted into the fumigation mixture. The results of many trials showed that growers may harvest tomato yield that is near equal to the yield obtained using methyl bromide and chloropicrin. Assuming that an herbicide is used that is as effective as pebulate, growers using a 1,3-D + chloropicrin + herbicide mixture may suffer an average of 6.2 percent yield losses (Chellemi *et al*., 2001). Florida and Georgia experts claim the yield losses using a combination of 1,3 D + chloropicrin + herbicides will be higher than 6.2 percent because pebulate is no longer registered and other herbicides have limitations. The experts were unable to provide yield loss estimate without 2-3 years of field trials. The experts claim that more time is needed to evaluate various methyl bromide fumigant alternatives, mulches and herbicides systems to study their effects on tomato yields.

South-Eastern United States – Table 16.1: Effectiveness of Alternatives – Key Pest 1

No additional information is available.

South-Eastern United States – Table C.1: Alternatives Yield Loss Data Summary

Alternative	List Type of Pest	Range of Yield Loss	Best Estimate of Yield Loss
1,3 D + chloropicrin + herbicide	Fungi, Nematodes and Nutsedges	2.3 – 10.1 (Chellemi *et al*., 2001)	6.2
Overall Loss Estimate for All Alternatives to Pests			**6.2%**

South-Eastern United States - 17. Are There Any Other Potential Alternatives Under Development which Are Being Considered to Replace Methyl Bromide?: *(If so, please specify.)*

A combination of 1,3 D + chloropicrin + pebulate appeared to be the best alternative in controlling key pests in tomato fields. Since pebulate herbicide is no longer available then the growers will have to substitute another herbicide, listed in table 14.1 and 15.1 (such as halosulfuron, rimsulfuron or trifloxysulfuron to achieve similar pest control). Florida and Georgia state expert claim the yield losses using a combination of 1,3 D + chloropicrin + herbicides will be higher than 6.2 losses because pebulate is no longer registered and other herbicides have limitations. The experts were unable to provide yield loss estimate without 2-3 years of field trials. The experts claim that more time is needed to evaluate various methyl bromide fumigant alternatives, mulches and herbicides systems to study their effects on tomato yields.

SOUTH-EASTERN UNITED STATES - 18. ARE THERE TECHNOLOGIES BEING USED TO PRODUCE THE CROP WHICH AVOID THE NEED FOR METHYL BROMIDE? *(e.g. soilless systems, plug plants, containerized plants. State proportion of crop already grown in such systems nationally and if any constraints exist to adoption of these systems to replace methyl bromide use. State whether such technologies could replace a portion of proposed methyl bromide use.)*

Tomatoes are grown in fields. In South-eastern united states, it is neither technically feasible nor economically viable to grow tomatoes in soil-less culture or in containers.

SOUTH-EASTERN UNITED STATES - SUMMARY OF TECHNICAL FEASIBILITY

The submitted data showed that using the above best alternative the growers are expected to suffer 6.2% yield losses (Chellemi, Botts and Noling. 2001). A combination of 1,3-D + chloropicrin + pebulate appeared to be the best alternative in controlling key pests in tomato fields. Since pebulate is no longer available then the growers will need to substitute another herbicides such as halosulfuron, rimsulfuron or trifloxysulfuron to control nutsedge weeds. But, these herbicides have significant limitations, as described in the notes to Table 15.1. In addition, losses will be higher in areas of Karst geology, where 1,3-D may not be used.

Florida and Georgia state expert claim that the yield losses using a combination of 1,3 D + chloropicrin + other herbicides will be higher than 6.2 losses because of limitations of other herbicides (see table 14.1 and 15.1). The experts were unable to provide yield loss estimate without 2-3 years of field trials. The experts claim that more time is needed to evaluate various methyl bromide fumigant alternatives, mulches and herbicides systems to study their effects on tomato yields.

