Beyond Compliance

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A Production Chain Framework for
Plant Health Risk Management in Trade

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Preface

Over the past decade, a considerable number of developing economies have benefited from integration into the global economy through export growth and diversification, supported by export promotion efforts, to create a virtuous circle of investment, innovation and poverty reduction. And although the importance of agriculture varies considerably among developing countries, it remains an engine of growth and the economic mainstay for the majority of them as the largest source of employment, Gross Domestic Product, exports and foreign exchange earnings.

Yet the share of developing countries and especially the least developed countries (LDCs) in global agricultural trade is still significantly low. Several challenges continue to permeate LDCs' agri-exports preventing them from realising their full potential. For instance, exports from LDCs remain concentrated in a few low value added primary commodities. Most attempts to diversify their export base so far have been directed towards a restricted number of high end markets creating an excessive vulnerability to changes into their destination markets. Accordingly, diversification into non-traditional exports and markets is of paramount importance for developing countries and LDCs to mitigate the risk of commodity price fluctuation and build their resilience to inelasticity of demand and other external shocks. But access to international markets for diversified products, including plants and plant products from developing countries, is restrained by severe supply-side productive capacity and trade-related constraints. These include weak logistics, poor infrastructure and limited capacity to comply with non-tariff measures required by destination markets notably Sanitary and Phytosanitary (SPS) requirements.

Specifically, in the realm of plant and plant products, competitiveness and compliance with import requirements begins upstream with the capacity of the exporting country to identify adequately its pest and disease status to: (i) ensure that this status does not deteriorate (avoid introduction of new pests and diseases that may affect productivity and hence undermine competitiveness), remains the same (control and containment), or improves (eradication); and (ii) provide the necessary information and assurances to the importing country for the latter to conclude its risk assessment as the basis for setting market access conditions. This in turn requires a number of competencies and skills that national plant protection organisations (NPPOs) in several developing countries are still lacking, such as capacity to carry out pest surveillance, pest identification and diagnosis, and Pest Risk Analysis (PRA). PRA is the method that allows importing countries to categorise and estimate the risk from pests associated with the "trade pathway" (imported plants and other regulated articles) and to decide on risk management measures. A considerable number of LDCs and developing countries are not fully knowledgeable about, and lack confidence in, presenting dossiers of information to the importing country's NPPO to conduct its PRA.

While targeted and specialised flows of technical assistance are gradually enhancing developing countries' capacity to conduct PRAs, Pest Risk Management remains the weakest component of this process. Pest Risk Management consists of evaluating various management options and selecting the best phytosanitary measure or ***combination of measures*** to apply to trade or other pathways to achieve an appropriate level of protection.

Combined control measures in a Systems Approach offer risk managers a wider array of options when considering Pest Risk Management. It consists of using a number of measures along the production chain that have the combined effect of reducing the pest risk to the desired level instead of relying solely on heavy use of pesticides or post-harvest measures such as fumigation with methyl bromide. In addition to being environmentally-unfriendly and less cost-effective, especially in developing countries where access to quality inputs is challenging, such treatments often lower market quality of the produce, reduce its shelf life and introduce the need to mitigate other types of risks related to food safety, such as a strict control of Maximum Residue Limits.

To facilitate the use of combined phytosanitary measures as a risk management option in international trade, the International Plant Protection Convention (IPPC) developed a standard to this effect (ISPM 14: Use of integrated measures in a systems approach for pest risk management). However, the implementation of ISPM 14 has been challenging in developed and developing countries alike mainly due to perceived complexity of calculating the combined impact of measures when the efficacy of each measure is not well known.

It is all the more daunting for exporting developing countries to question the proportionality of the required measures to the estimated risk if they do not fully grasp the purpose, role and impact of each measure which they or their trade partners are proposing. Mastering the production chain and understanding the scope and effectiveness of each control measure can enhance confidence of developing countries' NPPOs during market access negotiations.

This e-book introduces a set of decision-support tools (which range from a set of questions to consider when meeting stakeholders, through to advanced probabilistic modelling and Bayesian networks) developed and tested in the framework of a technical assistance project funded by the Standards and Trade Development Facility (STDF). This project focused on enabling developing countries to play an active role in negotiating phytosanitary measures that apply to their exports. An analogy with this approach can be drawn with the application of the Hazard Analysis Critical Control Point (HACCP) for food safety, which allows practitioners to clearly identify the stages of production where the risk is likely to spin out of control and hence the corrective measure(s) to avoid loss of control.

The STDF is a global partnership that aims to build developing countries' capacity to implement international SPS standards, guidelines and recommendations as a means to improve their human, animal and plant health status and their ability to gain and maintain access to markets. Dissemination of robust decision-support tools, like those produced under this project and outlined in this e-book, supports STDF's role in empowering developing countries to seize new market access opportunities. I hope that this e-book offers value to NPPOs, in both developing countries and LDCs, in enhancing their confidence in using a Systems Approach in pest management. I welcome feedback from NPPOs on their experience with these decision-support tools in negotiating effective and cost-efficient market access conditions for plant and plant products.

Melvin Spreij
Secretary
Standards and Trade Development Facility
Geneva, 2015

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Abbreviations and acronyms

AANZFTA	Australia New Zealand Free Trade Agreement
ACFS	National Bureau of Agricultural Commodity and Food Standards (Thailand)
ADB	Asian Development Bank
APHIS	Animal and Plant Health Inspection Service (USDA)
APPPC	Asia and Pacific Plant Protection Commission
ARDN	ASEAN Regional Diagnostic Network
ASEAN	Association of Southeast Asian Nations
ATIGA	ASEAN Trade in Goods Agreement
BC	Beyond Compliance
BN	Bayesian Network or network
BPI	Bureau of Plant Industry (Philippines)
COST	European Cooperation in the field of Scientific and Technical Research
CP-BN	Control Point–Bayesian Network
CPM	Commission on Phytosanitary Measures (IPPC)
CPT	conditional probability table
DOA	Department of Agriculture (Malaysia, Philippines, Thailand)
DOAE	Department of Agricultural Extension (Thailand)
DSS	Decision Support System
EC	European Commission
EFSA	European Food Safety Authority
EPPO	European and Mediterranean Plant Protection Organization

FAMA	Federal Agriculture Marketing Authority (Malaysia)
FAO	Food and Agriculture Organization of the United Nations
HACCP	Hazard Analysis Critical Control Point
IAEA	International Atomic Energy Agency
IAGPRA	International Advisory Group on Pest Risk Analysis
ICL	Imperial College London (UK)
IDRC	International Development Research Centre (Canada)
IICA	InterAmerican Institute for Cooperation in Agriculture
IPM	integrated pest management
IPPC	International Plant Protection Convention
IRSS	Implementation Review and Support System (IPPC)
ISPM	International Standards for Phytosanitary Measures (IPPC)
JICA	Japan International Cooperation Agency
LDC	least developed country
MARD	Ministry of Agriculture and Rural Development (Vietnam)
MARDI	Malaysian Agricultural Research and Development Institute
MBPEA	Mindanao Banana Producers Exporters Association (Philippines)
mt	metric tonne
MyGAP	Malaysian Good Agricultural Practices
NAPPO	North American Plant Protection Organization
NPPO	national plant protection organisation
OIE	World Organisation for Animal Health
PBGEA	Philippine Banana Growers Exporters Association
PCE	Phytosanitary Capacity Evaluation
PHRA	Plant Health Risk Assessment
PPD	Plant Protection Department (Vietnam)
PQDC	Plant Quarantine Diagnostic Centre (Vietnam)
PQS	Plant Quarantine Service (Philippines)

PRA	Pest Risk Analysis
PRATIQUE	Enhancements of Pest Risk Analysis Techniques (EU)
PVS	Performance, Vision and Strategy
QUT	Queensland University of Technology (Australia)
RPPO	regional plant protection organisation
RSPM	Regional Standards on Phytosanitary Measures
SE Asia	Southeast Asia
SPS	sanitary and phytosanitary
SPS Agreement	WTO Agreement on the Application of Sanitary and Phytosanitary Measures
STDF	Standards and Trade Development Facility
USDA	United States Department of Agriculture
VHT	vapour heat treatment
VietGAP	Vietnamese Good Agricultural Practices
WHO	World Health Organization
WTO	World Trade Organization

1

Introduction

1.1 Compliance as access to trade

Every country in the world depends on domestic and international trade. Most developing countries with any agricultural base have identified export of plant products as a key to economic development and inflow of hard currency. The status of the export sector is quite variable amongst developing countries. A large component of this trade is in plants and plant products such as fruits and vegetables, flowers and ornamental plants, seeds and plants for planting, grain, timber and other forest products. However, domestic and international trade and travel can introduce exotic pests that pose a threat to both natural plant resources and managed crop and forest production. An effective plant health scheme, operating in each country and region, can prevent the introduction of new plant pests (including disease) while still allowing movement of goods and people without undue restrictions.

In plant health regulation, activities include the evaluation and control of the risk of pest introductions from plant imports and exports, and in many cases the movement of plant products within a country as well. Given the importance of these activities, global collaboration was established through an international agreement, the International Plant Protection Convention (IPPC), over 60 years ago. Plant health activities are typically managed at the national level by entities or agencies comprising the national plant protection organisation (NPPO). Further collaboration is provided through regional plant protection organisations (RPPOs) and the international plant protection network, comprising 182 contracting parties to the IPPC. Formal rules, documents and processes for international trade in plants and plant products have been agreed and developed by these contracting parties through annual meetings of the Commission on Phytosanitary Measures (CPM) and its various bodies, panels, committees and ad hoc working groups.

The ability to manage pest risk is known as phytosanitary capacity. More precisely, national phytosanitary capacity has been defined as: "The ability of individuals, organizations and systems of a country to perform functions effectively and sustainably in order to protect plants and plant products from pests and to facilitate trade, in accordance with the IPPC" (IPPC, 2012).

A critical factor in the balance between preventing the introduction of exotic plant pests and allowing movement of goods and people is the use of pest risk management measures that are justifiable and in proportion to the threat posed. Beyond this point, measures may be considered to be non-tariff trade barriers. Under the harmonised regimes of the IPPC and the World Trade Organization (WTO) Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement), NPPOs use Pest Risk Analysis (PRA) (Table 1.1; FAO, 2007) to estimate the risk from specific trade or other pathways and to propose phytosanitary measures to reduce that risk to a level acceptable to the importing country.

Since risk-based decision making was clarified through these agreements and standards, there has been considerable capacity building in using PRA. The raison d'être for the PRA process,

Table 1.1 Stages in Pest Risk Analysis (International Standards for Phytosanitary Measures 2 – FAO, 2007)

Stage 1	Initiation
Stage 2	Pest Risk Assessment
Stage 3	Pest Risk Management

however, is to find the management options that will keep free trade 'safe'. The International Advisory Group on Pest Risk Analysis (IAGPRA) recognises that the Pest Risk Management phase is often the weakest. This phase consists in evaluation of management options and selection of the best phytosanitary measure, or combination of measures, to apply to trade or other pathways to achieve an appropriate level of protection. There has been relatively little support for capacity building in the decision-making process for the Pest Risk Management phase of PRA since the advent of the harmonised PRA approach. The current lack of capacity for pest risk management is confirmed further by the results of a global survey of NPPOs, carried out with support from the European Commission (EC). NPPOs from every region acknowledged the importance of trade-related International Standards for Phytosanitary Measures (ISPMs) but did not directly tie these to pest risk management standards. Pest risk management standards had variable implementation (IRSS, 2014). Responding NPPOs ranked implementation of pest risk management standards in general as moderate. Respondents in the same survey noted the lack of infrastructure or resources to carry out the pest risk management plans required by a target market in some cases, yet did not seek an equivalence agreement (described in ISPM 24 on determination and recognition of equivalent measures; FAO, 2005) for pest risk management more suitable to their country conditions.

Although phytosanitary capacity is an acknowledged international priority in many countries, particularly developing nations, it is hindered by a lack of resources, competence and confidence. Countries with less capacity will more likely be forced to accept unfavourable trade decisions, such as delays in opening markets or the imposition of possibly unjustified pest risk management measures for their plant exports. A number of cases exist in which risk averse importing countries propose redundant measures which do not reduce the pest risk further in combined use, and the exporting country NPPO accepts the plan rather than subjecting it to challenge. The attitude that it is better to accept excessive conditions from importing countries in order to establish trade, rather than to negotiate risk management proportional to the risk, is contrary to the spirit of the SPS Agreement.

In these instances, although providing access to trade, compliance does not provide ideal terms. This most often occurs when an NPPO has neither the capacity nor confidence to argue successfully for preferable alternatives. This is particularly the case when the alternatives involve newer concepts, strategies and processes.

Conversely, the cost of seeking a trade opportunity which then does not in fact develop, is very high for both the exporting and the importing country NPPOs. There have been over 2000 PRAs prepared by importing country NPPOs globally since the endorsement of ISPMs on that methodology (ISPM 2, originally adopted in 1995: FAO, 1995 [revised 2007], and ISPM 11, originally adopted in 2001: FAO, 2001 [since revised]). Many of these PRAs – in some target market countries the vast majority – have not resulted in trade within 3 to 5 years following completion (Mumford and Leach, 2009). The drain on resources in such a progression of trade negotiations is shown in Table 1.2.

An enhanced capacity scenario includes a more careful review of options between the export sector and their country's NPPO, so that they proceed together as partners in the trade proposal. This can provide a better basis for presenting full information and preferred options at the time of trade negotiation, and forestall unrealistic proposals.

One way to enhance capacity is to impose a more structured approach. A structured approach can clarify thinking and facilitates the introduction of risk quantification and risk reduction measures. More quantitative approaches are emerging for the design and evaluation of pest risk management plans. For example, in Australia, the recent loss of a post-harvest pesticide has led to a review of Bayesian networks (BNs) as a basis for negotiating interstate trade. In Europe, changes to the European and Mediterranean Plant Protection Organization (EPPO) PRA decision support scheme include addition of uncertainty and use of matrix models similar to BNs, and the European Food Safety Authority (EFSA) is introducing quantitative models into decisions, studies and contracts. In North America, the Regional Standards on Phytosanitary Measures (RSPMs) developed by the North American Plant Protection Organization (NAPPO) include encouraging quantitative approaches

Table 1.2 Typical and enhanced progression of trade negotiations

Typical progression of trade negotiations for NPPOs with lower capacity and confidence	**Progression of trade negotiations with enhanced capacity**
Industry sees opportunity for export, hoping to have sufficient quantity and quality to achieve the market benefit	Costs of likely pest risk management measures can be estimated and compared by NPPO to help evaluate feasibility of exports to target market
Industry asks their NPPO to initiate proposal to target market to accept commodity	Industry understands role of NPPO in market negotiations and provides resources and experiences, as partners in trade proposal
Pest Risk Analysis prepared by target market country NPPO, using information from exporting NPPO dossier	Dossier from exporting NPPO may include information on available infrastructure, feasibility of implementing measures, and preferred options for management
Importing country NPPO determines necessary measures to achieve appropriate level of protection (if any pest risk associated with proposed trade)	Importing country NPPO considers proposed measures along with any existing ones, to evaluate if they achieve appropriate level of protection (if any pest risk associated with proposed trade)
Exporting country NPPO informs industry of measures imposed by importing NPPO; Industry considers whether compliance is worth the market benefit, and if not the proposal is abandoned	NPPO works with export sector to review import measures, ensure feasibility and agree where real time indicators of impact of official measures are worth the cost

NPPO, national plant protection organisation

such as in a pathway analysis. The Production Chain framework introduced in this book is another such structured approach, comprising various tools summarised in the section on the project approach.

A Production Chain framework has proven a powerful tool that can be used in the development of trade proposals. This chain describes in some detail the sequence of processes and activities associated with the preparation of the plant product, from inception to the point of export. The Production Chain then forms the foundation for identifying and evaluating the critical points in the production process at which pest risk management measures can be applied, the measures available at each of these points, and the effectiveness of these measures individually and in combination.

The aim of this book is to introduce a Production Chain framework for plant health risk management in trade. This framework is described in the context of a major project undertaken in the Southeast (SE) Asian subregion, which focused on moving 'beyond compliance': that is, increasing the capacity, capability and confidence of countries to develop stronger, more informed pest management alternatives for plant exports and imports.

The Beyond Compliance (BC) project was funded by the Standards and Trade Development Facility (STDF) and implemented from July 2011 to July 2014. A page on the STDF website dedicated to the BC project (*http://standardsfacility.org/PG-328*) provides further information.

1.1.1 The Standards and Trade Development Facility

The STDF is a global partnership that supports developing countries to implement international food safety, animal and plant health standards, guidelines and recommendations, and hence to gain and maintain access to markets. In doing so, the partnership contributes to broader sustainable development goals of economic growth, poverty reduction and food security.

The STDF was established by the Food and Agriculture Organization of the United Nations (FAO), the World Organisation for Animal Health (OIE), the World Bank, the World Health Organization (WHO) and World Trade Organization (WTO). Other organisations involved in SPS-related technical cooperation, donors contributing funds to the STDF and selected developing country experts participate actively in the Facility's work. The Secretariats of the Codex Alimentarius Commission and the IPPC also participate in the partnership.

Specifically, the STDF acts as a coordinating and financing mechanism. As a coordination mechanism, the STDF provides a unique forum to exchange information, encourage collaboration and synergies in SPS capacity building. As part of its funding mechanism, the STDF provides funding for development and implementation of projects that support compliance with international SPS requirements to gain and maintain market access. Information on the STDF, including funding opportunities and eligibility criteria is available at *www.standardsfacility.org*.

The BC project was funded by an STDF Project Grant (PG), STDF/PG/328, after the concept was developed under the auspices of an STDF Project Preparation Grant. The development of the project is discussed further in Chapter 2.

1.2 The Southeast Asian context

Most countries in the SE Asian subregion have a high dependence on agriculture, and development of their agriculture sectors is essential to achieve food security, a reduction in poverty and sustainable growth. This is also true in the more developed countries in the subregion. In recent years, Malaysia has reorganised its quarantine service and allocated major new resources to relevant technical areas. The Philippines has run a number of initiatives in the past decade, focusing on training, using local expertise, and building technical capabilities in centres and ports. Thailand has revised its plant quarantine regulations and is integrating its quarantine research group with its regulatory and operational group. It is also providing annual budget allocations for technical pest resources. Vietnam has drafted a new plant protection and quarantine law and has increased numbers of plant health staff.

Such individual national initiatives demonstrate an increasing commitment to SPS capacity. Entry to high-value global markets is a priority in the subregion and the need for compliance with SPS requirements is clearly understood. Increased compliance with SPS requirements has been identified as a "key challenge to further unleash export potential" (STDF, 2010).

At the same time, countries are waking up to the impact of their own import policies in this sector. With the opening of borders and increases in trade, imports without adequate pest risk management measures have introduced numerous pests to countries in the subregion over the past decade. Most countries find that detection of a new pest occurs only after it has become well established (Whittle et al., 2010). The contiguous countries then face new introductions along unprotected borders, so that the subregion becomes harmonised – not in phytosanitary protection, but in phytosanitary problems.

For the subregion, the 2007 Charter of the Association of Southeast Asian Nations (ASEAN) envisages overcoming SPS barriers as providing a major contribution to economic integration and development. It identifies Food, Agriculture and Forestry as a "priority integration sector" and requires "harmonisation" of SPS measures. The Strategic Plan of Action on ASEAN Cooperation in Phytosanitary Measures (2005–2010) calls for harmonisation of phytosanitary measures, compliance with WTO/SPS requirements, strengthening of national PRA frameworks, and biosecurity planning. SPS issues are detailed in the draft ASEAN Trade in Goods Agreement (ATIGA) and the ASEAN–Australia–New Zealand Free Trade Agreement (AANZFTA).

The Asian Development Bank (ADB) draft action plan for improved SPS in cross-border trade includes making improvements in other components of a sound plant health system, such as enhanced diagnostic capacity, improved laboratories, low-cost disinfestation systems and improved quarantine treatments. This has been especially significant in Cambodia, the Lao People's Democratic Republic, Myanmar and Vietnam. Vietnam participated in a preparatory survey to strengthen phytosanitary measures, with financial support from the Japan International Cooperation Agency (JICA). These activities have been an important precedent for the NPPO's cooperation with external resources to achieve national objectives in plant health.

Ongoing regional efforts have complemented those at a national level. For example, over the last five years workshops on ISPM awareness, pest surveillance, PRA, diagnosis and taxonomic identification of specific plant pests and diseases, and management of pest and disease collections have been supported by the CABI centre in Southeast Asia to the benefit of the subregion. All of these training topics could constitute phytosanitary measures and/or control points. The CABI regional project funded by the Canadian International Development Research Centre (IDRC) on 'Knowledge Networks and Systems of Innovation to support Implementation of Sanitary and Phytosanitary Standards in the Developing Countries of Southeast Asia' identified the major constraints faced by developing countries in the region in their implementation of ISPMs. IDRC has since given support to the establishment of the ASEAN Regional Diagnostic Network (ARDN) for sharing plant pest diagnostic knowledge and resources.

Although significant PRA training opportunities have been provided in SPS capacity-building programmes, improvement in PRA remains a key objective, as noted in the ADB SPS action plan for five Greater Mekong Subregion countries. During the BC project inception workshop in 2010, each country emphasised its lack of confidence in being able to develop pest risk management plans in line with the results of the PRA. The concepts of Systems Approach were particularly problematic. The strengthening of national capacity for PRA will benefit from including improved decision making in the Pest Risk Management phase.

The BC project outcomes additionally can support national and regional objectives to reduce pesticide use and employ integrated pest management (IPM) practices. Some SE Asian exporters have suffered a high number of trade detentions for pesticide residues. Pesticide overuse is often in reaction to related pest detections in trade. The highest number of interceptions for regulated plant pests on commodity trade into Europe has come from SE Asia: well over 60% in 2009 (FCEC, 2010), a situation similarly noted in recent years by the United States NPPO (United States Department of Agriculture – Animal and Plant Health Inspection Service; USDA-APHIS).

1.3 The Beyond Compliance approach

The availability of appropriate measures is a critical part of the development of a pest risk management strategy. For new commodity pathways (origin to market), Pest Risk Management measures and plans may be developed by experienced plant health personnel by reflecting on the most relevant management options, weighing their appropriateness to the case and using previous experience to plan the operational details. This makes sense because there are a limited number of phytosanitary measures available for most situations. Therefore, this review process may be done 'all in one's head' and still result in successful management. For example, one report on implementing Systems Approach for management of fruit fly pest species lists nearly all possible measures to be used to either directly reduce the risk of spreading a quarantine pest species, or to validate that a measure was carried out or the efficacy of a measure or of the overall plan (IAEA, 2011).

However, the success of a pest risk management strategy involves consideration of a wider range of issues. Here, some of these issues are identified and discussed in the context of using the Beyond Compliance (BC) project outputs. While some issues are specific to the original BC project, the trade cases or Systems Approach, many are generic to plant health and risk management and indeed to large projects of any type. It is hoped that in addition to the tools, future BC type projects will benefit from the other components of the BC approach.

Generally when trade negotiations begin, plant health officials in the exporting country have in hand the dossier they presented for use by trade partners to prepare the Pest Risk Analysis (PRA) (FAO, 2013) or the PRA itself from the importing country NPPO. With only this information, and often few hard data, it seemed necessary to build stepping stones if one is to develop a combined set of measures based on a quantitative model. The step-wise process of BC includes developing a way of representing the actions taken along the sequence of commodity production that is henceforth called a Production Chain (capitalised to distinguish its use as a tool, versus a general concept). The Production Chain, described further in Chapter 4, is also an opportunity to challenge the experienced plant health personnel to justify decisions with evidence. Using this systematic approach further supports integration of measures without unconscious or unjustified duplication in terms of impact or contribution to the overall plan. The BC Decision Support System (DSS), covered in Chapter 5, takes a similar approach, providing the likely measures as options in a sequence of menus that cover the progression of the production system. BC moves the evaluation process from individual experience and judgement to a more transparent process, accessible to those with less experience and to other interested parties, not least the exporters and exporting country plant health officials.

The BC Production Chain forms the foundation stone of the BC tools. It provides a systematic way to organise a current or proposed management process. The tool is developed as a graphical flowchart comprising decision nodes and directional arrows in a series of columns. The spine of the BC Production Chain shows the stages along the process pathway, for example planting, growing, harvesting, packing and export. Arrows link these points to the associated control measures, for example, treatment of planting materials, sprays, pest surveillance, bagging fruit and inspection. Objectives of each of these measures, and verification measures, are also identified and linked via arrows.

The BC DSS comprises three sections: (i) background information about the pest, commodity, pathway and PRA information; (ii) selection of potential measures based on the Production Chain; and (iii) comparison of measures based on efficacy and verifiability scores by assessors of each short-listed measure and evaluation of candidate measures with respect to feasibility, cost/benefits, and acceptability. This leads to a systematic process for assembling an appropriate Systems Approach. Allowance is also made for an assessor rating of efficacy of the new Systems Approach, independent of Bayesian network (BN) assessment.

The BC Control Point–Bayesian Network (CP-BN), explained in Chapter 6, represents the collated knowledge about the system, based on the information provided through completing the Production Chain and DSS for the case at hand. The tool, which is formulated as a BN, summarises the measures, processes, probabilities and associated uncertainties. It can be used to assess the pest risk from a specific regulated pest species or a group or guild of similar pests, to develop scenarios assessments and to facilitate understanding of the system and potential alternative measures.

Moving through these various steps, or applying one BC tool on its own, involves decisions and skills for case or project management. The project experiences in this respect are highlighted in Chapter 2.

1.4 How to use this eBook

This book was prepared by the listed editors by drawing on BC project reports and discussions and investing considerable time since the close of the project. It is designed as a combination of an introduction to concepts and tools and dissemination of outputs. Most importantly, it is hoped that the book allows plant health officials who have not participated to understand and use some of the BC tools and benefit from the project experiences. The book can be read by individual chapter, if a particular theme is of most interest, or as a whole. It will be supplemented over time with access to templates of tools, which will be announced on the STDF website.

Every effort was made to align this work with the agreed interpretations, guidance and practices of the IPPC. If diversion is noted, the reader should always return to the IPPC for the final word.

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2

The Beyond Compliance Project: Experiences and Lessons Learned

2.1 Introduction

The project that forms the foundation for this book focused on an aspect of phytosanitary capacity – development of pest risk management plans using a combination of measures – in the SE Asian subregion of the membership of the Asia and Pacific Plant Protection Commission (APPPC), one of the RPPOs under the IPPC (Figure 2.1). The aim of the BC project was to provide a structured approach to evaluate and design a Systems Approach, or combination of integrated measures, useful for international trade in agricultural products associated with some specific plant pest risk. This was found helpful since comprehensive data on the effectiveness of such a system are frequently unavailable. Gaps in knowledge about either the pest or the efficacy of the measures, or areas of uncertainty due to local conditions, variability in pests and pest/host interactions, etc., can be taken into account, without delaying an operational decision. In order to meet the appropriate level of protection set by an importing country for protection of their own plant resources, the exporting country may either accept the requirements set by the importing NPPO or propose alternatives. This negotiation, carried out by government authorities, requires a clear understanding of the objectives of actions taken along the production chain through to export, for commodities associated with plant pest risks.

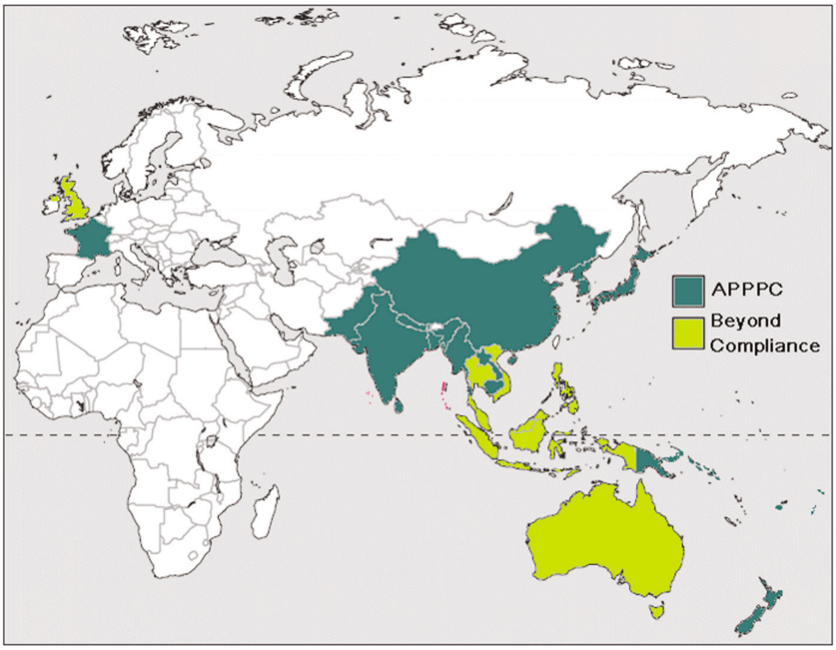

Figure 2.1 Asia and Pacific Plant Protection Commission (APPPC) countries participating in the Beyond Compliance (BC) project. The combined coloured areas represent membership of the APPPC (UK excepted, which is represented as a member of the BC project)

The project was funded by the STDF, a global partnership hosted by the WTO (see section 1.1.1, Chapter 1). The details of the project are described in an STDF fact sheet prepared at the end of the project, which appears in Appendix 1 in English and French.

NPPOs from Malaysia, the Philippines, Thailand, Vietnam and, to a lesser extent, Indonesia participated in the project, but the outputs are relevant to other countries in the subregion and to the region as a whole. Technical advisors from Imperial College London (ICL) in the UK and Queensland University of Technology (QUT) in Australia were involved in guiding the project and developing the technical tools in association with the country groups, as well as finalising reports such as this eBook. CABI provided project management within the subregion.

The project concept arose from a workshop held in Kuala Lumpur in August 2010, with funding from the STDF as a Project Preparation

Grant[1] (reported in Whittle et al., 2010) (Figure 2.2). Participants from each country made a presentation on its phytosanitary capacity, familiarity with the application of Systems Approach (ISPM 14: FAO, 2002) and needs in relation to the application of Systems Approach to Pest Risk Management. During the workshop, it became clear that many countries are employing or seeking to employ Systems Approach, but face difficulties related to lack of data and uncertainty about the risk mitigation measures and their application. They were seeking to use this approach more fully due to problems that were common to the countries, such as technical concerns about the food and occupational safety of some single treatments (generally chemical) and the high risk of trade disruption with single treatments when failure occurs. There was also a perceived power imbalance in trade agreements in which risk mitigation measures were imposed, rather than developed bilaterally.

Figure 2.2 Participants of an STDF-funded workshop, held in Kuala Lumpur in August 2010 that developed the concept of the Beyond Compliance project (Photo: Ministry of Agriculture and Agro-Based Industry, Malaysia)

1 STDF Project Preparation Grants (PPGs) are awards of up to US$50,000 to support development of complete project proposals that could be funded by the STDF or other donors. PPG/328 covered costs of this workshop to follow up on informal discussions already taking place between the PRATIQUE project team (ICL), its Observers (QUT) and NPPOs and capacity development bodies (JICA and CABI) in the subregion.

The Beyond Compliance project was launched with a meeting in 2011, again hosted by the Malaysian NPPO (Figure 2.3). This meeting built on the foundation of the initial workshop and was the start of many of the practices described in this Chapter.

During the project inception meeting, the ICL member of the project steering committee attempted to benchmark the capacity and confidence in using Systems Approach, and pest risk management in general, among the project participants. She tested two different existing tools for evaluating country capacity, although neither directly covered application of Systems Approach. The attempt to use existing materials for a rapid assessment of the capacity levels, which then might be rechecked at the end of the project, revealed that no existing capacity tool adequately assessed the capacity to design, evaluate, negotiate or monitor pest risk management in general or Systems Approach in particular.

The tools selected are widely used for plant health. The participating countries were already familiar with the Phytosanitary Capacity Evaluation (PCE) tool, as several had applied it through the IPPC or

Figure 2.3 Participants of the Beyond Compliance inception workshop in Kuala Lumpur in 2011 with the Director General of the Department of Agriculture for Malaysia (Photo: Ministry of Agriculture and Agro-Based Industry, Malaysia)

an FAO Technical Cooperation Programme. A section of this tool was considered, but the complexity in capacity to conduct pest risk management was not clearly benchmarked. The other tool tested, the Performance, Vision and Strategy (PVS) tool, originated by the InterAmerican Institute for Cooperation in Agriculture (IICA), did provide relevant sections in market access, for example, but was nevertheless not precisely suited. One of the first recommendations during the project was to ask the IPPC and IICA how the capacity and competence of applying Systems Approach might be monitored through those tools, though no specific actions towards this end have been taken.

2.2 Choosing trade cases

The BC tools encompassed in the Production Chain framework were developed and tested in the context of real case studies undertaken by the four country groups most involved in the BC project. To progress export cases, and two regional import cases. Table 2.1 provides a summary of these case studies.

The case studies had a range of objectives. These are described in more detail in subsequent chapters, but in summary included:

- Systems Approach for new trade
- Systems Approach for existing trade, aiming to reduce commodity treatment below probit nine (for quality issues)
- Systems Approach to remove end-point treatment of methyl bromide
- Systems Approach to reduce costs of treatment and gain benefit from effective field sanitation and area of low prevalence
- CP-BN to identify points where measures can be adjusted when system failure is detected
- CP-BN to convince importer of relative safety of measures in a live plant import

Table 2.1 Case studies for the Beyond Compliance project

Commodity	**Exporting country**	**Importing country/ region**
Fresh produce (not rubber plants) that may carry South American leaf blight (SALB) of rubber	Countries with SALB or in regions with SALB, therefore requiring surveillance surveys	Southeast Asia
Oil palm planting material	Countries outside Southeast Asia	Southeast Asia
Dragon fruit	Vietnam	South Korea, Taiwan
Jackfruit	Malaysia	Australia, China
Orchid cut flowers	Thailand	Europe
Banana[1]	Philippines	USA

[1] The Philippines case study originally focused on avocado to South Korea, but switched to banana to the USA in order to meet project time constraints.

The BC experience demonstrates the utility and efficacy of specific trade cases as a means of developing technical tools, engaging stakeholders and creating hands-on technology transfer, capability and confidence. However, the effectiveness of the case study approach depends critically on the choice of the studies, the way in which they are used in the project and the way in which they are communicated among project participants.

A large part of the early face-to-face meetings and subsequent email correspondence among BC participants focused on the choice of trade cases. Participants identified the following primary considerations in making this choice:

- The case study must be a priority to the country: it must be something that matters; participants must want to, and be allowed to, spend time on it; and a wider network of stakeholders must care about the result.
- The case study must be achievable: it must be able to be completed within the time frame of the project, and there must be sufficient resources (people, information, data, etc.) available.

- The case study must be aligned with the aims of the project: Systems Approach must be potentially useful; and it must have the potential to increase competency and confidence in Systems Approach.
- The case study must be able to be publicly discussed, either within the project group or more helpfully with the wider community at some level.

It is important to comment on the last point. Because trade issues are necessarily sensitive, it was essential to have early and regular discussions about confidentiality and intellectual property related to the trade cases. The participants needed to be confident about what they could say in the project meetings, what they could display on posters and in reports, and what they would allow to be disseminated to others outside the project. This involved establishing agreed protocols among all partners, as well as other participants, for example observers at the project meetings. It was also necessary for country groups involved in developing case studies to seek the necessary permissions from their supervisors. These permissions were given and a level of trust developed among project partners, later fostering direct communication between participants on other trade cases outside those of the project.

Communication among project participants about case study progress was also critical. An effective way of encouraging and actualising this communication was through the development of posters for the major face-to-face meetings. At the inaugural meeting, participants were asked to display a poster with a general description of the chosen case study and a list of the aims and anticipated outcomes. Work in progress was reported at the mid-term meeting using Microsoft PowerPoint® presentations, and the outcomes of the cases to date were shared in the poster presentations at the final meeting. Poster examples from the inception meeting are provided at the end of this chapter (Supplementary material 1).

The adoption of posters as a means of communication provided a number of ancillary benefits. Five of these were as follows:

1. The posters were a way to refine aims of participation in the project to a more focused and achievable statement, making it possible to monitor over what was originally going to be two years (the third year coming as a no-cost extension).
2. The posters encouraged progress on case studies: the need to produce a poster provided impetus to prioritise the required work for participants in view of their busy schedules.
3. The posters provided an effective focal point for formal and informal discussion between participants, and often led to identification of other issues, sharing stories, trading useful resources, etc.
4. The posters provided an accessible record of the progress of the trade cases during and after the project.
5. The posters were very effective resources for wider communication about the project, for example at international meetings, given permission from the project participants.

Case selection was also affected by internal issues. For one partner, a trade case which had already been negotiated to the point of preparing an operational plan was substituted for the original new trade case because of concerns about the number of measures imposed by the importer.

2.3 Project management

The CABI office in SE Asia was asked to manage the logistical and financial aspects of the NPPO participation, as a reliable presence within the subregion. Dr Annamalai Sivapragasam was the manager for the term of the project. In addition to management of the project itself, the BC project provided an ideal environment for collaborative enhancement of participants' project management skills. This was an additional positive outcome of the project.

This section describes a number of considerations that were found to be integral to the management of the BC project and may be of use in developing and managing other similar projects.

2.3.1 Choice of software

The software chosen for the project had to be easily accessible and easy to use. Consequently, the ubiquitous spreadsheet package Microsoft Excel® was chosen for the DSS and the small, freeware software GeNie2 (Decision Systems Laboratory, University of Pittsburgh, Pennsylvania; *http://dsl.sis.pitt.edu*) was chosen for the CP-BN. Participants generally had no problem in using either of these software products.

2.3.2 WordPress vs website

Although a full website would have been desirable, the cost of creating and maintaining such a site was outside the project budget. A WordPress (*https://wordpress.com*) site was created instead and served the project well. A blog was also initiated, although it was not actively used. The longer-term plan is to host the BC outputs on a more permanent site that is known to, and accessible by, a much wider range of potential users and other interested parties. Links to this eBook will be on the STDF website or the International Phytosanitary Portal.

2.3.3 Flexibility of budget line items

Although the budget was prescribed in detail at the commencement of the project, it was found to be useful to have some flexibility in some of the line items. This was due to various unknowns: the composition of the project group varied with the demands on participating NPPOs, changing communication needs as the project developed, the evolving nature of the group activities and products, and international currency fluctuations.

2.3.4 Other project management skills

The following items enhanced project management and communications methods. While often simple, these were unknown to most project participants until used in this project.

- The use of Meetomatic (*www.meetomatic.com/calendar.php*) to plan project meeting dates.
- The use of World Clock Meeting Planner (*www.timeanddate.com/worldclock/meetingtime.html*) to identify times for group calls across several time zones.
- The introduction of Skype® for group calls, and in particular individual case study consultations to follow up from field visits.
- Establishing a convener and minute taker for the monthly project communication to make the investment of time as efficient as possible and inform those who could not attend that month.
- The use of Dropbox (*www.dropbox.com*) for shared internet folders to facilitate last version accessibility and avoid emails with very large data files.
- Early agreement on file naming to support version management.
- Calling for volunteers within the project to prepare the project logo and brochure design, rather than outsourcing – individuals talented in this area self-identified.
- Provision of templates for posters, presentations, etc., in advance of all meetings with suggested topics and questions in order to harmonise information exchange and ensure important points were not omitted.

2.4 Stakeholder engagement

The BC approach confirmed and demonstrated that stakeholders are critical in developing appropriate pest risk management plans.

Stakeholder engagement on a country level is discussed in detail in the next chapter, but here we comment on three considerations that were important in setting up and running the BC project: choosing the stakeholders, keeping them engaged and communicating between stakeholders within the project.

2.4.1 Project internal stakeholders

The first set of stakeholders is the internal set: the project participants, namely members of each NPPO's pest risk management team with responsibility for their country's selected BC case; the international experts from QUT and ICL, with responsibility for the development of the BC tools and the international governance interface; and the administrative management team at CABI's office in SE Asia. Primary criteria for choosing these stakeholders included the following:

- Positive inclination and strong motivation to be involved in the project
- Complementary expertise and communication skills among the tool developers
- Capability to undertake a case study; desire and generally some external motivation to implement Systems Approach
- Prior knowledge of the plant health community and connections to disseminate project outcomes among the representatives of the target market country NPPOs, RPPOs and other key plant health project-external stakeholders
- Geographic convenience for the management and initial technical visits, which would have been challenging to conduct entirely from the UK

A level of goodwill was required to allow for reactive changes to the tools and critical discussion of concepts. This evolution, however, was the point of having a regionally based project using real trade cases, rather than refining tools based on theory and presenting them as a *fait accompli*. The BC approach therefore required more internal stakeholders than typical training projects.

2.4.2 Public sector internal stakeholders

The second set of stakeholders compromises those involved in pest risk management, research and policy. Only a small set of the pest risk assessment and management unit(s) from each NPPO could dedicate the time required for a specific trade case. Furthermore, most commodities were supported by government sponsored or conducted research, extension services and trade negotiation units. The BC direct participants became ambassadors to these public sector, or quasi-public sector (e.g. university or research sector), colleagues. Selection of these stakeholders related to:

- Position in the knowledge network for the selected case (commodity or market knowledge)
- Influence on the message to farmers and producers in terms of best field practices
- Willingness to engage with other sectors in government, even when they may not have been interacting in the past

2.4.3 Country private sector stakeholders

The third set of stakeholders is in-country private sector networks, namely those involved in production, processing and marketing the product under consideration, and those in the private sector who have influence on pest risk management and policy including use of voluntary standards and market-oriented certification. Primary reasons for choosing these stakeholders, and hence the case study chosen for the BC project, included the following:

- Direct interest, generally of a business nature, in the success of the selected case
- Ability to engage with a range of stakeholders, across the spectrum of the production chain
- Access to relevant qualitative and quantitative information about the product under consideration
- Capacity to undertake a case study, in particular in terms time and resource commitment

2.4.4 Project external stakeholders

The fourth set of stakeholders consists in the project observers. These were drawn from other academic institutions, and relevant regional and international offices and organisations. Primary considerations included:

- Positive inclination towards the project or the tools, possibly based on experience with similar tools
- Complementary expertise to inform and advise the project
- Ability to influence the sector

The criteria for stakeholder selection, while not always explicit, supported their ongoing engagement and interest in results. Trade cases pose a real challenge in the amount of time needed between initial interest and conception, all the way through to market access negotiation. This is frequently a matter of years (FAO, 2013), which can mean that those first interested in the opportunity have by then moved on. The BC approach actually keeps stakeholders more engaged by involving them in the process and decisions. An informed decision to abandon a case is as valuable as sustaining one through to negotiation, if in fact the positive outlook for the case is not warranted.

2.4.5 Communications among stakeholders

An important issue that arose from having such a diverse set of stakeholders was communication. This included the following.

- Form of communication
- Frequency of communication
- Documentation of communication

CABI staff provided support on communications, as well as report preparation and planning. To progress the work, a form of communication that was acceptable for all internal project participants had to be found. In this project, Facebook (*www.facebook.com*) and similar social media tools were proposed and dismissed because of lack of universal access. A project blog was set up but was not taken up by many participants, mainly due to lack of familiarity with this technology, time constraints and cultural inhibitions. The blog was set up on WordPress, which also served for external stakeholder communication for those interested in the project. This was selected by the communications expert at CABI's office in SE Asia, who was able to use the plug-in, web template system to load key documents, photos and news for a much lower cost than that associated with a bespoke website. The project support was originally programmed for two years. For this time period, and as outcomes can be posted on the STDF website, this approach was best suited.

Early attempts at telephone-based calls for discussions involving all project members were not successful. Skype® was then used, but it led to frustration and disengagement when it failed to work with the many different call-ins at one time. It was not always easy to understand each other in larger groups, due to the differences in accent while speaking English. The final decision on this was to communicate via phone and Skype® for small groups, and email for larger groups. Dropbox was also critical for internal communication.

Although expensive, personal visits and group meetings were by far the most effective form of communication. This is due in large part to the developmental nature of the project material. Equally important was the encouragement of participation by all members at these meetings. This was facilitated by the use of case studies, discussed below.

Progression of the cases was facilitated by varying degrees of success with: frequent meetings on calls, shared internet folders, a project blog, field visits, annual whole project meetings, extra discussions at routine meetings attended by project members and visits in conjunction with other travel.

2.5 Learning on the fly: the adaptive nature of a Beyond Compliance project

The BC project relied critically on a foundation of clearly defined, mutually agreed goals, definitions and processes. However, as the project evolved, it became clear that participants had different interpretations of these foundations, and the foundations themselves needed to evolve as the project developed[2]. It was therefore important that all participants were reminded about the innovative nature of the BC project, in particular that new methods, tools and procedures were being created, and that this necessitated continual discussion, debate and agreement about the project objectives and conceptual foundations.

An active approach of collaborative engagement was needed, rather than a more passive model of transmission of knowledge from one set of participants to the others. It also required a great deal of mutual trust, flexibility and positive disposition to adapt, or 'learning on the fly'. An important ingredient in achieving this was that participants felt comfortable about asking questions, offering suggestions and sharing expertise, resources and case studies. Given the multinational composition of the participants, it was important to set up these expectations at the outset, and reiterate them throughout the course of the project. This adaptive attitude was therefore as critical to the project success as the foundational goals, objectives and processes themselves.

2 See Supplementary material 2 at the end of the chapter for an example.

A corollary of this adaptive nature was the need to allow time for discussion of foundational aspects of the project at regular intervals, revisiting in particular the problem to be modelled, the process to be followed, and the plant health concepts and terms. The agreed outcomes were written down and disseminated to all participants, with encouragement for reflection and feedback. While regular communication was achieved through remote meetings (e.g. via Skype®), face to face meetings supported this way of learning far more effectively.

This aspect of success relied entirely upon the funder's willingness to consider reallocations of budget line items, with appropriate notice and justification, and a no cost extension for a third year of work together.

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Supplementary material 1

Examples of posters developed for the inception meeting. Corresponding posters developed for the final meeting are shown in Chapter 7. The Philippines case study originally focused on avocado to South Korea, but switched to banana to the USA in order to meet the time constraints of the project.

Queensland University of Technology
Brisbane Australia

Beyond Compliance: Integrated Systems Approach for Pest Risk Management in Southeast Asia
Project PG 328, funded by the Standards and Trade Development Facility

CASE STUDY: EXPORTATION OF DRAGON FRUIT (RED PITAYA) *(Hylocerus undatus)* FROM VIETNAM INTO SOUTH KOREA

Dr. Duong Minh Tu and Mr. Nguyen Tuan Anh
Plant Protection Department of Vietnam

Introduction

Dragon fruit (Red Pitaya) (*Hylocerus undatus*) which belongs to the Order Caryophyllales, Family Cactaceae is good for the domestic market and also has good potential for export to the USA, Japan, South Korea, Chile, etc.

The majority of dragon production in Vietnam (Dark Red color)

The majority of dragon fruit production in Vietnam is in Tien Giang, Long An and Binh Thuan provinces. Total production area of dragon fruit is 13,991 ha. Total Vietnam exports of dragon fruit in 2007 and 2008 were 24,958 and 81,671 tons, respectively.

The White flesh cultivar most is most widely distributed and destined for export markets. This variety thrives well locally, gives high yield, is white-fleshed, and has good shaped fruit. Flowering starts from April to September, fruit harvest begins 28-30 days after flowering.

Planting density: 700-1000 trees/ha. Propagation: By suckers

Yield capacity: 40-50 kg per tree from 5-7 year old trees.

