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 (Submitted in 2006 for 2008 Use Season)

NOMINATING PARTY CONTACT DETAILS

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

☐ Yes ☐ No

Signature ______ Name ______ Date ______

Title: ______

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

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

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

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

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PART A: SUMMARY

1. NOMINATING PARTY:

The United States of America (U.S.)

2. DESCRIPTIVE TITLE OF NOMINATION:

Methyl Bromide Critical Use Nomination for Pre-plant Soil Use for Tomato Grown in Open Fields (Submitted in 2006 for 2008 Use Season).

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)
2008	**1,840,100**	**14,131**

** Includes research amount*

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	*Michigan*	*Virginia*	*Southeast U.S***	*Georgia*	*Florida – North Florida*	*Florida – Ruskin / Palmetto*	*Florida – Palm Beach*	*Florida - Southwest*	*Florida – Dade County*
AMOUNT OF APPLICANT REQUEST									
2008 Kilograms	30,391	453,592	1,038,145	353,443	253,717	845,654	392,652	1,212,587	221,058
AMOUNT OF NOMINATION*									
2008 Kilograms	30,310	91,628	377,955	147,366	98,222	327,373	152,396	473,253	136,097

**See Appendix A for complete description of how the nominated amount was calculated.*
***Includes Alabama, Arkansas, Kentucky, Louisiana, North Carolina, South Carolina, and Tennessee.*

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 geology in the South-Eastern United States, including Florida. 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 2003 (HA)	PROPORTION OF REQUEST FOR METHYL BROMIDE IN 2003 (%)
Michigan Region	769	33
South-Eastern United States	28,646	100
NATIONAL TOTAL : *	51,506	57

* National total includes other regions not requesting methyl bromide
***Includes Alabama, Arkansas, Kentucky, Louisiana, North Carolina, South Carolina, Tennessee, and Virginia.*

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

TABLE 8.1: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE – MICHIGAN, SOUTHEAST U.S., AND GEORGIA

REGION:	***Michigan***	***Southeast U.S*****	***Georgia***
YEAR OF EXEMPTION REQUEST			
KILOGRAMS OF METHYL BROMIDE	30,391	1,491,737	353,443
USE: BROADCAST OR STRIP/BED TREATMENT	Strip/Bed	Mostly Strip/Bed	Mostly Strip/Bed
FORMULATION *(ratio of methyl bromide/chloropicrin mixture)* TO BE USED FOR THE CUE	67/33	Mostly 67/33	Mostly 67/33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(m^2 or ha)*	253	9,534	2,353
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	12.0	16.2	15.0

**Only 36.7% percent of an hectare receives this amount of methyl bromide formulation*
***Includes Alabama, Arkansas, Kentucky, Louisiana, North Carolina, South Carolina, Tennessee, and Virginia.*

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

REGION:	***Florida – North Florida***	***Florida – Ruskin / Palmetto***	***Florida – Palm Beach***	***Florida - Southwest***	***Florida – Dade County***
YEAR OF EXEMPTION REQUEST	**2008**				
KILOGRAMS OF METHYL BROMIDE	253,717	845,654	392,652	1,212,587	221,058
USE: BROADCAST OR STRIP/BED TREATMENT	Mostly Strip/Bed	Mostly Strip/Bed	Mostly Strip/Bed	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	Mostly 67/33	Mostly 67/33	Mostly 67/33
TOTAL AREA TO BE TREATED WITH THE METHYL BROMIDE OR METHYL BROMIDE/CHLOROPICRIN FORMULATION *(m^2 or ha)*	1,509	5,030	2,335	7,212	1,315
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF METHYL BROMIDE	16.8	16.8	16.8	16.8	16.8

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

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 geology, buffer zones, unsuitable terrain, and cold soil temperatures.

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	MB 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?

In Michigan, 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 may be too long (14 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:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	195	233	260	270	256	278
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)*	23,493	28,003	31,235	32,461	30,781	33,430
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	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*	120	120	120	120	120	120
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	12.0	12.0	12.0	12.0	12.0	12.0

**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

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. However, Michigan soil temperatures during April are too low to use this fumigant for an early fresh market tomato crop. Product label states that tomatoes cannot be transplanted to the field for up to 21 days after fumigation. Technically, it is MB alternative, but economically it is not a viable alternative.	No

Name of Alternative	Technical and regulatory* reasons for the alternative not being feasible or available + citations**	Is the alternative considered cost effective?
Chloropicrin	Chloropicrin is ineffective as a 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 MB 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 MB 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 MB 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. See paragraph below.	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE + CITATIONS**	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Metam sodium + crop rotation	Same as for metam sodium.	No