PART D: EMISSION CONTROL

19. TECHNIQUES THAT HAVE AND WILL BE USED TO MINIMIZE METHYL BROMIDE USE AND EMISSIONS IN THE PARTICULAR USE: *(State % adoption or describe change)*

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?	Start research during 2004	Already using 67:33 with the potential to use lower ratios in the future. Between 1997 and 2002, the US has achieved a 27 % reduction in use rates.	Already using 67:33 with the potential to use lower ratios in the future	The US anticipates that the decreasing supply of methyl bromide will motivate growers to try less frequent applications.
WHAT FURTHER USE/EMISSION REDUCTION STEPS WILL BE TAKEN FOR THE METHYL BROMIDE USED FOR CRITICAL USES?	Start research during 2004	Already using 67:33 with the potential to use lower ratios in the future	Already using 67:33 with the potential to use lower ratios in the future	Not applicable
OTHER MEASURES *(please describe)*	Not applicable	Not applicable	Not applicable	Not applicable

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 cucurbit nurseries 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 more 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, cultural practices are utilized by cucurbit growers.

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 analysis is organized by MeBr critical use application. Cost of MeBr and alternatives are given first in table 21.1. This is followed in table 22.1 by a listing of net and gross revenues by applicant. Expected losses when using MeBr alternatives are then decomposed in tables E1 through E3.

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

REGION	ALTERNATIVE	YIELD*	COST IN YEAR 1 (US$/ha)	COST IN YEAR 2 (US$/ha)	COST IN YEAR 3 (US$/ha)
CALIFORNIA	**Methyl Bromide**	**100**	**$ 50,240**	**$ 50,240**	**$ 50,240**
	Metam Sodium	85	$ 46,353	$ 46,353	$ 46,353
	Metam Sodium	80	$ 44,626	$ 44,626	$ 44,626
MICHIGAN	**Methyl Bromide**	**100**	**$ 30,559**	**$ 30,559**	**$ 30,559**
	1,3–D + Chloropicrin	78	$ 29,555	$ 29,555	$ 29,555
	Metam Sodium	78	$ 29,739	$ 29,739	$ 29,739
	Chloropicrin	78	$ 29,555	$ 29,555	$ 29,555
SOUTHEASTERN US	**Methyl Bromide**	**100**	**$ 26,380**	**$ 26,380**	**$ 26,380**
	1,3–D + Chloropicrin	83	$ 24,946	$ 24,946	$ 24,946

* *As percentage of typical or 3-year average yield, compared to methyl bromide e.g. 10% more yield, write 110.*

22. Gross and Net Revenue:

TABLE 22.1: YEAR 1 GROSS AND NET REVENUE

Year 1			
Region	**Alternatives** *(as shown in question 21)*	**Gross revenue for last reported year** *(US$/ha)*	**Net Revenue for last reported year** *(US$/ha)*
California	**Methyl Bromide**	**$ 83,367**	**$ 33,127**
	Metam Sodium (15% loss)	$ 70,862	$ 24,509
	Metam Sodium (loss 20%)	$ 66,694	$ 22,068
Michigan	**Methyl Bromide**	**$ 39,996**	**$ 9,438**
	1,3–D + Chloropicrin	$ 32,880	$ 3,325
	Metam Sodium	$ 34,931	$ 5,192
	Chloropicrin	$ 32,880	$ 3,325
Southeastern US	**Methyl Bromide**	**$ 40,914**	**$ 14,533**
	1,3–D + Chloropicrin	$ 33,772	$ 8,825

TABLE 22.2: YEAR 2 GROSS AND NET REVENUE

Year 2			
Region	**Alternatives** *(as shown in question 21)*	**Gross revenue for last reported year** *(US$/ha)*	**Net Revenue for last reported year** *(US$/ha)*
California	**Methyl Bromide**	**$ 83,367**	**$ 33,127**
	Metam Sodium (15% loss)	$ 70,862	$ 24,509
	Metam Sodium (loss 20%)	$ 66,694	$ 22,068
Michigan	**Methyl Bromide**	**$ 39,996**	**$ 9,438**
	1,3–D + Chloropicrin	$ 32,880	$ 3,325
	Metam Sodium	$ 34,931	$ 5,192
	Chloropicrin	$ 32,880	$ 3,325
Southeastern US	**Methyl Bromide**	**$ 40,914**	**$ 14,533**
	1,3–D + Chloropicrin	$ 33,772	$ 8,825

