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

NOMINATING PARTY CONTACT DETAILS

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

X Yes ☐ No

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

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

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

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

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PART A: SUMMARY

1. NOMINATING PARTY:

The United States of America (U. S.)

2. DESCRIPTIVE TITLE OF NOMINATION:

Methyl Bromide Critical Use Nomination for Preplant Soil Use for Forest Seedlings

3. CROP AND SUMMARY OF CROP SYSTEM

The Forest Seedling sector in the U. S. supplies conifer and hardwood seedlings that are used for reforestation, forest establishment, fiber production, and wildlife and conservation uses. In 1998, there were 1.6 billion forest seedlings produced in the U. S.; the southern region produced 80% of these seedlings (Ken McNabb, Director, Southern Forest Nursery Management Cooperative, personal communication). Nurseries in the U. S. are located in eight climate zones (Zones 3 to 10) mostly with light or medium soils. The majority of seedlings are species of conifers, especially pine. In addition, 30-40 species of hardwoods, such as oaks, hickory, poplars, and ash, are produced. Nurseries produce seedlings adapted to their respective regional conditions, such as climate and soil type. Overall, forest seedling nurseries include those operated by private forest industry, state and federal governments, and non-industry private concerns.

Nurseries produce conifer seedlings that are typically grown for one or two years followed by one or two years fallow or cover crops. Therefore, managers typically fumigate a particular conifer seedling bed with MB only once every 3-4 years, i.e., only 1/3-1/4 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 than conifers to root rots and damping-off diseases.

Upon maturity, forest seedlings are harvested in the nursery, packaged, and transported to the planting site. Seedlings may or may not be culled or sized during harvesting process, with cull trees discarded and typically recycled into nursery soil. Those nurseries that grade their seedlings into number 1 and number 2 grades can sell them at a price differential. The impact of seedling quality on the success of the plantation establishment process cannot be overstated. The production of large and healthy planting stock is essential to the economic viability of a reforestation process that typically includes soil preparation at the planting site, transportation to the planting site, planting, and weed control after planting. The quality of seedlings is strongly correlated with the success of the regeneration process and corresponding long-term economic and use benefits where a higher quality seedling implies better survival and faster growth. Nursery soil fumigation is the backbone of an integrated pest management approach to produce healthy seedlings that is the foundation for economically viable plantation establishment and management.

Ornamental herbaceous crops require MB to address problems primarily with nematode and weed pests. This industry (Michigan Field Grown Herbaceous Perennial Growers) has adopted alternative pest management strategies for part of the 646 ha of nursery land, and is conducting trials to assess the efficacy of alternatives for certain crops, such as hosta, delphinium, and phlox. Results of these ongoing trials are to be available around 2006. In the meantime, growers from this consortium have a critical need for MB.

4. METHYL BROMIDE NOMINATED

TABLE 4.1: METHYL BROMIDE NOMINATED

YEAR	NOMINATION AMOUNT (KG)	NOMINATION AREA (HA)
2006	**139,882**	**415**

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

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

- Pest control efficacy of alternatives: the efficacy of alternatives may not be comparable to methyl bromide in some areas, making these alternatives technically and/or economically infeasible for use in forest seedling production.
- Geographic distribution of key target pests: the U. S. is only nominating a CUE for forest seedlings where the key pest pressure is moderate to high.

At least for the coming three growing seasons, use of MB is critical to forest seedling nurseries in the U. S. Although alternative treatments can be foreseen as likely long-term solutions, timing will depend on the development of application technologies to better deliver these alternatives to soils containing target pests. In addition, because of MB efficacy, in many nurseries, up to three seedling crops can be grown with each MB application—generally applied only once in four years. Alternative treatments will require more frequent applications and increase costs and environmental pesticide burden. Finally, there have been significant outgassing incidents that resulted in destruction of millions of nursery seedlings (International Paper nursery). Because of the importance placed on seedling quality (due to the high correlation of quality and subsequent forest health and value), 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 for reforestation. In addition, 1,3-D may be restricted due to legal or geological factors. Non-chemical and biological control methods have not proven to be reliable independent treatments, although in some nurseries they have been integrated into the routine seedling production system.

Forest nurseries throughout the U. S. must contend with a variety of pests, but effective fumigation is primarily relied on to manage fungal pathogens (e.g., *Fusarium*, *Alternaria*, *Phytophthora*, *Pythium, Rhizoctonia*, *Cylindrocladium* spp., and *Macrophomina*) and especially, yellow and purple nutsedges (species of the *Cyperus* weed) (Cram and Fraedrich, 1997). Nutsedges are generally considered the major pests of all forest seedling nurseries and the pests most difficult to manage.

Inconsistency in pest management performance by chemical alternatives is 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 very 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.

TABLE A.1: EXECUTIVE SUMMARY FOR FOREST SEEDLINGS*

		A.	B.	C.	D.	E.	F.	G.	H.
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	MICHIGAN HERBACEOUS PERENNIALS
AMOUNT OF NOMINATION									
2006	**Kilograms (kg)**	87,348	13,455	1,911	8,981	7,943	12,970	4,477	2,381
	Application Rate (kg/ha)	375	250	263	336	236	341	263	392
	Area (ha)	233	54	7	27	34	38	17	6
AMOUNT OF APPLICANT REQUEST									
2005	**Kilograms (kg)**	246,032	27,305	4,264	17,962	24,752	33,112	9,144	5,619
	Application Rate (kg/ha)	375	250	263	336	263	341	269	397
	Area (ha)	656	109	16	53	94	97	34	14
2006	**Kilograms (kg)**	246,032	34,181	4,264	17,962	25,358	32,455	9,144	4,763
	Application Rate (kg/ha)	375	250	263	336	263	341	269	392
	Area (ha)	656	137	16	53	96	95	34	12
ECONOMICS									
Marginal Strategy		**1,3-D + CHLOROPICRIN**							
Yield Loss (%)		3%	3%	3%	3%	3%	3%	3%	5%
Loss per hectare (US$/ha)		$ 3,055.73	$ 3,694.51	$14,141.56	$ 1,709.73	$ 2,368.40	$ 6,546.88	$ 6,228.70	$28,359
Loss per kg MB (US$/kg)		$ 32.59	$ 59.14	$ 53.69	$ 20.34	$ 27.03	$ 38.37	$ 69.46	$145
Loss as % of Gross Revenue (%)		9%	11%	7%	6%	13%	20%	6%	20%
Loss as % of Net Revenue (%)		19%	20%	8%	15%	25%	66%	37%	28%

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

6. SUMMARIZE WHY KEY ALTERNATIVES ARE NOT FEASIBLE:

Although alternative treatments can be foreseen as likely long-term solutions, the replacement of critical uses of MB will depend on the development of application technologies that better deliver alternatives to soils containing target pests. While, alternatives to MB such as chloropicrin, and combinations of chloropicrin with metam-sodium or 1,3-D can be effective in reducing pest infestations, including some weed problems (e.g., Carey, 2000; Carey, 1996; Carey, 1994; Weyerhaeuser, #8, 1992-95; Weyerhaeuser, #10, 1994-96), they are problematic for their inconsistent performances, and therefore, unreliability, for nurseries with moderate to high pest (especially weed) pressure. Inconsistency in pest management performance by chemical alternatives is 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 very 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. Because of the importance placed on seedling quality (due to the high correlation of quality and subsequent forest health and value), 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 for reforestation. In addition, 1,3-D may be restricted due to legal or geological factors. Non-chemical and biological control methods have not proven to be reliable independent treatments, although in some nurseries they have been integrated into the routine seedling production system. 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) have observed some reduction in reducing populations of certain pathogens, but the effects appear to be variable depending on the nursery locations and species of seedlings, and it is unclear if the pathogen population is 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
H. Michigan Herbaceous Perennials	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.

Generally, MB is the product used in this industry, which allows 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 an unfumigated cover crop is planted for the purposes of soil organic matter maintenance. Less effective alternative products require fumigation more often, and consequently, higher management costs are incurred.

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?