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

The proposal by MBTOC to obviate the use of methyl bromide in Michigan by applying some alternative (specifically a combination of 1,3-D and chloropicrin) in the autumn preceeding crop planting will not work on tomatoes. In Michigan, the predominant agricultural treatment that uses methyl bromide is one where methyl bromide is applied in strips of raised beds. Areas between the raised beds are not treated. In addition to the risk that the harsh winter conditions (prolonged periods of below freezing weather with snow, sleet, and high winds) will tear the plastic barrier, there is significant risk of flooding and concomitant recontamination of the treated areas. The length and severity of the winter means 4-5 months of precipitation is 'stored' in frozen form and released over the short period of thaw in the spring. This thaw-based flooding can be exacerbated by heavy rainfalls (in excess of 25 mm/event) that occur throughout the spring and summer in Michigan. Because phytophthora and verticillium are endemic in the areas of Michigan for which methyl bromide is being requested, flooding will transfer spores from the untreated to treated areas, resulting in additional infected plants and severe crop losses.

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 crown 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. Registration package has been received.	Yes	Unknown
Propargyl Bromide	Not registered. No registration package has been received.	No	Unknown
Muscadore albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

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:

In 2003, the applicant submitted the results of one small scale field trial on the efficacy of methyl bromide alternatives in controlling *Phytophthora capsici* and its 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. Results were inconclusive. 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 if fields are fumigated in early May instead of April (using methyl bromide + chloropicrin). In addition, growers may also experience revenue losses if they miss early tomato market when prices are higher.

This study was repeated during the 2004 growing season. However, this study does not represent the typical Michigan conditions because due to the cool wet weather the plots were not treated until June 8 when the soil was warm enough for the alternatives to be effective. Results show that yields from tomato plots treated with metam potassium (K-Pam), alone or in combination with chloropicrin, and from plots treated with 1,3-D + chloropicrin (Telone C35) are not significantly different from yields from plots treated with MB + chloropicrin or from yields from untreated control plots (Hausbeck and Cartright, 2004). As for the 2003 trial discussed above, results of the 2004 study are still inconclusive, probably because of the occurrence of low pest pressure in the study area.

MICHIGAN REGION – TABLE #? . Evaluation of Fumigants for Managing *Phytophthora* Crown and Fruit Rot of Solanaceous and Cucurbit Crops 2004

Alternative & Rate	**Plant Loss (%)**	**Marketable Yield Loss**
MeBr 67:33 350 lb/A)	4.6 %	0%
Telone C-35 shank (392 gal/A)	15.3 %	30%
Chloropicrin shank (344 lb/A) plus Metam potassium drip (174 lb/A)	0.60%	-23%
Chloropicrin shank (344 lb/A) plus Metam potassium drip (348 lb/A)	0.40%	-12%
Chloropicrin 99% shank (25 gal)	24.30%	11%
Metam potassium drip (348 lb/A)	1.70%	-17%
Metam potassium drip (174 lb/A)	2.10%	7%

Footnote. Due to a wet spring the treatments were applied later than typical for Michigan on June 8, 2004. From Hausbeck and Cortright, 2004.

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 delays; Most likely losses are 6 % using 1,3 D + chloropicrin (the best alternative)**	

Reference: Alternatives for methyl bromide on cucurbit and Solanaceous crops, 2003. M.K. Hausbeck, B.D. Cortright. 2003. Unpublished.

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 1,3-D + 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?:

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 metam sodium and a combination of 1,3-D + chloropicrin can control the key target pest, *Phytophthora*, the resulting planting and harvesting delays 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 that delay tomato harvest by 14-28 days, resulting 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 alternatives 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

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?

In the Southeastern U.S., karst geology inhibits the use of all fumigants that contain 1,3-D in a significant portion of the tomato production areas.

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

VIRGINIA - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	1,439	1,719	2,038	2,102	1,983	Not Available

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)*	242,014	288,961	342,711	353,325	333,390	Not Available
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	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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)******	16.8	16.8	16.8	16.8	16.8	16.8

SOUTHEAST U.S. * - TABLE 12.2 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
AREA TREATED *(hectares)*	5,564	5,816	6,052	5,947	6,131	6,252
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)*	835,014	870,340	907,927	891,844	919,621	937,856
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	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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)******	15.0	15.0	15.0	15.0	15.0	15.0

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

GEORGIA - TABLE 12.3 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
AREA TREATED *(hectares)*	2,686	2,307	2,216	2,353	2,341	2,688
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)*	512,423	354,727	332,778	353,443	351,620	403,710

FORMULATIONS OF METHYL BROMIDE (*methyl bromide /Chloropicrin)*	67/33	67/33	67/33	67/33	67/33	67/33
METHOD BY WHICH METHYL BROMIDE	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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	19.1	15.4	15.0	15.0	15.0	15.0

FLORIDA – NORTH FLORIDA - TABLE 12.4 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
AREA TREATED *(hectares)*	1,032	1,376	1,376	1,942	1,700	1,509
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)*	199,690	246,754	246,754	348,359	335,295	291,740
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	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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	19.4	17.9	17.9	17.9	19.7	19.3