Dragon fruit is produced under GlobalGAP, VietGAP or EuroGAP

Harvest

Sharp pruning shears are used to cut off fruit. Harvested fruits are put in plastic baskets that are kept under shade, then promptly transported home for packing. Fruits are kept at 5ºC, 90% relative humidity in sealed polyethylene bag wrapping, pierced with 20-30 sewing-needle-made holes. Under such conditions, dragon fruits can be kept for 40-45 days. At 28ºC and 70% relative humidity, they can last for only a week.

Pest and disease control

The dragon fruit is less vulnerable to pests and diseases compared to other kinds of fruit crops.
Chemicals used are registered for controlling dragon fruit pests, with details of their spray calendar.
Fruit flies (*Bactrocera correcta* (Bezzi) and *Bactrocera dorsalis* (Hendel)) may be considered important insects in local fruit production.

Phytosanitary Crop Management

Irradiation treatment: Dragon fruit is treated using Electron Beam with dose 400 Gray for U.S market.
Vapor heat treatment: Dragon fruit is treated by Vapor heat for Japan market. Vapor heat treatment facilities are provided by Japanese Company.

Prospects for a systems approach

Vietnam's dragon fruit has got the license to enter the US and Japan market after the fruit fly problem was addressed by Irradiation technology or Vapor Heat Treatment. The application of these measures leads to increased production cost. Vietnam dragon fruit's market share is decreasing due to less competitive price. Our farmer's income is reduced.

Vietnam is looking for

- Using System Approach as an alternative for Pest Risk Management for exportation of dragon fruit to other market
- Applications of Bayesian Networks for Pest Risk Assessment

Funding Body: Standards and Trade Development Facility (STDF) of the WTO
Partners:
CABI Southeast and East Asia
Malaysia Department of Agriculture
Philippines Plant Quarantine Service
Indonesia Ministry of Agriculture
Australia Queensland University of Technology (QUT)
Vietnam Ministry of Agriculture and Rural Development
Thailand Ministry of Agriculture and Cooperatives
UK Imperial College London

Beyond Compliance: Integrated Systems Approach for Pest Risk Management in Southeast Asia
Project PG 328, funded by the Standards and Trade Development Facility

CASE STUDY: JACKFRUIT FROM MALAYSIA TO CHINA Case study staff: YUSOF OTHMAN AND LAILATUL JUMIAH SALEH
Agency & NPPO: DEPT. OF ARICULTURE, MALAYSIA

ABOUT THE TRADE

THE COMMODITY

Jackfruit is a large tree that can grow up to 20 meters tall and bear fruits weighing 10-20 kg per fruit. The fruit's exterior skin is yellow when ripe and emits a strong odour. The yellowish orange fruit pulp tastes like a combination of banana and pineapple. Fruits are sold as whole fruit or minimally processed into a ready-to-eat pack.

THE SUPPLY CHAIN

Harvested fruits are transported to packing house in plastic crates. The fruits undergo ripening and are sent for minimal processing or marketed in wholesale and retail stores

THE PEST ISSUES

Fruit flies, mealybugs ,fruit borers and fruit rot

THE CROP AND COMMODITY

Young Jackfruit plant (2 years)

Fruit

Edible Fruit bulbs

QUARANTINE PESTS AND THEIR MANAGEMENT

The management of these pests are through sanitation, bagging, pruning of infested parts, baiting and pesticide spraying

PROSPECTS FOR A SYSTEMS APPROACH

CURRENT TREATMENT(S)

Fruit bagging, sanitation and chemical control

POTENTIAL ELEMENTS OF S.A.

Fruit bagging, chemical control, sanitation and new fumigant ethyl format +CO_2 (Vapourmate)

TECHNICAL CHALLENGES TO BUILDING AN SA

Lack of efficacy data

POTENTIAL BENEFITS OF AN SA

The implementation of SA in fruit orchards will facilitate entry into several non-traditional markets such as China, Korea, USA, Australia and Japan. In addition, it will reduce cost and facilitate sustainable production. Malaysia is promoting large scale production of this fruit for export market so that farmers will obtain higher income.

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Beyond Compliance: Integrated Systems Approach for Pest Risk Management in Southeast Asia

Project PG 328, funded by the Standards and Trade Development Facility

CASE STUDY: ORCHID FROM THAILAND TO EU

Case study staff: Tasanee Pradyabumrung and Chortip Salayapongse

Agency & NPPO: National Bureau of Agricultural Commodity and Food Standards & Department of Agriculture

ABOUT THE TRADE

Orchid production is the most important floriculture crop in Thailand, which is currently the world largest exporter of Dendrobium. In 2009, the export value was 80 million US$ accounting for 77% of all Thai floriculture products.

There are many types of exported orchid products e.g. cut flower inflorescences, loose blooms, garland, bouquet, corsage, live plant, seedlings, tissue culture in flask, dried plants and root, bulb.

THE SUPPLY CHAIN

Orchid production areas are scattered around Central Thailand covering approximately 3,500 hectares. About half of the production goes to the local market and the other half are for export. Exporters deal directly with importers, growers for export usually have prior contracts with exporters. Some large exporters have their own production, packing house, and transportation to the airport.

THE PEST ISSUES

Thrips palmi is the major quarantine pest of concern to EU. Orchids from Thailand have been fumigated with Methyl bromide before export to EU, adversely affecting shelf life quality of the orchids.

QUARANTINE PESTS AND THEIR MANAGEMENT

Scientific Name: *Thrips palmi* Karny
Common Name: Cotton thrips, Melon thrips
Thai Name: เพลยไฟ
Order/ Family: Thysanoptera/ Thripidae
Management: Chemical control

PROSPECTS FOR A SYSTEMS APPROACH

Current treatment (s)	Methyl Bromide
Potential elements of system approach	New pest management techniques
Technical challenges to building an system approach	Industry fragmentation
Potential benefits of an system approach	Reduction of the use of methyl bromide as a phytosanitary measure

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Beyond Compliance: Integrated Systems Approach for Pest Risk Management in Southeast Asia

Project PG 328, funded by the Standards and Trade Development Facility

CASE STUDY: AVOCADO FROM PHILIPPINES TO REPUBLIC OF KOREA

Case study staff: Mr. Luben Q. Marasigan/Ms. Merle B. Palacpac, Loreta C. Dulce, Gerald Glenn F. Panganiban, Thelma L. Soriano, Elvin A. Carandang

Department of Agriculture/Bureau of Plant Industry-Plant Quarantine Service

ABOUT THE TRADE

THE COMMODITY

Avocado *(Persea Americana* Mill*)* is considered one of the most nutritious fruits in the world. Avocado fruit is a rich source of Vitamin A and also contains Vitamin B complex and E. It may be round, pear shaped, or oblong, and the skin of the fruit may vary in texture and color. The skin may be pliable to woody, smooth to rough, and green-yellow, reddish- purple, purple, or black in color.

THE SUPPLY CHAIN

From flower anthesis to fruit formation = 2 weeks

Immediately after fruit formation, fruits are tagged with colored ribbon to identify age of the fruit come harvest period

From fruit formation to harvest = 4 to 7 months

Flowering usually occurs during months of March to April

Harvest follows 4 - 7 months thereafter and at a moisture content of almost equal to 75%

The fruits of avocado are very perishable thus needs great care during harvest.

The Philippines is now exporting fresh fruits of Hass Variety of avocado grown by Dole Philippines into Singapore (4.2 MT 2009 & 2010) ,KSA (.49 Mt 2009 &2010, (frozen fruits into Korea and Japan (5.1 MT and 1.5 MT 2008 respectively)

Other outlets are local markets and near-by stores can also be sold direct to processors or processing companies interested in the product.

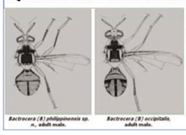
THE PEST ISSUES

Aleurodicus dispersus, Aonidiella aurantii, Aonidiella orientalis, Aspidiotus destructor, Bactrocera cucurbitae, Bactrocera dorsalis, Cerataphis latanlae, Ceroplastes ceriferus, Ceroplaster rubens, Dysmicoccus brevipes, Ferrisia virgata, Helix asperso, Hemiberlesia latanlae, Lasidoplodia theobromae, Maconellicoccus hirsutus, Nectria rigidiuscula, Phytophthora cinnamomi, Pseudococcus longispinus, Pulvinaria psidii, Selenothrips rubrocinctus.

Regular chemical treatment of trees for specific pest. Application of cultural practices.

THE CROP AND COMMODITY

QUARANTINE PESTS AND THEIR MANAGEMENT



Bactrocera (B) philippinensis sp. n., adult male. *Bactrocera (B) occipitalis, adult male.*

Fruit fly traps exposed to Methyleugenol:malathion (96:4).

Larva feeding on avocado fruit.

Cutting of fruit pedicel and dipping of tip to 0.5% chlorine solution.

PROSPECTS FOR A SYSTEMS APPROACH

CURRENT TREATMENT(S) – Post Harvest Water Treatment System

Prior to harvesting, fruits are inspected for presence of insect pests or signs of diseases. Samples of fruits are analyzed in the laboratory for moisture content. Individual inspection of fruits are again conducted for any biological or physical impurities that may have been overlooked in the field prior to and at cutting. Fruits are loaded in a chlorinated wash tank for disinfection purposes. Chlorine level is monitored to maintain the amount required during the process time. Regular chemical treatment of trees for specific pest.

POTENTIAL ELEMENTS OF S.A.

Accreditation /Registration of production areas, pre-clearance phytosanitary inspection, auditing and registration of packing facilities/ Annual survey of pest of concern, Treatment if necessary, Maximum Residue Level Certification by accredited agencies or laboratory, Good Agricultural Practice.

POTENTIAL BENEFITS OF AN SA

Prevent introduction of quarantine pest, faster opening and expansion of trade, generates additional income for the farmer, Ensure safety of agricultural fresh produce/commodity, exporting good improved quality of export commodities/GAP implementation will ensure safety of the environment .

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Supplementary material 2

A simple illustration of the need for ‘learning on the fly’ was the definition of what is really demonstrated by the BC tools. Surprisingly, this was not considered until the trade cases were nearly complete. The cases followed general plant health practices, which we begin to examine as the cases took shape.

Pest risk – we clarified that for the trade cases developed, we were only looking at the likelihood of entry of the regulated pest. We did not attempt to consider the probability of establishment and spread after entry nor the consequences of an introduction. The PRA from the importing country NPPO should cover those topics. While it is feasible to map those, and is useful to do so as an importing NPPO, the value in doing so as the exporting country NPPO is minimal. Despite that, we continued to use the terms pest risk management, pest risk, etc., as is the common practice. The idea of the pest challenge or threat was closer to what is mapped, but this term is not yet defined by the IPPC.

Time frame – we only covered the point up to leaving the field or packing house in the trade cases addressed. The tools could be used through to the point of import, but one would need to define the role of each NPPO in any official measures to show when responsibility transferred. (The regional import examples were exceptions, as the partners working on these already knew, and often controlled, procedures upon import.)

Unit – we realised that we were beginning anew with each consignment. The pest risk could change at any time, so that we were not even mapping it for an entire packing house, shipment or season. The same Production Chain could be used repeatedly, however, to sequentially enter the verification or real data into those points where ongoing monitoring and measuring are taking place, or to concurrently enter the information for parallel chains. One can envision that some iterations might be skipped, so that the control point is used every few weeks with possible increased frequency as the season advances and pest populations tend to rise. Or the actual data could be considered only at times of an audit or review of policy or programme.

3

Stakeholder Engagement

3.1 Introduction

The importance of stakeholder engagement in the Beyond Compliance (BC) approach was highlighted in Chapter 1. This chapter provides some further insights into the engagement activities that were held during the development of the BC case studies. The case studies are described further in Chapter 8.

The descriptions of stakeholder meetings are taken from reports by the project partners. In general, there was no established culture in SE Asia of consultation with industry. Each country had a different approach to stakeholder engagement. What support was available at the time is discussed in the next section.

The questions raised at the workshops were informative about the types of concerns held by stakeholders about Systems Approach in general and the BC project in particular. (Midway through the project, there was perhaps too much focus on the tools and the partners were reminded that it was the trade cases and not the tools that should be emphasised with stakeholders.) Feedback from these meetings provides an insight into the on-the-ground challenges faced by producers and potential ways in which these might be addressed. The broad benefits of the interactive process with stakeholders are clearly demonstrated; these are also identified in the last section of this chapter.

In one specific case, where equivalence would be sought, the economics of changing to an integrated systems approach for pest risk management was a key consideration. This led to the addition of cost of measures into the Control Point–Bayesian Network (CP-BN), through funding from a complementary source.

Some overarching lessons learned included the importance of having high-level support for the process of engagement as well as for the particular trade case. It was also found to be important to have a range of stakeholders attending the meetings. The stakeholders involved in case study meetings included government researchers such as entomologists, horticultural scientists, agricultural scientists; public sector experts in agricultural commodity and food standards, and extension services; statisticians or other researchers from a university or other non-ministerial research institutions; and producers and exporters. Spin-off benefits of stakeholder meetings included greater awareness of and coordination with related projects and participants identifying the need to set up a Stakeholder Network for sharing information relating to export.

3.2 Supporting stakeholder engagement

The original project plan did not focus heavily on private stakeholders. The usual elicitation of expert judgement on efficacy of measures, for example, can be conducted within the public sector or research sector, if not the NPPO itself. It became clear that to fully elaborate the options and consider the best choices for the Systems Approach schemes, broader engagement would be needed. It is now clear that it should be anticipated for any Systems Approach activity.

Due to a lack of stakeholder engagement history, funds for meeting expenses were not, as a rule, in the NPPO budgets. Funding from the project was reallocated to support stakeholder meetings (with the consent of the STDF). The initial plans were supported by discussions and a proposed set of questions (Table 3.1) to consider as a starting point.

Table 3.1 Questions for national plant protection organisations (NPPOs) to consider for stakeholder meetings (continued...)

Before the meeting	
Who or what event triggered the meeting, or need for a meeting? [Perhaps the Beyond Compliance project, but try to think beyond this trigger as well.]	If the meeting was requested by the industry, for example, the questions would differ.
What do you hope to achieve through this meeting?	Consider concrete and immediate outcomes for each meeting, as well as any longer term objectives.
What is your existing relationship with these stakeholders? What relationship would you aim for?	If you want to alter the relationship with stakeholders, as an additional objective, one avenue is to use a facilitated Performance, Vision and Strategy (PVS) session to understand the perception of the stakeholders of your work.
How much will these stakeholders know about market access and the NPPO?	Consider preparing a brief explanation. This could be included in the letter of invitation.
What do you specifically want to achieve at this meeting?	• How will you know you achieved it? • What needs to be in place to achieve it?
What follow-up do you need from this meeting?	• Who needs to follow-up? • By when? • What specifically do you need from each party for follow-up? • Will there be a cost, if so who will pay?
What outcome of the meeting (which you can control to some degree) would satisfy you?	• Numbers of participants • Range of representation • Active engagement through question/answer session

Table 3.1 continued

During the meeting	
Explain the role of the NPPO in trade and how this new framework might boost confidence and improve results in market access negotiation. Using the Production Chain, ask the stakeholders:	• What are you doing now? • What works? • What does not work? • What else could you do or have you tried? • If something else works, why are you not doing it already? (Barriers to implementation) • How much improvement would you expect with these new practices?
If the proposal is arising from the NPPO	
Explain why you propose a change:	• What is not working? • Will something change soon – e.g. loss of a pesticide, more resistance building up? • What is working in other places or on other commodities? • Why it is worth considering a different approach? • What would be expected in terms of additional costs or savings, including access to new markets or the threat of loss of a market?
Is there sufficient interest in maintaining access and improving quality (reducing damage from treatments, for example) to engage the stakeholders in a new approach?	Note – while Systems Approach may cost more for an individual consignment, it often allows trade to continue in situations where interceptions or poor quality previously stopped or reduced trade.

The questions are general and not appropriate to all situations. After the project had ended, a manual on managing stakeholder relationships was published by the IPPC (FAO, 2015).

3.3 The Malaysian experience

Two stakeholder meetings were held to introduce and gather information for Malaysia's case study for the STDF project PPG/328 'Beyond Compliance: integrated Systems Approach for pest risk management in Southeast Asia'.

3.3.1 Aims

The objectives of the stakeholder meetings were to:

1. Share import requirements;
2. Collate implementation problems;
3. Provide recommendations to improve farm activities; and
4. Introduce Systems Approach and application of a BN.

3.3.2 Identified issues

Discussion about possible export compliance by stakeholders revealed several important changes, especially in the mind-set of the stakeholders, and additional practices that would need to be in place before Malaysia is ready to export jackfruit to non-traditional markets. Four important changes were identified:

- *Registration* of farms that conform to requirements of having low pest prevalence production area and facilities ready for implementing good agricultural practices for food safety, phytosanitary measures and traceability, as required by importing countries.
- *Implementation*: few farmers understand and have the knowledge to implement Systems Approach to achieve the required standard.
- *Recording of activities on-farm:* recording is still poor and limited to certain activities only. Most farmers lack the knowledge

and capacity to record their activities, except certain well-established farms where workers have been trained to record their activities daily.

- *Accreditation*: currently, few packing houses could be accredited for compliance to the food safety and phytosanitary requirements of the importing countries. These facilities are located outside the production areas.
- *Facilities*: there is currently only one facility designed for minimal processing of jackfruit. A few more facilities need to be built or existing packing houses modified to ensure volume and feasibility of export.

Associated issues with jackfruit market access

Gaining market access to the non-traditional importing countries required submission of requests for market access, conducting a PRA and eventually signing the import protocol. Using materials from the negotiation process, the pests of concern to importing countries were identified and listed during the stakeholder meeting, and the available control methods were detailed.

3.3.3 Using the Production Chain

Break-out sessions were used to discuss the Production Chain and the critical points in the farm and the post-harvest stages that have impact on pest and disease control measures. Those that were included to meet the importing country requirements were identified. Among the issues of concern to the stakeholders were:

- Introduction of pest and disease control measures to reduce fruit flies or other pests or diseases of concern. The new control measures, e.g. male annihilation, might increase the production cost and be time consuming in terms of worker training.
- Increment in cost of production in getting MyGAP (Malaysian Good Agricultural Practices) certification.

- How efficient fruit bagging (materials and bag design) is in reducing the fruit fly infestation. Jackfruit is a large fruit and the current practice is to use bags made of clear plastic, paper and jute. Further studies need to be done to find a suitable material and design to ensure fruit quality and at the same time to avoid pest infestation and disease.
- Choosing the right harvesting index is crucial to avoid pest infestation and to ensure the quality and taste is acceptable when the fruit reaches the consumers.
- Most of the collecting centres did not comply with general phytosanitary standards, i.e. some are not insect proof and do not have proper collecting areas. For the proposed trade, at least one collecting centre that complies with the requirements, especially to avoid pest infestation and disease in the harvested fruit, needs to be set up and certified by the NPPO.

Figure 3.1 Discussion session on topics related to farm registration, the Production Chain and post-harvest management in Malaysia

- Documentation and farm records are crucial to monitor farm activities. Smallholder farmers might overlook recording activities and more awareness-raising needs to be done on the importance of farm record keeping.

3.3.4 Recommendations

The stakeholder meetings recommended follow-up action to facilitate the export of jackfruit to the non-traditional markets. Among the recommendations were:

1. Conduct roadshows to explain and share the import protocol for exporting to China and other non-traditional importing countries. The roadshow is recommended to be a half-day event involving all stakeholders such as farmers, packing house operators, treatment providers and regulatory bodies. This roadshow will be organised by the jackfruit producer association with assistance from the plant quarantine officers.
2. Give hands-on training to farmers in how to comply with the import protocol. This will ensure registered farms achieve the low pest prevalence production areas necessary to fulfil phytosanitary requirements.
3. Establish a one-stop centre for packaging, treatment operations and preparation of export documents. This will facilitate a reliable and continuous supply of jackfruits, maintain a premium price and reduce operational cost. The centre will strengthen regulatory compliance by, for example, providing an insect-proof packing house, and a proper facility for quarantine inspection and issuance of phytosanitary certificates. The centre could be owned by a cooperative of non-governmental stakeholders and run by appointed managers.
4. Strengthen research on planting technologies and management of quarantine pests of concern to the importing countries to facilitate the establishment of low pest prevalence production areas.

3.3.5 Lessons learned

Lessons learned from the stakeholders' engagement during this case study were as follows:

1. The readiness of the stakeholders to implement the activities to meet import requirements is based on their understanding of the requirements and the benefit gained from them, such as a premium price and increased export volume.
2. The involvement of all stakeholders during the discussion to finalise the response or comments on the proposed import protocol (if available from the importing country, following the completion of the PRA) is important, especially if the treatment recommended will/could affect the quality and shelf life of the produce.
3. Changing the mind-sets of the farmers was achievable once they were convinced of the benefits of the changes and the need to change in order to protect the industry. Several engagements, such as informal meetings and hands-on training, were required to initiate the mind-set changes.
4. Changing farm practices, especially proper bagging, harvesting based on number of days after anthesis, effective pesticide application, and reduced handling from farm to consumer will ensure compliance with the low pest prevalence production area requirements and reduce physical damage to fruit, adding to the higher profitability of the export venture.
5. Stakeholder meetings provide a forum for collating their problems and increase their understanding of the requirements for compliance in order to export. Personal engagement and explaining the responsibility of different stakeholders will contribute to the success of exporting of jackfruits to non-traditional markets.
6. All the stakeholders, especially the farmers, exporters and packaging house operators, can use meetings as platforms to exchange knowledge and experience, especially on farm practices and jackfruit production practised by the large and experienced producers.

These lessons learned showed the value of stakeholder engagement and should prove true for other production sectors or trade cases.

3.3.6 Conclusions

The various approaches used in the BC project to addressing the challenges of phytosanitary requirements and compliance with the relevant import protocol has changed the mind-sets of Malaysian stakeholders. Most of the stakeholders now understand the need to fulfil the requirements and the benefit of getting their product exported to the non-traditional and also biosecurity-stringent countries. Quality control standards should be in place at various critical control points in the jackfruit Production Chain for market acceptance as well. These approaches will ensure producers comply with the import protocol of the importing countries and safeguard against losses incurred if a consignment has to be re-treated at the point of entry, destroyed upon arrival, or returned to country of origin.

3.4 The Thai experience

Thailand's case study was the integrated Systems Approach of risk management for *Thrips palmi* on exported orchids from Thailand to the EU.

3.4.1 Aims

The objectives of stakeholder meetings were as follows:

- To introduce Systems Approach and use of a control point for reviewing the pest status as part of risk management of export orchids to the EU to stakeholders.
- To mutually share the knowledge – e.g. field experiences, product quality improvement, trade market access, and phytosanitary

requirements of importing countries – necessary to generate the Production Chain, Decision Support System (DSS) and CP-BN.
- To harmonise perceptions among orchid farmers, entomologists and IPM experts about the DSS and the BN-based sensitivity tests [sensitivity analysis is explained further in Chapter 7].
- To learn about techniques and alternatives measures to control *T. palmi* besides using methyl bromide fumigation.
- To build the working network for further research.

3.4.2 Activities

The Production Chain was prepared by the Thailand NPPO in consultation with orchid industry stakeholders. The Production Chain indicates a series of potential control measures and verification measures. These measures can be applied to manage the risk of infestation. The effects of the measures can be determined by a pest monitoring procedure, referred to as a control point if measures can be adjusted based on findings.

The Production Chain contains five control points and lists 23 possible measures to control *T. palmi*. The stages (time and place measures take place) are:

1. Pre-planting and preparation.
2. Production and control measures in the field.
3. Harvesting and picking.
4. Processing, treatment, packing in centralised facility.
5. Inspection at port of departure.

All possible measures at each stage were identified:

1. *Pre-planting and preparation*: (i) using healthy planting materials, provided from reliable sources; (ii) avoiding cultivating host plants of *T. palmi* around the planting area; (iii) using clean growing media; (iv) farm layout and building; (v) dipping

(treating) stem cuttings against *T. palmi*; (vi) sanitation before orchid cultivation; (vii) providing an area for disposing of damaged orchids; (viii) separating new planting material from existing plants.

2. *Production and control measures in the field*: (i) pest monitoring at the orchid flowering stage; (ii) using blue sticky traps; (iii) using materials to cover planting media; (iv) foliar and flower spray programmes; (v) field sanitation.
3. *Harvesting and picking*: (i) effective equipment and materials; (ii) flower holding/collecting areas away from the greenhouse.
4. *Processing, treatment, packing in centralised facility*: (i) soaking cut flower stems; (ii) selecting export quality stems; (iii) dehumidifying cut flowers; (iv) packing standard; (v) temperature control during the packing process; (vi) packaging boxes or containers for export to be new, clean and strong; (vii) methyl bromide fumigation treatment.
5. *Inspection at port of departure*: (i) quarantine inspection (phytosanitary certificate).

After full discussion and evaluation between the stakeholders, entomologists, IPM experts and orchid farmers, 11 effective measures were selected:

- Pre-planting and preparation
  - Avoid cultivating host plants of *T. palmi* around planting area
  - Dip (treat) stem cuttings against *T. palmi*
  - Sanitation before orchid cultivation
  - Provide area to dispose of damaged orchids
- Production and control measures in the field
  - Blue sticky traps
  - Foliar and flower spray programmes
  - Field sanitation

- Harvesting and picking
  - Holding/collecting areas away from greenhouse
- Processing, treatment, packing in centralised facility
  - Select export quality stems
  - Methyl bromide fumigation treatment
- Inspection at port of departure
  - Quarantine inspection (phytosanitary certificate)

3.4.3 Conclusions and implications for the project

Stakeholder meetings and field trips to the export orchid greenhouses, and a combination of research theory and productive discussions between farmers, entomologists, IPM experts and exporters resulted in the modification and improvement of the case's Production Chain as well as the completion of the DSS template. Having several meetings can increase the confidence (certainty) in the DSS responses, which may contribute to values entered into the CP-BN and the sensitivity analysis, which in turn help identify promising options for risk management. Stakeholders can learn about and understand the measures which are alternative to methyl bromide fumigation for controlling *T. palmi*. [They may also be complementary measures, if the methyl bromide treatment is reduced and becomes part of a Systems Approach.]

Opportunities

1. Critical thinking: the stakeholder meeting on Systems Approach allowed participants to think more analytically and systematically. The development of IPM, for example, is applied to the Systems Approach measure (IPM to Systems Approach is an idea discussed further in Taekul et al., 2013).
2. Better understanding of orchid cultivation, e.g. most production techniques are based on the investment cost; it is difficult for the farmers to replace current practice with other, higher cost measures.

3. Learning that theory may not be implemented in the field.
4. Sharing the experience among counterparts, e.g. brainstorming and thus gaining a promising result.
5. Being equipped with the knowledge base, especially analytical tools and field implementation information, to help comply with the requirements of importing countries or trading partners.
6. Being challenged to utilise an innovative method (CP-BN) for pest risk management.
7. Obtaining support and collaboration from several organisations involved in orchid export to the EU.

The knowledge base and project outcome has been mainly distributed to the NPPO Thailand (Department of Agriculture) and the official country SPS focal point, the National Bureau of Agricultural Commodity and Food Standards (ACFS), but has also been extended to the Thai Orchid Exporters Association and Thai Orchid Garden Enterprise Association. A Thai research paper of this case study has been published and presented at the 11th National Plant Protection Conference, Thailand (Taekul et al., 2013). For this case, the challenges in compliance with EU requirements is a long standing trade issue. The BC experience was only a first step in convincing the producers to consider some fundamental paradigm shifts. This includes reducing or eliminating methyl bromide use. The introduction of control points where not only activities are monitored by the NPPO, but also the pest status, could lead to cost savings if adjustments to procedures can be made immediately rather than shipping consignments destined to be stopped due to the presence of the quarantine pest.

3.5 The Vietnamese experience

Two stakeholder meetings were held in Vietnam, the first in Hanoi and the second in Ho Chi Minh City.

3.5.1 Aims

The aims of these stakeholder meetings were as follows:

- To present an integrated Systems Approach for pest risk management of export dragon fruit to South Korea and Taiwan as an alternative to the currently used stringent and expensive treatment.
- To elicit feedback from stakeholders to provide the details for creating a Production Chain, DSS and CP-BN for this case.
- To collect information on the knowledge of each stakeholder group on trade, market access and phytosanitary requirements of importing countries, and on quality improvement.
- To explain the need for setting up a Stakeholder Network for sharing information relating to export of dragon fruit.
- To learn more about holding and benefiting from stakeholder meetings.

3.5.2 Plan for production of dragon crop in Vietnam

The plan for domestic and export production of the dragon crop in Vietnam was described, based on information provided by Mr Huy (Head of Fruit Crop and Vegetable Division, Department of Plant Production, Ministry of Agriculture and Rural Development [MARD]). This plan is important for the dragon fruit grower, middleman, exporter, packing house operator, treatment provider, extension officer and NPPO officer as it deals with market access, quality improvement, phytosanitary requirements of importing countries and requirements of domestic consumers.

Discussion resulting from developing a Beyond Compliance Production Chain

The development of a Production Chain, and an associated field visit, produced important information for the BC team and also revealed important issues for the country group. These issues included the following:

- Stakeholder recognition that re-infestation is possible if treatments are not universally and correctly implemented.
- Acknowledgement of different crop seasons in different parts of the country.
- The need to consider efficacy of measures; for example, lure pheromone traps will only give a good result in areas where the dragon tree is the only host crop in the field, not in complex orchards with many kinds of hosts of fruit fly, which can fly long distances, so records from traps in these circumstances will be inaccurate.
- Recognition of a need to prioritise measures such as monitoring owing to budgetary constraints, and general stakeholder opinion that monitoring of pest challenge or infestation was not necessary since the fruit will be treated by irradiation or vapour heat treatment (VHT) before export.
- Widespread use of some treatments such as insecticide cover spray and flower trimming, fruit thinning and bagging, and clear understanding of the time of application of these treatments; some of these are mentioned in the VietGAP (Vietnamese Good Agricultural Practices) book and also demonstrated in some dragon crop farms. However, despite this knowledge, some measures may not be widely accepted by growers in practice because they interfere with other activities (e.g. bags need to be reopened to allow spraying with a nutrition solution after fruiting and during the growth of the fruit, or to perform chemical touch-ups to meet the demands of some markets (e.g. requiring the ear of the fruit to be hard and green at harvest time).
- Similar issues with implementation of measures owing to practical constraints were identified for a range of other treatments.
- Locations with high concentrations of dragon fruit, particularly in the Central Coast, offer potential for area-wide management (Figure 3.2).

Figure 3.2 High concentrations of dragon fruit in some regions offer potential for area-wide management with traps or sterile insects

Discussion on market access, phytosanitary requirements and the possibility of application of integrated Systems Approach in Vietnam

The extent of knowledge about market access and phytosanitary requirements was discussed.

In the North, where farms are typically small, growers were generally trained in IPM and knew how to use pesticide appropriately, but they did not know about foreign markets and phytosanitary requirements. This was possibly due to the role of middlemen, who collect the fruit directly from farms and deliver them to various markets.

In the southern regions, the Central Coast and the Mekong River Delta, some exporters are also investors in the wider sector so they work as dragon fruit producers, packing house operators, treatment providers and exporters. They have quite good knowledge on market access and phytosanitary requirements of importing countries. They have good opportunities for contact with importers and implement measures to meet phytosanitary requirements. In addition, they have a good relationship with local government, with the NPPO of Vietnam, with scientists and research institutions, with policy makers from MARD, and with trade counsellors at Vietnamese embassies in market countries.

Dragon fruit farmers in the North of Vietnam are in general only crop growers (versus buyers). They hire some workers and may farm together. Dragon fruit farmers in the Central Coast and Mekong River Delta are quite different. Most of them are investors so they do not farm directly but they can control workers on the farms. Export companies in these regions not only sell dragon fruit, but also other fresh fruit such as pomelo, longan, litchi, rambutan, mangosteen, mango, etc.

There is often a sense of competition in the market among dragon fruit producers, middlemen, packing house operators, treatment providers and exporters; therefore information (on market access and phytosanitary requirements) is not always shared.

The need to set up a Stakeholder Network for export of dragon fruit

During the meeting in Ho Chi Minh City, most of stakeholders said there is a need for a Stakeholder Network for export of dragon fruit, and proposed setting one up. Network members will meet every three months to share information relating to export of dragon fruit. The cost of the network is met by a contribution from each participant. A representative of the NPPO of Vietnam in Ho Chi Minh City is to be invited.

Coordination with other initiatives

The Government of Vietnam had identified dragon fruit as a priority for export promotion. For this reason, various initiatives were already in play at the time of the BC project. One such initiative was the review of feasibility of sterile insect technique for fruit flies, mentioned as an option in the Production Chain and DSS. This was supported by participation of the Food and Agriculture Organization of the United Nations/International Atomic Energy Agency

Figure 3.3 Prof John Mumford meets to collaborate with local partners of the FAO/IAEA project, to enhance stakeholder involvement in the dragon fruit case

(FAO/IAEA) technical cooperation project entitled, 'Supporting Area-Wide Integrated Pest Management to Improve the Quality of Fruit for Export'.

Coordination with this initiative supported some field demonstrations and meetings in the South region, which were complementary but outside the scope of the BC project and could not have taken place under its auspices.

3.5.3 Lessons learned

1. The application of integrated Systems Approach for pest risk management for export dragon fruit is quite new for all stakeholders in Vietnam. Management of plant pest risks through using a Production Chain, DSS tables and combined pest CP-BNs gave more confidence to the grower, middleman, packing

house operator, treatment provider, extension officer, scientist and quarantine officer.
2. Stakeholders in Vietnam will apply integrated Systems Approach for pest risk management in export dragon fruit if they receive acceptance from the NPPOs of South Korea, Taiwan or other importing countries.
3. Negotiation and consultation between the NPPOs of Vietnam and South Korea or Taiwan on application of integrated Systems Approach for export dragon fruit from Vietnam is critical.
4. 'Equivalence' is a principle in the SPS Agreement and the IPPC and is covered in ISPMs, principally ISPM 24 (FAO, 2005), but most importing countries still request application of a stringent treatment, such as irradiation or VHT, for importation of fresh fruit.

The case was left with a question of whether there is a better mechanism to request importing countries to accept the 'equivalence' proposal and integrated Systems Approach as an alternative for a stringent treatment.

Despite engagement with the target market country NPPO staff as well, this case remained unresolved at the end of the project. For the project, the lesson learned was that additional support in the market negotiations process may be needed beyond the understanding and ideas provided by the BC tools. The import countries must also be at a stage at which discussing alternatives is of sufficient priority for them, as well as for the producing country. The Vietnamese NPPO made some effort to draw the interest of import authorities, for example by inviting the South Korea NPPO to send an observer to a BC project meeting.

3.6 The Philippine experience

An orientation/seminar entitled 'STDF Project – Beyond Compliance Integrated Systems Approach for Pest Risk Management in Southeast Asia' was conducted by the Bureau of Plant Industry (BPI) Plant Quarantine Service (PQS), by personnel who were involved in the project, on 30 January 2013 in the BPI Director's conference room. A total of 30 participants from the BPI Pest Risk Analysis and Market Access teams attended the seminar.

The second orientation/seminar on the BC project, for the stakeholders, was conducted on 10 May 2013 at the Microtel, Davao City. Forty-five technical personnel participated from the Philippine Banana Growers Exporters Association (PBGEA), Mindanao Banana Producers Exporters Association (MBPEA), potential exporters of banana (pineapple and mango exporters) and technical staff from the regional office of the Department of Agriculture (DOA) and PQS Mindanao area.

3.6.1 Aims

The first seminar aimed to present the BC project and the CP-BN as a tool to help develop probabilistic technical evidence of Systems Approach for the export of banana to the USA and its use in building confidence in trade negotiations. The topics covered in the seminar, and the corresponding presenters, were as follows:

- Discussion of the project – Ms Merle B. Palacpac
- Definition of terms – Ms Thelma L. Soriano
- ISPM 14 for Systems Approach (FAO, 2002) – Mr Gerald Glenn F. Panganiban
- Developing Systems Approach for Pest Risk Management – Mr Elvin A. Carandang
- The Philippine case study – Ms Loreta C. Dulce
- The project meeting in Vietnam/next steps – Ms Merle B. Palacpac

The second seminar aimed to orient the stakeholders on how to develop a BN model for a Systems Approach for banana export to USA and to use the model to help in developing probabilistic technical evidence that could build confidence in trade negotiations.

The following topics were discussed:

- Project background and objectives
- Key definitions
- ISPM 14 for Systems Approach (FAO, 2002)
- Developing Systems Approach for Pest Risk Management
- Other country case studies from the project
- The Philippine case study (banana export to continental USA)

3.6.2 Questions raised

The following questions were raised by the participants after the first seminar.

- What are the things you need to start designing a CP-BN?
- How can it be done if there are many pests of concern?
- Are options for phytosanitary measures indicated in the system or will they be manually inputted?
- Is the system available for download or available only online?

In addition, other queries about the tools were addressed subsequently by the project technical team. Some of the queries raised during the second seminar were:

- Can the tool be used for plant diseases?
- Is the tool ready to be used?
- How can we get our hands on this system?
- Which comes first, certification or inspection?

Political issues and influence of politics in trading were also discussed.

3.6.3 Overall conclusions

The first seminar was reported to have helped the NPPO team members gain information and knowledge about the project as well as the CP-BN model, and how these could be used in the conduct of a PRA. The project team in the Philippines was particularly eager to have a visit aimed at embedding the concepts further in their own public sector group. Due to distances, time zones, no project meetings hosted, etc., fewer of the Philippine group were able to participate in project meetings. A follow-up visit focusing on this governance issue took place, as noted in Chapter 9.

3.7 Take-home messages

Five key take-home messages from the process of stakeholder engagement in the BC project are as follows:

1. Stakeholder meetings were extremely valuable for disseminating information about, and creating engagement in, the BC project.
2. They were also essential for obtaining information required to inform the BC case studies and corresponding Production Chain, DSS and CP-BN.
3. It was important to have representatives from each of the following groups at the meetings: the case study development team (typically the representative from the country's NPPO who was delegated to the BC project), an expert on the BC approach (typically a member of the team developing the BC tools), a senior member of the national or regional plant protection agencies (to demonstrate support for the project and provide a broader perspective on the issues discussed in the meeting) and, critically, a range of stakeholders representing the key aspects of the case study problem.
4. The stakeholder seminars were essential in order to identify gaps in knowledge and concerns about Systems Approach in general and the BC tools in particular. Some of the issues, such as lack of familiarity with Systems Approach, were conveyed back to the international partners for consideration. Many of the issues were taken up by the development teams in the BC project to improve the tools in partnership with the country groups.

5. The benefits of the BC project lay not only in the development of the tools, but also in the formalised processes required for their implementation. These benefits are most strongly seen in the process of stakeholder engagement. For example, the Malaysian experience described above demonstrated that the process of completing a Production Chain entailed careful discussion of the various steps involved in production, the issues arising at each of these steps, the more general needs associated with these issues and potential strategies to meet these needs.

The involvement of both internal and external stakeholders, from both public and private sectors, enhanced the use of the BC tools and preparations for the trade case negotiations. For the partner countries, this was not a widely used approach to improving trade proposals, although at the same time it was not the first such meeting. The project encouraged stakeholder involvement and gave a framework for those interactions.

Among countries most involved in the BC project, the partners identified approximately 20 domestic stakeholder meetings which arose directly from the project. This is considerably more than had occurred in these countries for other initiatives.

3.8 References

FAO (2002) *ISPM 14. The use of integrated measures in a systems approach for pest risk management.* IPPC, FAO, Rome.

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4

Beyond Compliance Tools: the Production Chain

4.1 Why go back to the basics?

At the start of the project it was assumed that there was a common understanding of the main concepts involved in PRA, or Pest Risk Management in particular, but it gradually emerged that this was not the case. Some concepts are complicated and not used consistently across plant health (see Supplementary material 1, for example). Even with a project policy of using the IPPC glossary (ISPM 5: FAO, 2015) for any terms, interpretations varied. Terms from the IPPC glossary used in the project appear in Appendix 3. As with other learning experiences, highlighted in Chapter 2, common agreement on concepts had to be reached and recorded at one of the project's interim meetings. This issue arose for a number of topics. It had to be realised by everyone in the project that it was a natural progression and a positive indication of project maturity. Indeed, it is a significant outcome from applying Beyond Compliance (BC) tools because clarity of thinking is challenged and enhanced by completing the framework tools.

One can imagine that if this confusion occurs about fundamental concepts in plant health in a small project, with several participants who attend the CPM of the IPPC, it is constantly present in communications amongst trade partners even though nearly all trade occurs between contracting parties to the IPPC.

At the time of the conception of the BC project, during the Project Preparation Grant discussions, the focus was on putting real data (versus estimates) derived from official phytosanitary measures serving as control points into a Bayesian Network (BN). These few nodes, which could be included as control points, would interact with the quantified estimates of pest risk management plans, eventually revealing more accurate ranges of efficacy to be expected from any given measure. The original intention of adding a Production Chain to the BC tools, therefore, was to map what steps are required for managing pest risk to the appropriate level of protection, as defined by the potential importing country. Thus the Production Chain was envisaged as a way to clarify some ideas about the pest risk and possible management before adding quantitative estimates of the measures' impact on risk reduction (efficacy), which would be used to build a BN of the same production system. The resulting Control Point–Bayesian Network (CP-BN) could be the basis of trade negotiation.

Instead the Production Chain tool on its own proved to be surprisingly powerful in building confidence and competence in use of Systems Approach. It was also revealed to be an important communication tool, particularly with domestic stakeholders in the exporting country. The experience of the case studies showed that the Production Chain can be more a robust bridge than a humble stepping stone.

The various conceptual underpinning and ways to use this tool are described in this chapter.

4.2 The Beyond Compliance Production Chain concept

The Production Chain tool (capitalised to distinguish its use as a tool, versus a general concept) is the foundation of the entire BC Production Chain framework for pest risk management. The Production Chain is a map of actions taken at various points along the time sequence of production of a plant product, generally going from planting to harvest.

The BC Production Chain may start before planting, however, if the preparation of the production site or planting material is important to plant health. It may also extend beyond harvest to the point of a post-harvest treatment, export or even arrival to the importing country if there are additional actions or conditions which affect the potential pest status of the shipment, as suggested in Figure 4.1. ISPM 14 (FAO, 2002) summarises potential measures to apply at pre-planting, pre-harvest, and harvest, and during post-harvest treatment and handling, and transportation and distribution. Many of the other training materials, articles and books on Systems Approach show the proposed or selected measures by the stage in the production process graphically as well, so that the basic idea is not unique to BC.

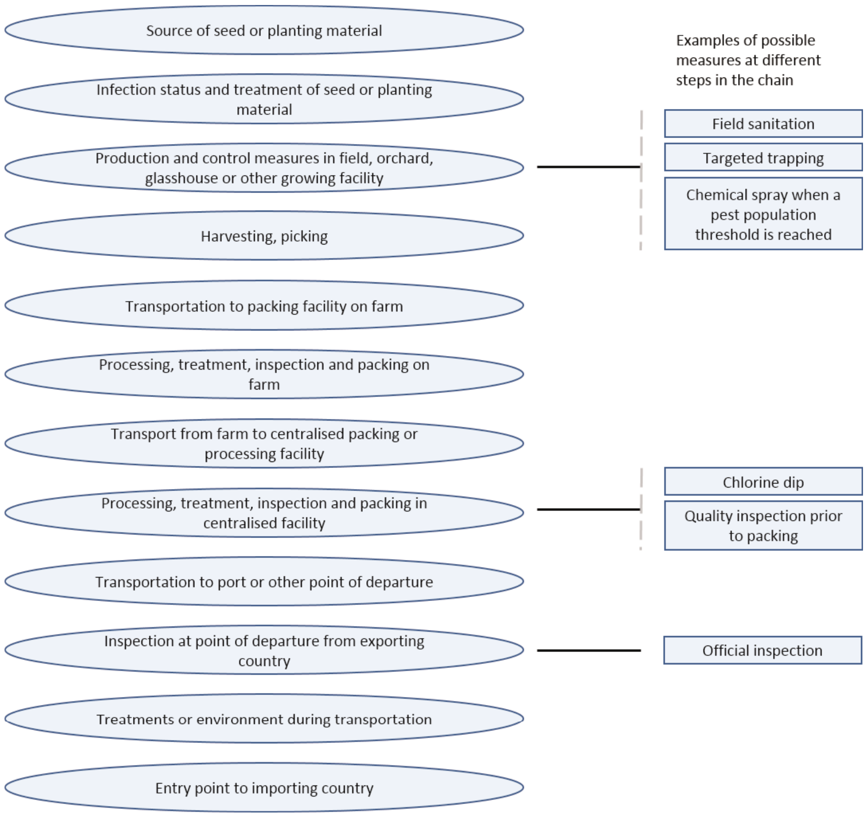

Figure 4.1 A generic Production Chain showing the key stages from planting through to import and concurrent example measures

The objective of this tool is to clarify thinking about and understanding of the trade case's pest risk through the development of a set of graphical flow-charts that show what actually happens over the course of production of the commodity of interest, or what could actually happen. Therefore, it may be used to represent how existing production is handled, or how it could be handled, for example for a new market requiring different pest risk management. The various applications of the tool are discussed below.

While the approach appears simple, it effectively challenges understanding of key concepts. Some of the ideas or concepts required to apply the tools which were not already defined in ISPM 5 include those shown in Table 4.1.

Although ISPM 14 refers to a critical control point in its annex 1 (see Appendix 2 of this eBook), the concept of a control point in plant health emerged to be a point slightly distinct from common understanding under the food safety regime of the Hazard Analysis Critical Control Point (HACCP). One official definition in that context (Codex Alimentarius, 2003) is:

> Critical Control Point (CCP): A step at which control can be applied and is essential to prevent or eliminate a food safety hazard or reduce it to an acceptable level.

This definition and other text in the HACCP guidelines focus on confirming the control of the hazard at particular points along the food production or processing chain. The original IPPC definition (now in Table 4.1) implies that it is/they are the measure(s) that one is monitoring and correcting to achieve the desired effect, rather than the hazard itself. This nuanced difference relates to the measures available for food safety versus plant health. It also explains why many examples in plant health have failed to set a clear threshold or critical limit at which corrective actions should be taken to improve the efficacy of a measure or of the entire system. Certainly some pest risk management focuses on monitoring the implementation of the measure, but monitoring the actual pest population or infestation is also commonly employed. The point of interest is the impact of the

Table 4.1 Terms and concepts considered for development of Beyond Compliance (BC) tools (continued...)

Term	**Definition**	**Source and Application**
Production Chain	A graphic representation of actions taken in relation to a featured crop (plant product), shown at the stage where and when taken, and coded by objective (in terms of risk – reduction of infestation, reduction of pest population in the production area, verification of performing a measure, etc.) and legal status of the action (phytosanitary measure, commercial activity, etc.).	Developed over the course of the project for the final BC Production Chain tool.
Activity	An action carried out along the Production Chain which is not a phytosanitary measure but was identified by one or more stakeholders.	Arose in Vietnam case study. Used in the Production Chain for coding the status or type of node.
Stage	A period of time (e.g. during growing season – pre-planting, flowering, harvest) in a specific place (e.g. nursery, glasshouse, field, orchard, packing house)	Adapted from ISPM 14. Used in the Production Chain in chronological order of occurrence, although some may occur concurrently. Probably the same as the word 'step' in the definition of Control Point, below.
Audit	Periodic official review to verify that a procedure or system of procedures is being carried out according to plan, based on documentation.	This was defined in BC when clarifying concepts for the DSS, to show that we are seeking to do something different from an audit with the BC approach. We are attempting to have a tool that could conceivably be updated regularly as new information is available and be used as a management tool. However, some documents such as certification of a site or a phytosanitary certificate are critical for market access and may be taken as verification of a defined system of measures such as a Pest Free Area.