The use of alternative methods depends on further research to establish viable alternatives that provide the same benefits as MB. Currently research is being conducted by all parties of 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

REGION A - Southern Forest Nursery Management Cooperative		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	246,032	246,032
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	98:2	98:2
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	656	656
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	375	375
DOSAGE RATE* *(g/m²)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	37.5	37.5
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	383	383
DOSAGE RATE* *(g/m²)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	38.3	38.3

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

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

REGION B - International Paper		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	27,305	34,181
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	109	137
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	250	250
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	25	25
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	373	373
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	37.3	37.3

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

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

REGION C - Illinois Department of Natural Resources		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	4,264	4,264
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	16	16
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	263	263
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	26.3	26.3
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	393	393
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	39.3	39.3

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

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

REGION D: Weyerhaeuser-South		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	17,962	17,962
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	90:10	90:10
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	53	53
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	336	336
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	33.6	33.6
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	373	373
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	37.3	37.3

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

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

REGION E - Weyerhaeuser-West		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	24,752	25,358
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	94	96
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	263	263
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	26.3	26.3
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	393	393
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	39.3	39.3

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

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

REGION F - Northeastern Forest and Conservation Nursery Association		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	33,112	32,455
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	98:2	98:2
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	97	95
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	341	341
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	34.1	34.1
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	348	348
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	34.8	34.8

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

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

REGION G - Michigan Seedling Association		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	9,144	9,144
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	67:33	67:33
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	34	34
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	269	269
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	26.9	26.9
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	402	402
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	40.2	40.2

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

TABLE 8.8. REGION H - MICHIGAN HERBACEOUS PERENNIALS: AMOUNT OF METHYL BROMIDE REQUESTED FOR CRITICAL USE

REGION H – Michigan Herbaceous Perennials		
YEAR OF EXEMPTION REQUEST	**2005**	**2006**
KILOGRAMS OF MB	5,619	4,763
USE: FLAT FUMIGATION OR STRIP/BED TREATMENT	flat fumigation	flat fumigation
FORMULATION *(ratio of MB/Pic mixture)* TO BE USED FOR THE CUE	98:2	98:2
TOTAL AREA TO BE TREATED WITH THE MB OR MB/PIC FORMULATION *(ha)*	14	12
APPLICATION RATE* *(kg/ha)* FOR THE **ACTIVE INGREDIENT**	397	392
DOSAGE RATE* *(g/m^2)* OF **ACTIVE INGREDIENT** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	39.7	39.2
APPLICATION RATE* *(kg/ha)* FOR THE **FORMULATION**	405	400
DOSAGE RATE* *(g/m^2)* OF **FORMULATION** USED TO CALCULATE REQUESTED KILOGRAMS OF MB	40.5	40

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

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

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

- The percent of regional hectares in the applicant's request was divided by the total area planted in that crop in the region covered by the request. Values greater than 100 percent are due to the inclusion of additional varieties in the applicant's request that were not included in the 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 methyl bromide 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 is the area in the applicant's request subject to QPS treatments. QPS hectares were removed from each application's request.
- Only the acreage experiencing moderate to heavy key pest pressure was included in the nominated amount.

TABLE A.2: 2005 SECTOR NOMINATION*

REGION		A.	B.	C.	D.	E.	F.	G.	H.
2005 FOREST SEEDLING NOMINATION		SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	INTERNATIONAL PAPER	ILLINOIS DEPARTMENT OF NATURAL RESOURCES	WEYERHAEUSER SOUTH	WEYERHAEUSER WEST	NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOC	MICHIGAN SEEDLING ASSOCIATION	MICHIGAN HERBACEOUS PERENNIALS
Applicant Request	Hectares (ha)	656	109	16	53	94	97	34	14
	Application Rate (kg/ha)	375	250	263	336	263	341	269	397
	Kilograms (kg)	246,032	27,305	4,264	17,962	24,752	33,112	9,144	5,619

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

TABLE A.3: 2006 SECTOR NOMINATION*

REGION		A.	B.	C.	D.	E.	F.	G.	H.
2006 Forest Seedlings Nomination		SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	INTERNATIONAL PAPER	ILLINOIS DEPARTMENT OF NATURAL RESOURCES	WEYERHAEUSER SOUTH	WEYERHAEUSER WEST	NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOC	MICHIGAN SEEDLING ASSOCIATION	MICHIGAN HERBACEOUS PERENNIALS
Applicant Request	**Hectares (ha)**	656	137	16	53	96	95	34	12
	Application Rate (kg/ha)	375	250	263	336	263	341	269	392
	Kilograms (kg)	246,032	34,181	4,264	17,962	25,358	32,455	9,144	4,763
CUE Nominated	**Hectares (ha)**	233	54	7	27	34	38	17	6
	Application Rate (kg/ha)	375	250	263	336	236	341	263	392
	Kilograms (kg)	87,348	13,455	1,911	8,981	7,943	12,970	4,477	2,381

2006 SECTOR NOMINATION TOTALS	**OVERALL REDUCTION (%)**	63%
	TOTAL 2006 U. S. SECTOR NOMINATED KILOGRAMS (KG)	**139,882**

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

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*;	MB allows three successive seedling crops with only one fumigation treatment (one treatment every four years). Alternative treatments will require more frequent fumigation due to reduced efficacy.
	Weeds [100% at times]: broadleaf, grasses, sedges	

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: *(e.g. transplants, bulbs, trees or cuttings)*	bareroot forest seedlings (96% pine, 4% hardwood species)
Annual or Perennial Crop: *(# of years between replanting)*	typically grown for 1 year for each of three crops before fumigation on fourth year
Typical Crop Rotation *(if any)* and use of methyl bromide for other crops in the rotation: *(if any)*	Two years of pine or hardwood followed by two years of cover crop. Fumigation occurs only before the first pine crop and every hardwood crop. Cover crops are not fumigated.
Soil Types: *(Sand, loam, clay, etc.)*	light (85%); medium (15%)
Frequency of methyl bromide Fumigation: *(e.g. every two years)*	typically, fumigated once in 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											
RAINFALL[a] *(mm)*	125	128	155	135	91	100	141	118	76	52	87	131
OUTSIDE TEMP. *(°C)*	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 occurs only once in four years after three successive, one year old seedlings are harvested.

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?

Because of MB efficacy, fumigation occurs only once in a four year cycle. Therefore, three successive annual seedling crops are produced for each fumigation event. Alternatives will require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, increasing significantly the costs and environmental burden. In addition, it is estimated (Dr. George Lowerts, International Paper, personal communication) that a 10 day delay would be incurred with alternative treatments such as 1,3-D to avoid phytotoxic effects.

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:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	not available	not available	not available	656	656	656
RATIO OF FLAT FUMIGATION METHYL BROMIDE USE TO STRIP/BED USE IF STRIP TREATMENT IS USED	not available	not available	not available	flat fumigation	flat fumigation	flat fumigation
AMOUNT OF METHYL BROMIDE ACTIVE INGREDIENT USED *(total kilograms)*	not available	not available	not available	246,032	246,032	246,032
FORMULATIONS OF METHYL BROMIDE *(methyl bromide:chloropicrin)*	not available	not available	not available	98:2	98:2	98:2
METHOD BY WHICH METHYL BROMIDE APPLIED *(e.g. injected at 25cm depth, hot gas)*	not available	not available	not available	shank injected w/tarp	shank injected w/tarp	shank injected w/tarp
APPLICATION RATE [ACTIVE INGREDIENT] (kg/ha*)	not available	not available	not available	375	375	375
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)**	not available	not available	not available	37.5	37.5	37.5
APPLICATION RATE [FORMULATION] (kg/ha*)	not available	not available	not available	383	383	383
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	not available	not available	not available	38.3	38.3	38.3

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

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 current production requirements, only methyl bromide acceptably meets goals. Containerized production increases costs 2.5-3 times, making it economically unfeasible.
	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: *(e.g. transplants, bulbs, trees or cuttings)*	Forest seedlings (all pine species)
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	typically grown for 1 year for each of three crops before fumigation on fourth year
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	None
SOIL TYPES: *(Sand, loam, clay, etc.)*	light, medium, heavy
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Fumigation once in 4 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											
RAINFALL *(mm)*	Not available, but varies with diverse climates											
OUTSIDE TEMP. *(°C)*	Not available, but varies with diverse climates											
FUMIGATION SCHEDULE								1st year				
PLANTING SCHEDULE[a]		2nd 3rd 4th years										

[a]Fumigation occurs only once in four years after three successive, one year old seedlings 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?

