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Review Article

An assessment of the use of the Code of Conduct for the Import and Release of Exotic Biological Control Agents (ISPM No. 3) since its endorsement as an international standard

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Abstract

The Code of Conduct for the Import and Release of Exotic Biological Control Agents was endorsed by FAO (Food and Agriculture Organization of the United Nations) members in 1995 and became the International Standards for Phytosanitary Measures (ISPM) No. 3 under the International Plant Protection Convention in 1996. ISPM No. 3 seeks to provide procedures for the safe import and release of biological control agents, including biopesticides, although it focused heavily on classical biological control programmes. This review critically assesses the use of ISPM No. 3 since it became an international standard for making decisions about biological control agents. Development of ISPM No. 3 was timely and appropriate. Either ISPM No. 3 or similar national procedures were applied in most cases to support decisions regarding import and release of exotic biological control agents since 1996. It has provided a mechanism for formalizing current good practice and provided internationally accepted standards to countries with little experience in implementing biological control. It provides a good basis for facilitation of regional projects. Countries noted some limitations in implementation of ISPM No. 3, however, including lack of technical capacity and, in some cases, appropriate quarantine facilities. Provision of technical guidelines and support with training to countries would be desirable. Case studies for decisions by Kenya, Colombia, the Caribbean, Yemen, Samoa and Brazil give further insights into the use of ISPM No. 3 over its first seven years.

Introduction

Classical biological control of arthropod pests and weeds has been carried out successfully for more than a century (Greathead & Greathead, 1992; Julien & Griffiths, 1998). Many introductions have been made by the experienced national programmes of Australia, Canada, New Zealand, South Africa and the USA. However, in developing countries, biological control programmes were often spearheaded by international or regional agencies, in consultation and partnership with national institutions. Increasingly, national institutions in these countries are now willing and more ready to undertake their own programmes.

Over the years, practitioners have become increasingly aware that introduced biological control agents may have undesirable side effects. Initially, this concern was limited to the possible impact of these introduced agents on economically important plants and insects (notably, honey bees, silk moths and weed biological control agents). More recently increased environmental awareness has drawn attention to the potential danger to all indigenous fauna and flora, particularly rare and endangered species. Concurrently, the emergence of the integrated pest management (IPM) concept, in response to overuse of pesticides and to further sustainable agriculture, has resulted in the adoption of biological control in the widest sense as a cornerstone of crop protection (Greathead, 1997).

Consequently, countries with little or no previous experience of biological control started to make introductions of biological control agents, both for classical biological control and as formulated products for use as biological pesticides (Box 1). Around 1989, the International Institute of Biological Control (IIBC, now integrated into CABI *Bioscience*) and the International Organization for Biological Control (IOBC), aware of the dangers of injudicious introductions, and the need to provide guidance for countries with little or no previous

Box 1. The demand for biological control and its associated risks.

In recent decades, a range of factors has increased the risk of accidental introduction of regulated pest species to new localities. These include more rapid means of transport, increased volume of trade, increased movement of people between countries, the opening of new trade routes, loss of chemicals to control pests (e.g. broad spectrum fumigants), etc. The animals and plants thus introduced usually arrive without the natural enemies that maintain their populations at manageable levels in their area of origin. Once introduced into new localities, some animal and plant populations can rapidly increase, becoming pests or weeds that cause serious economic and environmental damage. For many such pests, biological control provides a cost effective management strategy. Some substantial biological control successes in the 1980s (e.g. cassava mealybug, salvinia weed) highlighted this for many countries. Following the success of these programmes and associated publicity, developing countries began turning to biological control as a potential solution to some of their alien pest problems. This review focuses on over a hundred biological control introductions against insect pests alone that have been made since 1996 in 42 countries and territories that are relatively inexperienced in this discipline (see Table 2).

This Table does not include the much more numerous and widespread applications of biopesticides, for example *Bacillus thuringiensis* which is sometimes covered by a registration process without a risk analysis of the release. However, no form of biological control is without any risk, and failure to assess these risks before introducing a natural enemy can lead to disaster.

Starting in the 1980s, various university based scientists mostly in the developed world were raising concerns about current standards and procedures, suggesting that there were significant risks involved in biological control and that non-target effects were varied and substantial. This debate continues, but some objective field studies are now confirming that there have been significant non-target effects following some biological control introductions (e.g. Thomas & Willis, 1998; Howarth, 2000; Follet & Duan, 2000; Lynch & Thomas, 2000; Henneman & Memmott, 2001; Wajnberg *et al.*, 2001). Most of these could be considered predictable based upon pre-release studies. Hence, it should be appreciated that the decision making process, and the values used in the process were being challenged, as much as the scientific process. Decisions regarding introductions made 40 or more years ago paid little consideration to potential impact on indigenous species of no economic value; today this is not acceptable in many countries.

Another cause for concern was the possibility of accidentally introducing unwanted organisms together with the biological control agent. Cultures of insects and microorganisms can become contaminated, so that one unwanted species may completely displace a similar intended species, which can lead (and in the past has led) to the wrong species being released. Cultures can be contaminated by parasitic organisms that infest or kill the biological control agents being cultured. If these are released and become established, they can reduce the effectiveness of the biological control agent. Some natural enemies are capable of carrying spores of unwanted plant diseases. These risks can be assessed, and can usually be minimized, for example by the use of third country quarantine when moving natural enemies between continents, or rearing a generation in quarantine and sub-sampling to check purity before starting releases. Countries new to the practice of biological control need guidance on how to address these risks.

For introductions for the purpose of pest control other than classical biological control, this screening may necessarily be completed during the production phase rather than in quarantine after import. For example, sterile insects are mass reared for release in pest control programmes that often require transport across borders. Standard Operating Procedures have been developed to ensure purity and quality, and filter colonies sometimes are used to renew the breeding colonies. Biological control strategies that do not require or even allow for self-replication cannot be subjected to quarantine checks in the country of import. The sterile insect technique is an example of an approach to pest control in demand but that has not been included in the original ISPM No. 3. A revised ISPM No. 3 may support safe use of other biological control technologies (see General News, this issue, Proposals for revision of Code of Conduct).

experience of biological control, approached the Food and Agriculture Organization of the United Nations (FAO) to initiate discussions to determine the need for an international code of conduct (Greathead, 1997). The Code of Conduct was then developed during the ensuing years, under the guidance of Dr Gerard Schulten of FAO, with support from Dr David Greathead of IIBC, culminating in its endorsement by FAO member countries at the end of 1995 and formal publication in 1996 (IPPC, 1996; FAO, 1997). The Code of Conduct is the third in a series of International Standards for Phytosanitary Measures (ISPMs) developed by the International Plant Protection Convention (IPPC) (Box 2). The Code of Conduct, which is referred to in the rest of this paper as ISPM No. 3 is, like other ISPMs, due for review after five years. Against this background, this paper assesses the use of ISPM No. 3 since its endorsement as an international standard. It is anticipated that this information will be relevant to further development of the standard and its use.

Provisions of ISPM No. 3

The history of ISPM No. 3 is described by Greathead (1997). ISPM No. 3 is intended to facilitate the safe importation of exotic biological control agents capable of self-replication (parasitoids, predators, parasites, phytophagous arthropods and pathogens) for research and/or release into the environment, including those packaged or formulated as commercial products. To this end, it lists the responsibilities of government authorities, exporters, importers and other bodies involved in meeting the objectives of ISPM No. 3. Further, it is suggested that governments already fulfilling the objectives of ISPM No. 3 may consider adapting existing systems on the basis of the international standard. ISPM No. 3 is accompanied by a bibliography and a list of definitions and is available in Arabic, Chinese, English, French and Spanish.

