Phytosanitary measures: Preventing the introduction of exotic pests and pathogens occurring from the global trade of wood products

Majella Clarke
Finnish Forest Research Institute, Vantaa Research Center
Unioninkatu 40A, 00170 Helsinki, Finland
majella.clarke@metla.fi

Abstract

The decline in biological diversity arising from an increase in global trade is a trans-boundary environmental issue and the introduction of exotic species, have increased with ramifications for natural and managed ecosystems. Globalization and advances in technology and logistics have intensified the size and speed of the volume and transportation for international trade, and moving species between ecosystems can pose a serious threat to biodiversity. This paper will address phytosanitary measures that attempt to prevent the introduction of exotic species that arise from the global trade of wood products. Furthermore, this paper examines the biosecurity risks that a specific country can face when importing wood products, even after they have been treated by the required phytosanitary measure. The phase-out of the fumigant methyl bromide in accordance with the Montreal Protocol, will certainly affect the future cost and effectiveness of fumigation, and impair the ability of developing countries to comply with international standards for phytosanitary measures. The consequences of asymmetric information in the phytosanitary certification system are discussed using game theory to demonstrate the principle/agent problem that exists in the system.

Keywords: Phytosanitary Measures; Biosecurity; Trade; Exotic Species Invasion; Moral Hazard; Fumigation

1 Introduction

The threat to biodiversity that can arise from an exotic species invasion is significant and has consequences that cut across ecological, social, cultural, economical, recreational and aesthetic realms. There is an increasing awareness of the risks associated with trade and the introduction of exotic pests. Pest Risk Analyses (PRA) are now required by the World Trade Organisation's (WTO) Agreement on Sanitary and Phytosanitary (SPS) measures applied to trade. Furthermore, recent revisions by the International Plant Protection Convention

(IPPC) of harmonised guidelines and International Standards for Phytosanitary Measures (ISPM) provide examples of the growing need to place a higher priority on international and regional cooperation to protect biodiversity from an exotic species invasion. The IPPC and the WTO's SPS Agreement provide an international legal framework under which ISPMs are developed. The expected outcome of this structure will be greater transparency and harmonisation of phytosanitary measures based on a set of international standards and consequently, fewer disputes in trade arising from a nation implementing its own phytosanitary measures and standards.

This paper will address the issue of an exotic species invasion arising from the increase in the world trade of timber products and Solid Wood Packing Materials (SWPM). Biosecurity and quarantine measures instigated at a national level often have implications for trade. Phytosanitary measures have increased in importance with respect to facilitating the acceleration in the international trade of wood products. Growth in the world trade of timber products is expected to continue into the next decade. Consumption of lumber, structural panels, pulp and fuel wood are also expected to grow through the coming decades. Consequently, phytosanitary measures will become increasingly important from the viewpoint of safeguarding biodiversity and facilitating the trade of timber products.

The New Zealand Department of Conservation identified that "Introduced invasive species pose the single largest threat to the survival of New Zealand's threatened species and ecosystems." In the United States, approximately 400 of the 958 species that are listed under the Endangered Species Act are considered to be at risk from competition from non-indigenous invasive species, (Wilcove, Rothstein, Dubrow & Losos, 1998). According to one study, more than 50 000 non-indigenous species in the USA have caused approximately $US137 billion per year in damages, losses and control costs (Pimentel, Lach, Zuniga & Morrison, 2000). Finally, South Africa's Ministry for Water has employed a large number of local inhabitants to manually eradicate alien plants in water catchments. These exotic species are estimated to consume around 6.7% of the South Africa's water resources, (see Wilgen, 1999). The threat of an exotic species invasion is serious, particularly when it threatens the function of natural ecosystems that humans depend on for their well-being.

