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Assessment of potential impacts from the elimination of methyl bromide in fruit and vegetable trade

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Assessment of potential impacts from the elimination of methyl bromide in fruit and vegetable trade.

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Index words: Latin America, Plant protection, Quarantine, APHIS

Abstract

Methyl bromide is a broad spectrum fumigant effective against nematodes, diseases, insects, rodents, and weeds. Methyl bromide provides countries that import fruits and vegetables with an important safety net for preventing the spread of exotic pests across their borders and, therefore, plays an important role in reducing phytosanitary trade barriers and promoting free trade. However, U.S. environmental policy prohibits the production and importation of methyl bromide after December of 2000. Elimination of this economically significant fumigant could have a major impact on fresh fruit and vegetable production and trade, limiting future industry growth and raising consumer prices.

Introduction

Methyl bromide is a broad spectrum fumigant effective against nematodes, diseases, insects, rodents, and weeds. It has been widely used in pre-plant and postharvest applications around the world since the 1960s (Chakrabarti and Bell, 1993). Currently, about 85% of all methyl bromide manufactured is used in agriculture production for pre-plant soil fumigation, with another 10% used in postharvest treatments, and the remainder used for the fumigation of buildings and other structures. Methyl bromide is extensively used because it is an effective, low technology method for killing soil borne pests and for preventing the spread of pests during international shipment of both food and non-food products.

In order to prevent the spread of diseases and pests, government agencies use plant protection and quarantine (PPQ) programs to regulate imported produce and

maintain phytosanitary standards. Methyl bromide has become an integral part of almost every nation's PPQ program because of its effectiveness (Ross and Vail, 1993). These programs are designed to prevent the spread of pests along marketing channels and maintain pest free zones in major producing regions. Methyl bromide provides countries that import fruits and vegetables with an important safety net for preventing the spread of exotic pests across their borders and, therefore, plays an important role in reducing phytosanitary trade barriers and promoting free trade. However, U.S. environmental policy prohibits the production and importation of methyl bromide after December of 2000. This ban is based on research that suggests methyl bromide is involved in the depletion of the stratospheric ozone layer (U.S. General Accounting Office, 1995). Elimination of this economically significant fumigant could have a major impact on fresh fruit and vegetable production and trade, limiting future industry growth and raising consumer prices.

This article discusses the regulations that control methyl bromide with respect to the current use patterns, focusing on its value to the import and export trade of fresh fruits and vegetables, and the current status of alternatives to this multipurpose fumigant.

Regulation of methyl bromide

Concern over the depletion of the stratospheric ozone layer by industrial and agricultural substances prompted the United Nations Environmental Program to develop a protocol which limits such substances' use and availability (Hathaway and Giudice, 1996). In 1986, the Montreal Protocol, guidelines to limit production and consumption of chlorine- and bromine-containing substances that may deplete stratospheric ozone, was negotiated and accepted by the international community with over 150 countries signatory to the agreement. Subsequently, the U.S. Congress developed national regulations to prevent ozone layer degradation and then amended the Clean Air Act in 1990, adding Title VI to address the potential threat of ozone layer depletion (Hathaway

and Giudice, 1996). These regulations, the Montreal Protocol and Title VI of the Clean Air Act, attempt to limit or reduce the loss of stratospheric ozone by controlling ozone degrading substances. Regulatory action under these policies is based upon a substance's Ozone Depletion Potential (ODP) relative to chlorofluorocarbon-11 (CFC-11), a refrigerant and significant ozone depleting substance. The Montreal Protocol and Title VI of the Clean Air Act require that substances with an ODP greater than 0.2 (20% that of CFC-11) be listed as a Class I ozone depleting substance (U.S. General Accounting Office, 1995). All identified Class I ozone depleting substances have had limitations imposed on their production and eventually production of such substances may be completely banned.

