METHYL BROMIDE CRITICAL USE NOMINATION FOR PREPLANT SOIL USE FOR FOREST SEEDLINGS

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

NOMINATING PARTY:	The United States of America
BRIEF DESCRIPTIVE TITLE OF NOMINATION:	Methyl Bromide Critical Use Nomination for Preplant Soil Use for Forest Seedlings (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**

TABLE OF CONTENTS

LIST OF TABLES

PART A: SUMMARY

1. NOMINATING PARTY:

The United States of America (U.S.)

2. DESCRIPTIVE TITLE OF NOMINATION:

Methyl Bromide (MB) Critical Use Nomination for Preplant Soil Use for Forest Seedlings (Submitted in 2006 for 2008 Use Season)

3. CROP AND SUMMARY OF CROP SYSTEM

Forest seedling nurseries in the U.S. supply conifer and hardwood seedlings that are used for reforestation, forest establishment, fiber production, and wildlife and conservation uses. In a survey conducted in 2001-2002 (Southern Forest Nursery Management Cooperative, Appendix 1 of their request), there were approximately 1.7 billion pine seedlings produced in the southern region of the U.S., which accounted for 80% of U. S. pine seedling production. Nurseries in the U.S. are located in eight climate zones (Zones 3 to 10) and have mostly light or medium soils. The majority of seedlings are species of conifers, especially pine. In addition, 30-60 species of hardwoods, such as oaks, hickory, poplars, and ash, are produced. Nurseries produce seedlings adapted to their respective regional conditions, with variables such as climate and soil type. Forest seedling nurseries requesting critical use of MB include both public and private nursery operations.

Nurseries of this sector produce mostly conifer seedlings, which are typically grown for one or two years in seedling beds. After harvest, beds have one or two years of fallow or cover crops. Managers typically fumigate a particular conifer seedling bed with MB once every 3-4 years, i.e., one-quarter to one-third of the total nursery land is fumigated each year to produce two or three harvestable forest seedling crops per single bed fumigation. Effective fumigants, such as MB, permit less frequent bed fumigation per harvestable seedling crop. For hardwood seedlings, fumigation is usually provided prior to each seedling crop, as hardwood species are generally more prone to root rots and damping-off diseases than conifers, although the production volume of hardwoods is smaller than overall conifer production.

At the appropriate stage of maturity, forest seedlings are harvested in the nursery, packaged, and transported to the planting site. Seedlings are usually culled or sized during the harvesting process, with culled trees discarded. Nurseries that grade their seedlings may sell lower grade seedlings at a reduced price, or discard all but the highest grade seedlings. The impact of seedling quality, particularly seedling size, on the success of plantation establishment cannot be overstated. The production of large and healthy planting stock is essential to the economic viability of reforestation processes. These typically include soil preparation at the planting site, transportation to the planting site, planting, and weed control after planting. The quality of seedlings is highly correlated with the success of the regeneration process and corresponding long-term economic and use benefits, where seedling quality results in greater survival rates and faster growth. Maintaining pest-free nursery soils is the backbone of an integrated pest management approach to producing healthy seedlings and the foundation for establishing economically viable forests.

4. METHYL BROMIDE NOMINATED

TABLE 4.1: METHYL BROMIDE NOMINATED

YEAR	NOMINATION AMOUNT (KG)	NOMINATION AREA (HA)
2008	**133,140**	**527**

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

The U.S. nomination is for those areas where the alternatives are not effective against key pests when pressure is moderate to high. The use of MB is considered critical where alternatives are not suitable because of regulatory, economic, or technical constraints. Although alternative treatments can be foreseen as long-term solutions to MB use, transition from MB will depend on the development of application technologies to better deliver these alternatives to soils containing target pests. In addition, because of MB efficacy, two or three seedling crops can be grown with each MB application—generally applied once in three or four years. Alternative treatments are likely to be a combination of treatments, both chemical and non-chemical, which may involve increased costs and environmental pesticide burdens.

Forest nurseries throughout the U. S. contend with a variety of pests. Effective fumigation is relied on to manage fungal pathogens (e.g., *Fusarium*, *Alternaria*, *Phytophthora*, *Pythium*, *Rhizoctonia*, *Cylindrocladium* spp., *Cylindrocarpon*, and *Macrophomina*), nematodes (e.g., *Circonemoides*, *Helicotylenchus*), and yellow and purple nutsedges (species of *Cyperus*) (Cram and Fraedrich, 1997). Nutsedges are generally considered among the major pests of forest seedling nurseries in the southeastern U.S. and the pests most difficult to manage.

Concerns for crop damage and worker exposure of some alternatives have been expressed by nursery growers after a significant outgassing incident from metam-sodium, in 1999, resulted in destruction of millions of nursery seedlings (described in the request by International Paper). Because of the importance placed on seedling quality, failure to achieve consistently healthy seedlings in even a fraction of the production beds can have a devastating effect on this sector's ability to provide acceptable seedlings.

Inconsistency in pest management performance by alternatives has been the primary concern for this sector, and the reason that MB is currently critical for maintaining high quality seedlings. While direct yield losses, in terms of seedlings/hectare, were not large on average, intensive seedling production relies on the ability of nursery managers to meet quality, as well as yield, goals. In addition, economic issues such as increased application costs (e.g., costs associated with application of metam-sodium and a separate chloropicrin application) may have an impact on overall feasibility of these alternatives for the forest seedlings sector.

As research identifies the most effective alternatives and application methodologies with alternative treatments, industry transition to these alternatives will accelerate. Research is ongoing to develop protocols for likely alternatives, such as 1,3-D and metam-sodium, and integrated methods with chemicals and non-chemicals. The requesting consortia are developing timelines that will help determine how the transition from MB will be achieved, most likely by implementing an integrated management strategy with a combination of chemical and non-chemical treatments. While field trials proceed, however, there is a critical need for MB for this sector for the 2008 use season.

TABLE A.1: EXECUTIVE SUMMARY FOR FOREST SEEDLINGS*

REGION	SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	INTERNATIONAL PAPER	ILLINOIS DEPARTMENT OF NATURAL RESOURCES	WEYERHAEUSER SOUTH	WEYERHAEUSER WEST	NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOC	MICHIGAN SEEDLING ASSOCIATION
AMOUNT OF APPLICANT REQUEST							
2008 Kilograms (kg)	246,032	15,714	4,264	17,962	16,491	29,250	6,908
AMOUNT OF NOMINATION *							
2008 Kilograms (kg)	60,764	10,627	3,819	13,889	16,491	20,946	6,604

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

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

Alternatives to MB are currently problematic for optimal seedling production because of their inconsistent performance from season to season, for nurseries with moderate to high pest (especially weed) pressure (e.g., Fraedrich and Dwinell, 2003a, 2003b, 2003c; Carey, 2000; Carey, 1996; Carey, 1994; Weyerhaeuser, #8, 1992-95; Weyerhaeuser, #10, 1994-96). While chemicals such as chloropicrin, metam-sodium, dazomet, herbicides, or 1,3-D can be effective in some situations in reducing pest infestations, including weed problems, inconsistency in pest management by chemical alternatives is the primary concern for this sector, and the reason that MB is currently critical for maintaining high quality seedlings. For example, Fraedrich and Dwinell (2003b) found that dazomet had some efficacy against nutsedge in field trials one year in two southern nurseries. But in one of the nurseries in Georgia, nutsedge plant populations increased over the course of the summer. They cautioned that "…[i]f dazomet is to be used for nutsedge control, additional efforts will be necessary to better define the optimal use conditions". Fraedrich and Dwinell (2003c) also conducted studies with glyphosate as a possible control for nutsedge. Two years of study suggested that glyphosate in broadcast treatments might be a feasible treatment. However, an integrated system of pest management must first be developed to achieve acceptable levels of control.

Research studies with organic and inorganic soil amendments (Fraedrich and Dwinell, 1998; James et al., 1997; James et al., 2001; Lantz, 1997; Stone et al., 1998) resulted in reduction in populations of certain pathogens, but the effects were variable depending on the nursery locations and species of seedlings. Furthermore, it was unclear if pathogen population size was correlated with disease incidence. More research is required before there can be commercial application of these methods as independent treatments.

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 IN 2002 (HA)	PROPORTION OF TOTAL CROP AREA TREATED WITH METHYL BROMIDE IN 2002 (%)
A. Southern Forest Nursery Management Cooperative	Not available	Not available
B. International Paper	Not available	Not available
C. Illinois Dept of Natural Resources	Not available	Not available
D. Weyerhaeuser-South	Not available	Not available
E. Weyerhaeuser-West	Not available	Not available
F. Northeastern Forest and Conservation Nursery Association	Not available	Not available
G. Michigan Seedling Association	Not available	Not available
NATIONAL TOTAL:**	51,506	2%

***Typically, only a fraction of a nursery's beds are fumigated in a given year.
**National average may include states not requesting methyl bromide.

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

Alternatives such as metam-sodium, chloropicrin, dazomet are used in approximately half of nursery hectares, especially those without severe nutsedge problems. Where soil types and temperatures are conducive, and especially where pest pressure is not high, these alternatives can be effective. This nomination, however, applies to those nurseries where alternatives are not effective. MB allows conifer seedling beds to be fumigated after two or three crops (as opposed to after every crop) because of the effectiveness of MB, which usually makes a second-year treatment unnecessary. Moreover, during the subsequent two years, beds are fallowed or an unfumigated cover crop is planted. With severe infestations of pests alternative products usually are applied more often, or several treatments with more than one alternative are used. Higher costs can be incurred if appropriate pest management strategies have not been properly designed.

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?

Nurseries of this sector have been implementing some methods (cover crop or fallow) that can reduce pest infestations. Strategies to replace MB are being studied by all of the nurseries involved. Within the next few years there will be considerable empirical data to identify the effectiveness of MB alternatives feasible for this sector, probably by implementing an integrated management strategy with a combination of chemical and non-chemical treatments. Until this time, however, there is a critical need for MB for this sector.

8. AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

TABLE 8.1. REGION A – SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

YEAR OF EXEMPTION REQUEST	**2008**
KILOGRAMS OF MB	246,032
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	98:2
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	656
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	375
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	37.5

TABLE 8.2. REGION B - INTERNATIONAL PAPER: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

YEAR OF EXEMPTION REQUEST	**2008**
KILOGRAMS OF MB	15,714
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	98:2
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	41
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	386
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	30.4

TABLE 8.3. REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

YEAR OF EXEMPTION REQUEST	**2008**
KILOGRAMS OF MB	4264
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	67:33
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	16
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	263
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	26.3

TABLE 8.4. REGION D - WEYERHAEUSER-SOUTH: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

YEAR OF EXEMPTION REQUEST	**2008**
KILOGRAMS OF MB	17,962
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	98:2
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	53
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	336
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	33.6

TABLE 8.5. REGION E - WEYERHAEUSER-WEST: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

YEAR OF EXEMPTION REQUEST	**2008**
KILOGRAMS OF MB	16,491
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	67:33
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	69
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	239
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	23.9

TABLE 8.6. REGION F - NORTHEASTERN FOREST AND CONSERVATION NURSERY ASSOCIATION: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

YEAR OF EXEMPTION REQUEST	**2008**
KILOGRAMS OF MB	29,250
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	98:2
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	81
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	363
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	36.3

TABLE 8.7. REGION G - MICHIGAN SEEDLING ASSOCIATION: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

YEAR OF EXEMPTION REQUEST	**2008**
KILOGRAMS OF MB	6,908
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	67:33
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	26
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	266
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	26.6

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

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

- The percent of regional hectares in the applicant's request was divided by the total area planted in that crop in the region covered by the request. Values greater than 100 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. No adjustment was made for this sector.
- Hectares counted in more than one application, or rotated within one year of an application to a crop that also uses MB, were subtracted. The double counted hectares were removed.
- Growth or increasing production (the amount of area requested by the applicant that is greater than that historically treated) was subtracted. The five applicants that included growth in their request had the growth amount removed.

- Quarantine and pre-shipment (QPS) hectares were removed from each applicant's request.
- Only the hectares with moderate to heavy key pest pressure were included in the nominated amount.

REGION A – SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

REGION A – SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

REGION A – SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	**Fungi** [100% at times]: *Fusarium, Macrophomina, Rhizoctonia, Pythium*, P*hytophthora*;	For areas where pest pressure is high, MB provides sufficient protection for three successive seedling crops, with one fumigation treatment (one treatment every four years). Until protocols are developed to improve efficacy of alternative treatments, there may be a need to provide additional fumigation treatments, or use a combination of chemicals and other effective treatments that may increase costs, beyond what is feasible.
	Weeds [100% at times]: broadleaf, grasses, sedges	
	Nematodes [100% at times]: *Circonemoides, Helicotylenchus*	

REGION A – SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

REGION A – SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE
CROP TYPE:	Bareroot forest seedlings (91-96% pine, 4-9% hardwood species)
ANNUAL OR PERENNIAL CROP:	**Conifers:** Typically grown for 1 year for each of two or three crops before fumigation on fourth year; **Hardwoods:** Prior to each crop
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	Cover crops are used to reduce pest pressure on target crops; cover crops used include sorghum and corn
SOIL TYPES:	Light (85%); medium (15%)
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Typically, fumigated once in 3-4 years
OTHER RELEVANT FACTORS:	No other relevant factors were identified.

REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 7a, 7b, 8a, 8b (nurseries in: Alabama, Arkansas, Georgia, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia)											
RAINFALL[a] *(mm)*	125	128	155	135	91	100	141	118	76	52	87	131
OUTSIDE TEMP. *(℃)*	7.7	10.0	13.9	18.3	22.2	26.1	27.2	27.2	25.0	18.9	13.9	10.0
FUMIGATION SCHEDULE	1st year											
PLANTING SCHEDULE[b]		2nd 3rd 4th years										

[a]The rainfall and temperature data are for Alabama, which may be considered typical of the region.
[b]Fumigation generally occurs once in three or four years. According to this consortium, "The typical crop cycle would include a period of cover crop and fallow, nine to 24 months, after the second harvest (months 25-48). After the cover crop and/or fallow period, the area would be fumigated again and the crop cycle would continue."

REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Fumigation for conifer crops typically occurs once in a four-year cycle. Therefore, typically, two or three successive annual seedling crops are produced for each fumigation event. Alternatives may require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, which may increase the costs and environmental burden.

REGION A – SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1999	2000[a]	2001[a]	2002[a]	2003[a]	2004[a]
AREA TREATED *(hectares)*	656	656	656	656	656	656
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	not available	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	246,032	246,032	246,032	246,032	246,032	246,032
FORMULATIONS OF METHYL BROMIDE *(methyl bromide:chloropicrin)*	98:2	98:2	98:2	98:2	98:2	98:2
METHOD BY WHICH METHYL BROMIDE APPLIED)	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
APPLICATION RATE [ACTIVE INGREDIENT] (kg/ha*)	375	375	375	375	375	375
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)**	37.5	37.5	37.5	37.5	37.5	37.5

** For flat fumigation treatment application rate and dosage rate may be the same.*

[a]Data are based on a survey of consortium members in 2000. Consortium does not keep records of seedling production data but assumes that use rates and production information do not vary significantly from year to year.

REGION B - INTERNATIONAL PAPER - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

REGION B - INTERNATIONAL PAPER - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
International Paper	**Fungi**: *Rhizoctonia* (root rot);	For areas where pest pressure is high, MB allows two successive seedling crops with one fumigation treatment (one treatment every four years). Alternative treatments will require more frequent fumigation due to reduced efficacy until protocols are developed to improve efficacy.
	Weeds: *Cyperus esculentus/rotundus* (purple/yellow nutsedge)	

REGION B - INTERNATIONAL PAPER - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

REGION B – INTERNATIONAL PAPER - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	INTERNATIONAL PAPER
CROP TYPE:	Forest seedlings (all pine species) and some hardwoods
ANNUAL OR PERENNIAL CROP:	Typically grown for each of two years followed by two years of unfumigated cover crops before fumigation in the fourth year just before sowing the first seedling crop
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	None
SOIL TYPES:	Light, medium, heavy
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Fumigation once in four years
OTHER RELEVANT FACTORS:	No other relevant factors were identified.

REGION B – INTERNATIONAL PAPER - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 6b, 7a, 7b, 8a, 8b (Alabama, Arkansas, Georgia, South Carolina, Texas)											
RAINFALL *(mm)*	Not available, but varies with diverse climates											
OUTSIDE TEMP. *(℃)*	Not available, but varies with diverse climates											
FUMIGATION SCHEDULE								1st year				
PLANTING SCHEDULE[a]		2nd 3rd 4th years										

[a]Fumigation occurs once in four years for conifers after two or three crops are harvested.

REGION B - INTERNATIONAL PAPER - 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Fumigation for conifer crops typically occurs once in a four-year cycle. Therefore, typically, two or three successive annual seedling crops are produced for each fumigation event. Alternatives may require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, which may increase the costs and environmental burden. International Paper estimated in 2003 (Dr. George Lowerts, personal communication), that typically, a 10-day delay would be incurred with alternative treatments such as 1,3-D to avoid phytotoxic effects.

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

Region B - International Paper - 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)*	185	121	115	101	130	131
Ratio of flat fumigation methyl bromide use to strip/bed use if strip treatment is used	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation
Amount of methyl bromide active ingredient used	68,975	43,646	38,666	34,853	49942	50253
Formulations of methyl bromide *(methyl bromide:chloropicrin)*	98:2	98:2	98:2	98:2	98:2	98:2
Method by which methyl bromide applied	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
Application rate [Active Ingredient] (kg/ha*)	374	362	338	344	384	384
Actual dosage rate [active ingredient] *(g/m^2)* *****	37.4	36.2	33.8	34.4	38.4	38.4

** For flat fumigation treatment application rate and dosage rate may be the same.*

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
Illinois Department of Natural Resources	*Fusarium* spp.	Consistency in production for the variety of nursery plants grown in small public nursery.
	weeds	
	nematodes	

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	ILLINOIS DEPARTMENT OF NATURAL RESOURCES
CROP TYPE:	Hardwood seedlings (13 ha); shrubs (2 ha); prairie forbs (1 ha)
ANNUAL OR PERENNIAL CROP:	Typically grown for 1 or 2 years
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	None
SOIL TYPES:	Light
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Fumigation every year
OTHER RELEVANT FACTORS:	No other relevant factors were identified.

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 5b, 6b											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE						X						
PLANTING SCHEDULE								X				

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

For this small, public consortium, fumigation in the fall followed by planting is the most effective means of meeting production goals. Alternatives will require delays due to increased labor costs for hand weeding, and potential outgassing damage to already planted beds.

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - 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)*	17	16	13	16	15	15
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	4,370	4,211	3,411	4,232	3,869	3,869
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	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
APPLICATION RATE [ACTIVE INGREDIENT] (kg/ha*)	263	263	263	263	263	263
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)**	26.3	26.3	26.3	26.3	26.3	26.3

** For flat fumigation treatment application rate and dosage rate may be the same.*

REGION D - WEYERHAEUSER-SOUTH - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

REGION D - WEYERHAEUSER-SOUTH - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
WEYERHAEUSER-SOUTH	**Fungi**: *Fusarium, Pythium, Rhizoctonia*; **Weeds**: *Cyperus* (nutsedges)	Only #1 grade seedlings are sold; grade #2 and culls are discarded. To economically manage the range of pests (where infestation of fungal pathogens and nutsedges is severe), MB is necessary since no alternatives currently provide both reliable control and economic sustainability for #1 grade seedlings.

REGION D - WEYERHAEUSER-SOUTH - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

REGION D - WEYERHAEUSER-SOUTH - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	WEYERHAEUSER-SOUTH
CROP TYPE:	Primarily loblolly pine; some hardwood species
ANNUAL OR PERENNIAL CROP:	Typically grown for 1 year
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	None
SOIL TYPES:	Light (62%); Medium (22%)
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Fumigation once in four years (conifers)
OTHER RELEVANT FACTORS:	No other relevant factors were identified.

REGION D - WEYERHAEUSER-SOUTH - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA 7b, 8a (includes Alabama, Arkansas, North Carolina, and South Carolina)											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE								1st year				
PLANTING SCHEDULE[a]		2nd 3rd 4th years										

[a]Fumigation occurs once in four years, one year old conifer seedlings are harvested.

REGION D - WEYERHAEUSER-SOUTH - 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Fumigation for conifer crops typically occurs once in a four-year cycle. Therefore, typically, two or three successive annual seedling crops are produced for each fumigation event. Alternatives may require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, which may increase the costs and environmental burden.

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

REGION D - WEYERHAEUSER-SOUTH - 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)*	72	66	61	64	66	72 73
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(kg)*	29,649	21,516	21,709	24,231	26,079	29803
FORMULATIONS OF METHYL BROMIDE *(methyl bromide:chloropicrin)*	98:2	90:10	90:10	90:10	98:2	98:2
METHOD BY WHICH METHYL BROMIDE APPLIED)	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
APPLICATION RATE [ACTIVE INGREDIENT] **(kg/ha*)**	412	327	355	379	398	406
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m²)**	41.2	32.7	35.5	37.9	39.8	40.6

** For flat fumigation treatment application rate and dosage rate may be the same.*

REGION E - WEYERHAEUSER-WEST - PART B: CROP CHARACTERISTICS AND METHYL BROMIDE USE

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

REGION E - WEYERHAEUSER-WEST - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
Weyerhaeuser-West	**Fungi** [100% at times]: *Cylindrocarpon* (root rot); *Pythium* (damping-off, root rot), *Fusarium* (damping-off, root rot), *Phoma*, *Fusarium*, *Botrytis* (stem cankers); **Weeds**: *Cyperus* (yellow nutsedge) [100% at times]	Cylindrocarpon root rot is an increasingly important disease, with no registered chemicals. Applicant states that increased area reflects increased losses to the disease and necessity of continued production numbers. High pathogen populations and potential for contamination with *Phytophthora ramorum* (sudden oak death) leave little room for production variability.

REGION E - WEYERHAEUSER-WEST - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

REGION E - WEYERHAEUSER-WEST - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	WEYERHAEUSER-WEST
CROP TYPE:	Pine, Christmas trees, some hardwoods
ANNUAL OR PERENNIAL CROP:	Typically one year seedling bed, one year transplant bed; transplants can be grown for 2, 3, or 4 years
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	None
SOIL TYPES:	Light (60%), Medium (40%)
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Fumigation once in 3 years
OTHER RELEVANT FACTORS:	No other relevant factors were identified.

REGION E - WEYERHAEUSER-WEST - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 8a, 8b (includes Washington and western Oregon)											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE[a]						1st year						
PLANTING SCHEDULE		2nd 3rd										

[a]Typically fumigation occurs once in three years, one year old seedlings are harvested.

REGION E - WEYERHAEUSER-WEST - 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Fumigation occurs once in a three year cycle. Typically, two successive annual seedling crops are produced for each fumigation event. Alternatives may require more frequent fumigation (with 1,3-D + chloropicrin, for example) or a combination of treatments that could significantly increase the costs and environmental burden.

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

REGION E - WEYERHAEUSER-WEST - 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)*	43	70	65	70	76	95
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	11,360	17,864	17,125	14,647	16,935	19,122
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)*	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
APPLICATION RATE [ACTIVE INGREDIENT] (kg/ha*)	262	255	263	210	224	201
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)******	26.2	25.5	26.3	21.0	22.4	20.1

** For flat fumigation treatment application rate and dosage rate may be the same.*

Region F - Northeastern Forest & Conservation Nursery Association - Part B: Crop Characteristics and Methyl Bromide Use

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - 10. KEY DISEASES AND WEEDS FOR WHICH METHYL BROMIDE IS REQUESTED AND SPECIFIC REASONS FOR THIS REQUEST

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - TABLE 10.1: KEY DISEASES AND WEEDS AND REASON FOR METHYL BROMIDE REQUEST

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
Northeastern Forest & Conservation Nursery Association	**Fungi**: *Phytophthora* (damping-off, root rot) [80%], *Fusarium* (damping-off, root rot) [80%], *Cylindrocladium* [50%];	In humid, warm conditions damping-off is a significant problem; as with much of industry, weed problems, especially nutsedge and Canada thistle, are difficult to manage without MB.
	Weeds: *Cyperus* (yellow nutsedge) [40%], *Cirsium* (Canada thistle) [70%]	

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - 11. (*i*) CHARACTERISTICS OF CROPPING SYSTEM AND CLIMATE

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	NORTHEASTERN FOREST AND CONSERVATION NURSERY ASSOCIATION
CROP TYPE:	Conifers (10-15 spp.)= 1-yr, 8%; 2-yr, 4%; 3-yr, 14%; hardwoods (30-50 spp.)= 1-yr, 55%; 2-yr, 9%; shrubs and forbs (>75 spp.)= 10%
ANNUAL OR PERENNIAL CROP:	Bareroot cuttings, and transplants, typically grown 1-3 years
TYPICAL CROP ROTATION AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:	None
SOIL TYPES:	Light, Medium
FREQUENCY OF METHYL BROMIDE FUMIGATION:	Fumigation minimum, once in two years; depending on species, can be once in two to four years
OTHER RELEVANT FACTORS:	No other relevant factors were identified.

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

	MAR	APR	MAY	JUN	JUL	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 3a, 4b, 5a, 5b, 6a, 6b, 7a (includes state-owned nurseries in Illinois, Indiana, Kentucky, Maryland, Missouri, New Jersey, Ohio, Pennsylvania, West Virginia, and Wisconsin)											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE[a]							X					
PLANTING SCHEDULE[a]	X	X	X					X	X	X		

[a]Due to the large number of species and wide geographical area represented in this consortium, seedlings can be

planted at various times in the fall or spring. Generally, fumigation occurs once in two or three years, but beds for certain hardwood species may be treated every year.

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - 11. (*ii*) INDICATE IF ANY OF THE ABOVE CHARACTERISTICS IN 11. (*i*) PREVENT THE UPTAKE OF ANY RELEVANT ALTERNATIVES?

Fumigation occurs once in a two to three year cycle. Numerous species are grown by nurseries in this consortium, but typically, two successive annual seedling crops are produced for each fumigation event. Until effective combination treatments can be devised, alternatives (e.g., dazomet) may require application to each crop, or application of several different treatments, which could increase significantly the costs and environmental burden.

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - 12. HISTORIC PATTERN OF USE OF METHYL BROMIDE, AND/OR MIXTURES CONTAINING METHYL BROMIDE, FOR WHICH AN EXEMPTION IS REQUESTED

Variation in MB use is due to changes in products, and may be determined by market demand and/or availability of seed. Changes in product will affect area planted (and therefore treated). For example, hardwoods are grown at densities of 65-130 seedlings/m^2, while conifer seedlings are grown at densities of 215-320 seedlings/m^2. Changes in the proportion of hardwood and pine seedlings, therefore, will affect the area requiring fumigation.