FLORIDA – RUSKIN / PALMETTO - TABLE 12.5 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**
AREA TREATED *(hectares)*	5,443	5,261	6,313	6,313	6,313	5,030
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)*	1,009,806	887,226	990,645	948,189	1,089,709	850,841
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	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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	18.6	16.9	15.7	15.0	17.3	16.9

FLORIDA – PALM BEACH - TABLE 12.6 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	2,044	2,843	2,843	2,843	2,843	2,335
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)*	329,852	471,600	446,108	426,989	490,719	395,060
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	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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	16.1	16.6	15.7	15.0	17.3	16.9

FLORIDA – SOUTHWEST - TABLE 12.7 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	7,345	8,529	8,529	8,529	8,529	7,212
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)*	1,320,936	1,347,883	1,338,323	1,280,966	1,472,156	1,220,025
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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)**	18.0	15.8	15.7	15.0	17.3	16.9

FLORIDA – DADE COUNTY - TABLE 12.8 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000	2001	2002	2003	2004
AREA TREATED *(hectares)*	1,700	1,700	1,603	1,481	1,481	1,315
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)*	283,858	283,858	251,471	222,460	255,663	226,121
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	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
ACTUAL DOSAGE RATE OF ACTIVE INGREDIENT *(g/m^2)******	16.7	16.7	15.7	15.0	17.3	17.2

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		
1,3 dichloropropene (Telone)	Effective against nematodes, but not against fungal plant pathogens and nutsedge weeds. Approximately 40% of tomato land has Karst geology. Growers with Karst geology cannot use 1,3-D because of underground water contamination.	No
Metam sodium/potassium	Metam (sodium or potassium) will control many weeds, but control of nutsedge is very inconsistent, and this fumigant is not very effective against soil nematodes.	No
Chloropicrin	Chloropicrin controls soil fungi, but may also stimulate nutsedge weed growth, and therefore it is not a viable option. It 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°C or higher (Chase et al. 1999). While this may be achieved for some portion of the autumn cropping in southern 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°C at 5 cm depth, not high enough to destroy nutsedge tubers, and tubers lodged deeper in the soil would be completely unaffected.	No

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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 (cannot afford to take land out of production) feasible alternative to MB because it does not, by itself, provide adequate control of fungi and/or nutsedges. Crops available for rotation to growers are also susceptible to fungi, while fallow land can still harbor fungal oospores. The nutsedge tubers 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	This 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

NAME OF ALTERNATIVE	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
COMBINATIONS OF ALTERNATIVES		
1,3 D + chloropicrin+ a herbicide (such as napropamide + s-metolachlor + halosulfuron)	A combination of fumigants and herbicide partners 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 nearly equal to yields obtained using MB and chloropicrin. With this combination, in areas where it can be used, growers may lose an average of 6.2% yield (Chellemi *et al*., 2001).	Some combinations are promising
Metam sodium + Chloropicrin	Although this combination may be more effective than metam sodium alone in controlling fungal pests, it 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 MB alternative in the South-Eastern United States, where growers cannot use telone due to karst geology. Further studies need to be undertaken to ascertain whether or not it is technically and economically viable.	It shows promise
Telone + Chloropicrin	This combination 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 in these areas cannot use telone because of state regulations and underground water contamination issues.	No
Telone + metam sodium + herbicide (such as napropamide + s-metolachlor + halosulfuron)	This mixture could provide reasonable control of pests when weed pressure is low to moderate and land does not have Karst geology. Growers will need to use one of the newly registered herbicides if they use this combination, although they will be constrained by certain limitations (described below).	No
Metam sodium + Crop rotation	Same as metam sodium.	
Fumigant combination + herbicide partners	Current research suggests that in areas of low pest pressure this combination may be suitable for some growers as an alternative for methyl bromide. In these situations growers may employ a marginal strategy without major economic dislocation if given a reasonable time frame for the transition.	Yes

** 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	It is a non-selective herbicide that can be applied to row middles only, since direct application to the rows would cause injury to the tomato crop. It does not provide residual control. As a post-emergence treatment, glyphosate will not provide season long control of yellow and/or purple nutsedge in tomatoes.
Paraquat	It is a non-selective herbicide that will not control nutsedge in the plant rows. It does not provide residual control. Repetitive applications are required to achieve fair control of annual weeds in the row middle (Culpepper, 2003). It may also be applied prior to crop emergence. Direct 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 would not affect tuber viability, allowing the weed to grow again. Thus, paraquat cannot provide season long.

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, but its registration expired in December, 2002 (the manufacturer went out of business)	No	No longer registered
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	Unlikely due to phytotoxicity
Rimsulfuron	Registered for use on 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 postemergence 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. No registration package has been received.	No	Unknown
Furfural	Not registered. Registration package has been received.	Yes	Unknown
Propargyl Bromide	Not registered. No registration package has been received.	No	Unknown
Muscadore albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

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.