Scientific assessments performed in 1991 and 1992 determined that methyl bromide has an ODP of about 0.7. This rating indicates that methyl bromide can contribute significantly to the depletion of the stratospheric ozone layer, similar to CFC-11. In December of 1993, the U.S. Environmental Protection Agency issued regulations pertaining to future use of methyl bromide and, accordingly, U.S. methyl bromide production was limited to 1991 levels in 1995 as required by the the Clean Air Act and Montreal Protocol. Both the Montreal Protocol and the U.S. Clean Air Act restrict production of methyl bromide, however, the Clean Air Act is more restrictive than the Montreal Protocol. The Montreal Protocol allows production and/or importation of methyl bromide for pre-shipment fumigation of export products and PPQ uses and does not establish a phase-out target date for production and/or importation of methyl bromide for other uses. The Clean Air Act provides no exemptions on any methyl bromide use and has established a permanent phase out date for methyl bromide of January 1, 2001, at which time all U.S. production and importation of methyl bromide will be prohibited. Prior to the phase out date, no restrictions other than the reduced production (to 1991 levels) have been imposed.

Current methyl bromide PPQ usage

The U.S. Department of Agriculture's Animal and Plant Health Inspection Service (APHIS) PPQ treatment manual lists fumigants, aerosols, dips, dusts, and sprays as potential chemical treatments for PPQ purposes. However, there are few, if any, alternative chemical PPQ procedures for most of the imported commodities currently treated with methyl bromide. In addition, methyl bromide fumigation treatments are the only chemical procedures approved for use on fruit and vegetable imports. APHIS has developed methyl bromide treatment procedures for 59 different fruit and vegetable products and product categories (Table 1) (USDA, 1994). APHIS has also authorized some non-chemical treatments for PPQ purposes such as vapor heat, hot water, cold, and quick freeze, but, these treatments are only useful in a few selected pest/host combinations (USDA, 1994). Currently, 20 fruit and vegetable products and product categories (Asparagus, Avocado, blueberry, Cabbage, Cherimoya, Cherries, Cipollini, Garlic, Garden bean, Grapes, Horseradish, Kiwi, Lettuce, Lemon, Okra, Pear, Peas, Tuna (fruit), Yam, Stone fruit (apricot, peach, etc.)) require methyl bromide fumigation prior to entrance into the U.S. market, unless special preclearence is established (USDA, 1996).

Value of methyl bromide usage

In an attempt to reduce the impact of losing methyl bromide in January of 2001, government, academic and private industry research has focused on finding alternative treatment procedures for pest control. Since about 85% of all the methyl bromide used is in agricultural production as a soil fumigant, primarily in tomato and strawberry, alternative production applications are the primary focus of most current research (Hathaway and Giudice, 1996). This research approach, although important, ignores the growing importance and need for methyl bromide alternatives in the international trade of fruits and vegetables as a fumigant to prevent movement of unwanted pests and the control of food borne pathogens. The consequences to international trade from the loss

of methyl bromide are perhaps more significant than those to production agriculture because alternatives, although less effective than methyl bromide, do exist for methyl bromide's production applications. However, foreign grown produce destined for U.S. markets which is rejected at the port of entry because PPQ treatments do not exist represent not only a loss of production costs, but also marketing and transportation costs necessary to reach the port as well as the opportunity costs associated with lost markets and sales. The loss of methyl bromide for PPQ will be detrimental to international trade in fresh fruits and vegetables until alternatives are developed and treatment procedures are implemented.