Table 4.1 continued

Term	Definition	Source and Application
Verification	A procedure to quantify (within the limits of the method) the actual effect (or a mathematically related proxy for the effect, derived from methods research) of one or more risk management measures, to ascertain how close the outcome is to the expected, defined effect. A way to quantify the effectiveness of a measure in achieving its potential efficacy. More simply, Did the measure perform as expected?	Introduced from earlier discussions under the IPPC about efficacy and performance. Used in the Production Chain for coding one type of node. Ideally this would be a direct measurement of the impact on the target (e.g. trapping shows population drops; fruit cutting shows no pests – of course at the level the sampling permits). However, often there is an indirect indicator measuring the application of the management measure (e.g. irradiation at a particular dosage/time) that relates to the level of impact that the experiments showed would be achieved if applied this way.
Field infestation	Infestation of the host of interest by the target pest species (or infection by the target regulated plant disease) during cultivation of the host.	Discussions from BC, to be shown in Production Chain by stage and contributing to the structure of the BN.
Post-harvest infestation	Infestation of the host of interest by the target pest species (or infection by the target regulated plant disease) after harvest of the host (in the field, packing house, during transport).	Discussions from BC, as per above, although BC focused on mapping the host plant – pest interactions only to the point of export.
Control Point	A step in a system where specific procedures can be applied to achieve a defined effect and can be measured, monitored, controlled and corrected (ISPM 14, 2002).	This was an official definition developed with ISPM 14, which was later deleted from ISPM 5 (all definitions having been removed from individual ISPMs). It was removed with the rationale that it was not a term unique to the IPPC. The BC partners continued to use this definition, and consider it to be useful for understanding ISPM 14, especially its annex 1 (see Appendix 2 of this eBook).

Term	Definition	Source and Application
Monitoring of a Control Point	A planned sequence of observations or measurements at a predetermined Control Point to determine whether the required response has been achieved.	Discussions from BC, to be shown in Production Chain.
Unofficial control point	Control point along the Production Chain which is not under official control.	Emerged after stakeholder input.

BC, Beyond Compliance; BN, Bayesian Network; DSS, Decision Support System; IPPC, International Plant Protection Convention; ISPM, International Standards for Phytosanitary Measures

measure on the pest risk; this further recognises that the effect of the measure is a combination of what it is designed to do, and how and under what conditions it is applied (see Supplementary material 2). Such distinctions about a control point on a production chain may seem academic. This real data feedback, however, is at the heart of Systems Approach and the flexibility it offers for pest risk management. Including control points is the avenue to more proportional and effective measures, and therefore to much more cost efficient compliance.

The BC Production Chain uses the general production chain concept (Figure 4.1) to illustrate several factors related to pest risk along a time line:

1. **The key stages in the commodity production chain (*Stage*)**
   A stage is a place and time along the production chain. The location normally is a single place (e.g. the field or the packing house), but the time may be a time period (e.g. pre-planting, post-harvest) or phase of production (e.g. flowering, which could be sequential or clustered to the same brief time period).
2. **The objective of the potential phytosanitary measure(s), by stage or individual measure (*Objective*)**
   This relates to the purpose of the actions in relation to the pest

risk. It could be to reduce the pest population in the vicinity, reduce the possibility of infestation, kill pest already infesting the crop, etc. Although measures may fulfil the same objective for various types of pests, it is recommended to develop Production Chains by pest species or guild, rather than grouping too many associated pests into one Production Chain.

3. **For each of the objectives, available or preferred measures (*Measures*)**
   Actions taken to control or manage the pest of concern are illustrated as measures. These may be the ones in actual use, or those which could be used, or those proposed for use in a new Systems Approach plan. Further discussion below shows that, depending on the purpose of the specific Production Chain, these measures do not have to be restricted to official measures, although that was the original plan.
4. **Monitoring or verification activities that check the extent to which any measures used have been effective (*Verification*)**
   Monitoring and verification activities may not be available for each measure or stage. However, the concept of checking what actually occurs in the risk management system, versus simply relying on the predicted outcome, is at the heart of the BC approach. Verification may confirm or measure directly the pest population/infestation, or may confirm or measure the implementation or performance of a phytosanitary measure. The performance relates to how well the measure achieved what it was designed to do.

With use in real trade cases, the meaning and boundaries of the concepts of stage, objective, measure and verification became more precise. Colour coding was introduced to distinguish the legal status of the action or activity, or the role of the activity. For example, if the Production Chain is being developed with producers, commercial practices or quality related activities may need to be included for better comprehension of the overall chain. Even when illustrating official measures is the purpose of the Production Chain, there could be activities included which are not part of the official measures, because they are conducted by the producer, for example.

Finally, for the status of the pest population, it was important to clarify what was anticipated at the various stages, and in relation to which measures. This also allowed the BC tool to incorporate the additional risk of post-harvest infestation. Additional columns were used to show these factors concurrently. These all comprise the BC Production Chain in its format presented by the ICL and QUT technical teams for use by the participating NPPOs. An example of this approach appears in Figure 4.2. Variations in use occurred, as discussed below.

Although shown here as stopping at the point of embarkation or the site where a phytosanitary certification would be issued, which includes production and post-harvest activities, the chain could be shown through transport to arrival at the port of entry (or land crossing) when the market country NPPO may be inspecting, or through to the final distribution point such as a supermarket, if useful in covering all the pest risk and management measures.

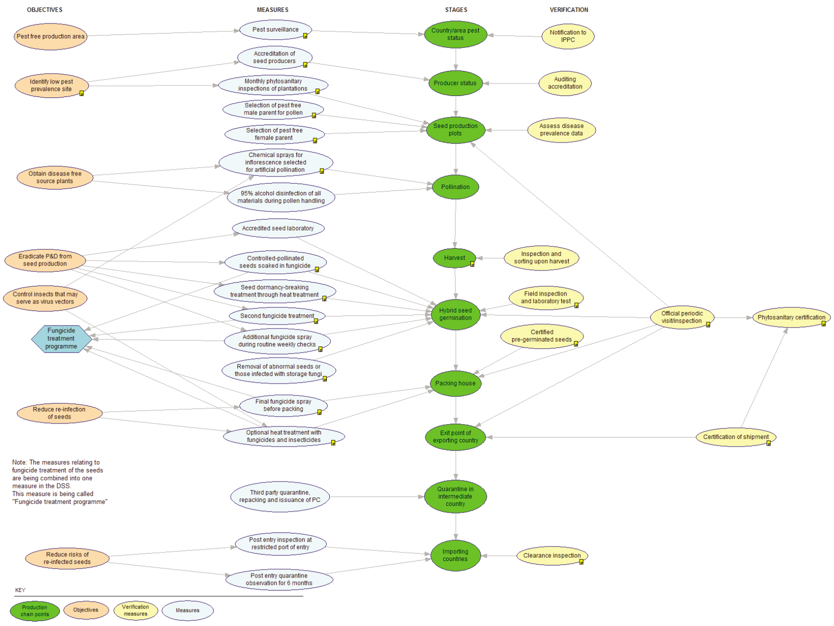

Figure 4.2 Beyond Compliance import case for oil palm planting material coming from Costa Rica to Southeast Asia. Example of the Production Chain format

DSS, Decision Support System; IPPC, International Plant Protection Convention; P&D, pests and diseases; PC, phytosanitary certificate

4.3 Steps to creating a Beyond Compliance Production Chain

The aim is to build a schematic diagram of the commodity (crop, plant, seed, etc.) Production Chain or sequence. Making it a graphic versus text-only document enhances the comprehension and communication value of the process. The factors can be most comprehensively represented in graphic software such as the one selected for building BNs (GeNIe2, 2010), particularly when incorporating the diverse details mentioned above. For a simple chain, one could also illustrate it in Microsoft PowerPoint® or by using sticky notes on the wall or drawing on a whiteboard.

The first step is to consider the crop (or other pathway) under review and the primary stages appropriate for that case. As concluded in the Supplementary material 1, at the end of this Chapter, Production Chains should be restricted to measures and actions related to one key pest, or a guild of similar pests. It is not effective to use the tool to show all pests on a single Production Chain, even if there is considerable overlap in the factors.

Other Production Chains may differ from the ones illustrated here; some stages may be unnecessary or missing. It is also likely that variations occur on similar Production Chains or even the same Production Chain constructed for different purposes or by different parties.

There may be two or more versions of a Production Chain, expressing differences such as:

- Production by large commercial operations versus by numerous smallholders, carrying out different measures
- Production within a certification system versus production outside that system
- Production for current domestic versus potential export markets
- Production inside a glasshouse versus in the open field
- Production for consumption versus for planting material
- Production for different export markets that require different measures

- Correct practices versus what is really happening, e.g. when practices are not complying with regulations or trade agreements
- Pest-specific differences in the chain when multiple pests have been identified for regulation

Where a variation affects only part of the chain, the unaffected part would simply duplicate the existing one and can, in fact, be copied across.

It is not necessary to take too much time for describing the details of events, but simply to record that something can or does happen.

During this exercise it is important to consider, at each stage, what the possible measures are to be applied, the objective of these measures and if verification is feasible.

For the purpose of moving on to a CP-BN, the development of a Production Chain helps to identify where data to evaluate the efficacy of the Systems Approach may be available. Thereafter, with the aid of Decision Support System (DSS) templates, pest risk management measures will be assessed for inclusion in the proposed pest risk management plan using a structured process, such as addressing a set of questions from a DSS template or selecting measures from a comprehensive list of possible options.

The construction of a Production Chain may also be done as a group process, with adjustments made according to discussion and agreement as described in Chapter 3. Confidence and competence were built within the participating NPPOs by using the BC tools, and the Production Chain in particular, to interact with stakeholders. This consultation supported the capacity of NPPO staff to develop the scientific basis of Systems Approaches with practical local examples. All participating countries held multiple stakeholder meetings to talk through the process of developing a common approach to the description and implementation of measures that could inform trade negotiations. This was a significant demonstration of improved capacity in the NPPOs.

An expert team, possibly from other government agencies and research institutes, needs to be identified early on to participate in an elicitation exercise for populating the DSS and CP-BN where empirical data, such as published research, are unavailable. Yet for a Production Chain, the producers and handlers of the plant product are best placed to map out all the activities associated with each stage. This collaboration with the private sector proved extremely valuable to all of the NPPOs in the BC project as a means to learn what is actually occurring in the field, what the producers considered to be feasible and cost effective, and any variation among producers, regions, etc. The interaction also gave the opportunity for a true indication of the interest of the private sector in pursuing the trade case. These factors are often not documented in a PRA, leaving the importing country NPPO to aim for an anticipated scenario rather than ones that are potentially more realistic. As the exporting country NPPO learns more about its industry's activities and preferred management measures, these can be provided to the importing country NPPO in advance of decision making.

4.4 Uses of Beyond Compliance Production Chains

4.4.1 Production Chain of all activities

The original concept of the Production Chain was to show official measures in a trade agreement, but it quickly became apparent that with stakeholders there is an advantage to mapping every activity (official and not official – e.g. voluntary standards, commercial quality, etc.) in existing production. This is true for production already going for export and may be a starting place for a proposed export, or for export to a new market with greater restrictions. Showing all activities has a number of advantages in terms of the information it provides.

- It clarifies for the NPPO all of the activities taking place currently for already existing production. It can also be a confidence builder, by positioning the stakeholders as the experts.
- It will probably cover actions against all pests of concern, both regulated and unregulated pests, since producers may not distinguish the reason behind established practices.

- It will also include actions taken to maintain quality or to meet private voluntary standards for quality, for example a buyer's requirement may include no detectable pesticide residues.
- If there is an IPM programme in place, it could show the control point for that system, for example the monitoring point where once a pest population passes the established threshold a predetermined activity, such as spraying, would be implemented.
- Finally, one could return to the concept of a comprehensive Production Chain to map out the final operational agreement for trade, because at that point there will be activities and measures for more than one pest and additional, often dependent, measures will be introduced for operational purposes. This then comes full circle to what needs to be done, with less importance on the objective (by individual species at any rate).

In Vietnam, many of the higher quality exporters were working under GLOBALG.A.P.[1] or VietGAP (Vietnamese Good Agricultural Practices). It was confusing to leave out these measures, which were dominating their attention during that period. It was easier to have all measures mapped out and then begin to show the same Production Chain after eliminating those activities considered to be only for quality, for example.

This is facilitated by using the GeNIe2 software adopted by the project, so that each version can be saved. A sample of another approach, using SmartArt in Microsoft® Word, appears in Figure 4.3. The comprehensive Production Chain is generally useful for communication between the NPPO and other stakeholders. It is not recommended to share this with trade partners, however, because many of the activities would be unofficial, driven by market quality requirements and superfluous to the phytosanitary trade agreement. Sharing extraneous information may encourage inclusion of additional measures as official ones in the final agreement.

1 A widely recognised voluntary certification scheme to indicate compliance with worldwide standards in good agricultural practices (*www.globalgap.org/*).

Colour coding facilitates rapid differentiation of types of node (Figure 4.4), so this could be used for any of the applications of the Production Chain tool.

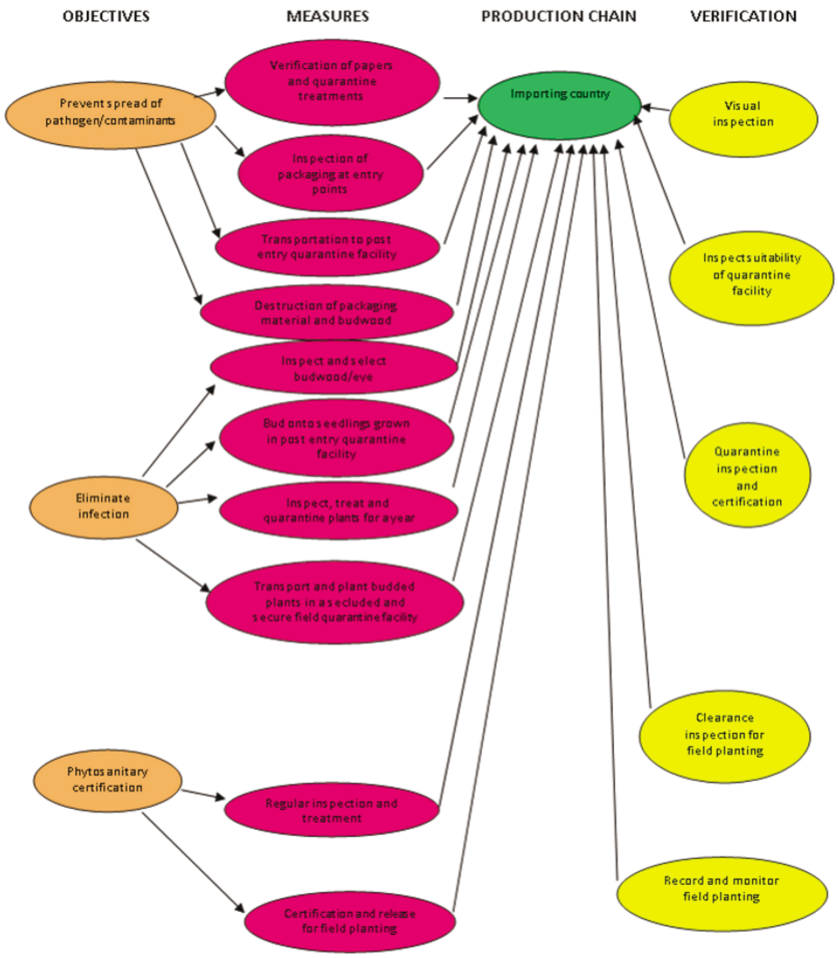

Figure 4.3 Portion of a Production Chain for the Beyond Compliance trade case of materials associated with South American leaf blight of rubber being imported to Southeast Asia

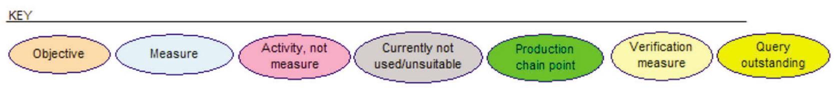

Figure 4.4 Example of colour coding as a way to distinguish activities

4.4.2 Production Chain showing measures for one pest only

Whilst there may be a time when showing all practices in a Production Chain on one schematic is useful as mentioned above, in general to show more than one of these above examples on the same schematic will make it so crowded as to be confusing. The comprehensive Production Chain can be edited to show only activities and measures that could be applied against one pest (or guild of pests) as discussed in the Supplementary material 1. Most stakeholders would understand this, if they think through the impact of their actions. The information provided for this could contribute to the dossier presented by the NPPO to the potential market country NPPO.

In fact, one valuable outcome is the ability to compare the single-pest Production Chains, which visually highlights the measures that may be more effective because they affect more than one pest.

4.4.3 Production Chain showing proposed phytosanitary measures

A Production Chain may illustrate a proposal for measures which exporters believe to be sufficient to meet a trade partner's appropriate level of protection, based, for example, on requirements for imports from other sources to the target market country. A completed DSS for the trade case can provide the list of all potential measures for graphic representation in a Production Chain. This approach may support discussions about selecting the appropriate measures at each stage, particularly if working in a large group. This selection then provides the basis to assemble different Systems Approaches within the DSS table format to record and present these for further appraisal. Therefore, the Production Chain and DSS can be used to support each other, in either order of use.

A structured framework developed with stakeholders will also speed up consideration of proposals for equivalence (ISPM 24: FAO, 2005). Presently, while the guidance provided for equivalence is useful, the lack of agreement on how to determine efficacy results in challenges in implementation of ISPM 24 because each importing country or region may have different data requirements, or even inconsistent requirements, for analysis of efficacy. Originally it was understood that the ISPM on equivalence could not be implemented until a common understanding of efficacy and some means to measure it had been achieved. This view was abandoned when a series of IPPC Expert Working Group meetings and consultations failed to reach a satisfactory conclusion. Although the Production Chain framework described will not take the place of an ISPM on efficacy, it could enhance clarity on the concept and provide some useful examples for further discussion from a common perspective.

As a result of the BC project, the participants from the Philippines NPPO used the Production Chain concept to work efficiently with industry to address apparent non-compliance issues encountered with China and South Korea. The Production Chain with the existing measures was shown to industry. The additional measure proposed by the importing country NPPO to address increased detections of a regulated pest was explained. Industry was told to come up with any other additional preferred measures to avoid the one proposed by the NPPOs of the market countries. In a matter of weeks, the alternative measures proposed by the Philippine stakeholders were approved as equivalent by the importing countries' NPPOs.

4.4.4 Production Chain showing only those official phytosanitary measures to achieve an importing country's appropriate level of protection

A Production Chain could be developed to share the conclusions of the PRA with export stakeholders. By showing what is required to enter the market country, the exporting country NPPO can support understanding of the requirements, reinforce the official status of the requirements, and work with industry to see where a control point might be added if beneficial.

An ISPM for risk management, such as ISPM 15 on wood packaging (FAO, 2013) could be represented in this fashion as well, although additional steps not mentioned in the ISPM may be required for verification, notification, etc., under the operations of the trade.

4.5 Conclusion

The STDF-funded BC project, completed in 2014, resulted in the creation of a network of staff in NPPOs in the SE Asian and observer countries with significant understanding of the Systems Approach concepts, some new decision support tools for a range of market access scenarios, and experience in working with export industry stakeholders to develop a stronger basis for negotiating the use of such approaches. The Production Chain tool has been the BC tool easiest to explain and share and has been a major contributor to the increase in confidence amongst the project participants. It proved to be particularly useful as a framework for discussions with industry stakeholders to consider the feasible measures that could be practically and effectively applied in the field.

With the material in this chapter, new Production Chains can be created taking advantage of the framework and colour coding to consider the important factors in pest risk management for trade cases.

4.6 References

Codex Alimentarius (2003) Hazard Analysis and Critical Control Point (HACCP) system and guidelines for its application. Annex to *General Principles of Food Hygiene*, CAC/RCP 1-1969 (rev. 4 – 2003). Codex Alimentarius, FAO, Rome.

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Supplementary material 1

In response to one partner country asking to adapt the BC approach to model all the pests together on the case study pathway, a brief survey was done by the BC project through the Plant Health Risk Assessment (PHRA)-List Serv (6 December 2011) to determine what important market plant health experts would consider constitutes the plant pest risk – individual pest risk or overall risk from a pathway – and how they would prefer to view it when making decisions. The result was to reiterate a single species approach, which was adopted for the BC tools. Mapping, assessment, analysis and management were all on a pest by pest basis. Multiple pests can be represented in parallel iterations of the tools, often with some common features and components.

The summary in the Box takes ideas from responses from individuals in the USA (R. Griffin, C. Devorshak), Australia (M. Stanaway, R. Ikin), New Zealand (M. Ormsby) and other individuals who wished to remain anonymous (personal communications, 2011). Comments are drawn from these responses, while not attempting to attribute them to individuals who were not representing any official policies in any case.

Questions related to:

Is it enough to summarise and draw conclusions about the acceptability of a pathway (e.g. commodity), using an estimate of each individual pest risk identified?

How useful will it be to model the overall risk of any regulated pest entering along the same pathway?

Would there be any value in considering a combined or consolidated risk for an entire pathway, or must the risk be considered by individual pests? (The exception being groups of pest species which have similar characteristics, such as fruit fly pests, surface pests, etc.).

It was recognised that the whole pathway risk could be an ideal approach, if one could create a model which accounts for all pests along a certain pathway. A model accounting for the entire pathway has the advantage that possible interactions between pests within the pathway can be taken into account, for example if one pest leads to damage that makes the host more susceptible to another pest. An unregulated pest arriving on a trade pathway may stress the hosts so that the vulnerability to the associated regulated pest increases, or the impact is greater. Increasingly, plant health research and discussions have proposed that pest risk decisions account for other sources of vulnerability of the receiving environment as well. This scenario does not fall precisely into the scope of existing ISPMs, however, and has some conceptual challenges which make it currently unattainable.

Interactions between pests and the cumulative effects of both regulated and non-regulated pests on the host are not presented or required for a PRA, however, where the assessment is conducted essentially one single regulated species at a time. It is likely that these interactions are not entirely known.

Other respondents question the value of more complexity in decision making tools, e.g. to the point of incorporating more than one species at a time, in so far as the reliance on expert judgement, unsupported theories and even unproven quantitative approaches may lead to lack of transparency rather than greater certainty. A call was made for using simpler approaches which are technically justifiable, transparent and easily applied to improve conversations around Systems Approach. This is what, in the end, the BC Production Chain tool has attempted.

Other projects on enhancing the PRA process have concluded that, contrary to combining factors for risk, it is more informative to separate the risk of entry from the risk of establishment and spread, and these from any estimates of the consequences. In fact, after further discussion within the BC project it was clear that the BC tools are entirely aimed at informing the parties involved about the likelihood of a pest entering the endangered area (or even this likelihood at the time of export). Other methods for considering the likelihood of survival after entry, the possibility of establishment, etc., already exist and extending knowledge in invasion biology was not the purpose of the project. This clarification was an important step towards harmonisation of concepts. Ultimately, the likelihood of entry does not include an estimate of impacts so that the BC tools were actually not addressing pest 'risk' at all. Given that the project engaged countries wanting to export, this perspective is also appropriate because the exporting country NPPO is not in a position to determine the appropriate level of protection for the importing country NPPO. The consideration of consequences is a responsibility for the importing country NPPO, representing its domestic industry and other national interests.

Despite this, the project continued using terms such as PRA and pest risk and risk management, because this is how much of the plant health community responds to trade proposals – analysing the prevention of pest entry rather than the reduction of impact upon establishment.

Conclusion

The purpose of a PRA is to come to a 'regulatory position'. For a commodity pathway this involves accounting for all the pests on that pathway, including those which have a lower risk than the 'key' pests. The different pest species present different risks and may interact with potential hosts and other established or introduced species in a way that results in considerable uncertainty about overall impact.

What is typically done in practice is that management measures are planned for the key pests, possibly one or two species. Then there is a determination whether the measures applied for the key pests are also sufficient and appropriate to manage the other regulated pests, or even pests of concern which are not regulated. This process results in management along the pathway that is still on an individual pest basis. The BC tools are also designed to consider one pest or closely related group of pests at a time, and so conform to this practical management approach. The BC tools help to demonstrate where and how measures occurring in common on parallel applications of the tools for different pests provide a relevant and efficient level of control across the range of pests analysed.

Supplementary material 2

The addition of further quantification of efficacy for the Production Chain developed with the idea of verification. If one could verify the outcome of a measure, it was simple to know the result. But if direct verification could not be done, indirect proxies may be used. Furthermore, we considered ranking of performance by either the exporting or importing parties. If the exporting NPPO was aware of a negative impact from prevailing conditions such as weather, staffing shortages, failure to observe a treatment, etc., the potential for a lower performance of the measure would mean that the expected efficacy might not be met. Conversely if the importing NPPO had reason to consider the performance of a measure to be uncertain, the measure in question can be attenuated to show possible impact of this failure. Other forms of uncertainty can also be noted on a Production Chain, although they are more easily described and quantified in the DSS or CP-BN.

5

Beyond Compliance Tools: Decision Support System

5.1 Introduction

The Beyond Compliance (BC) Decision Support System (DSS) is a tool to collate, elicit and visualise available information about pest–crop systems for use in the BC Bayesian Network (BN) tool. Its use follows on from the BC Production Chain tool, described in the previous chapter, which considers all relevant management measures that could be implemented at various points on a production chain, from pre-planting to the point of export. The DSS uses information elicited in the Production Chain tool to provide a shortlist of measures whose efficacy and feasibility can be semi-quantified from various data sources (expert elicitation, PRAs and scientific literature).

The tool requires each management measure to be rated in two dimensions: (i) on five-point scales of efficacy and feasibility, and (ii) by a four-point scale of the uncertainty that the expert has in assigning those ratings to each measure. Visualisation of the resulting distributions (as a histogram) for the efficacy and feasibility ratings and associated uncertainty scores allows users to check that the distributions derived from the inputs match their internal perceptions. Users are able to add explanatory comments and citations of relevant references.

The purpose of the DSS is to draw on the PRA in order to highlight issues that may impact on pest risk management and show management options clearly. As a development of the Production Chain tool, additional information is required for the DSS on efficacy and uncertainty as well as greater detail on measures. Expert judgement will normally suffice to answer these questions. Representing expert judgement for some key variables as a distribution means new data are generated.

The DSS should make management decision making more transparent and be a resource for answering related questions in the importing country's PRA (specifically the section on risk). Equally, it can be used to organise data to support a request from the exporting country for recognition of equivalence of alternative measures.

The BC DSS is based on a DSS for Systems Approach developed by Imperial College London during the European PRATIQUE (Enhancements of Pest Risk Analysis Techniques) project as a demonstration of concept. The PRATIQUE DSS was designed to use outputs from the PRA process applied to commodities entering EPPO countries, drawing on information entered during the Pest Risk Management assessment regarding measures available to control the pest at different stages along the pathway. Compared with this initial version of a DSS, the layout of the BC DSS has been greatly enhanced, with worksheets linked to allow transfer of relevant data/lists from one sheet to another, an improved logical structure, graphical feedback, greater capacity for commenting and greater flexibility for comparing different Systems Approaches. Moreover, it facilitates expert judgement that is independent of the results of the BN.

Broadly, the BC DSS comprises three sections: (i) background information about the pest, commodity, pathway and PRA; (ii) selection of measures possible at specified points on the Production Chain; and (iii) comparison of shortlisted measures based on efficacy and verifiability scores given by expert assessors for each one, and evaluation of these candidate measures with respect to feasibility, cost/benefit and acceptability. This leads to a systematic process for assembling an appropriate Systems Approach. The tool also allows assessors to rate the efficacy of the new Systems Approach, independent of the BN assessment.

Figure 5.1 Screenshot of the worksheet tab at the bottom of the Decision Support System screen

CP-BN: Control Point–Bayesian Network

5.2 Using the tool

The different sections of the DSS spreadsheet file are held on separate worksheets navigable by clicking on the tabs at the bottom of the screen (Figure 5.1).

5.2.1 Part A. Background information

The first worksheet in the file allows the user to enter background information about the pest and commodity in question and requires data entry into three tables: DSS Authorship, in which the names, date and organisation (to which the experts belong) are added (Figure 5.2); Table A1, in which basic information about the pest and commodity is outlined (Figure 5.3); and Table A2, in which the user is asked to present key factors that are important to consider for the proposed commodity/pathway (Figure 5.4).

Table A2 (Figure 5.4) uses dropdown boxes to limit user inputs to those from a specific list and contains conditional formatting, colour coding responses to give an indication of risk level and uncertainty for each response (green for low risk and low uncertainty through to red for high risk and high uncertainty). Figure 5.5 shows a hypothetical example of the conditional formatting used to help visualise risk levels based on user inputs. The data for A2.01 through A2.04 should come from a PRA (based on ISPM 11 [FAO, 2004] specifications) or from referenced material and/or expert opinion (justified in the comments box to the right of the data input dropdowns.

	Name of the Author:	Date: DD/MM/YYYY	Organisation:
DSS Authorship			

Figure 5.2 Authorship table

DSS: Decision Support System

	TABLE A1. Basic information	
A1.01	Commodity/pathway addressed in this management plan	*Commodity X*
A1.02	Pest species addressed in this management plan	*Pest sp. Y*
A1.03	Exporting country	*Exporting country*
A1.04	Importing countr(y/ies)	*Importing countr(y/ies)*
A1.05	Means of entry covered in this management plan	
A1.06	Means of entry considered in the PRA (commercial trade [air, sea, land, post]; informal trade; natural spread...)	
A1.07	Key host plants at risk	
A1.08	Is a PRA and/or management plan (requirements for trade) already available for this or a closely related commodity/pathway?	
A1.09	Is there existing similar trade in other regions using management measures? (Add details at end of table B2)	

Figure 5.3 Decision Support System Table A1. Basic information

PRA: Pest Risk Analysis

	TABLE A2. Key factors to consider based on the proposed commodity/pathway			
	Key Factors	Score	Uncertainty	Comment
A2.01	Overall rating - Entry			
A2.02	Overall rating - Establishment			
A2.03	Overall rating - Spread			
A2.04	Overall rating - Impact			
A2.05	How easy is it to detect the key organisms on the commodity/pathway?			
A2.06	How easy is it to identify the key organisms?			
A2.07	How well organised is the sector at risk in the importing country?			
A2.08	What is the estimated prevalence of the pest in the area where commodity is cultivated?			
Conclusions on key factors relating to risk management measures:				

Figure 5.4 Decision Support System Table A2. Key factors

	TABLE A2. Key factors to consider based on the proposed commodity/pathway			
	Key Factors	Score	Uncertainty	Comment
A2.01	Overall rating - Entry	Likely	Low	
A2.02	Overall rating - Establishment	Moderately unlikely	High	
A2.03	Overall rating - Spread	Massive	Low	
A2.04	Overall rating - Impact	Moderate	Medium	
A2.05	How easy is it to detect the key organisms on the commodity/pathway?	Difficult	Very low	
A2.06	How easy is it to identify the key organisms?	Easy	Low	
A2.07	How well organised is the sector at risk in the importing country?	Mod. well organised	Medium	
A2.08	What is the estimated prevalence of the pest in the area where commodity is cultivated?	High	Low	
Conclusions on key factors relating to risk management measures:				

Figure 5.5 Decision Support System Table A2 with some example values entered to illustrate conditional formatting

5.2.2 Part B. Selection of measures

The 'Part B: Selection of measures' worksheet contains two tables: Table B1, in which all candidate measures can be listed for each point in the Production Chain. In Table B2, the user must make a shortlist of all the measures that are going to be further evaluated (Figure 5.6). The shortlist is created by using the dropdown boxes that are populated by the measures entered in Table B1. *N.B.* In this version of the DSS, no more than 20 measures can be evaluated. Once the list of measures for evaluation is complete, it is necessary to click a macro button to trigger the compilation of a list of these measures for use in the next sheet (Part C: Comparison of measures).

5.2.3 Part C. Comparison of measures

This is the largest and most demanding worksheet in terms of user input: in this sheet experts are asked to express their views regarding the different measures. In Table C1 they must provide judgements (a rating and the associated uncertainty they attach to that rating) regarding the efficacy and verifiability of each shortlisted measure from the previous sheet. Efficacy is defined as the measure's potential contribution to risk reduction. This is likely to be based at least partially on expert judgement and experience rather than data,

Planting and preparation			*Field/orchard/farm*		*Harvesting*		*On farm processing*	
Source of seed or planting material	*Infection status and treatment of seed or planting material*	*Pre-season for perennial crops/Pre-planting for annual biannual crops*	*Production and control measures in field, orchard, glasshouse or other growing facility*	*Flowering and Fruiting*	*Harvesting, picking*	*Transportation to processing and/or packing facility on farm*	*Processing, treatment, inspection and packing on farm*	*Transport from farm to centralised packing or processing facility*
		3.1 Field sanitation at the start of season	4.5 Pest surveillance	5.2 Fruit bagging	6.1 Harvested fruit kept in shade, in plastic boxes with insect netting for prompt transportation to processing facility			
			4.6 Pheromone traps/male annihilation technique (MAT)		6.2 Collect and destroy dropped fruit at each harvest time during fruiting season			
			4.7 Protein bait		6.3 Sorted by worker for grower or buyer, removal and destruction of damaged and infested fruit by grower			
			4.8 Insecticide cover spray					

Processing and treatment		*Export from country*		*Import to country*	
Processing, treatment, and inspection in centralised facility	*Packing in centralised facility*	*Transportation to port in exporting country*	*Inspection at port of departure from exporting country*	*Treatments or environment during transportation*	*Entry point to importing country*
10.1 Harvested dragon fruit are held in pest-proof covers while awaiting packing	11.1 Packing boxes are manufactured to a high standard with ventilation holes covered in mesh to prevent insects entering	12.1 Consignments transported only in sealed, refrigerated vehicles			
10.4 Fruits are VHT'd at 46.5C for 40 minutes. Then cooled down, washed and dried for 30 minutes	11.2 Quarantine inspection (before signing physanitary certificate)				

Figure 5.6 Decision Support System Table B2. Shortlist of measures – populated with example data for fruit flies in dragon fruit

VHT: vapour heat treatment

hence the use of a semi-quantified scale. The efficacy estimate should be based on the effect predicted from the design of the measure, without consideration of likely performance and application (which are considered in feasibility questions in the next table). The system requires the user to choose from five levels of efficacy rating (Very high, High, Medium, Low, Very low). The user must then select how uncertain they are about the rating. Four levels of uncertainty are used (Very low, Low, Medium and High). Based on Holt et al. (2013) *, the levels adopted are:

- 'Very low' uncertainty = 90% chance of the selected score being correct
- 'Low' uncertainty = 80% chance of it being correct
- 'Medium' uncertainty = 50% chance of it being correct
- 'High' uncertainty* = 35% chance of it being correct

*An additional 'Low' uncertainty level is added. Holt et al. (2013) use only three levels and the high uncertainty value had to be modified from the original IPCC classification because that recommends 20%, which equates to a flat distribution or 'No certainty' in a five-category scoring system.

With these uncertainty classifications in mind, it follows that:

- 90% of the distribution should be in the selected score when the expert considers the uncertainty attached to the score to be 'Very Low'
- 80% should be in the selected score when the expert considers the uncertainty to be 'Low'
- 50% should be in the selected score when the expert considers the uncertainty to be 'Medium'
- Only 35% should be in the selected score when the expert considers the uncertainty to be 'High'

The Beta distribution was parameterised to give the above result for each of the 20 combinations of efficacy score and uncertainty (five possible ratings each with four levels of uncertainty). Figure 5.7

illustrates all 20 combinations of efficacy rating and uncertainty. By being able to see the distribution, the expert can, if needs be, modify their efficacy score and uncertainty choices to better match their perceptions. Distributions are also transparent for reviewers and interested parties after the PRA is completed.

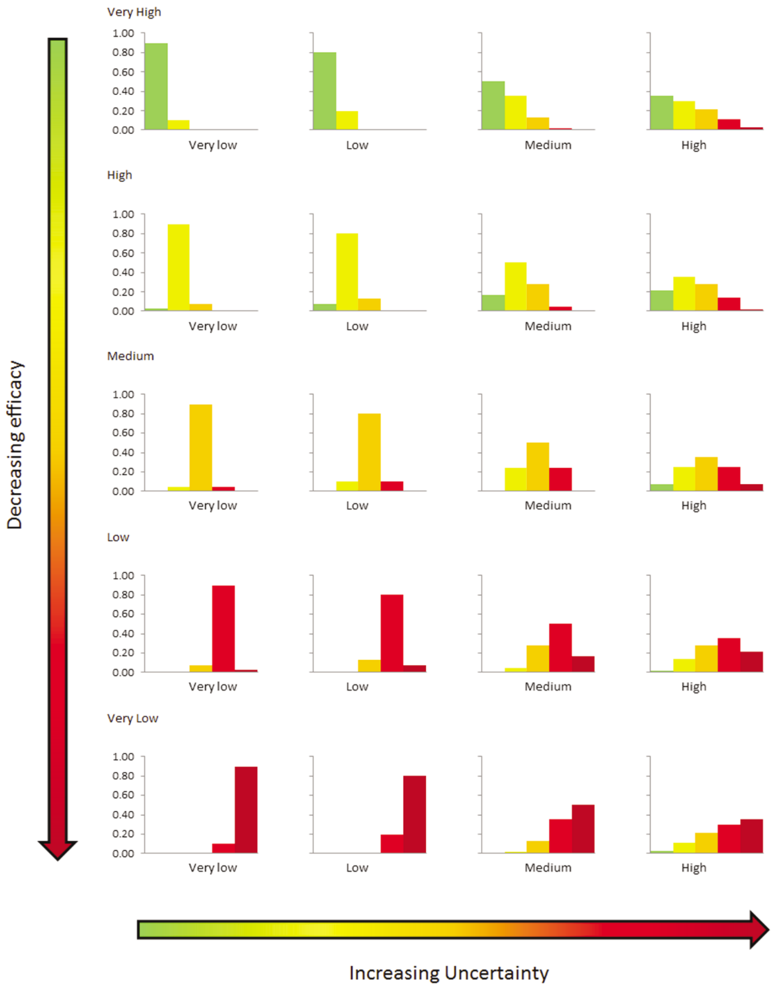
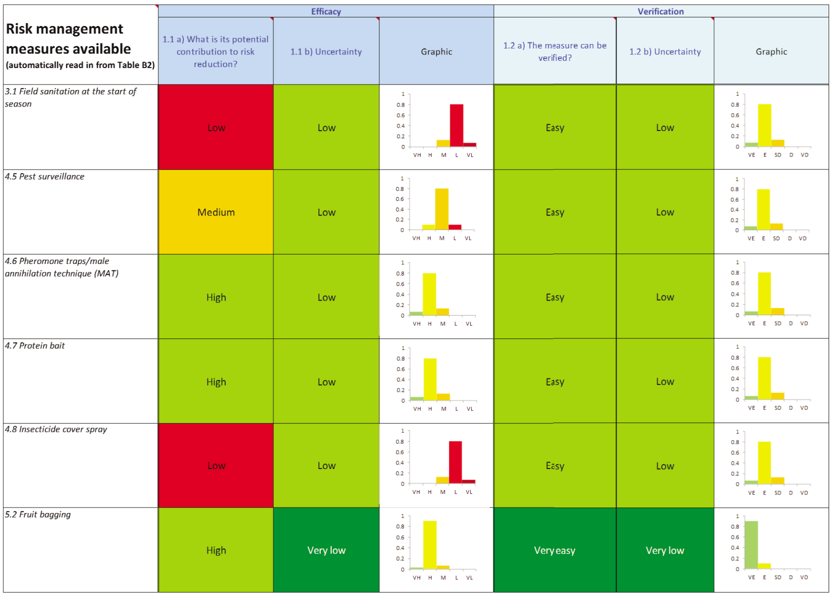


Figure 5.7 Distributions illustrating the 20 combinations of efficacy and uncertainty

Different criteria for assessing a measure require different rating scales. For example, a judgement regarding the ease or difficulty of verifying the efficacy of the measure uses the five terms: 'Very easy', 'Easy', 'With some difficulty', 'Difficult' and 'Very difficult'. For consistency, the ratings are always:

1. On a five point scale and
2. The four-point uncertainty score is applied to each rating in the same way.

Figure 5.8 shows example data for six management measures for fruit flies in dragon fruit. From the conditional colour coding in the table and from the histograms, it is easy to see that '3.1 Field sanitation' and '4.8 Insecticide cover sprays' were considered as having low efficacy for reducing risk from fruit flies while '5.2 Fruit



Risk management measures available (automatically read in from Table B2)	Efficacy			Verification		
	1.1 a) What is its potential contribution to risk reduction?	1.1 b) Uncertainty	Graphic	1.2 a) The measure can be verified?	1.2 b) Uncertainty	Graphic
3.1 Field sanitation at the start of season	Low	Low		Easy	Low	
4.5 Pest surveillance	Medium	Low		Easy	Low	
4.6 Pheromone traps/male annihilation technique (MAT)	High	Low		Easy	Low	
4.7 Protein bait	High	Low		Easy	Low	
4.8 Insecticide cover spray	Low	Low		Easy	Low	
5.2 Fruit bagging	High	Very low		Very easy	Very low	

Figure 5.8 Screenshot of Decision Support System Table C1 populated with example data for fruit flies in dragon fruit

VH, 'Very high' (efficacy); H, 'High'; M, 'Moderate'; L, 'Low'; VL, 'Very low'
VE, 'Very easy' (to verify); E, 'Easy'; SD, 'Some difficulty'; D, 'Difficult'; VD, 'Very difficult'

bagging' had high efficacy with very low uncertainty and was also very easy to verify. *N.B.* Extensive comments and notes on the choices and audit trails should be provided in boxes on the right-hand side of this table (not shown in the figure).

In Table C2, the measures are further evaluated within the broad areas of feasibility (three questions), costs/benefit (four questions) and acceptability (four questions).

For feasibility, the questions (numbered as in DSS Table C2) are:

2.1 Would existing infrastructure or other facilities be sufficient to apply this measure?
Note: if the infrastructure is unique, specialised or uncommon, the measure may still be offered as an option but should not be the only measure available.

2.2 How easy will it be to apply this measure taking into account enforcement, resources and operational factors?
Note: if the measure requires a high level of capacity to implement, extensive management and record keeping, addresses a risk that is hard to assign to a particular responsible party, etc., then it may be considered more difficult to apply.

2.3 Reproducibility: how likely is the application of this measure to be consistent across all producers (or shippers or others involved in implementing the measure)?

For costs/benefit:

2.4 How acceptable are the direct costs of the measure to importers?

2.5 How acceptable are the direct costs of the measure to exporters?

2.6 How large are the direct costs of the measure to the government of the exporting country?
Note: if the government has a cost recovery system, funds that are paid externally from the NPPO budget are not included.

2.7 Are there indirect benefits from the measure (e.g. controls other pests, enhances quality, etc.)?

Note: a measure that is already in place against another pest, or could control more than one pest of concern, provides a greater benefit. Although only regulated pests are of concern to the NPPO for this exercise, impact on quality-reducing pests that are not regulated will also be noted here.

For acceptability:

2.8 Estimate the measure's potential impact on trade and movement of travellers.
Note: minor or easily implemented measures should have little impact on trade. Prohibition has the highest impact.

2.9 How acceptable is the potential social impact of the measure to the exporting region?
Note: this includes impact on the general public, for example from required measures such as treatment or removal of host trees from home gardens, domestic quarantine areas, road stations, etc.

2.10 How acceptable is the potential social impact of the measure to the importing region?
Note: this includes impact on consumers in the importing region. The impact of competing imports on domestic industry facilitated by the phytosanitary measure is not included here. Reduction of pesticide use is included in a final column dealing with environmental impact.

2.11 Estimate the acceptability of the measure in terms of potential environmental impact.

Again, all measures are evaluated on a five-point rating scale using the same four-point uncertainty scoring system described above.

Table C3 requires the user to specify combinations of measures for a Systems Approach. A maximum of five different Systems Approaches can be specified, utilising different measure combinations (Figure 5.9). The DSS uses dropdown boxes to constrain the choice of measures to those shortlisted in Part B.

TABLE C3. Risk management combinations for evaluation

	Overall system proposed	Measure 1	Measure 2	Measure 3	Measure 4	Measure 5	Measure 6
a	*Systems Approach - Fruit fly only*	3.1 Field sanitation at the start of season	4.5 Pest surveillance	4.6 Pheromone traps/male annihilation technique (MAT)	4.7 Protein bait	4.8 Insecticide cover spray	5.2 Fruit bagging

Measure 7	Measure 8	Measure 9	Measure 10	Measure 11	Measure 12	Measure 13	Measure 14
6.1 Harvested fruit kept in shade, in plastic boxes with insect netting for prompt transportation to processing facility	6.2 Collect dropped fruit and destroy them at each harvest time during fruiting season	6.3 Sorted by worker for grower or buyer, removal and destruction of damaged and infested fruit by grower	10.1 Harvested dragon fruit are in held in pest-proof covers while awaiting packing	10.4 Fruit are VHT'd at 46.5C for 40 minutes. Then cooled down, washed and dried for 30 minutes	11.1 Packing boxes are manufactured to a high standard with ventilation holes covered in mesh to prevent insects entering	11.2 Quarantine inspection (before signing phyosanitary certificate)	12.1 Consignments transported only in sealed, refrigerated vehicles

Figure 5.9 Decision Support System Table C3 showing example measures combined into Systems Approach proposed for fruit flies in dragon fruit

VHT: vapour heat treatment

In Table C4, experts are asked to provide a summary of their beliefs about their selected Systems Approach in five broad categories that echo the assessments provided for individual measures, namely: efficacy, verifiability of efficacy, feasibility, costs and benefits, and acceptability; and, finally, an overall judgement on the overall rating of success of the combined measures (Systems Approach) (Figure 5.10). This facilitates a comparison of expert judgement based on their overall expectations of the suggested Systems Approach against the outputs of the Bayesian rule-based model, which uses the distributions generated from the expert judgement provided in Tables C1 and C2.

Another sheet, labelled 'Part C: Stakeholder comments', is structured similarly to 'Part C: Comparison of measures', in which up to three stakeholders can add additional comments to those made by experts in the comment boxes of the latter.