2 Current issues in global trade and safeguarding biodiversity

Economic agendas are evidently given priority over the conservation of biodiversity and economic activities have been, and continue to be responsible for the decline in global biodiversity. Many of the regulations and policies governments implement favor economic gain over the preservation of the environment and biodiversity. The New Zealand institutional and budgetary framework for biosecurity favored 94.4% of financial allocation on biosecurity was allocated to the Ministry of Agriculture and Forestry; 3% allocated to the Department of Conservation; 2.4% to the Ministry of Fisheries; and 0.2% to the Ministry of Health (Jay, Morad & Bell 2003). The general consequence of this allocation is that the framework is set up to contend with agricultural and forestry pests, and neglect the consequence of environmental pests. Furthermore, economic incentives for afforestation and reforestation created for carbon sequestration programs under the Kyoto Protocol are expected to result in a surplus of plantations containing fast growing alien species with a potential negative impact on biodiversity (Caparros & Jacquemont, 2003).

Quarantine and border controls are, and will become, increasingly important for the conservation of biodiversity given the growth in global trade volumes within the multilateral trading system. Currently there are few binding standards that apply to the international transport of invasive species arising from the multilateral trading arena. They are generally limited to a national level. Many countries face serious constraints on their inspection abilities and facilities, taxonomic capacity, access to information as well as human and financial resources to implement an effective and efficient biosecurity system (CBD, 2001).

The world is still developing its knowledge and databases on endangered species and ecosystems. The deficient knowledge on how invasive species may impact an ecosystem is still limited and has been discussed in various contexts by Wingfield, Slippers, Roux and Wingfield (2001), Campbell (2001), and Pimental et al. (2000). By applying trade agreements on this limited knowledge, disputes and threats of exotic species in natural ecosystems have, and will continue to evolve. Some examples of this include the WTO Appellate body's ruling in favour of Canada, on Measures Affecting the Importation of Salmon into Australia, (WT/DS18/RW) and Egypt's Import Prohibition of Canned Tuna with Soybean Oil from Thailand (WT/DS205/1).

To give an idea of the current situation with respect to the available scientific knowledge, according to the Australian Quarantine and Inspection Service (AQIS), who consider it a priority to identify all interceptions to a species level, less than 50% of interceptions were identified to a genus level and 30% to the species level. Furthermore, 24% of the pests are not recorded in Australia and consequently it is unclear to what proportion of these can be classified as quarantine pests, see Biosecurity Australia (1999). To date, there has not been a systematic survey of forest pests in Australia. Available data on forest pests in Australia between 1971-95, identified 9 exotic pathogens on forest trees and only 2 species of exotic forest pests. In comparison, New Zealand carried out systematic forest surveillance between 1988-97. This resulted in the discovery of 91 new introductions of forest pests and pathogens, 84% were forest fungi. One can see the disparity of information and the need for regular systematic forest surveillance.

According to the Office of Technology Assessment, USA, about 35% of exotic insect species that have been known to become established have harmful effects, whereas 91% of plant pathogens established have harmful effects. The process for detecting plant pathogens is more difficult given most inspection is visual. The risk of exotic pest introduction is significant. One estimate cites plant pathogens and pests cost $US14 billion in loss of forest products per year in the USA. 30% of these pathogens and pests are non-indigenous, therefore forest losses attributed to invasive forest species are $US4.2 billion per year (Pimentel et al. 2000).

The Global Invasive Species Database (ISSG), was the result of the CBD to address this gap in knowledge in conjunction with the Scientific Committee on Problems of the Environment and the World Conservation Union. However, this is still in its most preliminary stages. There is much more work needed to integrate and update the database using information sharing as stipulated in the SPS Agreement and the CBD.

2.1 Harmonisation and international standards for phytosanitary measures

Transparency in rules will make unnecessary protective behaviour easier to detect and enhance cooperation in trade liberalisation. Generally, harmonisation of agreements can be recognised for its benefits to the economic and legal implementation of global trade. However, harmonisation does not take into account the different risks that individual members assume with respect to biosecurity, and in this case it is very difficult to set a uniform standard that will be optimal for all countries.