The loss of ethylene dibromide (EDB) is a example of the impact that the loss of methyl bromide will have on the international trade fruits and vegetables. EDB fumigation was the primary PPQ procedure used by the U.S. for controlling fruit flies, Tephritidae, and mango weevils, *Sternochetus* spp., on imported mangoes. In 1988, the EPA prohibited its use, the ban left the mango trade without a PPQ procedure causing a 33% reduction in U.S. mango imports, a 40% increase in U.S. mango prices and the number of countries exporting mangoes to the U.S. dropped from nine to four between 1987 and 1988. In 1989, a hot water treatment, specific to mangoes, which kills the fruit fly eggs and larvae was implemented as the PPQ procedure. But, treatment facilities are expensive to build and operate. They require trained technical staff to maintain compliance with U.S. food safety requirements, which is cost prohibitive to small producing countries and negatively impacts mango production for export. However, as a result of having a PPQ progam to prevent the spread of these pests during mango trade and an increased demand for mangoes, 14 countries had developed mango export programs by 1991. This example shows the impact of losing a PPQ procedure specific to one crop. In this case, development of new a PPQ procedure required only one treatment specific to this pest/host combination. The loss of methyl bromide, a more broadly use

PPQ treatment, would have further reaching effects, requiring the development of new treatments for over 60 produce pest/host combinations (USDA, 1994).

The Guatemalan snow pea/leafminer crisis of 1995 is another example of how important methyl bromide is in international produce trade (Sullivan et al., 1996). In December of 1995, the U.S. Department of Agriculture determined that snow peas imported from Guatemala must be fumigated with methyl bromide due to above threshold levels of leafminers and the threat of intruducing exotic species into the United States. This action was initiated primarily to protect Florida agriculture from leafminers, because leafminers currently do not pose significant economic risks to Florida agriculture. This action increased the PPQ use of methyl bromide on Guatemalan snow peas from the 1.3 tonnes (t) used in fiscal year (FY) 1995 to 3.4 t in FY 1996 for 8,800 t and 6,176 t of snow pea imports respectively. Methyl bromide fumigation increased the cost of exporting snow peas as well as reduced their market value (Beever et. al, 1985), therefore significanly reducing grower and exporter income. However, without methyl bromide, the about a third of Guatemalan snow pea shipments would have been rejected at the U.S. border because they contained unacceptable pest levels. This further supports the fact that unless viable PPQ alternatives to methyl bromide fumigation are developed prior to 2001, the future production of many Central American nontraditional agriculture export crops for U.S. markets is in serious jeopardy.

PPQ treatments account for less than 1% of methyl bromide used in the U.S. (159 of 23,339 t in 1991) (Hathaway and Giudice, 1996), however, the loss of methyl bromide for PPQ applications will clearly have a significant impact on the fresh produce in domestic markets. Production data from California and APHIS fumigation data on imports from Mexico and Central America can be used to estimate the market value of the commodities that result from the two different methyl bromide uses, PPQ applications and soil fumigation applications. California production practices used the equivalent of 1 kg of methyl bromide for soil fumigation to produce 7.27 dollars worth of almonds, or

171.91 dollars worth of strawberries at farmgate prices (Table 2) (White, 1994). In contrast, the value of imported fresh fruits and vegetables fumigated with 1 kg of methyl bromide at the port of entry for PPQ reasons ranged from 350 dollars for an average shipment from Guatemala to 1,342 dollars for an average shipment from Costa Rican, f.o.b. Miami, Florida, in 1994 (Table 3). The small volume of methyl bromide used for PPQ fumigation and the high value of the crops involved emphasize the current importance of methyl bromide for PPQ applications and clearly supports the case for more research on PPQ alternatives to methyl bromide and/or limited use approvals for methyl bromide.

There are other examples that support the importance of methyl bromide use for PPQ as well. A 1993 USDA study indicated that the loss of methyl bromide for PPQ purposes in the U.S. would result in an annual loss to consumers of about 450 million dollars through higher produce prices (U.S. General Accounting Office, 1995). This same study projects that the combination of increased domestic production costs and the reduced imports will force consumers to pay 4.7 to 5 billion dollars more over five years for their fresh fruits and vegetables. Tuszynski and Grimes (1992) estimated that if methyl bromide is lost and no replacement PPQ procedures are established, economic losses in nine commodities (apricots, grapes, grapefruit, lemons, nectarines/peaches, plums, oranges, and tangerines) would range from 973 million to 990 million dollars over five years for the U.S. import market, an annualized loss of about 200 million dollars. These studies underscore the urgency of developing satisfactory long term solutions/alternatives for the PPQ uses of methyl bromide.