Box 2. International Standards for Phytosanitary Measures of the IPPC.

The International Plant Protection Convention (IPPC) (www.ippc.int) is an international treaty for protection of plant resources first adopted in 1951. The IPPC seeks to achieve international harmonization of phytosanitary measures with the aim to facilitate trade and to avoid the use of unjustifiable measures as barriers to trade, while mitigating economic impact to agriculture and forestry and preserving natural plant and fungal biodiversity. The 120 countries currently contracting parties to the IPPC have endorsed 17 ISPMs (International Standards for Phytosanitary Measures) to date on topics such as import regulations, export certification, compliance procedures, pest surveillance, exotic pest response, pest management and post-entry quarantine. The Code of Conduct for the Import and Release of Exotic Biological Control Agents was endorsed in November 1995 by the 28th Session of the FAO Conference.

Several of the ISPMs can be deemed a success based on the amount (volume or value) of trade and related benefits resulting from application of the measures (e.g. the use of pest free areas that allow for exports without eradication of a pest throughout an entire country). It is more difficult to evaluate the impact of ISPM No. 3, since trade in biological control agents *per se* is a small portion of the overall purpose of the standard. The value of implementation of ISPM No. 3 may include reduced application of pesticides; reduced impact of the invading pests and weeds on the native flora and fauna and ecosystem functions; and increased investment and development of biological control technologies that would be hindered if private interests faced differing regulations in each market. These impacts may be expressed more in terms of increased development of agricultural resources while maintaining biodiversity, rather than directly in terms of economic benefits through increased trade.

Table 1. Countries responding to the formal questionnaire survey.

Antigua and Barbuda	Jamaica
Belize	Kenya
Brazil	Malawi
Colombia	Mexico
Cuba	St Lucia
Dominica	Trinidad and Tobago
Guatemala	Uganda
Guyana	Zambia
India	

The key recommendations from the ISPM are:

1. That a national body be designated to administer the regulatory process.
2. That a dossier be prepared for each new introduction, with details of the pest (its identification, importance and known natural enemies), the natural enemy (identification, biology, host specificity, hazards to non-target hosts, its natural enemies and possible contaminants and procedures for their elimination), human and animal health and safety issues, and protocols for the introduction.
3. That exporters of biological control agents conform to local legislation and the legislation of the importing country, and label and package material appropriately.
4. That the national body encourage proper documentation and deposition of voucher specimens, encourage monitoring of the release and its impact, monitor for subsequent problems and take corrective action if necessary.
5. That importers of biological control agents ensure that relevant staff are properly trained, disseminate information on safety and environmental impact, consider scientific publication of results, notify authorities of problems and help to find solutions.

Implementation of ISPM No. 3

Following ISPM No. 3, the agency or institution requesting the introduction would prepare or commission a comprehensive dossier on the proposed introduction that provides all the relevant information, and highlights the issues, so that the responsible party can then make an informed decision. Thus, of the steps set out in ISPM No. 3, the preparation and evaluation of a dossier for each introduction is perhaps the most significant in terms of the decision making process and so has tended to become the main focus of the process. Preparation of a dossier is also perhaps the easiest aspect to document and assess retroactively.

Use of such dossiers for natural enemy introductions made since 1996 was assessed based on published reports, the authors' knowledge and specific enquiries to national programmes. Additionally, a survey was carried out to assess general aspects of use of ISPM No. 3 in developing countries which did not have a long history of independently mounting biological control projects prior to its endorsement. Countries included in the survey were those that had made introductions of natural enemies during the period since 1996 according to BIOCAT records (Greathead and Greathead, 1992), literature records, or the authors' knowledge or personal communications. A questionnaire was developed covering various aspects of the use of ISPM No. 3. Of the 25 countries included in the survey, 17 sent responses to the questionnaire and these are listed in Table 1. A summary of the results is provided below.

Preparation of Dossiers

A total of 104 introductions made since 1996 in 42 countries/territories was considered in this study (Table 2). Twenty-eight pests were targeted using 43 natural enemy species. Dossiers or environmental assessments were prepared in support of at least 75 introductions. In five introductions no dossiers were prepared while in the remaining 22 introductions, it was not ascertained what process was used. Of

Table 2 . Partial table of classical biological control introductions against insect pests made since 1996. Introductions into countries experienced in biological control, and with well-established procedures prior to ISPM No. 3 (Australia, Canada, New Zealand, South Africa and the USA) are excluded; introductions into Brazil are not listed here (see case study).

Country/Area	Pest	Agent	Date	Dossier prepared?[1]	Information[2]
Afghanistan	*Eriosoma lanigerum*	*Aphelinus mali*	1997	No	BIOCAT
Algeria	*Phyllocnistis citrella*	*Semielacher petiolatus*	1996-98	?	BIOCAT
Anguilla	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1999	Yes	Other
Antigua and Barbuda	*Maconellicoccus hirsutus*	*Anagyrus kamali*	2001	Yes	Other
Antigua and Barbuda	*Paracoccus marginatus*	*Cryptolaemus montrouzieri*	1998	No	Other
Bahamas	*Phyllocnistis citrella*	*Ageniaspis citricola*	1996	?	BIOCAT
Belize	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1999	Yes	BIOCAT
Belize	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	1999	Yes	BIOCAT
Belize	*Maconellicoccus hirsutus*	*Gyranusoidea indica*	1999	EA by USDA-APHIS	BIOCAT
Benin	*Plutella xylostella*	*Cotesia plutellae*	1996	?	BIOCAT
British Virgin Islands	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1998	Yes	Other
British Virgin Islands	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	1998	Yes	Other
British Virgin Islands	*Maconellicoccus hirsutus*	*Scymnus coccivora*	1998	Yes	Other
Canary Islands	*Aleurodicus dispersus*	*Encarsia guadeloupae*	1999?	?	BIOCAT
Canary Islands	*Lecanoideus floccissimus*	*Encarsia guadeloupae*	1998	?	BIOCAT

Canary Islands	*Phyllocnistis citrella*	*Ageniaspis citricola*	1996-99	?	BIOCAT
Colombia	*Hypothenemus hampei*	*Phymastichus coffea*	2001	Yes	BIOCAT
Cuba	*Diatraea saccharalis*	*Cotesia flavipes*	1998	Yes	Other
Cuba	*Maconellicoccus hirsutus* (not present in country	*Cryptolaemus montrouzieri* (pre-emptive introduction)	2001	Yes	Other
Curacao	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1999	Yes	Other
Dominica	*Aleurocanthus woglumi*	*Amitus hesperidum*	1997-98	After introduction	BIOCAT
Dominica	*Aleurocanthus woglumi*	*Encarsia perplexa*	1997-98	After introduction	BIOCAT
Dominica	*Maconellicoccus hirsutus*	*Anagyrus kamali*	2001	Yes	Other
Dominica	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	2001	Yes	Other
Dominica	*Maconellicoccus hirsutus*	*Gyranusoidea indica*	2001	EA by USDA-APHIS	Other
Dominican Republic	*Paracoccus marginatus*	*Acerophagus papayae*	2000	EA by USDA-APHIS	Other
Dominican Republic	*Paracoccus marginatus*	*Anagyrus loecki*	2000	EA by USDA-APHIS	Other
Dominican Republic	*Paracoccus marginatus*	*Apoanagyrus californicus*	2000	EA by USDA-APHIS	Other
ninican Republic	*Paracoccus marginatus*	*Pseudaphycus angelicus*	2000	EA by USDA-APHIS	Other
Grenada	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1996	Yes	BIOCAT
Grenada	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	1997	Yes	BIOCAT
Grenada	*Maconellicoccus hirsutus*	*Gyranusoidea indica*	1998	EA by USDA-APHIS	Other
Grenada	*Maconellicoccus hirsutus*	*Scymnus coccivora*	1998	Yes	Other
Guatemala	*Hypothenemus hampei*	*Phymastichus coffea*	2001	Colombian dossier used	BIOCAT
Guyana	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1997	Yes	BIOCAT
Guyana	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	1997	Yes	BIOCAT
Honduras	*Hypothenemus hampei*	*Phymastichus coffea*	2001	Colombian dossier used	BIOCAT
India	*Hypothenemus hampei*	*Phymastichus coffea*	1999	Yes	