More specifically, given the different risks countries face with respect to timber trade and SWPMs, the trade regime must allow the ability of a nation to safeguard their biodiversity, including the right to keep their own phytosanitary standards and not admit products that do not comply with these. Currently this ability is somewhat constrained given that protective behaviour must be based on scientific evidence and PRAs. The example below provides a comparison of heat treatments between New Zealand's standard enforced by the Ministry of Agriculture and Forestry (MAF) and the ISPM No. 15 Approved Measures Associated with Wood Packing Material.

Heat Treatment	**Minimum core temperature**	**Minimum time period**
ISPM No.15	56 deg C	30 Minutes
MAF standard	70 deg C	+ 4 Hours

It is recognised in ISPM No. 15 that some pests have a higher thermal tolerance, in which identified quarantine pests in this case should be managed by the National Plant Protection Organisation (NPPO) on a case-by-case basis.

2.2 Phytosanitary and fumigation certificates

Certification is given when a product has undergone an inspection or certified process that complies with the specified phytosanitary import regulations and standards of the importing country. In this context we differentiate between phytosanitary and fumigation certificates. A phytosanitary certificate is a much broader official document and can verify whether the commodity has undergone heat treatment, prior treatment that guarantees no pests or pathogens are present, or that the commodity is bark free. In many bilateral agreements a phytosanitary certificate is accepted in lieu of a fumigation certificate. The IPPC has designed a model certificate in which the NPPO of a country can issue a phytosanitary certificate based on this standard included in the ISPM No.12.

2.3 Phytosanitary certification

A phytosanitary certificate is an official document issued by the exporting country, which certifies that the phytosanitary status of a shipment meets the specified regulations of the importing country. The practices for issuing such certificates differ between countries and the costs associated with certification also differ. There are fees that can act as technical barriers to trade that governments initiate to cover the cost of inspection and operating costs. Moreover, certificates required in the case of an emergency can have significant impacts on trade.

In May 31st, 2000, the Ministry of Agriculture and Forestry of Finland began requiring phytosanitary certificates for coniferous SWPM, from Japan, Canada, China, Korea, Mexico, U.S. and Taiwan. This action was taken following interceptions of SWPM with pinewood nematodes, grub holes, and bark. Consequently, the Animal and Plant Health Inspection Service (APHIS) recommended U.S. exporters to use non-coniferous pallets or packing material. Approximately $US100 million of U.S. exports to Finland per month had the potential to be affected by this urgent measure.

Conversely, the US has had to review its regulations with regard to SWPM and additional entry requirements for SWPM from the bordering state of Mexico and China have been found necessary. The interim rule for China requires SWPM shipped with goods into the US be 100% bark free, heat treated without moisture reduction, kiln dried, fumigated with Methyl Bromide, or subject to a preservative pressure treatment (USDA, 2000).

2.4 Fumigation certification

Fumigation certificates are particularly relevant to the import of timber products. They verify that a commodity has been fumigated to the required standard of the importing country. The standards differ across nations; however, methyl bromide is the most preferred chemical for effective fumigation. In many cases, particularly from Asia, fumigation has been ineffective.

Table 1 provides a comparison between four countries that have an advanced biosecurity framework and the IPPC. It demonstrates the potential difficulty of harmonising fumigation standards facing wood products. There are many different standards and treatments that can be certified that apply to a specific range of products. Small differences in temperature, concentration of fumigant and exposure time have a vital function for ensuring the wood is free of pests. For example, phosphine is a highly toxic fumigant killing pests, humans and animal life, but contains no fungicidal properties. Sulfuryl fluride has also been used to kill wood-boring insects, however, the eggs stages of wood-borers and bark beetles are more resistant. The dose required to attain 100% mortality is 130g/m^3 for 24hrs at 15 deg C. This is considered too high to be practical, see Dwinell (2001).

At this point in time, Methyl Bromide is still considered the most effective fumigant for pests, nematodes and most fungi. However, there are several predicaments with using this substance that not only affect phytosanitary measures, but more importantly the social, environmental and economical consequences must be considered in the context of sustainable development.

