PROTOCOLS FOR PLANT INTRODUCTIONS WITH PARTICULAR REFERENCE TO FORESTRY: CHANGING PERSPECTIVES ON RISKS TO BIODIVERSITY AND ECONOMIC DEVELOPMENT

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ABSTRACT

There is growing awareness of the serious threat that alien plant species pose to ecosystems, habitats and species. Despite this, intentional introductions are continuing in most countries with, in many cases, minimal scrutiny and regulation. This paper examines the risks and benefits of introductions with particular reference to forestry species and outlines possible alternative approaches using indigenous species. It is concluded that the protocols currently used to regulate the movement of biocontrol agents provide a suitable framework for regulation of new plant introductions. Currently available protocols are synthesized and presented. The difficulties posed by the unpredictability of the outcome of introductions, including the long time perspective involved and likelihood of hybridization are also discussed.

INTRODUCTION

The marked lack of procedures covering introductions of plant species and varieties, where whole genomes, or new biotypes, are translocated between continents largely without scrutiny or regulation, stands in stark contrast to the strict protocols governing movement of biocontrol agents or genetically-modified organisms. Biocontrol agents and genetically-modified organisms provide a useful comparison to plant species introductions in terms of risks, but are treated cautiously with a case-by-case approach to risk assessment despite general agreement that genetically-modified organisms, with their relatively minor genetic modifications, pose significantly lower risks of invasion than introduced species (Shorrocks and Coates, 1993; Raybould and Gray, 1994). In general, it is extremely easy to move seed of little-known plant species from one continent to another often with minimal regulation.

Even in those countries with a long history of introductions, severe problems of invasive plants, high awareness of the risks of invasion and well-developed plant quarantine departments, inflow of non-native species is continuing. For example, in Hawaii, where these conditions apply (Smith, 1985b), it has been possible to import legally, seed of a diverse range of *Leucaena* species and varieties, that are closely related to *L. leucocephala* subsp. *leucocephala*, which is one of the worst weeds in Hawaii (Smith, 1985a). Panetta (1993) cites a similar example of *Kochia scoparia*, a known weed introduced legally to western Australia. Only a handful of developed countries and states which have experienced severe problems of invasion, such as Australia, New Zealand, South Africa and the State of Hawaii, USA, are attempting to regulate in a serious way, with legislation and policing by government agencies, the flow of non-native species into their territories. For the vast majority of tropical developing countries regulation is currently minimal. Awareness of invasive plants is low. Conservation agencies are small, in many cases embryonic, and have limited resources that are fully stretched in establishment and management of protected areas. In many countries, there are no complete species check lists for native plants, let alone introduced species or invasives. There is a strong case for development assistance to support the establishment of effective plant import regulations and authorities in many tropical countries (see Stanford University project on regulation of agricultural introductions in developing countries, Kennedy, pers. comm.[1]). Even within those organisations that operate large scale intentional introduction programmes, the present process is characterized by a low level of concern about the hazards of invasives. In a few cases, warnings are provided by seed suppliers (*e.g.* Hughes, 1993), but these, at best, shift responsibility from the supplier (often a development organisation) to the seed recipient (usually in a developing country), who is often poorly placed to judge the advisability of introductions. In many cases both seed suppliers and recipients are unaware of the hazards; complete information on species characteristics is usually lacking, and legislation covering plant introductions is non-existent or inadequate in most tropical countries. In such situations it is not clear if responsibilities (and potential liabilities) for the outcome of introductions should remain entirely with the seed recipient or importer or whether the seed supplier should bear some responsibility also.

There is increasing concern among foresters, ecologists, botanists and conservationists about the threat of invasion of natural and semi-natural ecosystems posed by the continued, uncontrolled introduction of plant species. Although the main threat to biodiversity continues to be the direct destruction of habitats by people, invasion of natural and semi-natural habitats by alien organisms is widely recognized to be a serious and underestimated world-wide problem (Heywood, 1989; Coblentz, 1990; Soulé, 1990; Cronk and Fuller, 1995). Indeed, the Convention on Biological Diversity, CBD, states that alien species are a serious threat to biodiversity second only to habitat loss (Glowka *et al.*, 1994). These concerns have resulted in greater attention being focused on biological invasions and their control by national and international organisations over the last decade (*e.g.* the Species Survival Commission of IUCN (IUCN, 1987), and WWF (Cronk and Fuller, 1995)). Biosafety is one of the major concerns of the CBD, both in terms of genetically modified organisms (or living-modified organisms) and in terms of introductions of non-native species. Article 8(h) of the Convention states that each contracting party shall, as far as possible and as appropriate, *"prevent the introduction of, control or eradicate those alien species which threaten ecosystems, habitats or species"* and *"it is, therefore, absolutely vital that Parties and non-Parties prevent further introductions of invasive species"* (Glowka *et al.*, 1994: 46). Finally, adverse ecological impacts of exotic species in forestry are acknowledged and recognized in the Forest Stewardship Council principles and criteria on responsible forestry.