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - 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)*	91	87	80	72	87	78
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	31,961	28,308	26,844	26,273	30,798	29,027
FORMULATIONS OF METHYL BROMIDE *(methyl bromide:chloropicrin)*	98:2	98:2	98:2	98:2	98:2	98:2
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
APPLICATION RATE [ACTIVE INGREDIENT] (kg/ha*)	352	326	337	363	359	372
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)******	35.2	32.6	33.7	36.3	35.9	37.2

** For flat fumigation treatment application rate and dosage rate may be the same.*

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

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

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

REGION WHERE METHYL BROMIDE USE IS REQUESTED	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED
Michigan Seedling Association	Primarily annual and perennial weeds (e.g., nutsedge, Canada thistle); also, fungal pathogens; nematodes	Nutsedge (50% of area), common groundsel (95% of area), hairy bittercress (60% of area), Canada thistle (25% of area), and mugwort (20% of area); Soil-borne diseases are also of concern; dazomet and metam-sodium are not reliable in this region because of cooler soil temperatures.

Region G - Michigan Seedling Association - 11. (*i*) Characteristics of Cropping System and Climate

Region G - Michigan Seedling Association - Table 11.1: Characteristics of Cropping System

Characteristics	Michigan Seedling Association
Crop Type:	Conifers, hardwoods
Annual or Perennial Crop:	Conifers: bareroot and transplants, typically 1, 2, or 3 years growth; Hardwood: 1-year (80%) and 2-year (20%)
Typical Crop Rotation and use of methyl bromide for other crops in the rotation:	Crop grown on half the area. Land not in production are left fallow for 1-2 years, and planted with rye in Oct-Nov and Sudex in March-April.
Soil Types:	Light
Frequency of methyl bromide Fumigation:	Fumigation every year on land in production (approximately half the land). Therefore, an average area of nursery is fumigated once in two years.
Other relevant factors:	No other relevant factors were identified.

Region G - Michigan Seedling Association - Table 11.2 Characteristics of Climate and Crop Schedule

	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb
Climatic Zone	USDA zones 4b, 5a, 5b											
Rainfall *(mm)*	Not available											
Outside Temp. *(℃)*	Not available											
Fumigation Schedule[a]			(sometimes) Spring			(usually) Fall	(usually) Fall					
Planting Schedule			for conifers, after Fall fumigation					for hardwoods, after Fall fumigation				

[a]Fumigation schedules depend on growth as annual seedlings or additional bed requirements as transplants. Generally, fumigation occurs each year on the production land (half of the total nursery land)—therefore a particular parcel of land will receive fumigation once in two years.

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

Michigan Seedling Association working with Michigan State University is in the midst of conducting research (with grants from USDA MB Alternatives program) to assess the efficacy of alternatives with an economic survey conducted to define costs associated with alternatives. Results of this research that will be available in 2006-2007, should help identify true alternatives to MB. Feasible alternatives should be identified and available by 2007-2008 growing season, according to the requesting consortium. Until this time, MB is critical for the continuation of this industry. The consortium has stated that growers have been transitioning to use of 1,3-D for pest problems that can be effectively managed by this treatment. Tarp studies and studies of various herbicides are being conducted and hold promise to manage key weed problems.

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

REGION G - MICHIGAN SEEDLING ASSOCIATION - 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)*	46	51	34	35	26	26
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation	flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	13,825	9,144	9689	9493	9420	9420
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)*	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
APPLICATION RATE [ACTIVE INGREDIENT] **(kg/ha*)**	302	178	285	270	364	364
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m²)**	30.2	17.8	28.5	27.0	36.4	36.4

** For flat fumigation treatment application rate and dosage rate may be the same.*

PART C: TECHNICAL VALIDATION

13. REASON FOR ALTERNATIVES NOT BEING FEASIBLE

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: *ALSO, SEE SECTION 14 FOR ADDITIONAL CHEMICALS NOT LISTED BY MBTOC.*		
Dazomet (400 kg/ha)	Inconsistent results with weeds, especially w/moderate to high weed pressure. Does not consistently provide acceptable levels of nutsedge control, nor does it manage some diseases associated with fungal pathogens (root rot and damping-off pathogens). Most effective use will probably be incorporated with other methods, but protocols must be developed (Fraedrich and Dwinell, 2003b). Field trials show that seedling size (diameter and height) and root volume were inconsistent, non-uniform, and reduced with dazomet, leading to higher counts of Grade #2 seedlings and culls compared to greater numbers of Grade #1 seedlings with MB. Reduced efficacy requires production cycle compensation by increasing the frequency of fumigation or lengthening the fallow period in order to obtain better control of weeds and other pests. These strategies result in reduced seedling production. Damage to seedlings growing adjacent to beds being fumigated with dazomet has resulted in significant loss of seedlings due to fumigant drift. Soil temperature requirements (above 6° C/ optimal 12-18° C) of dazomet, due to vapor pressure properties, constrains use in some areas (north and west) (Landis and Campbell, 1989); (Fraedrich and Dwinell, 2003b; Campbell and Kelpsas, 1988; Carey, 1996; Carey, 1994; Enebak et al., 1990; Weyerhaeuser, #3, 1984-87; Weyerhaeuser, #4, 1985-87; Weyerhaeuser, #6, 1992; Weyerhaeuser, #7, 1994-96; Weyerhaeuser, #8, 1992-95; Weyerhaeuser, #9, 1994-95; Weyerhaeuser, #10, 1994-96)	No

Name of Alternative	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Metam-sodium (485 kg/ha)	Inconsistent results with weeds, especially w/high weed pressure. Average yield losses are estimated to be approximately 5% with metam-sodium, although the addition of other pesticides to provide broader control could reduce losses. As with dazomet, reduced efficacy requires production cycle compensation by increasing the frequency of fumigation or lengthening the fallow period in order to obtain better control of weeds and other pests. These strategies result in reduced seedling production. As with dazomet, seedling quality is inconsistent resulting in less predictable seedling production factors. Damage to seedlings growing adjacent to beds being fumigated with metam-sodium has resulted in significant loss of seedlings due to fumigant drift. Fumigant drift may result in issues related to human safety and legal liability. Soil temperature requirements (above 4° C) of metam-sodium, due to vapor pressure properties, can constrain use in some areas (north and west) (Landis and Campbell, 1989); (Campbell and Kelpsas, 1988; Carey, 1996; Carey, 1994, Darrow, 2002; Weyerhaeuser, #4, 1985-87; Weyerhaeuser, #6, 1992)	No
NON CHEMICAL ALTERNATIVES		
Containerized production	Containerization of nursery production would (1) require a large capital investment by all participants in the sector, (2) increase seedling production costs by 300 to 600%, (3) reduce reforestation rates as public nurseries opt out of reforestation as expenditures go up. (see Section 18 and Appendix B.). Some nurseries with specialized markets have a portion of their production in containers (Barnett and McGilvrary, 1997; Darrow, 2002; Lowerts, 2003).	For seedling production goals, is not cost effective for the complex production system. [see Section 18 and Appendix B.]
Virtually Impermeable Film (VIF)	Current technology does not allow the gluing together of overlapping sheets and therefore makes this product non-functional for flat fumigation treatments, and currently available products are relatively weak and torn by wind or pressure. However, manufacturers believe problems can be resolved (Rimini and Wigley, 2004). Both factors combine to make VIF film impractical using current technology. In the future, VIF might have a role in reducing MB use rates while maintaining efficacy, due to reduced emissions. Ongoing studies may help assess value of VIF with MB and chemical alternatives. (Carey and Godbehere, 2004; Guillino et al., 2002; Martin, 2003).	Not currently cost effective; not allowed in California

Name of Alternative	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Solarization	Not able to generate acceptable heat to allow spring planting; most effective time for solarization is not compatible with timing for production; uses solar radiation to heat soil under clear plastic, and under certain conditions in some locations in the summer, soil can be heated to as high as 60 C to a depth of 7.5 cm. Effective solarization would likely require several months of covered bed treatments, to heat soil to a sufficient depth (25-30 cm) in order to affect soil-borne pathogens. Seeds of some weed species are resistant even to higher temperatures obtained with solarization. Nutsedges, *Fusarium* spp., *Macrophomina* spp. are not controlled, or unpredictably controlled, by solarization (Elmore et al., 1997). Therefore, this alternative is not considered technically feasible. Conceivably, solarization could be optimized for efficacy and incorporated into an integrated pest management (IPM) program that would help reduce chemical use for bed preparation, but because of intensive scheduling of seedling production, solarization is inadequate as a sole replacement for MB in the forest seedling industry even in the southern U. S. (Weyerhaeuser, #8, 1992-95)	Not cost effective as drop-in replacement
Biofumigation	This is a process where mustard species (*Brassica* spp.) are grown and ultimately disked into soils. A bioactive breakdown product of some of these species is MITC. However, this alternative is not considered feasible due to the difficulty in obtaining sufficient biomass to produce effective amounts of MITC to manage diseases and weeds under nursery conditions. 11,500 kg per ha of *Brassica* plants—an amount that is considered very high production—is equivalent to approximately 25 kg dazomet, an amount significantly less than effective fumigation rates. In addition, increased *Fusarium* populations due to favorable conditions provided by *Brassica* plants have been reported to increase seedling diseases after biofumigation treatments. While some Petri dish studies (e.g., Charron and Sams) have indicated a reduction in growth of some fungal pathogens limited field studies have been conducted to verify effects.	Not able to provide sufficient biomass
Flooding/Water management	Nursery beds generally are designed and graded for good drainage to prevent standing water. Flooding could increase incidence of *Phytophthora* and *Pythium*, which cause important damping-off and root rot diseases. Therefore, this alternative is not considered technically feasible.	No
General Integrated Pest Management (IPM)	Nurseries currently use IPM techniques, but these measures do not provide adequate weed and disease control. Therefore, this alternative is not considered technically feasible.	Not as drop-in replacement

Name of Alternative	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
Plowing/Tillage	Nursery beds, especially medium type soils with higher clay or organic matter than light soil beds, are susceptible to damage to soil structure and development of an impermeable "plow pan" layer. Increased plowing can result in less productive seedling beds, therefore, this alternative is not considered feasible.	No
Physical Removal/ Sanitation	Appropriate sanitation practices are already followed by nurseries, as this improves productivity. Weed control by mechanical means would not be technically feasible for large-scale nursery seedling production.	No
Organic Amendments/ Compost	Not acceptably effective alone in weed management; often cover crops are already used for beds not in current production, as part of general IPM program; can be issue with weed introduction by plant-based mulches (James et al., 1997; James et al., 2001; Stone et al., 1998). Most nurseries employ various soil amendments to enhance seedling growth and quality, but these measures do not provide adequate weed and disease control, therefore, this alternative is not considered feasible.	No
COMBINATIONS OF ALTERNATIVES **See *Section 14 for non-MBTOC alternatives***		

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

14. List and Discuss Why Registered *(and Potential)* Pesticides and Herbicides Are Considered Not Effective as Technical Alternatives to Methyl Bromide:

Chloropicrin and 1,3-D were not listed as one of the MB alternatives by MBTOC. These have been investigated by the industry as potential alternatives, and in certain circumstances (e.g., low weed pressure), can be effective in reducing weed, fungi and nematode populations.

Table 14.1: Technically Infeasible Alternatives Discussion

Name of Alternative	Discussion
Chloropicrin (340 kg/ha)	A good fungicide, but not acceptably effective with moderate or high weed pressure, some reports of enhanced weed seed germination (Carey, 2000; Carey, 1996; Enebak et al., 1990; Weyerhaeuser, #7, 1994-96; Weyerhaeuser, #10, 1994-96). Weed pressure will likely increase overtime.
Metam-sodium (485 kg/ha) + chloropicrin (115 kg/ha)	Can be effective against weeds and fungi, especially with low to moderate pressure and light soils (Carey, 2000; Carey, 1996; Carey, 1994; Weyerhaeuser, #10, 1994-96). There is a history of outgassing problems and significant seedling damage.
1,3-D (260 kg/ha) + chloropicrin (140 kg/ha)	A good nematicide, requires light soils with optimal moisture content. Not sufficiently effective against weeds, especially with even moderate weed pressure; may have legal restrictions on use (Carey, 1996; Carey, 1994; Weyerhaeuser, #7, 1994-96; Weyerhaeuser, #10, 1994-96)
Herbicides	Research will help to identify herbicides (e.g., glyphosate) that can effectively reduce high populations of nutsedge with consistent and reliable activity, most likely as part of an integrated program of alternatives (e.g., Fraedrich and Dwinell, 2003c).

15. List Present *(and Possible Future)* Registration Status of Any Current and Potential Alternatives:

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:
Sodium Azide	Not registered in U. S. No registration package has been received.	No	Unknown
Propargyl bromide	Not registered in U. S. No registration package has been received.	No	Unknown
Iodomethane	Not registered in U. S.	Yes	Unknown
Muscador albus Strain QST 20799	Registration package has been received.	Yes	Registered but not yet for sale in the U.S.

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.