Firstly, methyl bromide has been identified as an ozone depleting substance and under the binding Montreal Protocol it must be phased-out in developed countries by the year 2005. Developing countries have an extra tens years to comply with the ban. This has important implications for phytosanitary measures as Methyl Bromide will become increasingly prohibitive in its cost and primarily affect the phytosanitary measures specified in ISPM No. 15. Since its phase-out which commenced in 1999, the average price of methyl bromide has more than doubled.

Secondly, methyl bromide affects human health both directly and indirectly. It is hazardous for people who work or live near it and its toxins attack the central nervous system. Indirectly, as an ozone depleting substance, its affect on human health is primarily in the form of skin cancer. Methyl Bromide is a regulated substance in some countries, for example, the Environmental Health Authority (EHA) in Singapore prohibits fumigation with methyl bromide at rates above 40g/m3 for occupational health reasons. Accordingly, a bilateral phytosanitary agreement is necessary for the trade in wood products.

Table 1. Comparison of methyl bromide fumigation standards.

Prescribed minimum concentration of methyl bromide for various temperatures						
	Average commodity temp	**General rate grams/m^3**	**Exposure (hrs)**			
Australia Quarantine regulations for fumigating 20 ft / 40ft shipping containers of personal effects / household goods and commercial cargo containing wood / timber / bamboo	min 21 deg C or + 16 deg C 11 deg C 6 deg C 1 deg C	48 56 64 72 80	24 24 24 24 24			
Canada Bamboo poles, torches, stakes and other reg. bamboo products, decorative wood items, tree branches, tree roots, cones without seed	21 deg C or + 16-20.9 deg C 10-15.9 deg C	48 56 64	16 (24 regulated bamboo products) 16 (24 regulated bamboo products) 16 (24 regulated bamboo products)			
USA Wood products including containers as such undergoing treatment T404-d MB at NAP.	27 deg C 21-26 deg C 15.5-20 deg C 10-15 deg C 4.4-9 deg C	45 58 77 96 116	Extend normal 16 hr exposure time to 24 hr for poles and garden stakes made of bamboo. Refer to Treatment manual as times vary depending on the Minimum Concentration Readings. NB: Figures converted into metric system			
New Zealand Applied only to bamboo, cane, willow and rattan. For other timber and wood products, refer to specific requirements for wood packing material	20+ deg C 16-20 deg C 11-15 deg C 6-10 deg C	48 56 64 72	24+ 24+ 24+ 24+			
IPPC Applied to wood packing material			Min concentration (g/m3) at:			
			0.5hrs	2hrs	4hrs	16hrs
	21 + deg C	48	36	24	17	14
	16+ deg C	56	42	28	20	17
	11+ deg C	64	48	32	22	19

Sources: AQIS, CFIA, USDA, MAF and IPPC

Finally, most research on alternative fumigants is currently in relation to agricultural and horticultural crops. Many of the alternative fumigants for timber apply to specific pests and pathogens, and do not successfully destroy the variety that methyl bromide does without environmental consequences.

3 Risks and responses associated with the import of wood products

In Australia, imported timber products comprise the greatest proportion of imports involving quarantine breaches. Since 1986, AQIS has recorded over 13,000 interceptions of pests on imports of timber and wood products. The overall annual rate averaged 900 interceptions a year until 1996. After increased efforts in quarantine following the Nairn Report (1996), the number of interceptions averaged 1,500 a year (Biosecurity Australia, 1999). Many of the breaches have been cleared through quarantine upon certification with respect to fumigations performed overseas. In all, 82% of timber pest breaches are suspected for failed fumigation (AQIS Import Operations, 2000).

AQIS has identified that failure can occur from a variety of reasons, including untrained staff, inadequate equipment, fraudulent activities, time delays between treatment and export, and commercial pressures. In response, AQIS has suspended the acceptance of certification from 80 overseas fumigation companies (AQIS 2000).