Large numbers of plant species have been introduced in the past; most do not naturalize (see Mack, this volume), and most of those that naturalize do not become important invasives. Estimates broadly agree that an introduced plant species has about a 1% chance of becoming an invasive pest (Groves, 1986; Williamson and Brown, 1986). However, this may be an

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underestimate given the time lag typical between time of introduction and realization of invasion (see below for further discussion). Also for certain groups, such as tropical tree species, introductions may make more impact as invasives than other plants (Richardson *et al.*, 1992), especially as foresters deliberately seek aggressive species (see below) such as the woody legumes that currently dominate much non-industrial tree planting (*e.g.* Felker, 1994; Brewbaker and Sorensson, 1994) and higher rates of invasiveness may be expected. Similarly, Lonsdale (1994) showed that amongst forage species introductions in northern Australia, 13% are listed as weeds, again indicating higher than average invasive potential amongst forage introductions. At any rate, if plants continue to be translocated in large numbers, problems of invasion will continue to arise sooner or later. A relatively small invasive fraction can cause enormous and costly conservation problems. The realization that the current scale of translocation of organisms is too great is not confined to plants; the same dilemmas are being confronted in relation to translocation of other organisms with similar calls for greater control to reduce the current worldwide translocation of, for example, freshwater fish (Horowitz, 1990).

Alongside this growing awareness of the risks and consequences of introductions, perspectives are also changing with respect to agricultural, livestock and forestry production systems, use of local species, *circa situ* conservation of local diversity and the sustainability of high input low diversity systems that are raising further doubts about the justification for continued plant introduction programmes (Lonsdale, 1994; Hughes, 1994).

The objective of this paper is to assess briefly the risks and benefits of continued large scale plant introductions, discuss new approaches and outline protocols for the regulation of species introductions in the context of both growing awareness of risks and issues of biosafety and changes in the context in which introduction programmes are pursued. Some of the difficulties of predicting the outcome of introductions are discussed in relation to proposed guidelines and protocols. It is critical that guidelines/regulations/legislation are both effective and realistic, and compatible with both conservation objectives and those of economic development. Improved dialogue between agronomists, foresters, ecologists and conservationists is needed to establish rigorous and realistic procedures which will minimize the risks associated with introduction of new plant species.

Introductions may be intentional or accidental; this paper addresses issues related to intentional introduction programmes. The majority of intentional introductions have been in horticulture (*e.g.* Stirton, 1978; Wells *et al.*, 1986; Panetta, 1993); in countries, such as UK, with a long gardening tradition and history of introduction of ornamental plants, the reservoir of introduced species and ornamentals has been estimated to be as high as 50,000 species and cultivars (Nelson, 1994), of which 1280 have already escaped and naturalized to some extent. Other important sources of introductions with invasive potential are agriculture and forestry, and in the last few decades, global movement of tropical tree and tropical/subtropical forage germplasm has increased dramatically in terms of numbers of species, levels of intraspecific variation and geographic spread, and continues largely unabated and uncontrolled at present (Hughes, 1994; Lonsdale, 1994). This paper focuses particularly on forestry species which are at the forefront of introduction programmes particularly in many tropical developing countries, although the clear parallels in tropical forages are also mentioned.

This paper on plant introductions is about minimizing risks and damage limitation rather than cure. Methods to control invasive species include physical, chemical and biological methods and environmental management, and are amply reviewed by Cronk and Fuller (1995).