Rimsulfuron

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 rotational interval needed for second crop production and 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 show that growers may harvest tomato yields that are nearly equal to yields 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 crop experts maintain that tomato 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. However, in areas of low to moderate pest pressure, information suggests that some growers may employ a marginal strategy without major economic dislocation if given a reasonable time frame for the transition. The assessment of need was adjusted to account for this. The crop experts were unable to provide yield loss estimate without 2-3 years of field trials and maintain that more time is needed to evaluate various MB 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

South-Eastern US Alternatives Yield Loss Data Summary 2005

SOUTH-EASTERN U.S. ALTERNATIVES – TABLE 16.1: SOUTH-EASTERN US TRELLIS TOMATO FUMIGATION TRIAL

Treatment	Fusarium infected stems	Dead Plants (%)	Marketable Yield Loss (%)
Terrogas 98:2 (245 MeBr + 5 Pic lb ai/A)	1.5	10.8	0
Terrogas 80:20 (200 + 50 lb ai/A)	2.0	2.2	25
Telone C-17 (35 gal/A)	3.0	9.8	14
Metam sodium (50 gal/A)	1.8	3.3	15

Footnote: Baldwin, R.E. & C.M. Waldenmaier. 1991.

SOUTH-EASTERN U.S. ALTERNATIVES – TABLE 16.2: SOUTH-EASTERN US FUMIGANTS AND VARIETIES TO MANAGE SOUTHERN BACTERIAL WILT OF TOMATO

Treatment	Diseased Plants (%) *Ralstonia solanacearum*	Marketable Yield
MeBr 98:2 (292 + 8 lb/A)	59%	0%
Telone C-35 (35 gal/A)	84%	23%
Chlor-O Pic (10.5 gal)	81%	28%
Telone C-35 (30 gal/A)	84%	35%

Footnote: A *Ralstonia solanacearum* resistant variety BHN 446 was tried with low disease incidence but commercially undesireable because fruit was small and late maturing.
Driver , J.G.,& F.J. Louws. 2000

SOUTH-EASTERN U.S. ALTERNATIVES – TABLE 16.3: EFFICACY OF METHYL BROMIDE ALTERNATIVES FOR VERTICILLIUM AND WEED MANAGEMENT IN TOMATOES

Treatment	*Verticillium dahliae Infected (%) 2004*	Weeds per meter^2 (Aug 19, 2004)	Marketable Yield Loss 2003
MeBr 67:33 (268 + 132 lb/A)	29	0	0%
Telone C-35 shank (35 gal/A)	17.4	5.8	4%
Telone InLine C-35 drip (35 gal/A)	-	-	13%
Chloropicrin 99% (150 gal)	24.2	26.5	14%
Metam sodium drip (75 gal/A)	-	-	8%
Metam sodium spray/till (75 gal/A)	-	-	15%
Tri chlor EC (200 lb/A)		-	22%

Footnote: Louws, F.J., L.M. Ferguson, K. Ivors, J. Driver, K. Jennings, D. Milks, P.B. Shoemaker & D.W. Monks. 2004

SOUTH-EASTERN U.S. ALTERNATIVES – TABLE 16.4: METHYL BROMIDE ALTERNATIVES IN TOMATO PRODUCTION SYSTEMS IN NORTH CAROLINA

Treatment	*Verticillium dahliae Rating* (July 7, 2002)	Marketable Yield Loss
MeBr 67:33 (268 + 132 lb/A)	4.9bc	0%
Telone C-35 shank (35 gal/A)	10.6 bc	-3%
Telone InLine C-35 drip (35 gal/A)	24.6 ab	5%
Chloropicrin shank (15 gal)	0 c	-4%
Metam sodium drip (75 gal/A)	13.4 abc	2%
Metam sodium spray/till (75 gal/A)	9.3 bc	5%
Tri chlor EC (200 lb/A)	17.6 abc	9%
Tri chlor EC (200 lb/A) 1 week delay Metam (75 gal/A)	15.1	7%

Footnote: Louws, F.J., L.M. Ferguson, N.P. Lynch, & P. B. Shoemaker. 2002

In Florida Gilreath et al 2003 looked at methyl bromide plus chloropicrin (350 lb per acre of 67:33) versus 1,3-D-35%Pic/trifluralin/napropamide/chloropicrin (28 gal/0.5 lb/2 lb/125 lb) for pepper yield. While the yields were not significantly different there was a 14 to 13 percent yield loss compared to methyl bromide plus chloropicrin. In addition this alternative treatment with additional chemicals willl require extra time to apply the other pesticides and allow the second application of chloropicrin to off gas so that the transplants are not killed. This additional time delay would lead to impacts in terms of the key market windows.