One particular source that must be addressed at a global level is SWPM. This should be of particular concern because SWPM is generally made from low quality wood that is normally unacceptable for higher lumber grades (Allen, 2001). Moreover, it is not a commodity, unless traded for packing purposes, which makes it difficult to monitor during inspection procedures. Between 1996-98, the USA's Animal and Plant Health Inspection Service (APHIS) inspectors recorded 1 205 interceptions of live wood pests associated with quarantine significance with SWPM alone (USDA, 2000).

The USA now requires all SWPM from China to undergo special treatment as it was discovered that the Asian Long Horned Beetle and other closely related species were in SWPM imported from China into the US. This resulted in substantial damage to urban trees in Chicago and the State of New York.

A Canadian survey conducted in 1997, found that bark was present and usually hidden in layers in 90% of wooden spools shipped from China, Korea and Malaysia, 14% of the spools contained live insects. Another survey of wooden packing materials used to brace granite blocks, conducted by Canada, found 32% of wood packing pieces contained live insects and 50% had bluestain fungi (www.apsnet.org).

Table 2. Breaches recorded by AQIS since July 1997 by commodity/pest type.

Pest type	Number of breaches	% of breaches
Timber pests	80	83
Storage Pests	5	5
G.A.S.	3	3
Grain	2	2
Straw	2	2
Seeds	1	1
Bark	1	1
Ants	1	1
Soil	1	1
Bamboo	1	1
Total	**97**	**100**

Source: AQIS 2000

Table 3. Comparison of timber pest detections in consignments covered by valid fumigation certificates with the total number of consignments subject to quarantine from origin. Source: AQIS 2000

Source region	% of timber pest detections where consignments covered by valid fumigation certificates Jan 98 - Jan 2000	% of total consignments subject to quarantine July 98 - Jun 99
SE Asia	48	6
Rest of Asia	38	20
Rest of World	14	74

Table 4. Continents of origin for cargo from which exotic pests were intercepted with SWPM at US Ports of entry during 1996-98. Source: USDA 2000.

Continent of origin	Number of interceptions 1996-1998	% of interceptions
Asia	633 (7 uncertain)	52
Europe	451 (1 uncertain)	37
North America	38 (4 uncertain)	3
South America	34	3
Africa	30	2
Oceania	4	less than 1
Unknown	15	1
Total	1205	100

AQIS has identified three factors that are significant to timber pest breaches.

1. The commodity
2. Country from which the product was exported
3. Ineffective fumigation undertaken at the point of origin

Asia has recently been identified as the most risky continent given the number of breaches with certification of fumigation. Interestingly, AQIS has required mandatory fumigation of all timber imported from South East Asia and Africa.

The risk arises from the lack of capacity to effectively detect, through inspection, potential exotic species given the timber volumes, and instead an Import Risk Analysis (IRA) is used to identify potential infested consignments. The global change from bulk to containerisation cargo, which is more sea worthy, affects SWPM inspection capacity. The increasing use of containers is a global trend. Interestingly in the USA, "importers must pay high fees ranging from $US800-$1,500 per container for removing or unloading cargo to facilitate inspection. Inspectors are often reluctant to impose these additional costs on importers unless there is reasonable certainty that pests will be found. As a result, APHIS inspectors do not gain access to most imported SWPM." (USDA, 2000).

The economical costs of fumigation, phytosanitary certification and inspection should not be underestimated. It was identified at the 18th Session of the Global Biodiversity Forum, September 2003, that "the economic, administrative and legal costs of certification and labeling can also present a market liability to small producers, producing the opposite result of the one intended." Treatments are estimated to increase the cost of SWPM by 10%, or even double the cost of SWPM in some cases, see Illman (2001). Since SWPMs are made from low grade lumber, this may become an economically unviable option. Moreover, many developing countries are constrained by relatively poor scientific and technical infrastructure and are therefore less able than developed nations to use the procedures established by the SPS Agreement, see Henson & Loader (2001).