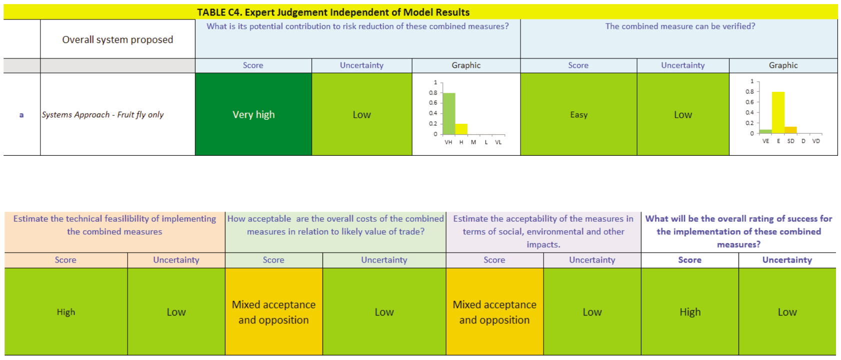


TABLE C4. Expert Judgement Independent of Model Results							
	Overall system proposed	What is its potential contribution to risk reduction of these combined measures?			The combined measure can be verified?		
		Score	Uncertainty	Graphic	Score	Uncertainty	Graphic
a	*Systems Approach - Fruit fly only*	Very high	Low		Easy	Low	

Estimate the technical feasilibility of implementing the combined measures		How acceptable are the overall costs of the combined measures in relation to likely value of trade?		Estimate the acceptability of the measures in terms of social, environmental and other impacts.		**What will be the overall rating of success for the implementation of these combined measures?**	
Score	Uncertainty	Score	Uncertainty	Score	Uncertainty	**Score**	**Uncertainty**
High	Low	Mixed acceptance and opposition	Low	Mixed acceptance and opposition	Low	High	Low

Figure 5.10 Decision Support System Table C4. Expert judgement of efficacy of the selected combined measures in Systems Approach

VH, 'Very high' (efficacy); H, 'High'; M, 'Moderate'; L, 'Low'; VL, 'Very low'
VE, 'Very easy' (to verify); E, 'Easy'; SD, 'Some difficulty'; D, 'Difficult'; VD, 'Very difficult'

5.2.4 Part D. Control Point–Bayesian Network

This sheet converts the available data into a format for use as inputs to conditional probability tables (CPTs) in the BN. For each measure, the BN tool requires two outputs from the DSS: the maximum possible efficacy of the measure and the implementation standard of that measure in practice. The measure of efficacy elicited in Part C is used directly (Table D1) but the implementation standard for each measure is calculated by averaging the distributions for answers to the three feasibility questions in Part C (Table D2).

When the DSS was constructed, it was anticipated that the BN would use the five-bin distribution directly from the elicited distribution in the DSS. However, in the course of development of the BN a three-bin input system was adopted (Negligible effect/Off; Low effect; High effect). The 'Negligible effect\Off' state results in the measure imposing no reduction on pest infestation levels and does not use the elicited information in a five-bin system.

The ‘Low’ and ‘High’ effect bins were derived from the five-bin distribution by ‘cutting’ the five-bin distribution in half, taking the P(High) from the probability mass from the high efficacy half of the five-bin distribution ($P[High]_{2\ bin} = P[Very\ High]_{5\ bin} + P[High]_{5\ bin} + P[0.5 * Medium]_{5\ bin}$) and P(Low) from the low efficacy half of the five-bin distribution ($P[Low]_{2\ bin} = P[Very\ low]_{5\ bin} + P[Low]_{5\ bin} + P[0.5 * Medium]_{5\ bin}$). This methodology conserves the original elicited outputs but at a lower resolution. Although, ideally, it would have been preferable to elicit the data in exactly the same form that

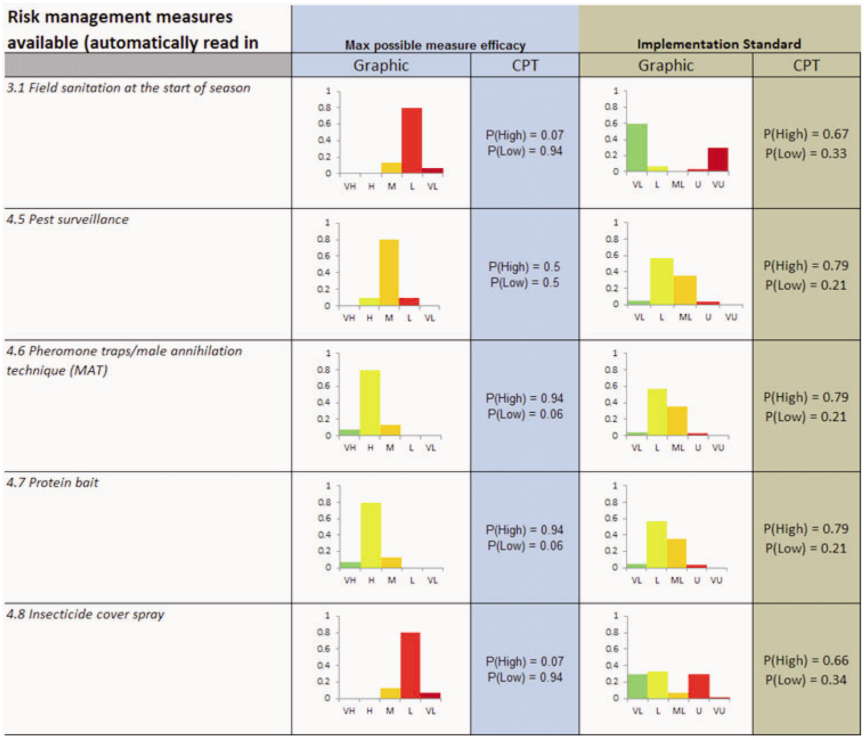


Figure 5.11 Five-bin elicited distribution for five example measures and their conversion to a ‘High–Low’ two-bin distribution for use in the conditional probability tables (CPTs) of the Bayesian Network tool

VH, ‘Very high’ (maximum possible efficacy); H, ‘High’; M, ‘Moderate’, L, ‘Low’; VL, ‘Very low’

VL, ‘Very likely’ (to be implemented to standard); L, ‘Likely’; ML, ‘Moderately likely’; U, ‘Unlikely’; VU, ‘Very unlikely’ was going to be used directly by the CPTs in the BN tool, it was not possible to cover this level of detail across many case studies within the resources of the project. Figure 5.11 shows some example distributions in their original five-bin state and following conversion to the two 'Low' and 'High' effect bins (the third bin 'Negligible effect/Off' has the effect of turning the measure 'off'). Note that the bimodality in the implementation standard for '3.1 Field sanitation' is caused by averaging the distributions of the three feasibility questions.

5.3 Summary and future developments

The DSS tool was designed to elicit the views of expert stakeholders on the efficacy and feasibility of various management measures for controlling pests along a production supply chain. The outputs of the DSS are used as inputs for the BN tool to calculate the overall impact of a potential Systems Approach applied to the crop/pest combination in a country or region. The DSS concept has been introduced in this chapter, and specific examples of the DSS tables developed within the BC project can be seen in the case studies in Chapter 8.

5.4 References

FAO (2004) *ISPM 11. Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms.* IPPC, FAO, Rome. Revised as FAO (2013) *ISPM 11. Pest risk analysis for quarantine pests.*

Holt, J., Leach, A.W., Schrader, G., Petter, F., MacLeod, A., van der Gaag, D.J., Baker, R.H.A., Mumford, J.D. (2013) Eliciting and combining decision criteria using a limited palette of utility functions and uncertainty distributions: illustrated by application to Pest Risk Analysis. *Risk Analysis* 34: 4-16. DOI: 10.1111/risa.12089

6

Beyond Compliance Tools: Models Employing Bayesian Networks

6.1 Overview of Bayesian networks

A Bayesian network (BN) graphically represents and then quantifies the relationship between an outcome of interest and the (possibly many, and interacting) variables that influence this outcome. It is a common method for modelling complex systems with many different information sources. It is thus a natural model for PRA, which is a complex process with many factors to consider, and which requires a combination of data, information from technical literature and expert knowledge.

BNs explicitly incorporate uncertainty in model variables (Pearl, 1988). ISPM 11 (FAO, 2004, since revised as FAO, 2013) highlights the importance of considering and documenting uncertainty in a PRA. BNs are hierarchies of dependency between variables which define how the probabilities of the events being modelled interact. A key feature of BN models is that all the factors represented are transparent in terms of the relationships among them and underlying assumptions. The models can be presented graphically so that the dependencies between variables are visible. They can provide, therefore, a visual as well as mathematical framework to help members of a group with perhaps disparate views or expertise to understand the issue in question and so assist in the building of a consensus for action. Tools based on BNs have been developed in the context of PRA for Pest Risk Assessment (Holt et al., 2012, 2013); here we extend their use to Pest Risk Management, specifically in connection with horticultural or, more broadly, agricultural commodity production destined for international trade.

A BN is typically constructed in three main stages: create the model, quantify the model and then use the model. We describe these stages briefly below. In the Beyond Compliance (BC) project, tools were developed to equate to these three stages: structuring the BN based on the development of the Production Chain (Chapter 4); parameterising the BN using the information gathered and collated using the BC Decision Support System (DSS) template (Chapter 5); and using the BN as a tool to help an NPPO or trade negotiation team clarify points with stakeholders and negotiate management measures for the pest risks associated trade (Chapter 7). (Although various people may make use of the outcome of the tools and benefit from them and the process, we employ the term 'user' of the tools below to mean the person who is applying and parameterising them for a particular case.)

6.2 Creating and structuring a Bayesian network

A BN is created by considering three main questions:

1. What is the outcome of interest?
2. What are the variables that affect this outcome?
3. How are the relationships linked; i.e. what variables affect other variables in this system?

The answers to these questions are represented graphically as a network: the outcome and the variables are represented as circles or rectangles (nodes), and the relationships between these nodes are represented as arrows (arcs). An example of a possible BN for Pest Risk Management along a commodity pathway is given in Figure 6.1.

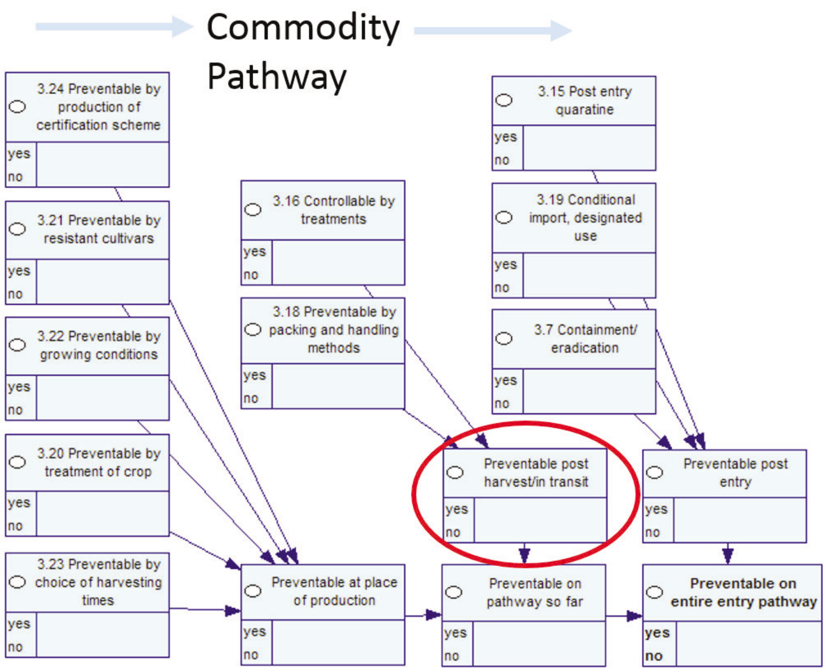


Figure 6.1 An example of a Bayesian network structure representing a series of pest management intervention options at points along a commodity production chain

This BN was an example of a commodity pathway BN structure considered early in the BC project. It is useful here to help explain the basic building blocks of a BN. A more comprehensive BN framework then evolved from this, which in turn formed the basis for the country case study models described in Chapter 8.

The simple pathway BN (Figure 6.1) comprises three points at which interventions can be made to control potential pests: prevention of the pest at the location of production, after post-harvest, and along the entire pathway through to import and distribution. Successful prevention of an eventual pest introduction at each stage or 'control point' is influenced by a number of (possibly interacting) factors. A node that has arcs (arrows) feeding into it is called a 'child node', and the nodes feeding into it are called 'parent nodes'. Hence the circled node, 'Preventable [at] post-harvest/in transit' is a child node, and its parent nodes are 'Preventable by packing and handling methods' and 'Controllable by treatments'.

In the BC project, the model creation stage followed naturally from the development of a Production Chain (Chapter 4). In constructing the BN, the Production Chain was taken as the starting point and could even be translated directly into the same software. In creating the BN particular attention was paid to where simplifying the structure was possible, to maintaining consistency in model nodes and relationships, and to representing the problem in a way that facilitated parameterisation.

For example, it is good practice to phrase node definitions to ensure that all variables act in the same direction, so a 'No' for all variables consistently increases (or decreases) the outcome of interest, rather than 'Yes' increasing risk in relation to some variables but decreasing it in relation to others. In Figure 6.1, answering 'Yes' to any of the parent nodes always potentially decreases risk.

Depending on the nature of the problem, particular types of relationship between sets of nodes may re-occur, so it is helpful to maintain consistency of structure in representing these. In the Production Chain structure shown above, there is a chain of three points and a number of variables influence changes in the target variable at each point, so each point and its associated explanatory variables form a sub-structure which can be repeated along the chain.

The BC approach, discussed further in Chapter 2, focused on the probability of any specific consignment being infested and therefore posing a pest risk to the importing country. The possible interventions to prevent pest introduction after pest entry to the importing country (shown as the third intervention point in Figure 6.1) were not included, as most phytosanitary policy is aimed at actions prior to entry.

Models could be designed to consider the pest challenge from other perspectives, such as the probability of various sources of commodities (e.g. various trade partners) associated with a regulated pest together leading to entry of the pest to the new area.

6.3 Parameterising a Bayesian network

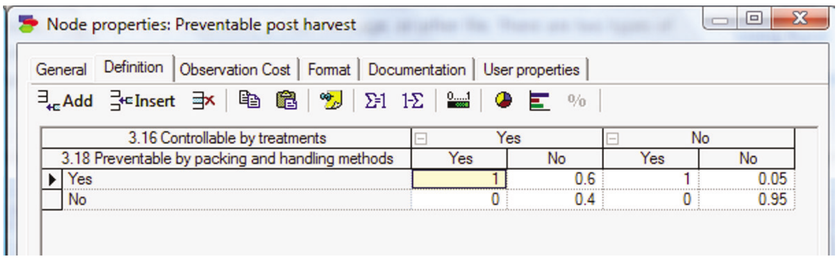
Once the three questions relating to model creation are answered (the outcome of interest, the variables that affect this outcome and how their relationships are linked) and by which the model structure is established, the model needs to be quantified. A common way to do this is as follows.

1. Divide each node into a set of categories or states (e.g. Low/Medium/High; 0–10, 10–20, 20+; Yes/No). These states should be clearly defined (e.g. for the circled node in Figure 6.1, it is important to define what 'Yes' means when asking for a probability to be assigned to the state 'Yes').
2. For each node without parents, ask the question: 'what is the probability (or likelihood) of this variable being in each state?' (e.g. the probability that a pest is prevented by packing and handling methods would be the probability of the 'Yes' state for this node.)
3. For each child node, ask the question: 'what is the probability (or likelihood) of this variable being in a particular state, given the state of its parent nodes?' (e.g. for the circled node above: if both the parent states are 'Yes' [i.e. the product has undergone packing and handling methods and treatments], what is the probability that this node is 'Yes' [i.e. the pest is prevented post-harvest]?)
4. The answers (in the form of probabilities) are entered into a conditional probability table (CPT) by the user of the model. Note that these values can be based on data, literature, model outputs, expert judgement, decision rules and so on. For example, the CPT for the circled node in the BN in Figure 6.1 appears as shown in Figure 6.2. The circled node is a child node with two parents ('3.16 Controllable by treatments', '3.18 Preventable by packing and handling methods') each of which has two possible states, 'Yes' and 'No'. This makes four possible combinations of states and for each combination the CPT contains the probabilities that the value of the child node is 'Yes' or 'No'. For example, when both parents have the state 'No',

there is a 5% chance (P=0.05) that the state of the child node ('Preventable post harvest/in transit') is 'Yes' and a 95% chance (P=0.95) that it is 'No' (Figure 6.2).

Decomposition of the problem into networks of dependency between variables makes the process of quantification more manageable. Even if a network is very large or complicated, the big problem characterised by interactions between many variables is broken down into a set of much smaller problems with fewer interactions. Each node can be quantified by considering only its parents and ignoring the rest of the network. The parameterised BN is shown in Figure 6.3.

Model parameterisation is facilitated by a structure in which each child node does not have too many immediate parents because the number of columns in the CPT describing a child node increases geometrically with the number of parent nodes. The circled node (Figure 6.1) contains a CPT with only two parents and it is therefore relatively easy to make judgements about the conditional probabilities associated with each possible combination of parent states because there are only four of them (Yes/Yes, Yes/No, No/Yes, No/No). The node 'Preventable at place of production' in Figure 6.3 has five parents and parameterisation of the CPT is much more laborious. In the BN framework used in the case studies (Chapter 8), the network structure was restricted, as far as was consistent with an accurate problem description, so that each child node had only two parents.



3.16 Controllable by treatments	Yes		No	
3.18 Preventable by packing and handling methods	Yes	No	Yes	No
Yes	1	0.6	1	0.05
No	0	0.4	0	0.95

Figure 6.2 Example of a conditional probability table: the body of the table defines the probabilities of the child node, 'Preventable post harvest [/in transit]', for all possible combinations of states of the parent nodes, '3.16 Controllable by treatments' and '3.18 Preventable by packing and handling methods'

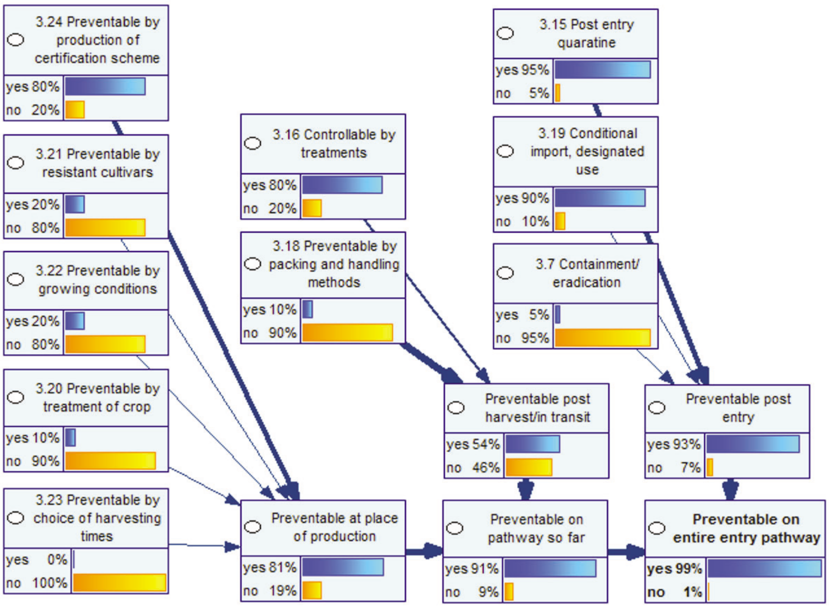


Figure 6.3 Example of a Bayesian network that has been parameterised; the probabilities associated with each node can then be calculated and displayed

In the BC project, the values used to populate the parent nodes with probabilities were elicited and collated in a systematic manner using the DSS template (Chapter 5). It is important that the elicitation of values is methodical and well documented as the output of the model is directly dependent on the assumptions and judgements made. The uncertainty associated with the variables is a central feature of the problem and BNs are particularly suited to its modeling. Both pest challenge and the efficacy of measures can be predicted with varying accuracy and it is essential to take these uncertainties into account, so providing the user with a powerful tool for reasoning under uncertainty (Pearl, 1988). A large part of the value of a well-constructed BN is the inherent transparency and flexibility, which enables values to be questioned and changed according to the differing views of stakeholders.

In the development of a BN, the child nodes (the CPTs) are frequently parameterised in the same way as the parent nodes by a process of expert elicitation. This is a more complicated process than that for the parent nodes because, in child nodes, all the probabilities are conditional on the values of other nodes (see points 3 and 4 above). In the BC project, this elicitation was carried out only once by the project team. In this way generic values were used to populate the CPTs. This approach had the advantage that the interactions between the variables were modelled in the same way for all the case studies, making the results directly comparable. This in turn has the disadvantage that the generic values may not accurately reflect every specific circumstance. A similar approach was adopted in developing models for Pest Risk Assessment (Holt et al., 2012, 2013) where it was essential that all assessments had the same underlying logic in the way that the risk factors (parent nodes) were combined. The details of parameterisation of the CPTs in the BC models are fully described in Holt et al. (in prep).

6.4 Using a Bayesian network

When properly designed, the BN can be used to answer the following questions:

1. What is the probability of the outcome, given all of the variables that influence it and their interactions?
2. What are the main variables that influence the outcome?
3. What is the impact on the outcome if we change part of the network (e.g. if we increase the efficacy of packing and handling methods, how does this change the probability of prevention post-harvest, and therefore prevention on the entire pathway, given all of the other factors that affect pest risk on this commodity pathway)?

For example, in Figure 6.3, the overall probability of prevention of the pest on the entire pathway is 0.99 ('Yes' 99%), and the variables that are most influential in prevention along the commodity pathway are shown by the arcs with heavier lines (thicker arrows).

In the context of BC, the objective of the BNs is specifically to aid discussion between exporting country NPPO and importing country NPPO concerning the set of phytosanitary measures required by an importing country. The models can be used to compare the performance of different combinations of measures, making use of any evidence as well as judgements about the impact of each measure. The models are intended to provide a framework to support communication about any differences in perceptions of the risk reductions achieved by pest control measures deployed throughout the production chain.

6.5 Bayesian network-based models implemented for Pest Risk Analysis

A number of BNs and BN-based tools have been developed previously to facilitate the assessment of risks posed by pests and particularly to improve consistency in PRA (Schrader et al., 2012). Recent work to improve European decision support schemes for Pest Risk Assessment, in the Prima phacie project (MacLeod et al., 2010, 2012), and for PRA, in the PRATIQUE project (Baker et al., 2009; Baker, 2012), have used BN-based models. They use decision rules based on expert judgement to define the CPTs, which integrate components of risk (Holt et al., 2012, 2013). These models use states or categories of the variables which are consistent with the existing risk-rating systems, and the decision rules accommodate the difficulties frequently encountered in estimating the absolute values of probabilities. A network which concerns the risk of pest entry to the EU is shown as an example (Figure 6.4).

Decision support schemes for PRA, such as that used by EPPO, generate many ratings for likelihood or magnitude of risk factors, each with an associated uncertainty. In accordance with ISPM 11 (FAO, 2004), questions were devised to assess the key elements of pest risk in the four main sections of the Pest Risk Assessment: Entry, Establishment, Spread and Impact. The questions associated with

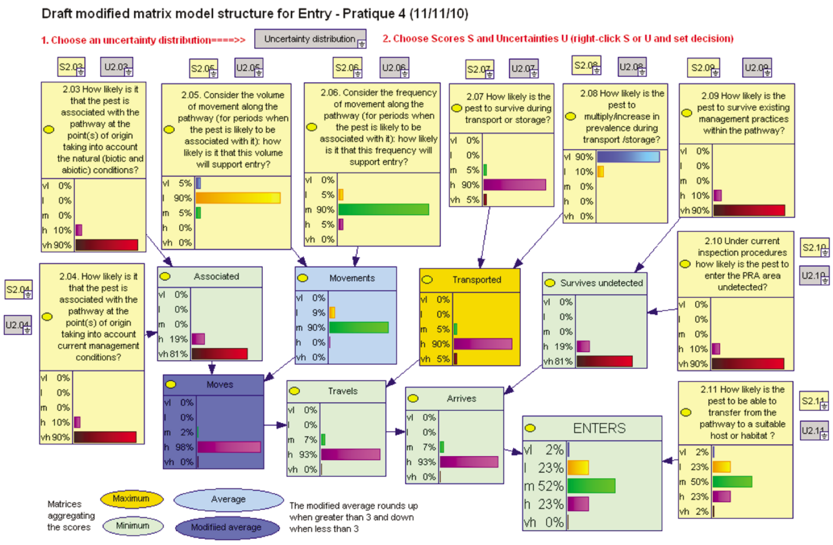


Figure 6.4 The pest entry part of a Bayesian network model as demonstrated in the PRATIQUE project dissemination meeting, Hammamet, November 2010. The child nodes (or conditional probability tables, CPTs) are colour-coded by type according to the decision rules chosen by Pest Risk Analysis experts to integrate the parent nodes, i.e. the numbered risk factors (shown in yellow) (Reproduced from Holt et al., 2012)

vl, 'Very low' (risk); l, 'Low'; m, 'Moderate'; h, 'High'; vh, 'Very high'

the Entry section are shown in the numbered yellow nodes in Figure 6.4. The ratings these were assigned are contained in nodes labelled 'S…' (for score) and 'U…' (for uncertainty) located above each question in the network diagram (Figure 6.4) and these inform the frequency distributions which define the response to the questions. Risk assessors from across the EU were actively involved in developing the structure of the model and the decision rules contained in the CPTs (Holt et al., 2013). The risk-factor ratings and uncertainties, the structure of the network hierarchy and the underlying logic contained in the CPTs combine to give an overall rating of the risk of pest entry to the EU with an accompanying expression of uncertainty.

6.6 The generic structure of the Bayesian networks developed for Beyond Compliance

As far as possible, similar approaches to those used for the Pest Risk Assessment models were used in the development of BNs in the context of the BC project.

The final form of the BNs developed during the course of the BC project model the probability of pest infestation along the Production Chain of the agricultural commodity concerned. Widely accessible software developed for BN construction (GeNIe2, 2010) was used to develop the models.

In these applications, the network is essentially a single chain in which the sequence of nodes represents the predicted level of pest infestation of the commodity at a sequence of points in time (Figure 6.5). It starts with an initial probability distribution of potential infestation dependent on the prevalent pest population size and the susceptibility of the commodity concerned. Nodes located in side-branches of the chain allow the effects of phytosanitary measures to be incorporated; these interventions may reduce the existing infestation of the commodity (those shown on the left in Figure 6.5) or prevent new infestation (those shown on the right in Figure 6.5). Nodes in the side-branches also provide for the possibility of additional new infestation of the commodity occurring at points along the chain, such as during post-harvest handling.

For each of the models presented in the case studies (Chapter 8), the phytosanitary measures have been grouped according to the stages along the production chain when they can be implemented; some hypothetical groupings are shown in Figure 6.5. The relevant control interventions have been included in the models for each case study, and the effect of different combinations can be examined by selecting or de-selecting measures as required. Each measure is modelled by a small submodel containing two parent nodes, one specifying the maximum efficacy expected under ideal conditions and the other specifying a standard of implementation. In this way, the effects of poor measure implementation can be examined as well as the effects of measure inclusion or exclusion.

The models developed in the case studies follow the general pattern shown in Figure 6.5, but differ in the detail of the structures (number of nodes in the chain, number of measures, points where measures act, points where additional infestation can occur) and different parameter values for the variables (efficacy of measures, implementation standards of measures, pest challenges). Parameter values for the CPTs are generic and therefore consistent for all the models. These parameter values were established for each case using the DSS tool (Chapter 5). A detailed description of the BN developed for the case study based in Vietnam is given in Holt et al. (in prep).

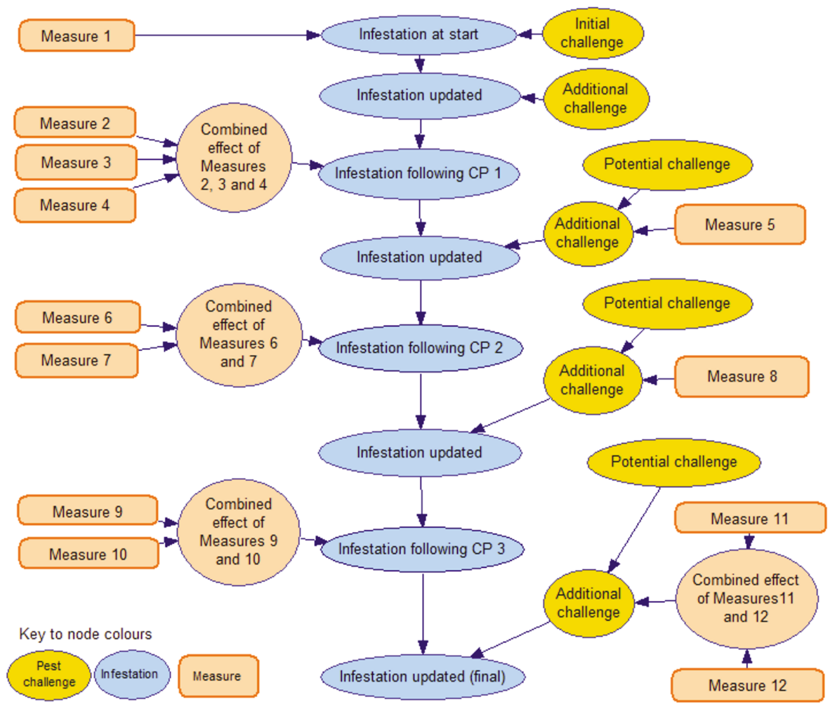


Figure 6.5 The general structure used for the Beyond Compliance Bayesian Networks showing how, in a repeating sequence, possible pest control measures carried out on the crop or commodity (left) alternate with potential additional pest challenge, which can also be affected by control interventions (right). A series of control points, CP, indicate where in the Production Chain it is possible to obtain some estimate of pest infestation

An important feature of BNs is that evidence (or hypothetical evidence) may be added at any stage by adjusting node state probabilities for a node about which some evidence has become available. Where control points can be identified in the models, these may provide appropriate points at which the effects of information gained by monitoring can be evaluated. In the general model structure illustrated in Figure 6.5, there are three separate points at which infestation can be estimated after measures are applied: CP 1 where Measures 2, 3 and 4 are applied; at CP2 with Measures 6 and 7; and at CP3 with Measures 9 and 10. So, for example, if pest infestation of the commodity could be estimated by introducing field surveillance, then the potential impact of the information gained could be examined; e.g. if we know that infestation is 'Low' at the end of the growing season, then the model can be updated with this evidence and the effect on the range of predicted outcomes examined. The conditional use of measures can also be investigated hypothetically in this way by observing model outcomes when measures are included or excluded in response to evidence gained.

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6.8 Further reading

BNs are used for modelling complex systems in many areas, including computational biology and bioinformatics, medicine, document classification, information retrieval, image processing, engineering, gaming, law, social science, water science, industrial risk analysis, conservation, ecology and environmental systems. Here are some of the papers that describe the ways in which we have used BNs in practice.

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7

Using the Tools

7.1 Introduction

Various drivers are pushing NPPOs to develop quantitative pathway risk analyses as part of decision making on acceptance and management of pest risk (Mumford et al., 2013). ISPMs encourage quantitative assessments, where possible, and quantitative assessments help to ensure that risk management responses are proportionate to the risk (Mumford, 2013). These pathway-based approaches have focused on imported horticultural commodities as pathways, with increasing interest in other pathways such as wood packaging and dunnage, conveyances and sea containers, and plants for planting. Systems Approach (FAO, 2002), using an integrated combination of pest risk management measures, will benefit from some form of quantitative or semi-quantitative analysis to demonstrate the cumulative effect of a range of risk mitigation measures, at least two of which must be independent of each other (Mengersen et al., 2012). Decision making regarding these management measures is enhanced by the use of indicators of pest challenge, and the impact of management, at ‘control points’ along the production and transport chain.

In North America, NAPPO member countries endorsed guidance on pathway risk analysis in 2012 (NAPPO, 2012). USDA and other national authorities have also shown interest in some highly quantified pathway analyses. In Europe, the regional authority EFSA has commissioned demonstrations of quantitative pathway risk analyses for several example commodities. This type of analysis involves detailed descriptions of the pest risk at each stage along the overall pathway, including quantification of the commodity volume, pest challenge and control efficacy at each step. The level of detail greatly affects the cost and feasibility of obtaining and interpreting data. The intention of this approach to quantitative pathway risk analysis is to describe the overall annual risk of an import pathway, but also to allow quantification on more local scales of time and space, and ultimately of the risk posed by an individual consignment, or to any defined receptor location. This level of attention at each stage could, in effect, identify potential control points at which the challenge and the efficacy of management are measured.

There are several implications to quantitative or semi-quantitative risk analyses, either of pathways with independent risk management measures or in Systems Approaches. Practical and verifiable indicators of the pest challenge must be available at various points along the production and transport chain, either directly or as proxies. Interpretative rules need to be determined to guide decisions on responses to the level of challenge identified and the effect of additional control. Much of the evidence generated will be probabilistic, so analyses and interpretation need to be based on consistent descriptions of values and rules (Schrader et al., 2012). Analyses could be based on objective quantification from experiments or observations in the field or on subjective understanding, depending on the information available.

The challenges to putting a Systems Approach plan into place include describing a system (pest and control challenges implied in the chain and the performance and equivalence of measures in a system); organising a practical and acceptable system with domestic stakeholders; negotiating a system with importing country NPPOs; and finally, actually running a system and keeping it up to standard with stakeholders.

7.2 Verification and validation

The presentation of a clearly articulated, step-wise chain from field to market supports the objective use of evidence from pest monitoring and control performance checks.

The Beyond Compliance (BC) project was based on the rationale that systematic review of a pest risk from a particular production system and trade pathway, and of the reasoning behind each potential management measure, will increase the confidence of the exporting country NPPO in negotiating its case for effective control from management using a systems approach. This could offer significant advantages to producers compared to a reliance on single post-harvest treatments. Drawing on initiatives from other regions, tools were developed to give a structured approach to conceptualise, develop and evaluate a systems approach for both import and export trade case studies from the SE Asian region. A probabilistic model was then used to estimate efficacy or impact on the risk that each measure provides individually and as part of a systems approach.

7.3 Sensitivity analysis

A further step in validating systems approaches is to determine how robust the management measures are in dealing with the range of pest challenges identified in the analysis. The pest challenge covers a series of threat level distributions over the specified stages of the production season and each risk management measure applied as part of a systems approach will have a range of performance outcomes affecting these pest challenge distributions, depending on how it is applied and the conditions at the time. So the final result of a set of risk management actions may range from an outcome in which the pest challenge is at the most damaging level and the management measures are at the lower end of their effectiveness (the least favourable result in terms of produce quality) through to a low pest challenge and very good performance of measures (resulting in very good quality). One of the important benefits of a sensitivity analysis of systems approach is that this range of potential outcomes can be described and the distribution of the overall result can be tested for each management action and for each assumption about the pest challenge. This ensures that sufficient measures, and sufficient supervision of the measures, can be applied to meet the required phytosanitary standards across the full range of expected pest challenges. Systems Approaches may potentially include many different management measures and the full range of different combinations would be expensive and impractical to test in the field. A sensitivity analysis carried out within a Bayesian network (BN) can provide an inexpensive screen for the sets of measures that appear to deliver good outcomes over a wide range of conditions, so that their performance can then be tested in the field.

Sensitivity analysis can be carried out in several ways, illustrated here in a BN example. At each step, the individual measures in the possible set of Systems Approach measures can be included or not. Figures 7.1 and 7.2 illustrate the potential difference between a reduced set of measures that does not result in effective control (Figure 7.1) and another set with several additional measures included that ensures a higher level of control by the final export stage (Figure 7.2). Any combination of measures can be included or not included and the estimated uptake of measures within a system can be tested at different levels to see what mix of measures would need to be used to achieve the necessary quality. The costs, logistics and feasibility of including the various measures and reaching the necessary uptake can then be considered in developing the specific Systems Approach to recommend (Kehlenbeck et al., 2012).

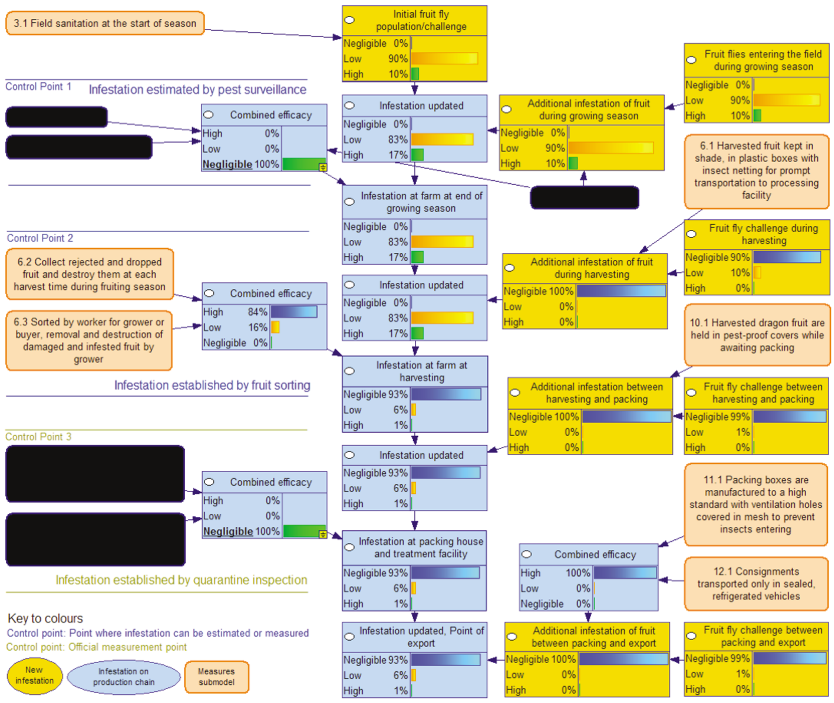

Figure 7.1 Beyond Compliance Bayesian Network example with several possible measures not applied, giving an ineffective unacceptable result at the point of export (the last box in the Production Chain, the blue box in the centre at the bottom)

The software used to describe BNs, such as GeNIe2 (Decision Systems Laboratory, University of Pittsburgh, Pennsylvania; *http://dsl.sis.pitt.edu*), includes ways to test the sensitivity of assumptions and parameters in the BNs. So, for example, the arrows between nodes in the BN can show the strength of influence on the next node and nodes with greater influence can be highlighted. Nodes with stronger influence may deserve greater attention in establishing evidence for performance of measures.

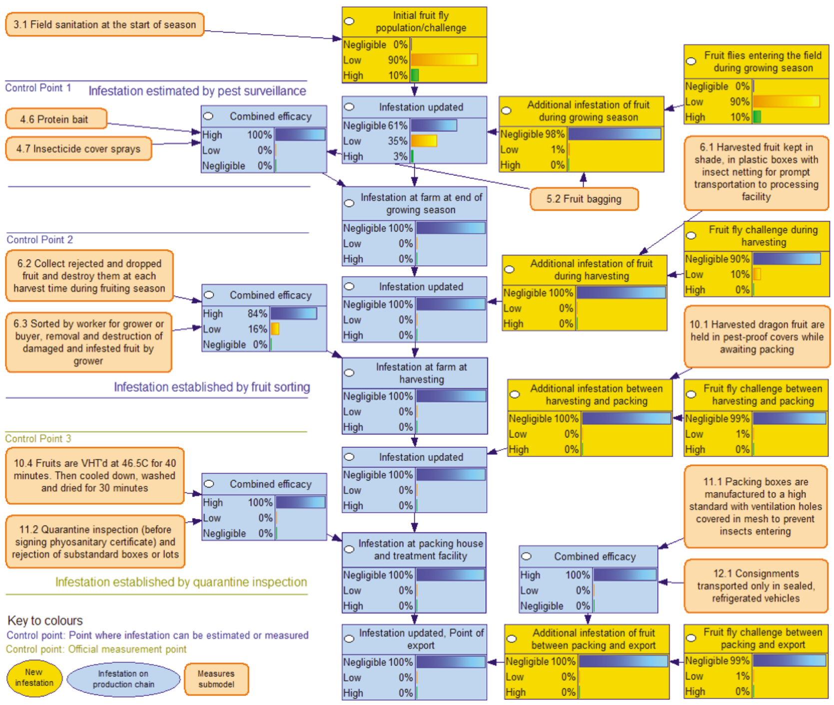

Figure 7.2 Beyond Compliance Bayesian Network example with all measures applied, giving an effective acceptable result at the point of export (the last box in the Production Chain, the blue box in the centre at the bottom)

VHT, vapour heat treatment

7.4 Putting tools into use in negotiations

The NPPOs from Vietnam, Thailand, the Philippines and Malaysia participating in case studies found that the process directly increased their confidence and competence, not only in preparation for trade negotiations with importing country NPPOs, but also for interacting with domestic stakeholders (Figure 7.3).

The three key tools developed in the BC project serve very different purposes. Production Chains are a tool that brings the NPPO and stakeholders together to describe potential systems in which each of the various stakeholders, including the NPPO, have distinct roles.

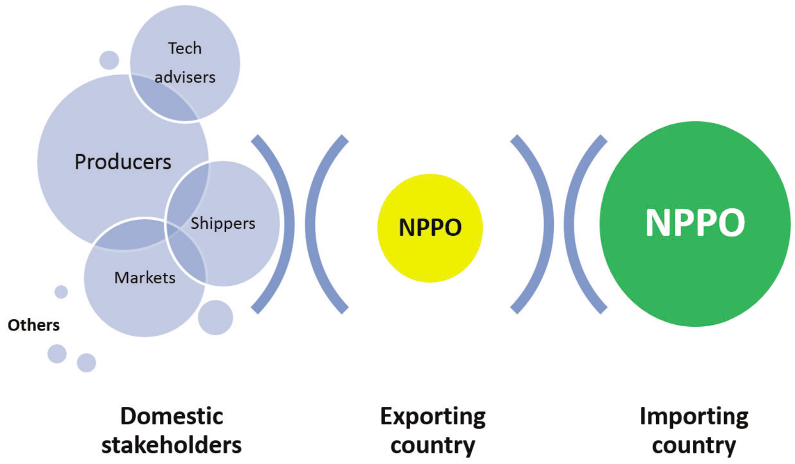

Figure 7.3 Exporting country national plant protection organisations (NPPOs) must often work with diverse domestic stakeholders and powerful importing country NPPOs to develop and communicate Systems Approach in response to a Pest Risk Analysis in which control needs are identified

The BC Production Chain provides a graphical statement of the process by which the product will reach the importing country at a specified phytosanitary quality. The Decision Support System (DSS) collates research evidence, operational experience and expert opinion to describe the performance of available measures, and this may also involve discussion with domestic stakeholders to obtain their experience of how each of the measures performs. The DSS is specifically designed to be used to capture the uncertainty that might affect performance for each measure, and other attributes that might serve as selection criteria when planning a Systems Approach. The BNs provide a way to demonstrate probability distributions of outcomes across a range of challenges, actions and performance levels.

Using any of the tools helps to demonstrate that NPPOs and other stakeholders have a clear understanding of their production system, the pest challenges and the likely performance of practical control measures and control points. They support communication between NPPOs of importing and exporting countries and make assumptions and targets more explicit.

7.5 Regional issues

The BC approach was intended to increase competence and confidence within the region in the use of Systems Approach. This has been achieved through NPPOs of different countries working together on case studies using common tools, but with national examples. At the regional level having a common understanding of the concepts of Systems Approach, the pest challenges, the performance of measures and the role of control points helps to make negotiations more efficient and effective. A common set of tools and skills and a common way of communicating Systems Approach is an important step to ensuring that it gets wider recognition and uptake.

It is unlikely that the Systems Approach for a specific commodity would be exactly the same in several countries across a region, because the pest challenges, the production systems and the intended markets may be quite different. A feature of the experience of the NPPOs in SE Asia working within BC was that the development of Systems Approaches needed very close interaction between the exporting country NPPO and both its domestic stakeholders and the importing country NPPO (Figure 7.3). It may be difficult to achieve this across a region, since each NPPO has responsibility only within its own country. However, an importing country NPPO may be responsible for approving phytosanitary measures for imports from several countries in a region with similar production chains and potential control measures. In such a case there may be a good opportunity for producers and NPPOs of countries within that region to benefit from Systems Approaches developed jointly or already in place in other countries. An ability to adapt approaches developed in other countries and to communicate both risks and risk management to importing authorities to a common standard will make it easier for exporters to achieve acceptance.

7.6 Conclusions

A systematic process was applied to describing pest challenges (particularly from fruit flies), management options and performance assessments. This comprised a series of tools including descriptive Production Chains (describing options), DSSs (eliciting performance estimates) and BNs (evaluating systems approaches against performance goals). Together these tools provide an improved basis on which to design, demonstrate and negotiate systems approaches to meet phytosanitary requirements.

Negotiation of new market entry can take a long time and the full benefits of using the Production Chain, DSS and BN tools have not yet been completely achieved. NPPO participants in the project have already found that in some cases where existing trade had been disrupted by importing country NPPOs, as a result of unacceptable phytosanitary interceptions, it was possible to use some tools to resolve the issues. The Production Chain has provided an effective focus to systematically identify points for improvement with domestic stakeholders and to communicate these improvements to importing country NPPOs, even without formal quantification. The tabulation of performance values for measures in a DSS provides a consistent catalogue to describe the expected outcomes of combinations of measures in describing a Systems Approach to an importing country NPPO. The final stage, applying these in a BN, may be best carried out as part of the national planning by the exporting country NPPO and domestic stakeholder groups to devise Systems Approach components that provide acceptable costs for exporters and acceptable phytosanitary quality for importers. All three tools improve the communication about challenges, measures and results and provide a more systematic development of Systems Approaches.

The development of a Systems Approach follows five steps:

- Importing country NPPO PRA provides links from assessment to proportionate management
- Exporting country NPPO and domestic stakeholders use tools as frameworks for interaction to determine current practice, potential management and control point options, and performance of measures
- Production Chain developed jointly by domestic stakeholders and exporting country NPPO
- DSS: risk management measures, with evidence of performance agreed with importing country NPPO
- Control Point–Bayesian Network (CP-BN), to assess expected performance by domestic stakeholders and exporting country NPPO, possibly with participation of importing country NPPOs familiar with the concepts

In conclusion, the BC experience indicates that Systems Approaches need to start with the management implied from an importing country NPPO PRA. It is essential to have stakeholder inputs to describe current practice and a practical set of potential improvements to meet the required phytosanitary standards. This interaction with domestic stakeholders needs a structured framework, in which Production Chains, DSSs and BNs can help. The DSSs and BNs can make use of expert judgement/experience, which is often more accessible than hard evidence of performance. These tools help to catalogue and communicate this subjective evidence in a way that can be judged in discussions with stakeholders and importing authorities. Finally, full analysis is not always necessary to convince trade partners of the value of a proposed Systems Approach. The ability to demonstrate an agreed approach developed together with domestic stakeholders, with clearly identified control points, adds credibility to negotiations.

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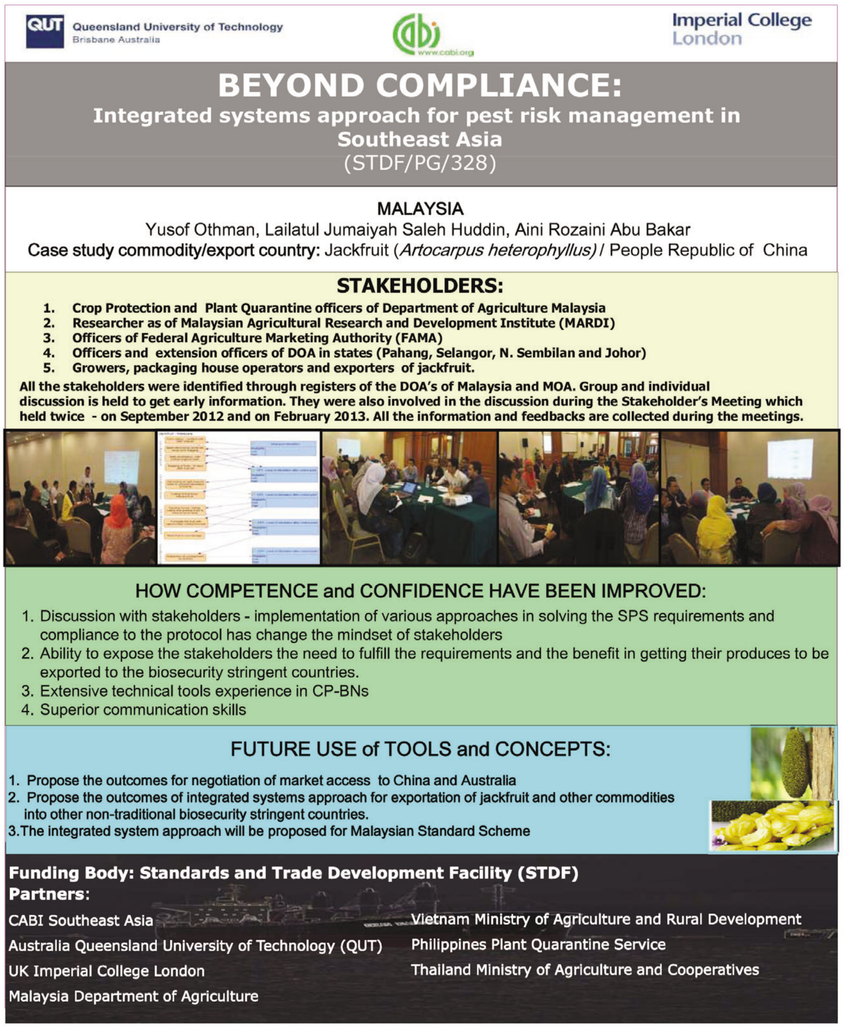
Supplementary material 1

Examples of posters developed for the final meeting. Corresponding posters developed for the inception meeting are shown in Chapter 2.