16.1.A: Effectiveness of Alternatives – Weeds

Research Results for Weed Management with Methyl Bromide (MB) and/or Alternatives							
Treatment	**# Trials**	**Yield**	**Quality**	**Relative Quality**	**Weed Severity**	**Weed Incidence**	**Citation**
[Chem. trts w/tarp] [1] Control (no fumigation) [2] Chloropicrin (340 kg/ha) [3] Chloropicrin (340 kg/ha) + metam sodium (320 kg/ha)	1 (W/ Loblolly pine)	Average Total Yield (per m^2) [1] 193b [2] 236a [3] 236a	Average Grade #1 Yield (per m^2) [1] 6b [2] 19ab [3] 45a	Quality (% Grade #1 compared to total) [1] 3% [2] 8% [3] 19%	(# Nutsedge rhizomes per m^2) [1] 91a [2] 43b [3] 5b	No MB trt	Carey, 2000
[Chem. trts w/tarp] [1] Control (no fumigation) [2] Chloropicrin (285 kg/ha) [3] Chloropicrin (285 kg/ha) + metam sodium (240 kg/ha)	1 (W/ Loblolly pine)	Average Total Yield (per m^2) [1] 150b [2] 214ab [3] 246a	Average Grade #1 Yield (per m^2) [1] 8b [2] 15ab [3] 53a	Quality (% Grade #1 compared to total) [1] 5% [2] 7% [3] 22%	(Nutsedge dry wt, kg/ha) [1] 551a [2] 40b [3] 11b	No MB trt	Carey, 2000
[Chem. trts w/tarp] [1] Control (no fumigation) [2] Chloropicrin (340 kg/ha) [3] Chloropicrin (340 kg/ha) + metam sodium (320 kg/ha) [4] MB (385 kg/ha) + Pic (8 kg/ha)	1 (W/ Loblolly pine)	Average Total Yield (per m^2) [1] 150b [2] 193a [3] 204a [4] 204a	Average Grade #1 Yield (per m^2) [1] 27b [2] 114ab [3] 150a [4] 131a	Quality (% Grade #1 compared to total) [1] 18% [2] 59% [3] 74% [4] 64%	Not reported	Not reported	Carey, 2000
[Chem. trts w/tarp] [1] Control (no fumigation) [2] Chloropicrin (340 kg/ha) [3] Chloropicrin (340 kg/ha) + metam sodium (320 kg/ha) [4] MB (385 kg/ha) + Pic (8 kg/ha)	1 (W/ Slash pine)	Average Total Yield (per m^2) [1] 107a [2] 150a [3] 150a [4] 129a	Average Grade #1 Yield (per m^2) [1] 63b [2] 109ab [3] 136a [4] 109ab	Quality (% Grade #1 compared to total) [1] 59% [2] 73% [3] 91% [4] 84%	Not reported	Not reported	Carey, 2000
"Heavy" soil (57% silt, 14% clay, 29% sand) [Chem. trts w/tarp] [1] Control (no fumigation) [2] Chloropicrin (285 kg/ha) [3] Metam sodium (455 kg/ha) [4] Chloropicrin (130 kg/ha) + metam sodium (455 kg/ha) [5] 1,3-D (240 kg/ha) + Pic (100 kg/ha) [6] Dazomet (285 kg/ha) [7] MB (265 kg/ha)+Pic(130kg/ha)	1 (w/ Loblolly pine	Average Total Yield (per m^2) [1] 194 [2] 181 [3] 204 [4] 192 [5] 238 [6] 214 [7] 188 [LSD, 0.05=20]	Average Grade #1 Yield (per m^2) [1] 41 [2] 31 [3] 35 [4] 31 [5] 28 [6] 25 [7] 23 [LSD, 0.05=40]	Quality (% Grade #1 compared to total) [1] 21% [2] 17% [3] 17% [4] 16% [5] 12% [6] 12% [7] 12%	(# Total weeds/ m^2; 53 days after treatment) [1] 37 [2] 16 [3] 25 [4] 7 [5] 12 [6] 12 [7] 6 [LSD, 0.05=14]	(% Coverage of weeds per plot (30 m^2); 53 days after treatment) [1] 39%a [2] 14%bc [3] 25%ab [4] 11%bc [5] 21%bc [6] 22%bc [7] 6%c	Carey, 1996

Research Results for Weed Management with Methyl Bromide (MB) and/or Alternatives							
Treatment	**# Trials**	**Yield**	**Quality**	**Relative Quality**	**Weed Severity**	**Weed Incidence**	**Citation**
[Chem. trts w/tarp] [1] Control (no fumigation) [2] 1,3-D (240 kg/ha) + chloropicrin (100 kg/ha) [3] Metam sodium (455 kg/ha) [4] Chloropicrin (130 kg/ha) + metam sodium (455 kg/ha) [5] Dazomet (340 kg/ha) [6] Dazomet (170 kg/ha) +Pic (130kg/ha) [7] MB (265 kg/ha)+Pic(130kg/ha)	Not reported	Not reported	Not reported	Not reported	(# *Nutsedge* /m^2; 7 months after treatment) [1] 85abc [2] 5c [3] 27bc [4] 15bc [5] 98abc [6] 127abc [7] 1c [LSD, 0.05=38]	(% Coverage of *weeds* per plot (175 m^2)7 months after treatment) [1] 100%a [2] 35%c [3] 36%c [4] 38%c [5] 95%a [6] 46%c [7] 29%c [LSD, 0.05=16]	Carey, 1994
[1] Metam-sodium (485 kg/ha) [2] MB (235 kg/ha) + chloropicrin (115 kg/ha) [spring trt] [3] MB (235 kg/ha) + chloropicrin (115 kg/ha) [fall trt]	1 (1st year Ponderosa pine)	Average Total Yield (per m^2) [1] 245/m^2 [2] 221/m^2 [3] 208/m^2	Not reported	Not reported	Not reported	Not reported	Weyer-haeuser #2, 1980
[1] MB (235 kg/ha) + chloropicrin (115 kg/ha) [2] Metam-sodium (485 kg/ha) [3] Dazomet (400 kg/ha)	1 (2nd year crop Douglas fir)	(# Of packable seedlings relative to MB trt) [2] –54/m^2 [3] –5/m^2	Loss (based on 480 seedlings/m^2 w/MB): [2] 11% [3] 1%	Consortium (CUE 03-0021) Comment: "Height, caliper, shoot weight were greater w/ MBC treated soil"	Not reported	Not reported	Weyer-haeuser #4, 1985-1987
[1] MB (235 kg/ha) + chloropicrin (115 kg/ha) [2] Dazomet (285 kg/ha) [3] Dazomet (400 kg/ha) [4] Control	1 (2nd year crop w/ Douglas fir)	(# Of packable seedlings relative to MB trt) [2] –88/m^2 [3] –13/m^2 [4] –75/m^2	Loss (based on 480 seedlings/m^2 w/MB): [2] 18% [3] 3% [4] 16%	Consortium (CUE 03-0021) Comment: "Seedling size not significantly different between MBC and dazomet at 285 kg/ha; size reduced w/ dazomet at 400 kg/ha (toxicity?")	Not reported	Not reported	Weyer-haeuser #5, 1985-1987

Research Results for Weed Management with Methyl Bromide (MB) and/or Alternatives							
Treatment	**# Trials**	**Yield**	**Quality**	**Relative Quality**	**Weed Severity**	**Weed Incidence**	**Citation**
[1] MB (400 kg/ha) + chloropicrin (10 kg/ha) [2] Metam sodium (485 kg/ha) [3] Dazomet (400 kg/ha) [4] Control	1 (1st year crop w/ loblolly pine)	(# Of packable seedlings relative to MB trt) [2] –27/m^2 [3] –13/m^2 [4] –27/m^2	Loss (based on 480 seedlings/m^2 w/MB): [2] 6% [3] 3% [4] 6%	Consortium (CUE 03-0021) Comment: "Seedling height averaged 5 cm shorter for dazomet and 10 cm shorter for metam sodium and control." "Caliper (diameter) was reduced by 1 mm in metam sodium and control seedlings."	Not reported	Not reported	Weyer-haeuser #6, 1992
[1] MB (390 kg/ha) + chloropicrin (8 kg/ha) [tarped] [2] MB (300 kg/ha) + chloropicrin (100 kg/ha)) [tarped] [3] Dazomet (400 kg/ha) [tarped] [4] Dazomet (400 kg/ha) [un-tarped] [5] Pic-chlor (400 kg/ha) [tarped] [6] Chloropicrin (340 kg/ha) [tarped] [7] Control	1 (1st and 2nd year crops w/loblolly pine)	(# Of packable seedlings relative to MB trt) **1st year crop:** [1] =[2] [3] –64/m^2 [4] –99/m^2 [5] +11/m^2 [6] +19/m^2 [7] –88/m^2 **2nd year crop:** [1] =[2] [3] –83/m^2 [4] –59/m^2 [5] –59/m^2 [6] –19/m^2 [7] Not reported	Loss (based on 480 seedlings/m^2 w/MB): **1st year crop:** [1] =[2] [3] 13% [4] 21% [5] 2% gain [6] 4% gain [7] 18% **2nd year crop:** [1] =[2] [3] 17% [4] 12% [5] 12% [6] 4% [7] Not reported	Consortium (CUE 03-0021) Comment: [1st year crop reduction with dazomet due to stunting, and reduced root volume] [2nd year crop yield reduction due to stunting, and reduced root volume]	Not reported	Not reported	Weyer-haeuser #7, 1994-1996
[1] MB (390 kg/ha) + chloropicrin (8 kg/ha) [tarped] [2] Dazomet (400 kg/ha) [tarped] [3] Dazomet (400 kg/ha) [tarped & solarized 3 mo.] [4] Solarization [tarped, solar. 3 mo] [5] Control	1 (1st and 2nd year crops w/loblolly pine) (bare fallow from harvest Feb., 1992 through fumigation and tarp (3 mo.) summer 1992	(# Of packable seedlings relative to MB trt) **1st year crop:** [2] –8/m^2 [3] –5/m^2 [4] –11/m^2 [5] = [1] **2nd year crop:** [2] –8/m^2 [3] –5/m^2 [4] –11/m^2 [5] +19/m^2	Loss (based on 480 seedlings/m^2 w/MB): **1st year crop:** [2] 2% [3] 1% [4] 2% [5] no loss **2nd year crop:** [2] 2% [3] 1% [4] 2% [5] 4% gain	[# weeds/m^2 May, 1993; dominant species: *Amaranthaceae* spp., *Mollugo verticillata, Euphorbia supine*] [1] 31b [2] 25b [3] 35b [4] 54ab [5] 104a	[# weeds/m^2 June, 1993; dominant species: *Euphorbia supine, Digitaria ciliaris, Digitaria ischaemun*] [1] 13b [2] 10b [3] 17b [4] 28a [5] 36a	Not reported	Weyer-haeuser #8, 1992-1995

Research Results for Weed Management with Methyl Bromide (MB) and/or Alternatives							
Treatment	**# Trials**	**Yield**	**Quality**	**Relative Quality**	**Weed Severity**	**Weed Incidence**	**Citation**
[1] MB (400 kg/ha) + chloropicrin (8 kg/ha) [tarped] [2] Dazomet (400 kg/ha) [tarped] [3] Dazomet (400 kg/ha) [un-tarped] [4] Control	1 (1st year crop w/loblolly pine)	(# Of packable seedlings relative to MB trt) [2] –19/m^2 [3] –35/m^2 [4] –5/m^2	Loss (based on 480 seedlings/m^2 w/MB): [2] 4% [3] 7% [4] 1%	Consortium (CUE 03-0021)Comment: Short trees and poor root structure were main cull factors	Not reported	Not reported	Weyer-haeuser #9, 1994-1995
[1] MB (400 kg/ha) + chloropicrin (8 kg/ha) [2] 1,3-D (260 kg/ha) + chloropicrin (140 kg/ha) [3] Chloropicrin (130 kg/ha) + metam sodium (240 kg/ha) [tarped] [4] Dazomet (400 kg/ha)[tarped] [5] Dazomet (400 kg/ha)[untarped] [6] Chloropicrin (340 kg/ha) [tarped] [7] Control	1 (1st and 2nd year crops w/loblolly pine)	(# Of packable seedlings relative to MB trt [1]) **1st year crop:** [2] –40/m^2 [3] –8/m^2 [4] +3/m^2 [5] –29/m^2 [6] –13/m^2 [7] –46/m^2 **2nd year crop:** [2] –3/m^2 [3] –3/m^2 [4] +3/m^2 [5] Not reported [6] +3/m^2 [7] Not reported	Loss (based on 480 seedlings/m^2 w/MB): **1st year crop:** [2] 8% [3] 2% [4] no loss [5] 6% [6] 3% [7] 10% **2nd year crop:** [2] No loss [3] No loss [4] No loss [5] Not reported [6] No loss [7] Not reported	**1st year crop:** Culls were short with small diameters **2nd year crop:** Study was suspended due to high nutsedge populations	Not reported	Not reported	Weyer-haeuser #10, 1994-1996