In the case of Australia, given the number of wooden artifacts that have been infested by exotic pests from Africa, AQIS requires that all consignments of wooden artifacts and natural forest products from Africa are unpacked and inspected regardless of fumigation certification. Border response and the targeting of high risk commodities is becoming increasingly important to prevent timber pest breaches in imported wooden artifacts into Australia. However, it is important to recognise that this mode of extreme response is only viable given Australia's low trade volume of wooden items from Africa (AQIS Import Operations, 2000).

4 Information asymmetry and fumigation certificates

In the timber market, it is difficult to acquire complete information about the standard (in this context, disease free, with no invasive species, and has undergone fumigation) of the import except by observing the average quality in the market. Inspections at the port may provide some form of estimation of quality through examination and appraisal but this will only reduce, not eliminate the risk of exotic species and pathogens.

In this context we analyse the principle/agent problem with respect to the fumigation and inspection of wood products. Given the lack of inspection ability, that is, low probability of inspection or difficulty in detection from importers, fumigators from exporting countries may not have the incentive to apply prudence and assurance in their process. Increasing volumes and global movement of timber and wood products make inspection and detection more difficult and a costly process. Consequently, quarantine and inspection services are going to rely on valid fumigation certificates to ensure the product is pest and pathogen free.

There is a significant presence of asymmetric information in the case of trading effectively fumigated timber products. Exporters have access to full knowledge of the type of product they have, generally where it has come from, and the risks of pathogens and pests. They also have the information on the phytosanitary treatment of the product and the credibility of the certifier. On the other side, importers are limited to Import Risk Analysis, probability of interception through inspection, and largely depend on the certificate to verify regulations are met. This has led to the increasing incidence of moral hazard experienced in particular by the USA and Australia receiving imports with fumigation certificates from Asia.

4.1 Moral hazard and fumigation certification

When comparing the current AQIS import requirements for green, sawn timber with those of the USA, New Zealand and Canada, AQIS currently inspects 1-2% of external surfaces for insects compared with 10% in New Zealand. The USA and Canada require mandatory treatment of high risk commodities. However, the USA defines its capability to detect breaches as limited. In the largest US container port, if inspection was to occur in all SWPM containers, this would require inspectors to search 39 000 containers a week. Currently APHIS is able to inspect 120-200 shipments of SWPM per week (USDA, 2000), quite a fraction.

The inability of importers to observe the care and effort of exporting fumigators is difficult if not impossible, and thus forms the basis of moral hazard in the enforcement and monitoring of fumigation certification. Fumigators have an incentive to cheat given the low probability of being detected. In this particular case, the prisoner's dilemma is used to depict that the current system does not necessarily lead to the most effective outcome.

To clarify Table 5, the entries in each cell of the matrix represent the utility that each agent assigns to the various implications, such as detection of infestations, paying the cost to comply with fumigation regulations or the hazard of an exotic species invasion. Benefits accruing to importers and exporters are (9) and (8) respectively; fumigators that co-operate with the importer's phytosanitary standards create the optimal efficient outcome given the probability of inspection. An exporter can improve their economic position from (8) to (10) if they choose not to pay for complete fumigation and/or reproduce a fraudulent or invalid certificate. In this case, given the rate of inspection, there is a high probability that a breach in quarantine may occur, leaving the importing nation worse off both economically and environmentally, hence (3) this is the worst possible scenario. As a response to the incidence of infestations occurring in wood products, the importing nation must induce a policy of 100% inspection to detect exporters that cheat. 100% inspection is expensive, time consuming and in most cases impossible, as a consequence the importing nation is economically disadvantaged to (5) and may even attempt to transfer a proportion of this additional cost associated with inspections to fumigators (7). The exporting country can slightly improve of their economic position from (5) to (6) if their policy of 100% inspection can identify cheat fumigators and halt the economic and environmental damage caused by quarantine breaches. As a result of the identification of cheat fumigators, the importing country can induce a policy to suspend the acceptance of certification from cheat fumigators (4).