SOUTH-EASTERN U.S. ALTERNATIVES – TABLE 16.5: TOMATO YIELDS ARE NOT SIGNIFICANTLY DIFFERENT BUT PERCENT YIELD LOSS CAN BE LARGE

Treatment	Bradenton FL		Immokalee FL	
	Marketable Yield (kg per 10 plants)	% Yield Change versus MeBr	Marketable Yield (kg per 10 plants)	% Yield Change versus MeBr
Untreated	23	-56%	49	-16%
Methyl bromide:chloropicrin (350 lb of 67:33)	53	0%	58	0%
1,3-D-35%Pic + trifluralin + napropamide + chloropicrin	46	-14%	51	-13%

(28 gal/0.5 lb/2 lb/125 lb)				

Footnote: From Gilreath et al. 2003. Proc. Fla. State Hort. Soc.

Recent research on have suggested that metham sodium, with and without chloropicrin can provide yields that are not significantly different than methyl bromide plus chloropicrin treated fields. However, under heavy rainfall years (in June through July of 2004 in North Carolina rain fell for 41 of 61 days) 1,3 D/Pic combinations have not shown effective control in fields where heavy nutsedge pressure is present. Combinations including trifluralin have shown stunting in tomato especially during years of above average rainfall on the production areas of the Southeastern US.

In other Florida research (Gilreath et al 2005) looked at methyl bromide in combination with high barrier films for pepper production. In that study which had a high *Cyperus spp.* pressure there were no significant difference in yield between any of the rates of methyl bromide with the different types of films. However, the non-significant difference between treatment 2 and 3 is a 22% reduction in yield. And while not significant the difference between treatment 2 and 5 and 6 are equal to 17 and 14 yield losses respectively. The data does go on to show that there are virtually no difference in yield between treatment 2 and 4 (LDPE versus VIFP at one quarter the rate). This type of inconsistency suggests that even for very adept researchers there appear to be other factors at play that can impact plant yield. It also helps to reinforce the fact that statistical significance may not always be the appropriate benchmark when talking about yield loss.

SOUTH-EASTERN U.S. ALTERNATIVES – TABLE 16.6: PEPPER YIELDS ARE NOT SIGNIFICANTLY DIFFERENT BUT PERCENT YIELD LOSS CAN BE LARGE

	Treatment	Use Rate kg/ha	Yield t/ha	% Change
1	Untreated		9.5	-31%
2	MeBr + Pic LDPE	392	13.8	0%
3	MeBr + Pic VIFP	196	10.8	-22%
4	MeBr + Pic VIFP	98	13.6	1%
5	MeBr + Pic VIFV	196	11.4	-17%
6	MeBr + Pic VIFV	98	11.9	-14%

Footnote: From Gilreath et al. 2005. Crop Protection 24: 285-287.
LDPE is low density polyethylene, VIFP and VIFV are virtually impermeable film by Plastopil and Vikase respectively.

Another study by Gilreath, Santos, Motis, Noling and Mirusso (2005) looks at nematode and *Cyperus* control in bell pepper (*Capsicum annum*). In that study the authors state "For bell pepper yield, the application of metam sodium and metam sodium + chloropicrin provided similar fruit weight as for methy bromide + chloropicrin in two of the three seasons." However, in that one year (Fall 2002) the yields went from 18.8 t/ha for methyl bromide + chloropicrin to 13.7 t/ha for metam sodium + chloropicrin or a 27% drop in yield. This level of yield loss could have severe economic impacts for a grower. Because of the inconsistency of some of the alternative treatments the U.S. does not consider them to be a replacement for methyl bromide.

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	1.3 – 10.1 (Chellemi *et al*., 2001)	6.2
Telone C-35 shank (35 gal/A + herbicide	*Verticillium*	3.0 better to 4% worse. Loews et al 2002 & 2004	0 (+/- 3.5%)
Chloropicrin followed by metam sodium	*Verticillium*	7% loss Loews et al 2002	7%
			Range 3.0 to 10.1%
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?

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 for postemergence application, 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 crop 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?

Tomatoes are grown in fields. In south-eastern U.S., 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 for postmergence application 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 experts 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:

Several members of MBTOC and the USG were recently able to tour field research sites in Florida and Georgia including the plots of Dr. Gilreath. During those discussions and in his recent research publications (Gilreath et al 2005, Gilreath et al in press, and Gilreath & Gilreath 2005) the improved pest control when using Virtually Impermeable Film (VIF) or metalized films (using an aluminum layer such as Canslit) was described (see also Table 16.5). Dr. Gilreath and other researchers were contacted on the topics of low permeability barrier films, and newer application techniques. Based on their input it appears that VIF films have still not been widely adopted because of problems in: laying the films, inelasticity and the resultant difficulty in conforming to the bed shape, problems with linear shear, and the fact that embossed films are not available. The current versions of metalized films are being widely tested by several researchers and growers and they have the potential to reduce fumigant use rates with better laying and bedshape conforming characteristics. It is anticipated that the results of many of these research plots and growers field tests will be available next year. These metalized films pose several questions for adoption: the fate of the aluminum coating if it “flakes off” on the soil during removal and the photostability of the coating during multiple crop cycles as is common in the southeastern U.S. An additional concern with all of the low permeability films and reduced use rates is poor uniformity of treatment unless the application equipment must be redesigned to accommodate reduced flow rates and pressure (Gilreath and Gilreath 2005). While all of these results are promising there are only a few researchers that have multi-year trials with these films and new or modified application equipment. Many growers are said to be testing the new films, reduced rates of methyl bromide, and other alternatives. Without multi-year trials under a range of environmental conditions the consistency, feasibility, and adaptability cannot be assessed.