Impact on fruit and vegetable trade with Latin America

The U.S. ban on methyl bromide will hinder economic development of Latin American countries by decreasing their ability to export fresh fruits and vegetables to U.S. markets (Sullivan et al., 1996). Fruits and vegetables imported from Latin America

were treated with about 118 t of methyl bromide for PPQ reasons at U.S. ports-of-entry in FY 1996. There are two senarios which cause produce shipments to undergo PPQ procedures before gaining access to a market: when mandated by the importing country because the pests in question are difficult to detect during inspection, or if an unwanted or exotic pest is detected during inspection. Since most countries have not implemented preinspection programs for produce exported to the United States, and the use of methyl bromide on perishable products produces off-flavors and increases respiration which reduces their shelf life, most required fumigations are performed at the port of entry rather than in the country of origin. Since methyl bromide treatment is the primary method used by certain Latin American countries to meet U.S. phytosanitary requirements, its loss will restrict their access to important export markets within the United States. Many fruits and vegetables (asparagus, avocados, beans, cabbage, pineapple, okra, grapefruit, lemons, peas, garlic, and yams) imported into the U.S. from Central America, Mexico, and the Caribbean must be fumigated when unwanted pests are detected. If these exports cease, developing countries that depend upon agriculture exports as a critical component of their economic development and foreign exchange strategy will face increased economic hardships. As shown in the 1995-96 Guatemalan snow pea/leafminer crisis, over 18,500 small farmers were negatively impacted and temporarily lost access to the U.S. markets. In 1995, the commodities mentioned above were valued at over 63.5 million dollars for the Central American and Caribbean countries, and 161.1 million dollars for Mexico. In total, Latin America accounts for about 82% of all U.S. fresh fruit and vegetable imports, which were valued at about 3.4 billion dollars in FY 1996. These export earnings help to stabilize the economies of developing countries by providing jobs which reduces the wholesale migration of rural populations to urban areas stablizing their socioeconomic welfare.

Potential alternatives to methyl bromide

There are several potential chemical substitutes for some methyl bromide's PPQ applications. However, among the alternatives only phosphine has shown reasonable potential as a substitute in selected methyl bromide applications (U.S. General Accounting Office, 1995). Phosphine gas is created when magnesium or aluminum phosphide combine with water. Phosphine treatment is primarily used in raw agricultural and processed food grains, cereal flours and tobacco. Phoshine requires four to seven days for treatment and costs about 20 dollars per tonne. In addition, a Phospine treatment facility costs about 65,000 dollars, as compared to methyl bromide, which requires 3 to 12 hours for treatment and costs about 10 dollars per tonne with negligible start-up costs (Yarkin et. al, 1994).

There are also some non-chemical procedures that may be appropriate for PPQ use such as hot water treatments, cold storage, controlled atmosphere storage, and irradiation (Table 5). However, APHIS has only allowed their use in very limited applications because of uncertain effectiveness and the multinational negotiations required for agreement on the use of specific procedures (McDowell and Martines, 1994).

Some longer-term solutions to many of the quarantine problems involve the establishment of pest free zones around production regions. This concept has the benefit that no quarantine treatments are required. However, such strategies depend upon ecological and geographical conditions to exclude specific pests from the production region. These conditions are difficult to establish if not already present in nature (Forsythe and Evangelou, 1994). However, intergrated pest management (IPM) systems that include precision pest management, pre-inspection along with a HACCP (Hazard Analysis and Critical Control Point) system would prevent any products with quarantinable pests from reaching the ports of importing countries. An alternative put forth by the EPA (U.S. Environmental Protection Agency, 1995) suggests that pest-free zones could be established using a five phase program consisting of 1) wide spread

implementation of IPM field practices, 2) prevention-based practices to exclude pests from produce prior to its arrival at the packing house, 3) post-harvest inspection practices that removes infested and damaged produce, 4) inspection and certification at the packing house, and 5) stringent control during shipment and distribution of the product. This approach has had some success in reducing codling moths infestations in apple, cherry, and nectarine.