Queensland University of Technology
Brisbane Australia

Imperial College London

BEYOND COMPLIANCE:

Integrated systems approach for pest risk management in Southeast Asia

(STDF/PG/328)

PHILIPPINES

BANANA FRUIT EXPORT TO CONTINENTAL UNITED STATES OF AMERICA

M.B. Palacpac, L.C. Dulce, L.Q.Marasigan
G.F. Panganiban, E.C. Carandang, T.L. Soriano

STAKEHOLDERS:

- **The Philippine Banana Growers Exporters Association (PBGEA) Mindanao Banana Producers Exporters Association (MBPEA), and Potential Banana Exporters -** We met them through Orientation Seminar and Consultation Meeting conducted in Davao City. The following were discussed: the Project background and objectives, key definitions, ISPM Systems Approach, Developing Systems Approach for Pest Risk Management and the Philippine Case study.
- **Trading partner –USA (USDA as the NPPO) -** We had constant communication through meetings, phone conversations and emails.
- **BPI-PQS Pest Risk Analysis and Market Access Team -** Seminar/workshop was conducted with this group at the Bureau of Plant Industry (BPI); The project status and outputs were also discussed during the regular meetings of the group.

HOW COMPETENCE and CONFIDENCE HAVE BEEN IMPROVED:

- Beyond compliance process objectives, production chain, DSS provided a systematic approach to risk management.
- It encourages structured and critical process of doing risk analysis identifications and risk management measures
- Efficacy of each phytosanitary measure was evaluated and the appropriate risk management measures identified to reduce risk to a level acceptable to the trading partner
- The PRA and Market Access team gained knowledge on the use of the tool and how it can be applied in the conduct of PRA and in negotiating for market access of export commodities.
- Enhanced the NPPO's capability to explain and make the stakeholders understand and accept the different phytosanitary measures imposed by the trading partner to address a pest of concern

FUTURE USE of TOOLS and CONCEPTS:

- Can be used to have a systematic approach and gain confidence in negotiating for market access of export commodities
- Can be used to enhance the conduct of PRA to be able to identify the potential risk of introducing a quarantine pest into the country and the appropriate phytosanitary measures to address the identified risk.
- Can help to address concerns on pest interceptions and other phytosanitary issues with our existing export markets

Funding Body: Standards and Trade Development Facility (STDF)
Partners:
CABI Southeast Asia
Malaysia Department of Agriculture
Philippines Plant Quarantine Service
Australia Queensland University of Technology (QUT)
Vietnam Ministry of Agriculture and Rural Development
Thailand Ministry of Agriculture and Cooperatives
UK Imperial College London

Queensland University of Technology
Brisbane Australia

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BEYOND COMPLIANCE:

Integrated systems approach for pest risk management in Southeast Asia

(STDF/PG/328)

Country partner name: Thailand
Staffs name: Department of Agriculture (DOA): Dr. Manita Kongchuensin, Dr. Charuwat Taekul
Ms. Chortip Salyapongse, Mr. Somrouy Roumchaiapicul
National Bureau of Agricultural Commodity and Food Standards (ACFS) :
Ms. Tasanee Pradyabumrung
Case study commodity/export country: Orchids/EU

STAKEHOLDERS:

Collaborated Stakeholders in the program containing two primary exporter groups:

1) Thai Orchid Exporters Association
2) Thai Orchids Garden Enterprise Association.

Contacting was made via Ms. Chortip Salyapongse, the officer of the export plant quarantine service group, Office of Agricultural Regulation, DOA.

HOW COMPETENCE and CONFIDENCE HAVE BEEN IMPROVED:

1. Obtain the critical thinking: the system approach program allows us to think more analytically and systematically. The development of Integrated Pest Management, for example, is applied to the system approach measure (IPM to System approach).
2. Better understanding in the orchid cultivation e.g. most application techniques based on investment cost that is difficult for the farmers to alter other higher cost measures.
3. Learn the fact that the theory may not be implemented in the field.
4. Share the experience among counterparts, brainstorming and thus gain the promising result.
5. Equipped with the knowledge base, especially analytical tools, to help comply the requirements of importing countries or trading partners.
6. Challenge to utilize the new innovation method (CP-BN) for pest risk management.

FUTURE USE of TOOLS and CONCEPTS:

1. Demonstrate to the EU countries that the system approach can be applied as an alternative measure which is equivalent to the existing measure.
2. Negotiate with EU to make amendments on the Council Directive 2000/29/EC (Commission Decision of 2 February 1998) in regard to fumigation of exported orchid to EU.
3. Implementing the use of system approach for the market access of other commodities, such as rose apples, mangoes, and mangosteen to trading partners.
4. Model testing: the CP-BN model shall be applied to the orchid farms.
5. The concept of the integrated measures in a system approach for pest risk management will be transferred to the people involving in the production chain.

Funding Body: Standards and Trade Development Facility (STDF)
Partners:
CABI Southeast Asia
Australia Queensland University of Technology (QUT)
Malaysia Department of Agriculture
Vietnam Ministry of Agriculture and Rural Development
Philippines Plant Quarantine Service
Thailand Ministry of Agriculture and Cooperatives
UK Imperial College London

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BEYOND COMPLIANCE

Integrated systems approach for pest risk management in Southeast Asia

(STDF/PG/328)

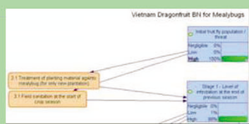
Country partner name: Vietnam
Staff names: Dr. Duong Minh Tu, Mr. Luong Ngoc Quang Ms. Dinh Thi Nhu, and Mr. Nguyen Tuan Anh
Case study commodity/export country: Dragon fruit (*Hylocerus undatus*)/South Korea

STAKEHOLDERS:

1. Stakeholder group in Hanoi (contact by telephone/mobile/email)
2. Stakeholder group in Ho Chi Minh City (contact by telephone/mobile/email through Mr. Nguyen Van Nga, Director of Regional Plant Quarantine Sub-Department No. II, Ho Chi Minh City)
3. Stakeholder group in Binh Thuan (contact by telephone/mobile/email through Mr. Nguyen Huu Quang, Head of Technical Division, Binh Thuan Plant Protection Sub-Department)

HOW COMPETENCE and CONFIDENCE HAVE BEEN IMPROVED:

1. Discussing with stakeholders



2. Extensive technical tools experience in CP-BNs

3. Ability to work well in groups

4. Superior communication skils

5. Produced and presented science reports in Vietnamese and English

FUTURE USE of TOOLS and CONCEPTS:

1.Using this outcomes to negotiate with the South Korea for adoption of integrated systems approach as alternative for VHT treatment
2. Opening discussion with Taiwan on using of systems approach for export dragon fruits from Vietnam.
3.Studying on using of integrated systems approach for export dragon fruits into other markets.

Funding Body: Standards and Trade Development Facility (STDF)
Partners:
CABI Southeast Asia
Malaysia Department of Agriculture
Philippines Plant Quarantine Service
Australia Queensland University of Technology (QUT)
Vietnam Ministry of Agriculture and Rural Development
Thailand Ministry of Agriculture and Cooperatives
UK Imperial College London

8

Case Studies

8.1 Overview

This chapter provides a summary of the country-based case studies developed by the partner countries as part of the Beyond Compliance (BC) project. The country case studies are summarised in Table 8.1.

A variety of formats for the case studies is presented, to illustrate the different ways in which information was communicated and reported throughout the project. Sections 8.2, 8.3, 8.4 and 8.5 contain extracts from the final report for the case studies presented by Vietnam, Thailand, Malaysia and the Philippines, respectively.

Table 8.1 Summary of country-based case studies developed in the Beyond Compliance project

Commodity	Exporting country	Importing country/region
Dragon fruit	Vietnam	South Korea, Taiwan
Orchid cut flowers	Thailand	Europe
Jackfruit	Malaysia	Australia, China
Banana	Philippines	USA

[1] The Philippines case study originally focused on avocado to South Korea, but switched to banana to the USA in order to meet the time constraints of the project.

8.2 Case study: Vietnam

8.2.1 Overall aim

The overall aim of this project was to have a proposal dealing with costs of Systems Approach as an alternative and as a basis for discussion with stakeholders and use a Bayesian network (BN) for pest risk management decisions.

8.2.2 Description of commodity

Dragon fruit (*Hylocerus undatus*) is good for the domestic market and also has good potential for export. The majority of dragon fruit production in Vietnam is in Binh Thuan province in South Central Coast and in Tien Giang, Long An and Vinh Long provinces in Mekong Delta. In 2007, the total production area was about 13,991 ha and has expanded rapidly to 22,000 ha at the time of this report.

Flowering occurs from April to September, and fruit harvest begins 28–30 days after flowering.

- Planting density: 700–1,000 trees/ha
- Propagation: by vegetative propagation, by sucker
- Yield capacity: 40–50 kg per tree from 5- to 7-year-old trees
- Produce: more than 500,000 metric tonnes (mt)/year

8.2.3 Export country/region

Total Vietnam exports of dragon fruit in 2007 and 2008 were 24,958 and 81,671 mt, respectively. The most widely distributed and destined for export markets is the white flesh cultivar. This variety thrives locally, gives high yield, and has a good-shaped fruit.

Primary export markets are the USA, Japan, South Korea and Chile. Dragon fruit is treated by irradiation (dose 400 Gray) for the United States market or subjected to vapour heat treatment (VHT) for the Japanese market.

8.2.4 Pest risk mitigation issues

Quarantine pests requiring mitigation

Pests that require pest risk management measures:

- Fruit fly, three species: oriental fruit fly (*Bactrocera dorsalis*); melon fly (*Bactrocera cucurbitae*) and guava fly (*Bactrocera correcta*)
- Mealybug, seven species: *Dysmicoccus neobrevipes*; *Dysmicoccus brevipes*; *Ferrisia virgata*; *Planococcus lilacinus*; *Planococcus minor*; *Maconellicoccus hirsutus* and *Pseudococcus jackbeardsleyi*

Is this PRA-based? (Or how are pests known?)

A PRA report was done by USDA APHIS. This PRA report was considered by the South Korean NPPO, which then proposed risk mitigation options for their country.

Existing pest risk management requirements

Import requirements were proposed by the South Korean NPPO as follows:

1. Dragon fruit must be treated by VHT at 46.5°C for 30 minutes.
2. Pre-clearance must be carried out by a South Korean quarantine inspector (VHT machine supervision).

Pest risk management problems to solve

All dragon fruit consignments must be treated by VHT but the cost of that is very high ($2/kg). In addition, only two VHT plants in the south of Vietnam are currently installed and running at this time, both in Binh Duong Province. Each VHT plant has a capacity of about 3.6–4.2 mt/treatment only. Two more plants are being installed in Long An and Binh Thuan provinces.

Suggested alternative Systems Approach

- Application of an integrated Systems Approach for pest risk management of export dragon fruit from Vietnam to South Korea to reduce treatment cost and allow for a higher quantity of dragon fruit.

8.2.5 Trade opportunity

Existing or new trade

South Korea is an existing market for export of dragon fruit from Vietnam, but the volume of exports in 2011 was only 95 mt.

A potential Taiwan market was still being negotiated between the NPPOs of Vietnam and Taiwan at the time of this report. It was hoped that this market would be opened for export of dragon fruit from Vietnam in 2014.

Current or potential volume and value of trade

Dragon fruit from Vietnam has been exported into 28 countries around the world, including China, Malaysia, Indonesia, Japan, South Korea, Germany, the UK and the USA. Export volumes in 2011 and 2002 are given in Table 8.2.

Potential economic outcomes of a Systems Approach from Beyond Compliance

The Systems Approach is proposed to replace VHT. The cost of VHT is $2/kg of fruit and reduces the shelf life of the fruit. With only two VHT plants in the country, access to VHT is very limited and distant from dragon fruit farms. Some of the measures in the proposed Systems Approach are already carried out in the Production Chain of a good farm. Some other measures are not currently common, such as using new boxes and the fruit bagging technique. We have not calculated the costs of these yet.

Table 8.2 Exportation of dragon fruit from Vietnam and quarantine treatment requirement (2011 and 2012)

Importing country	**Quarantine treatment required**	**Volume (mt/year)/Ho Chi Minh seaport**		**Volume (mt/year)/ Lang Son land border crossing**		**Volume (mt/ year)/Lao Cai land border crossing**	
		2011	**2012**	**2011**	**2012**	**2011**	**2012**
Brunei			0.828				
Belgium		5.758					
Brazil		38.4					
Canada		784.542	1,205.0787				
Chile			0.9				
China		154,682.72545	256,570.46761	213,987	247,779		1,182
France		24.84	53.361				
Germany		31.9225	299.381				
Hong Kong		296.484	136.247				
Indonesia		12,328.2018	12,722.9877				
Iran		17.48					
Italy		8.512	39.925				
Japan	VHT	517.686	743.920				
Malaysia		1,773.1715	1,523.013				
Myanmar		0.04					
Netherlands		2,341.507	1,964.1961				
Philippines			64.846				
Qatar			28.25				
Saudi Arabia		18.16					
Singapore		77.76	169.36				
South Korea	VHT	94.974	150.05389				
Spain		12.74	18.5945				
Switzerland		15.41	29.903				
Thailand		16,474.6772	18,388.8935				
UAE		367.46	798.40028				
Ukraine			0.12				
UK		264.106	84.068				
USA	Irradiation	1,194.822	1,236.543				
Sub-total		**191,371.37945**	**296,229.33731**	**213,987**	**247,779**		**1,182**

Total export volume: 2011, 405,358.3794 metric tonnes (mt); 2012, 545,190.3373 mt.
VHT, vapour heat treatment.

8.2.6 Case study process and activities

This case study was carried out over about 2.5 years (1 July 2011 to 30 December 2013) by the Plant Quarantine Diagnostic Centre (PQDC), Plant Protection Department (PPD) of Vietnam.

8.2.7 Production Chain

With the assistance of experts from Queensland University of Technology (QUT), Australia, Imperial Colleague London (ICL), UK and CABI, Malaysia, the Vietnam project team discussed with Vietnamese stakeholders (e.g. growers, farmers, workers, middlemen, packing house operators, treatment providers, exporters, quarantine inspectors, extension officers, policy makers and scientists) how to develop a Production Chain for dragon fruit with possible measures and monitoring actions for insect pests (Figure 8.1).

Treatment of planting materials against mealybug (new plantations only)

This measure is applied (by growers or workers) to control mealybug on planting materials used to establish new dragon fruit plantations. Insecticide cover spray could reduce initial infestation of mealybug on planting materials.

Field sanitation at the start of crop season

Field sanitation is applied (by growers or workers) at the start of each crop season. There is one crop season per year in the North, and two in South Central Coast and Mekong Delta. Application of field sanitation could reduce the initial source of plant pest infestations (e.g. fruit fly and mealybug) in dragon fruit plantations.

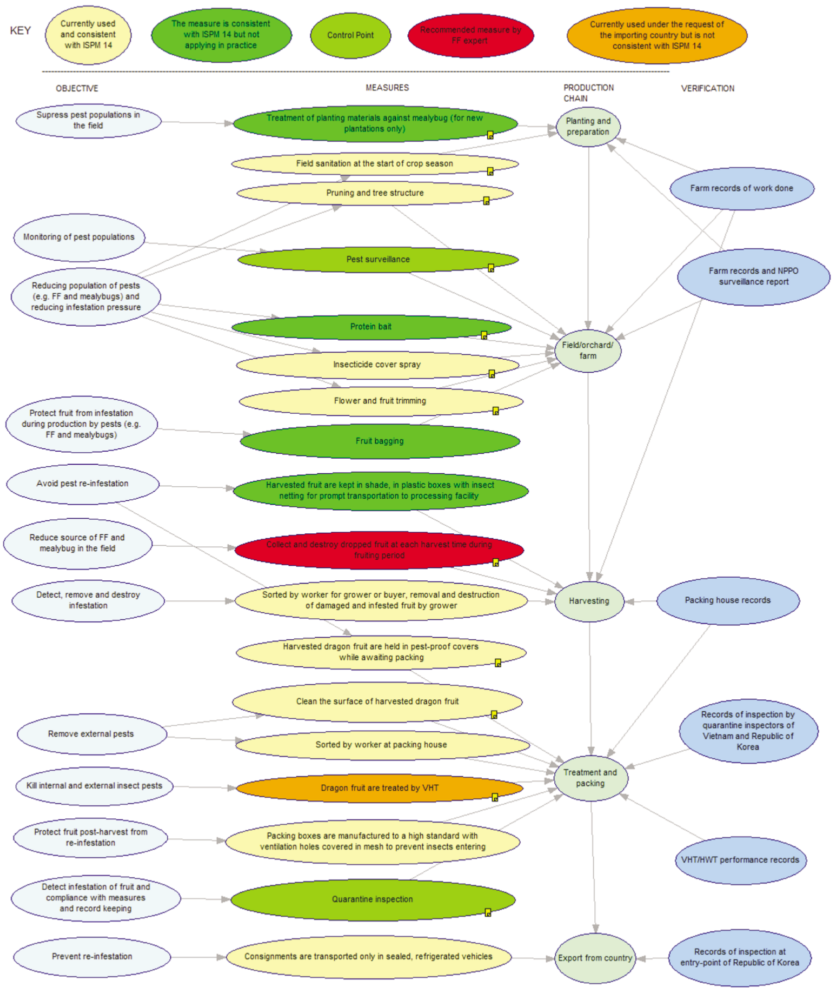


Figure 8.1 Production Chain for dragon fruit in Vietnam with possible measures and monitoring actions against insect pests

FF, fruit fly; HWT, hot water treatment; ISPM, International Standards for Phytosanitary Measures: NPPO, national plant protection organisation, VHT, vapour heat treatment

Pruning and tree structure

Pruning to improve tree structure is a common technique (done by growers or workers) to create well-shaped dragon fruit trees. This measure could reduce infestation levels of mealybug on the trees.

Pest surveillance

Fruit fly surveillance can be done by using a pheromone trap to attract and collect adult fruit fly in South Central Coast (Binh Thuan Province) where the dragon fruit tree is the only fruit fly host. For other regions, such as in the North and Mekong Delta, where complex orchard systems with many fruit fly hosts, including citrus, mango, rambutan, longan and melon, are common, fruit fly surveillance should be done by collecting dragon fruit.

Mealybug surveillance is done by collecting dragon fruit and tree branches.

Pest surveillance could reduce the level of fruit fly infestation (but would have little impact on mealybug) in dragon fruit tree plantations.

Protein bait

Protein bait (Ento-Pro 150SL) or methyl eugenol mixed with insecticide are registered and quite commonly used in Vietnam. They could be used to control fruit fly in dragon fruit tree plantations.

Insecticide cover spray

An insecticide cover spray could be used to control mealybug and ants in dragon fruit tree plantations. Ants are believed to carry mealybugs between dragon fruit trees and other host plants. An insecticide cover spray is applied when mealybugs or ants appear.

Flower and fruit trimming

Flower and fruit trimming is a common technique (done by growers or workers) to keep a suitable number of flowers and fruit per branch. It is done to manage the nutritional balance of the dragon fruit tree. This measure could only be used to reduce infestation levels of mealybug on the trees.

Fruit bagging

This measure could protect dragon fruit from infestation by pests (e.g. fruit fly and mealybug) during production.

Harvested fruit kept in shade, in plastic boxes with insect netting for prompt transportation to processing facility

This measure is done to avoid re-infestation of harvested dragon fruit by plant pests (e.g. fruit fly and mealybug).

Collect and destroy dropped fruit at each harvest time during fruiting period

There are 3–5 harvest times per crop season (during the fruiting period); therefore if all dropped fruit were collected and destroyed at each harvest time, the level of infestation of plant pests (e.g. fruit fly and mealybug) would be reduced.

Sorted by worker for grower or buyer, removal and destruction of damaged and infested fruit by grower

Sorting after harvest could allow the removal and destruction of all damaged and infested dragon fruit. Application of this measure could detect and remove all fruit infested by plant pests.

Harvested dragon fruit held in pest-proof covers while awaiting packing

This measure is done to avoid the re-infestation of harvested dragon fruit by plant pests (e.g. fruit fly and mealybug).

Clean the surface of harvested dragon fruit

This measure is done to remove mealybug infestations on dragon fruit.

Sorted by worker at packing house

Sorting at the packing house could lead to the removal and destruction of all damaged and infested dragon fruit. Application of this measure could detect and take out all fruit infested with plant pests.

Dragon fruit treated by VHT

VHT is applied to all consignments of dragon fruit being exported to the South Korean market following the agreement signed by both NPPOs. VHT machines and the VHT treatment procedure is supervised by a South Korean quarantine inspector.

Packing boxes manufactured to a high standard with ventilation holes covered in mesh to prevent insects entering

This measure is done to avoid the re-infestation of treated dragon fruit by plant pests (e.g. fruit fly and mealybug).

Quarantine inspection

Quarantine inspection is done by both South Korean and Vietnamese quarantine inspectors following the agreement signed by both NPPOs.

Consignments transported only in sealed, refrigerated vehicles

This measure is done to avoid the re-infestation of treated dragon fruit by plant pests (e.g. fruit fly and mealybug).

8.2.8 Decision Support System

The Decision Support System (DSS) contains the important components that are used to build the structure of the BN, and the probability estimates within it.

We used a collaborative approach to complete the DSS, centred around a team of plant health experts in the PPD. They considered all sources of information about the Production Chain, the pest risk management measures, and the farming system. This information came from formal publications such as journal articles, informal publications, consulting with agronomy advisors with specialist knowledge of dragon fruit farming, and consulting with farmers and processors in the dragon fruit industry. The expert team worked together many times for hundreds of hours in completing the process.

Part of the DSS for fruit fly is shown in Figure 8.2a–c. A DSS for mealybug was also developed.

8.2.9 Control Point–Bayesian Network

Control Point–Bayesian Networks (CP-BNs) for fruit fly and mealybug were developed by the Vietnam team (Figures 8.3 and 8.4) through further consultation with the industry, in September and October 2012 and May 2013, where the estimates were presented and feedback sought.

8.2.10 Control Point–Bayesian Network analysis

A sensitivity analysis was carried out for both CP-BNs.

Comparison of efficacy of measures

For the CP-BN for fruit fly, there is only one measure in Stage 1 (Field sanitation). Turning this measure 'On' and 'Off', with all other measures set to the opposite state, gave different results (Figures 8.5 and 8.6).

Risk management measures available (automatically read in from Table B2)	Objective of measure	Feasibility: 2.1) Would existing infrastructure or other facilities be sufficient to apply this measure?			2.2) How easy will it be to apply this measure taking into account enforcement, resources and operational factors?			2.3) Reproducibility - How likely is the application of this measure to be consistent across all producers (or shippers or others involved in implementing the measure)?		
		Score	Uncertainty	Graphic	Score	Uncertainty	Graphic	Score	Uncertainty	Graphic
3.1 Field sanitation at the start of crop season	*Reduces pest challenge*	Very likely	Very low		Very unlikely	Very low		Very likely	Very low	
4.5 Pest surveillance	*Evidence of measure implementation*	Likely	Low		Moderately likely	Low		Likely	Low	
4.6 Pheromone traps/male annihilation technique (MAT)	*Reduces pest challenge*	Likely	Low		Moderately likely	Low		Likely	Low	
4.7 Protein bait	*Reduces pest challenge*	Likely	Low		Moderately likely	Low		Likely	Low	
4.8 Insecticide cover spray	*Reduces pest challenge*	Very likely	Low		Unlikely	Very low		Likely	Low	
5.2 Fruit bagging	*Reduces pest challenge*	Very likely	Low		Unlikely	Low		Likely	Low	
6.1 Harvested fruit kept in shade, in plastic boxes with insect netting for prompt transportation to processing facility	*Prevents re-infestation*	Likely	Low		Very unlikely	Low		Very likely	Very low	
6.2 Collect and destroy dropped fruit at each harvest time during fruiting season	*Reduces pest challenge*	Very likely	Very low		Very unlikely	Very low		Very likely	Very low	
6.3 Sorted by worker for grower or buyer, removal and destruction of damaged and infested fruit by grower	*Reduces pest infestation*	Very likely	Very low		Very unlikely	Very low		Very likely	Very low	
10.1 Harvested dragon fruit are held in pest-proof covers while awaiting packing	*Prevents re-infestation*	Likely	Low		Unlikely	Low		Likely	Low	
10.4 Fruits are VHT'd at 46.5C for 40 minutes. Then cooled down, washed and dried for 30 minutes	*Measures level of pest challenge/infestation*	Likely	Very low		Very likely	Low		Moderately likely	Low	
11.1 Packing boxes are manufactured to a high standard with ventilation holes covered in mesh to prevent insects entering	*Prevents re-infestation*	Very likely	Low		Very unlikely	Very low		Very likely	Very low	
11.2 Quarantine inspection (before signing phyosanitary certificate)	*Evidence of measure implementation*	Very likely	Very low		Very likely	Low		Moderately likely	Low	
12.1 Consignments transported only in sealed, refrigerated vehicles	*Prevents re-infestation*	Very likely	Very low		Very likely	Very low		Very likely	Very low	

Figure 8.2 Decision Support System for Systems Approach for fruit fly in dragon fruit in Vietnam: evaluation of candidate measures, (a) Feasibility (continued...)

VHT, vapour heat treatment
VL, 'Very likely'; L, 'Likely'; ML, 'Moderate likely'; U, 'Unlikely'; VU, 'Very unlikely'

Risk management measures available (automatically read in from Table B2)	Objective of measure	Costs (cost/benefit) 2.4) How acceptable are the direct costs of the measure to importers?		2.5) How acceptable are the direct costs of the measure to exporters?		2.6) How large are the direct costs of this measure to the government?		2.7) Are there indirect benefits to these measures (e.g. controls other pests, enhances quality, etc.)?	
		Score	Uncertainty	Score	Uncertainty	Score	Uncertainty	Score	Uncertainty
3.1 Field sanitation at the start of crop season	*Reduces pest challenge*	Widely accepted	Low	Widely accepted	Very low	Minimal	Very low	Very likely	Very low
4.5 Pest surveillance	*Evidence of measure implementation*	Widely accepted	Low	Widely accepted	Low	Minimal	Very low	Unlikely	Very low
4.6 Pheromone traps/male annihilation technique (MAT)	*Reduces pest challenge*	Widely accepted	Low	Widely accepted	Low	Minimal	Very low	Unlikely	Very low
4.7 Protein bait	*Reduces pest challenge*	Widely accepted	Low	Widely accepted	Low	Minimal	Very low	Unlikely	Very low
4.8 Insecticide cover spray	*Reduces pest challenge*	Widely accepted	Low	Widely accepted	Low	Minimal	Very low	Very likely	Low
5.2 Fruit bagging	*Reduces pest challenge*	Widely accepted	Low	Accepted	Low	Minimal	Very low	Very likely	Very low
6.1 Harvested fruit kept in shade, in plastic boxes with insect netting for prompt transportation to processing facility	*Prevents re-infestation*	Widely accepted	Low	Widely accepted	Very low	Minimal	Very low	Likely	Low
6.2 Collect and destroy dropped fruit at each harvest time during fruiting season	*Reduces pest challenge*	Widely accepted	Low	Widely accepted	Very low	Minimal	Very low	Likely	Low
6.3 Sorted by worker for grower or buyer, removal and destruction of damaged and infested fruit by grower	*Reduces pest infestation*	Widely accepted	Low	Widely accepted	Very low	Minimal	Very low	Likely	Low
10.1 Harvested dragon fruit are held in pest-proof covers while awaiting packing	*Prevents re-infestation*	Widely accepted	Low	Widely accepted	Low	Minimal	Very low	Likely	Low
10.4 Fruits are VHT'd at 46.5C for 40 minutes. Then cooled down, washed and dried for 30 minutes	*Measures level of pest challenge/infestation*	Accepted	Low	Mixed acceptance and opposition	Low	Minimal	Very low	Moderately likey	Medium
11.1 Packing boxes are manufactured to a high standard with ventilation holes covered in mesh to prevent insects entering	*Prevents re-infestation*	Widely accepted	Low	Accepted	Low	Minimal	Very low	Likely	Low
11.2 Quarantine inspection (before signing phyosanitary certificate)	*Evidence of measure implementation*	Accepted	Low	Mixed acceptance and opposition	Low	Minimal	Very low	Likely	Low
12.1 Consignments transported only in sealed, refrigerated vehicles	*Prevents re-infestation*	Widely accepted	Low	Widely accepted	Low	Minimal	Very low	Likely	Low

Figure 8.2 Decision Support System for Systems Approach for fruit fly in dragon fruit in Vietnam: evaluation of candidate measures, (b) Costs (cost/benefit) (continued...)

VHT, vapour heat treatment
VL, 'Very likely'; L, 'Likely'; ML, 'Moderate likely'; U, 'Unlikely'; VU, 'Very unlikely'

Risk management measures available (automatically read in from Table B2)	Objective of measure	Acceptability							
		2.8) Estimate the measure's potential impact on trade and movement of travellers		2.9) How acceptable is the potential social impact of the measures to the exporting region?		2.10) How acceptable is the potential social impact of the measures to the importing region?		2.11) Estimate the acceptability of the measure in terms of potential environmental impact	
		Score	Uncertainty	Score	Uncertainty	Score	Uncertainty	Score	Uncertainty
3.1 Field sanitation at the start of crop season	*Reduces pest challenge*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Low
4.5 Pest surveillance	*Evidence of measure implementation*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Low
4.6 Pheromone traps/male annihilation technique (MAT)	*Reduces pest challenge*	Minimal	Very low	Accepted	Low	Accepted	Low	Accepted	Low
4.7 Protein bait	*Reduces pest challenge*	Minimal	Very low	Accepted	Low	Accepted	Low	Accepted	Low
4.8 Insecticide cover spray	*Reduces pest challenge*	Medium	Low	Mixed acceptance and opposition	Low	Mixed acceptance and opposition	Very low	Mixed acceptance and opposition	Very low
5.2 Fruit bagging	*Reduces pest challenge*	Medium	Low	Accepted	Low	Widely accepted	Very low	Widely accepted	Low
6.1 Harvested fruit kept in shade, in plastic boxes with insect netting for prompt transportation to processing facility	*Prevents re-infestation*	Minimal	Very low	Accepted	Low	Widely accepted	Very low	Widely accepted	Low
6.2 Collect and destroy dropped fruit at each harvest time during fruiting season	*Reduces pest challenge*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Low
6.3 Sorted by worker for grower or buyer, removal and destruction of damaged and infested fruit by grower	*Reduces pest infestation*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Very low
10.1 Harvested dragon fruit are held in pest-proof covers while awaiting packing	*Prevents re-infestation*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Low
10.4 Fruits are VHT'd at 46.5C for 40 minutes. Then cooled down, washed and dried for 30 minutes	*Measures level of pest challenge/infestation*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Very low
11.1 Packing boxes are manufactured to a high standard with ventilation holes covered in mesh to prevent insects entering	*Prevents re-infestation*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Low
11.2 Quarantine inspection (before signing phyosanitary certificate)	*Evidence of measure implementation*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Very low
12.1 Consignments transported only in sealed, refrigerated vehicles	*Prevents re-infestation*	Minimal	Very low	Widely accepted	Very low	Widely accepted	Very low	Widely accepted	Low

Figure 8.2 Decision Support System for Systems Approach for fruit fly in dragon fruit in Vietnam: evaluation of candidate measures, (c) Acceptability

VHT, vapour heat treatment
VL, 'Very likely'; L, 'Likely'; ML, 'Moderate likely'; U, 'Unlikely'; VU, 'Very unlikely'

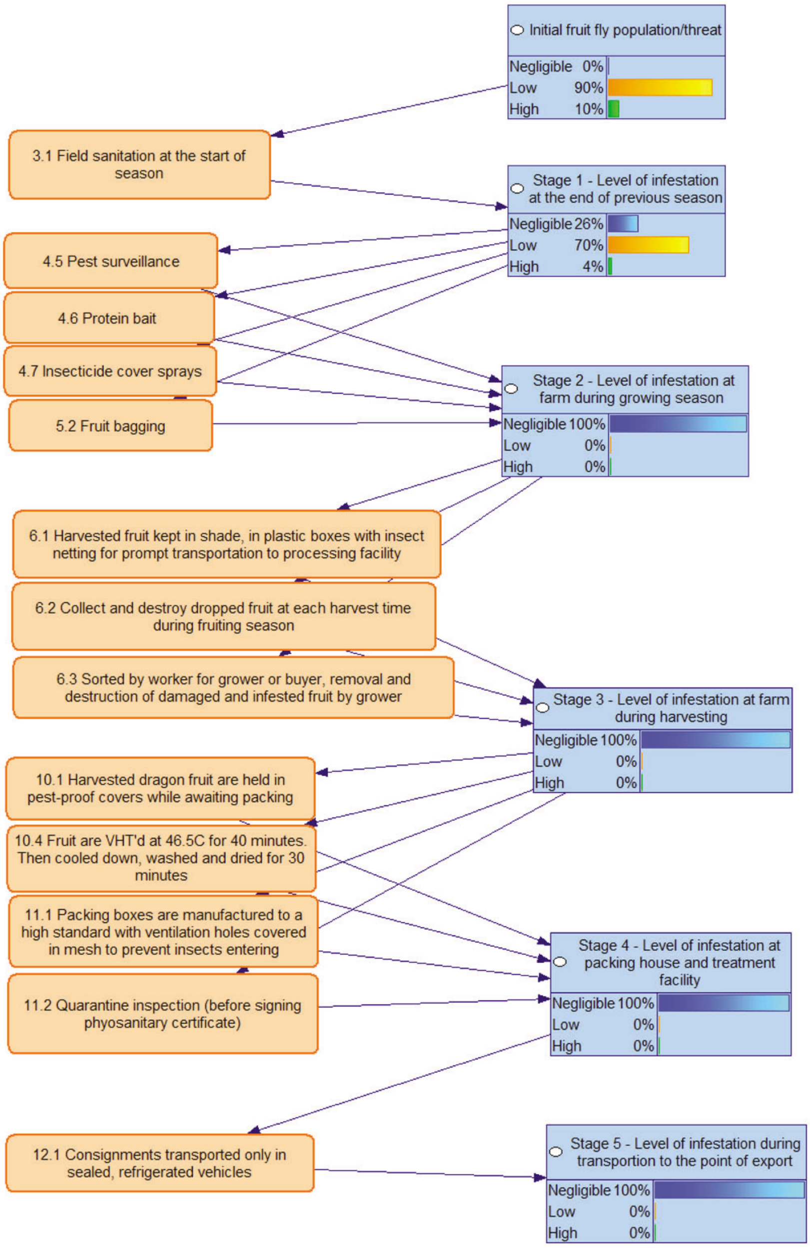


Figure 8.3 Control Point–Bayesian Network for fruit fly in dragon fruit in Vietnam

VHT, vapour heat treatment

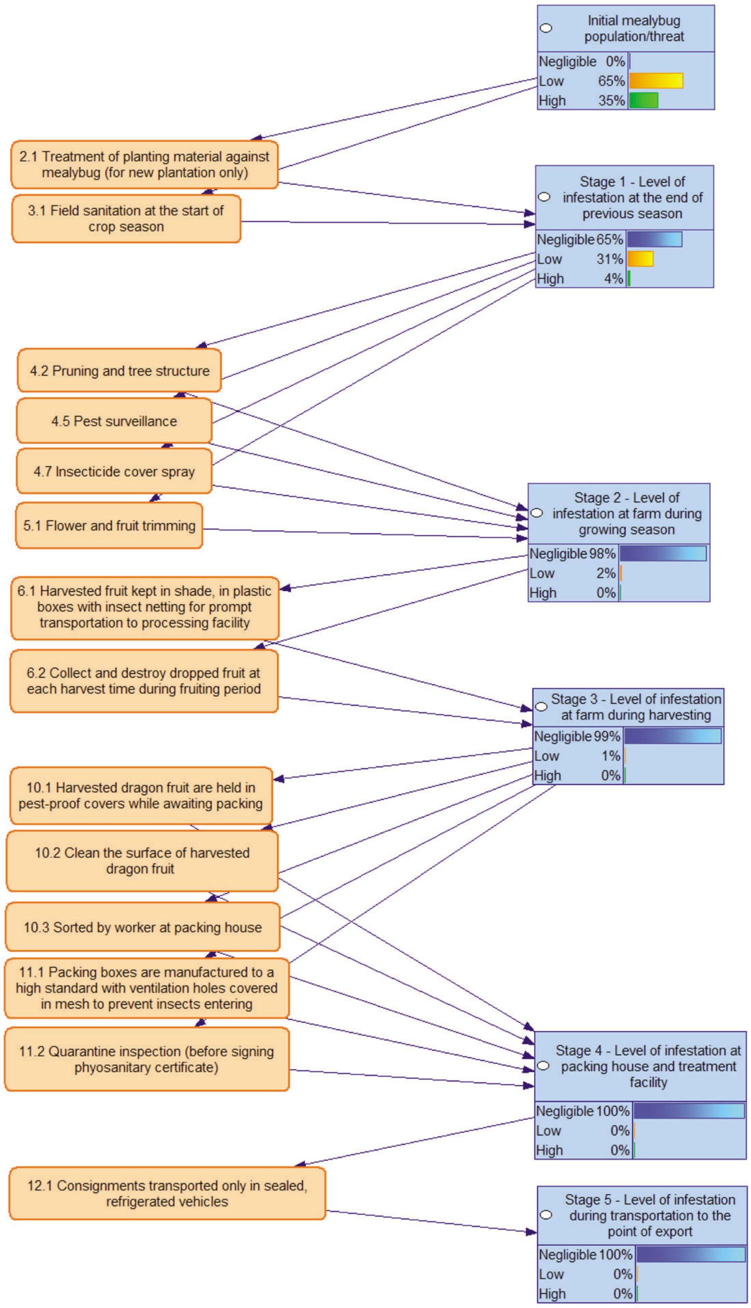


Figure 8.4 Control Point–Bayesian Network for mealybug in dragon fruit in Vietnam

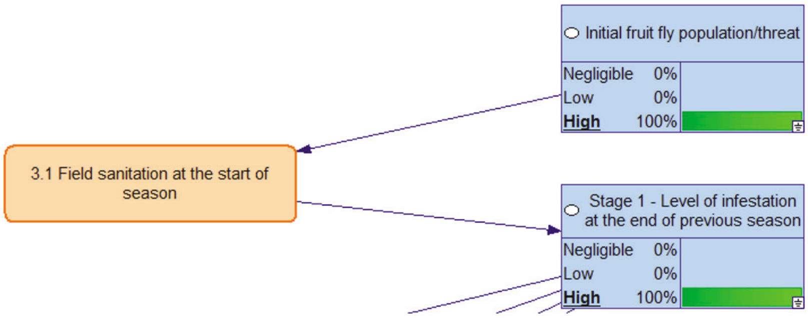


Figure 8.5 Fruit fly: Measure 3.1. 'Off' and others 'On'

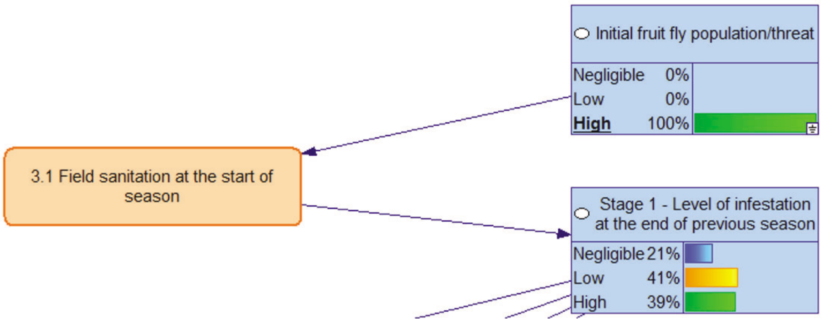


Figure 8.6 Fruit fly: Measure 3.1. 'On' and others 'Off'

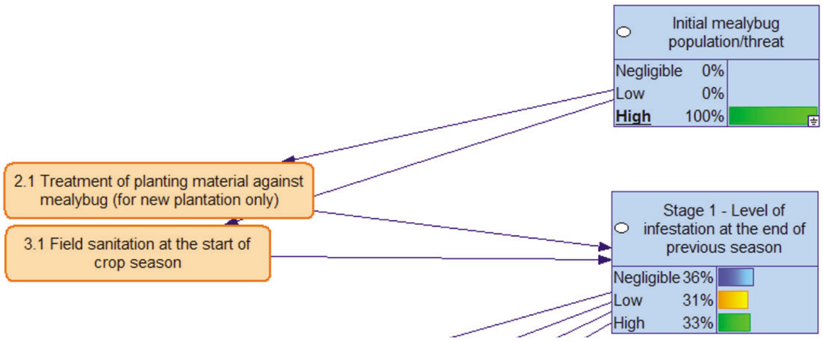


Figure 8.7 Mealybug: Measure 2.1. 'Off' and others 'On'

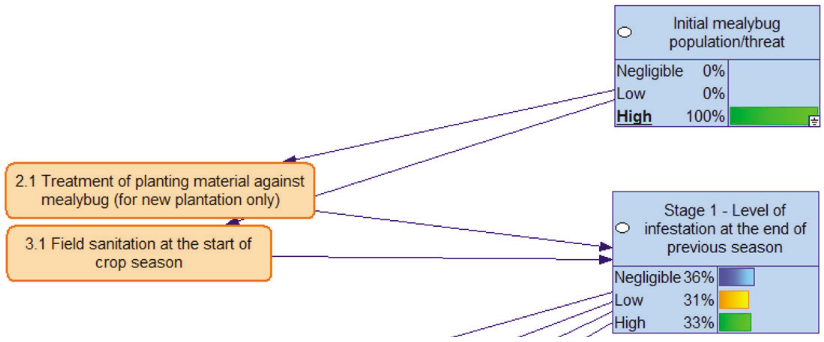


Figure 8.8 Mealybug: Measure 2.1. 'On' and others 'Off'

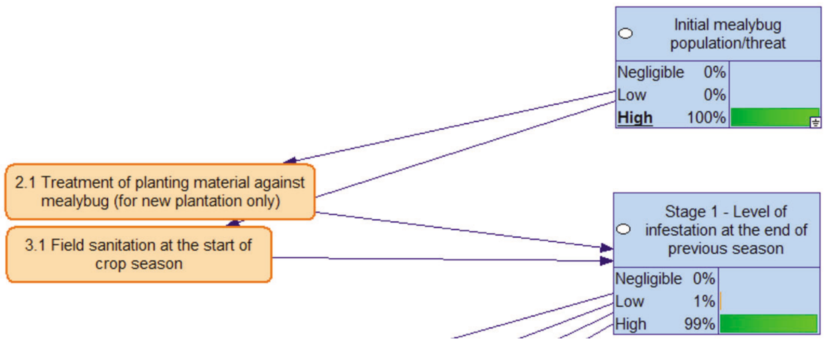


Figure 8.9 Mealybug: Measures 2.1 and 3.1 'Off' and others 'On'

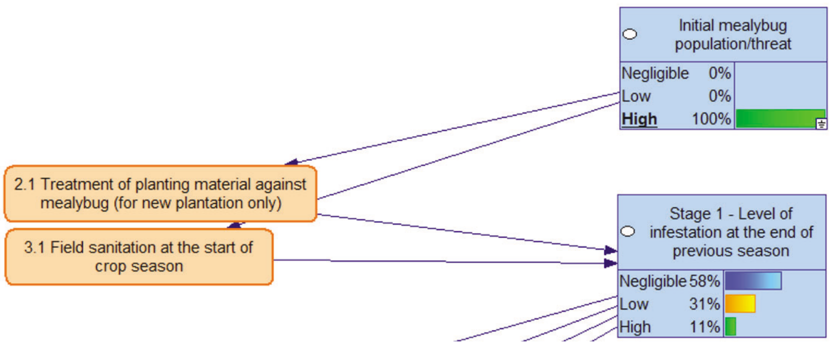


Figure 8.10 Mealybug: Measures 2.1 and 3.1 'On' and others 'Off'

For the CP-BN for mealybug, there are two measures in Stage 1 (2.1. Treatment of planting materials and 3.1. Field sanitation). Turning Measure 2.1 'On' and 'Off', with all other measures set to the opposite state, gave the same results (Figures 8.7 and 8.8).

Turning both Stage one measures (Measures 2.1 and 3.1) 'On' and 'Off', with all other measures set to the opposite state, gave quite different results (Figures 8.9 and 8.10).

Assessment of implementation standard of measures

Fruit fly

Measure 3.1: With Measure 3.1. turned 'On' and all other measures 'Off', and the implementation standard of Measure 3.1 set to 'High', then click 'run' the model, the result is shown in Figure 8.11. The result when the implementation standard is set to 'Low' is shown in Figure 8.12 (The comparison is shown for a situation where the current level of pest infestation is 'High').