TABLE 16.1.B: EFFECTIVENESS OF ALTERNATIVES – DISEASE

Research Results for Disease (*Fusarium, Pythium, Rhizoctonia*) Management with Methyl Bromide (MB) and/or Alternatives								
Treatment	**# Trials**	**Yield**	**Percent Survival**	**Average Yield Post Emergence (per m^2)**	Percent Healthy Root Tips (1 year old seedlings)	**Stand density, seedlings/m^2 (fumigation Sept. 1986, seeding Oct., 1986)**		**Citation Number**
						May 1987	**Sept 1987**	
[1] Control (no fumigation) [2] Chloropicrin (196 kg/ha) [3] MB (392 kg/ha] [4] MB (263 kg/ha) + chloropicrin (65 kg/ha) [5] MB (130 kg/ha) + chloropicrin (131 kg/ha) [6] Dazomet (280 kg/ha) [7] Captan (6 kg/ha) [soil drench] [8] Thiram (38 g/kg seed) [seed trt.] [9] Captan (6 kg/ha) [soil drench] + thiram (38 g/kg seed) [seed trt.] [10] Silica sand (overlay seeds)	6 reps (w/white pine in WI)	[Yield per m^2 at seedling emergence, based on survival from damping-off diseases, calculated rate of 720 seedlings/ m^2 at seeding rate of 14 g seed/ m^2] [1] 496b [2] 550a [3] 570a [4] 566a [5] 564a [6] 522ab [7] 474b [8] 404c [9] 408c [10] 366c	Percent survival from damping-off at seedling emergence [1] 69%ab [2] 76%a [3] 79%a [4] 79%a [5] 78%a [6] 73%a [7] 66%ab [8] 57%c [9] 57%c [10] 51%c	[Yield per m^2 after seedling emergence based on survival from damping-off diseases at cotyledon or primary needle stage] [1] 592d [2] 702a [3] 694ab [4] 710a [5] 682abc [6] 686ab [7] 580d [8] 646c [9] 670abc [10] 662bc	[1] 20%c [2] 55%ab [3] 68%a [4] 72%a [5] 76%a [6] 31%bc [7] 8%c [8] 18%c [9] 16%c [10] 38%bc	[1] 464 [2] 464 [3] 464 [4] 464 [5] 464 [6] 464 [7] 320 [8] 360 [9] 360 [10] 320	[1] 110 [2] 464 [3] 464 [4] 464 [5] 464 [6] 250 [7] 106 [8] 106 [9] 106 [10] 80	Enebak et al., 1990
[1] Control (no fumigation) [2] MB (266 kg/ha) + chloropicrin (130 kg/ha) [3] Metam sodium (485 kg/ha) [4] Dazomet (400 kg/ha)	4 reps (w/ pon-derosa pine in Pacific NW)	[% Mortality due to *Pythium*, and *Fusarium*, during 1st growing season] [1] 25%a [2] 12%b [3] 8%b [4] 10%b	[# Of seedlings after 1st growing season] (per m^2) [1] 150a [2] 300b [3] 343b [4] 300b					Campbell and Kelpsas, 1988
[1] Control (no fumigation) [2] MB (266 kg/ha) + chloropicrin (130 kg/ha) [3] MB (580 kg/ha) + chloropicrin (285 kg/ha) [4] Dazomet (400 kg/ha)	1 (with Douglas fir)	**1st crop year**: Seedlings/m^2 [1] 429 [2] 482 [3] 455 [4] 469						Weyer-haeuser #3, 1984-1987

TABLE C.1: ALTERNATIVES YIELD[a] LOSS DATA SUMMARY

ALTERNATIVE	LIST TYPE OF PEST	RANGE OF YIELD LOSS (COMPARED TO MB)	BEST ESTIMATE OF YIELD LOSS
Chloropicrin	Fungi	+3% to –13%	5% loss
Metam-sodium	Weeds	+3% to –13%	5% loss
Dazomet	Weeds	+3% to –13%	5% loss
1,3-D	Nematodes, Weeds	+3% to –13%	5% loss
Metam-sodium + chloropicrin	Weeds, Fungi	+5% to –8%	0-3% loss
1,3-D + chloropicrin	Nematodes, Weeds, Fungi	+5% to –8%	0-3% loss
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			3-5%

[a]Yield loss estimates for the forest nursery sector do not adequately address the greater effect of seedling quality for forest plantings. Forests planted with undersized seedlings will have reduced survival and slowed growth if initial seedling health is compromised. No alternatives have been sufficiently tested to currently be substituted for MB.

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

According to one applicant (CUE 05-0007), "an IPM system using true fallow, pathogen resistant cover crops, increased supplemental organic matter applications, increased herbicide and insecticide use, and annual chloropicrin and Telone fumigation for bareroot pine production" are the likely alternatives that could replace MB. Combinations of chemicals, such as chloropicrin, metam-sodium, or 1,3-D appear to be effective for some nurseries in reducing pest infestations, including some weed problems (e.g., Carey, 2000; Carey, 1996; Carey, 1994; Weyerhaeuser, #8, 1992-95; Weyerhaeuser, #10, 1994-96). Combinations of these compounds and application techniques (such as deep injection) to achieve the same pest control efficiencies as MB are being studied along with integrating non-chemical treatments, such as bed-fallow or cover crops. So far, none have proven cost effective and have generally resulted in an increased input of pesticides. Because of their physical limitations (e.g., low vapor pressure of metam-sodium), these products are frequently not used by nursery managers due to their lack of consistency. Conclusions based on individual research trials may be skewed since large-scale production may result in greater differences between treatments due to scale-up and different pest pressure. In addition, economic issues may have an impact on overall acceptability of these alternatives for the forest seedling nursery sector. Tests are being conducted with methyl iodide, which has potential as a MB replacement, although it is unknown when, or if, registration might occur.

As MBTOC has stated in questions to the U.S. in summer, 2005, the use of metam without tarping is not feasible due to crop injury and worker exposure issues. It might appear appropriate, then, to tarp the material to prevent out-gassing problems. However, the application of metam followed by chloropicrin under flat-tarping, considering the large number of hectares treated each year, is not practical or cost effective, and currently, not technically feasible (personal communication, International Paper [Region B]; Southern Forest Nursery Management Cooperative [Region A]). A three-step process would be required, first application of metam, then chloropicrin, and finally, application of the tarp. Incorporation of metam using a rotovator is an extremely slow process, and the area to be treated within a given treatment window (determined by weather: temperature, moisture, wind) is limited. This window of application is generally 4-6 weeks, and even under the best application methods, this treatment takes four times as long to apply as the typical MB treatment. Therefore, to treat the necessary hectares each year would require a four-fold increase in labor and additional available equipment in order to apply metam, chloropicrin and cover with tarp. According to the label, and depending on soil and weather conditions, there would be a two to six week delay before planting after application of metam, chloropicrin and tarp-covering. This would affect market production costs.

The equipment needed to treat the area in spring and fall would not be available without the purchase of four additional applicator units and would greatly increase the cost to growers, as would the "set-up" time for the treatment with additional machinery. In order for tarps to be placed on the treated metam areas, workers must return into the treated area to lay down tarps after chloropicrin has been injected into the soil. In this case, out-gassing occurs, and workers must wear personal protection equipment that is not practical given the temperatures that normally occur at the time of application. Nursery growers of these regions are currently using high density films to decrease emissions of MB, but have found that for current production VIF is not an option due to excessive costs and technical difficulties of gluing during application. Nursery members of the Southern Forest Nursery Cooperative, among others, are experimenting with VIF, but are not able to adopt this technology for the 2008 season.

The use of virtually impermeable film (VIF) may offer a means of reducing MB use rates while maintaining efficacy and production goals (Carey and Godbehere, 2004). However, in the U.S. availability of VIF is limited and nursery applicators do not currently have experience laying this material. Research is being conducted to determine if this type of film is feasible in the U. S. (e.g., does it hold up physically in field conditions? can it be glued to acceptable specifications?, is the cost acceptable?). VIF manufacturers believe that technical problems will be solved (Rimini and Wigley, 2004). However, the efficacy of VIF for U. S. agriculture may be different than that for Europe (Federal Register, 1998); California does not permit the use of VIF and costs are higher in the U.S. due to transportation and greater areas treated. There has been research examining the effects of certain fertilizer salts (e.g., ammonium thiosulfate, see Gan and Yates, 1998), which may act as barriers to volatile compounds (e.g., 1,3-D, MB) when applied to the soil surface, thus reducing emissions and improving efficacy, although this method is in the beginning stages of testing.

A major limitation with respect to ongoing research is the general lack of information to accurately assess pest control in large scale, compared to small research trials. Topics, such as outgassing damage as a result of metam-sodium applications and application of VIF and associated costs, are being studied. Technical difficulties in extrapolating research scale plots to "real world" applications make it difficult to transition away from MB and calculate implementation timelines, since production consistency is frequently compromised. As discussed in Section 23 below, considerable research dollars have been spent on research of MB alternatives. However, phasing out MB for many current uses may be foreseeable. A combination of methods can conceivably be used to reduce MB, but this will require several seasons of testing and analyses.

In research plots, the reduction of MB from 98:2 to 65:35 or 50:50, increased periods of cover crop growth, use of herbicides glyphosate (Fraedrich and Dwinell, 2003c), and an increased use of mechanical cultivation might reduce pest populations, and the overall use of MB. However, nursery managers are unlikely to adopt the use of glyphosate immediately, since it kills both hardwoods and conifers. More research will be necessary to devise special application technology if the use of glyphosate is to be employed. Experiments have indicated that some soil amendments can reduce possible adverse growth effects of some alternatives (e.g., dazomet). Work in Wisconsin (Enebak et al., 1990; Iver, undated) suggested that white pine seedlings subjected to dazomet, but supplied with various nutrients, could reduce chlorosis sometimes observed in dazomet treated beds. Large scale trials will be necessary to confirm this effect. For disease control, studies (James et al., 1997) comparing cultivation practices, such as till vs. no-till and organic amendments indicate that effects vary according to the species grown, thus each nursery may have to consider alternatives with species and local environment in mind, unlike the more consistent effects of MB fumigation. Promising results in disease management have been observed (Lantz, 1997; Stone et al., 1998) with organic amendments, but successful weed management has not been adequately achieved.

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

Containerization is used for seedling production in a limited capacity throughout the forest nursery sector. One Michigan grower (CUE 04-0039) produces greenhouse-grown plug plants, which are grown for 1-2 years, then planted in beds for an additional 1-3 years. Containers can also be for special circumstances where species survival or an genetic value of the planting stock make them economically feasible. Recent surveys indicate that of the 1.2 billion seedlings grown in the southeastern U. S. in the 2002-2003 season, fewer than 5% were produced in containers (McNabb and VandersSchaaf, 2003). An estimate can be made that less than 10% of the national forest seedling production is containerized. Container production is used for specialty purposes, for example, to reforest mine-spoil sites which are extremely harsh edaphic environments requiring a soil plug system to obtain adequate seedling survival (Lowerts, 2003).

A large investment would be necessary to shift the national production to containerization, as well as a shift for many nurseries in the well established protocols of growing seedlings. According to Darrow (2002) (also see Appendix B) the transition from bed to container production would require additional capital and operating costs. Investment would be necessary for the purchases of greenhouses, container filling and sowing machines, containers, outdoor holding areas, fertigation systems, and new seedling transport systems both in the nursery and in the field. Not all sectors of seedling production would have this capital available to them. It is likely that smaller bareroot operations would close and many state-run nurseries would opt to close rather than budget state funds for such a significant capital outlay. There is little doubt that seedling prices could increase by up to six times current prices. A typical one year old bareroot seedling currently sells for $0.04 each, while the typical container seedling of the same species *begins* at $0.12 each. In addition to an increase in seedling costs, there are significant cost increases associated with transportation and planting container stock. Fewer container plants can be transported per truck and fewer seedlings can be carried by individual tree planters. More trucks and more fuel are needed to get seedlings to the planting site and more labor and time are needed to plant a given area. One study found that daily production decreased from 9.7 ha per day with bareroot seedlings to 7.3 ha per day with containerized seedlings, a decrease of 25%, without increasing planting crew size (Lowerts, 2003).

The inevitable result of containerization would be a significant increase in reforestation costs and a decrease in the rate of reforestation. According to the U. S. Forest Service, 48% of all reforestation in the U. S. is done on non-industrial private lands, an additional 42% is done on industrial lands, and 10% on government lands (Moulton and Hernandez, 2000). It is well established that non-industrial forest owners are very sensitive to reforestation costs, decreasing their investment in direct proportion to increasing costs (Hardie and Parks, 1991; Royer, 1987). Given the importance of non-industrial owners on the general timber supply, a reduction in reforestation efforts by this group may have serious long-term negative impacts on the sustainability of the forest economy. Industrial owners will also be negatively impacted by increased reforestation costs as raw material costs will increase (typically about 40-60% of the cost of final fiber products), impacting the competitiveness of their industry.

Conclusion: The infrastructure investment necessary for containerization is enormous and would probably force many nurseries out of business. Seedling production costs would increase, resulting in seedling price increases of over 250%. New transportation and planting systems would have to be adopted. Reforestation costs would go up significantly and probably result in fewer non-industrial forest owners reforesting after harvest. The potential long-term effect of these changes on the forestry economy is enormous. Overall, containerization would result in a significant increase in seedling production, transportation, and planting costs and would most likely decrease reforestation rates.

SUMMARY OF TECHNICAL FEASIBILITY

This nomination includes requests for MB for those nurseries where sufficient pest control can not be achieved otherwise. While combinations of chemicals, such as chloropicrin, metam-sodium, and 1,3-D appear to be effective for some nurseries in reducing pest infestations, including some weed problems (e.g., Carey, 2000; Carey, 1996; Carey, 1994; Weyerhaeuser, #8, 1992-95; Weyerhaeuser, #10, 1994-96), currently all nurseries can not rely solely on alternatives. For example, 1,3-D is an effective nematicide that may have some efficacy against plant pathogens, but for efficacy for weed management additional inputs will be required (such as use of a formulation with chloropicrin and use of VIF). Its overall use may be limited by local legal restrictions and pest-free permit requirements, and VIF has technical problems and is restricted in California (e.g., Carey, 1996; Carey, 1994; Weyerhaeuser #10, 1994-96). In addition, economic issues such as application costs may have an impact on overall acceptability of these alternatives for the forest seedling nursery sector.

Recent studies with dazomet in Georgia and North Carolina nurseries (Fraedrich and Dwinell, 2003b) and glyphosate (Fraedrich and Dwinell, 2003c) suggest that both might have potential as nutsedge treatments, but will be used in seedling production after research can "…better define the optimal use conditions". However issues remaining preventing immediate implementation.