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Table 2 (Continued). Partial table of classical biological control introductions against insect pests made since 1996. Introductions into countries experienced in biological control, and with well-established procedures prior to ISPM No. 3 (Australia, Canada, New Zealand, South Africa and the USA) are excluded; introductions into Brazil are not listed here (see case study).

Country/Area	Pest	Agent	Date	Dossier prepared?[1]	Information[2]
Kenya	*Tetranynchus* spp.	*Phytoseiulus persimilis*	2002	Yes	Other
Malawi	*Aleurothrixus floccosus*	*Cales noacki*	1996	Yes	Other
Malawi	*Chilo partellus*	*Cotesia flavipes*	1999	Yes	Other
Malawi	*Heteropsylla cubana*	*Tamarixia leucaenae*	1997	Yes	BIOCAT
Malawi	*Mononychellus tanajoa*	*Typhlodromalus aripo*	1999	Yes	Other
Malawi	*Prostephanus truncatus*	*Teretriosoma nigrescens*	1997	Yes	Other
Marshall Is	*Icerya aegyptiaca*	*Rodolia limbata*	1998	?	BIOCAT
Mexico	*Bactericera cockerelli*	*Tamarixia triozae*	2001	Yes	Other
Mexico	*Glycaspis brimblecombei*	*Psyllaephagus bliteus*	2001	Yes	Other
Mexico	*Hypothenemus hampei*	*Phymastichus coffea*	2001	Colombian dossier used	BIOCAT
Mexico	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1999	Yes	Other
Mexico	*Maconellicoccus hirsutus*	*Gyranusoidea indica*	1999	Yes	Other
Mexico	*Phyllocnistis citrella*	*Ageniaspis citricola*	1997	Yes	Other
Mexico	*Planococcus ficus*	*Anagyrus pseudococci*	2001	Yes	Other
Montserrat	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1997	Yes	BIOCAT
Morocco	*Phyllocnistis citrella*	*Semielacher petiolatus*	1996-98	?	BIOCAT
Mozambique	*Chilo partellus*	*Cotesia flavipes*	1996	?	BIOCAT
Nevis	*Aleurodicus pulvinatus*	*Encarsiella* sp. D	1998	Yes	BIOCAT
Palau Is	*Icerya aegyptiaca*	*Rodolia limbata*	1998	?	BIOCAT
Somalia	*Chilo partellus*	*Cotesia flavipes*	1997	?	BIOCAT
St Helena	*Plutella xylostella*	*Cotesia plutellae*	1999	?	BIOCAT
St Helena	*Plutella xylostella*	*Diadromus collaris*	1999	?	BIOCAT
St Kitts	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1996	Yes	BIOCAT
St Kitts	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	1997	Yes	BIOCAT
St Kitts	*Maconellicoccus hirsutus*	*Scymnus coccivora*	1996	Yes	BIOCAT
St Lucia	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1997	Yes	BIOCAT
St Lucia	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	1997	Yes	BIOCAT
St Vincent	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1997	Yes	BIOCAT
Suriname	*Maconellicoccus hirsutus*	*Anagyrus kamali*	2001	Yes	Other
Suriname	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	2001	Yes	Other
Taiwan	*Aleurodicus dispersus*	*Encarsia ?haitiensis*	1996-98	?	BIOCAT
Taiwan	*Aleurodicus dispersus*	*Encarsia guadeloupae*	1996-98	?	BIOCAT
Tanzania	*Heteropsylla cubana*	*Psyllaephagus yaseeni*	1996	Yes	BIOCAT
Trinidad	*Aleurocanthus woglumi*	*Amitus hesperidum*	2000	Yes	Other
Trinidad	*Aleurocanthus woglumi*	*Encarsia perplexa*	2001	Yes	Other
Trinidad	*Boophilus microplus*	*Metarhizium anisopliae*	2000	Yes	Other
Trinidad	*Maconellicoccus hirsutus*	*Anagyrus kamali*	1996	Yes	BIOCAT
Trinidad	*Maconellicoccus hirsutus*	*Cryptolaemus montrouzieri*	1997	Yes	BIOCAT
Trinidad	*Maconellicoccus hirsutus*	*Scymnus coccivora*	1996	Yes	BIOCAT
Tunisia	*Phyllocnistis citrella*	*Ageniaspis citricola*	1996	?	BIOCAT

Table 2 (Continued). Partial table of classical biological control introductions against insect pests made since 1996. Introductions into countries experienced in biological control, and with well-established procedures prior to ISPM No. 3 (Australia, Canada, New Zealand, South Africa and the USA) are excluded; introductions into Brazil are not listed here (see case study).

Country/Area	Pest	Agent	Date	Dossier prepared?[1]	Information[2]
Uganda	*Aleurothrixus floccosus*	*Cales noacki*	1996-98	No	BIOCAT
Uganda	*Chilo partellus*	*Cotesia flavipes*	1997	?	BIOCAT
Uganda	*Cinara cupressivora*	*Pauesia juniperorum*	1996	Yes	Other
Uganda	*Pineus boerneri*	*Tetraphleps raoi*	1996	?	Other
Uganda	*Prostephanus truncatus*	*Teretriosoma nigrescens*	1998	Yes	Other
Venezuela	*Maconellicoccus hirsutus*	*Anagyrus kamali*	2000	Yes	Other
Venezuela	*Phyllocnistis citrella*	*Ageniaspis citricola*	1998	?	BIOCAT
Yemen	*Pterochloroides persicae*	*Pauesia antennata*	1997	Yes	BIOCAT
Zambia	*Chilo partellus*	*Cotesia flavipes*	1999	?	Other
Zambia	*Mononychellus tanajoa*	*Typhlodromalus aripo*	1999-2000	?	Other

[1]EA by USDA-APHIS = Environmental Assessment by the US Department of Agriculture ñ Animal and Plant Health Inspection Service; ? = procedure unknown (does not imply a process did not exist).

[2]Entries are based either on published information abstracted to the BIOCAT database (Greathead & Greathead, 1992) up until the end of 2001, or on selected additional publications, responses to the questionnaire and the authors' personal knowledge.

the 42 countries/territories included in the study, at least 30 used dossiers or environmental assessments. The detailed results are presented in Figure 1.