Because of MB efficacy, fumigation occurs only once in a four year cycle. Therefore, three successive annual seedling crops are produced for each fumigation event. Alternatives will require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, increasing significantly the costs and environmental burden. In addition, it is estimated (Dr. George Lowerts, International Paper, personal communication) that 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:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	139	88	185	121	114	101
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)*	53,028	32,580	68,975	43,646	38,666	34,853
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*)**	381	371	374	362	338	345
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)**	38.1	37.1	37.4	36.2	33.8	34.5
APPLICATION RATE [FORMULATION] **(kg/ha*)**	389	379	382	369	345	352
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	38.9	37.9	38.2	36.2	33.8	34.5

** 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	KEY PESTS	SPECIFIC REASONS WHY METHYL BROMIDE IS NEEDED

METHYL BROMIDE USE IS REQUESTED		
Illinois Department of Natural Resources	**Fungi**: *Fusarium*;	Consistency in production of the variety of nursery plants grown.
	"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: *(e.g. transplants, bulbs, trees or cuttings)*	Hardwood seedlings, shrubs, prairie forbs
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Typically grown for 1 or 2 years
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	None
SOIL TYPES: *(Sand, loam, clay, etc.)*	Light
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	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:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	15	15	17	16	13	16
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)*	5,835	5,757	4,370	4,211	3,411	4,232
FORMULATIONS OF METHYL BROMIDE *(methyl bromide:chloropicrin)*	98:2	98:2	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*)	384	384	263	263	263	263
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)**	38.4	38.4	26.3	26.3	26.3	26.3
APPLICATION RATE [FORMULATION] (kg/ha*)	392	392	392	392	392	392
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	39.2	39.2	39.2	39.2	39.2	39.2

** 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*;	Only number 1 grades are sold; grade 2 and culls are discarded. To economically manage the range of pests, especially problematic fungal pathogens and nutsedges, methyl bromide is necessary as no alternatives provide both sufficient control and economic sustainability for high grade seedlings.
	Weeds: *Cyperus* (nutsedges)	

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: *(e.g. transplants, bulbs, trees or cuttings)*	Primarily loblolly pine; some hardwood species
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Typically grown for 1 year
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	None
SOIL TYPES: *(Sand, loam, clay, etc.)*	Light (62%); Medium (22%)
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Fumigation once in four years
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											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE								1st year				
PLANTING SCHEDULE[a]		2nd 3rd 4th years										

[a]Fumigation occurs only once in four years after three successive, one year old 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?

Because of MB efficacy, fumigation occurs only once in a four year cycle. Therefore, three successive annual seedling crops are produced for each fumigation event. Alternatives will require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, increasing significantly the costs and environmental burden. In addition, it is estimated (Dr. George Lowerts, International Paper, personal communication) that a 10 day delay would be incurred with alternative treatments such as 1,3-D to avoid phytotoxic effects.

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:	1997	1998	1999	2000	2001	2002
Area Treated *(hectares)*	63	64	72	66	61	64
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)*	25,642	25,935	29,649	21,516	21,709	24,231
Formulations of methyl bromide *(methyl bromide:chloropicrin)*	98:2	98:2	98:2	90:10	90:10	90:10
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*)**	407	405	412	327	355	379
Actual dosage rate [active ingredient] *(g/m²)**	40.7	40.5	41.2	32.7	35.5	37.9
Application rate [formulation] **(kg/ha*)**	415	413	420	363	394	421
Actual dosage rate of formulations *(g/m²)**	41.5	41.3	42.0	36.3	39.4	42.1

** 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	Key Pests	Specific reasons why methyl bromide is needed

USE IS REQUESTED		
Weyerhaeuser-West	**Fungi** [100% at times]: *Pythium* (damping-off, root rot), *Fusarium* (damping-off, root rot), *Phoma*, *Fusarium*, *Botrytis* (stem cankers);	High pathogen populations and potential for contamination with *Phytophthora ramorum* (sudden oak death) leave little room for production variability.
	Weeds: *Cyperus* (yellow nutsedge) [100% at times]	

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: *(e.g. transplants, bulbs, trees or cuttings)*	Pine, Christmas trees, some hardwoods (?)
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Typically one year seedling bed, one year transplant bed; transplants can be grown for 2, 3, or 4 years
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	None
SOIL TYPES: *(Sand, loam, clay, etc.)*	Light (60%), Medium (40%)
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	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											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE[a]						1st year						
PLANTING SCHEDULE		2nd 3rd										

[a]Typically fumigation occurs only once in three years after two successive, 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?

Because of MB efficacy, fumigation occurs only once in a three year cycle. Therefore, typically, two successive annual seedling crops are produced for each fumigation event. Alternatives will require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, increasing significantly the costs and environmental burden. In addition, it is estimated (Dr. George Lowerts, International Paper, personal communication) that a 10 day delay would be incurred with alternative treatments such as 1,3-D to avoid phytotoxic effects.

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:	1997	1998	1999	2000	2001	2002
Area Treated *(hectares)*	39	47	43	70	65	69
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)*	10,126	12,296	11,360	17,864	17,125	14,647
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*)**	263	263	263	255	263	211
Actual dosage rate [active ingredient] *(g/m^2)**	26.3	26.3	26.3	25.5	26.3	21.1
Application rate [formulation] **(kg/ha*)**	393	393	393	381	393	315
Actual dosage rate of formulations *(g/m^2)**	39.3	39.3	39.3	38.1	39.3	31.5

** 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 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: *(e.g. transplants, bulbs, trees or cuttings)*	Conifers (10-15 spp.), hardwoods (30-50 spp.), shrubs and forbs (>75 spp.)
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Bareroot cuttings, and transplants, typically grown 1-3 years
TYPICAL CROP ROTATION *(if any)* AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION: *(if any)*	None
SOIL TYPES: *(Sand, loam, clay, etc.)*	Light, Medium
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Fumigation typically once in a 1-3 year rotation, depending on species
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											
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?

Because of MB efficacy, fumigation occurs only once in a three year cycle. Therefore, typically, two successive annual seedling crops are produced for each fumigation event. Alternatives will require fumigation (with 1,3-D + chloropicrin, for example) prior to each crop, increasing significantly the costs and environmental burden. In addition, it is estimated (Dr. George Lowerts, International Paper, personal communication) that a 10 day delay would be incurred with alternative treatments such as 1,3-D to avoid phytotoxic effects.

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

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:	1997	1998	1999	2000	2001	2002
Area Treated *(hectares)*	83	98	91	87	80	72
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)*	31,772	34,997	31,961	28,308	26,844	26,273
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*)**	383	357	352	326	337	363
Actual dosage rate [active ingredient] *(g/m^2)**	38.3	35.7	35.2	32.6	33.7	36.3
Application rate [formulation] **(kg/ha*)**	391	364	359	333	344	370
Actual dosage rate of formulations *(g/m^2)**	39.1	36.4	35.9	33.3	34.4	37.0

** 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	fungal pathogens, annual and perennial weeds (e.g., nutsedge, Canada thistle); nematodes	Soil-borne diseases are of major concern, as well as nutsedge; best alternatives dazomet and metam-sodium are not effective against these pests in this climatic region.

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: *(e.g. transplants, bulbs, trees or cuttings)*	Conifers, hardwoods
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	Bareroot and transplants, typically 1, 2, or 3 years growth
TYPICAL CROP ROTATION *(if any)* AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION: *(if any)*	None
SOIL TYPES: *(Sand, loam, clay, etc.)*	Light
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	Fumigation every 3-4 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	JUI	AUG	SEPT	OCT	NOV	DEC	JAN	FEB
CLIMATIC ZONE	USDA zones 4b, 5b											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE[a]			(sometimes) Spring			(usually) Fall	(usually) Fall					
PLANTING SCHEDULE			usually after Fall fumigation									

[a]Fumigation schedules depend on growth as annual seedlings or additional bed requirements as transplants. Generally, fumigation occurs once in two or three years, but beds for certain hardwood species may be treated every year.

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. Until this time, MB is critical for the continuation of this industry. Because of MB efficacy, fumigation generally occurs only once in a three year cycle. Therefore, typically, successive crops are produced for each fumigation event.

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:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	52	55	46	51	34	34
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)*	14,043	14,914	12,301	13,825	8,954	8,954
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*)	269	269	269	269	263	263
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)**	26.9	26.9	26.9	26.9	26.3	26.3
APPLICATION RATE [FORMULATION] (kg/ha*)	401	401	401	401	401	401
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	40.1	40.1	40.1	40.1	40.1	40.1

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

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

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

REGION H - MICHIGAN HERBACEOUS PERENNIALS - 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 Herbaceous Perennials	**Nematodes:** *Meloidogyne hapla*, *Pratylenchus* spp., *Ditylenchus* spp.; **Fungi:** *Pythium* (damping-off, root rot), *Fusarium* (damping-off, root rot), *Phytophthora, Rhizoctonia;* **Weeds**: *Cyperus esculentus* (yellow nutsedge), *Inula brittanica*, *Oxalis stricta*, *Cirsium arvense*, *Rorippa sylvestris*	Research for effective alternative to MB is ongoing with USDA supported research due to be analyzed and reported after 2006 studies end. Until this time when field-tested alternatives can be identified, MB is critical to pest management for this industry.