TABLE 22.3: YEAR 3 GROSS AND NET REVENUE

Year 3			
Region	**Alternatives** *(as shown in question 21)*	**Gross revenue for last reported year** *(US$/ha)*	**Net Revenue for last reported year** *(US$/ha)*
California	**Methyl Bromide**	**$ 83,367**	**$ 33,127**
	Metam Sodium (15% loss)	$ 70,862	$ 24,509
	Metam Sodium (loss 20%)	$ 66,694	$ 22,068
Michigan	**Methyl Bromide**	**$ 39,996**	**$ 9,438**
	1,3–D + Chloropicrin	$ 32,880	$ 3,325
	Metam Sodium	$ 34,931	$ 5,192
	Chloropicrin	$ 32,880	$ 3,325
Southeastern US	**Methyl Bromide**	**$ 40,914**	**$ 14,533**
	1,3–D + Chloropicrin	$ 33,772	$ 8,825

MEASURES OF ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

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

CALIFORNIA	METHYL BROMIDE	METAM SODIUM	
PRODUCTION LOSS (%)	0%	15%	20%
PRODUCTION PER HECTARE	11,106	9,440	8,885
* PRICE PER UNIT (US$)	$ 8	$ 8	$ 8
= GROSS REVENUE PER HECTARE (US$)	$ 83,367	$ 70,862	$ 66,694
- OPERATING COSTS PER HECTARE (US$)**	$ 50,240	$ 46,353	$ 44,626
= NET REVENUE PER HECTARE (US$)	$ 33,127	$ 24,509	$ 22,068
LOSS MEASURES *			
1. LOSS PER HECTARE (US$)	$ -	$ 8,618	$ 11,059
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 82	$ 105
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	10%	13%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	26%	33%

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

MICHIGAN	METHYL BROMIDE	1,3-D + PIC	METAM SODIUM	CHLOROPICRIN
PRODUCTION LOSS (%)	0%	6%	6%	6%
PRODUCTION PER HECTARE	4,248	3,976	3,976	3,976
* PRICE PER UNIT (US$)	$ 9	$ 8	$ 9	$ 8
= GROSS REVENUE PER HECTARE (US$)	$ 39,996	$ 32,880	$ 34,931	$ 32,880
- OPERATING COSTS PER HECTARE (US$)**	$ 30,559	$ 29,555	$ 29,739	$ 29,555
= NET REVENUE PER HECTARE (US$)	$ 9,438	$ 3,325	$ 5,192	$ 3,325
LOSS MEASURES				
1. LOSS PER HECTARE (US$)	$ -	$ 6,113	$ 4,246	$ 6,113
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 127	$ 88	$ 127
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	15%	11%	15%
4. LOSS AS A PERCENTAGE OF NET REVENUE (%)	0%	65%	45%	65%

SOUTHEASTERN US - TABLE E.3: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

SOUTHEASTERN US	METHYL BROMIDE	1,3-D + PIC
PRODUCTION LOSS (%)	0%	6%
PRODUCTION PER HECTARE	4,382	4,110
* PRICE PER UNIT (US$)	$ 9	$ 8
= GROSS REVENUE PER HECTARE (US$)	$ 40,914	$ 33,772
- OPERATING COSTS PER HECTARE (US$)**	$ 26,380	$ 24,946
= NET REVENUE PER HECTARE (US$)	$ 14,533	$ 8,825
LOSS MEASURES *		
1. LOSS PER HECTARE (US$)	$ -	$ 5,708
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 38
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	14%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	39%

SUMMARY OF ECONOMIC FEASIBILITY

The economic analysis of the tomato application compared data on yields, crop prices, revenues and costs using methyl bromide and using alternative pest control regimens in order to estimate the loss of methyl bromide availability. The alternatives identified as technically feasible - in cases of low pest infestation - by the U.S. are: (a) 1,3-Dichloropropene + Chloropicrin; (b) Metam sodium; and (c) Chloropicrin. Changes in pest control costs for tomatoes are less than 4 percent of total variable costs therefore they would have little impact on any of the economic measures used in the analysis.