BENEFITS AND RISKS OF INTRODUCTIONS

In earlier papers (Hughes and Styles, 1989; Hughes, 1994), the benefits, risks and current scale of species introductions in tropical forestry were discussed. The rationale of tropical tree species introductions has been the overriding belief that use of a selection of light demanding exotic species is the most successful way to create abuse-resistant ecosystems (Armstrong, 1992) that give first priority to provision of human needs (fuel, timber, fodder, environmental stabilization). This is coupled with the philosophy that, in the end, it will be most effective to preserve intensively small, manageable reserves of natural ecosystems and accept that extensive areas will be colonised by ecosystems resistant to abuse to provide for human needs. This approach has fuelled the on-going, and in recent years dramatically expanded, search for new species and seed sources that can be imported to optimize such programmes, concentrating on species which have the ability to capture the site rapidly and tolerate harsh soil and climatic conditions and abuse from animals, humans and fire, traits that are a pre-requisite for success on the often highly degraded sites where tree planting is needed. Yield advantages of exotics over indigenous species have been attributed to their greater tolerance of degraded sites and their escape from specialized pests and diseases, although these may arrive later, reducing this advantage (*e.g.* the psyllid defoliator *Heteropsylla cubana* on *Leucaena leucocephala*; Napompeth and MacDicken, 1990). In the quest for suitable species, "send us anything that will grow" has emerged as a frequent plea in the face of adverse site conditions. Over the last three decades, the search for useful tropical tree species and intraspecific genetic variation for tree improvement has intensified. This has led to a period of unprecedented movement of tropical tree germplasm around the globe. Whereas historical spread of tropical trees was unsystematic, often casual or accidental and operated on a limited scale, recent programmes have embarked on a different scale of operation in three ways: (i) numbers of species that are being moved internationally have increased as whole woody floras are scoured for new species and close relatives of the few well-known species; (ii) intensive sampling of intraspecific variation with range-wide provenance collections of more species results in wide distribution of complete packages of genetic diversity compared to the narrow genetic base of most historical introductions – The implications of movement of diverse genotypes in terms of increased risk of invasion are not well understood; (iii) whereas in the past species were introduced to a few locations in a small number of countries, with more efficient communications and transport, seed can now be distributed simultaneously to virtually every country in the tropics with relative ease. If, as estimates suggest, 1% or more of introductions become invasives, these programmes have introduced a significant number of invasive pests, a fact never acknowledged or considered in the assessment of the benefits of these intentional introduction programmes. These research-scale tree seed distribution networks are small in terms of quantities of seed and numbers of species compared to the commercial seed trade.

As a result of the frequent need to employ aggressive trees, often those that seed heavily, many of the species used by foresters have the capacity to spread outside the area where they are being planted and are potentially invasive. Forestry is thus often working with "conflict" species. Forestry species are particularly problematic as invasives in open forest types, savannas, fire-dominated ecosystems and numerous semi-natural habitats (Richardson *et al.*, 1992; Usher, 1988), rather than in closed moist tropical forest ecosystems which are generally resistant to invasion except by highly shade tolerant species or in species-poor island forests (Whitmore, 1991). Disturbance, whether natural or induced by man, is a key factor permitting invasion (Whitmore, 1991).

The relatively small invasive fraction of introduced trees poses huge conservation problems, with the risk of diverse natural vegetation being replaced by exotic species. An invasive plant species may be defined as "an alien plant spreading naturally (without the direct assistance of people) in natural or semi-natural habitats, to produce a significant change in terms of composition, structure or ecosystem processes" (modified from Cronk and Fuller, 1995). Invasion may cause major loss of biodiversity and species extinction either due to direct replacement by exotics or indirect effects on the ecosystem. For example, in Mauritius and Hawaii, *Psidium cattleianum* has spread and dominates areas of wet evergreen forest, replacing much of the native vegetation (Lorence and Sussman, 1986). Introduced *Acacia* and *Pinus* species have spread over large areas of fynbos vegetation in South Africa forming monospecific stands that now dominate thousands of hectares with severe impacts to the natural vegetation, leading to a reduction in biodiversity and threatening as many as 750 of the endangered species listed in the IUCN Red Data Book (Richardson *et al.*, 1992). The dramatic and large scale floristic changes and consequent negative effects on birds and reptiles and favourable effects on small mammals, following invasion of 450km^2 of seasonally inundated flood plains in northern Australia by the introduced shrub *Mimosa pigra*, provides another example. In this case, six staff are employed full time to prevent *M. pigra* taking hold in the neighbouring Kakadu National Park, a large (13,000 km^2) and significant conservation area, up to 13% of which would be covered by a major invasion if left unattended (Braithwaite *et al.*, 1989). The costs of such control or eradication efforts are thus very high.