Another viable option is to develop containment systems that use methyl bromide for PPQ programs, but recover the gas not allowing its release to the atmosphere. Such recovery systems may support the argument for amending current regulations by adding a limited use clause for methyl bromide in PPQ applications. An efficient recovery system has two potential impacts. First, it would reduce methyl bromide emissions, and second, without relief from regulation it could extend the life of existing supplies of methyl bromide for this limited use. Current systems have the potential to recycle 90% of the methyl bromide used during fumigation (Bailey, 1995). This would extend the time available to develop alternatives to methyl bromide PPQ fumigation treatments. However, without changes in the laws governing present and future methyl bromide uses, this is only a short term solution.

There is, however, a possibility that the need for alternatives or substitutes for methyl bromide's PPQ application as discussed above may never materialize. The current regulations may be changed to exempt PPQ applications from the production and importation restrictions. Pending legislation in the U.S. congress would bring U.S. regulations in line with the Montreal Protocol. On August 4, 1995, H.R. 2230 was introduced by Representative Dan Miller of Florida to meet the obligations of the Montreal Protocol without placing U.S. producers at a disadvantage in world markets. After its introduction, the bill was referred to the Agriculture and Commerce committees of the House of Representatives. To date, no further action has been taken on the bill.

If attempts to change current legislation fail, substitutes for methyl bromide treatments will be essential if continued growth in the international trade of fresh fruits and vegetables is to occur. Ross and Vail (1993) propose the following preformance objectives to determine if a methyl bromide substitute for PPQ proposes is acceptable.

- Does treatment provide an acceptable level of control of the commodity and pest combinations that present threats to trade? APHIS requires efficacy levels of 99.9968% for most treatments (U.S. General Accounting Office, 1995).
- Is it as convenient and effective as methyl bromide, but poses less of a health and environmental risk?
- Does the treatment time requirement allow for market flexibility?
- How is the market life and quality of the product after treatment?
- What are the costs and equipment necessary in order to perform protection or quarantine procedure?
- What is the public response to the usage of this compound on food?
- How safe is the compound?
- What is the availability of the compound and materials needed and how easy is the treatment procedure?

Conclusions

The U.S. fresh fruit and vegetable industry is clearly at risk, facing potentially devastating structural and performance changes in January of 2001. Unless current regulations are changed, new PPQ procedures and/or substitute treatments will have to be developed for most current methyl bromide PPQ applications. However, the critical need for PPQ alternatives to methyl bromide does not appear to be receiving appropriate attention. Research efforts are focused on finding alternatives for methyl bromide's

production applications more than its PPQ aplications. The U.S. fresh fruit and vegetable market depends upon imports from Latin America as an integral part of its year round supply chain. In the modern world, there are no off season products. Supply sources shift with the season, from summer regional production to winter production sites in California, Florida, and Latin America. Consumers have become accustomed to buying a variety of quality fresh fruits and vegetables year round. The loss of methyl bromide as an agent to control unwanted pests on imported produce means that consumers will experience higher prices due to reduced availability, and reduced variety as well as from higher producer costs. Without methyl bromide, some fresh produce may only be available seasonally and others not available at all. These changes will hurt both domestic producers and consumers because of higher prices and reduced consumption. However, the biggest losers in this scenario will be producers and developing economies of Latin America. Some of these developing countries will no longer be able to export to U.S. markets because of pest problems, eliminating an important source of foreign exchange necessary to buy foreign goods. Likewise, continued expansion of U.S. fruit and vegetable exports, an important part of the fruit and vegetable economy, which is heavily dependent upon the ability of foreign consumers to purchase U.S. produce, will also be restricted.