The economic factors that really drives the feasibility analysis for fresh market tomato uses of methyl bromide are: (1) yield losses, referring to reductions in the quantity produced, (2) increased production costs, which may be due to the higher-cost of using an alternative, additional pest control requirements, and/or resulting shifts in other production or harvesting practices (3) quality losses, which generally affect the quantity and price received for the goods, and (4) missed market windows due to plant back time restrictions, which also affect the quantity and price received for the goods.

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

(1) **Loss per Hectare.** For crops, this measure is closely tied to income. It is relatively easy to measure, but may be difficult to interpret in isolation.

(2) **Loss per Kilogram of Methyl Bromide**. This measure indicates the value of methyl bromide to crop production.

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

(4) **Loss as a Percentage of Net Operating Revenue**. We define net cash revenues as gross revenues minus operating costs. This is a very good indicator as to the direct losses of income that may be suffered by the owners or operators of an enterprise. However, operating costs can often be difficult to measure and verify.

(5) **Operating Profit Margin**. We define operating profit margin to be net operating revenue divided by gross revenue per hectare. This measure would provide the best indication of the total impact of the loss of methyl bromide to an enterprise. Again, operating costs may be difficult to measure and fixed costs even more difficult, therefore fixed costs were not included in the analysis.

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

California

We conclude that, at present, no economically feasible alternatives to MeBr exist for use in California tomato production. Yield loss in California tomato production is expected to be 15~20% when using MeBr alternatives. Growers will experience loss on a per hectare basis of approximately US$8,618 to US$11,059 and approximately 10% and 35% losses in gross and net operating revenues, respectively. These measures clearly indicate that Metam-Sodium is not an economically feasible alternative to MeBr.

We have quantified the economic conditions of tomato growers as best as possible but, primarily due to limited data availability, are unable to capture every aspect of the economic picture in our numeric analysis. Factors not accounted for in this analysis are distribution of yield loss across individual growers and the yield risk associated with using MeBr alternatives.

Michigan

We conclude that, at present, no economically feasible alternatives to MeBr exist for use in Michigan tomato production. Three factors have proven most important in our conclusion. These are yield loss, quality loss, and missed market windows, which are discussed individually below.

1. Yield Loss - Expected yield losses of 6% are anticipated throughout Michigan tomato production.

2. Quality Loss – Expected quality losses of 7% are anticipated throughout Michigan tomato production. The quality losses are translated into a reduction in the season average price by 1~3%.

3. Missed Market Windows - We agree with Michigan's assertion that growers will likely receive significantly lower prices for their produce if they switch to 1,3-D + chloropicrin or Metam-Sodium or 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 these alternatives.

Our analysis of this effect is based on the fact that prices farmers receive for their tomatoes 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 tomatoes 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, tomato growers manage their production systems with the goal of harvesting the largest possible quantity of tomatoes when the prices are at their highs. The ability to sell produce at these higher prices makes a significant contribution toward the profitability of tomato operations.

To describe these conditions in Michigan tomato production, we used daily tomato sales data from the U.S. Department of Agriculture for the previous year to gauge the impact of early season price fluctuations on gross revenues. Though data availability is limiting, we assume that if tomato growers adjust the timing of their production system, as required when using 1,3-D + Chloropicrin or Metam-Sodium or Chloropicrin, that they will, over the course of the growing season, accumulate gross revenues reduced by approximately 4~11%. We reduced the season average price by 4~11% in our analysis of the alternatives to reflect this. Based on currently available information, we believe this reduction in gross revenues serves as a reasonable indicator of the typical effect of planting delays resulting when MeBr alternatives are used in Michigan.

Southeastern US

We conclude that, at present, no economically feasible alternatives to MeBr exist for use in Southeastern US tomato production. Two factors have proven most important in our 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 tomato production.

2. Missed Market Windows - We agree with Southeastern US'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 these alternatives.