A summary list of genera that include species that are both important for forestry and the focus of eradication efforts following invasion (*Acacia, Acer, Ailanthus, Albizia, Cedrela, Dichrostachys, Eucalyptus, Leucaena, Maesopsis, Melaleuca, Melia, Parkinsonia, Pinus, Pittosporum, Prosopis, Prunus, Psidium, Robinia, Schinus, Sesbania, Swietenia, Tamarix* and *Toona*; largely from Cronk and Fuller, 1995) is indicative of the scale of the problem and the degree of overlap between species that are used in forestry and those that are invasive. This coincidence of useful species and invasives, for example of *Pinus* species used in plantations, (Richardson *et al.*, 1994) or forage legumes and grasses (Lonsdale, 1994), is striking. Several species are the focus both of current germplasm collection and distribution efforts in tree improvement <u>and</u> of biocontrol or eradication programmes (*e.g. Acacia nilotica* promoted in Africa and India and being eradicated in Australia and Indonesia).

Concern about weediness hazards associated with continued introductions has been growing over the last decade. Many conservationists are strongly opposed to further introductions; movement of forestry and agroforestry germplasm and forage species have been the target of specific criticism (Stirton, 1978; Janzen 1987a; Lonsdale, 1994). Conservation agencies faced with large bills for the control of invasive plants are seeking greater accountability from individuals and agencies involved in species introductions. It seems likely that the "polluter pays" principle may be applied where invasion occurs in the future. The examination of the issue of liability and redress for damage to biological diversity was selected for specific discussion and action to be taken at the first Conference of the Parties of the CBD (Glowka*et al.*, 1994).

The value and benefits of species introduction programmes in tropical forestry have never been fully assessed beyond the immediate evaluation of performance of species and provenances in trials. These demonstrate clear yield and product quality benefits of some exotic species over native alternatives. However, the outcome of such introduction programmes in terms of the percentage of tested species that are superior and enter wide use remains unknown. What is clear however, is that the majority of introduced species turn out not to be suitable for widespread use in practise. One example of the introduction of 25 Central American dry zone multipurpose tree species tested on a wide range of sites across the dry tropics (Hughes and Styles, 1984), suggested that only 6 species had any significant potential (Stewart and Dunsdon, 1993). The full analysis of benefits (in terms of new species added to the forestry repertoire) and costs (species that become invasives) for forestry introductions remains to be done.

Perhaps the most notable analysis of this type is the study carried out by Lonsdale (1994) of the outcome of the forage species introduction programme in northern Australia. This study showed that the fate of an introduced pasture species was much more likely to be a listing as a weed than as a useful plant. While 13% of the 466 species introduced were listed as weeds, only 5% were found to be potentially useful. Furthermore, of the 21 species regarded as useful, 17 were also listed as weeds. Overall only 4 species (<1%) were useful without being weedy. As Lonsdale (1994) points out *"it is difficult to assess whether there has been a net gain to the nation from these introductions and whether the benefits of the 21 useful plants have outweighed the costs of the 60 weeds"*. Moreover, in this case the benefits accrue to the livestock industry where profits per hectare are low (< $2.00/ha), while the costs are borne by others and may be substantial ($30-120/ha for control).

Lack of accountability for the costs of introductions provides little deterrent to unabated introduction without adequate preliminary screening and has undoubtedly encouraged a casual approach to trying out a new species driven partly by curiosity and vested research interests.

ALTERNATIVES TO INTRODUCTIONS

Alternatives to continued promotion and planting of exotics that involve management and/or restoration of natural or degraded forest, secondary forest or disturbed thorn scrub forests or promotion of native species for *in-* or *circa-situ* planting are now being actively pursued by many organisations. Similar calls for alternative grazing systems that do not compromise ecological sustainability have been made (Winter, 1991 quoted from Lonsdale, 1994).

In industrial plantation forestry, cogent arguments in terms of yield gains, economics, marginal returns and uniformity of product can be made to support widespread use of a small number of exotic species that have generally out-performed native alternatives in terms of survival, yield and product quality. These species have dominated industrial plantations to the exclusion of the majority of native alternatives. Indeed, Evans (1992) suggests that 85% of industrial plantations in the tropics are established with species from three genera; *Eucalyptus, Pinus* and *Tectona*.