When evaluating research that MBTOC cites (Gilreath et al 2003) at the Bradenton site the untreated control has 53 nutsedge (*Cyperus rotundus*) plants per square yard while the Immokalee site has less than one plant per square yard. The current standard that the US recommends for moderate nutsedge pressure is 5 to 30 plants per square yard. At the Bradenton site the nutsedge control was not significantly different between MeBr:Pic (350 lb per acre) versus 1,3-D-35%Pic/trifluralin/napropamide/chloropicrin (28 gal/0.5 lb/2 lb/125 lb) but had 39% more nutsedge plants and a 17% reduction in yield. When comparing the same treatments at the second site at Immokalee which had low nutsedge pressure (< 1 plant per square yard) and no significant difference in *Fusarium*, or nematodes such as *Meloidogyne spp, Belonolainus spp. and Tylenchorhynchus spp.* still had a 12.5% reduction in yield compared to methyl bromide.

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?	Began research during 2003	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?	Began research during 2003	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 tomato 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 tomatoes 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 98% methyl bromide and 2% 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 tomato 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$/ha)*
MICHIGAN	**Methyl Bromide**	**100**	**$ 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)*
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)*
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)*
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

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

MICHIGAN	METHYL BROMIDE	1,3-D + PIC	METAM SODIUM	CHLOROPICRIN
PRODUCTION LOSS (%)	0%	6%	13%	6%
PRODUCTION PER HECTARE	4,414	4,132	3,845	4,132
* PRICE PER UNIT (US$)	$ 9.44	$ 9.44	$ 9.44	$ 9.448
= GROSS REVENUE PER HECTARE (US$)	$ 41,652	$ 38986	$ 36,279	$ 38986
- OPERATING COSTS PER HECTARE (US$)**	$ 37,055	$ 32453	$ 31,170	$ 32,453
= NET REVENUE PER HECTARE (US$)	$ 4596	$ 6,533	$ 5,109	$ 6,533
FIVE LOSS MEASURES *				
1. LOSS PER HECTARE (US$)	$ -	$ 1,937	$ 512	$ 1,937
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 16	$ 4	$ 16
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	5%	1%	5%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	42%	11%	42%
5. OPERATING PROFIT MARGIN (%)	11%	17%	14%	17%

**Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

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

SOUTHEASTERN US	METHYL BROMIDE	1,3-D + PIC
PRODUCTION LOSS (%)	0%	6%
PRODUCTION PER HECTARE	4,551	4,269
* PRICE PER UNIT (US$)	$ 10	$ 10
= GROSS REVENUE PER HECTARE (US$)	$ 46,986	$ 44,073
- OPERATING COSTS PER HECTARE (US$)**	$ 26,660	$ 29,860
= NET REVENUE PER HECTARE (US$)	$ 20,326	14,212
FIVE LOSS MEASURES *		
1. LOSS PER HECTARE (US$)	$ -	$ 6,113
2. LOSS PER KILOGRAM OF METHYL BROMIDE (US$)	$ -	$ 36
3. LOSS AS A PERCENTAGE OF GROSS REVENUE (%)	0%	13%
4. LOSS AS A PERCENTAGE OF NET OPERATING REVENUE (%)	0%	30%
5. OPERATING PROFIT MARGIN (%)	43%	32%

**Note that the measures in the tables below must be interpreted carefully. Operating costs do not include fixed costs and net revenue equals gross revenue minus operating costs.

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 and 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.

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.

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.

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?

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 USDA/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 2007. 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.

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

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

Georgia experts (Culpepper, 2004) claims 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 a few more years to evaluate and refine these systems in large scale trials prior to large scale implementation at growers' field level.

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APPENDIX A. 2008 Methyl Bromide Usage Newer Numerical Index (BUNNI).