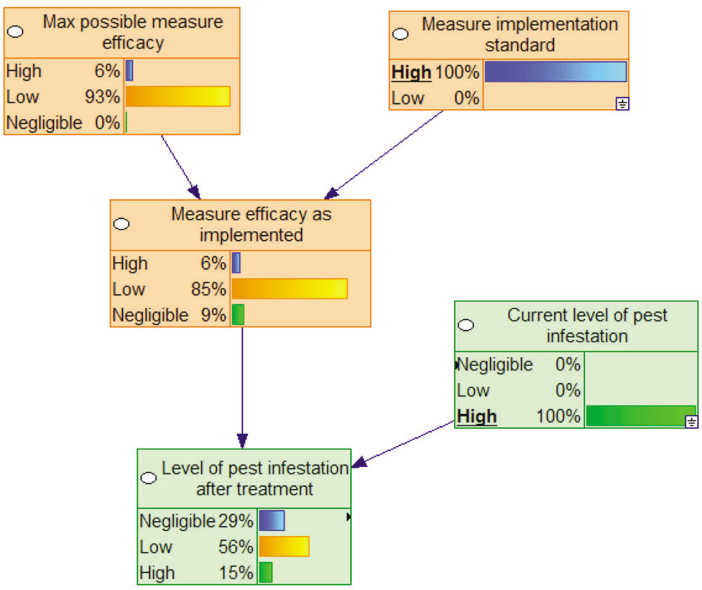


Figure 8.11 Fruit fly: assessment of the implementation standard of Measure 3.1 – 'High'

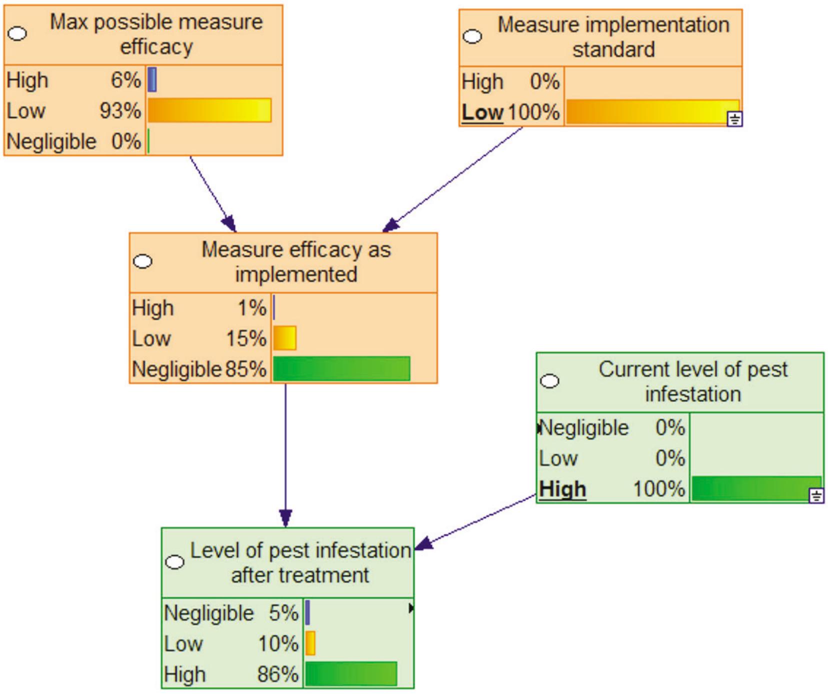


Figure 8.12 Fruit fly: assessment of the implementation standard of Measure 3.1 – 'Low'

Mealybug

Measure 2.1: With Measure 2.1. turned 'On' and all other measures 'Off', when we set measure implementation to 'High' with 'High' for current level of pest infestation, then click 'run', the result is shown in Figure 8.13. When measure implementation is set to 'Low', the result is shown in Figure 8.14.

8.2.11 Conclusions about Systems Approach

The appropriate international standards for PRA provide general guidance on measures for pest risk management. Systems Approaches, which integrate measures for pest risk management in a defined

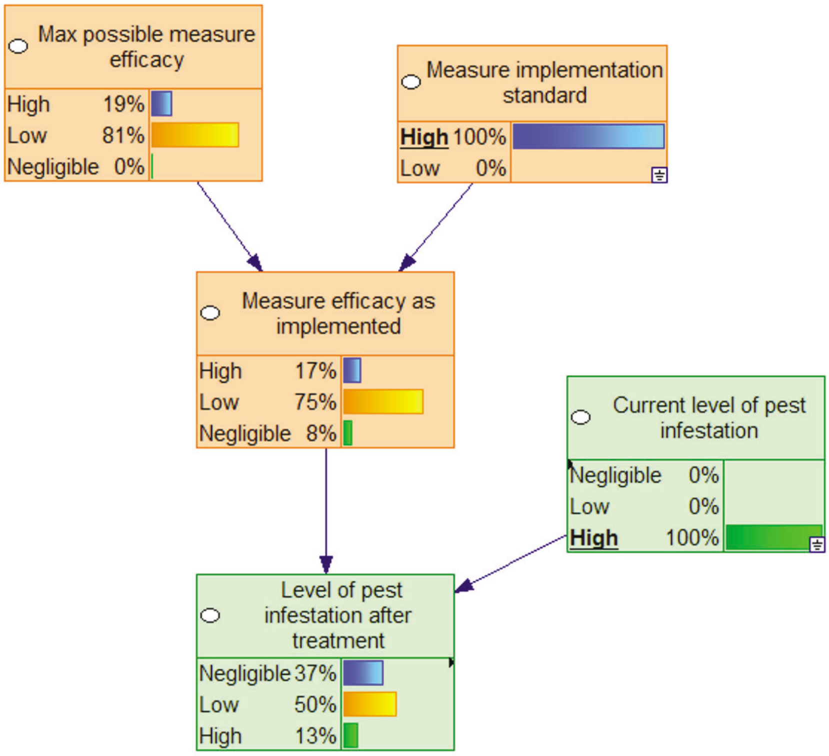


Figure 8.13 Mealybug: assessment of the implementation standard of Measure 2.1 – 'High'

manner, could provide an alternative to single measures to meet the appropriate level of phytosanitary protection for an importing country. They can also be developed to provide phytosanitary protection in situations where no single measure is available. A Systems Approach requires the integration of different measures, at least two of which act independently, with a cumulative effect (ISPM 14 – FAO, 2002).

Systems Approaches range in complexity. The application of a critical control points system in a Systems Approach may be useful to identify and evaluate points in a pathway where specified pest risks can be monitored and reduced. The development and evaluation

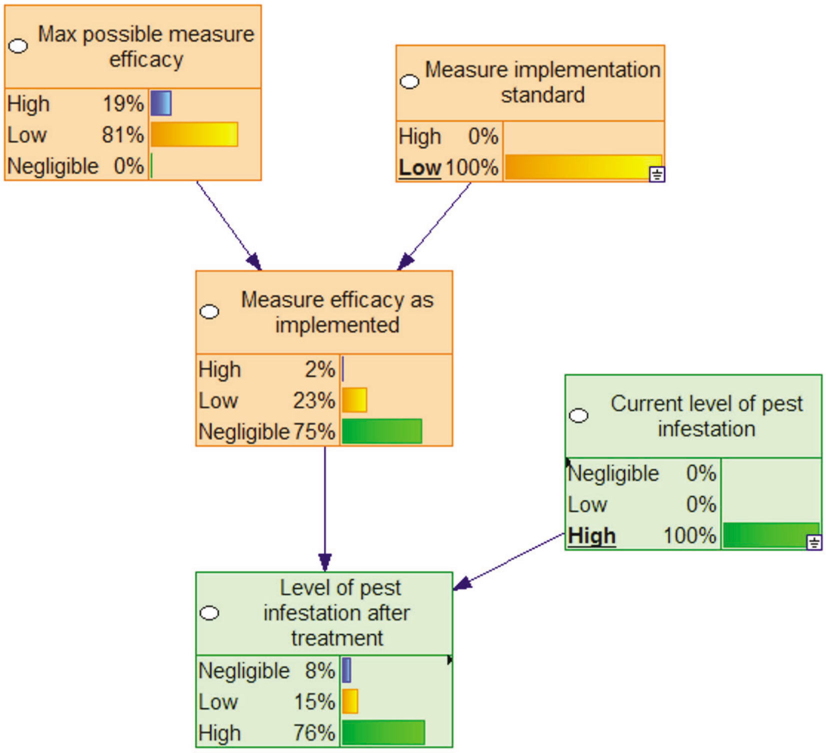


Figure 8.14 Mealybug: assessment of the implementation standard of Measure 2.1 – 'Low'

of a Systems Approach may use quantitative or qualitative methods. The NPPOs of exporting and importing countries may consult and cooperate in the development and implementation of a Systems Approach. The decision regarding the acceptability of a Systems Approach lies with the importing country, subject to consideration of technical justification, minimal impact, transparency, non-discrimination, equivalence and operational feasibility. A Systems Approach is usually designed as an option that is equivalent to but less restrictive than other measures (ISPM 14 – FAO, 2002).

Application of a Systems Approach for pest risk management in plant health to facilitate trade of agricultural products is new for Vietnam and other ASEAN member countries.

8.2.12 Conclusions about the Beyond Compliance project

Project process

The Vietnam case study component was carried out in accordance with permission from the Vietnam Ministry of Agriculture and Rural Development (MARD) and a signed contract between CABI and the Vietnam NPPO.

Project methodology

Using a BN offers a range of benefits to developing, negotiating and managing Systems Approach agreements, compared to conventional systems:

- Using modelling based on a control point approach to risk management, as opposed to ad hoc consideration of the effects of phytosanitary measures, allows a more structured and objective decision-making process.
- A Bayesian approach accommodates uncertainty in the model, which in most situations will be substantial owing to a lack of quantitative data. Bayesian statistics can use expert estimates, which are often well-founded even where there is no published information. The sensitivity of the system to uncertainty in these estimates can then be tested, so that further data can be sought, or it can be demonstrated that additional data are not essential.
- Developing a BN and populating it with node estimates can be a highly cooperative activity among stakeholders, which will potentially simplify agreement on jointly developed solutions.
- A BN is a learning system, so as data become available during trade or during a test period, the model can be updated. This also could provide a mechanism for monitoring and reviewing the trade and its phytosanitary security. It may also create opportunities for seasonal or otherwise restricted trade, thus requiring monitoring of changes in key factors.

Project outcomes for the Vietnam case study

A model of a Systems Approach for pest risk management for export of dragon fruit from Vietnam to South Korea was built and led to the project outcomes summarised below:

1. A Production Chain for the dragon fruit crop was developed.
2. DSSs for screening for Systems Approach measures were developed for fruit fly and mealybug.
3. CP-BNs for fruit fly and mealybug were developed.
4. A CP-BN for combined pests was developed.
5. Three stakeholder meetings were held (2012 and 2013) for discussion and sharing information about proposed measures to be used for plant pest risk mitigation, assessments of each proposed measure in DSS versions and the draft CP-BNs models.
6. Setting up a network for the dragon fruit crop industry in Vietnam was proposed to act as an official forum for sharing experience and information relating to the dragon fruit crop in Vietnam.
7. Feedback from stakeholder meetings was reviewed by the BC project team and used for development of the final versions of CP-BNs.
8. The capacity of the BC project team was increased not only in Systems Approach but also in market access negotiation skills.

8.3 Case study: Thailand

8.3.1 Overview

Orchid cut flowers from Thailand are currently treated for *Thrips palmi* by applying methyl bromide fumigation prior to export to EU countries. The treatment meets the EU requirements set out in the Council Directive 2000/29/EC Commission Decision of 2 February 1998. However, the export market has been threatened by high pest interceptions demonstrating that the treatment, as applied, is sometimes insufficient. Furthermore, the methyl bromide fumigation measure may reduce the flower quality and be prohibited by certain countries in the future. The objective of this case study is to employ a BN to identify key control points and alternative measures to meet the EU's phytosanitary requirements. The developers of the case study hope that the alternative phytosanitary measures, shown to be equivalent to methyl bromide fumigation, may facilitate amendment of Council Directive 2000/29/EC through the process described in ISPM 24 (FAO, 2011).

The BC project activities in Thailand included: a general project meeting, software training, three stakeholder meetings, and two international workshops. Modelling for control points was generated based on phytosanitary measures to control *T. palmi* during the following stages of the Production Chain: planting and preparation; production, harvesting and picking; processing and inspection; packing; and inspection at the port of departure. Fifteen selected approaches were evaluated using the DSS. Estimated values from CP-BNs were executed via GeNIe2 software (Decision Systems Laboratory, University of Pittsburgh, Pennsylvania; *http://dsl.sis.pitt.edu*). Our modelled results revealed that the selected measures can be used to control *T. palmi* as an alternative to methyl bromide fumigation. Field sanitation at both the pre-planting and flowering stages together with spray programmes can compete with the fumigation measure. Sensitivity analysis applied to the completed CP-BN played a critical role in verifying the promising results.

8.3.2 Scope of case study

Commodity

- Commodity: cut flowers of Orchidaceae (orchid cut flowers)
- Commercial cultivars: *Dendrobium* Mokara, Aranda, Oncidium, Vanda, Ascenda, Cattleya, etc.

Export country/region

Thailand was for a long time the world's largest orchid exporter (since 1965) and is currently the second-largest orchid exporter with many types of product such as stem, bloom, garland, dried flower, bouquet, corsage, etc. The Ministry of Agriculture and Cooperatives has promoted the efficiency of orchid production in accordance with Good Agricultural Practices. Orchid production is scattered around the central region of the country, with a total cultivated area of about 3,500 ha, some 3,300 ha for orchid cut flowers and 200 ha of orchid plants.

Import country/region

- Countries of the EU

Objective of case study

The case study aimed to facilitate reducing methyl bromide fumigation of orchids for export from Thailand to EU countries, by developing a Systems Approach for alternative phytosanitary measures that are equivalent to methyl bromide fumigation and as per ISPM 24 (FAO, 2011) that should also be economically and technically feasible. The case study also aimed to review existing use of methyl bromide to ensure it conforms to the Commission on Phytosanitary Measures (CPM) recommendation (FAO, 2008).

8.3.3 Pest risk mitigation issues

Quarantine pest requiring mitigation

- *Thrips palmi* Karny (Thripidae; Thysanoptera)

Is this PRA-based? (Or how are pests known?)

No PRA seems to have been conducted by the EU on orchids. *Thrips palmi* is known to occur on orchids in Thailand and has been intercepted in the commodity in the EU.

The EU requirement is to have cut orchids free from *T. palmi* (Council Directive 2000/29/EC Commission Decision of 2 February 1998).

Existing pest risk management requirements

Fumigation with methyl bromide at a dose of 20 to 22 g/m^3 for 90 minutes, which should be able to eradicate *T. palmi* completely within 3 hours.

Pest risk management problems to solve

Control of *T. palmi* during the stages of orchid production is, apart from methyl bromide treatment, currently not successful. This may be the result of the control procedures applied along the Production Chain. A restriction on using methyl bromide fumigation as a phytosanitary measure is likely to be imposed by some importing countries.

Suggested alternative Systems Approach

The case study modelled the existing Production Chain and identified control measures that could be used 'as is', or enhanced, to provide a Systems Approach. The measures at specified stages of the Production Chain, were:

- *Farm condition*: sanitation of previous crop residues that may be infested
- *Pre-planting*: clean growing media
- *Planting*: chemical control, sticky trapping
- *Harvest*: cleaning the holding and collecting areas
- *Post-harvest*: inspecting and cutting off defective flowers; temperature control in the storing room
- *Export*: visual inspection

8.3.4 Trade opportunity

Existing or new trade

- Existing trade

Current or potential volume and value of trade

In 2011, around 8,866,000 orchid stems were exported, each worth 25-30 baht (for premium quality), representing a total value of around US$8,000,000.

Potential economic outcomes of a Systems Approach from Beyond Compliance

Reduced use of methyl bromide would be a direct saving and would have some environmental benefit. The application of Systems Approach may have some higher offsetting costs that have not been determined. Orchids not treated with methyl bromide may be of higher quality and have longer shelf life. The use of a Systems Approach in the production phase might reduce the quantity of pesticides used, and lead to less development of pesticide resistance amongst pests.

8.3.5 Case study process and activities

The project was implemented by two main government organisations: the Department of Agriculture (DOA) as NPPO and the National Bureau of Agricultural Commodity and Food Standards (ACFS) as the focal point. Project meetings were of two kinds: general meetings among project staff held twice a week, and Skype calls with collaborating advisors from QUT and ICL. The stakeholders involved in the case study comprised people with different career expertise, including ten entomologists from the Plant Protection Research and Development Office (DOA), one post-harvest entomologist from the Postharvest and Processing Research and

Development Office (DOA), four horticultural scientists from the Horticulture Research Institute (DOA), five agricultural scientists from the Office of Agricultural Regulation (DOA), ten experts on agricultural commodity and food standards, seven scientists from ACFS, one statistician from Kasetsart University, two administrators from the Ministry of Finance Thailand, four major orchid farmers and exporters, and one agricultural scientist from the Department of Agricultural Extension (DOAE). Three stakeholder meetings were held, on 6–10 February 2010, 29 May 2012 and 19 July 2013, and these were also attended by two important orchid exporters: the Thai Orchid Exporters Association and the Thai Orchid Garden Enterprise Association.

8.3.6 Production Chain

The Production Chain was prepared by the Thailand NPPO in consultation with orchid industry stakeholders before a mid-term meeting in July 2012 and developed in July 2013 at the final meeting (see Figure 8.15). The project was reviewed by the BC technical team and Dr Alan MacLeod (Fera, UK). The Production Chain indicates a series of potential control measures and verification measures. These measures can be applied to manage the risk of infestation. The effects of the measures can be determined by pest monitoring procedures. The Production Chain contains five stages and, within each, a number of possible measures to control *T. palmi*. The stages are: (1) pre-planting and preparation, (2) production and control measures in the field, (3) harvesting and picking, (4) processing, treatment and packing in a centralised facility, and (5) inspection at port of departure. Leading up to the selection shown in the Production Chain (Figure 8.15), potential measures considered were:

1. Pre-planting and preparation

- Using healthy planting materials, provided from reliable sources
- Avoid cultivating host plants of *T. palmi* around planting area

- Using clean growing media
- Farm layout and building
- Dipping of stem cuttings against *T. palmi*
- Sanitation before orchid cultivation
- Provide area to dispose of damaged orchids
- Separate new planting material from existing plants

2. Production and control measures in the field

- Pest monitoring at the orchid flowering stage
- Blue sticky traps are applied
- Using materials to cover planting media
- Foliar and flower spray programmes
- Field sanitation

3. Harvesting and picking

- Effective equipment and materials
- Holding and collecting areas kept clean and far from greenhouses

4. Processing, treatment and packing in a centralised facility

- Soaking cut flower stems
- Select export quality stems
- Dehumidifying cut flowers
- Packing standard
- Temperature control during the packing process
- Packaging box or container for export to be new, clean and strong
- Methyl bromide fumigation treatment

5. Inspection at port of departure

- Quarantine inspection (phytosanitary certificate)

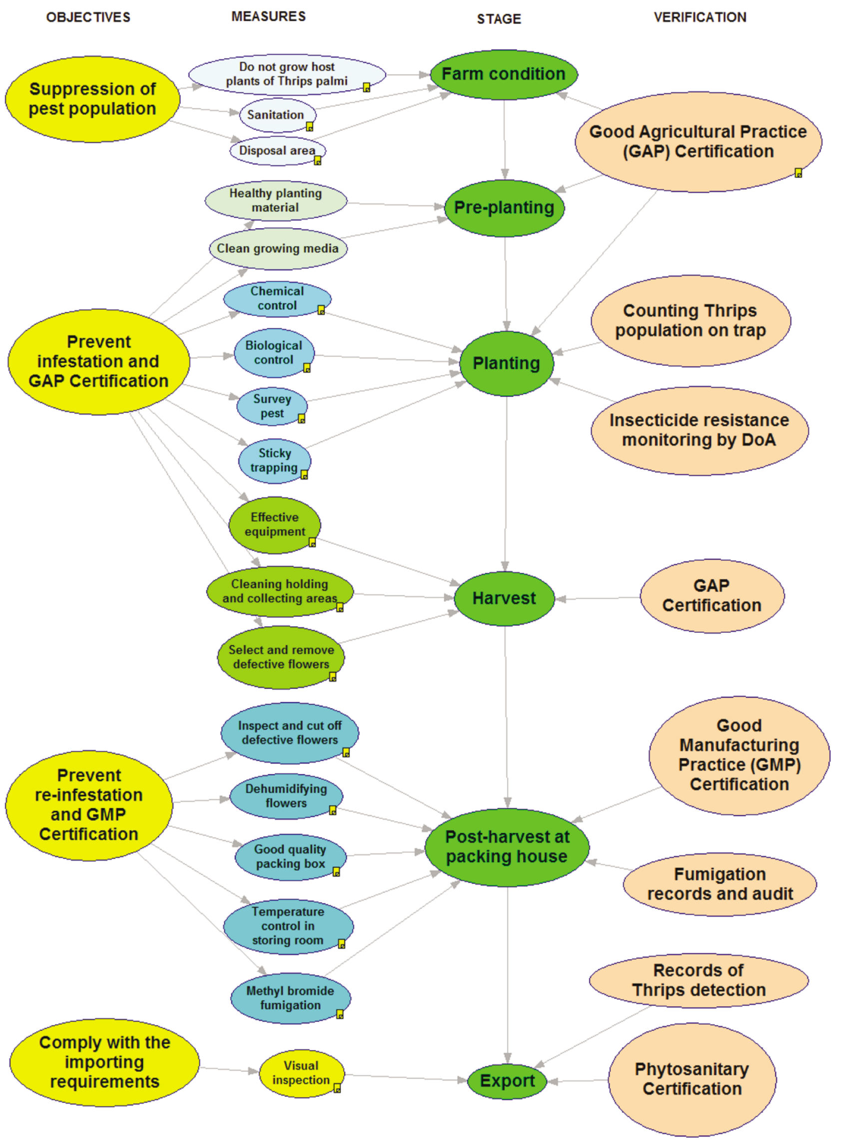


Figure 8.15 Production Chain for orchid cut flowers in Thailand, for export to the EU. The diagram identifies actual and potential pest risk management measures, monitoring measures and verification measures

After full discussion and evaluation between the stakeholders, entomologists, IPM experts and orchid farmers, 11 effective measures were selected, and these are described more fully below.

Pre-planting and preparation

Avoid cultivating host plants of *T. palmi* around planting area

Infestation from reservoir populations of *T. palmi* on host plants such as melon, mango, citrus, cucumber and round eggplant are one of the critical factors rendering control of *Thrips palmi* on orchids relatively ineffective. If those host plants are neglected, *Thrips* may accumulate and from there re-infest orchid plants. This measure can reduce *Thrips* infestation of orchid stem cuttings in the long run.

Dipping of stem cuttings against *T. palmi*

Stem cuttings may be contaminated with *Thrips* pupae and eggs. Therefore, dipping whole stem cuttings in an effective insecticide would potentially reduce the *Thrips* population. An adjuvant should be added into the insecticide mixture.

Sanitation before orchid cultivating

Sanitation both inside and surrounding the farm or greenhouse is needed. *Thrips* pupation might occur on dead leaves, plants and humus accumulated in the greenhouse. This measure can reduce *Thrips* infestations on orchids.

Provide area to dispose of damaged orchids

An area to dispose of orchids damaged by any developing stages of *T. palmi* should be provided. The orchids should be monitored during flowering stages. Insecticides should also be applied. This is considered effective for reducing the population.

Production and control measures in the field

Blue sticky traps

Deploying blue sticky traps is the method used for both pest monitoring and control in orchid farming systems. It is suggested that farmers hang one blue sticky trap per 4 m^2 above the tips of flowering orchid stems. The traps should be changed occasionally. This method is efficient at reducing the infestation of *Thrips* on orchids.

Foliar and flower spray programmes

A control measure, considered as effective as using methyl bromide, to reduce *Thrips* infestation on orchids for cut stems is foliar and flower spray programmes. These programmes include:

- Programme A (low population of *Thrips*): carbosulfan/imidacloprid/acephate
- Programme B (medium population of *Thrips*): fipronil/carbosulfan/imidacloprid
- Programme C (high population of *Thrips*): spinosad/carbosulfan/imidacloprid/fipronil

Choice of programme depends on *T. palmi* density, therefore monitoring is needed before spraying. The presence of *Thrips* are classed as low, medium and high population density, in 10, 11–50 or > 50 inflorescences in a typical 0.16 ha area respectively. Insecticide application techniques should be considered, e.g. spray volume, nozzle types, pressure and timing.

Field sanitation

During orchid cultivation, field sanitation is important and necessary to reduce the population of *Thrips* in greenhouses. It is suggested that farmers remove unwanted planting materials and infested flowers as well as weeds on and under the planting table. Material for disposal should be sprayed with insecticides to eradicate *T. palmi* with which it may be contaminated.

Harvesting and picking

Holding and collecting areas for cut flowers kept clean and far from greenhouse

Thrips palmi can be easily distributed from place to place because of its small size and hence wind or the cultivation process have significant impacts on pest infestation in orchid cut stem products. Therefore we suggest that the flower cutting area should be cleaned and also be far from the greenhouse. Also, flower containers should be covered with plastic or closed jars used.

Processing, treatment, packing in centralised facility

Select export quality stems

Removing defective flowers from the orchids of export quality is important to reduce the chances of *Thrips* infestations. Orchid cut stems with pests or signs of pests should be disposed of in the assigned area. The examination should be performed under a magnifying glass. Persons well-trained at diagnosing *T. palmi* are necessary.

Methyl bromide fumigation treatment

This treatment is currently thought to be the most effective measure to eradicate *T. palmi* contaminating orchid cut-stem flowers. A dose of 20g/m^3 of methyl bromide is used to fumigate flowering boxes for 90 minutes, after which they are left for 3 hours to ensure that *T. palmi* is entirely eradicated. Fumigation chambers must be certified in good condition by the DOA.

Inspection at port of departure

Quarantine inspection (phytosanitary certificate)

This measure is to ensure that there is no *T. palmi* infestation in exported products. Persons well-trained in diagnosing *Thrips* are necessary to carry this out. Appropriate sample sizes should be considered. The sample of cut flower stems is examined by quarantine officers using a magnifying glass and approved by releasing a phytosanitary certificate.

8.3.7 Decision Support System

Creating the DSS and evaluating the measures primarily involved four expert members: Dr Manita Kongchuensin (decision making and evaluation), Dr Charuawat Taekul and Dr Peter Whittle (DSS preparation and CP-BN analysis) and Mr Somrouy Roumchaiapicul (decision making and orchid field expertise). Decision making was based on information from stakeholders (Thai Orchid Exporters Association and Thai Orchids Garden Enterprise Association), entomologists and local orchid farmers.

Evaluation of the DSS was done several times based on the parameter sensitivity, recognised from CP-BN analysis. The preliminary result (Figure 8.16) showed the estimates in the DSS that contribute to the CP-BN analysis which shows no *Thrips* infestation at Control Point 1. This suggests that the estimation of measure parameters was too optimistic and in fact should be rather lower. A second evaluation, therefore, was made on several aspects after full discussions taking into account information from scientific papers, experts, orchid farmers and stakeholders. The results of the second evaluation are promising (Figure 8.17). These findings suggest that the sensitivity test in the DSS process is important because it can help generate more reliable results.

8.3.8 Control Point–Bayesian Network

The CP-BN is constructed from the DSS. The structure was corrected and verified by the team. After review, 'Monitoring with a Berlese funnel' was removed as a separate measure since this should be included in the measure 'Spray programmes' as part of achieving maximum efficacy. The 'Farm layout and buildings' measure was also excluded from the model, following comments from stakeholders that greenhouses are difficult to relocate and the cost of implementation would be relatively high. 'Soaking flower stems' was also left out.

Risk management measures available (automatically read in from Table B2)	Efficacy: 1.1 a) What is its potential contribution to risk reduction?	Efficacy: 1.1 b) Uncertainty	Efficacy: Graphic	Verification: 1.2 a) The measure can be verified?	Verification: 1.2 b) Uncertainty	Verification: Graphic
2.1 Avoid cultivating host plants of Thrips palmi around planting area	Medium	Low		With some difficulty	Medium	
2.3 Farm layout and building	Low	Low		Difficult	Low	
2.4 Dipping of stem cuttings against Thrips palmi	High	Low		Very easy	Very low	
3.1 Sanitation both inside and surrounding farm or greenhouse	High	Low		Very easy	Very low	
3.2 Provide area to dispose of orchids damaged by pests and planting materials which may host Thrips palmi, and insecticides should be applied on them	High	Very low		Very easy	Very low	
4.1 Pest monitoring at flowering stage either by eye or using Berlese funnel	Very high	Very low		Easy	Low	
4.2 Blue sticky traps are applied	Low	Medium		Easy	Low	
4.4 Foliar and flower spray programmes: - programme A (low population of Thrips): carbosulfan/imidacloprid/acephate - programme B (medium population of Thrips): fipronil/carbosulfan/imidacloprid - programme C (high population of Thrips): spinosad/carbosulfan/imidacloprid/fipronil	Very high	Low		Very easy	Low	
4.5 Field sanitation	High	Medium		Easy	Low	
6.2 Holding collecting areas for cut flowers kept clean and far from greenhouse	Low	High		With some difficulty	Medium	
10.1 Soaking cut flower stems in water container to remove Thrips palmi and store in the separated area	Medium	Low		Easy	Low	
10.2 Select export quality stems by removing defective cut flowers of orchids with pests or sign of pests and disposing of them in the assigned area	Very high	Very low		Easy	Low	
11.3 Packaging box or container for export shall be new, clean and strong	High	Very low		With some difficulty	Medium	
11.4 Methyl bromide fumigation treatment	Very high	Medium		Very easy	Medium	
13.1 Quarantine inspection/interception (phytosanitary certificate)	Very high	Very low		Easy	Very low	

Figure 8.16 Decision Support System (Table C1) for *Thrips* on orchids in Thailand. The measure parameters in the first evaluation are estimated too optimistically and should be rather lower

VH, 'Very high'; H, 'High'; M, 'Moderate', L, 'Low'; VL, 'Very low'
VE, 'Very easy'; E, 'Easy'; SD, 'Some difficulty'; D, 'Difficult'; VD, 'Very difficult'

Risk management measures available (automatically read in from Table B2)	Efficacy			Verification		
	1.1 a) What is its potential contribution to risk reduction?	1.1 b) Uncertainty	Graphic	1.2 a) The measure can be verified?	1.2 b) Uncertainty	Graphic
2.1 Avoid cultivating host plants of Thrips palmi around planting area	Low	High		Easy	Medium	
2.3 Farm layout and building	Low	Medium		Easy	Medium	
2.4 Dipping of stem cuttings against Thrips palmi	Very low	Medium		Very difficult	Medium	
3.1 Sanitation both inside and surrounding farm or greenhouse	Low	Low		With some difficulty	Low	
3.2 Provide area to dispose of orchids damaged by pests and planting materials which may host Thrips palmi, and insecticides should be applied on them	Low	High		Difficult	Medium	
4.1 Pest monitoring at flowering stage either by eye or using Berlese funnel	High	Medium		Easy	Very low	
4.2 Blue sticky traps are applied	Low	Medium		Easy	Very low	
4.4 Foliar and flower spray programmes: - programme A (low population of Thrips): carbosulfan/imidacloprid/acephate - programme B (medium population of Thrips): fipronil/carbosulfan/imidacloprid - programme C (high population of Thrips): spinosad/carbosulfan/imidacloprid/fipronil	High	Very low		Very easy	Very low	
4.5 Field sanitation	Medium	Low		Easy	Medium	
6.2 Holding collecting areas for cut flowers kept clean and far from greenhouse	Very low	Very low		Very difficult	Very low	
10.1 Soaking cut flower stems in water container to remove Thrips palmi and store in the separated area	Very low	Very low		Very difficult	Very low	
10.2 Select export quality stems by removing defective cut flowers of orchids with pests or sign of pests and disposing of them in the assigned area	Very high	High		Easy	Medium	
11.3 Packaging box or container for export shall be new, clean and strong	Very low	Very low		Very difficult	Very low	
11.4 Methyl bromide fumigation treatment	Very high	High		Very easy	Very low	
13.1 Quarantine inspection/interception (phytosanitary certificate)	Medium	Low		Very easy	Low	

Figure 8.17 Decision Support System (Table C1) for *Thrips* on orchids in Thailand. The second evaluation is fully estimated from the experts and stakeholders

VH, 'Very high'; H, 'High'; M, 'Moderate', L, 'Low'; VL, 'Very low'
VE, 'Very easy'; E, 'Easy'; SD, 'Some difficulty'; D, 'Difficult'; VD, 'Very difficult'

8.3.9 Control Point–Bayesian Network analysis

The CP-BN analysis followed the steps described below.

a. Run the model and evaluate 'realism'

The starting point for *Thrips* infestation was set at 90% 'High' and 10% 'Low' and the parameters for the submodel in each measure were set according to the CP-BN in the DSS spreadsheet. The model was executed, and the results are shown in Figure 8.18.

The potential infestation of *Thrips* at the pre-planting Control Point after applying four effective measures (No alternative host

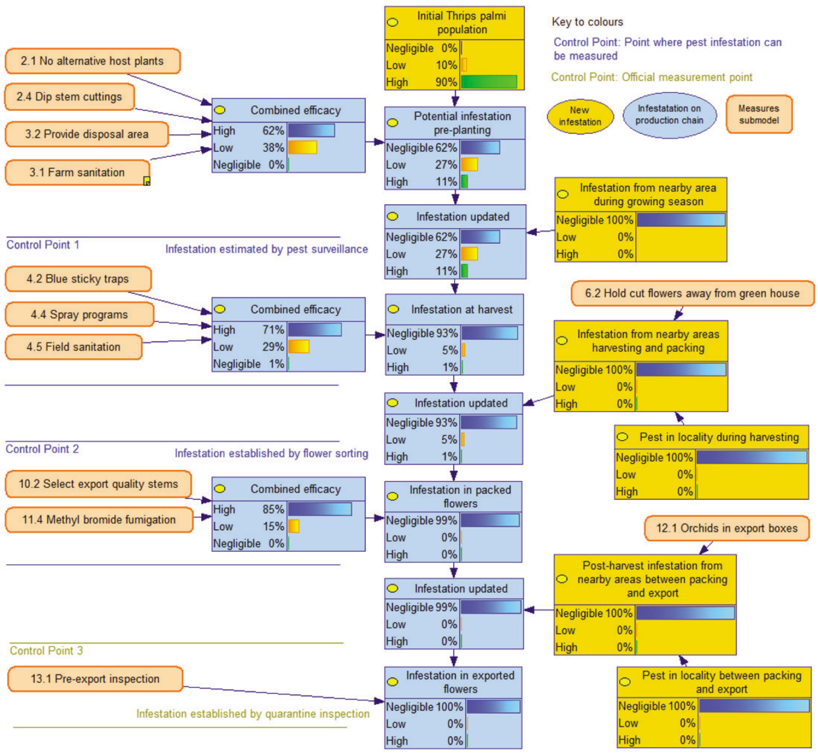


Figure 8.18 Systems Approach model of risk management for *Thrips palmi* on exported orchids from Thailand to the EU. Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation

plants, Dip stem cuttings, Provide disposal area and Farm sanitation) is displayed as 11% 'High', 27% 'Low' and 62% 'Negligible'. The infestation level, however, reaches 1% 'High', 5% 'Low' and 93% 'Negligible' after applying the control measures in the field including 'Blue sticky traps', 'Spray programs' and 'Field sanitation'. The orchid export product is free from pest infestation after Control Point 2 (Figure 8.18) and applying the measures: 'Select export quality stems' and 'Methyl bromide fumigation'.

Using the same parameters (for efficacy and implementation) in each measure, the model was executed again using an initial 90% *Thrips* infestation and contamination at each control point along the Production Chain at a rate of 50% infestation. The results here

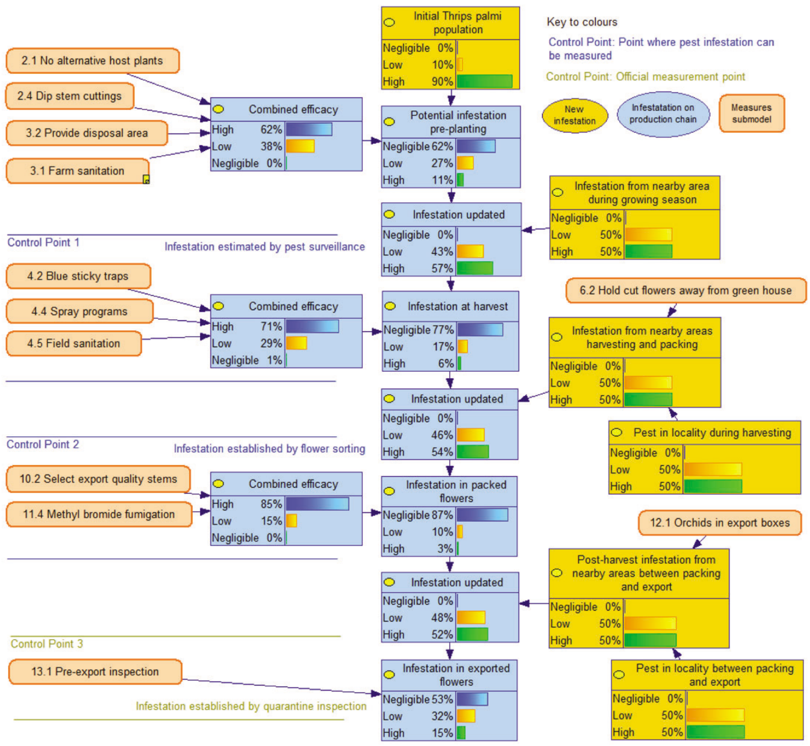


Figure 8.19 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation and contamination at each control point along the Production Chain at a rate of 50% infestation

revealed that the density of *Thrips* infestation before export is 15% 'High', 32% 'Low' and 53% 'Negligible' (Figure 8.19).

b. Switch off all measures and check infestation

After switching off all measures at each control point, and using the same initial pest infestation level of 0% 'Negligible', 10% 'Low' and 90% 'High' (Figure 8.20), the model was run again. The results are the same at each control point.

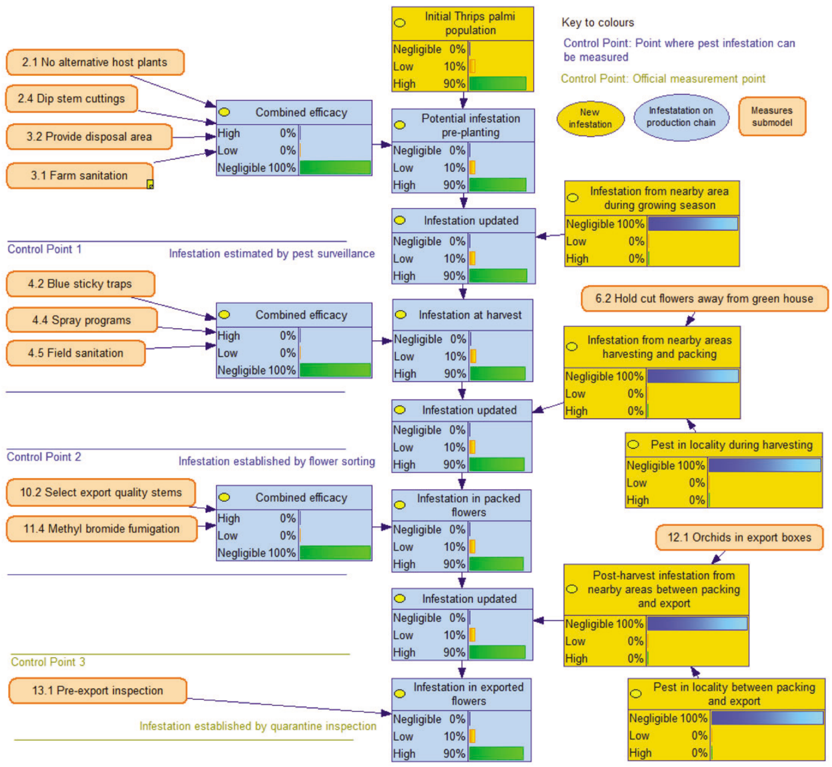


Figure 8.20 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation and all control measures inactivated

c. Switch back on one at a time and test sensitivity to changing the measure parameters

After inactivating all measures, switching back on a single measure was seen to alter the level of pest infestation at the relevant control point and thereafter. Activating only 'Farm sanitation', for example, gave these rates of infestation: 34% 'High', 55% 'Low', and 12% 'Negligible', maintaining the same rate from infestation at harvest to infestation in exported flowers (Figure 8.21). This run of the model excluded contamination by *Thrips* at each control point. Similar results were shown in another execution of the model: activating the measure 'No alternative host plant', the rate of infestation (32% High, 41% Low and 27% Negligible) is consistent until the end of Production Chain before export (Figure 8.22).

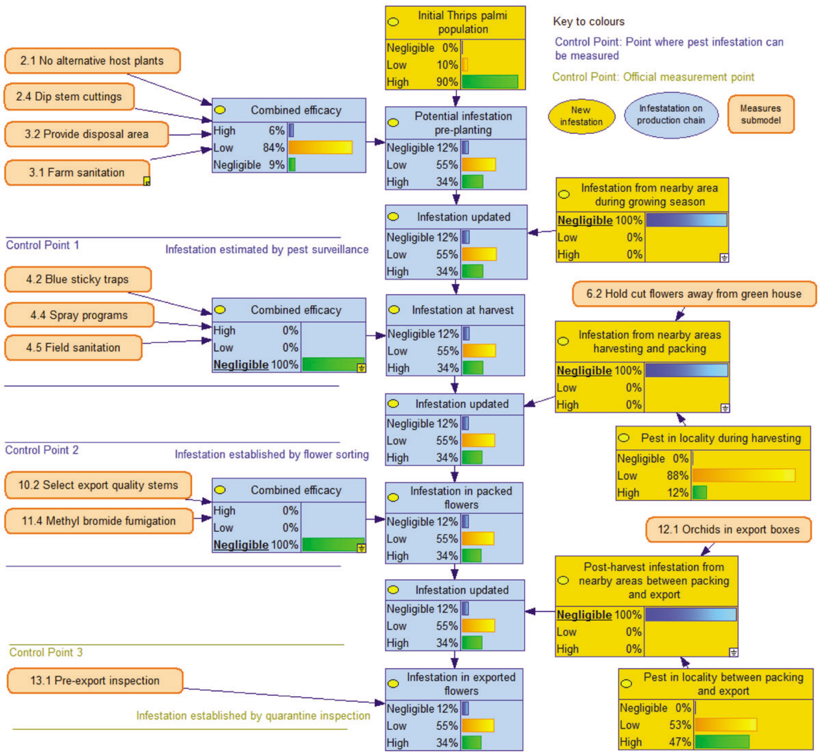


Figure 8.21 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation and only the 'Farm sanitation' measure activated

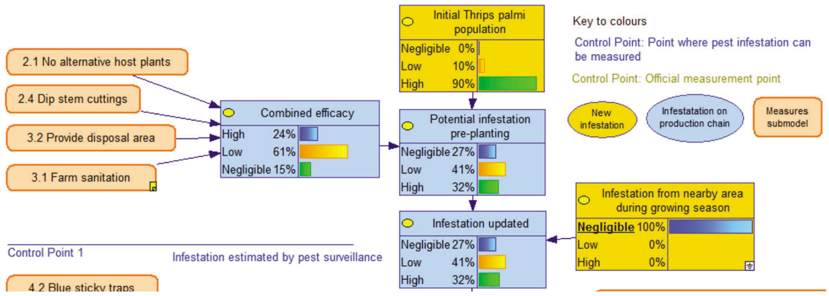


Figure 8.22 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation and activating a single measure, 'No alternative host plants'

d. Switch off each measure singly and report on changes

For an initial *Thrips* infestation of 90% and no infestation along the Production Chain, despite inactivating the important measure 'Methyl bromide fumigation', the level of *Thrips* infestation in flowers at the export stage is relatively low: 0% 'High', 1% 'Low' and 99% 'Negligible' (Figure 8.23). This suggests that integrated control measures can have a significant impact on controlling *Thrips* infestation.

Nevertheless, an execution of the model with a 90% initial *Thrips* density and a 50% chance (either low or high) of further infestation at each control point revealed that *Thrips* density on the orchid flower at the export stage was relatively high: 5% 'High', 15% 'Low' and 81% 'Negligible' (Figure 8.24). However, 50% may be an overestimation of the chance of a high infestation between packing and export. This process is quite sensitive because it depends on management after Control Point 2 measures. If methyl bromide fumigation is applied, the orchid cut-stems should be left for 3 hours to allow the *Thrips* to be fully eradicated. If the integrated control measures are effective without using methyl bromide, the process between packing and exporting is not as long and thus contamination and/or re-infestation may not occur.

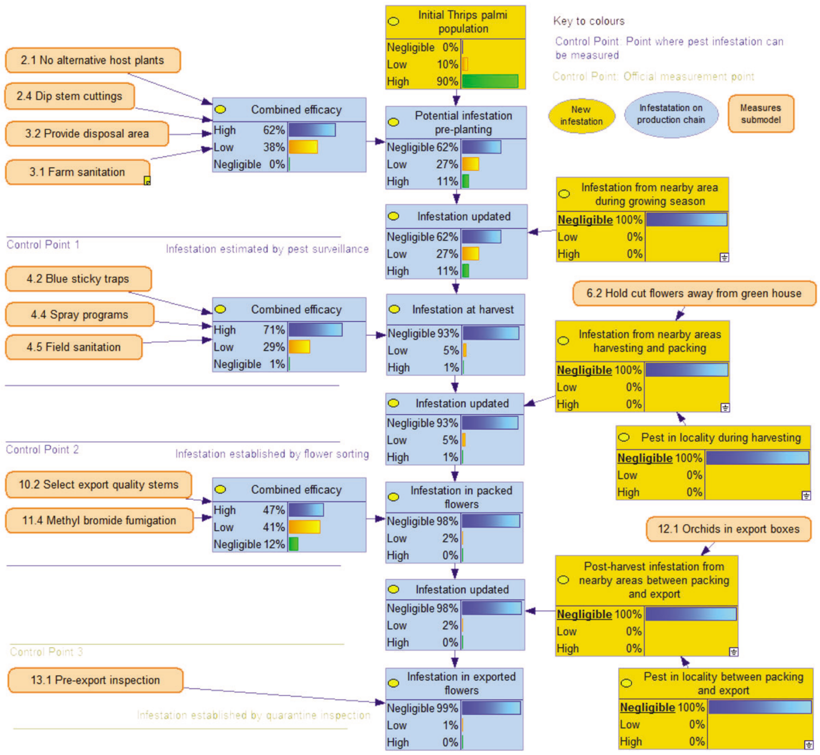


Figure 8.23 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation and inactivated single measure, 'Methyl bromide fumigation'

e. Make different combinations of measures and evaluate

Arrangements of different combinations of measures were tested. In Figure 8.25, the model was run with an initial 90% *Thrips* infestation, inactivation of two measures (Methyl bromide fumigation and Spray programs) and 50% contamination at Control Points 1 and 2. The result showed that the level of infestation before export was high: 4% 'High', 13% 'Low' and 83% 'Negligible'.

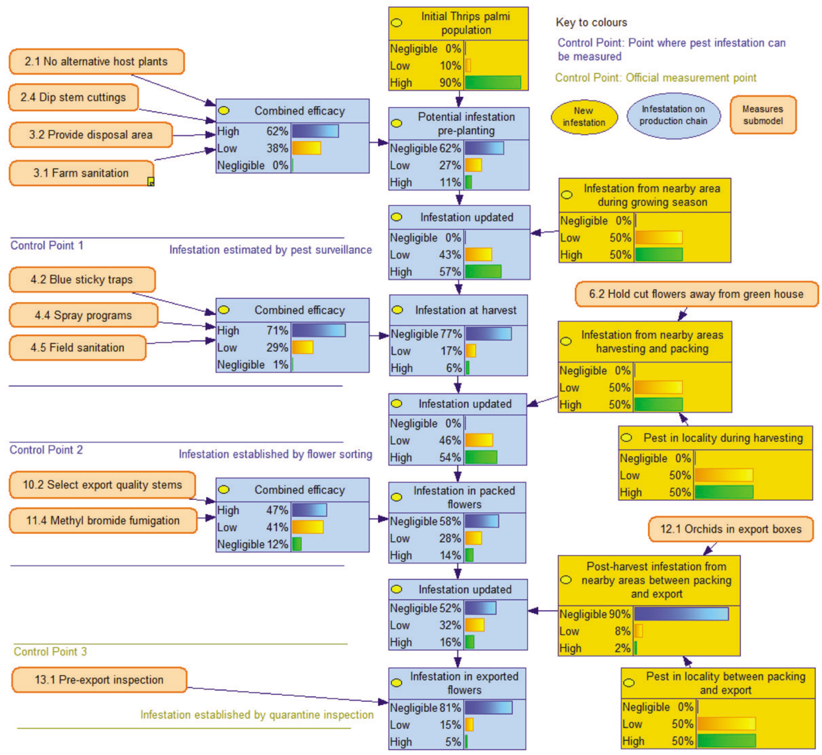


Figure 8.24 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation, the single measure 'Methyl bromide fumigation' inactivated, and 50% contamination of Thrips at each control point

In order to examine what was judged to be a more realistic scenario, infestation from an area nearby was added at Control Point 2 during harvesting, set as 100% 'Low'. The model execution (i.e. with initial *Thrips* at 90%, 50% 'High' and 'Low' at Control Point 1, and 100% 'Low' at Control Point 2) after activating 'Methyl bromide fumigation' at 100% full efficacy and implementation showed that the level of *Thrips* infestation at the export stage is low: 0% 'High', 1% 'Low' and 99% 'Negligible' (Figure 8.26).