Awareness and Use of ISPM No. 3

The general awareness and use patterns of ISPM No. 3 are summarized in Figures 2a-f, which are based on responses to specific questions. It is clear that a majority of the countries were aware of ISPM No. 3. In cases where it was not used, there were other procedures in place or there was no designated national authority. In the latter case, there was also no national legislation. Most of the countries also followed the provisions of ISPM No. 3 either partially or completely. However, most countries indicated that, in general, knowledge of ISPM No. 3 among relevant national agencies and other stakeholders in biological control was limited. (This finding

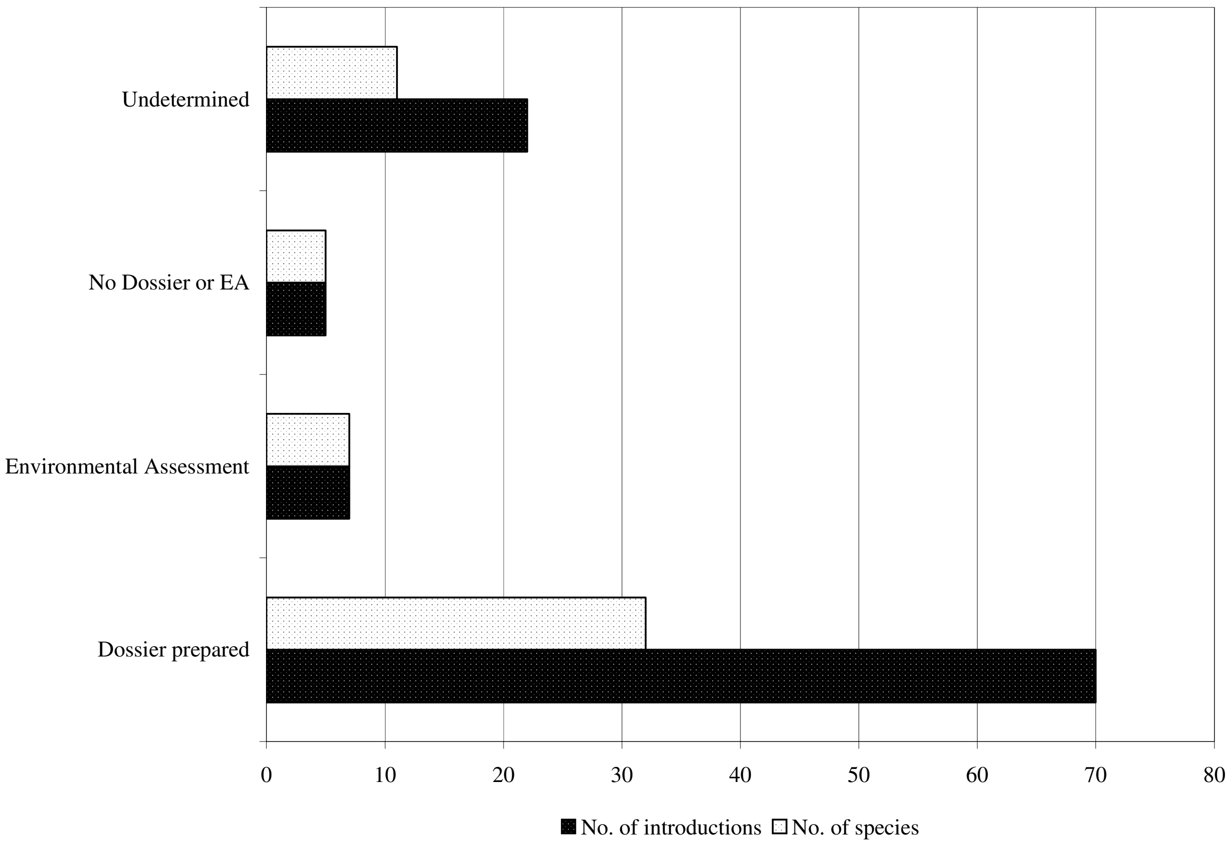

Figure 1. Use of ISPM No. 3 during introductions made from 1996-2002 is assessed on the basis of whether a dossier on the candidate natural enemy was prepared or if other guidelines (e.g. the USA requires preparation of an environmental assessment) were used.

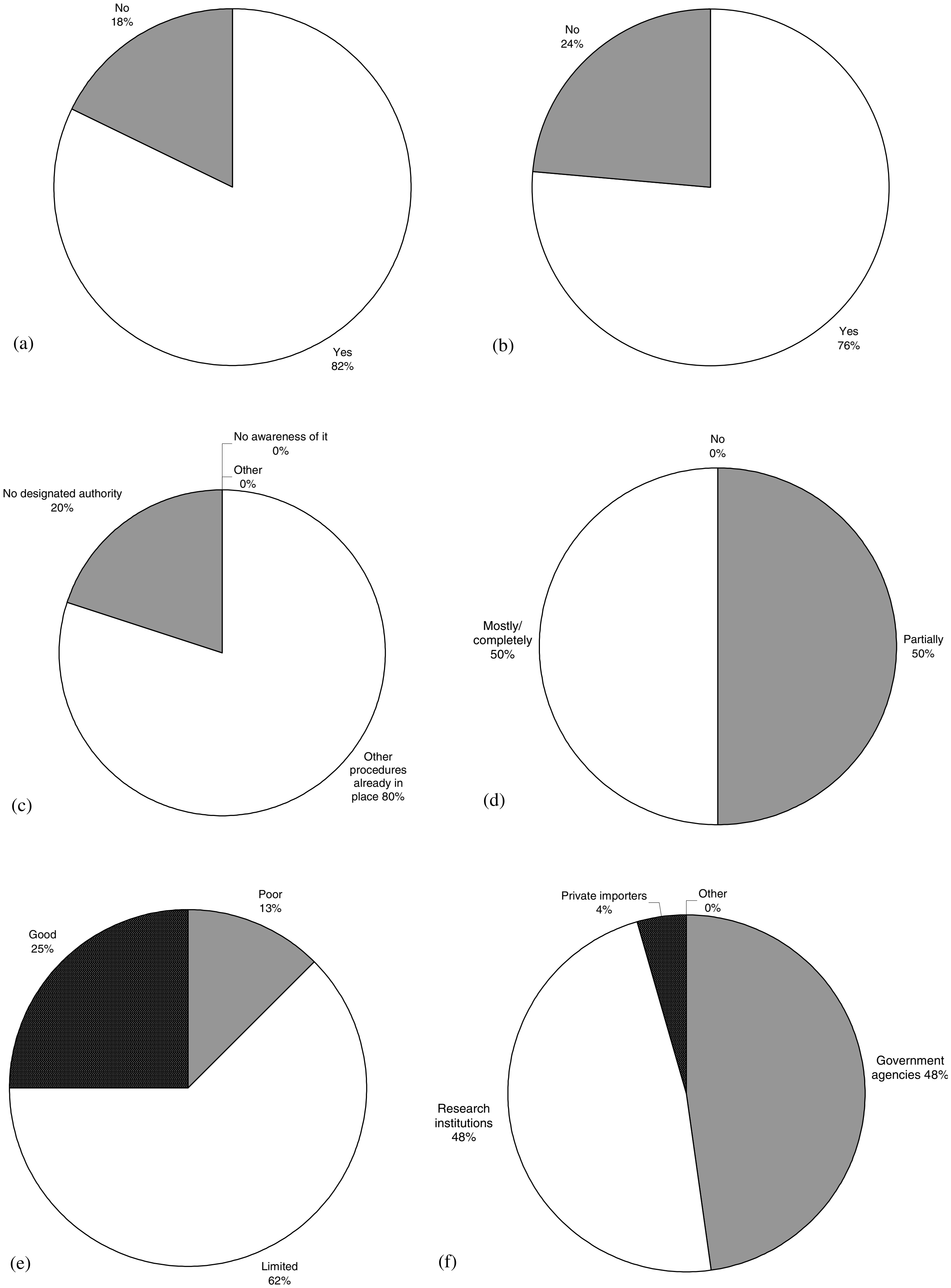

Figure 2. General awareness and use of ISPM No. 3 (responses to questions). (a) Were you/the country aware of ISPM No. 3 when the introduction was made? (b) Have you used ISPM No. 3? (c) What are the reasons for not using ISPM No. 3? (d) Did you follow the provisions of ISPM No. 3? (e) What is the awareness of ISPM No. 3 among relevant agencies and stakeholders in biological control? (f) Who is allowed to import natural enemies?