2008 Methyl Bromide Usage Newer Numerical Index - BUNNI							Tomato	
January 24, 2006	Region		Michigan Tomato	Southeast Tomato Total	Georgia Tomato	Florida Tomato Total	Sector Total or Average	Notes
Dichotomous Variables	Strip or Bed Treatment?		Strip	Strip	Strip	Strip		
	Currently Use Alternatives?		Yes	Yes	Yes	Yes		
	Tarps / Deep Injection Used?		Tarp	Tarp	Tarp	Tarp		
Most Likely Combined Impacts (%)	Karst -1,3-D Limitation (%)		0%	6%	11%	45%		
	100 ft Buffer Zones (%)		0%	0%	0%	0%		
	Key Pest Distribution (%)		100%	43%	43%	43%		
	Regulatory Issues (%)		0%	0%	0%	0%		
	Unsuitable Terrain (%)		0%	0%	0%	0%		
	Cold Soil Temperature (%)		100%	0%	0%	0%		
	Total Combined Impacts (%)		**100%**	**46%**	**49%**	**68%**		
Most Likely Baseline Transition	(%) Able to Transition		0%	57%	57%	57%		
	Minimum # of Years Required		0	7	7	7		
	(%) Able to Transition / Year		**0%**	**8%**	**8%**	**8%**		
EPA Adjusted Use Rate (kg/ha)			120	130	130	130		
EPA Adjusted Strip Dosage Rate (g/m2)			18	20	20	20		
2008 Applicant Requested Usage	*Amount - Pounds*	*Pounds*	*67,000*	*3,288,720*	*779,210*	*6,450,000*	*10,584,930*	
	Area - Acres	*Pounds*	*625*	*23,560*	*5,815*	*43,000*	*73,000*	
	Rate (lb/A)	*Pounds*	*107.20*	*144.81*	*134.00*	*150.00*	*145*	
	Amount - Kilograms	Metric	**30,391**	**1,491,737**	**353,443**	**2,925,668**	**4,801,240**	
	Treated Area - Hectares	Metric	253	9,534	2,353	17,401	29,542	
	Rate (kg/ha)	Metric	120	162	150	168	163	
EPA Preliminary Value		**kgs**	**30,391**	**1,409,865**	**353,443**	**2,925,668**	**4,719,367**	
EPA Baseline Adjusted Value has been adjusted for:			MBTOC Adjustments, Double Counting, Growth, Use Rate/Strip Treatment, LPF Transition, and Combined Impacts					
EPA Baseline Adjusted Value		kgs	30,310	488,389	149,177	1,534,507	2,202,383	
EPA Transition Amount		kgs	-	(18,806)	(1,811)	(347,167)	(367,784)	
Most Likely Impact Value (kgs)		kgs	**30,310**	**469,583**	**147,366**	**1,187,340**	**1,834,599**	
		ha	**252**	**3,612**	**1,134**	**9,133**	**14,131**	
		Rate	**120**	**130**	**130**	**130**	**130**	
Sector Research Amount (kgs)			**5,501**	**2008 Total US Sector Nomination**		**1,840,100**		

1 Pound = 0.453592 kgs 1 Acre = 0.404686 ha

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

Footnotes for Appendix A:

Values may not sum exactly due to rounding.

1. **Dichotomous Variables** – dichotomous variables are those which take one of two values, for example, 0 or 1, yes or no. These variables were used to categorize the uses during the preparation of the nomination.
2. **Strip Bed Treatment** – Strip bed treatment is 'yes' if the applicant uses such treatment, no otherwise.
3. **Currently Use Alternatives** – Currently use alternatives is 'yes' if the applicant uses alternatives for some portion of pesticide use on the crop for which an application to use methyl bromide is made.
4. **Tarps/ Deep Injection Used** – Because all pre-plant methyl bromide use in the US is either with tarps or by deep injection, this variable takes on the value 'tarp' when tarps are used and 'deep' when deep injection is used.
5. **Pest-free cert. Required** - This variable is a 'yes' when the product must be certified as 'pest-free' in order to be sold