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

REGION H - MICHIGAN HERBACEOUS PERENNIALS - TABLE 11.1: CHARACTERISTICS OF CROPPING SYSTEM

CHARACTERISTICS	MICHIGAN HERBACEOUS PERENNIALS
CROP TYPE: *(e.g. transplants, bulbs, trees or cuttings)*	ornamental herbaceous perennials (e.g., Delphinium, Hosta, Phlox)
ANNUAL OR PERENNIAL CROP: *(# of years between replanting)*	perennial: 2-year seeded (6% of treated area) and 2-year transplants (29% of treated area) are on a 2 year replant/fumigation cycle; 3-year transplants (65% of treated area) are on a 3 year replant/fumigation cycle
TYPICAL CROP ROTATION *(if any)* **AND USE OF METHYL BROMIDE FOR OTHER CROPS IN THE ROTATION:** *(if any)*	none
SOIL TYPES: *(Sand, loam, clay, etc.)*	various, light to heavy
FREQUENCY OF METHYL BROMIDE FUMIGATION: *(e.g. every two years)*	once in 2 to 3 years
OTHER RELEVANT FACTORS:	No other relevant factors identified.

REGION H - MICHIGAN HERBACEOUS PERENNIALS - TABLE 11.2 CHARACTERISTICS OF CLIMATE AND CROP SCHEDULE

Year 1 of two-year cycle.

	MAR-YEAR 1	APR-YEAR 1	MAY-YEAR 1	JUN-YEAR 1	JUL-YEAR 1	AUG-YEAR 1	SEPT-YEAR 1	OCT-YEAR 1	NOV-YEAR 1	DEC-YEAR 1	JAN-YEAR 1	FEB-YEAR 1
CLIMATIC ZONE	USDA zones 5a, 5b, 6a											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE			2-year transplants			2-year seedlings; 3-year transplants						
PLANTING SCHEDULE			2-year transplants				3-year transplants	3-year transplants				

Year 2 of two-year cycle.

	MAR-YEAR 2	APR-YEAR 2	MAY-YEAR 2	JUN-YEAR 2	JUL-YEAR 2	AUG-YEAR 2	SEPT-YEAR 2	OCT-YEAR 2	NOV-YEAR 2	DEC-YEAR 2	JAN-YEAR 2	FEB-YEAR 2
CLIMATIC ZONE	USDA zones 5a, 5b, 6a											
RAINFALL *(mm)*	Not available											
OUTSIDE TEMP. *(℃)*	Not available											
FUMIGATION SCHEDULE												
PLANTING SCHEDULE		2-year seedlings										

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

Until research results are compiled and analyzed, in 2006-2007, MB is the only proven treatment for the numerous plant species grown by this consortium. Fumigation schedule with MB is based on the effectiveness in managing the numerous pests. With alternatives, fumigation will likely have to be increased and timing of seedling and transplant production will be affected. Consequently, the ongoing research program must be completed to address implementation of production processes with newly identified alternatives.

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

REGION H - MICHIGAN HERBACEOUS PERENNIALS - TABLE 12.1 HISTORIC PATTERN OF USE OF METHYL BROMIDE

FOR AS MANY YEARS AS POSSIBLE AS SHOWN SPECIFY:	1997	1998	1999	2000	2001	2002
AREA TREATED *(hectares)*	263	258	248	228	129	128
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)*	103,351	101,.287	97,477	89,539	50,485	51,068
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)*	injected	injected	injected	injected	injected	injected
APPLICATION RATE [ACTIVE INGREDIENT] (kg/ha*)	392	392	392	392	392	392
ACTUAL DOSAGE RATE [ACTIVE INGREDIENT] *(g/m^2)**	39.2	39.2	39.2	39.2	39.2	39.2
APPLICATION RATE [FORMULATION] (kg/ha*)	400	400	400	400	400	400
ACTUAL DOSAGE RATE OF FORMULATIONS *(g/m^2)**	40	40	40	40	40	40

** 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). 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); (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
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

Name of Alternative	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
	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 A.). 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 A.]
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. 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. (Guillino et al., 2002; Martin, 2003).	not currently 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

Name of Alternative	TECHNICAL AND REGULATORY* REASONS FOR THE ALTERNATIVE NOT BEING FEASIBLE OR AVAILABLE	IS THE ALTERNATIVE CONSIDERED COST EFFECTIVE?
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 only 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
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. Disease problems would still require additional measures, and therefore, this alternative is not considered feasible.	no
Organic Amendments/ Compost	Not acceptably effective alone in weed management; often already incorporated 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)

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

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**

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 (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
[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 LOSS DATA SUMMARY

Yield loss estimates for the forest nursery sector do not adequately address the even greater effect that less than optimally healthy seedlings have on subsequent 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 substitute for MB.

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	Weeds, Fungi	+5% to –8%	0-3% loss
OVERALL LOSS ESTIMATE FOR ALL ALTERNATIVES TO PESTS			3-5%

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

Combinations of chemicals, such as chloropicrin in addition to 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. So far, none have proven cost effective and have generally resulted in an increased input of other pest control products. These products because of their physical limitations (e.g., low vapor pressure of metam-sodium) are criticized by nursery managers mostly for their lack of consistency, thus individual research trials are said to be skewed since large-scale production will result in more glaring differences between MB and many alternatives. As previously mentioned, 1,3-D may be restricted due to legal or geological factors. In addition, economic issues may have an impact on overall acceptability of these alternatives for the forest seedling nursery sector. Tests are being conducted on numerous crops on methyl iodide, although it has yet to complete the registration process, and it is unknown when registration might occur.

The use of virtually impermeable film (VIF) may offer a means of reducing MB use rates while maintaining efficacy and production goals . Work is being conducted to determine if this type of film is feasible in the U. S. from a technical standpoint (e.g., does it hold up physically in field conditions? can it be glued to acceptable specifications?, etc.) and economically feasible (e.g., cost of material, cost of application). However, the efficacy of VIF for U. S. agriculture may be different than that for Europe (Federal Register, 1998;). There is also interest in 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. Also, reduction in MB formulations from 98:2 to

50:50, reduction in use rate, and additional time with cover crop to reduce weed populations, and additional use of glyphosate to reduce weeds might reduce the overall use of MB. Experiments have indicated that some soil amendments can reduce adverse growth effects of some alternatives (e.g., dazomet). Work in Wisconsin (Enebak et al., 1990; Iver, ?) 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.

A major limitation with respect to the aforementioned research is the general lack of information to accurately assess pest control in large scale, compared to small research trials, including issues such as outgassing damage as a result of metam-sodium applications (e.g., see Application Request Packages). 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.

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. Its use is limited, however, to special circumstances where species survival or an extreme genetic value of the planting stock makes it 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 (Mc Nabb and VandersSchaaf, 2003) An estimate can be made that fewer than 10% of the national forest seedling production is containerized. Containerization is mandated by species or site requirements. An example is the use of containerized seedlings to reforest mine-spoil sites which are extremely harsh edaphic environments requiring a soil plug system to obtain adequate seedling survival (Lowerts, 2003).

A massive infrastructure investment would be necessary to shift the national production to containerization. According to Darrow (2002) (also see Appendix A) 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 would increase by *at least* 250% and may go up to 400%. 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 (or 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 only 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

Combinations of chemicals, such as chloropicrin in addition to 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). However, these products because of their physical limitations (e.g., low vapor pressure of metam-sodium) are criticized by nursery managers for their lack of consistency and outgassing problems of seedling destruction. As a result, individual research trials are said to be skewed, since large-scale production will result in more glaring differences between MB and many alternatives. As previously mentioned, 1,3-D may be restricted due to legal or geological factors. In addition, economic issues such as application costs may have an impact on overall acceptability of these alternatives for the forest seedling nursery sector.

Alternatives of chemical combinations with chloropicrin and 1,3-D, dazomet, or metam sodium can be feasible alternatives to MB in managing some common fungal pests, such as rot diseases (e.g., *Fusarium*, *Pythium*, and *Phytophthora* and other fungal pathogens) (e.g., Fraedrich and Dwinell, 1998; James et al., 2001). Overall, however, they have not been successful in effectively controlling the major pest problem of nurseries, nutsedge (Fraedrich and Dwinell, 1998). In nurseries that have a significant weed (usually nutsedge) problem, dazomet and metam-sodium have not been consistently effective in acceptably managing the pest [e.g., compare results (Carey, 1996; Carey, 1994) with (Weyerhaeuser #8, 1992-95)]. 1,3-dichloropropene (1,3-D) is an effective nematicide that may have some efficacy against plant pathogens, but its efficacy for weed management is unclear, and its overall use may be limited by local legal restrictions and pest-free permit requirements (e.g., Carey, 1996; Carey, 1994; Weyerhaeuser #10, 1994-96).

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 highly variable at best. The long-term impact on reforestation success with alternatives is not known. An important factor that should be considered for this industry 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 forest seedlings sector has made a strong case that MB is currently critical for production of healthy, high quality (and high value) forest seedlings in many nursery situations.