Restricting the market access of Latin American producers, restricts the financial resources available for their development. What appears to be a minor increase in produce selection and availability to U.S. consumers is, in turn, a tremendous boom in Latin America, and one that greatly supports local economics at all levels. Exports of fruits and vegetables provide an opportunity for many small producers to take part in the world economy. Their off-season production location and low production costs provide the means by which they are able to make a better life for their children as well as help shift their country's economy from a foreign aid recipient to a full fledged trading partner in which their goods are traded equally with others. These exports are the life blood of

their development progress, thus a restriction on an irreplaceable pesticide in the U.S., could bring catastrophic losses to many impoverished regions in Latin America, where agriculture exports are the single most important development tool available.

Currently, APHIS has no published plan for January 1, 2001. In order to prevent a shock to the fresh produce market, the U.S. Department of Agriculture should address the issue of PPQ alternatives. The potential for developing alternatives should be weighted against the hazards of regulatory changes, and an action plan outlined for the replacement or restricted use of methyl bromide in this key regulatory application.

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Table 1. Fruit and vegetable products and product categories with established methyl bromide quarantine procedures.

Apple	Asparagus	Avocado	Banana	Beet
Blackberries	Blueberries	Cabbage	Cantaloupe	Carrot
Cassava	Celery	Chayote	Cherimoya	Cherries
Chestnuts	Chicory	Cipollini	Citrus	Coconut
Corn	Cucumbers	Dasheen	Endive	Faba bean
Garlic	Ginger root	Grapes	Grapefruit	Horseradish
Kiwi	Lettuce	Leek	Lemon	Melons
Okra	Onion	Parsnip	Pineapple	Plantain
Potatoes	Prickly pear	Pumpkin	Radish	Raspberry
Scallion	Shallot	Squash	Strawberries	Sweet potato
Tomato	Tuna (fruit)	Turnip	Yam	Zucchini
Dried bean and lentils beans (pod, snap, and string)				
Green pod vegetables (snap, string, beans, and peas)				
Leafy vegetables, coles, and fresh herbs				
Stone fruit (apricot, nectarine, peach, and plum)				

Table 2. Average farm gate value of selected California produce per kg of methyl bromide used as soil fumigant.

Commodity	Value ($/kg)
Almond	7.23
Grape	16.09
Nectarine	19.75
Peach	22.90
Strawberry	172.49
Tomato, fresh	73.88
Walnut	23.47

Table 3. Average f.o.b. value of PPQ fumigated produce imports from selected countries per kg of methyl bromide used.

Country	Value ($/kg)
Costa Rica	1331.20
El Salvador	601.69
Guatemala	343.83
Honduras	643.56
Mexico	952.19
Nicaragua	811.07
Panama	945.52

Table 4. Current and potential non-chemical PPQ procedures

Treatment	Description	Costs
Hot Water (Yarkin et. al, 1994)	Treatment primarily to control fruit flies on mangoes. Fruit is submerged in hot water to raise the fruit pulp temperature which kills fly adults and larvae.	Start up cost are about $150,000 per facility. Treatment cost about $240 per ton of mangoes treated.
Cold Storage (Yarkin et. al, 1994)	The storage of commodities at 36°F (2.2°C) for 10 to 22 days. Only applicable to 17 commodities and must be performed in APHIS approved containers.	Start up cost between $100,000 and $200,000 per facility. Treatment cost between $46 and $600 per ton of commodity treated.
Controlled Atmosphere Storage (U.S. Environmental Protection Agency, 1995)	Storage at low oxygen levels with high carbon dioxide levels which asphyxiates the pests. It requires about 3 to 4 days.	Start up cost between $100,000 and $200,000 per facility. Treatment cost between $50 and $600 per ton of commodity treated.
Irradiation (General Accounting Office, 1995)	The process of treating produce with ionized radiation. It has the potential to kill a broad range of pests. However, public perception regarding the safety of irradiated food currently limits use.	Start up costs may exceed five million dollars per facility. No cost per unit treated available.