Our analysis of this effect is based on the fact that prices farmers receive for their tomatoes 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 tomatoes 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, tomato growers manage their production systems with the goal of harvesting the largest possible quantity of tomatoes when the prices are at their highs. The ability to sell produce at these higher prices makes a significant contribution toward the profitability of tomato operations.

To describe these conditions in Southeastern US tomato production, we used weekly tomato sales data from the U.S. Department of Agriculture for the previous three years to gauge the impact of early season price fluctuations on gross revenues. Though data availability is limiting, we assume that if tomato 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, accumulate gross revenues reduced by approximately 12%. We reduced the season average price by 12% in our analysis of the alternatives to reflect this. Based on currently available information, we believe this reduction in gross revenues serves as a reasonable indicator of the typical effect of planting delays resulting when MeBr alternatives are used in Southeastern US.

PART F. FUTURE PLANS

23. WHAT ACTIONS WILL BE TAKEN TO RAPIDLY DEVELOP AND DEPLOY ALTERNATIVES FOR THIS CROP? *(Based on responses to Question 13, the answer should include activities that would be undertaken to overcome the difficulties that resulted in the alternatives being considered unsuitable. Include a timetable for completion of key activities.)***:**

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.

As per Culpepper (2004), over 50 vegetable trials, focusing on weed management, were conducted by the University of Georgia. Four of these trials compared methyl bromide alternatives and another 30 trials searched for the development and labeling of new herbicides for vegetables. During 2004, these experiments will be continued to find methyl bromide alternatives.

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 tomatoes research will require 5501 kg per year of methyl bromide for 2005 and 2006. This research request also includes the amounts for asparagus, cabbage, ginseng, and nutsedge for 74 kg per year. 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? *(Include a plan of the stepwise reduction schedule for methyl bromide as alternatives are phased in and/or additional emission controls are implemented)***:**

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. Georgia experts (Culpepper, 2004) note that the ability to reduce the use of methyl bromide will rely on the interaction of fumigant alternatives, plastic mulches and herbicide systems under specific growing conditions. More time is needed to develop these systems.

25. ADDITIONAL COMMENTS ON THE NOMINATION?)

Research efforts began in the early 1990's to find out methyl bromide alternatives in various crops including tomato. With each year of experimentation the researchers became more familiar and efficient with methyl bromide fumigant alternatives for nutsedge management. The researchers learned strengths and weakness of each fumigant system, plastic film types, herbicide system, and various production environments. The researchers need more time to evaluate and refine these systems in large scale trials prior to large scale implementation at growers field level.

26. CITATIONS

Chellemi, D., Botts, D.A. and Noling, J.W. 2001. Field scale demonstration/validation studies of methyl bromide in plastic mulch culture in Florida, USDA ARS specific co-operative agreement SCA # 58-6617-6-013, Executive Summary (1996-2001) submitted to the US-EPA.

Burnette, G. 2003. Personal communication, November 25, 2003.

Culpepper, Stanley. 2004. Faculty, University of Georgia, Athens, GA. Comments on methyl bromide Critical use nomination for preplant soil use for tomato grown in open fields.

Florida. 2000. Florida soil temperatures. Web address: www.imok.ufl/edu/weather/archive/200/clim00

Hausbeck, M. and Cortright, B. 2003. Soil temperature data submitted to BEAD (OPP, US-EPA) in support of methyl bromide critical use exemption application.

Jacob, W. C. 1977. Range of mean outside temperature and rainfall in South-Eastern United States. Climatic Atlas of the United States. Published by the US Department of Commerce.

Lamour, H.H. and Hausbeck, M. 2003. Effect of crop rotation on the survival of *Phytophthora capsici* in Michigan. Plant Disease 87: 841-845.

Locasio, S.J., Gilreath, J.P., Dickson, D.W., Kucharek, T.A., Jones, J.P. and Noling, J.W. 1997. Fumigant alternatives to methyl bromide for polyethylene-mulched tomato. HortScience 32(7) 1208-1211.

Morales, J.P., Santos, B.M., Stall, W.M. and Bewick. T.A. 1997. Effects of purple nutsedge (*Cyprus rotundus*) on tomato and bell pepper vegetative growth and fruit yield. Weed Science Technology 11: 672-676.