For example, seedling nurseries have stated that forest tree seedlings cannot be exposed to glyphosate as the herbicide kills both hardwood and conifer species (personal communication, International Paper [Region B]; Southern Forest Nursery Management Cooperative [Region A]). While 'shielded sprayers' with glyphosate have been tested in small trials, seedling mortality from over-spray does occur. An International Paper nursery, for example, will typically produce 300 million seedlings per year, and so, even 1% mortality due to herbicide sprays could result in significant seedling loss. Consequently, glyphosate would not be an option to control nutsedge in nursery beds.

Statistically analyzed trials measuring quantity and quality losses due to specific pests (e.g., weeds or pathogens) are not readily available. More commonly found are trials indicating overall yield (and sometimes quality assessments), allowing a comparison of treatments based on yield, but making it difficult to ascribe losses to particular pests. This is particularly a problem since the numerous forest seedling nurseries can experience various problems unique to the combination of climate, soil, seedling species, market forces, and customer base (e.g., public vs. private nursery, or commercial vs. recreational end uses). Overall yield losses with the best alternatives, compared to MB, were estimated at 0-3% based on research data. In estimating the yield of alternatives in comparison to MB, it should be remembered that these figures are for the general case, and individual nurseries will likely experience greater or lesser efficacy with a given treatment, depending on soil, climate, production practices, market requirements, species of seedling, etc. The yield estimates listed in Table C.1 are based on research results described in Section 16. Quality factors are as important in this industry as yield, and may affect the efficacy of a given alternative beyond considerations of yield alone (e.g., "Percent 'Healthy Root Tips'" in Table 16.1B, Enebak et al., 1990).

Larger seedling size and improved seedling vigor translate to improved reforestation success and increased growth rate of young plantations. This positive contribution to reforestation is well documented for seedlings produced in MB fumigated soil. Increases in seedling size and quality resulting from fumigation with MB alternatives have been variable. The long-term impact on reforestation success with alternatives is not known. An important factor is the long-term implication associated with forest growth and health over a 20-40 year period of forest life. Seedling quality has been highly correlated with productive and healthy forests impacting both commercial and public interests.

The industry is continuing to sponsor research alternatives and test improved chemical application technologies to increase the efficacy of some of the most viable alternatives. The use of metam without tarping is not feasible due to crop injury and worker exposure issues. However, the application of metam followed by chloropicrin under flat-tarping, considering the large number of hectares treated each year, is not practical or cost effective either, and currently, not technically feasible (personal communication, International Paper [Region B]; Southern Forest Nursery Management Cooperative [Region A]). A three-step process would be required—first, application of metam, then chloropicrin, and finally, application of the tarp. Incorporation of metam using a rotovator is an extremely slow process, and the area to be treated within a given treatment window (determined by weather: temperature, moisture, wind) is limited. This window of application is generally 4-6 weeks, and even under the best application methods, this treatment takes four times as long to apply as the typical MB treatment. Therefore, to treat the necessary hectares each year would require a four-fold increase in labor and additional available equipment in order to apply metam, chloropicrin and cover with tarp. According to the label, and depending on soil and weather conditions, there would be a two to six week delay before planting after application of metam, chloropicrin and tarp-covering. This would affect market production costs.

The equipment needed to treat the area in spring and fall would not be available without the purchase of four additional applicator units and would greatly increase the cost to growers, as would the "set-up" time for the treatment with additional machinery. In order for tarps to be placed on the treated metam areas, workers must return into the treated area to lay down tarps after chloropicrin has been injected into the soil. In this case, out-gassing occurs, and workers must wear personal protection equipment that is not practical given the temperatures that normally occur at the time of application. Nursery growers of these regions are currently using high density films to decrease emissions of MB, but have found that for current production VIF is not an option due to excessive costs and technical difficulties of gluing during application. Nursery members of the Southern Forest Nursery Cooperative, among others, are experimenting with VIF, but are not able to adopt this technology for their 2007 production.
MB is considered to be critical in the short-term, with chemical alternatives the likely long-term solution. Non-chemical and biological control methodologies are not advanced enough to rely on in the foreseeable future. Research with organic and inorganic soil amendments (Fraedrich and Dwinell, 1998; James et al., 1997; James et al., 2001; Lantz, 1997; Stone et al., 1998) have had some successes under certain conditions, but the effects appear to be variable depending on the nursery locations and species of seedlings. Integration of several alternative treatments is the most likely alternative to MB.

PART D: EMISSION CONTROL

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

The Forest Seedlings sector has reduced its MB consumption through several techniques developed over the past several years. First, the sector has incorporated the use of high-density polyethylene (HDPE) tarp material that has helped increase fumigation efficiencies and reduced application rates. HDPE increases MB soil residence time, increasing efficiency and reducing application rates. VIF is likely to be an important means of further reducing emissions if a method can be developed to efficiently glue overlapping sheets of VIF film (e.g., Carey and Godbehere, 2004). VIF film becomes impractical if adjacent overlapping sheets cannot be glued. In addition, there is a problem with film breakage during application. Suppliers believe technical problems can be fixed (Rimini and Wigley, 2004), however, currently regulations prevent the use of VIF in California.

Second, MB fumigation in the forest seedlings sector increasingly has been made using deep injection that places the material deeper into the soil than previously. Deeper placement contributes to longer residence time in the soil and greater application efficiency. This has been accomplished at considerable capital investment on the part of applicators.

Third, forest seedlings nurseries have increased the percentage of chloropicrin in fumigation mixtures. While 98% MB and 2% chloropicrin was the most widely used compound a few years ago, a 66:33 formulation is now more common, especially in areas without heavy nutsedge infestations. Growers still applying 98:2 formulations, such as International Paper, are currently examining the effects of 66:33 in their nursery trials. Some efficiency in weed control has been sacrificed by this change in procedure, however, and higher concentrations of chloropicrin become increasingly less satisfactory as weed pressure, particularly nutsedge, increases. Some nurseries are investigating use of herbicides as an economic means of weed control (e.g., Fraedrich and Dwinell, 2003c; Northeastern Consortium request, Worksheet 4).

Fourth, forest seedlings nurseries routinely use integrated pest management (IPM) techniques to develop their fumigation strategies. Nurseries fumigate once every four years, growing two seedling crops and two cover crops following fumigation. Soil organic matter content, weed populations, and disease incidence are carefully monitored during the crop rotation to ensure the correct timing and rate of MB application. Monitoring pest populations is an integral part of an IPM approach and helps ensure MB efficiency.

Finally, the forest seedlings sector has devoted considerable resources to investigating MB alternatives and continues to search for methodologies to reduce MB use rates. The industry is committed to continuing research to address the issue of improved consistency (especially for nutsedge control) with available chemical alternatives and to test new products in order to determine efficacy and obtain the information necessary for U. S. registrations

TABLE 19.1: TECHNIQUES TO MINIMIZE METHYL BROMIDE USE AND EMISSIONS

TECHNIQUE OR STEP TAKEN	VIF OR HIGH BARRIER FILMS	METHYL BROMIDE DOSAGE REDUCTION	INCREASED % CHLOROPICRIN IN METHYL BROMIDE FORMULATION	LESS FREQUENT APPLICATION
WHAT USE/EMISSION REDUCTION METHODS ARE PRESENTLY ADOPTED?	Currently some growers use HDPE tarps.	No trend was identified.	Research is ongoing examining lower proportion of MB	No trend was identified.
WHAT FURTHER USE/EMISSION REDUCTION STEPS WILL BE TAKEN FOR THE METHYL BROMIDE USED FOR CRITICAL USES?	The U. S. anticipates that the decreasing supply of MB will motivate growers to try high barrier film.	The U. S. anticipates that the decreasing supply of MB will motivate growers to try dosage reduction.	The U. S. anticipates that the decreasing supply of MB will motivate growers to try increasing the chloropicrin percentage in formulations.	The U. S. anticipates that the decreasing supply of MB will motivate growers to try less frequent applications.
OTHER MEASURES *(please describe)*	Unknown	Unknown	Unknown	Unknown

20. IF METHYL BROMIDE EMISSION REDUCTION TECHNIQUES ARE NOT BEING USED, OR ARE NOT PLANNED FOR THE CIRCUMSTANCES OF THE NOMINATION, STATE REASONS:

As stated previously, emission reduction technologies are being addressed by the sector (e.g., VIF, reduced MB component of formulation, use of advanced delivery techniques to make alternative chemicals more effective at deeper soil levels).

PART E: ECONOMIC ASSESSMENT

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

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

REGION	ALTERNATIVE	YIELD*	COST IN YEAR 1 *(U.S. $/ha)*	COST IN YEAR 2 *(U.S. $/ha)*	COST IN YEAR 3 *(U.S. $/ha)*
REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	**Methyl Bromide**	**100**	**$ 17,820**	**$ 17,820**	**$ 17,820**
	Dazomet	95	$ 20,750	$ 20,750	$ 20,750
	1,3-D + Chloropicrin	97	$ 19,865	$ 19,865	$ 19,865
	Metam Sodium + Chloropicrin	97	$ 20,258	$ 20,258	$ 20,258
REGION B - INTERNATIONAL PAPER	**Methyl Bromide**	**100**	**$ 15,740**	**$ 15,740**	**$ 15,740**
	Dazomet	95	$ 18,284	$ 18,284	$ 18,284
	1,3-D + Chloropicrin	97	$ 18,343	$ 18,343	$ 18,343
	Metam Sodium + Chloropicrin	97	$ 18,621	$ 18,621	$ 18,621
REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES	**Methyl Bromide**	**100**	**$ 46,031**	**$ 46,031**	**$ 46,031**
	Dazomet	95	$ 48,442	$ 48,442	$ 48,442
	1,3-D + Chloropicrin	97	$ 48,442	$ 48,442	$ 48,442
	Metam Sodium + Chloropicrin	97	$ 48,442	$ 48,442	$ 48,442
REGION D - WEYERHAEUSER SOUTH	**Methyl Bromide**	**100**	**$ 16,960**	**$ 16,960**	**$ 16,960**
	Dazomet	95	$ 17,758	$ 17,758	$ 17,758
	1,3-D + Chloropicrin	97	$ 17,736	$ 17,736	$ 17,736
	Metam Sodium + Chloropicrin	97	$ 17,656	$ 17,656	$ 17,656
REGION E - WEYERHAEUSER WEST	**Methyl Bromide**	**100**	**$ 10,187**	**$ 10,187**	**$ 10,187**
	Dazomet	95	$ 11,748	$ 11,748	$ 11,748
	1,3-D + Chloropicrin	97	$ 11,748	$ 11,748	$ 11,748
	Metam Sodium + Chloropicrin	97	$ 10,342	$ 10,342	$ 10,342
REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION	**Methyl Bromide**	**100**	**$ 32,718**	**$ 32,718**	**$ 32,718**
	Dazomet	95	$ 38,747	$ 38,747	$ 38,747
	1,3-D + Chloropicrin	97	$ 37,994	$ 37,994	$ 37,994
	Metam Sodium + Chloropicrin	97	$ 37,994	$ 37,994	$ 37,994
REGION G - MICHIGAN SEEDLING ASSOCIATION	**Methyl Bromide**	100	**$ 94,908**	**$ 94,908**	**$ 94,908**
	Dazomet	95	$ 96,186	$ 96,186	$ 96,186
	1,3-D + Chloropicrin	97	$ 96,394	$ 96,394	$ 96,394
	Metam Sodium + Chloropicrin	97	$ 95,959	$ 95,959	$ 95,959

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

** The category Various Alternatives includes physical removal and sanitation, the use of artificial media, and soil treatment with 1,3-D +chloropicrin.

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** *(U.S. $/ha)*	**NET REVENUE FOR LAST REPORTED YEAR** *(U.S. $/ha)*
REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	**Methyl Bromide**	**$ 33,682**	**$ 15,862**
	Dazomet	$ 31,998	$ 11,247
	1,3-D + Chloropicrin	$ 32,671	$ 12,806
	Metam Sodium + Chloropicrin	$ 32,671	$ 12,413
REGION B - INTERNATIONAL PAPER	**Methyl Bromide**	**$ 31,096**	**$ 15,356**
	Dazomet	$ 29,541	$ 11,257
	1,3-D + Chloropicrin	$ 30,163	$ 11,820
	Metam Sodium + Chloropicrin	$ 30,163	$ 11,542
REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES	**Methyl Bromide**	**$ 178,824**	**$ 132,794**
	Dazomet	$ 169,883	$ 121,441
	1,3-D + Chloropicrin	$ 173,460	$ 125,018
	Metam Sodium + Chloropicrin	$ 173,460	$ 125,018
REGION D - WEYERHAEUSER SOUTH	**Methyl Bromide**	**$ 26,719**	**$ 9,759**
	Dazomet	$ 25,383	$ 7,626
	1,3-D + Chloropicrin	$ 25,918	$ 8,182
	Metam Sodium + Chloropicrin	$ 25,918	$ 8,262
REGION E - WEYERHAEUSER WEST	**Methyl Bromide**	**$ 18,759**	**$ 8,571**
	Dazomet	$ 17,821	$ 6,073
	1,3-D + Chloropicrin	$ 18,196	$ 6,448
	Metam Sodium + Chloropicrin	$ 18,196	$ 7,854
REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION	**Methyl Bromide**	**$ 48,759**	**$ 16,041**
	Dazomet	$ 46,321	$ 7,574
	1,3-D + Chloropicrin	$ 47,296	$ 9,302
	Metam Sodium + Chloropicrin	$ 47,296	$ 9,302
REGION G - MICHIGAN SEEDLING ASSOCIATION	**Methyl Bromide**	**$ 143,815**	**$ 48,907**
	Dazomet	$ 136,624	$ 40,438
	1,3-D + Chloropicrin	$ 139,501	$ 43,107
	Metam Sodium + Chloropicrin	$ 139,501	$ 43,542

* The category Various Alternatives includes physical removal and sanitation, the use of artificial media, and soil treatment with 1,3-D +chloropicrin.