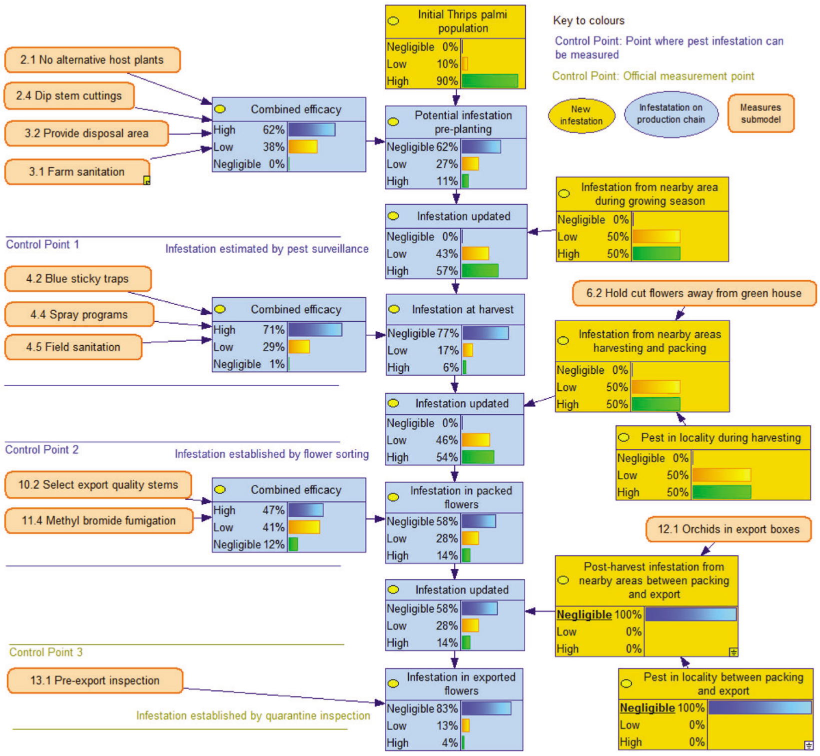


Figure 8.25 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation, inactivation of 'Methyl bromide fumigation' and 'Spray programs', and 50% contamination at Control Points 1 and 2

f. Based on strength of influence – select the strongest ones, or the ones most likely to be included in a documented and regulated Systems Approach

The model was run again to investigate the integrated measures representing equivalence to using methyl bromide fumigation. As shown in Figure 8.27, the CP-BN model was generated with an initial 90% *Thrips* infestation, 'Methyl bromide fumigation' inactivated, and 'Spray programs' and 'Field sanitation' activated at 100% full efficacy and implementation. The results showed that the level of *Thrips* infestation in orchids at the export stage was relatively low: 0% 'High', 8% 'Low' and 92% 'Negligible'. In comparison,

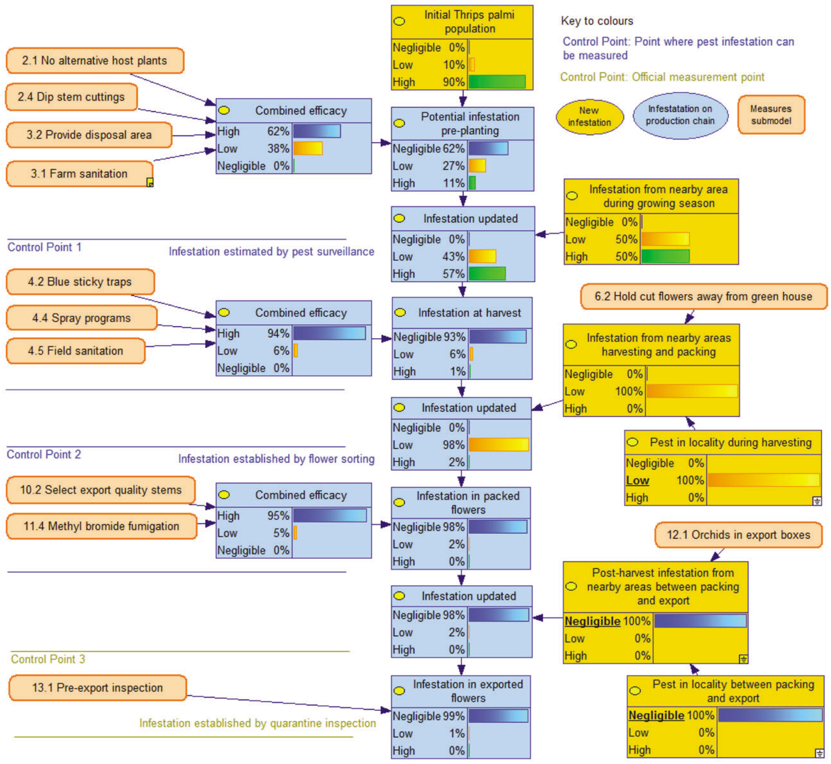


Figure 8.26 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation and activation of 'Methyl bromide fumigation' at 100% full efficacy and implementation

using methyl bromide fumigation (Figure 8.26) gave an infestation level for orchid stems at the export stage of 1% 'Low' and 99% 'Negligible'. However, if other measures besides 'Spray programs' and 'Field sanitation', e.g. 'Blue sticky traps' and 'No alternative host plants', are set at 100% implementation, the integrated measures could ultimately replace the use of methyl bromide fumigation.

g. What is the minimum number of measures required to achieve objective?

In general more than two control measures are required to achieve the objective.

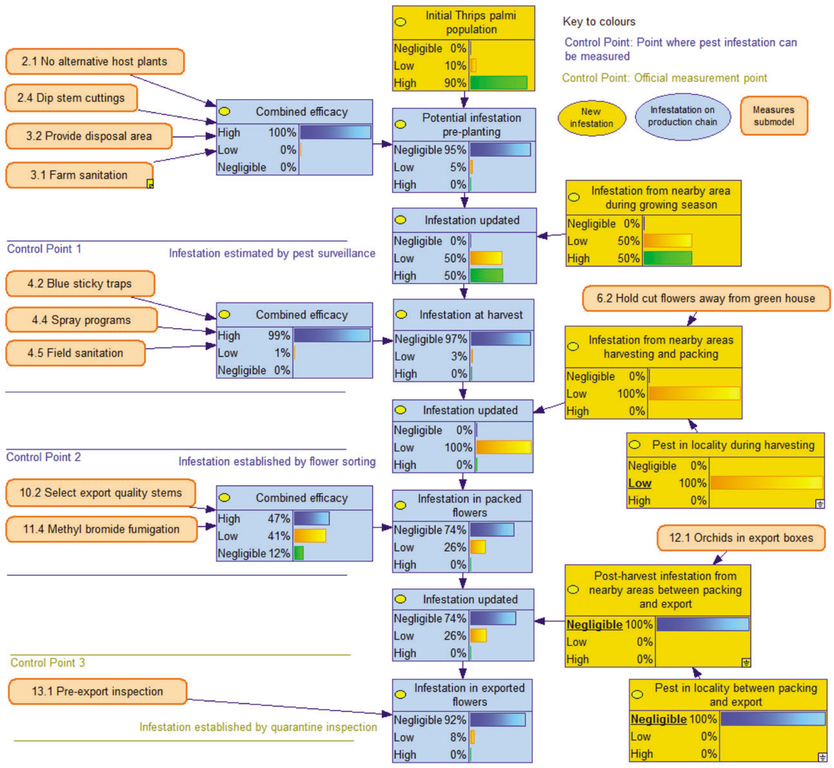


Figure 8.27 Control Point–Bayesian Network output with initial 90% *Thrips palmi* infestation 'Methyl bromide fumigation' turned off and 'Spray programs' and 'Field sanitation' activated at 100% full efficacy and implementation

h. Enter evidence at each control point to simulate re-infestation or multiplication or treatment failure

Adding evidence at each control point to simulate re-infestation shows the importance of the management programme. The 'Field sanitation' measure, for example, plays a vital role in pre-planting and pest control in the field. Leaving some plant material in the field facilitating re-infestation by *Thrips* or carelessly moving products from one place to another are primary causes of treatment failure.

i. Identify measures that could be improved technically to deliver an improved pest management outcome

The 'Spray programs' and 'Field sanitation' measures need to be improved in order to obtain better pest management outcomes. Many procedures should be taken into account such as type of insecticides, spray techniques, and pest monitoring.

8.3.10 Conclusions about Systems Approach

The selected measures including 'Spray programmes' and 'Field sanitation' are likely to alter the use of methyl bromide fumigation to control *T. palmi* infestation in export orchids. More evaluation, however, may be needed to obtain better results with these alternative measures. Understanding the evaluation system was important for obtaining the promising results. Collaborating with the stakeholders facilitated better understanding of the difference between evaluated theory and practical implementation.

The productive discussion on the evaluation system with the experts and stakeholders is acknowledged.

8.3.11 Conclusions about the Beyond Compliance project

The Systems Approach allows scientists to think more analytically and systematically (critical thinking). The development of IPM, for example, is applied to the Systems Approach measure (IPM to Systems Approach). The Beyond Compliance project helped to improve understanding of orchid cultivation; e.g. measures are chosen by farmers based on investment cost and it is difficult for them to change to other higher cost measures. One lesson learnt was that theory may not be practical to implement in the field. The project allowed experience to be shared among counterparts and to brainstorming, which led to the promising result. Throughout the project, the people involved were equipped with the knowledge base, especially analytical tools, to facilitate compliance with the requirements of importing countries and trading partners. They learned to utilize a new and innovatory method, i.e. CP-BN, for pest risk management and other challenges for agricultural export products.

8.4 Case study: Malaysia

8.4.1 Overview

This case study involved the export of jackfruit (*Artocarpus heterophyllus*) from Malaysia to China. The primary objective of the study was to expand market access for jackfruit into this SPS-stringent market. The secondary objectives were to use the BN model to support a proposal for a Systems Approach for jackfruit, and to increase confidence and communication in trade negotiations. The lead organisation for this case study was the Malaysia Department of Agriculture (DOA). The case study team included Yusof Othman, Lailatul Jumaiyah, Saleh Huddin, Aini Rozaini and Abu Bakar. The stakeholders in the case study included: crop protection and plant quarantine officers of the DOA; researchers at the Malaysian Agricultural Research and Development Institute (MARDI); officers of the Federal Agriculture Marketing Authority (FAMA); officers and extension officers of the DOA in various states (Pahang, Selangor, North Sembilan and Johor); and growers, packing house operators and exporters of jackfruit. All the stakeholders were identified through registers of the DOAs of Malaysia and the Ministry of Agriculture and Agri-based Industry (MOA). Group and individual discussions were held to elicit early information. They were also involved in the discussions during two stakeholder meetings held in September 2012 and in February 2013.

Jackfruit is one of the largest fruit known, each typically weighing 15–20 kg. Its yellowish-orange fruit pulp tastes like a combination of banana and pineapple. It is sold as whole fruit or minimally processed into a ready-to-eat pack. Presently the jackfruit-planted area is about 3,962 ha with an annual production of 27,459 mt. The fruit is marketed to Singapore, the Chinese Special Administrative

Region of Hong Kong and Taiwan, and this will be expanded into non-traditional markets such as mainland China, South Korea, the USA, Australia and Japan. These non-traditional markets have stringent phytosanitary requirements for imports. If Malaysia is to export jackfruit to the non-traditional markets, phytosanitary treatments need to be negotiated bilaterally with scientific evidence that the proposed alternative measures fulfil the SPS requirement of the importing country.

The principal jackfruit pest is fruit fly, although fruit borer and mealybug were also considered in this PRA-based study.

Existing pest risk management requirements include: sterile insect technique (SIT), pesticide spray management, male annihilation utilising the attraction of males to methyl eugenol baits, culling of over-crowded and disease-infested fruit, bagging of fruit 14 days after fruit set, harvesting at the right maturity index to prevent infestation of fruit fly, culling of fruit borer-infested fruit, securing fruit in bags to prevent pest re-infestation, fumigation with methyl bromide, quarantine inspection, and clearance inspection by China.

The pest risk management problem to solve was the appropriate combination of treatments as an alternative to the existing phytosanitary measures for the export of jackfruit to this non-traditional market.

8.4.2 Production Chain

The Production Chain developed during the case study is shown in Figure 8.28.

8.4.3 Decision Support System

The scope of DSS work was limited to information required to create and analyse the CP-BN. The study did not focus on completing the aspects of the DSS peripheral to the CP-BN, or that focus more specifically on governance.

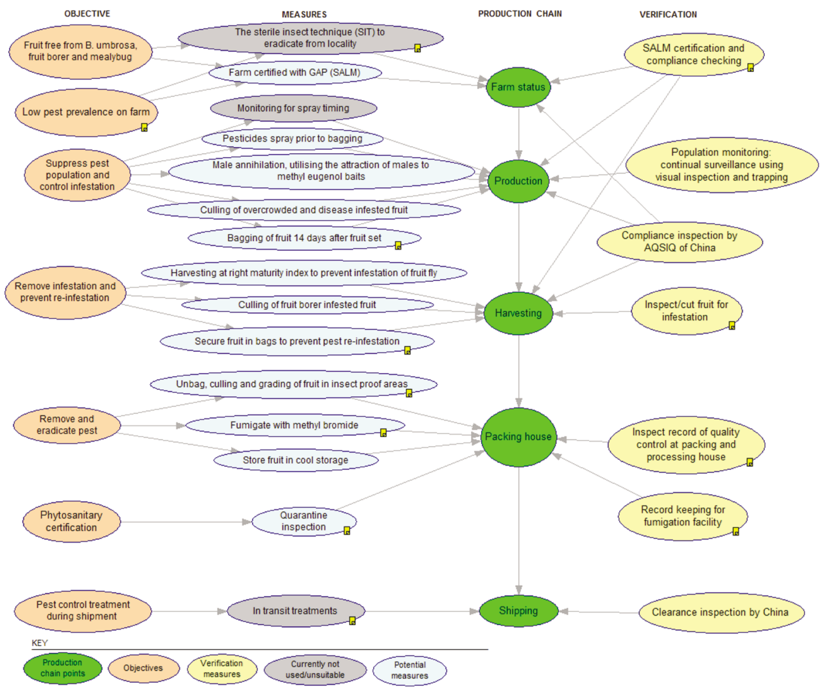


Figure 8.28 Production Chain for jackfruit in Malaysia

AQSIQ, General Administration of Quality Supervision, Inspection and Quarantine (China); B. umbrosa, *Bactrocera umbrosa*; GAP, Good Agricultural Practices; MB, methyl bromide; SALM, Skim Amalan Ladang Baik Malaysia (Malaysian Farm Certification Scheme for Good Agricultural Practice)

The following figures are based on tables extracted from the DSS Excel™ spreadsheet constructed for the case study.

- Table A1. Basic information
- Table A2. Key factors to consider based on the proposed commodity/pathway
- Table B2. Selection of measures for fruit fly (and also fruit borer and mealybug) in whole jackfruit
- Table C1. Description of candidate measures
- Table C2. Evaluation of candidate measures

A1.01	Commodity/pathway addressed in this management plan	*Jackfruit whole fruit*
A1.02	Pest species addressed in this management plan	*Fruit flies (also fruit borer & mealybug)*
A1.03	Exporting country	*Malaysia*
A1.04	Importing countr(y/ies)	*China*
A1.05	Means of entry covered in this management plan	*Whole fruits on ship*
A1.06	Means of entry considered in the PRA (commercial trade [air, sea, land, post]; informal trade; natural spread...)	*Whole fruits on ship*
A1.07	Key host plants at risk	*Many hosts*
A1.08	Is a PRA and/or management plan (requirements for trade) already available for this or a closely related commodity/pathway?	*Yes, there is a USA PRA from Malaysia. China is preparing a PRA.*
A1.09	Is there existing similar trade in other regions using management measures? (Add details at end of table B2)	*Don't know*

Figure 8.29 Decision Support System (Table A1): Basic information

PRA, Pest Risk Analysis

- Tables D1 and D2. Maximum measure efficacy and Implementation standard conditional probability tables (CPTs)
- Examples of CPTs for the BN based on the above DSS information

Comments on Table A2 (Figure 8.30):

- A2.01: For fruit fly, the fruit bought at the supermarket will be of good quality and transported in refrigerated trucks and will be unlikely to be infested with fruit fly
- A2.02: Fruit fly would be likely to survive in some areas of China but less likely in other areas; it would depend on presence of suitable host plants and other conditions in the vicinity of where the fruit is sold in China
- A2.03: If the pest has the conditions to establish, it probably would also have the conditions to spread

- A2.04: Considering impact at local, regional and national levels
- A2.05: Minor infestation requires expertise to detect
- A2.06: Ease of detection depends on the stage of the life cycle of the pest. There are other fruit fly species that are not quarantine pests and they cannot be separated (identified) by morphology until the adult stage
- A2.07: Not known. It is assumed China has a similar organisation to Malaysia
- A2.08: If not controlled in an orchard, infestation would be common

All potential measures from the Production Chain were listed in Table B1 (not shown). After consideration of the potential and feasibility of these, a selection of measures for testing was drawn up (Table B2, excerpt shown in Figure 8.31). Table C1 (Figure 8.32) characterises the performance and implementing potential for each of the selected measures from Table B2. Notes associated with each row on Table C1 (Figure 8.32) included 'Way in which measure reduces risk' and 'Verification measure'.

	Key Factors	Score	Uncertainty
A2.01	Overall rating - Entry	Unlikely	Low
A2.02	Overall rating - Establishment	Moderately unlikely	Low
A2.03	Overall rating - Spread	Moderate	Low
A2.04	Overall rating - Impact	Minor	Low
A2.05	How easy is it to detect the key organisms on the	Easy	Medium
A2.06	How easy is it to identify the key organisms?	With some difficulty	Medium
A2.07	How well organised is the sector at risk in the importing country?	Mod. well organised	Medium
A2.08	What is the estimated prevalence of the pest in the area where commodity is cultivated?	High	Low

Figure 8.30 Decision Support System (Table A2): Key factors to consider based on the proposed commodity/pathway

(A) Stages: Planting and preparation, Field/orchard/farm, Harvesting

Pre-season for perennial crops / pre-planting for annual biannual crops	*Production and control measures in field, orchard, glasshouse or other growing facility*	*Flowering and fruiting*	*Harvesting, picking*
Sterile insect technique (SIT)	Pesticides spray programme Male annihilation, utilising the attraction of males to methyl eugenol baits	Culling of overcrowded and disease infested fruit Bagging of fruit 14 days after fruit set	Harvesting at right maturity index to prevent infestation of fruit fly Culling of fruit borer infested fruits Secure fruit in bags to prevent pest re-infestation

(B) Stages: Processing and treatment, Export from country, Import to country

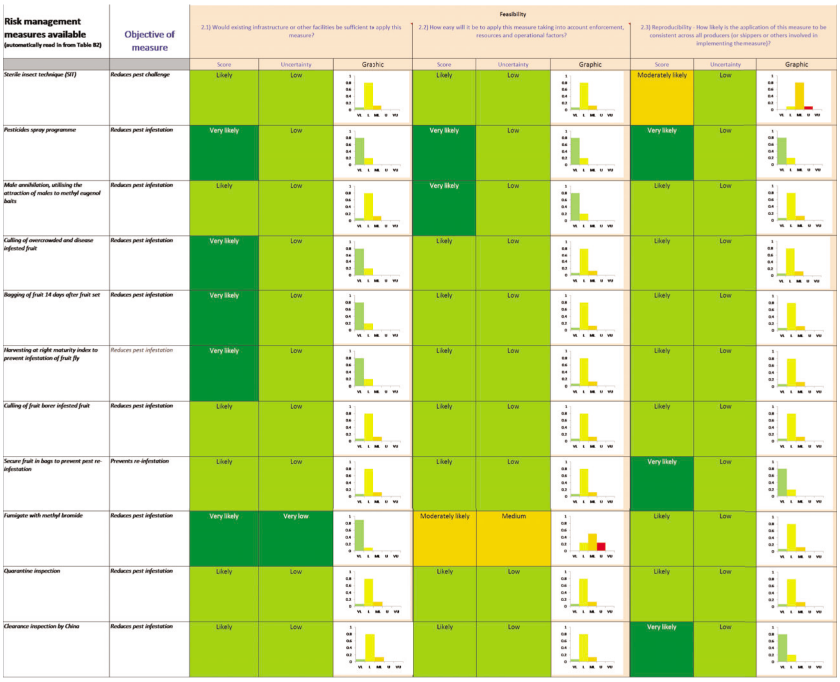
Processing, treatment, and inspection in centralised facility	*Packed in centralised facility*	*Transportation to port in exporting country*	*Inspection at port of departure from exporting country*	*Treatments or environment during transportation*	*Entry point to importing country*
Fumigate with methyl bromide			Quarantine inspection		Clearance inspection by China

Figure 8.31 Decision Support System (Table B2): Selection of measures for fruit fly (and also fruit borer and mealybug) in jackfruit (whole fruit) in Malaysia

Risk management measures available (automatically read in from Table B2)	Efficacy			Verification		
	1.1 a) What is its potential contribution to risk reduction?	1.1 b) Uncertainty	Graphic	1.2 a) The measure can be verified?	1.2 b) Uncertainty	Graphic
Sterile insect technique (SIT)	Very high	Low		Very easy	Very low	
Pesticides spray programme	High	Medium		Easy	Low	
Male annihilation, utilising the attraction of males to methyl eugenol baits	High	Low		With some difficulty	Low	
Culling of overcrowded and disease infested fruit	High	Low		Easy	Low	
Bagging of fruit 14 days after fruit set	Very high	Low		Easy	Low	
Harvesting at right maturity index to prevent infestation of fruit fly	High	Low		Easy	Medium	
Culling of fruit borer infested fruit	Medium	Low		Very easy	Low	
Secure fruit in bags to prevent pest re-infestation	High	Low		Easy	Very low	
Fumigate with methyl bromide	Very high	Very low		Very easy	Very low	
Quarantine inspection	High	Low		Easy	Low	
Clearance inspection by China	High	Low		Easy	Low	

Figure 8.32 Decision Support System (Table C1): Description of candidate measures for fruit fly in jackfruit in Malaysia

VH, 'Very high'; H, 'High'; M, 'Medium', L, 'Low'; VL, 'Very low'
VE, 'Very easy'; E, 'Easy'; SD, 'Some difficulty'; D, 'Difficult'; VD, 'Very difficult'



Risk management measures available (automatically read in from Table B2)	Objective of measure	Feasibility: 2.1) Would existing infrastructure or other facilities be sufficient to apply this measure?			2.2) How easy will it be to apply this measure taking into account enforcement, resources and operational factors?			2.3) Reproducibility - How likely is the application of this measure to be consistent across all producers (or shippers or others involved in implementing the measure)?		
		Score	Uncertainty	Graphic	Score	Uncertainty	Graphic	Score	Uncertainty	Graphic
Sterile insect technique (SIT)	*Reduces pest challenge*	Likely	Low		Likely	Low		Moderately likely	Low	
Pesticides spray programme	*Reduces pest infestation*	Very likely	Low		Very likely	Low		Very likely	Low	
Male annihilation, utilising the attraction of males to methyl eugenol baits	*Reduces pest infestation*	Likely	Low		Very likely	Low		Likely	Low	
Culling of overcrowded and disease infested fruit	*Reduces pest infestation*	Very likely	Low		Likely	Low		Likely	Low	
Bagging of fruit 14 days after fruit set	*Reduces pest infestation*	Very likely	Low		Likely	Low		Likely	Low	
Harvesting at right maturity index to prevent infestation of fruit fly	Reduces pest infestation	Very likely	Low		Likely	Low		Likely	Low	
Culling of fruit borer infested fruit	*Reduces pest infestation*	Likely	Low		Likely	Low		Likely	Low	
Secure fruit in bags to prevent pest re-infestation	*Prevents re-infestation*	Likely	Low		Likely	Low		Very likely	Low	
Fumigate with methyl bromide	*Reduces pest infestation*	Very likely	Very low		Moderately likely	Medium		Likely	Low	
Quarantine inspection	*Reduces pest infestation*	Likely	Low		Likely	Low		Likely	Low	
Clearance inspection by China	*Reduces pest infestation*	Likely	Low		Likely	Low		Very likely	Low	

Figure 8.33 Decision Support System (Table C2): Evaluation of candidate measures for fruit fly in jackfruit in Malaysia

VL, 'Very likely'; L, 'Likely'; ML, 'Moderately likely', U, 'Unlikely'; VU, 'Very unlikely'

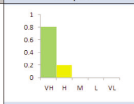
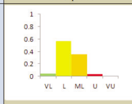
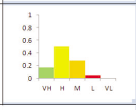
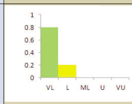
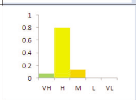
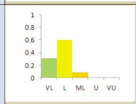
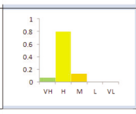
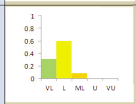
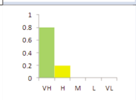
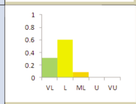
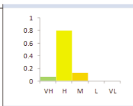
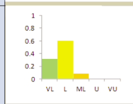
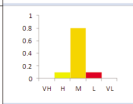
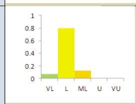
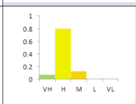
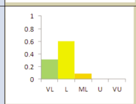
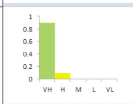
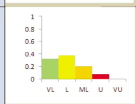
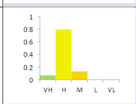
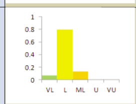
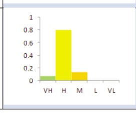
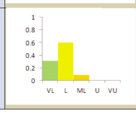
Risk management measures available (automatically read in from Table B2)	**Max. possible measure efficacy**		**Implementation standard**	
	Graphic	CPT	Graphic	CPT
Sterile insect technique (SIT)		P(High) = 1 P(Low) = 0		P(High) = 0.79 P(Low) = 0.21
Pesticides spray programme		P(High) = 0.81 P(Low) = 0.19		P(High) = 1 P(Low) = 0
Male annihilation, utilising the attraction of males to methyl eugenol baits		P(High) = 0.94 P(Low) = 0.06		P(High) = 0.96 P(Low) = 0.04
Culling of overcrowded and disease infested fruit		P(High) = 0.94 P(Low) = 0.06		P(High) = 0.96 P(Low) = 0.04
Bagging of fruit 14 days after fruit set		P(High) = 1 P(Low) = 0		P(High) = 0.96 P(Low) = 0.04
Harvesting at right maturity index to prevent infestation of fruit fly		P(High) = 0.94 P(Low) = 0.06		P(High) = 0.96 P(Low) = 0.04
Culling of fruit borer infested fruit		P(High) = 0.5 P(Low) = 0.5		P(High) = 0.94 P(Low) = 0.06
Secure fruit in bags to prevent pest re-infestation		P(High) = 0.94 P(Low) = 0.06		P(High) = 0.96 P(Low) = 0.04
Fumigate with methyl bromide		P(High) = 1 P(Low) = 0		P(High) = 0.81 P(Low) = 0.19
Quarantine inspection		P(High) = 0.94 P(Low) = 0.06		P(High) = 0.94 P(Low) = 0.06
Clearance inspection by China		P(High) = 0.94 P(Low) = 0.06		P(High) = 0.96 P(Low) = 0.04

Figure 8.34 Decision Support System (Tables D1 and D2): Maximum measure efficacy and Implementation standard conditional probability tables (CPTs) for fruit fly in jackfruit in Malaysia

VH, 'Very high'; H, 'High'; M, 'Medium', L, 'Low'; VL, 'Very low'
VL, 'Very likely'; L, 'Likely'; ML, 'Moderately likely; U, 'Unlikely'; VU, 'Very unlikely'

TABLE D3. CPT FOR NODE "Measure efficacy as implemented"		
Max. possible measure efficacy	**High**	**High**
Measure implementation standard	**High**	**Low**
HIGH	**0.9**	**0.1**
LOW	**0.1**	**0.8**
NEGLIGIBLE	**0**	**0.1**

TABLE D4. CPT FOR NODE "Level of pest infestation after treatment"					
Measure efficacy as implemented	**High**	**High**	**Negligible**	**Negligible**	**Negligible**
Current level of infestation	**Negligible**	**Low**	**Negligible**	**Low**	**High**
NEGLIGIBLE	**1.00**	**0.99**	**1.00**	**0.00**	**0.00**
LOW	**0.00**	**0.01**	**0.00**	**1.00**	**0.00**
HIGH	**0.00**	**0.00**	**0.00**	**0.00**	**1.00**
			Unchanged pest infestation if		
			measure efficacy is negligible		

Figure 8.35 Examples of conditional probability tables (CPTs) for the Bayesian Network based on Decision Support System information

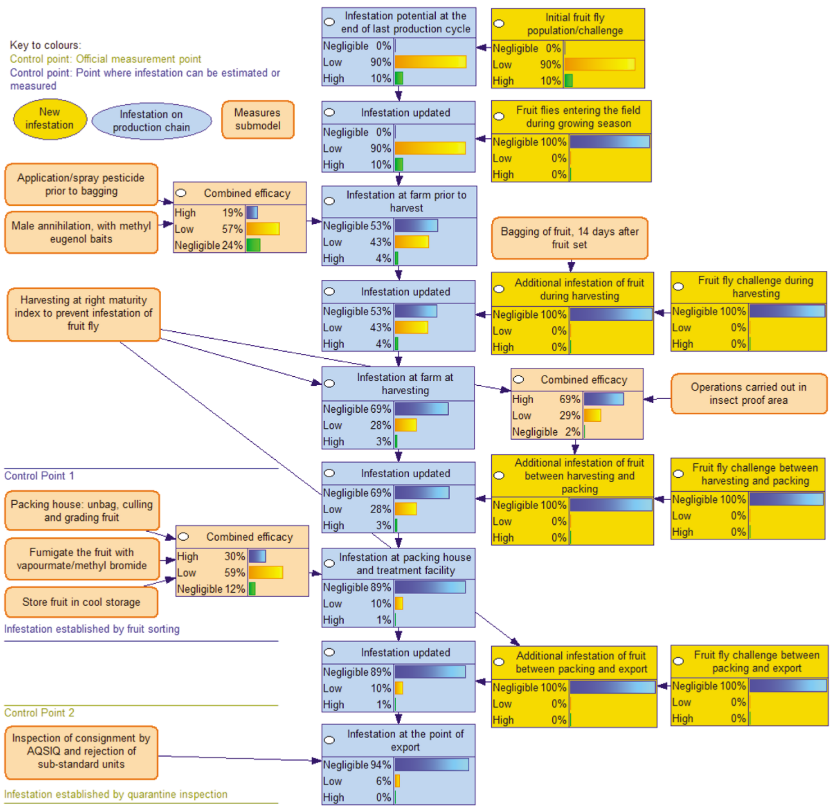


Figure 8.36 Bayesian Network for fruit fly in jackfruit in Malaysia

AQSIQ, General Administration of Quality Supervision, Inspection and Quarantine (China)

8.4.4 Control Point–Bayesian Network

Figure 8.36 shows the CP-BN for fruit fly in jackfruit, based on the developed Production Chain and DSS.

The CP-BN (Figure 8.36) provided a representation of the collated knowledge about this system, based on the information provided through the Production Chain and DSS. The CP-BN summarised the measures, processes, probabilities and associated uncertainties. It was used to assess the overall risk, develop scenarios assessments and facilitate understanding of the system and potential alternative measures.

8.4.5 Discussion

This project improved confidence and competence in the application of Systems Approaches, through:

- Discussion with stakeholders – implementation of various approaches in solving the SPS requirements and compliance to the protocol has changed the mindset of stakeholders
- Being able to expose stakeholders to the need to fulfil requirements, and to the benefit in exporting their products to the biosecurity stringent countries
- Gaining extensive technical tool experience in CP-BNs
- Developing better communication skills

8.5 The Philippines

8.5.1 Case study process and activities

For the Philippines we present a portion of the country report on the case study illustrating the Production Chain and its use with internal and external stakeholders.

8.5.2 Activity timeline and work plan progress

The initial step in the process was to formalise a group to work on the case study. The members of this group were: Merle B. Palacpac, Loreta Dulce, Thelma Soriano, Luben Marasigan, Glenn Panganiban and Elvin Carandang, all from the Bureau of Plant Industry (BPI) Plant Quarantine Service (PQS).

The topic finally selected for the case study for the Philippines was banana fresh fruit export to the continental USA. A work plan for the case study was developed for the two years July 2011 to June 2013. The Philippines started the project with a case study on the export of Hass avocado to South Korea. However, there was delay in South Korea completing the PRA process and hence the Philippines case study team decided to switch to the export of banana to the USA, which was then at the final stage of negotiation.

The first activity in the work plan was to gather information and evaluate the Production Chain from planting to the final product for export. The case study team visited banana production areas in Davao, specifically Dole Philippines, to evaluate the system for the production of banana from land preparation to harvest. Information gathered on this visit was used to inform the banana Production Chain used in the study.

The final Production Chain was evaluated and the phytosanitary measures that would address fruit fly (*Bactrocera* spp.) problems were identified for each step in the Production Chain. Evaluation and finalisation of the Production Chain was done with the help of Mr Peter Whittle and Ms Sandra Johnson (QUT, Australia) during their visit to the Philippines, 27 February – 2 March 2012 and remotely by the ICL team.

After completion of the draft model of Systems Approach for banana production, additional data requirements were established to move from a PRA to a CP-BN for pest risk management of banana. The DSS was developed to facilitate screening the Systems Approach measures for *Bactrocera* spp.

As part of the work plan, two orientation seminars on the BC project were conducted. The first, for the BPI PQS Pest Risk

Assessment and Market Access teams, was held on 30 January 2013 at the BPI Conference Room in Malate, Manila.

On 10 May 2013, the second seminar was organised for the different banana stakeholders: members of the Philippine Banana Growers Exporters Association (PBGEA) and Mindanao Banana Producers Exporters Association (MBPEA), potential exporters of banana, mango, pineapple, and technical staff from the regional office of the Department of Agriculture (DOA) and PQS Mindanao area.

The seminars aimed to inform the participants of the project about using the BN model as a tool in the Systems Approach for banana export to the USA and in developing probabilistic technical evidence that could build confidence in trade negotiations. They aimed to show how the tool can be applied to the conduct of a PRA for import commodities and in negotiating for access to new markets and sustaining existing markets.

Thirty members of the Market Access and Pest Risk Analysis teams and 45 technical staff representing the stakeholders participated in the seminars.

The following topics were discussed:

- Project background and objectives
- Key definitions
- ISPM on Systems Approach (FAO, 2002)
- Developing Systems Approach for pest risk management
- The Philippine case study (banana export to continental USA)

Some of the queries raised during the seminars are given in Box 8.1.

Box 8.1 Questions raised during Beyond Compliance orientation seminars

From the Pest Risk Assessment and Market Access Team:

- What are the things you need to start with the CP-BN?
- How to do it if you have many pests of concern?
- Are options indicated in the system or will they be manually inputted?
- Is the system available for download or only online?
- Who sets the standard?

From banana, mango and pineapple exporters and government agencies:

- Can the tool be used for plant diseases?
- Is the tool ready to be used?
- How can we get our hands on this system?
- Which comes first, certification or inspection?

8.5.3 Production Chain

The BC case study group formulated the banana Production Chain by first studying and evaluating the actual banana production chain in some of the banana producing areas in Mindanao. The Production Chain describes the whole process from planting to the final product for export.

The banana Production Chain is an important component of the case study. It shows the different stages in production where the pest of concern can be present and the points in the chain where measures can be applied to address the pest. It is a systematic approach in evaluating where and when to apply measures to mitigate the risk of a pest being included in the final export product.

The Production Chain (Figure 8.37) comprises the 11 stages in banana production and the mitigating measures identified to address fruit fly problems at each stage. Measures are described in more detail in Table 8.3.

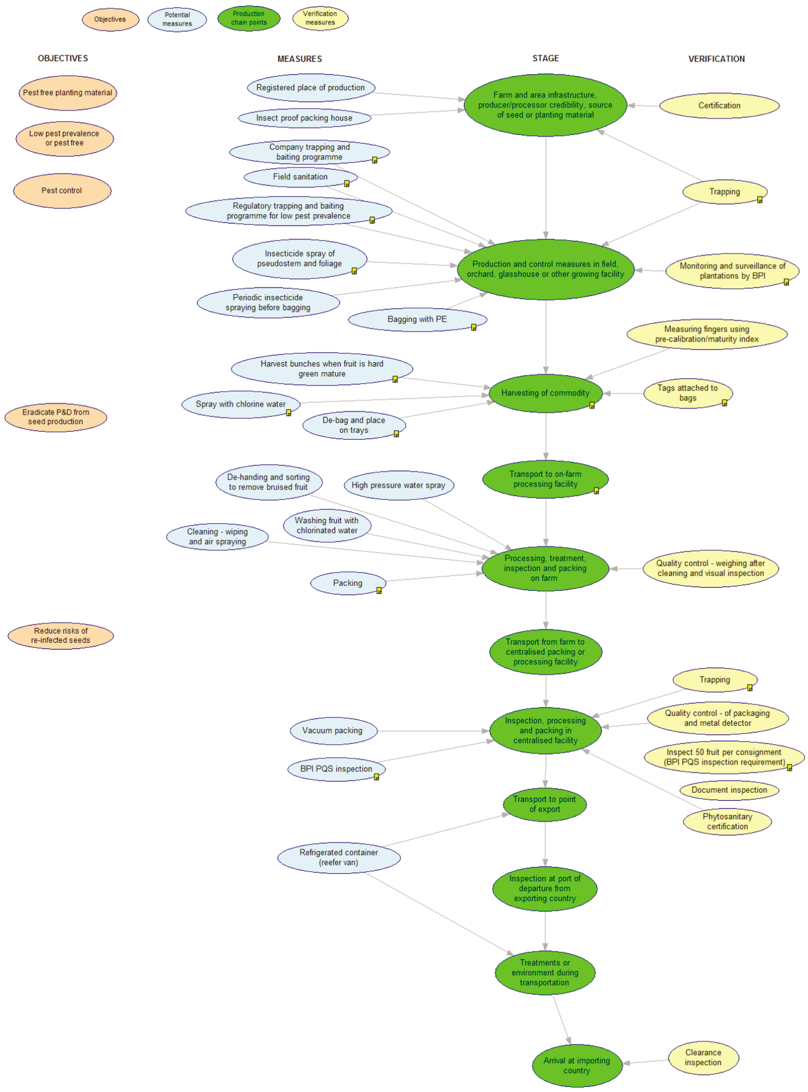


Figure 8.37 Production Chain for banana in the Philippines

BPI, Bureau of Plant Industry; P&D, pests and diseases; PE, polyethylene; PQS, Plant Quarantine Service

Table 8.3 Control measures for fruit fly in banana in the Philippines

	Stage	Measure
1.	Farm and area infrastructure, producer, processor, credibility, source of planting material	**Registered place of production**: BPI has an existing policy that all fruit and vegetable exporter and production areas, farmers, growers and packing facilities should be accredited/registered with BPI
2.	Production and control measures in field, orchard, glasshouse or other growing facility	**Company trapping and baiting**: fruit fly trapping using different baits to detect and monitor the prevalence of fruit fly
		Field sanitation: pseudostem sanitation to eliminate insect breeding sites; weed control to eliminate alternate hosts; hence reducing resident insect pest populations in plantations
		Regulatory trapping and baiting programme for low pest prevalence: PQS does regular fruit fly trapping and baiting to monitor the fruit fly population (if the CPTD is 2, additional measures are applied to lower the fruit fly population)
		Insecticide spraying of pseudostem and foliage: to eliminate external insect pests like scale insect, mealybug, aphid
		Periodic insect spraying: to prevent mealybug, scale insect and other pests from colonising the developing fruit bunch; also kills foraging fruit fly if present
		Bagging with chlorpyrifos-impregnated polyethylene (PE): covering the fruit bunches after bunch spray to further prevent infestation by mealybug, scale, other external pests and fruit fly if present
3.	Harvesting of commodity	**Harvest bunches when fruit is hard green mature**: bunches for harvest are identified/ tagged one day before harvest (pre-calibration). Fruit fly does not infest hard green banana
4.	Transport to on-farm processing facility	–

	Stage	Measure
5.	Processing, treatment, inspection at packing facility	**High pressure water spray**: fruit bunches are sprayed with high-pressure water to eliminate any possible mealybug and other external pest infestation
		De-handing and sorting to remove bruised fruit and colour break: individual hands are thoroughly inspected for possible mealybug and other surface insect infestation. Hands with 'faults' are culled to remove fruit fly infestation (faults include fruit that are precociously ripened or damaged, have compromised skin integrity, tip rot or fused fingers).
		Washing fruit with chlorine: mixture of chlorine and aluminium sulphate in the de-handing and floatation tanks. Chlorine is lethal to bacterial and fungal pathogens that adhere to the surface of the fruit
		Cleaning, wiping and packing: cleaning and wiping to confirm freedom from mealybug and other surface insects during weighing, and immediately before packing inside the shipping box
6.	Transport from farm to centralised packing or processing facility	–
7.	Inspection, processing and packing in centralised facility	**Vacuum packing**: fruit for export must be vacuum packed to prevent movement and thus prevent bruising of the fruit
		BPI PQS inspection: a sample of boxes from each consignment will be inspected visually for quarantine pest prior to issuance of a PC
8.	Transport to point of export	**Refrigerated container (reefer van)**: transport of packed fruit from the centralised facility up to the destination (USA) should be in fully closed container van
9.	Inspection at port of departure from exporting country	–
10.	Treatment or environment during transport	–
11.	Arrival at importing country	–

BPI, Bureau of Plant Industry; CPTD, catch per trap per day; PC, phytosanitary certificate; PQS, Plant Quarantine Service.

Each of the measures described in Table 8.3 was evaluated to determine its potential contribution to risk reduction and efficacy in controlling fruit fly. After evaluation the following phytosanitary measures were identified as the most effective in addressing fruit fly:

- Field sanitation
- Combined regulatory and company trapping baiting programme for low pest prevalence
- Periodic insecticide spraying before bagging
- Bagging fruit bunches in an insecticide impregnated polyethylene bag
- Harvesting bunches when fruit is hard green matured
- Sorting to remove bruised fruit and colour break
- Inspection by the plant quarantine staff of the BPI prior to export

The decision to consider these measures as the most appropriate for fruit fly is also based on the following documented supporting evidence as well as evaluating or screening each measure with the use of the DSS:

- A qualitative pathway-initiated risk assessment on the importation of banana, *Musa* spp., as fresh, hard green fruit from the Philippines to the continental USA
- Comprehensive work plan for the Republic of the Philippines export of banana to the continental USA
- Current system of mango export to Japan and South Korea

8.6 References

FAO (2002) *ISPM 14. The use of integrated measures in a systems approach for pest risk management.* IPPC, FAO, Rome.

FAO (2008) Replacement or reduction of the use of methyl bromide as a phytosanitary measure, 2008. CPM Recommendation. IPPC, FAO, Rome.

FAO (2011) *ISPM 24. Guidelines for the determination and recognition of equivalence of phytosanitary measures.* IPPC, FAO, Rome.

9

Outcomes of Beyond Compliance

9.1 The project in review

Under the international framework for plant health, elaborated in the IPPC, NPPOs must balance the objectives of facilitating agricultural trade with protection of natural plant and crop resources. To achieve these often conflicting objectives, phytosanitary measures may be used to reduce the risk of new pests entering the importing country territory. Most decisions about import requirements to reduce pest risk are made by the importing country NPPO for a specific commodity coming from a specific country, or area within a country, or even place of production. The decision process, therefore, includes an estimate of the risk of a new pest introduction and of the impact of the phytosanitary measures in reducing that risk. Many countries still apply precaution and require more management than might be justified if the evaluation of impact of measures was transparent and more easily carried out. Negotiations over market access can be very resource demanding.

The concept of the Beyond Compliance (BC) project was to adapt and introduce a series of decision-support tools for NPPOs to use in designing and evaluating risk management plans for trade in agricultural products that may be associated with pests, and are thus considered a source of pest risk. In the current context of reduced chemical use and IPM, a combination of pest risk management measures is often necessary to reach the appropriate level of protection. In plant health, this combination of measures is called Systems Approach, which is described in ISPM 14 (FAO, 2002).

The objective of the project was to enhance competency and confidence within the SE Asian subregion for applying Systems Approach to plant health. Systems Approach is the most complicated of risk management plans and it was assumed that any enhancement for this would work for simpler cases as well. It was also assumed that the best way to learn about and try out these tools was to use them in real cases of potential trade. Each participating NPPO was asked to select appropriate cases which would be supported by political will and producer interest. Two regional cases for import were selected in conjunction with the APPPC, the RPPO covering the SE Asia subregion. The participating NPPOs were from Malaysia, Vietnam, Thailand and the Philippines. The Indonesian NPPO, after initial inputs to one of the regional case studies, was unable to continue participation.

9.2 Direct outcomes

The primary direct outcomes from the BC project were threefold:

- The BC tools
- Facilitation of the use of the tools
- The trade cases

The intention was to enhance capacity by using new tools to support the design and evaluation of pest risk management measures, or systems of measures specifically when trade requires a combination of risk management measures rather than only end-point fumigation. Most important to this process was the use of priority trade cases as the means to become familiar with the tools, rather than straight training workshops.

The initial focus of the project was the use of influence diagrams or mathematical models with causal relationships shown, such as Bayesian networks (BNs), to support explanation of pest risk management systems and thereby facilitate market negotiations. This quantitative approach seemed important based on experiences of the more extreme cases (including in development of ISPMs) which require resolution after years of debate over possibly one single scientific principle. In such cases, resolution could be reached much faster by having quantitative estimates and sensitivity analysis or scenario plans that reveal whether the point of contention is even significant for the overall efficacy of the system. An explanation of the advantages of using such a framework is provided in the Mengersen et al. (2012) article prepared as part of the BC project soon after its launch.

Before the project even began, however, the need was recognised for some bridging steps between a quantitative model and the information that would be available at the time of seeking market access. As laid out in Chapter 1, it would be either the dossier of information submitted by the NPPO of the country wishing to export, or the PRA provided by the NPPO of the target market country, if this had been completed. Important information about the pests of concern and routine practices in production of the associated commodity would be available in either document. This led to conceptual progression of a case through the process shown in Figure 9.1.