The industry is continuing to research alternatives and test improved chemical application technologies to increase the efficacy of some of the most viable alternatives. MB is considered to be critical in the short-term, with chemical alternatives the likely long-term solution. Non-chemical and biological control 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.

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) tarping material that has helped increase fumigation efficiencies and reduced application rates. HDPE increases MB soil residence time, increasing efficiency and reducing application rates. VIF would be considered a feasible means of further reducing emissions if a method could be developed to efficiently glue overlapping sheets of VIF film. VIF film becomes impractical if adjacent overlapping sheets cannot be glued. In addition, there is a problem with film breakage during application. Hopefully, current research underway can eliminate both these problems.

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 ratio is now more common. 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.

Fourth, forest seedlings nurseries routinely use integrated pest management (IPM) techniques to develop their fumigation strategies. Nurseries fumigate only once every four years, growing two seedling crops and two cover crops from one 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.	No trend was identified.	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 methyl bromide will motivate growers to try high barrier films.	The U. S. anticipates that the decreasing supply of methyl bromide will motivate growers to try lower MB dosage rates.	The U. S. anticipates that the decreasing supply of methyl bromide will motivate growers to try increasing the chloropicrin percentage in formulations.	The U. S. anticipates that the decreasing supply of methyl bromide 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: COSTS OF 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. $/ha)
REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	**Methyl Bromide**	**100**	**$ 17,819.99**	**$ 17,819.99**	**$ 17,819.99**
	Dazomet	95	$ 20,750.22	$ 20,750.22	$ 20,750.22
	1,3-D + Chloropicrin	97	$ 19,865.27	$ 19,865.27	$ 19,865.27
	Metam Sodium + Chloropicrin	97	$ 20,258.16	$ 20,258.16	$ 20,258.16
REGION B - INTERNATIONAL PAPER	**Methyl Bromide**	**100**	**$ 15,198.04**	**$ 15,198.04**	**$ 15,198.04**
	Dazomet	95	$ 17,834.62	$ 17,834.62	$ 17,834.62
	1,3-D + Chloropicrin	97	$ 17,890.23	$ 17,890.23	$ 17,890.23
	Metam Sodium + Chloropicrin	97	$ 18,199.16	$ 18,199.16	$ 18,199.16
REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES	**Methyl Bromide**	**100**	**$ 46,233.38**	**$ 46,233.38**	**$ 46,233.38**
	Dazomet	95	$ 53,883.26	$ 53,883.26	$ 53,883.26
	1,3-D + Chloropicrin	97	$ 53,883.26	$ 53,883.26	$ 53,883.26
	Metam Sodium + Chloropicrin	97	$ 53,883.26	$ 53,883.26	$ 53,883.26
REGION D - WEYERHAEUSER SOUTH	**Methyl Bromide**	**100**	**$ 15,509.50**	**$ 15,509.50**	**$ 15,509.50**
	Dazomet	95	$ 16,421.86	$ 16,421.86	$ 16,421.86
	1,3-D + Chloropicrin	97	$ 16,400.54	$ 16,400.54	$ 16,400.54
	Metam Sodium + Chloropicrin	97	$ 16,320.23	$ 16,320.23	$ 16,320.23
REGION E - WEYERHAEUSER WEST	**Methyl Bromide**	**100**	**$ 9,445.43**	**$ 9,445.43**	**$ 9,445.43**
	Dazomet	95	$ 11,250.12	$ 11,250.12	$ 11,250.12
	1,3-D + Chloropicrin	97	$ 11,250.12	$ 11,250.12	$ 11,250.12
	Metam Sodium + Chloropicrin	97	$ 9,844.09	$ 9,844.09	$ 9,844.09
REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION	**Methyl Bromide**	**100**	**$ 23,535.53**	**$ 23,535.53**	**$ 23,535.53**
	Dazomet	95	$ 30,009.19	$ 30,009.19	$ 30,009.19
	1,3-D + Chloropicrin	97	$ 29,077.80	$ 29,077.80	$ 29,077.80
	Metam Sodium + Chloropicrin	97	$ 29,077.80	$ 29,077.80	$ 29,077.80
REGION G - MICHIGAN SEEDLING ASSOCIATION	**Methyl Bromide**	100	**$ 88,948.96**	**$ 88,948.96**	**$ 88,948.96**
	Dazomet	95	$ 89,095.00	$ 89,095.00	$ 89,095.00
	1,3-D + Chloropicrin	97	$ 91,778.48	$ 91,778.48	$ 91,778.48
	Metam Sodium + Chloropicrin	97	$ 88,919.97	$ 88,919.97	$ 88,919.97
REGION H - MICHIGAN HERBACEOUS PERENNIALS	**Methyl Bromide**	**100**	**$12,195.67**	**$12,195.67**	**$12,195.67**
	Various Alternatives*	95	$52,172.45	$52,172.45	$52,172.45

**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. $/ha)*
REGION A - SOUTHERN FOREST NURSERY MANAGEMENT COOPERATIVE	**Methyl Bromide**	**$ 33,681.79**	**$ 15,861.80**
	Dazomet	$ 31,997.70	$ 11,247.48
	1,3-D + Chloropicrin	$ 32,671.34	$ 12,806.07
	Metam Sodium + Chloropicrin	$ 32,671.34	$ 12,413.18
REGION B - INTERNATIONAL PAPER	**Methyl Bromide**	**$ 33,410.60**	**$ 18,212.57**
	Dazomet	$ 31,740.07	$ 13,905.45
	1,3-D + Chloropicrin	$ 32,408.29	$ 14,518.06
	Metam Sodium + Chloropicrin	$ 32,408.29	$ 14,209.13
REGION C - ILLINOIS DEPARTMENT OF NATURAL RESOURCES	**Methyl Bromide**	**$ 216,389.24**	**$ 170,155.86**
	Dazomet	$ 205,569.78	$ 151,686.52
	1,3-D + Chloropicrin	$ 209,897.56	$ 156,014.30
	Metam Sodium + Chloropicrin	$ 209,897.56	$ 156,014.30
REGION D - WEYERHAEUSER SOUTH	**Methyl Bromide**	**$ 27,289.61**	**$ 11,780.11**
	Dazomet	$ 25,925.13	$ 9,503.28
	1,3-D + Chloropicrin	$ 26,470.92	$ 10,070.38
	Metam Sodium + Chloropicrin	$ 26,470.92	$ 10,150.69
REGION E - WEYERHAEUSER WEST	**Methyl Bromide**	**$ 18,790.12**	**$ 9,344.69**
	Dazomet	$ 17,850.62	$ 6,600.50
	1,3-D + Chloropicrin	$ 18,226.42	$ 6,976.30
	Metam Sodium + Chloropicrin	$ 18,226.42	$ 8,382.33
REGION F - NORTHEASTERN FOREST & CONSERVATION NURSERY ASSOCIATION	**Methyl Bromide**	**$ 33,486.87**	**$ 9,951.34**
	Dazomet	$ 31,812.52	$ 1,803.33
	1,3-D + Chloropicrin	$ 32,482.26	$ 3,404.46
	Metam Sodium + Chloropicrin	$ 32,482.26	$ 3,404.46
REGION G - MICHIGAN SEEDLING ASSOCIATION	**Methyl Bromide**	**$ 105,266.80**	**$ 16,317.84**
	Dazomet	$ 100,003.46	$ 10,908.46
	1,3-D + Chloropicrin	$ 102,108.80	$ 10,330.31
	Metam Sodium + Chloropicrin	$ 102,108.80	$ 13,188.83
REGION H - MICHIGAN HERBACEOUS PERENNIALS	**Methyl Bromide**	**$139,837.54**	**$101,527.78**
	Various Alternatives*	$132,945.66	$73,169.07

* 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 Spp	*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%)	***$ 27,442.51***	***$ 26,070.39***	***$ 26,619.24***	***$ 26,619.24***
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%)	***$ 762.81***	***$ 724.67***	***$ 739.93***	***$ 739.93***
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%)	***$ 5,476.47***	***$ 5,202.64***	***$ 5,312.17***	***$ 5,312.17***
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 33,681.79**	**$ 31,997.70**	**$ 32,671.34**	**$ 32,671.34**
- Fixed Costs per Hectare (U.S. $)	**$ 17,819.99**	**$ 20,750.22**	**$ 19,865.27**	**$ 20,258.16**
= Net Revenue per Hectare (U.S. $)	**$ 15,861.80**	**$ 11,247.48**	**$ 12,806.07**	**$ 12,413.18**
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 4,614.32**	**$ 3,055.73**	**$ 3,448.63**
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	**812,976**	**772,327**	**788,587**	**788,587**
*** Price per Unit (U.S. $/seedling)**	**$ 0.04**	**$ 0.04**	**$ 0.04**	**$ 0.04**
= Gross Revenue per Hectare (U.S. $)	**$ 33,410.60**	**$ 31,740.07**	**$ 32,408.29**	**$ 32,408.29**
- Fixed Costs per Hectare (U.S. $)	**$ 15,198.04**	**$ 17,834.62**	**$ 17,890.23**	**$ 18,199.16**
= Net Revenue per Hectare (U.S. $)	**$ 18,212.57**	**$ 13,905.45**	**$ 14,518.06**	**$ 14,209.13**
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 4,307.11**	**$ 3,694.51**	**$ 4,003.44**
2. Loss per Kilogram of MB (U.S. $)	**$ 0**	**$ 68.94**	**$ 59.14**	**$ 64.08**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**13%**	**11%**	**12%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**24%**	**20%**	**22%**