was supported by an informal survey of biopesticide companies by a participant at a workshop held in December 2002 [see General News, this issue, 'Proposals for revision of Code of Conduct'], which found virtually no knowledge of ISPM No. 3 among commercial biopesticide manufacturers.)

Only governmental agencies or recognized research institutions were allowed to make introductions of biological control agents**.** Among the respondents, there were also cases where requests for introduction were denied, suggesting that the Code of Conduct had indeed facilitated informed decision making (Figure 3a). The reasons cited for rejection included: health concerns, host specificity concerns, inadequate justification and procedural issues. Although in general respondents indicated that ISPM No. 3 had made introductions more rigorous or lengthy, this did not appear to have affected the overall number of introductions (Figure 3b).

Regulatory Framework

Countries with no relevant legislation could use ISPM No. 3 as a 'soft law' to facilitate implementation. Access to ISPM No. 3 did not in itself give countries the capability to implement biological control introductions, but it did give substantial help to those mandated with the decision making process. Normally this would be the Minister (or Ministry) of Agriculture through the senior technical officer, sometimes with the benefit of an established advisory committee, but often without. ISPM No. 3 provides confidence that the decision being considered is within the framework of accepted international procedures, and points the way in terms of what steps should be followed. Most of the countries surveyed had some legislation governing importation and release of biological control agents (Figure 4a). For those without any legislation or where this was inadequate, ISPM No. 3 was seen as a useful guide in development of legislation (Figure 4b).

Constraints

Adequate measures to ensure unwanted organisms are not inadvertently introduced along with the import of the approved biological control agent is an important element in classical biological control programmes. However, many countries do not have quarantine facilities (Figure 5a). For most countries, lack of technical capacity was identified as the major constraint (Figure 5b). Other reasons cited included: lack of practical guidelines, lack of interest from or champions within the responsible authority, or the lack of a responsible authority as stipulated in ISPM No. 3. Interestingly two countries had not experienced any problems applying ISPM No. 3. Other countries which did not use ISPM No. 3 had other procedures in place.

Case Studies

In order to illustrate the application of ISPM No. 3 in different countries, several specific examples of its use are discussed below.

Kenya

The need for a process for importation of biological control agents into Kenya had already been addressed before ISPM No. 3 was published in 1996. Authority for releases is vested with the Minister of Agriculture and implemented on his behalf by the Director of Agriculture. The Kenya Standing Technical Committee on Imports and Exports advises the Director on this and related questions. The Committee is composed mainly of Ministry of Agriculture officials including the Pest Control Products Board. Other relevant ministries such as the Ministry of Environment, Natural Resources and Wildlife are not usually invited. The Chair of the Committee is the Director of Agriculture while the Managing Director, Kenya Plant Health Inspectorate Service (KEPHIS) is the secretary. After the request for importation of an exotic biological control organism is approved, KEPHIS issues the import permit on behalf of the Director of Agriculture. Draft legislation governing importation is largely based on ISPM No. 3. Before ISPM No. 3 became available, requests for the importation and release of biological control agents were normally required to be supported by a written petition and often a verbal presentation. Decisions or requests for more information were made based on these. The introduction of ISPM No. 3 validated this arrangement and refined the required contents of the dossier petitioning for permission to release.

Colombia

From several perspectives, coffee is a very important crop in Colombia and, even at the current low world coffee prices, it is a major contributor to the economy. Coffee berry borer, *Hypothenemus hampei*, is an important worldwide scolytid pest of coffee (*Coffea* spp.), originally from Africa, which has spread through Latin America. In the 1980s it spread through Colombia becoming the key insect pest. Hence, there were many important stakeholders in efforts to develop effective control for this pest, including coffee farmers, the Federation of Coffee Growers, the government and, since coffee is a force for stability in the country, the population as a whole. Coffee berry borer is difficult to control using pesticides because most or all of its life cycle takes place within the coffee berry. Furthermore the use of chemical pesticides runs contrary to the environmentally friendly Café de Colombia image. Rigorous harvesting to remove all ripe berries provides some control, but the establishment of effective biological control agents would facilitate the development of more effective and cost-efficient IPM strategies.

During the late 1980s, Colombia started a programme of biological control against the newly arrived coffee berry borer and two parasitoids were introduced and established before ISPM No. 3 was available. A UK Department for International Development (DFID) funded project to develop IPM capacity at Cenicafé (the coffee research station of the Federation of Coffee Growers of Colombia) with support from CABI was started in 1993, one part of which involved the introduction of an additional parasitoid, *Phymastichus coffea*. In 1995, CABI ran a workshop on the draft Code of Conduct with scientists of the Ministry of Agriculture (who are responsible for authorizing biological control introductions) in order to familiarize them with the reasoning behind ISPM No. 3 and its recommendations.

Anticipating the need to assess possible risks to the environment, CABI carried out studies in quarantine to assess the potential risk to non-target organisms (Lopez-Vaamonde & Moore, 1998). These showed that under no-choice conditions some other small scolytid beetles could be parasitized and killed by *P. coffea*. Whether this would happen in the field and what impact this might have on indigenous scolytids or their role in the local ecology could not be assessed, but the possibilities were presented in the dossier prepared (Lopez-Vaamonde *et al*., 1997). This dossier was submitted to the Ministry of Agriculture by the Federation of Coffee Growers; it was reviewed and permission given for the release of the wasp, perhaps not least because of the great importance of coffee in the economy of Colombia (Cock, in press). In the absence of ISPM No. 3, there would have been little hesitation in approving this wasp for release. If anything, following ISPM No. 3 may have delayed the process. However, it did ensure that the authorities were aware of the potential of some non-target impact, enabling them to make an informed decision based upon the overall national interest. Subsequent monitoring in Colombia suggests the parasitoid will make a useful contribution to the control of coffee berry borer, and there are no indications of adverse non-target impact to date (Baker, 1999; Baker *et al*., 2002).

Caribbean

Although many classical biological control programmes were implemented in the Caribbean before the 1980s (Cock, 1985), only a few programmes were mounted in the following two decades. In terms of biological control implementation, in the early 1990s the region could be characterized as having:

- Limited or no experience of biological control at the national level
- No national mechanisms governing introduction of biological control agents or independent procedures (for many countries, plant protection legislation was outdated or non-existent)
- Limited capacity or experience for implementing ISPM No. 3

Since 1990, however, the region has faced a spate of exotic pests including, citrus leaf miner (*Phyllocnistis citrella*), citrus blackfly (*Aleurocanthus woglumi*), papaya mealybug (*Paracoccus marginatus*), giant African snail (*Achatina fulica*) and coconut whitefly (*Aleurodicus pulvinatus*), but the most notable was the hibiscus mealybug (*Maconellicoccus hirsutus*).