MEASURES OF ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE - TABLE E.1: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	Methyl Bromide	Dazomet	1,3-D + Chloropicrin	Metam-Sodium + Chloropicrin
YIELD LOSS (%)	*0%*	*5%*	*3%*	*3%*
Yield (seedling) per Hectare Pine	*779,617*	*740,636*	*756,228*	*756,228*
** Price per Unit (U.S. $/seedling)*	*$ 0.04*	*$ 0.04*	*$ 0.04*	*$ 0.04*
Gross Revenue per Proportion (88%)	***$ 27,443***	***$ 26,070***	***$ 26,619***	***$ 26,619***
Yield (seedling) per Hectare Longleaf Pine	*423,785*	*402,596*	*411,072*	*411,072*
** Price per Unit (U.S. $/seedling)*	*$ 0.06*	*$ 0.06*	*$ 0.06*	*$ 0.06*
Gross Revenue per Proportion (3%)	***$ 763***	***$ 725***	***$ 740***	***$ 740***
Yield (seedling) per Hectare Hardwood	*243,399*	*231,229*	*236,097*	*236,097*
** Price per Unit (U.S. $/seedling)*	*$ 0.25*	*$ 0.25*	*$ 0.25*	*$ 0.25*
Gross Revenue per Proportion (9%)	***$ 5,476***	***$ 5,203***	***$ 5,312***	***$ 5,312***
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 33,682**	**$ 31,998**	**$ 32,671**	**$ 32,671**
- Operating Costs per Hectare (U.S. $)	**$ 17,820**	**$ 20,750**	**$ 19,865**	**$ 20,258**
= Net Revenue per Hectare (U.S. $)	**$ 15,862**	**$ 11,247**	**$ 12,806**	**$ 12,413**
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 4,614**	**$ 3,055**	**$ 3,449**
2. Loss per Kilogram of MB (U.S. $)	**$ 0**	**$ 49.21**	**$ 32.59**	**$ 36.78**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**14%**	**9%**	**10%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**29%**	**19%**	**22%**

REGION B - INTERNATIONAL PAPER - TABLE E.2: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

REGION B - INTERNATIONAL PAPER	Methyl Bromide	Dazomet	1,3-D + Chloropicrin	Metam-Sodium + Chloropicrin
Yield Loss (%)	0%	5%	3%	3%
Yield (seedling) per Hectare	741,315	704,250	719,076	719,076
* Price per Unit (U.S. $/seedling)	$ 0.04	$ 0.04	$ 0.04	$ 0.04
= Gross Revenue per Hectare (U.S. $)	$ 31,096	$ 29,541	$ 30,163	$ 30,163
- Operating Costs per Hectare (U.S. $)	$ 15,740	$ 18,284	$ 18,343	$ 18,621
= Net Revenue per Hectare (U.S. $)	$ 15,356	$ 11,257	$ 11,820	$ 11,542
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	$ 0	$ 4,099	$ 3,536	$ 3,814
2. Loss per Kilogram of MB (U.S. $)	$ 0	$ 78.97	$ 68.13	$ 73.49
3. Loss as a Percentage of Gross Revenue (%)	0%	13%	11%	12%
4. Loss as a Percentage of Net Revenue (%)	0%	27%	23%	25%

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES - TABLE E.3: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES	Methyl Bromide	Dazomet	1,3-D + Chloropicrin	Metam-Sodium + Chloropicrin
Yield Loss (%)	**0%**	**5%**	**3%**	**3%**
Yield (seedling) per Hectare - Tree	295,564	280,786	286,697	286,697
** Price per Unit (U.S. $/seedling)*	$ 0.55	$ 0.55	$ 0.55	$ 0.55
Gross Revenue per Proportion (81.6%)	**$ 132,615**	**$ 125,984**	**$ 128,636**	**$ 128,636**
Yield (shrub) per Hectare - Shrub Seedling	249,107	236,651	241,634	241,634
** Price per Unit (U.S. $/shrub)*	$ 0.31	$ 0.31	$ 0.31	$ 0.31
Gross Revenue per Proportion (13.2%)	**$ 10,161**	**$ 9,653**	**$ 9,856**	**$ 9,856**
Yield per Hectare - Forb Root Stock	123,298	117,134	119,600	119,600
** Price per Unit (U.S. $/root stock)*	$ 0.04	$ 0.04	$ 0.04	$ 0.04
Gross Revenue per Proportion (5.3%)	**$ 260**	**$ 247**	**$ 252**	**$ 252**
Yield (kilograms) per Hectare - Forb Seed	411	390	399	399
** Price per Unit (U.S. $/kilogram)*	$ 87.08	$ 87.08	$ 87.08	$ 87.08
Gross Revenue per Proportion	**$ 35,789**	**$ 34,000**	**$ 34,715**	**$ 34,715**
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 178,824**	**$ 169,883**	**$ 173,460**	**$ 173,460**
- Operating Costs per Hectare (U.S. $)	**$ 46,031**	**$ 48,442**	**$ 48,442**	**$ 48,442**
= Net Revenue per Hectare (U.S. $)	**$ 132,794**	**$ 121,441**	**$ 125,018**	**$ 125,018**
LOSS MEASURES				
1. Loss per Hectare (U.S $)	**$ 0**	**$ 11,352**	**$ 7,776**	**$ 7,776**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 43.10**	**$ 29.52**	**$ 29.52**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**6%**	**4%**	**4%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**9%**	**6%**	**6%**

REGION D - WEYERHAEUSER SOUTH - TABLE E.4: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

REGION D - WEYERHAEUSER SOUTH	Methyl Bromide	Dazomet	1,3-D + Chloropicrin	Metam-Sodium + Chloropicrin
Yield Loss (%)	0%	5%	3%	3%
Yield (seedling) per Hectare	574,612	545,882	557,374	557,374
* Price per Unit (U.S. $/seedling)	$ 0.05	$ 0.05	$ 0.05	$ 0.05
= Gross Revenue per Hectare (U.S. $)	$ 26,719	$ 25,383	$ 25,918	$ 25,918
- Operating Costs per Hectare (U.S. $)	$ 16,960	$ 17,758	$ 17,736	$ 17,656
= Net Revenue per Hectare (U.S. $)	$ 9,759	$ 7,626	$ 8,182	$ 8,262
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	$ 0	$ 2,134	$ 1,578	$ 1,497
2. Loss per Kilogram of Methyl Bromide (U.S. $)	$ 0	$ 25.38	$ 18.77	$ 17.81
3. Loss as a Percentage of Gross Revenue (%)	0%	8%	6%	6%
4. Loss as a Percentage of Net Revenue (%)	0%	22%	16%	15%

REGION E - WEYERHAEUSER WEST - TABLE E.5: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

REGION E - WEYERHAEUSER WEST	Methyl Bromide	Dazomet	1,3-D + Chloropicrin	Metam-Sodium + Chloropicrin
Yield Loss (%)	0%	5%	3%	3%
Yield (seedling) per Hectare	60,610	57,579	58,792	58,792
* Price per Unit (U.S. $/seedling)	$ 0.31	$ 0.31	$ 0.31	$ 0.31
= Gross Revenue per Hectare (U.S. $)	$ 18,759	$ 17,821	$ 18,196	$ 18,196
- Operating Costs per Hectare (U.S. $)	$ 10,187	$ 11,748	$ 11,748	$ 10,342
= Net Revenue per Hectare (U.S. $)	$ 8,571	$ 6,073	$ 6,448	$ 7,854
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	$ 0	$ 2,499	$ 2,124	$ 718
2. Loss per Kilogram of Methyl Bromide (U.S. $)	$ 0	$ 28.52	$ 24.24	$ 8.19
3. Loss as a Percentage of Gross Revenue (%)	0%	13%	11%	4%
4. Loss as a Percentage of Net Revenue (%)	0%	29%	25%	8%

REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION - TABLE E.6: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

Region F - Northeastern Forest & Conservation Nursery Association	Methyl Bromide	Dazomet	1,3-D + Chloropicrin	Metam-Sodium + Chloropicrin
Yield Loss (%)	**0%**	**5%**	**3%**	**3%**
Yield per Hectare Conifer Seedling 1-0	247,105	234,750	239,692	239,692
** Price per Unit (U.S. $/seedling)*	$ 0.22	$ 0.22	$ 0.22	$ 0.22
Gross Revenue per Proportion (8%)	**$ 4,349**	**$ 4,132**	**$ 4,219**	**$ 4,219**
Yield per Hectare Conifer Seedling 2-0	247,105	234,750	239,692	239,692
** Price per Unit (U.S. $/seedling)*	$ 0.22	$ 0.22	$ 0.22	$ 0.22
Gross Revenue per Proportion (4%)	**$ 2,175**	**$ 2,066**	**$ 2,109**	**$ 2,109**
Yield per Hectare Conifer Seedling 3-0	135,908	129,112	131,831	131,831
** Price per Unit (U.S. $/seedling)*	$ 0.31	$ 0.31	$ 0.31	$ 0.31
Gross Revenue per Proportion (14%)	**$ 5,898**	**$ 5,603**	**$ 5,721**	**$ 5,721**
Yield per Hectare Deciduous Tree Seedling 1-0	185,329	176,062	179,769	179,769
** Price per Unit (U.S. $/seedling)*	$ 0.28	$ 0.28	$ 0.28	$ 0.28
Gross Revenue per Proportion (55%)	**$ 28,541**	**$ 27,114**	**$ 27,684**	**$ 27,684**
Yield per Hectare Deciduous Tree Seedling 2-0	123,553	117,375	119,846	119,846
** Price per Unit (U.S. $/seedling)*	$ 0.34	$ 0.34	$ 0.34	$ 0.34
Gross Revenue per Proportion (9%)	**$ 3,781**	**$ 3,592**	**$ 3,667**	**$ 3,667**
Yield per Hectare Deciduous. Shrub Seedling 1-0	154,441	146,719	149,808	149,808
** Price per Unit (U.S. $/seedling)*	$ 0.26	$ 0.26	$ 0.26	$ 0.26
Gross Revenue per Proportion (10%)	**$ 4,015**	**$ 3,815**	**$ 3,895**	**$ 3,895**
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 48,759**	**$ 46,321**	**$ 47,296**	**$ 47,296**
- Operating Costs per Hectare (U.S. $)	**$ 32,718**	**$ 38,747**	**$ 37,994**	**$ 37,994**
= Net Revenue per Hectare (U.S. $)	**$ 16,041**	**$ 7,574**	**$ 9,302**	**$ 9,302**
Loss Measures				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 8,467**	**$ 6,738**	**$ 6,738**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 49.38**	**$ 39.30**	**$ 39.30**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**17%**	**14%**	**14%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**53%**	**42%**	**42%**

REGION G - MICHIGAN SEEDLING ASSOCIATION - TABLE E.7: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

Region G - Michigan Seedling Association	Methyl Bromide	Dazomet	1,3-D + Chloropicrin	Metam-Sodium + Chloropicrin
Yield Loss (%)	**0%**	**5%**	**3%**	**3%**
Yield per Hectare Conifer Seedlings	1,070,789	1,017,250	1,038,665	1,038,665
** Price per Unit (U.S. $/seedling)*	$ 0.14	$ 0.14	$ 0.14	$ 0.14
Gross Revenue per Proportion (60%)	**$ 89,946**	**$ 85,449**	**$ 87,248**	**$ 87,248**
Yield per Hectare Conifer Transplants	74,132	70,425	71,908	71,908
** Price per Unit (U.S. $/ transplants)*	$ 0.60	$ 0.60	$ 0.60	$ 0.60
Gross Revenue per Proportion (10%)	**$ 4,448**	**$ 4,225**	**$ 4,314**	**$ 4,314**
Yield per Hectare Deciduous Transplants	329,474	313,000	319,589	319,589
** Price per Unit (U.S. $/ transplants)*	$ 0.50	$ 0.50	$ 0.50	$ 0.50
Gross Revenue per Proportion (30%)	**$ 49,421**	**$ 46,950**	**$ 47,938**	**$ 47,938**
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 143,815**	**$ 136,624**	**$ 139,501**	**$ 139,501**
- Operating Costs per Hectare (U.S. $)	**$ 94,908**	**$ 96,186**	**$ 96,394**	**$ 95,959**
= Net Revenue per Hectare (U.S. $)	**$ 48,907**	**$ 40,438**	**$ 43,107**	**$ 43,542**
Loss Measures				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 8,469**	**$ 5,800**	**$ 5,365**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 95.26**	**$ 65.24**	**$ 60.35**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**6%**	**4%**	**4%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**17%**	**12%**	**11%**

SUMMARY OF ECONOMIC FEASIBILITY

An economic assessment was made for three technically feasible in-kind (chemical) alternatives for the forest seedlings sector: dazomet, 1-3 D + chloropicrin, and metam-sodium + chloropicrin. The economic assessment of feasibility for pre-plant uses of MB included an evaluation of economic losses from three basic sources: (1) yield losses, referring to reductions in the quantity produced, (2) quality losses, which generally affect the price received for the goods, and (3) 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.