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	*281,507*	*267,431*	*273,062*	*273,062*
** Price per Unit (U.S. $/seedling)*	*$ 0.63*	*$ 0.63*	*$ 0.63*	*$ 0.63*
Gross Revenue per Proportion (82.5%)	***$ 145,539.00***	***$ 138,262.05***	***$ 141,172.83***	***$ 141,172.83***
Yield (shrub) per Hectare - Shrub Seedling	*259,032*	*246,081*	*251,261*	*251,261*
** Price per Unit (U.S. $/shrub)*	*$ 0.37*	*$ 0.37*	*$ 0.37*	*$ 0.37*
Gross Revenue per Proportion (12.5%)	***$ 11,872.30***	***$ 11,278.69***	***$ 11,516.14***	***$ 11,516.14***
Yield per Hectare - Forb Root Stock	*369,683*	*351,199*	*358,592*	*358,592*
** Price per Unit (U.S. $/root stock)*	*$ 0.04*	*$ 0.04*	*$ 0.04*	*$ 0.04*
Gross Revenue per Proportion (5%)	***$ 739.37***	***$ 702.40***	***$ 717.18***	***$ 717.18***
Yield (kilograms) per Hectare - Forb Seed	*669*	*635*	*649*	*649*
** Price per Unit (U.S. $/kilogram)*	*$ 87.08*	*$ 87.08*	*$ 87.08*	*$ 87.08*
Gross Revenue per Proportion	***$ 58,238.57***	***$ 55,326.64***	***$ 56,491.41***	***$ 56,491.41***
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 216,389.24**	**$ 205,569.78**	**$ 209,897.56**	**$ 209,897.56**
- Fixed Costs per Hectare (U.S. $)	**$ 46,233.38**	**$ 53,883.26**	**$ 53,883.26**	**$ 53,883.26**
= Net Revenue per Hectare (U.S. $)	**$ 170,155.86**	**$ 151,686.52**	**$ 156,014.30**	**$ 156,014.30**
LOSS MEASURES				
1. Loss per Hectare (U.S $)	**$ 0**	**$ 18,469.34**	**$ 14,141.56**	**$ 14,141.56**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 70.12**	**$ 53.69**	**$ 53.69**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**9%**	**7%**	**7%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**11%**	**8%**	**8%**

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	**586,621**	**557,290**	**569,022**	**569,022**
*** Price per Unit (U.S. $/seedling)**	**$ 0.05**	**$ 0.05**	**$ 0.05**	**$ 0.05**
= Gross Revenue per Hectare (U.S. $)	**$ 27,289.61**	**$ 25,925.13**	**$ 26,470.92**	**$ 26,470.92**
- Fixed Costs per Hectare (U.S. $)	**$ 15,509.50**	**$ 16,421.86**	**$ 16,400.54**	**$ 16,320.23**
= Net Revenue per Hectare (U.S. $)	**$ 11,780.11**	**$ 9,503.28**	**$ 10,070.38**	**$ 10,150.69**
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 2,276.84**	**$ 1,709.73**	**$ 1,629.42**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 27.08**	**$ 20.34**	**$ 19.38**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**8%**	**6%**	**6%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**19%**	**15%**	**14%**

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	**62,634**	**59,502**	**60,755**	**60,755**
*** Price per Unit (U.S. $/seedling)**	**$ 0.30**	**$ 0.30**	**$ 0.30**	**$ 0.30**
= Gross Revenue per Hectare (U.S. $)	**$ 18,790.12**	**$ 17,850.62**	**$ 18,226.42**	**$ 18,226.42**
- Fixed Costs per Hectare (U.S. $)	**$ 9,445.43**	**$ 11,250.12**	**$ 11,250.12**	**$ 9,844.09**
= Net Revenue per Hectare (U.S. $)	**$ 9,344.69**	**$ 6,600.50**	**$ 6,976.30**	**$ 8,382.33**
LOSS MEASURES				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 2,744.20**	**$ 2,368.40**	**$ 962.37**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 31.32**	**$ 27.03**	**$ 10.98**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**15%**	**13%**	**5%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**29%**	**25%**	**10%**

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. $/seedling)*	*$ 0.20*	*$ 0.20*	*$ 0.20*	*$ 0.20*
Gross Revenue per Proportion (8%)	***$ 3,887.79***	***$ 3,693.40***	***$ 3,771.15***	***$ 3,771.15***
Yield per Hectare Conifer Seedling 2-0	*185,329*	*176,062*	*179,769*	*179,769*
** Price per Unit (U.S. $/seedling)*	*$ 0.20*	*$ 0.20*	*$ 0.20*	*$ 0.20*
Gross Revenue per Proportion (4%)	***$ 1,457.92***	***$ 1,385.02***	***$ 1,414.18***	***$ 1,414.18***
Yield per Hectare Conifer Seedling 3-0	*123,553*	*117,375*	*119,846*	*119,846*
** Price per Unit (U.S. $/seedling)*	*$ 0.28*	*$ 0.28*	*$ 0.28*	*$ 0.28*
Gross Revenue per Proportion (14%)	***$ 4,900.92***	***$ 4,655.87***	***$ 4,753.89***	***$ 4,753.89***
Yield per Hectare Deciduous Tree Seedling 1-0	*123,553*	*117,375*	*119,846*	*119,846*
** Price per Unit (U.S. $/seedling)*	*$ 0.25*	*$ 0.25*	*$ 0.25*	*$ 0.25*
Gross Revenue per Proportion (55%)	***$ 16,988.48***	***$ 16,139.06***	***$ 16,478.83***	***$ 16,478.83***
Yield per Hectare Deciduous Tree Seedling 2-0	*123,553*	*117,375*	*119,846*	*119,846*
** Price per Unit (U.S. $/seedling)*	*$ 0.31*	*$ 0.31*	*$ 0.31*	*$ 0.31*
Gross Revenue per Proportion (9%)	***$ 3,410.05***	***$ 3,239.55***	***$ 3,307.75***	***$ 3,307.75***
Yield per Hectare Decid. Shrub Seedling 1-0	*123,553*	*117,375*	*119,846*	*119,846*
** Price per Unit (U.S. $/seedling)*	*$ 0.23*	*$ 0.23*	*$ 0.23*	*$ 0.23*
Gross Revenue per Proportion (10%)	***$ 2,841.71***	***$ 2,699.62***	***$ 2,756.46***	***$ 2,756.46***
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 33,486.87**	**$ 31,812.52**	**$ 32,482.26**	**$ 32,482.26**
- Fixed Costs per Hectare (U.S. $)	**$ 23,535.53**	**$ 30,009.19**	**$ 29,077.80**	**$ 29,077.80**
= Net Revenue per Hectare (U.S. $)	**$ 9,951.34**	**$ 1,803.33**	**$ 3,404.46**	**$ 3,404.46**
Loss Measures				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 8,148.00**	**$ 6,546.88**	**$ 6,546.88**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 47.75**	**$ 38.37**	**$ 38.37**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**24%**	**20%**	**20%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**82%**	**66%**	**66%**

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	*535,395*	*508,625*	*519,333*	*519,333*
** Price per Unit (U.S. $/seedling)*	*$ 0.16*	*$ 0.16*	*$ 0.16*	*$ 0.16*
Gross Revenue per Proportion (60%)	***$ 51,397.87***	***$ 48,827.98***	***$ 49,855.94***	***$ 49,855.94***
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%)	***$ 4,447.89***	***$ 4,225.50***	***$ 4,314.46***	***$ 4,314.46***
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%)	***$ 49,421.03***	***$ 46,949.98***	***$ 47,938.40***	***$ 47,938.40***
= Aggregate Gross Revenue per Hectare (U.S. $)	**$ 105,266.80**	**$ 100,003.46**	**$ 102,108.80**	**$ 102,108.80**
- Fixed Costs per Hectare (U.S. $)	**$ 88,948.96**	**$ 89,095.00**	**$ 91,778.48**	**$ 88,919.97**
= Net Revenue per Hectare (U.S. $)	**$ 16,317.84**	**$ 10,908.46**	**$ 10,330.31**	**$ 13,188.83**
Loss Measures				
1. Loss per Hectare (U.S. $)	**$ 0**	**$ 5,168.20**	**$ 6,228.70**	**$ 2,887.84**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$ 0**	**$ 57.64**	**$ 69.46**	**$ 32.21**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**5%**	**6%**	**3%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**33%**	**37%**	**19%**