However, even for industrial plantations, there are many examples of successful use of native species (Kanowski and Savill, 1992). It has been argued that many valuable species have been excluded from consideration and that the growth potential of most tropical species remains unknown with only limited investment in the development of native species for plantation use. The information gap in itself favours continued use of well-known exotics (*e.g.* Butterfield and Fisher, 1994); "new" species with potential for plantation establishment continue to be "discovered" (*e.g.* Nichols, 1994, Butterfield and Fisher, 1994) and in the last few years proposals for "complex" plantation forestry with use of a wider range of species have been made (discussed in Kanowski and Savill, 1992).

For non-industrial tree planting, the arguments in favour of choosing from only a handful of globally promoted exotic species appear to be less compelling. In small scale agroforestry planting, in addition to simple evaluation of species in terms of yield, (the main criterion usually employed in species elimination trials), there are wider considerations of stability, security and risk reduction, sustainability, micro-site matching, product quality and timing of production in relation to seasons, compatibility with crops and livestock, market participation, and self-sufficiency and autonomy. These considerations demand use of highly diverse material that matches the diversity of products that has been traditionally harvested, in some areas, from natural forest. In general, the more diverse the forest in terms of species, the more secure the services and the wider the range of available products (Sargent, 1992). Such planting must incorporate a wide diversity of species in any one area (Marten, 1988; Sinclair *et al*, 1994). The "multipurpose" tree concept in itself has mitigated against use and conservation of a wider range of species (Barnes, 1990) as a way of obtaining multiple products and reducing risks. There has also been some discussion about risk reduction through careful maintenance of a broad genetic base within multipurpose species (*e.g.* Simons, 1992); a much simpler and more effective way to reduce risks is simply to use a wider range of species. The arrival of the psyllid defoliator *Heterospylla cubana* in Asia was devastating not because of the narrow genetic base in *Leucaena leucocephala*, but because certain communities had become heavily dependent on *L. leucocephala* which was planted to the exclusion of all other species in some areas.

The prevalent idea of the 1970s-80s that a few "multipurpose" species could adequately meet the complex needs of resource-poor farmers, is now being overtaken by new strategies for choice of species that concentrate on a wider range of local trees (Carter and Gronow, 1992 in Nepal; Kiambi and Opole, 1992 in Kenya; Tietema *et al.*, 1992 in Botswana). Local species have the advantages of being non-invasive, well adapted to the environment, accepted by local people, of having a wide range of existing uses supported by existing local knowledge and may be important in the local culture. Additional benefits of *circa situ* genetic conservation through use in agroforestry (Cooper *et al.*, 1992; Pimental *et al.*, 1992; Gajeseni and Jordan, 1992; del Amo, 1992; Kanowski and Boshier, in press) also argue for wider use of native species. Conversely, wide use of exotic trees in farm and agroforestry may greatly hasten the demise of native trees that are used in traditional agroforestry systems (*e.g.* Hellin and Hughes, 1993 for Honduras). Indeed promotion of exotic agroforestry trees over indigenous alternatives strongly parallels the loss of traditional crop varieties following promotion of green revolution improved varieties (*e.g.* Altieri and Merrick, 1987; Cooper *et al*, 1992). In many cases, foresters are handicapped by their limited knowledge of local floras and, under pressure to plant *x* trees or *y* hectares per year, fall back on the limited set of well-known exotics with which they are familiar and for which seed is often more readily available. Rarely is time taken to investigate the potential of lesser-known local species for which seed may not be readily available and for which reliable propagation methods and silvicultural regimes are only poorly known. In Central America, detailed field exploration over several years was needed to "discover" some of the species with greatest potential for agroforestry, which were little-known to science and often geographically restricted, although locally highly preferred and offering considerable potential for tree planting (*e.g.* *Leucaena salvadorensis* in Honduras; Hellin and Hughes, 1993). Greater attention to propagation methods for indigenous species can often yield rapid results (Tietema *et al.*, 1992).

While native species are not risk free, and can alter seed flows into neighbouring natural vegetation when extensively planted in surrounding areas, they do not have the same potential for catastrophic invasion. The vast majority of invasive species are exotics. A switch of philosophy from promoting species as exotics across the tropics (*e.g.* NAS, 1984), the common exercises of recent years of setting species priorities across regions, and reliance on standardised trial networks, to promoting greater use of and research on local tree diversity, could ameliorate the problems associated with introductions, arguably improve the sustainability and value of agroforestry planting, and make a significant contribution to *in-situ* conservation of biological diversity.