Hibiscus mealybug is native to parts of Asia, but has been introduced to other regions in the tropics. It appeared in the Caribbean for the first time in 1994, in Grenada, but since then, it has spread to most countries in the Caribbean basin. Hibiscus mealybug attacks the new flush growth, young shoots, flowers and fruits of a wide range of plants, particularly those in the family Malvaceae. Important hosts include ornamental hibiscus (*Hibiscus rosa-sinensis*), blue mahoe (*Hibiscus elatus*, an important indigenous watershed tree), samaan (*Samanea saman*), teak (*Tectona grandis*), soursop (*Annona muricata*), ochro [okra] (*Abelmoschus esculentus*), sorrel (*Hibiscus sabdariffa*), cotton (*Gossypium hirsutum*), cocoa (*Theobroma cacao*) and citrus (*Citrus* spp.). Damage to these crops was often substantial, including loss of fruit, defoliation and death of plants. Economic losses due to the hibiscus mealybug have been estimated for several countries (Kairo *et al.*, 2000). Thus for the period 1995-98, losses in Grenada were estimated at US$18.3 million while projected annual losses to US agriculture would be US$750 million should the pest invade the main US agricultural areas, without an effective control strategy in place.

The first biological control programme against hibiscus mealybug in the Caribbean was an FAO Technical Cooperation Project (TCP) started in 1995 for Grenada. Subsequently, several initiatives including a regional (15 country) FAO funded project were implemented (Kairo *et al*., 2000). From the outset, it was agreed that ISPM No. 3 would be followed for the FAO funded projects. Indeed these projects were perhaps the first where the project documents specified that ISPM No. 3 would be applied. Pressure to apply ISPM No. 3 came from the funding agency (FAO) and the implementing agency (CABI). Dossiers were prepared on four candidate agents. In some of the countries, notably Trinidad and Tobago, *ad hoc* committees were constituted to oversee implementation of the biological control programmes. These comprised officials from several different national agencies but were usually convened by the Ministries of Agriculture. These committees were also responsible for evaluation of dossiers. It is noteworthy that while there were risks associated with some of the agents, particularly the generalist mealybug predator, *Cryptolaemus montrouzieri* (Peterkin *et al*., 1998), these were considered of less importance than those posed by the pest, and thus introductions were made (Cock, in press). In 1996, the United States Department of Agriculture – Animal and Plant Health Inspection Service (USDA-APHIS) began assisting islands in the northern Caribbean including US Territories to implement biological control against the hibiscus mealybug. This effort focused on introduction of two parasitoids, *Anagyrus kamali* and *Gyranusoidea indica*. For this purpose, Environmental Assessments were prepared to support introduction of the parasitoids following US guidelines.

Following its use in the hibiscus mealybug example, the significance of ISPM No. 3 in providing internationally accepted standards and as a basis for national action are best exemplified in a subsequent project mounted by the government of Trinidad and Tobago against the citrus blackfly. This pest was first recorded in Trinidad in 1997 and a biological control programme was established in 1999. The national programme used ISPM No. 3 as the basis for considering introductions of natural enemies and thus dossiers were prepared for the two candidate natural enemies (Lopez *et al*., 2000a, b). A formalized committee comprising several local experts mainly drawn from the Ministry of Agriculture, Land and Marine Resources examined the dossiers and granted approval for introduction and release of natural enemies. This committee also included smallholder farmers who were represented through their association, the Cooperative Citrus Growers Association.

For many of the smaller Caribbean island states with little national capacity, ISPM No. 3 provided an important basis for implementation of biological control. This was the case in Nevis when it implemented a biological control project for coconut whitefly, using newly discovered biological control agents (Kairo *et al*., 2001). In general, however, most countries still do not have specific legislation governing importation of natural enemies and most have not established specific committees to oversee implementation of ISPM No. 3.

Yemen

Before the arrival of the brown peach aphid, *Pterochloroides persicae*, in 1993, the General Department of Plant Protection (GDPP) in Yemen had recently implemented its first biological control project in partnership with the Yemeni-German Plant Protection Project. This project was against potato tuber moth, *Phthorimaea operculella*, using well known and widely used parasitoids imported from Australia with the assistance of the Keith Turnbull Research Institute, Australia. However, there were no set mechanisms for assessing potential introductions, nor for involving potential stakeholders in the decision making process.

An FAO TCP was started in 1995 to mount a biological control effort against brown peach aphid. This aphid originates in Pakistan, and when established in Yemen caused large yield reductions and death of stone and pome fruit trees, especially almonds on which more than 200,000 families depended for their livelihood. The project was implemented by CABI and followed the provisions of the draft Code of Conduct. The natural enemy prioritized for introduction was a parasitic wasp, *Pauesia antennata*, from Pakistan, which had not previously been used for biological control. A dossier was prepared (Cross & Poswal, 1996) and submitted to the GDPP. For the first time, this allowed a critical look at the introduction of a natural enemy in Yemen, and clearly established the important role of the national authority, the GDPP. The parasitoid was safely introduced, and the biological control effort was an outstanding success that led to the establishment of sustainable control of brown peach aphid (Anon., 1997). Indeed the GDPP subsequently won the Edward Souma Prize awarded by FAO to the national agency that most effectively implemented a TCP project.

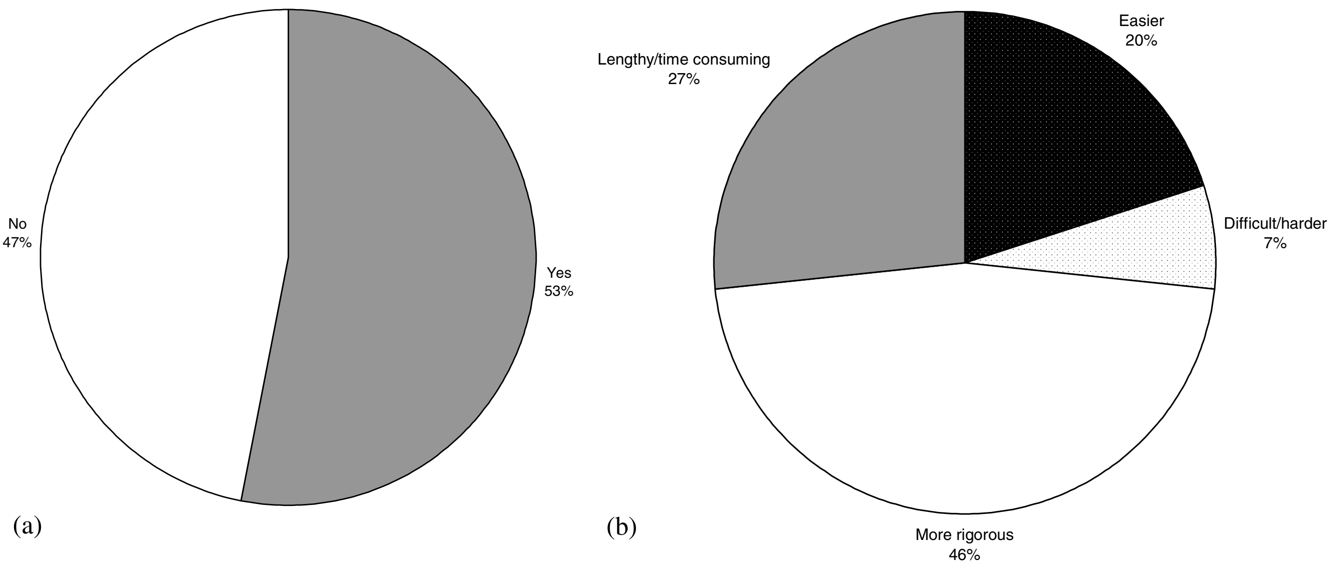

Figure 3. Impact of ISPM No. 3 on biological control introductions (responses to questions). (a) Have any requests for importation been denied? (b) How has ISPM No. 3 affected biological control in your country? Made it:

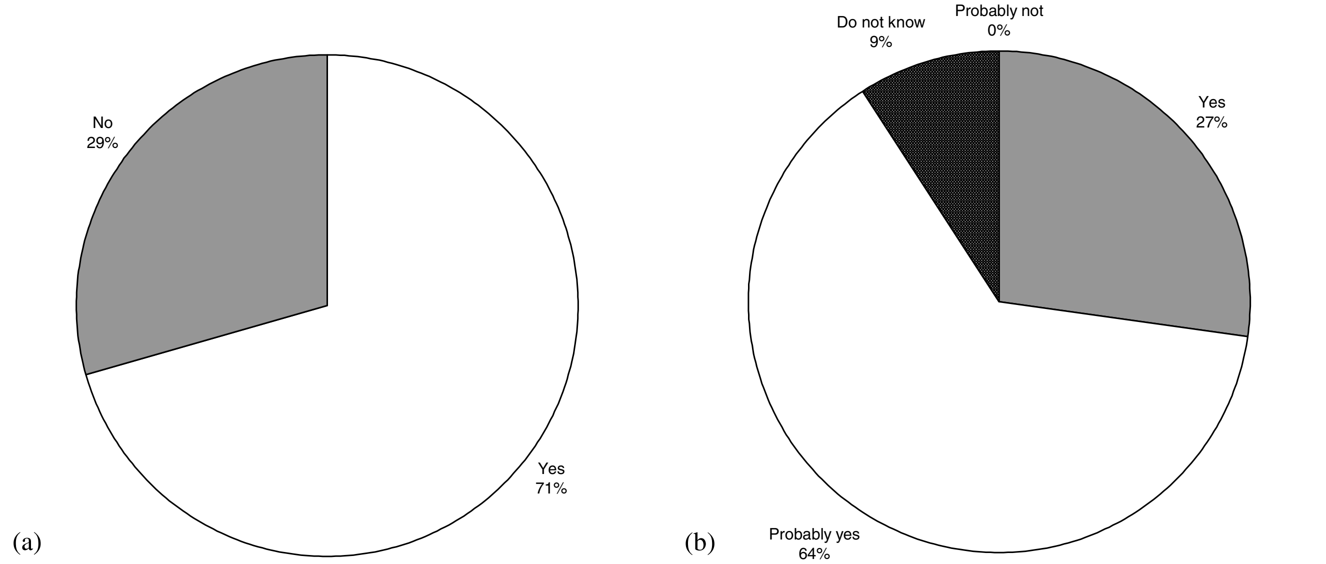

Figure 4. National legislative frameworks in support of ISPM No. 3 (responses to questions). (a) Do you have national legislation governing the introduction and release of biological control agents? (b) Will ISPM No. 3 provide a basis for development of legislation?

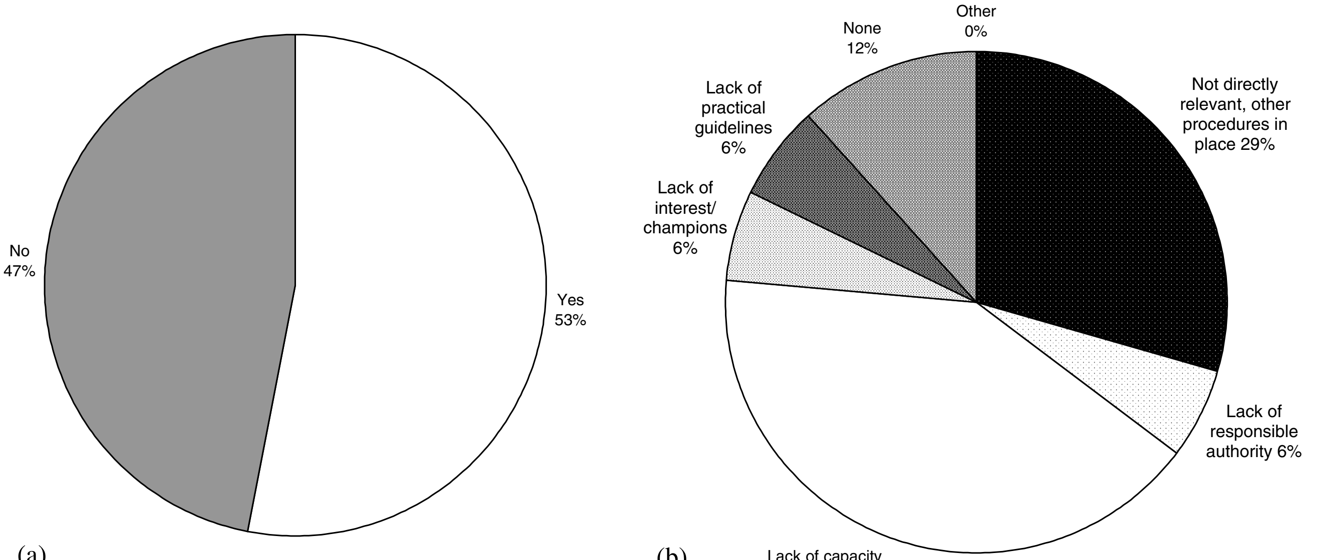

Figure 5. Constraints to use of ISPM No. 3 (responses to questions). (a) Is there a quarantine facility in your country? (b) What are the main constraints to the implementation of ISPM No. 3?

Samoa

The giant African snail, *Achatina fulica*, has been introduced widely (usually as a potential food source) in Asia, to islands in the Pacific and Indian Oceans, and recently to the Caribbean. Feeding on many plant species, in large numbers it is a serious agricultural and garden pest. During the 20th century, one tactic used to try to control it was biological control by the introduction of predatory snails, such as the rosy wolf snail, *Euglandina rosea*, which did not effectively control giant African snail, but in many cases caused the extinction of indigenous snails.

The giant African snail was found in Western Samoa in the early 1990s. Initial attempts at containment and eradication by the Ministry of Agriculture, Forests, Fisheries and Meteorology were not successful, and biological control was then considered. FAO was asked to provide emergency assistance through a TCP project to implement biological control by the introduction of *E. rosea* and other generalist snail predators. FAO approached CABI for advice and assistance and, as a result, Western Samoa was advised not to introduce these predators, but to seek alternative control strategies. In the process of a drawn out negotiation and redesign of the TCP to try and follow the draft Code of Conduct, at one stage it was agreed to compile dossiers on the proposed biological control agents, to make clear the implications of introducing predators such as these. In the end, dossiers were not compiled, no releases were made and resources were channeled to support eradication efforts and evaluation of an indigenous disease found to affect giant African snail in Western Samoa.