REGION H - MICHIGAN HERBACEOUS PERENNIALS - TABLE E.8: ECONOMIC IMPACTS OF METHYL BROMIDE ALTERNATIVES

Region H - Michigan Herbaceous Perennials	Methyl Bromide	Various Alternatives**
Yield Loss (%)	**0%**	**5%**
Yield per Hectare Conifer Seedlings	144,942	*137,694*
*** Price per Unit (U.S. $/seedling)**	*$0.96*	*$0.96*
Gross Revenue per Proportion (60%)	***$139,838***	***$132,846***
= Operating Cost per Hectare (U.S. $)	**$38,310**	**$59,677**
= Net Revenue per Hectare (U.S. $)	**$101,528**	**$73,169**
Loss Measures		
1. Loss per Hectare (U.S. $)	**$0**	**$28,359**
2. Loss per Kilogram of Methyl Bromide (U.S. $)	**$0**	**$145**
3. Loss as a Percentage of Gross Revenue (%)	**0%**	**20%**
4. Loss as a Percentage of Net Revenue (%)	**0%**	**28%**

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

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 <u>*pre-plant uses of methyl bromide*</u> 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 methyl bromide requested. This measure indicates the value of methyl bromide to crop production but is also useful for structural and post-harvest uses.

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

(5) Changes in profit margins. We define profit margin to be profits as a percentage of gross revenues, where profits are gross revenues minus all fixed and operating costs. This measure would provide the best indication of the total impact of the loss of methyl bromide to an enterprise. Again, operating costs may be difficult to measure and fixed costs even more difficult.

These measures represent different ways to assess the economic feasibility of methyl bromide alternatives for methyl bromide 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 methyl bromide. 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 percent 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 operating profit 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 cash returns 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 only quantified for the Northern region where the 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.

Michigan Herbaceous Perennials

Michigan herbaceous perennials, labeled Region H above, comprises three categories of production systems with numerous plant varieties grown within each category. These categories are 2-year seeded (6% of plants), 2-year transplanted (29% of plants), and 3-year transplanted (65% of plants). To represent growing conditions on a typical hectare of production, and to account for the fact that each category has different revenues and costs of production, the above measures were calculated using representative revenues and costs for each category; these were weighted by the proportion of total production. In addition, various combinations of alternative pest control measures would need to be employed to accomplish the most effective and lowest cost pest control without MB. These various alternative pest control measures include physical removal and sanitation, the use of artificial media, and soil treatment with 1,3-D +chloropicrin.

Using alternatives to MB would lead to an estimated yield loss of 5% and an approximate 100% increase in operating costs. This will result in losses as a percent of gross and net revenue of 20% and 28%, respectively. If growers switch to MB alternatives, their losses, in terms of MB per kilogram no longer used, will be approximately $145. Based on the economic impact of switching to MB alternatives, the U. S. believes that currently, alternatives to MB are not economically feasible and growers of herbaceous perennials have a critical need for MB.

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 includes commercial interests, has spent $1.2 million on MB alternatives since 1992. This is significant, considering 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. The Michigan Field Grown Herbaceous Perennial Growers is currently assisting in field trials with Michigan State University in research supported in part by the USDA MB Alternatives Grant Program. For 2002-2004, $68,979 has been allocated for weed and nematode studies and $370,701 has been granted for a study that runs from 2003-2006. This work is a large investment in identifying alternatives for Michigan growers.9

One difficulty in identifying alternatives to MB is the problem of applicability of information obtained from research plots to large-scale commercial production requirements. Fumigants applied to small plots may not exhibit similar effects when applied to commercial seedling beds. Overall, especially under high pest pressure, alternative chemicals have not demonstrated consistently effective results compared to MB. Continued research into methods adaptable to large-scale application 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.

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

Plans to reduce MB in formulations to 50% mixed with chloropicrin are already underway, even though nurseries currently use MB only once in three to four years on a particular bed. 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 methyl bromide 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 methyl bromide 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 use is considered critical because there are conditions in some nurseries within this sector with high pest pressure where no feasible alternatives or substitutes are currently effective. While some alternatives appear to offer an alternative to MB for some pests in some research trials, the high production nursery industry demands a consistent and reliable pre-plant fumigation treatment that can allow production goals to be met. Currently MB is the only consistent provider of this requirement.

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APPENDIX A. 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 (Over and above ~$50,000 cost for soil-based system)	$ 150,000
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

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

Methyl Bromide Critical Use Exemption Process — Date: 2/26/2004 — Average Hectares in the US: 51,506

2006 Methyl Bromine Usage Numerical Index (BUNI) — Sector: FOREST SEEDLINGS — % of Average Hectares Requested: 2%

REGION	2006 Amount of Request: Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	2001 & 2002 Average Use*: Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	Quarantine and Pre-Shipment	Regional Hectares**: 2001 & 2002 Average	% of Average	% of Requested Hectares
Southern Forest Nursery Mgmt Coop.	246,032	656	375	246,032	656	375	50%	not available	not available	not available
International Paper	34,181	137	250	36,759	108	341	50%	not available	not available	not available
Illinois Department of Natural Resources	4,264	16	263	3,822	15	263	50%	not available	not available	not available
Weyerhaeuser (SE)	17,962	53	336	22,970	63	367	50%	not available	not available	not available
Weyerhaeuser (NW)	25,358	96	263	15,886	67	236	50%	not available	not available	not available
NE Forest & Conservation Nursery Assoc.	32,455	95	341	26,558	76	349	50%	not available	not available	not available
Michigan Seedling Association	9,144	34	269	8,954	34	263	50%	not available	not available	not available
Michigan Herbaceous Perennials	4,763	12	392	50,723	129	392	50%	not available	not available	not available
TOTAL OR AVERAGE	**374,159**	**1,100**	**311**	**411,704**	**1,147**	**323**	**50%**	not available	not available	not available

REGION (2006 Nomination Options)	2006 Request	Subtractions from Requested Amounts (kgs): (-) Double Counting	(-) Growth or 2002 CUE Comparison	(-) Use Rate Difference	(-) QPS	Combined Impacts Adjustment (kgs): HIGH	LOW	MOST LIKELY IMPACT VALUE: Kilograms (kgs)	Hectares (ha)	Use Rate (kg/ha)	% Reduction
Southern Forest Nursery Mgmt Coop.	246,032	71,336	-	-	87,348	87,348	87,348	87,348	233	375	64%
International Paper	34,181	-	7,271	-	13,455	13,455	13,455	13,455	54	250	61%
Illinois Department of Natural Resources	4,264	-	442	-	1,911	1,911	1,911	1,911	7	263	55%
Weyerhaeuser (SE)	17,962	-	-	-	8,981	8,981	8,981	8,981	27	336	50%
Weyerhaeuser (NW)	25,358	-	7,669	1,803	7,943	7,943	7,943	7,943	34	236	69%
NE Forest & Conservation Nursery Assoc.	32,455	-	6,514	-	12,970	12,970	12,970	12,970	38	341	60%
Michigan Seedling Association	9,144	-	-	191	4,477	4,477	4,477	4,477	17	263	51%
Michigan Herbaceous Perennials	4,763	-	-	-	2,381	2,381	2,381	2,381	6	392	50%
Nomination Amount	**374,159**	**302,823**	**280,926**	**278,933**	**139,467**	**139,467**	**139,467**	**139,882**	**415**	**337**	**63%**
% Reduction from Initial Request	**0%**	**19%**	**25%**	**25%**	**63%**	**63%**	**63%**	**63%**	**62%**		

REGION (Adjustments to Requested Amounts)	Use Rate (kg/ha): 2006	Low	(%) Karst Topography: High	Low	(%) 100 ft Buffer Zones: High	Low	(%) Key Pest Distribution: High	Low	Regulatory Issues (%): High	Low	Unsuitable Terrain (%): High	Low	Cold Soil Temp (%): High	Low	Combined Impacts (%): HIGH	LOW
Southern Forest Nursery Mgmt Coop.	375	375	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
International Paper	250	250	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
Illinois Department of Natural Resources	263	263	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
Weyerhaeuser (SE)	336	336	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
Weyerhaeuser (NW)	263	236	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
NE Forest & Conservation Nursery Assoc.	341	341	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
Michigan Seedling Association	269	263	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%
Michigan Herbaceous Perennials	392	392	0	0	0	0	100	100	0	0	0	0	0	0	100%	100%