6. **Other Issues**.- Other issues is a short reminder of other elements of an application that were checked
7. **Frequency of Treatment** – This indicates how often methyl bromide is applied in the sector. Frequency varies from multiple times per year to once in several decades.
8. **Quarantine and Pre-Shipment Removed?** – This indicates whether the Quarantine and pre-shipment (QPS) hectares subject to QPS treatments were removed from the nomination.
9. **Most Likely Combined Impacts (%)** – Adjustments to requested amounts were factors that reduced to total amount of methyl bromide requested by factoring in the specific situations were the applicant could use alternatives to methyl bromide. These are calculated as proportions of the total request. We have tried to make the adjustment to the requested amounts in the most appropriate category when the adjustment could fall into more than one category.
10. **(%) Karst geology** – Percent karst geology is the proportion of the land area in a nomination that is characterized by karst formations. In these areas, the groundwater can easily become contaminated by pesticides or their residues. Regulations are often in place to control the use of pesticide of concern. Dade County, Florida, has a ban on the use of 1,3D due to its karst geology.
11. **(%) 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.
12. **(%) 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.
13. **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.
14. **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.
15. **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.
16. **Total Combined Impacts (%)** - Total combined impacts are the percent (%) of the requested area where alternatives cannot be used due to key pest, regulatory, soil impacts, temperature, etc. In each case the total area impacted is the conjoined area that is impacted by any individual impact. The effects were assumed to be independently distributed unless contrary evidence was available (e.g., affects are known to be mutually exclusive). For example, if 50% of the requested area had moderate to severe key pest pressure and 50% of the requested area had karst geology, then 75% of the area was assumed to require methyl bromide rather than the alternative. This was calculated as follows: 50% affected by key pests and an additional 25% (50% of 50%) affected by karst geology.
17. **Most Likely Baseline Transition** – Most Likely Baseline Transition amount was determined by the DELPHI process and was calculated by determining the maximum share of industry that can transition to existing alternatives.
18. **(%) Able to Transition** – Maximum share of industry that can transition
19. **Minimum # of Years Required** – The minimum number of years required to achieve maximum transition.
20. **(%) Able to Transition per Year** – The Percent Able to Transition per Year is the percent able to transition divided by the number of years to achieve maximum transition.
21. **EPA Adjusted Use Rate** - Use rate is the lower of requested use rate for 2008 or the historic average use rate or is determined by MBTOC recommended use rate reductions.
22. **EPA Adjusted Strip Dosage Rate** – The dosage rate is the use rate within the strips for strip / bed fumigation.
23. **2008 Amount of Request** – The 2008 amount of request is the actual amount requested by applicants given in total pounds active ingredient of methyl bromide, total acres of methyl bromide use, and application rate in pounds active ingredient of methyl bromide per acre. U.S. units of measure were used to describe the initial request and then were converted to metric units to calculate the amount of the US nomination.
24. **EPA Preliminary Value** – The EPA Preliminary Value is the lowest of the requested amount from 2005 through 2008 with MBTOC accepted adjustments (where necessary) included in the preliminary value.

25. **EPA Baseline Adjusted Value** – The EPA Baseline Adjusted Value has been adjusted for MBTOC adjustments, QPS, Double Counting, Growth, Use Rate/ Strip Treatment, Miscellaneous adjustments, MBTOC recommended Low Permeability Film Transition adjustment, and Combined Impacts.
26. **EPA Transition Amount** – The EPA Transition Amount is calculated by removing previous transition amounts since transition was introduced in 2007 and removing the amount of the percent (%) Able to Transition per Year multiplied by the EPA Baseline Adjusted Value.
27. **Most Likely Impact Value** – The qualified amount of the initial request after all adjustments have been made given in total kilograms of nomination, total hectares of nomination, and final use rate of nomination.
28. **Sector Research Amount** – The total U.S. amount of methyl bromide needed for research purposes in each sector.
29. **Total US Sector Nomination** - Total U.S. sector nomination is the most likely estimate of the amount needed in that sector.

APPENDIX B. List of Treatments in MBTOC Final Databases.

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

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

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

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

#	Treatment Code	Treatment Description	Tomatoes	Comments
44	PPDev	PlantPro 45B EC; PlantPro 45B EC (3% iodine compound), Napropamide (Devrinol™ 50WG)		Refer to # 13.
45	PPFosDev	PlantPro 45B; PlantPro 45B; Fosthiazate 500 EC, Napropamide (Devrinol™ 50WG)		Refer to # 13.
46	TC17	1,3-dichloropropene (Telone™) plus Chloropicrin (17%)	Yes	Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
47	TC17MNa	1,3-dichloropropene (Telone™); Metam Sodium	Yes	Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
48	TC17Nap	1,3-dichloropropene (Telone™); Napropamide (Devrinol™ 50WG)		Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
49	TC17PicDev	1,3-dichloropropene (Telone™) plus Chloropicrin (17%); Napropamide (Devrinol™ 50WG)		Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
50	**TC35**	1,3-dichloropropene (Telone™) plus Chloropicrin (35%)	Yes	Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
51	**TC35Daz**	TC35, Dazomet	Yes	Refer to #2.
52	**TC35Dev**	TC35; Napropamide (Devrinol™)		Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
53	**TC35EC**	TC35 EC	Yes	Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
54	**TC35ECDaz**	Dazomet; TC35 EC	Yes	Refer to #2.
55	**TC35ECMNa**	Metam Sodium; TC35 EC		Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
56	**TC35ECPicECDaz**	TC35 EC; Chloropicrin EC, Dazomet		Refer to #2.
57	**TC35ECTrefDev**	TC35 EC; Trifluralin (Treflan™), Napropamide (Devrinol™)	Yes	Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
58	**TC35MesTref**	TC35; Harpin protein (Messenger ™); Trifluralin (Treflan™)	Yes	Refer to # 11.
59	**TC35MNa**	TC35, Metam Sodium		Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
60	**TC35Nap**	TC35; Napropamide (Devrinol™)		Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
61	**TC35Pic**	TC35; Chloropicrin		Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
62	**TC35PicTrefDev**	TC35; Treflan; Napropamide (Devrinol™); Chloropicrin	Yes	Referred to in Tomato CUN as components of multiple chemical mixtures (South-Eastern United States – Part C Technical Validation).
63	**TC35Sol**	Solarization; TC35		See #3.
64	Vrlx	Vorlex CP		Registered cancelled in the United States.

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