In 1998, Samoa (Government of Samoa, 1998) reported to the Convention on Biological Diversity:

"The most significant threat to the land-snails comes from the recent establishment in the country of the vegetarian Giant African Snail (*Achatina fulica*) (current outbreak began in 1990 and three areas now infested). Many islands (including American Samoa) have reacted to the arrival of this agricultural pest by introducing two carnivorous snails (*Euglandina rosea* and *Gonaxis kibweziensis*). These have had little impact on the target species but decimated native land-snail populations, causing mass extinctions on Hawaii for example. The South Pacific Commission argues strongly against this approach in a recent pest leaflet. Eradication efforts are continuing but with very limited success due to the shortage of staff and financial resources."

It seems likely that, with hindsight, the lack of support for the introduction of *E. rosea* and other predators will be seen to have led to a nationally correct decision. Undoubtedly, the draft Code of Conduct ensured that possible non-target effects were considered at the TCP planning stage, and lent significant weight to the arguments against introduction of *E. rosea*.

Brazil

Since 1991, all imports and exports of beneficial organisms have been overseen by a national quarantine facility, Laboratório de Quarentena 'Costa Lima', EMBRAPA Meio Ambiente. Specific procedures have been developed on handling biological control agents and these have been agreed among the countries of the Southern Cone Plant Protection Committee, COSAVE (Comité de Sanidad Vegetal del Cono Sur) (Argentina, Brazil, Chile, Paraguay and Uruguay). The regional standards were endorsed by the Committee in December 1996 (www.cosave.org.py/st40100v010303.html). In developing the regional standards, the Committee referred to ISPM No. 3, individual national legislation and US guidelines on importation of natural enemies. The application process requires that a dossier of information on the target pest and candidate natural enemy is compiled. The Brazilian facility complies with the regional standards for all biological introductions. Between 1991 and December 2000, the national quarantine laboratory has processed 170 introductions of biological control agents (Tambasco *et al*., 2001). The list of introductions is available online: www.cnpma.embrapa.br/biocontrol.

The Need for Additional Support to ISPM No. 3

ISPM No. 3 in itself is a largely mechanistic description of what should be done. It does not include explanations of why various actions are needed, how documentation should be evaluated, what protocols should be used, etc. Countries reasonably familiar with biological control do not find it difficult to adapt or adopt this framework, whereas countries inexperienced in biological control would find it difficult to interpret and apply in isolation. Hence, implementation by inexperienced countries needs further support through additional information, training and partnerships.

It was intended that ISPM No. 3 should be supplemented by a set of guidelines to be published by FAO. These would set out in more detail how to set up a biological control programme against a particular pest, test for host specificity of candidate control agents, eliminate hyperparasites and diseases from cultures of agents, and carry out risk assessment and quarantine procedures for imported agents, and would specify appropriate export and import documentation for biological control agents. Drafts of these were prepared, and were circulated by FAO for comment but, mainly due to turnover of staff, they were not finalized or issued. Various working groups have since been addressing this piecemeal or at the regional rather than international level, e.g. North American Plant Protection Organization (NAPPO), European and Mediterranean Plant Protection Organization (EPPO), COSAVE and the Organisation for Economic Cooperation and Development (OECD) Biological Control Working Group. Once further detail is incorporated at the international level in the form of a revised ISPM No. 3, regional standards of the Regional Plant Protection Organizations (e.g. NAPPO, EPPO) will need to be reviewed for compliance and cohesiveness with that version. Completion of one or more technical guidelines in support of ISPM No. 3 would be desirable. Even once such technical guidelines were available, as pointed out earlier, inexperienced countries are still likely to need some support through training and partnerships.

Discussion and Conclusions

The production and dissemination of ISPM No. 3 was timely and appropriate. In many developing countries the economic and social factors influencing biological control decisions tend to be more concerned with economic and food security issues than impact on indigenous species (Neuenschwander & Markham, 2001; Cock, in press). Even so, it is appropriate to raise environmental issues, and the use of dossiers within the framework of ISPM No. 3 ensures this is done. The decision as to whether to release a biological control agent has to be a national one, however, based upon the greater national good at that time.

From the perspective of scientists working to implement biological control, ISPM No. 3 was a mechanism to formalize current good practice. It also set standards to follow in terms of the information to be provided for decision making that reflected the concerns that had been raised regarding the potential for environmental damage, without going to over-restrictive control measures.

Countries that were already practising biological control to a significant degree (mainly Australia, Canada, New Zealand, South Africa and the USA) already had some protocols and/or legislation in place and in many ways ISPM No. 3 reflects selected best practice from these tried and tested systems. Nevertheless, not all was as it should have been in these countries. For example, even though weed biological control introductions are rigorously evaluated in the USA (under APHIS's mandate to address plant feeding organisms), there has been a gap with regard to biological control agents of insect pests. Releases of generalist predators and parasitoids continued until recently. None of these countries adopted ISPM No. 3 formally, having their own procedures in place. Europe, which has lagged behind in the implementation of biological control, has recently formulated its own regional standards that are strongly influenced by ISPM No. 3.

It is those mostly developing countries recently starting to use biological control or with an opportunity to use biological control, which benefited most from ISPM No. 3. Until ISPM No. 3 was prepared, there was little guidance available to these countries and none with the international authority that is embodied in ISPM No. 3. ISPM No. 3 gave them increased confidence to proceed, based on the assurance that they were following international standards and procedures.

ISPM No. 3 has provided a good basis for facilitation of regional projects and dialogue between countries facing similar problems. While the decision to introduce a biological control agent is essentially a national one, in today's global economy it is also important to act, and be seen to act, responsibly within a region. ISPM No. 3 has therefore provided internationally accepted procedures through which countries can demonstrate this. This is of particular significance for countries sharing land borders, since pests and natural enemies are unlikely to be restricted to one country once established. ISPM No. 3 provides a basis for sharing information and for national and regional consultation, including collective decision making. The decision as to whether to introduce *Nephaspis bicolor* for control of spiralling whitefly, *Aleurodicus dispersus*, in West Africa (Lopez *et al*., 1997) was deliberated at the regional level using ISPM No. 3 as the basis (Neuenschwander & Markham, 2001). While the natural enemy was not introduced in this case, ISPM No. 3 provided a basis for regional cooperation. Even now, however, the application of ISPM No. 3 does not always mean that all countries to which introduced biological control agents could spread would necessarily be consulted.

Biological control in developing countries is often supported by donor agencies. Knowing that the proposed programmes would follow an international standard gives donors reassurance that the work programmes proposed are appropriate and that their funding is to be spent responsibly. No biological control programme should be funded today that is not going to follow ISPM No. 3 or comparable national standards. However, in planning donor support to a biological control initiative it should be recognized that ISPM No. 3 prescribes a risk assessment decision process. Accordingly, work programmes and funding needs to be sufficiently flexible to recognize that these are not foregone decisions, and proposed biological control introductions sometimes will need additional information to be adequately evaluated.

On balance, the production of ISPM No. 3 has facilitated the process of import and release of biological control agents. Detailed dossiers have been prepared which provide adequate information to make appropriate decisions. Few negative decisions have been made. This does not reflect a lack of discrimination, but rather the fact that faced with the process of preparing a dossier of justification, agencies responsible for introductions saw for themselves the drawbacks of candidate agents. Whether this has led to potentially effective agents not being used cannot be evaluated at this time, but it is a possibility. Certainly by introducing a greater demand for accountability and transparency into the process, one result has been an increasing tendency to concentrate on the most promising agents (but see the dossier on *Cephalonomia stephanoderis* which actually points out that this is unlikely to be an effective agent (Baker, 1998)).

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