REGION (Other Considerations)	Dichotomous Variables (Y/N): Strip Bed Treatment	Currently Use Alternatives?	Research / Transition Plans	Tarps / Deep Injection Used	Pest-free Cert. Requirement	Other Issues: Change from Prior CUE Request (+/-)	Verified Historic MB Use / State	Frequency of Treatment	Economic Analysis: Loss per Hectare (US$/ha)	Loss per Kilogram of MB (US$/kg)	Loss as a % of Gross Revenue	Loss as a % of Net Revenue	Quality/ Time/ Market Window/ Yield Loss (%)	Marginal Strategy
Southern Forest Nursery Mgmt Coop.	No	Yes	Yes	Tarp	Yes	0	No		$ 3,056	$ 33	9%	19%	3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic
International Paper	No	Yes	Yes	Tarp	Yes	-	No		$ 3,695	$ 59	11%	20%	3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic
Illinois Department of Natural Resources	No	Yes	Yes	Tarp	Yes	0	No		$ 14,142	$ 54	7%	8%	3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic
Weyerhaeuser (SE)	No	Yes	Yes	Tarp	Yes	-	No		$ 1,710	$ 20	6%	15%	3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic
Weyerhaeuser (NW)	No	Yes	Yes	Tarp	Yes	0	No		$ 2,368	$ 27	13%	25%	3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic
NE Forest & Conservation Nursery Assoc.	No	Yes	Yes	Tarp	Yes	0	No		$ 6,547	$ 38	20%	66%	3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic
Michigan Seedling Association	No	Yes	Yes	Tarp	Yes	0	No		$ 5,988	$ 67	6%	37%	3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic
Michigan Herbaceous Perennials	No	Yes	Yes	Tarp		N/A	No						3 ~ 5% Yield Loss	metam/Pic or 1,3-D/Pic

Notes: * International Paper and Weyerhaeuser (SE) were included in the Southern Forest Nursery Management Cooperative, therefore they were removed from the Southern Forest Nursery Mgmt. Coop. Application as double counting.

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

Footnotes for Appendix B:

Values may not sum exactly due to rounding.

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

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

14. **<u>Subtraction from Requested Amounts, Use Rate Difference</u>** – Subtractions from requested amounts, use rate difference is the estimate measured in kilograms of the lower of the historic use rate or the requested use rate. The subtraction estimate is calculated as the 2006 Request minus Double Counting, minus Growth or 2002 CUE Comparison, minus the QPS amount, if applicable, minus the difference between the requested use rate and the lowest use rate applied to the remaining hectares.

15. **<u>Adjustments to Requested Amounts</u>** – Adjustments to requested amounts were factors that reduced to total amount of methyl bromide requested by factoring in the specific situations were the applicant could use alternatives to methyl bromide. These are calculated as proportions of the total request. We have tried to make the adjustment to the requested amounts in the most appropriate category when the adjustment could fall into more than one category.
    16. **<u>(%) Karst topography</u>** – Percent karst topography is the proportion of the land area in a nomination that is characterized by karst formations. In these areas, the groundwater can easily become contaminated by pesticides or their residues. Regulations are often in place to control the use of pesticide of concern. Dade County, Florida, has a ban on the use of 1,3D due to its karst topography.
    17. **<u>(%) 100 ft Buffer Zones</u>** – Percentage of the acreage of a field where certain alternatives to methyl bromide cannot be used due the requirement that a 100 foot buffer be maintained between the application site and any inhabited structure.
    18. **<u>(%) Key Pest Impacts</u>** - Percent (%) of the requested area with moderate to severe pest problems. Key pests are those that are not adequately controlled by MB alternatives. For example, the key pest in Michigan peppers, *Phytophthora* spp. infests approximately 30% of the vegetable growing area. In southern states the key pest in peppers is nutsedge.
    19. **<u>Regulatory Issues (%)</u>** - Regulatory issues (%) is the percent (%) of the requested area where alternatives cannot be legally used (e.g., township caps) pursuant to state and local limits on their use.
    20. **<u>Unsuitable Terrain (%)</u>** – Unsuitable terrain (%) is the percent (%) of the requested area where alternatives cannot be used due to soil type (e.g., heavy clay soils may not show adequate performance) or terrain configuration, such as hilly terrain. Where the use of alternatives poses application and coverage problems.
    21. **<u>Cold Soil Temperatures</u>** – Cold soil temperatures is the proportion of the requested acreage where soil temperatures remain too low to enable the use of methyl bromide alternatives and still have sufficient time to produce the normal (one or two) number of crops per season or to allow harvest sufficiently early to obtain the high prices prevailing in the local market at the beginning of the season.
    22. **<u>Combined Impacts (%)</u>** - Total combined impacts are the percent (%) of the requested area where alternatives cannot be used due to key pest, regulatory, soil impacts, temperature, etc. In each case the total area impacted is the conjoined area that is impacted by any individual impact. The effects were assumed to be independently distributed unless contrary evidence was available (e.g., affects are known to be mutually exclusive). For example, if 50% of the requested area had moderate to severe key pest pressure and 50% of the requested area had karst topography, then 75% of the area was assumed to require methyl bromide rather than the alternative. This was calculated as follows: 50% affected by key pests and an additional 25% (50% of 50%) affected by karst topography.

23. **<u>Qualifying Area</u>** - Qualifying area (ha) is calculated by multiplying the adjusted hectares by the combined impacts.
24. **<u>Use Rate</u>** - Use rate is the lower of requested use rate for 2006 or the historic average use rate.
25. **<u>CUE Nominated amount</u>** - CUE nominated amount is calculated by multiplying the qualifying area by the use rate.
26. **<u>Percent Reduction</u>** - Percent reduction from initial request is the percentage of the initial request that did not qualify for the CUE nomination.
27. **<u>Sum of CUE Nominations in Sector</u>** - Self-explanatory.
28. **<u>Total US Sector Nomination</u>** - Total U.S. sector nomination is the most likely estimate of the amount needed in that sector.
29. **<u>Dichotomous Variables</u>** – dichotomous variables are those which take one of two values, for example, 0 or 1, yes or no. These variables were used to categorize the uses during the preparation of the nomination.
    30. **<u>Strip Bed Treatment</u>** – Strip bed treatment is ‘yes’ if the applicant uses such treatment, no otherwise.
    31. **<u>Currently Use Alternatives</u>** – Currently use alternatives is ‘yes’ if the applicant uses alternatives for some portion of pesticide use on the crop for which an application to use methyl bromide is made.

32. **Research/ Transition Plans** – Research/ Transition Plans is 'yes' when the applicant has indicated that there is research underway to test alternatives or if applicant has a plan to transition to alternatives.
33. **Tarps/ Deep Injection Used** – Because all pre-plant methyl bromide use in the US is either with tarps or by deep injection, this variable takes on the value 'tarp' when tarps are used and 'deep' when deep injection is used.
34. **Pest-free cert. Required** - This variable is a 'yes' when the product must be certified as 'pest-free' in order to be sold

35. **Other Issues**.- Other issues is a short reminder of other elements of an application that were checked
    36. **Change from Prior CUE Request**- This variable takes a '+' if the current request is larger than the previous request, a '0' if the current request is equal to the previous request, and a '-' if the current request is smaller that the previous request.
    37. **Verified Historic Use/ State**- This item indicates whether the amounts requested by administrative area have been compared to records of historic use in that area.
    38. **Frequency of Treatment** – This indicates how often methyl bromide is applied in the sector. Frequency varies from multiple times per year to once in several decades.

39. **Economic Analysis** – provides summary economic information for the applications.
    40. **Loss per Hectare** – This measures the total loss per hectare when a specific alternative is used in place of methyl bromide. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars.
    41. **Loss per Kilogram of Methyl Bromide** – This measures the total loss per kilogram of methyl bromide when it is replaced with an alternative. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars.
    42. **Loss as a % of Gross revenue** – This measures the loss as a proportion of gross (total) revenue. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars.
    43. **Loss as a % of Net Operating Revenue** -This measures loss as a proportion of total revenue minus operating costs. Loss comprises both the monetized value of yield loss (relative to yields obtained with methyl bromide) and any additional costs incurred through use of the alternative. It is measured in current US dollars. This item is also called net cash returns.

44. **Quality/ Time/ Market Window/Yield Loss (%)** – When this measure is available it measures the sum of losses including quality losses, non-productive time, missed market windows and other yield losses when using the marginal strategy.
45. **Marginal Strategy** -This is the strategy that a particular methyl bromide user would use if not permitted to use methyl bromide.

APPENDIX C. Summary of New Applicants

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

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

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

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

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

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

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