Nelson, K.A. and Renner, K.A. 2002. Yellow nutsedge (*Cyprus esculentus*) control and tuber production with glyphosate and ALS-inhibiting herbicides. Weed Technology 16(3): 512-519.

Norton, J., Nelson, R.D., Nelson, M.D., Olson, B.O., Mey, B.V. and Lepez, G. 2000. Field evaluation of alternatives to methyl bromide for pre-plant soil fumigant in California tomatoes. USDA IR-4 methyl bromide alternatives program for minor crop. Report submitted to the US-EPA during 2003 in support of methyl bromide critical use exemption.

Stall, W.M. and Morales-Payan, J.P. 2003. The critical period of nutsedge interference in tomato, Florida. Web address: http://www.imok.ufl.edu/liv/groups/ipm/weed_con/nutsedge.htm

U.S. Environmental Protection Agency. 1998. Re-registration Eligibility Decision (RED) 1,3 dichloroprppene. Available at http://www.epa.gov/REDs/0328red.pdf

U.S. Environmental Protection Agency. 1998. Feasibility of using gas permeable tarps to reduce methyl bromide emissions associated with soil fumigation in the United States.

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

Methyl Bromide Critical Use Exemption Process	Date:	2/26/2004	Average Hectares in the US:	51,506
2006 Methyl Bromide Usage Numerical Index (BUNI)	Sector:	TOMATOES	% of Average Hectares Requested:	62%

2006 Amount of Request				2001 & 2002 Average Use*			Quarantine and Pre-Shipment	Regional Hectares**		
REGION	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)		2001 & 2002 Average	% of 2001 & 2002 Average	% of Request
Michigan	31,606	656	48	31,848	661	48	0%	749	88%	88%
California	102,058	971	105	110,779	990	112	0%	15,479	6%	6%
Southeastern US	4,519,688	30,104	150	4,442,326	28,887	154	0%	29,672	97%	101%
TOTAL OR AVERAGE	4,653,353	31,731	101	2,079,698	30,537	105	0%	45,900	67%	69%

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
Michigan	31,606	-	-	2	-	10,745	10,745	10,745	223	48	66%
California	102,058	-	-	-	-	102,058	102,058	102,058	971	105	0%
Southeastern US	4,519,688	-	137,191	-	-	2,910,861	2,352,736	2,799,236	18,645	150	38%
TOTAL	4,653,353	4,653,353	4,516,161	4,516,159	4,516,159	3,023,665	2,465,540	2,931,879	19,839	101	37%
% Reduction from Initial Request	0%	0%	3%	3%	3%	35%	47%	37%	37%		

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
Michigan	48	48	0%	0%	0%	0%	34%	34%	0%	0%	0%	0%	34%	34%	34%	34%
California	105	105	0%	0%	0%	0%	0%	0%	9%	1%	100%	100%	0%	0%	100%	100%
Southeastern US	150	150	32%	32%	0%	0%	50%	29%	0%	0%	0%	0%	0%	0%	66%	53%

Other Considerations	Dichotomous Variables (Y/N)					Other Issues			Economic Analysis				Quality/ Time/ Market Window/ Yield Loss (%)	Marginal Strategy
REGION	Strip Bed Treatment	Currently Use Alternatives?	Research / Transition Plans	Tarps / Deep Injection Used	Pest-free Cert. Requirement	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		
Michigan	Yes	Yes	Yes	Tarp	No	-	Yes		$ 4,730	$ 98	12%	50%	22%, 6% Yield Loss + 16% delay	1,3-D + Pic
California	Yes	Yes	Yes	Tarp	No	-	Yes		$ 8,618	$ 82	10%	26%	15% Yield Loss, Range 15 to 20%	Metam-Sodium
Southeastern US	Yes	Yes	Yes	Tarp	No	-	Yes		$ 5,708	$ 38	14%	39%	21%, 6.2% Yield Loss + 14.8% delay	1,3-D+Pic+herbicide

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**

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