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) Losses as a percent of gross revenues. 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.

(2) Absolute losses 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.

(3) Losses per kilogram of MB requested. This measure indicates the value of MB to crop production but is also useful for structural and post-harvest uses.

(4) Losses as a percent of net revenues. We define net 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.

These measures represent different ways to assess the economic feasibility of MB alternatives for MB users, who are forest seedling 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 MB. The economic measures provide the basis for making that determination.

Economic reviewers analyzed potential economic losses from using dazomet, 1-3 D + chloropicrin, and metam-sodium + chloropicrin because they are currently considered technically feasible alternatives for nursery seedlings production.

Total losses are similar for both 1-3-D + chloropicrin and metam-sodium + chloropicrin. Quantifiable losses originate from yield losses and cost increases. Dazomet has slightly higher yield losses than 1-3-D + chloropicrin, and metam-sodium + chloropicrin, but similar treatment costs. Indirect yield losses occurred due to lengthening of the production cycle, which resulted in less land in production and more in fallow or longer time for seedlings to reach appropriate size. Additional losses may also arise due to a shift from high quality Grade #1 seedlings to lower quality Grade #2, which causes a loss of about 30% of value, and more seedlings that must be culled. Unfortunately, data were lacking to measure this shift. Thus, total losses are underestimated.

Tables E.1 - E.8 provides a summary of the estimated economic losses. A measure of net revenue loss may not be completely accurate partly because many nurseries are publicly owned and seedling prices or production costs are subsidized. Although attempts were made to appropriately value the seedlings at a true market price, losses as a percentage of gross revenues and of net revenue should be viewed with caution. Direct yield losses are similar across the regions, mainly because the same studies were used to predict impacts. The range of losses in the studies is rather large because both dazomet and metam-sodium provide inconsistent pest control. Indirect losses arising from shifts in the production cycle were not quantified. In the Northern region this impact is expected to be more pronounced due to cooler temperatures and longer time required for production of a seedling crop. Changes in production costs arise due to differences between the costs of methyl bromide and the alternatives, shifts in the production cycle (increasing the frequency of fumigation or lengthening the fallow period) and additional expenses such as supplementary irrigation. These costs vary across regions and within the Western region, which is highly diverse, because of differences in pests, production systems and regional differences in costs of water and labor. Costs are higher in the South, in part because warmer temperatures increase pest pressure.

PART F. FUTURE PLANS

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

Because of high costs associated with forest seedlings considerable resources have been spent examining methods to reduce costs and improve efficiency in seedling production. The Southern Forest Nursery Management Cooperative has spent $1.2 million on MB alternatives since 1992. This is significant, since several of the nurseries are publicly owned and have limited resources for independent research. Research has included trials conducted to assess the effectiveness of the most likely chemical and non-chemical alternatives (two year cover crops—see International Paper request CUE 03-0007) to MB, including some potential alternatives that are not currently listed by MBTOC, including combinations of chemicals such as 1,3-D, chloropicrin, metam-sodium, and methyl iodide (not currently registered in the U. S.). Development of technologies to improve efficacy of alternatives are underway and include work with deep injection application methods, soil moisture management by improving drip technologies, and trials with VIF to increase efficacy and decrease emissions while allowing reasonable cost effectiveness. Even where MB is considered critical, an improvement in efficient delivery techniques will result in reduction of MB use requirements. As of 2005, International Paper is testing “an IPM system using true fallow, pathogen resistant cover crops, increased supplemental organic matter applications, increased herbicide and insecticide use, and annual chloropicrin and Telone fumigation for bareroot pine production”.

One difficulty in identifying alternatives to MB is that information obtained from research plots must be transferred to large-scale commercial production requirements. Fumigants applied to small plots may not exhibit similar effects when applied to commercial seedling beds. Overall, especially for nurseries with high pest pressure, protocols for alternative chemicals have not been sufficiently developed to provide consistent and effective production results. Continued research on alternatives that will be adaptable to large-scale applications will shift the industry to MB alternatives.

Weyerhaeuser Corporation, one of the largest growers of forest seedlings, suggested their preference for MB alternatives (in descending order): 1) chloropicrin, 340 kg/ha; 2) 1,3-D at 260 kg/ha + chloropicrin at 140 kg/ha; 3) metam-sodium, (485 kg/ha) and chloropicrin (115 kg/ha); 4) dazomet, 400 kg/ha; 5) non-chemical treatments such as steam; 6) biological control agents.

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

24. ARE THERE PLANS TO MINIMIZE THE USE OF METHYL BROMIDE FOR THE CRITICAL USE IN THE FUTURE?

It may be possible to reduce MB in formulations to 65% or 50% mixed with chloropicrin, especially in locations where pathogens are the key pests. Reduction in MB may be achieved with use of VIF if technological and cost issues can be resolved (Carey and Godbehere, 2004). Weed management is the issue of most concern by most nurseries and work is ongoing to study the strategic use of herbicides (e.g., $370,701 USDA grant for MB alternatives research by Michigan State University that will test numerous herbicides and other weed control methods). Also cultural practices are being examined to increase mechanical cultivation and/or soil amendments and fertilizers to maximize productivity and reduce reliance on MB. Development of predictive models to strategically determine when fumigation is appropriate can reduce overall use of fumigants (e.g., Fraedrich and Dwinell, 1998). As stated in Section 23, minimizing use of MB can be achieved through the development of technologies to improve efficacy of alternatives such as deep injection methods, soil moisture management by improving drip technologies, experience with virtually impermeable films to increase efficacy and decrease emissions, and still have reasonable cost effectiveness. Even where MB is considered critical, an improvement in efficient delivery techniques will result in reduction of MB use requirements.

25. ADDITIONAL COMMENTS ON THE NOMINATION?

The MB critical use exemption nomination for Forest Seedlings has been reviewed by the U. S. Environmental Protection Agency and the U. S. Department of Agriculture and meets the guidelines of The *Montreal Protocol on Substances That Deplete the Ozone Layer*. This nomination includes requests for MB for those nurseries where sufficient pest control can not be achieved otherwise. This use is considered critical because there are conditions in some nurseries within this sector with high pest pressure where no feasible alternatives are currently effective. High production nurseries require a consistent and reliable pre-plant fumigation treatment that will allow production goals to be met. Currently MB is the only consistent provider of this requirement for nurseries with severe pest infestations and where other treatments are not effective. The loss of MB, therefore, would result in a significant market disruption. The effort to avoid market disruption provides the basis for nomination of this sector for critical use exemption of MB.

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

2008 Methyl Bromide Usage Newer Numerical Index - BUNNIE									Forest Seedlings	
January 24, 2006	Region	Southern Forest Nursery	Interna-tional Paper	IL Dept of Natural Resources	Weyer-haeuser (SE)	Weyer-haeuser (NW)	NE Forest & Conserv. Nursery	Michigan Seedling Assoc.	Sector Total or Average	Notes
Dichotomous Variables	Strip or Bed Treatment?	Flat Fume	Flat Fume	Flat Fume	Flat Fume	Flat Fume	Flat Fume	Flat Fume		
	Currently Use Alternatives?	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
	Tarps / Deep Injection Used?	Tarp	Tarp	Tarp	Tarp	Tarp	Tarp	Tarp		
	Pest-free Cert Requirements?	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Other Issues	Frequency of Treatment (x/ yr)	1x/4years	1x/4years	1x/1year	1x/4years	1x/3years	1x/1-3years	1x/3-4years		*
	QPS Removed?	Yes	Yes	Yes	Yes	Yes	Yes	Yes		
Most Likely Combined Impacts (%)	Karst -1,3-D Limitation (%)	0%	0%	0%	0%	0%	0%	0%		
	100 ft Buffer Zones (%)	0%	0%	0%	0%	0%	0%	0%		
	Key Pest Distribution (%)	100%	100%	100%	100%	100%	100%	100%		
	Regulatory Issues (%)	0%	0%	0%	0%	0%	0%	0%		
	Unsuitable Terrain (%)	0%	0%	0%	0%	0%	0%	0%		
	Cold Soil Temperature (%)	0%	0%	0%	0%	0%	0%	0%		
	Total Combined Impacts (%)	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	100%		
Most Likely Baseline Transition	(%) Able to Transition	0%	0%	0%	0%	0%	0%	0%		
	Minimum # of Years Required	0	0	0	0	0	0	0		
	(%) Able to Transition / Year	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**	**0%**		
EPA Adjusted Use Rate (kg/ha)		260	260	260	260	211	260	260		
EPA Adjusted Strip Dosage Rate (g/m2)		26	26	26	26	21	26	26		
2008 Requested Usage (Pounds)	*Amount - Pounds*	*542,408*	*34,643*	*9,400*	*39,600*	*36,357*	*64,485*	*15,529*	*742,422*	
	Area - Acres	*1,621*	*101*	*40*	*132*	*170*	*199*	*64*	*2,327*	
	Rate (lb/A)	*334.61*	*343.00*	*235.00*	*300.00*	*213.36*	*324.05*	*242.64*	*319*	
2008 Requested Usage (Metric)	**Amount - Kilograms**	**246,032**	**15,714**	**4,264**	**17,962**	**16,491**	**29,250**	**7,044**	**336,757**	
	Treated Area - Hectares	656	41	16	53	69	81	26	942	
	Rate (kg/ha)	375	384	263	336	239	363	272	358	
EPA Preliminary Value	kgs	**246,032**	**15,714**	**4,264**	**17,962**	**16,491**	**29,250**	**6,908**	**336,621**	
EPA Baseline Adjusted Value has been adjusted for:		MBTOC Adjustments, QPS, Double Counting, Growth, Use Rate/Strip Treatment, Miscellaneous, and Combined Impacts								
EPA Baseline Adjusted Value	kgs	60,764	10,627	3,819	13,889	16,491	20,946	6,604	133,140	
EPA Transition Amount	kgs	-	-	-	-	-	-	-	-	
Most Likely Impact Value (kgs)	kgs	**60,764**	**10,627**	**3,819**	**13,889**	**16,491**	**20,946**	**6,604**	**133,140**	
	ha	**234**	**41**	**15**	**53**	**78**	**81**	**25**	**527**	
	Rate	**260**	**260**	**260**	**260**	**211**	**260**	**260**	**253**	
Sector Research Amount (kgs)			**-**	**2008 Total US Sector Nomination**					**133,140**	

1 Pound = 0.453592 kgs 1 Acre = 0.404686 ha

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. Estimated Costs Of Converting A Loblolly Forest Tree Seedling Nursery From Soil-Based To Containerized Soilless Culture[1]

The costs below are based on the conversion of a 10 million bareroot seedling, soil-based, nursery [typical nurseries in the southern U. S. can produce 20-60 million bareroot seedlings] to a container, soilless, nursery for the raising of Loblolly pine seedlings in the southern USA. The cost estimates include estimates of additional expenditures (over and above $.04 per seedling cost for soil-based system) for:

A. Capital Infrastructure
B. Operating Costs

Limitations of analysis:
There are also expected to be additional shipping costs, due to the larger size and weight of containerized plants, but estimating these costs were beyond the scope of this analysis. Economy of scale can be significant and regional costs vary, making it difficult to provide a precise cost.

Additional note:
The capital costs associated with conversion from a soil-based to a soilless nursery are much less than the capital costs of establishing a new soilless nursery. All of the basic infrastructure and much of the equipment would already be in place with a soil-based nursery.

A. Capital Infrastructure:
Many of the facilities required for the operation of a soil-based seedling nursery are required for a soilless nursery, so conversion costs and the conversion costs are

Conversion cost:	
Water supply	$ 0
Power	$ 0
Buildings	$ 0
Landscaping/leveling/roads	$ 0
Equipment - assuming no trade-ins	$ 100,000
Nursery structures + irrigation	$ 130,000

B. Operating costs:
Working capital requirements are greater in a soilless nursery than a soil-based nursery as more labor is used. The cost of conversion from a soil-based nursery to a soilless nursery should include the need for additional working capital.

Working capital:

Additional container system cost	$ 150,000
(Over and above ~$50,000 cost for soil-based system)	
Containers	$ 410,000

C. Land
The soil-based nursery requires 13.3 hectares exclusive of buildings, storage and administrative area. The soilless nursery requires 4 hectares for the same production.

Assuming the soil-based nursery owner is able to sell or exchange the surplus land, the change from soil-based to soilless will be a source of revenue. A review of land prices in the southern USA, in localities where forest tree nurseries are situated reveals an average of $12,350 per hectare.

Land Savings:
Land (9.3 hectares at $12,350 per hectare) ($ 114,855)

D. Analysis of Net Costs:
Converting 10 million Seedling Nursery from Bareroot to Containerized, Soilless Culture

	Capital Cost	Years of Use*	Annual Cost	Cost per Seedling
EQUIPMENT	$100,000	10	$11,723	$0.0012
Nursery Structures	$130,000	10	$15,240	$0.0015
Running Container System			$150,000	$0.015
Containers			$410,000	$0.041
Total Additional Cost**			$586,963	$0.059
Land rent savings***			($3,450)	($0.0003)
Net additional cost				**$0.0583**
Base production cost (for bareroot and soilless system)				**$0.04**
Total Cost per Seedling				**$0.0983**

*Incorporates real interest cost at 3% per year.
**Does not include additional cost of shipping due to larger and heavier containers.
***Using land capitalization rate of 3%.

Conclusion:
Converting to a soilless containerized system would increase the cost of production by approximately 250%, and could be higher when the increased cost of shipping containerized seedlings is included.

[1] Based on communication with Kevin Darrow, Sept. 2002