In the earlier discussion Hughes (1994) concluded that as one of the principal agents involved, foresters must accept their responsibility and adopt a more cautious approach, guided by rigorous procedures of assessment and local testing with strict monitoring. The current lack of awareness and complacency amongst foresters about the risks of species introductions may stem from the fact that only a relatively small number of tropical trees have so far become serious weeds; this complacency is unjustified given the recent scale of introductions and the prevalent "incubation" period before invasion becomes apparent. Hughes (1994) proposed not a complete halt to introductions but a reduction in the scale of operations and imposition of a framework that demands a more considered approach. Similarly, it was accepted that ecosystems are dynamic and continue to evolve with introduced species as part of that process but that the present scale of introductions is unacceptable in terms of wholesale movement of species and potential for catastrophic invasion that may jeopardize future evolutionary potential.

Increased attention to choice of species, particularly in non-industrial tree planting programmes where there appears to be ample scope to concentrate much more on native species, offers perhaps the greatest scope to reduce the current magnitude of forestry introductions and the associated problems of invasion. Nevertheless, for industrial plantation forestry, the reliance on exotics and further introductions are likely to continue. However, in the industrial sector, with its generally well-defined, documented, controlled and managed plantations, there is greater scope to predict and control spread (*e.g.* Ledgard, 1994 for introduced conifers in New Zealand) and greater opportunity to seek more accountability from agencies who continue to test or introduce species that are known or potential invasives, conditions that patently do not apply in the non-industrial forestry arena.

PROCEDURES AND PROTOCOLS FOR PLANT INTRODUCTIONS

It is striking that closer scrutiny of plant introductions in two quite separate disciplines of forestry (Hughes, 1994) and forage plants (Lonsdale, 1994) have reached similar conclusions about the clear need for a marked reduction in the scale of plant introductions and for new protocols to guide plant introductions. Draft guidelines for species introductions have been provided by IUCN (1987) and discussed by Hazard (1988), Hughes and Styles (1989), Panetta (1993), Lonsdale (1994), Hughes (1994) and Cronk and Fuller (1995). An amalgamation and synthesis of these guidelines is presented (see box) and discussed here in relation to tropical forestry species introductions.

As a starting point in any tree planting programme, alternative native species that might be used to provide similar benefits to the well-known exotics should first be considered. Introductions should only be contemplated if no native species are suitable for the purpose for which the introduction is being made (IUCN, 1987). In the majority of situations this simple recommendation is consistently ignored and only rarely is a thorough assessment of native alternatives undertaken. If introductions are contemplated, greater efforts should be directed at screening out the majority of possible species at an earlier stage prior to widespread field testing (Lonsdale, 1994).

Fundamental to an improved approach is adequate assessment of benefits and risks **prior** to seed distribution. A "guilty until proven innocent" approach, where potential introductions are considered first as potential weeds until evidence suggests otherwise, has been suggested as an alternative to the current experimental approach where species are introduced first and assessed as invasives later (Panetta, 1993, Lonsdale, 1994, Hughes, 1994, Cronk and Fuller, 1995). At present, species are assessed only **after** they have become invasive, when it is usually already too late to prevent wider spread through control or eradication. This approach has now been adopted under new legislation in New Zealand which requires that any plant not in New Zealand must be investigated for potential weediness should anyone wish to import it. It will clearly be impossible to certify a species as 100% safe; introduction will always carry some element of risk. Assessment should proceed essentially as a cost-benefit exercise. What is important is assessment not only of risk but also what degree of risk is acceptable in relation to likely benefits. Although a "guilty until proven innocent" approach may, at first sight, appear to be unacceptably dictatorial and could prove impractical if strictly applied, it appears to offer the only viable framework to ensure that prior assessment of risks and benefits is undertaken in a thorough and serious way. Such an approach is based on similar procedures to those applied to biocontrol agents (Lonsdale, 1994). These are assessed on a case by case basis using well established protocols guided by legislation. Introduction and release is formally a two-stage process and demands thorough background research on the species in question; risk assessment takes several years per species, but the cost is regarded as worthwhile and there have so far been few, if any, undesirable ecological consequences resulting from properly conducted biocontrol programmes (Lonsdale, 1994). To be effective, prior assessment needs to be supported by a permit system whereby introductions are authorized by the appropriate government agency with adequate administrative, scientific and technical support to accept responsibility for decision-making. In the absence of official authorization, agreement of liability to bear the costs of control should the introduced plant become invasive is an alternative. The importer would have to bear the cost of assessment of

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