Inspection is costly and the optimal rate of inspection given manpower, budget and trade volume of a state is considered consistent with the countries rate of inspection probability (1-p) defined by the Import Risk Analysis.

However, if there are fraudulent fumigators, they will be better off economically under a low probability of inspection, and as a consequence, there is a greater risk of exotic specie invasion into the import destination. This may become an increasing dilemma considering the cost of using methyl bromide for fumigation will continue to increase. 100% inspection is non-optimal, even when the detection of a fraudulent fumigator occurs, while it can mediate the information asymmetry and potential consequence of an exotic species invasion, it is a costly and difficult control to implement.

Some solutions to remedy this problem may be to internationally regulate who carries out the fumigation of exports and accredited fumigators that comply with international standards may solve a small proportion of this problem, however as demonstrated before, countries have different standards for fumigation. Currently there is a plan by AQIS to certify credible fumigators, whose products do not have infestations.

By following the harmonised guidelines for phytosanitary certificates (ISPM No. 12), border control and information regarding different consignments will make multilateral trade in wood products less risky under the assumption that both importing and exporting parties co-operate to insure against the risk of pest and pathogen introduction. However, the incidence of invalid and fraudulent certificates continues and provides a good reason for a state to implement their own standards. It is interesting to note that in the harmonised guideline for phytosanitary certificates (ISPM No. 12); the inclusion of a financial liability statement in a phytosanitary certificate is optional, thereby creating a case of adverse selection. In other words, those exporters that can guarantee that their consignment is 100% pest free will have incentive to sign a financial liability statement, whilst exporters that can not guarantee, will choose not to sign the statement. Perhaps a mandatory financial liability statement attached to a phytosanitary certificate will eliminate some problems of moral hazard and adverse selection.

Table 5. Prisoner's dilemma payoff matrix between fumigators in exporter countries and inspectors in importers countries.

		Exporter (E)			
Importer (I)		Fumigators		Cheat Fumigator	
	Inspection (1-p)	9_I	8_E	3_I	10_E
	100% Inspection	5_I	7_E	6_I	4_E

5 Conclusions

Nations do not have uniform ecosystems and the risks associated with exotic pests through trade differ significantly. While standardisation may provide a basis for setting safe minimum standards, it should not undermine a states ability to implement its own controls. Trade volumes in wood products are likely to increase in the future, and as a result, inspection at the port of entry will continue to become more difficult. Therefore, if wood products and materials are to move globally, without causing environmental harm and threaten biodiversity, coherent regulations and policies are needed to ensure that the wood materials transported are free of pests and pathogens.

Given the number of exotic specie invasions and interceptions that have occurred in relation to SWPMs, phytosanitary measures must be taken seriously to safeguard biodiversity. Emergency restrictions to trade can have significant implications. Therefore there is a growing global need for credible certification that guarantees the phytosanitary status of a containment or product requiring treatment. This may turn out to be a costly measure and in an attempt to liberalise trade, it may also create a barrier for developing countries through extra value added costs.

A more concerning, short-term feature of harmonising phytosanitary standards is that the use of methyl bromide must be phased-out under the Montréal Protocol. This phase-out may have several implications for trade and phytosanitary measures. The developed world must comply with a complete phase-out of the substance by 2005. If a viable alternative for fumigation is not found to meet international standards in the meantime, a new assortment of bilateral agreements may evolve concerning the use of different fumigants. From the developing country perspective, methyl bromide will continue to become an increasingly expensive fumigant, particularly for those deriving their income from trading wood products. Given the asymmetric information associated with the fumigation market, this may provide a greater incentive for exporters to pursue invalid certificates of fumigation.

The real challenge is how to make exporters more accountable for their commodities, and by what means can this be successfully attained. Phytosanitary and fumigation certifications still have a long path of development given the current number of "certified" consignments infested with pests. The difficulty that faces policy makers and scientists though, is not so much how to kill pests, but how to meet the inconsistent regulations and enforcement procedures of individual countries without endangering the unique arrangement of biological diversity inherent in a nation.

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