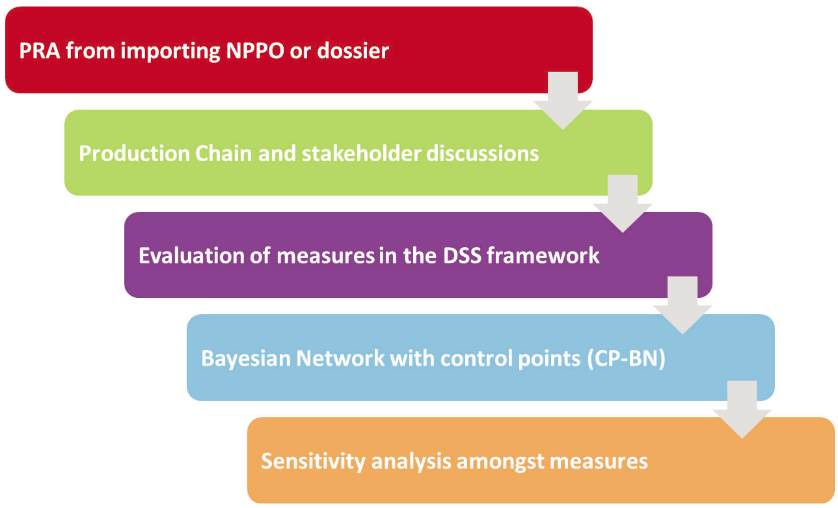


Figure 9.1 Planned relationship of primary Beyond Compliance tools to each other

CP-BN, Control Point–Bayesian Network; DSS, Decision Support System; NPPO, national plant protection organisation; PRA, Pest Risk Analysis

9.2.1 Beyond Compliance tools

To best support the different levels of capacity and experience in NPPOs, the tools developed in the BC project ranged from simple preparatory steps and tools that would either be useful as foundational learning or could be developed independently with little training, to more sophisticated tools that required some training and/or facilitation even for experienced NPPO personnel.

The preparatory tools included the following:

- Using a poster presentation, for example to select trade cases and clarify objectives as far as the trade proposal
- Clarifying objectives for the trade proposal in terms of pest risk management – new trade, equivalence, etc.
- Using a check list, for example what to do to prepare for meeting stakeholders on a new trade case
- Options for communication with domestic stakeholders
- Review of concepts and terms in relation to a specific case

The more sophisticated BC tools were primarily:

- *Production Chain tool*: a process of mapping each step of production of a product (using free software or simply drawing on a board) so that each activity was clearly understood in terms of its purpose (reducing pest risk, verifying the performance of the measure, market quality or other non-regulatory purposes) and its potential mechanism for achieving impact.
- *Decision Support System (DSS)*: an Excel™-based decision tool drawing on ISPM 11 (FAO, 2004) and organising information from a PRA or dossier for a PRA, along with expert judgement. The DSS spreadsheet can be used with experts to display management options and represents their evaluation of management choices.

- *Control Point–Bayesian Network (CP-BN)*: used to display and quantify the causal relationships between each phytosanitary measure and the overall pest risk for a particular consignment. The CP-BN therefore encapsulates all of the information gathered and developed for a Systems Approach.

The most popular tool turned out to be mapping each step for a Production Chain. Most NPPO personnel would understand the concept of showing steps taken along a chain from planting to export, for example. The more basic examples shown in Chapter 4 are still a big step forward for understanding the possibilities of Systems Approach. While creation of the Production Chain in its most basic form is a simple process, the systematic thinking and stakeholder engagement it required led to a much greater clarity on which phytosanitary measures would be needed to achieve safe trade.

The Production Chain was also a means to clarify the purpose of each measure – reduction of likelihood of infestation, reduction of survival after infestation, etc., or simply verification that a measure was applied or carried out properly. This systematic thinking about what purpose each measure applied serves is key to increased understanding of the measures imposed so that one can begin to discover alternatives. One might also in this way identify duplicate or redundant measures and question their purpose.

The addition of mapping a Production Chain proved an effective way to capture input from other stakeholders. The tool was envisioned as a way to identify all the official measures applied, or requested by the importer, so as to facilitate identification of points where the actual impact could be measured. The focus on market quality standards or certification requirements has clouded understanding of the plant health requirements for import to target markets. In some cases, the tools were embraced and expanded or reinterpreted to fit the circumstances. The Production Chain, for example, was used to map all activities, including quality assurance, voluntary private standards, quality control, etc. It made more sense to the producers to see the full picture of what was being done and then discuss the role of each activity in terms of official measure, quality control, market requirement, voluntary certification, etc. The Production

Chain is a way to include those activities but clarify their place in an official trade agreement, which will generally ignore those efforts.

This idea of a control point was not required in plant health, and requires some discussion and support for those not already using it. It is explained in the annex of ISPM 14 (FAO, 2002) by relating Systems Approach to HACCP methodology. NPPOs should be certain they understand the concept and its usefulness before meeting with stakeholders to identify points where official control can support more cost efficient and flexible trade.

The ICL team had previously identified some of the main characteristics of a pest which would directly affect the selection of risk management measures and these appear on the first sheet of the DSS (Quinlan et al., 2011). From there, points raised in ISPM 11 (FAO, 2004) were in the DSS prototype which was introduced in the European PRATIQUE project (Quinlan et al., 2011). The DSS was a way of collating expert opinion and graphically representing the range and certainty of opinion on pest risk management options. Expert opinion would frequently be contributed by colleagues in plant health, either in research or with experience in implementing the measures. Producers and other private industry might contribute but it was pitched more in the context of risk-based decision making for official agreements.

Those NPPOs with extensive experience completing PRAs should be able to work with the DSS independently or with little training. In contrast, if capacity and understanding of some of the underlying concepts for PRA are not clear, a facilitated use of the DSS could increase competence.

Finally, once completed, the Production Chain and DSS were designed to show the information needed to build a BN of the entire system of measures and the pest threat along the same Production Chain. Real-time data would only be generated at a control point, in contrast to projected data based on the design of the measure and expected outcome. A relationship to the performance of the measure – carrying it out properly – was added in acknowledgement of the difference in probable outcomes. One could add other factors such as climatic conditions, effect of other hosts nearby, etc., if these were important.

The hardest tool to prepare as a 'generic template' was the CP-BN. It required substance of the trade cases before all of the details could be worked out. Therefore even highly experienced plant health experts will still require an orientation and/or facilitator to achieve greatest value from the tool. If one is building a BN, it is useful to start with the Production Chain in the same software. GeNIe2 (the Graphical Network Interface for SMILE, a Structural Modelling, Inference, and Learning Engine; Decision Systems Laboratory, University of Pittsburgh, Pennsylvania; *http://dsl.sis.pitt.edu*) was selected as a good fit for purpose while also being readily available at no cost.

After the experience of using these tools on several real trade cases, the original progression through a series of tools, as shown in Figure 9.1, is considered now to be less important than familiarity with the range of tools so that one may pick and choose which aspect of the decision making and preparation for market access negotiation requires support.

9.2.2 Facilitation of use of the Beyond Compliance tools

Various approaches were used to facilitate the understanding and use of the tools among the project partners. Posters were prepared by each NPPO for the project inception meeting to show existing knowledge and information on the selected trade case. This also encouraged participants to settle on one case ahead of time and also to avoid time being diverted to details which were not vital to the project discussions. Meetings comprised a few lecture style introductions of topics, but then moved quickly to discussion and questions where participants learned from each other's cases and experiences.

Practical sessions run on computers, while the demonstrator showed each step, were another way to familiarise the participants with the methods used.

The development of a CP-BN away from the project context was found to be intimidating for most participants. These NPPO personnel were managing large portfolios of work and were concerned that they would not have the time required to learn

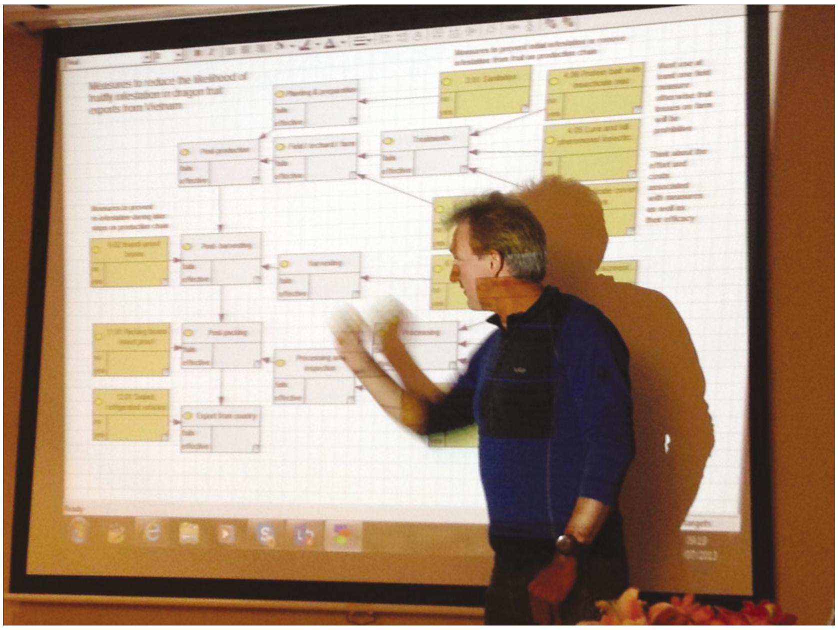


Figure 9.2 Dr Adrian Leach and other facilitators supported proper structuring of a Control Point–Bayesian Network (CP-BN)

methods and software for mathematical modelling. The exception was the Thai case, owing to support from a recent PhD graduate familiar with such tools: Dr Taekul was able to demonstrate the possibility of abandoning methyl bromide, using a sensitivity analysis of the CP-BN he had completed. This was presented to the Thai orchid grower associate conference (Taekul et al., 2013) but more needs to be done to convince the industry of such a drastic change. That team was considering demonstration plots with the more progressive growers to try to spark a paradigm shift.

Therefore, while some of the tools should be supported with learning through examples, such as in this book, a facilitator for initial orientation and possibly further support of the more sophisticated tools is recommended. In fact, even outside the issue of applying Systems Approach, the entire process of market access and negotiation would be enhanced by providing additional materials, mentors, databases of example operational plans, and expert facilitation. As with the IPPC PCE tool or PVS process (STDF, 2011), this could be achieved through a single visit at which point the tools would remain with the NPPO for updating on the trade case and use on other examples.

9.2.3 Trade cases

The trade cases were progressed through to at least a proposal for trade. The Malaysian case led to a national discussion of Systems Approach components and a proposal to China for trade. The Thai case led to a clearer stakeholder discussion on what would be required to leap from heavy reliance on methyl bromide to a combination of other measures. The Vietnamese case was presented

Figure 9.3 Representatives of national plant protection organisations presenting their case studies during a session led by Prof Kerrie Mengersen at the Final Meeting in Thailand

to South Korea in 2014 but no conclusion has yet been reported. The Philippines case led to proposed changes to the operational plan for exports which had already been agreed when the case was selected. Even before the project ended, the process has been applied to new cases of trade negotiation, particularly by the Philippines participants. The regional case studies were complicated and politically sensitive. They were taken through to completed Production Chain and DSS but are not likely to alter decisions regarding import to the region any time soon.

9.3 Indirect outcomes

The primary goal of the BC project was to increase capacity of the participating country NPPO staff, and to the degree possible other NPPO colleagues. Ways in which this increased capacity was demonstrated included the following:

- Deeper understanding of the Pest Risk Management step in PRA
- Increased confidence in communicating with stakeholders
- Supporting implementation of international standards
- Increased confidence in negotiating alternative measures

9.3.1 Deeper understanding of pest risk management

A substantive value of the BC tools lies in collating input from various stakeholders. In most cases, there are few hard data related to efficacy of measures in the field, even if research had been conducted to develop the measures with resulting lab data. Expert judgement or measurement of impact by proxy (e.g. measuring that temperature remains cold, which was shown in a lab to cause mortality) are the main sources of data for completing the DSS and BN.

Figure 9.4 Vietnam national plant protection organisation representatives and other government partners complete the Microsoft Excel™-based Decision Support System with Dr Peter Whittle and Dr Sandra Johnson

9.3.2 Increased confidence in communicating with stakeholders

One surprising outcome was the extent to which the tools supported communication with the production sector, as well as with trade negotiation teams. This was particularly true for the Production Chain mapping process. The project contributed to a marked increase in number, and presumably the quality, of stakeholder meetings. The Production Chain for one case, for example, highlighted that earlier negotiations were based on measures not even feasible for small-scale producers. International companies have far more capacity to engage in market access negotiation, albeit not officially, and can skew the outcome. The tools provided a framework for discussion and integration of this spectrum of capacity for management options.

The IPPC manual on market access (FAO, 2013), at that time in draft, was reviewed at one meeting. A generic Work Plan outline for Systems Approach from an International Atomic Energy Agency report (IAEA et al., 2011) was considered very helpful, along with a few examples of actual bilateral Work Plans for Systems Approach-based trade, which were obtained through friendly connections with NPPOs. Other materials (e.g. the IPPC manual on Managing Stakeholder Relations; FAO, 2015) and future projects should help to support this start.

9.3.3 Supporting implementation of international standards

The project had a secondary goal of supporting implementation of international standards, in particular ISPM 11, 14 and 24 (FAO, 2004, 2002 and 2005, respectively). The systematic thinking required for application of the tools also supported a better understanding of the principles of the IPPC and the SPS Agreement, including the imposition of restrictions proportional to the risk and the concept of equivalence.

Overall, the BC tools developed in the project were shown to support more systematic thinking in both designing and defending risk management proposals. The additional time required to organise thoughts and data proved to be worth the investment for most cases. The more advanced modelling was important for cases with more varying or contrasting viewpoints or to introduce something new, but not essential for simple cases. Competence among project participants in designing and evaluating risk management plans and presenting the estimated impact of measures improved by using these tools; then confidence rose as well.

9.3.4 Increased confidence in negotiating alternative measures

There were cases where, perhaps for the first time, stakeholders understood that the use of control points along the production chain (where official verification by the NPPO would be required) could strengthen risk management claims to the point of reducing import requirements. The production sector has not always understood the unique role of the NPPO in both negotiating and overseeing implementation of trade agreements. Showcasing the role of the NPPO in this way also increases its credibility.

A new trade issue arose during the project in which the Philippines NPPO employed the Production Chain to consult with industry because pest interceptions into South Korea had become unacceptable. This entire consultation took under a month, owing to the clarity of the message from the NPPO to industry and their rapid response. South Korea accepted the counter proposal and trade continued with additional measures preferred by the industry rather than the additional measure originally proposed by the South Korean NPPO.

It was noted that meeting each other over time also subsequently encouraged individuals to occasionally pick up the phone and speak about trade concerns with project partners. This is a small show of confidence that could resolve a trade issue before it even starts.

9.3.5 Other indirect outcomes

As discussed in Chapter 2, additional results relate to enhanced project management skills and communications methods. While often simple, these were unknown to most participants until used in this project.

In addition to the direct involvement of NPPO staff, industry stakeholders and observers in SE Asia, plant health officials and observers were introduced to the BC tools in the IPPC CPM side sessions and the SPS Committee meeting in October 2013; at the 10th International Congress of Plant Pathology in Beijing in 2013; and the New Zealand Plant Protection Society Conference at Napier in 2013 (Mumford et al., 2013). The project was described in the *EPPO Bulletin* and the tools have been taken up as component inputs to the EU DROPSA project on management of quarantine pests on fruit in the EU, and in the EC Horizon 2020 projects EMPHASIS and EUCLID on improving pest management options in field and protected crop systems. BC has collaborated with related projects in the SE Asian region, such as the FAO/IAEA area-wide fruit fly project on dragon fruit in Vietnam and a National University of Singapore study on a regional PRA framework, adding further to the network of skilled personnel across the region.

9.4 Making a difference: in the words of the participants

Halfway through the project, NPPO partners were asked: *What is different?* The intention was to identify how the BC project had changed the participants' thinking, practice or future intentions. Box 9.1 is an extract of the responses.

Box 9.1 What is different about the Beyond Compliance approach

To do the Production Chain and the DSS for this project, we needed to go to the field. When we saw how things were done in the field, we could better evaluate the measures in the Production Chain.

Using the DSS gives a structured approach. There is a system now. Before it was 'look in the sky'. This process has made us think about and critique what we are doing in the group. Before, we didn't do this, sit in a group, talk things over.

This project works up our critical thinking.

With what we have seen and evaluated, things will need to be changed. But it's not only what we are doing with the study we were working on for the BC project. For example, another country has given us a list of pests for another export, so we are approaching this quite differently. It's much more structured now.

It's useful to look at the analysis of impact at all stages of the Production Chain, otherwise you could miss important things. An activity might be how to see impacts, e.g. economic impact.

We were in close contact with our industry stakeholders, when we went to develop the Production Chain for our product. Even the stakeholders came to realise that there are some requirements in the workplan that should not be there. So now we can work hand in hand to identify what should and shouldn't be. They can help us, especially scientists and researchers. We are all now more confident to address requirements. Our stakeholder is happy to participate and engage with us; this was as a result of this project.

A simple example of how things are different now is how we have improved the log frame. There was much more interaction by the NPPOs, indicating that they understand the project a lot more now.

The BC technical and governance development team was also invited to comment on the development of competency and confidence. Box 9.2 includes some of their comments.

Box 9.2 Empowering competency and confidence during Beyond Compliance

When we started, we were using the DSS based on PRATIQUE, so we used the language from EPPO. During this project, we realised that we can't talk about risk here, especially in the case studies, so we needed to go back and examine what is really being asked. This is the difference between creating a tool on good theoretical understanding, versus applying it in practice.

When I was at the meeting in July last year, I took away a lot and have used it in activities. It made us realise that we needed to go through the whole process. It adds a lot to bilateral discussion, increases conversations between the two countries and makes us all keen to fill in information gaps to help the model. It changes the way you think about modelling. It's not about risk analysis. It's about setting targets, and then we can go off and work out how to meet these targets and the final process is then much more simple. Systems information is used much better in this approach (in BNs). There is confidence about what is important and what is not, more discussion, ability to state targets, number of survivors, maximum pest limits, etc. We have developed the methodology described for BC ourselves.

9.5 Going forward

As described above, the BC project produced both direct and indirect outputs and outcomes. A natural question is how these are sustained into the future.

There have been numerous discussions with NPPOs around the world about the opportunity provided by these tools. The Observers who went back to New Zealand and Australia began similar work.

At the time of writing this book, there have been numerous dissemination activities. For example:

- Ms Palacpac, Dr Taekul and Ms Quinlan gave a side session on Risk Management to meet import requirements and facilitate market access, on 17 October 2013, at the SPS Committee Meeting in Geneva, Switzerland. Two CPM sessions included Beyond Compliance in side sessions.
- In 2012 Ms Quinlan presented at the STDF-WTO Side Meeting, at the VIIth Session of the CPM. In 2014, she and Ms Kongchuesin presented results and experience about the tools developed in the project at the IXth Session of the CPM at FAO, Rome, Italy.
- Dr Holt and Ms Quinlan reported on the Production Chain and CP-BN to members of the Secretariat of the IPPC as well as from the Codex Alimentarius, Rome in mid-2012. Ms Quinlan presented the DSS to the IPPC Secretariat in October 2015 in relation to capacity needs in use of PRAs and linking Pest Risk Management.
- The IPPC webpage showed news of the Beyond Compliance project, including announcing it was holding its Final Meeting in Bangkok. This raised the profile of the project with many plant health counterparts.
- The head of the European PRATIQUE project, Dr Richard Baker, reported on the project in 2012 in New Zealand: 'Tools for risk analysis with systems approach for risk management: PRATIQUE + follow on project for further development.'
- Prof Mumford presented results of the cases involving fruit fly pests at the 9th International Symposium on Fruit Flies of Economic Importance, Bangkok, Thailand, in May 2014, after a final visit to the Philippines to support transfer of the methodology to other sections of the NPPO and a wrap up visit with the Thai team.
- Ms Quinlan shared the concepts and discussed possible application for forest pests and plants that are pests at a COST FP1401 (European Cooperation in the field of Scientific and

Technical Research) meeting in York, October 2015, regarding national legislation for import of plant propagation material.
- The concepts of the project are being further developed as part of an IPM project funded by the EU (DROPSA) focusing on two emerging pests of high significance in the fruit industry, which started in 2014.

Those working in risk management other than plant health have also been shown the tools. There was broad participation at the SPS Committee side session, including from outside the committee. People immediately see the relevance and possible applications of the approach. It is accessible conceptually to most people with experience in plant or animal health or food safety. Indeed, the use of BNs in these fields has been expanding, although not usually for market negotiation.

One recommendation arising from the BC project is to encourage global exchange and understanding of ISPM 14 (FAO, 2002) and Systems Approach trade examples, in order to provide greater awareness of these success stories. Entire national teams for research, trade negotiation and plant health need to be convinced that a great volume of trade takes place using combined measures. Letting go of the security provided by methyl bromide, for example, is a paradigm shift in many cases. This lack of confidence in Systems Approach is exacerbated by the fact that few trading partners share their operational or management plans, even though PRAs they are based on are becoming more available. A global database detailing successful trade cases using Systems Approach would begin to address this.

It would also be useful to have long-term tracking of efforts towards market access, possibly through the IPPC's Implementation Review and Support System (IRSS), because trade proposals will often take years from first submission to agreement. Even with regular clarification of what could be expected, not achieving trade in some cases during the project time frame was disappointing to some.

For now, the tools are appropriate to cases of new trade, maintaining trade that has been challenged owing to interceptions, a

Figure 9.5 Field visit to one of the largest orchid growers during the Beyond Compliance Final Meeting in Thailand

proposal for equivalence and evaluating import as well as export questions. The tools were designed for commodities, focusing on two or three pests or pest guilds at a time and would need further revision for plants that are pests (weeds), seeds, or pathways such as conveyances. The BN tools for more contentious cases will *require* facilitation and all of the tools will *benefit* greatly from facilitation, just as application of the IPPC PCE tool is more robust when facilitated.

It would be useful to have the materials translated into other languages and for regional facilitators to be trained.

9.6 Overall recommendations

1. **Share information**

   The lack of confidence in ISPM 14 and Systems Approach is exacerbated by the fact that few trading partners share their operational or management plans, even though PRAs they are based on are becoming more available. A global database detailing successful trade cases using Systems Approach would begin to address this.

2. **Share success stories**
   This will increase awareness about the success of ISPM 14 and Systems Approach. A collection of Systems Approach operational plans or implementation agreements would also provide valuable insights for those who are less experienced with the methodology.
3. **Promote the Beyond Compliance outputs**
   Links to the IPPC phytosanitary resources page are imperative for effective awareness-raising. BC materials should be promoted and shared with other projects and training courses addressing risk management. Any other initiatives in risk management should be consulted to ensure all useful tools are grouped together for future access and use. At this time, there is no person to play this role. Perhaps it could be a request to the implementation staff of the IPPC Secretariat. A tracking mechanism for future use of the tools should be included in any posting or sharing, in order to better capture details of their impact and also gather suggestions for improvements.
4. **Track the impact of Beyond Compliance**
   The tracking mechanism mentioned above can be designed to provide valuable data for indicators of the impact of the IPPC, as well as of the project. This recommendation was noted also in discussions on indicators for the IPPC overall (Quinlan et al., 2013).
5. **Continue to refine and disseminate the tools**
   The tools developed in the BC project were designed for commodities, focusing on two or three pests or pest guilds at a time and would need further revision for plants that are pests (weeds), seeds, or pathways such as conveyances.

An effective way of disseminating the BC tools is to train point persons in NPPOs and other relevant organisations who will become experts or facilitators in each region. The advantage is that a single point person could support use of the concept for other topics in the country or region, such as food safety and animal health. However, even with experience, a network with regular contact with the developers of the tool is advisable. In recent years, BNs have been taken up for a range of applications in plant health. The BC tool is already tailored over years of testing. Without serious consideration of the ideas, assumptions and experiences underpinning the BC tool, uptake of other applications of BN methodology could confuse matters rather than help.

On the other hand, the use of the tested BC tools does not indicate a natural pathway for applying BNs to all plant health challenges without appropriate training and consideration. There is room for more tools, but there must always be the appropriate checks and peer review to align with the IPPC and SPS experiences.

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Appendix 1: STDF Fact Sheets

English version

STDF/PG/328 Title *Beyond Compliance*: Integrated Systems Approach for Pest Risk Management in Southeast Asia
Implementing Agency CABI SEA (South East Asia office), Queensland University of Technology (QUT) and Imperial College London (ICL)
Partners NPPOs of Malaysia, Philippines, Thailand, Viet Nam and (year 1) of Indonesia
Start Date 11/07/2011
End Date (including one year no cost extension) 10/07/2014
Beneficiary Malaysia, Philippines, Thailand, Viet Nam
Budget Project value: US$ 904,686 STDF contribution: US$ 600,000

Key Objective

The project objective was to enhance competency and confidence in the Southeast Asian sub-region in applying Systems Approach to trade opportunities through the use of innovative decision-support tools. Confidence in market access negotiations using this complex approach to pest risk management can be enhanced by using frameworks for organising information, showing causal relationships and representing graphically the components of risk management. This was applied to priority trade opportunities already of interest to the participating countries.

The tools support the design and evaluation of risk management plans for pest risks associated with trade. The systematic thinking required to apply the tools, coupled with the data and judgements contributed by stakeholders using the tools, increases competency of those representing specific trade cases and therefore the confidence for market access negotiation.

Background

Sanitary and Phytosanitary (SPS) capacity is a priority in all of the Southeast Asian countries and has been the focus of national strategies and development projects. The National Plant Protection Organisations (NPPOs) of Philippines, Malaysia, Thailand and Vietnam, among other Southeast Asian countries, participate consistently in standard setting processes, through the International Plant Protection Convention (IPPC) and the relevant Regional Plant Protection Organisation (RPPO). All participating countries were using Pest Risk Analysis (PRA), described in International Standards for Phytosanitary Measures (ISPM) 11, as the method to categorise and estimate risk from pests associated with agricultural products entering trade for any proposed imports. Similarly, they are accustomed to presenting dossiers of information for a PRA to target market country NPPOs for exports. The weakest component, however, has been the Pest Risk Management phase, which consists of evaluation of management options and selection of the best phytosanitary measure, or combination of measures, to apply to trade or other pathways to achieve an appropriate level of protection. This has recognised by the International Advisory Group on Pest Risk Analysis (IAGPRA), among others, as a global challenge. There has been relatively little capacity building in the decision-making process for the Pest Risk Management phase of PRA since the advent of the harmonised PRA approach.

An earlier STDF Project Preparation Grant (PPG) funded a workshop in Kuala Lumpur in 2010 for the development of the original project. During the workshop it was concluded that countries were seeking to use the Systems Approach to Pest Risk Management (described in ISPM 14 *Use of integrated measures in a Systems Approach for pest risk management)*. Reasons given for this interest included: technical concerns about the food and occupational safety of some single treatments (generally chemical); feasibility of implementing measures due to lack of infrastructure or if more locally preferred combination of measures would be more cost effective, for example; and the high risk of trade disruption with single treatments when a failure occurs.

There was also a perceived power imbalance in trade negotiation and agreements in which risk mitigation measures were imposed, rather than developed bilaterally. This lack of experience and confidence in the final step results in SE Asian contracting parties, among many others, accepting the risk management proposals from potential trade partners without effective negotiation. Market access negotiation should recognise equivalent measures and aim for measures proportional to the risk. This project developed and tested decision-support tools for design, evaluation and estimating efficacy of pest risk management measures.

The spirit of the project, therefore, was to create a platform from which less resourced countries may go beyond compliance with the import restrictions, to a situation in which options for risk management can be discussed and considered, for proportional and mutually acceptable options to be agreed.

Achievements

Greater inclusion of stakeholders in the lead up to market negotiation

This project increased inclusion of stakeholders in the process of considering preferred and feasible risk management systems, particularly through the use of the tool for mapping pest management measures in the Production Chain. From the start of the project, progress was made in increasing the confidence of the NPPOs in engaging stakeholders in talks about Systems Approach for international trade. This confidence is traced back to the use of the tools and the value of discussions with other NPPOs in similar situations. Although the NPPOs in *Beyond Compliance* had met with stakeholders from industry in the past, the ability to engage on a complex topic such as Systems Approach was entirely new. The Vietnamese partners reported that a formal network has been formed in the dragon fruit industry, which did not exist prior to this project. The synergy with an IAEA/FAO project on area-wide control resulted in a clear understanding of the importance of "low pest prevalence" around the major production areas and the relationship of that to Systems Approach, particularly for the fruit fly pests.

More confidence in trade negotiations

The project goal was to increase confidence and competence in trade negotiations. The project achieved an increase in capacity of relevant NPPO staff and stakeholders to put tools into use through the development of technical resources. The development of capacity in the use of Systems Approach tools has translated into increased confidence in negotiations. The Philippines NPPO staff now have greater confidence to approach trade partner NPPOs with their own ideas and to request review of some existing agreements which appear to them to be too trade restrictive. The Thai partners in the NPPO and Standards Institute are showing enthusiasm for Systems Approach as a way to introduce better practices for thrips control in the orchid cut flower industry and minimise the problems due to methyl bromide use. This is a big shift from anxiety about convincing stakeholders to fully participate in project assignments to a sense of confidence about the future of trade if interceptions are going to be reduced. In the Malaysian context, increased confidence and competence from experiences with the case study led the NPPO to consider accreditation of the Systems Approach as a key approach for production under Good Agricultural Practices (GAP).

More opportunities for trade in a phytosanitary context

The Pest Risk Management component of this project potentially enables a greater openness to new phytosanitary trade agreements based on Systems Approaches. Because of limited capacities, developing economies in the region have approached international standards, particularly those related to Pest Risk Management, from the perspective of meeting importing country requirements. A systematic framework for application of Systems Approach allows phytosanitary and market access personnel to understand contributions of each individual management measure to the reduction of risk. The project already changed experiences for one NPPO with additional trade proposals arising since the case study. Simply using the versatile and effective method to map out and model pest risk management in trade, one equivalence proposal was agreed within weeks (Philippines to Korea). Such a transparent, mutually agreed framework for understanding how much each phytosanitary measure – or measures in combination – reduces the estimated risk can accelerate the trade negotiations.

More robust pest risk management in the region

The project outcomes can address a range of common challenges in market access negotiations and agreements for trade based on single risk-mitigation measures. Systems Approaches, a combination of integrated measures, may address many of these issues, but at the same time can be complex to develop and negotiate due to structural and quantitative uncertainty about the system. Uncertainty can be managed using probabilistic modelling, thus the project implemented a Control Point/Bayesian Network modelling approach for a set of case studies in SE Asia to show real quantitative evidence of efficacy of measures. It is not necessary to have such a tool to develop a Systems Approach; however, experience and a recent global review concluded that many NPPOs either lack experience with Systems Approach or do not have confidence in its application. This tool clarified thinking around proposed risk reduction measures, proxy indicators for risk reduction (e.g. performance of carrying out the measures) and direct verification measures (e.g. reduced population of the pest) and eased comparisons of similar pest risks, thereby developing a more robust pest risk management in the region.

Recommendations

1. Share information and success stories about trade using Systems Approach

The lack of awareness, acceptance and confidence in ISPM 14 and Systems Approach is exacerbated by the fact that few trading partners share their operational or management plans, even though PRAs they are based on are becoming more publicly available. Moreover, there is no current mechanism for sharing success stories about the implementation of ISPM 14 and Systems Approach. A global database detailing successful trade cases using Systems Approach would begin to address this. Combinations of measures have been the basis of substantial trade for decades. The implementation of this ISPM is significantly slowed because NPPOs do not have wide access to the details of this trade.

2. Disseminate the *Beyond Compliance* outputs

Links to the phytosanitary resources page are imperative for effective awareness-raising. However, this cannot be a passive activity. *Beyond Compliance* materials should be actively promoted and shared with other projects and training courses addressing risk management. Any other initiatives in risk management should be consulted to ensure a harmonised approach to basic concepts so that all useful tools are grouped together for future access and use. At this time, there is no person to play this role. This role might fall to the implementation staff of the IPPC Secretariat, if supported by the CPM.

An effective way of disseminating the *Beyond Compliance* tools is to train point persons in NPPOs, RPPOs or other relevant organisations who will become experts and facilitators in each region. The entire process of preparing for market access negotiations requires ongoing and long term support, the way that the Phytosanitary Capacity Evaluation (PCE) tool and process has become embedded regionally, but supported centrally.

Another advantage is that a single point person could support use of the concepts for other topics in the country or region, such as food safety, animal health or similar applications. However, even with experience, a network with regular contact with the developers of the tool is advisable. In recent years, BNs are being taken up for a range of applications in plant health. The *Beyond Compliance* tools are already tailored over years of testing. Without serious consideration of the ideas, assumptions and experiences underpinning the *Beyond Compliance* tools, uptake of other applications of BN methodology could confuse matters rather than help.

3. Track the impact of *Beyond Compliance*

The tools should be available from the STDF website or the phytosanitary resources page, but for those who want to try them out without a facilitator, there needs to be a communication and tracking systems such as through a licensing system (used by FAO in earlier software development), or the requirement for registering to use the tools when downloading. While a tracking mechanism can provide the number of downloads, it is better to have a two way communication mechanism for future users of the tools. This way, the details of their impact can be collected through short surveys, for example, but also suggestions for improvements and support requests can be gathered. The tracking mechanism can also be designed to provide valuable anonymised data for indicators of the impact of the IPPC and needs assessment for ISPM implementation.

4. Continue to refine and disseminate the tools

The tools developed in the *Beyond Compliance* project were designed for commodities, focusing on two or three pests or pest guilds at a time and would need further revision for plants that are pests (weeds), seeds, or pathways such as conveyances. Additional cases should be shared, while respecting any requirements for confidentiality. The greater the number of real cases shared, the more everyone will understand the process, the tools and their application.

The materials to date are all in English, so those tools ready to use are less accessible to non-English speakers, although the strong emphasis on graphical presentation makes the outcomes understandable in multilingual contexts but also across levels of expertise. Translations of the most relevant materials would complement the training of regional experts and use of facilitators from each region and dissemination to those who learn best from written explanations.

French version

Titre
Au-delà de la simple conformité (Beyond Compliance): Approche systématique intégrée à la gestion du risque phytosanitaire dans le Sud-Est Asiatique
Organismes d'exécution
CABI SEA (bureau du SE Asiatique), Université de Technologie du Queensland (QUT) et Imperial College London (ICL)
Partenaires
ONPV de Malaisie, Philippines, Thaïlande, Vietnam et, initialement, d'Indonésie
Date de début
11/07/2011
Date d'achèvement (dont une année sans coût supplémentaire)
10/07/2014
Bénéficiaires
Malaisie, Philippines, Thaïlande, Vietnam
Budget
Valeur du Projet: US$ 904,686 Contribution STDF: US$ 600,000

Objectif Principal

L'objectif de ce projet était d'améliorer les compétences et la confiance dans la sous-région du Sud-Est Asiatique relative à l'utilisation de l'Approche Systémique dans le cadre des négociations d'opportunités commerciales grâce à des outils innovants d'aide à la prise de décision. La confiance dans les négociations d'accès au marché avec cette approche complexe de la gestion du risque phytosanitaire peut être améliorée en utilisant des cadres pour organiser les informations qui montrent les relations de cause à effet et représentent graphiquement les composants de la gestion du risque. Ceci a été appliqué à la négociation d'opportunités commerciales prioritaires qui ont déjà suscitées un intérêt dans les pays participants.

Les outils permettent la conception et l'évaluation de plans de gestion des risques pour les risques phytosanitaires liés au commerce. La pensée systématique nécessaire pour l'utilisation de ces outils, couplée avec les données et les jugements apportés par les parties prenantes améliore la compétence de ceux qui représentent des cas commerciaux spécifiques et, par conséquent, la confiance dans les négociations pour l'accès aux marchés.

Contexte

Les capacités sanitaires et phytosanitaires (SPS) sont une priorité dans tous les pays du Sud-Est de l'Asie et ont été l'objet de vastes projets d'étude et de développement. Les Philippines, la Malaisie, la Thaïlande et le Vietnam, parmi d'autres pays, participent régulièrement aux processus d'établissement des normes à travers la Convention Internationale pour la Protection des Végétaux (CIPV) et l'Organisation Régionale de la Protection des Végétaux (ORPV) concernée. L'Analyse du Risque Phytosanitaire (ARP), décrite dans les Normes Internationales pour les Mesures Phytosanitaires (NIMP) 11, est la méthode utilisée pour classer et évaluer le risque associé aux organismes nuisibles aux produits agricoles entrant sur le marché, et pour proposer des options de gestion afin de réduire ce risque et ne pas compromettre le libre-échange. La phase de gestion du risque phytosanitaire – qui consiste à l'évaluation des options de gestion et à la sélection de la meilleure mesure, ou combinaison de mesures, phytosanitaires, applicables aux échanges ou aux autres voies pour atteindre un niveau approprié de protection – est souvent la partie la plus faible du processus d'ARP (tel que reconnu, entre autres, par le Groupe consultatif international sur l'analyse du risque phytosanitaire (IAGPRA)). Il y a eu relativement peu de renforcement des capacités dans le processus décisionnel pour la phase de gestion du risque phytosanitaire de l'ARP depuis la mise en place de l'approche harmonisée du ARP.

Ce manque d'expérience et de confiance en la dernière étape de l'ARP conduit les parties contractantes du SE de l'Asie, parmi beaucoup d'autres, à accepter les propositions de gestion des risques de partenaires commerciaux potentiels sans négociation. Les négociations pour l'accès aux marchés devraient reconnaître les mesures équivalentes et avoir comme objectif des mesures proportionnelles au risque. Ce projet a développé et testé des outils d'aide à la prise de décision pour l'application d'une approche systémique de la gestion du risque phytosanitaire, qui pourrait soutenir directement la mise en oeuvre des NIMP 14 (*Utilisation de mesures intégrées dans une approche systémique pour la gestion du risque phytosanitaire*).

Un don pour l'élaboration de projets (DEP) préalablement octroyé par le STDF a financé un atelier à Kuala Lumpur en 2010 pour le développement du projet initial. Au cours de l'atelier, il a été conclu que les pays cherchaient à appliquer l'approche systémique à la gestion du risque phytosanitaire principalement à cause de problèmes communs, tels que les préoccupations techniques au sujet de la nourriture et la sécurité au travail de certains traitements (généralement des traitements chimiques), et du risque élevé d'interruption des échanges avec des traitements simples en cas de panne. Il y avait aussi un déséquilibre de pouvoir perçu dans les négociations et les accords commerciaux dans lesquels des mesures d'atténuation des risques étaient imposées, plutôt que développées de manière bilatérale. L'esprit du projet était, en conséquence, de créer une plateforme à partir de laquelle les pays avec moins de ressources puissent aller **au-delà de la simple conformité** aux exigences à l'importation, pour atteindre une situation où ils peuvent examiner et débattre de toutes les options possibles de gestion des risques afin de se mettre d'accord sur une combinaison de mesures appropriées localement et proportionnelle aux risques en questions.

Résultats

Une plus grande inclusion des parties prenantes avant les négociations commerciales

Ce projet a augmenté l'inclusion des parties prenantes dans le processus d'examen des systèmes idéaux et réalisables de gestion des risques, en particulier à travers l'utilisation d'outils pour la représentation graphique des mesures de gestion des organismes nuisibles dans la chaîne de production. Dès le début du projet, des progrès ont été réalisés dans l'augmentation de la confiance des ONPV dans l'engagement des parties prenantes dans le cadre d'une approche systémique au commerce international. Cette confiance est attribuable à l'utilisation de ces outils et la contribution positive des discussions avec d'autres ONPV dans des situations similaires. Bien que les ONPV impliquées dans *Au-delà de la simple conformité* aient déjà rencontré des parties prenantes de l'industrie dans le passé, la capacité de prendre part à une discussion sur un sujet aussi complexe que l'approche systémique était entièrement nouvelle. Les partenaires vietnamiens ont signalé qu'un réseau formel a été crée dans l'industrie du pitaya, qui n'existait pas avant ce projet. La synergie avec un projet de l'AIEA/FAO sur le contrôle à l'échelle d'une zone a abouti à une compréhension claire de l'importance du concept de « faible prévalence d'organismes nuisibles » autour des principales zones de production et de la relation entre ce concept et l'approche systémique, en particulier pour les mouches des fruits.

Plus de confiance pendant les négociations commerciales

Le but du projet était d'augmenter la confiance et les compétences dans les négociations commerciales. Le projet a atteint un accroissement de la capacité du personnel et des parties prenantes des ONPV pertinentes à adopter ces outils à travers le développement des ressources techniques. Le développement des capacités dans l'utilisation de l'approche systémique d'est traduit dans une confiance majeure dans les négociations. Le personnel de l'ONPV des Philippines a désormais plus de confiance à aborder les ONPV des partenaires commerciaux avec leurs propres idées et à demander la révision de certains accords existants qui leur paraissent être trop restrictifs pour le commerce. Les partenaires thaïlandais de l'ONPV et du Standards Institute se montrent enthousiastes envers dans l'approche systémique comme façon d'introduire des meilleures pratiques pour le control des thrips dans l'industrie des fleurs d'orchidée coupées, et de minimiser les problèmes liés à l'utilisation de bromure de méthyle.

Ceci est un grand changement de l'inquiétude de devoir convaincre les parties prenantes à participer pleinement dans les activités du projet à un sentiment de confiance quant à l'avenir du commerce si les interceptions sont réduites. Dans le contexte de la Malaisie, une confiance et des compétences accrues grâce aux expériences avec l'étude de cas ont conduit l'ONPV à considérer l'accréditation de l'Approche Systémique en tant qu'approche clé pour la production selon les Bonnes Pratiques Agricoles (BPA).

Plus d'opportunités commerciales dans un contexte de risque phytosanitaire

La composante de gestion du risque phytosanitaire de ce projet permet une ouverture potentielle majeure vers des nouveaux accords commerciaux et phytosanitaires basés sur l'Approches Systémique. En raison de leurs capacités limitées, les économies émergentes dans la région ont approché les normes internationales, en particulier celles liés à la gestion du risque phytosanitaire, avec le but de répondre aux exigences des pays importateurs. Un cadre systématique pour l'application de l'Approche Systémique permet au personnel phytosanitaires et commercial de comprendre les contributions de chacune des mesures de gestion à la réduction globale du risque. Le projet a déjà changé l'attitude d'une ONPV envers des nouvelles propositions commerciales survenues depuis l'étude de cas. Simplement en utilisant la méthode souple et efficace qui consiste à créer une représentation spatiale et un modèle de la gestion des risques phytosanitaires dans le commerce, une proposition d'équivalence a été convenue en quelques semaines (entre Philippines et Corée). Un cadre mutuellement convenu et transparent pour comprendre dans quelle proportion chaque mesure phytosanitaire – ou combinaison de mesures - réduit le risque estimé peut accélérer les négociations commerciales.

Une gestion du risque phytosanitaire renforcée dans la région

Les résultats du projet peuvent répondre à un éventail de défis communs dans le cadre des négociations pour l'accès au marché et des accords commerciaux basés sur des mesures individuelles d'atténuation du risque. Les approches systémiques, une combinaison de mesures intégrées, pourraient aborder beaucoup de ces problèmes, mais en même temps pourraient être difficiles à développer et négocier à cause de l'incertitude structurale et quantitative du système. L'incertitude peut être géré à l'aide de la modélisation probabiliste. En vue de cette considération, le projet a mis en oeuvre une approche de modélisation point de contrôle/réseau bayésien pour un ensemble d'études de cas dans le SE de l'Asie dans le but montrer des vrais résultats quantitatives de l'efficacité de ces mesures. Un outil de ce genre n'est pas nécessaire pour développer un Approche Systémique, néanmoins, l'expérience directe et une récente revue globale ont conclu que plusieurs ONPV manquent soit d'expérience avec l'Approche Systémique, soit de la confiance pour l'appliquer. Cet outil a clarifié la pensée autour des mesures proposées de réduction du risque, des indicateurs indirects pour la réduction du risque (par exemple la performance dans l'exécution des mesures) et des mesures de vérification directes (par exemple une réduction dans la population de l'organisme nuisible) et a facilité des comparaisons entre des risques phytosanitaires semblables, développant ainsi une gestion plus robuste du risque dans la région.

Recommandations

1. Partage des informations et des succès commerciaux liés à l'Approche Systémique

Le manque de sensibilisation, acceptation et confiance dans la NIMP 14 et dans l'Approche Systémique est exacerbé par le fait que peu de partenaires commerciaux partagent leurs plans opérationnels ou leurs mesures de gestion, même si les ARP sur lesquels ils sont basés deviennent de plus en plus accessibles au public. En plus, il n'y a aucun dispositif actuel pour partager les réussites obtenues à travers l'implémentation de la NIMP 14 ou de l'Approche Systémique. Une base de données mondiale détaillant les réussites commerciales obtenues grâce à l'Approche Systémique pourrait aider à faire face au problème. L'utilisation d'une combinaison de mesures a été une base substantielle du commerce depuis des décennies. La mise en oeuvre de cette NIMP est considérablement ralentie par le simple fait que les ONPV n'ont pas accès à ces détails commerciaux.

2. Diffuser les résultats d'*Au-delà de la simple conformité*

Des liens vers la page des ressources phytosanitaires sont impératifs pour une sensibilisation efficace. Cependant, cela ne peut pas être une activité passive. Les ressources d'*Au-delà de la simple conformité* devraient être promues activement et partagées avec d'autres projets et cours de formation sur la gestion du risque. Toutes les autres initiatives en matière de gestion des risques devraient être consultées pour assurer une approche harmonisée aux concepts de base de telle sorte que tous les outils utiles sont regroupés pour l'accès et l'utilisation futurs. Actuellement, il n'y a personne qui joue ce rôle. Ce rôle pourrait être exécuté par le personnel du Secrétariat de la CIPV, sous réserve de l'approbation de la CMP.

Un moyen efficace de diffuser les outils d'*Au-delà de la simple conformité* serait de former des représentants dans les ONPV, les ORPV ou dans d'autres organisations pertinentes afin qu'il puissent assumer le rôle d'experts et des facilitateurs dans chaque région. Le processus entier de préparation pour les négociations pour l'accès aux marchés nécessite un soutien continue de longue durée, tout comme l'Evaluation des Capacités Phytosanitaires (ECP) en tant qu'outil et processus a été intégré régionalement, mais soutenu centralement.

Un autre avantage est qu'un facilitateur pourrait soutenir l'utilisation des concepts dans d'autres domaines dans le même pays ou région, tels que la sécurité sanitaires des aliments, la santé animale ou des applications similaires. Néanmoins, même avec de l'expérience, un réseau de contacts réguliers avec les développeurs de l'outil est conseillé. Au cours des dernières années, les BN ont été mis en oeuvre pour une gamme variées d'applications dans le domaine de la santé des plantes. Les outils d'*Au-delà de la simple conformité* sont issus d'un certains nombre d'années de tests. Sans un examen sérieux des idées, des expériences et des hypothèses sur lesquelles s'appuient les outils d'*Au-delà de la simple conformité*, l'adoption d'autres applications des BN pourrait confondre plutôt qu'aider.

3. Suivre l'impact d'*Au-delà de la simple conformité*

Les outils devront être disponibles à partir du site web de STDF ou de la page des ressources phytosanitaire, mais pour ceux qui veulent les essayer sans facilitateur, il doit y avoir une communication et un systèmes de suivi comme un système de licences (utilisé par la FAO dans le passé pour des logiciels qui y ont été développés), ou l'exigence d'enregistrement pour utiliser les outils lors du téléchargement.

Alors qu'un mécanisme de suivi peut fournir le nombre de téléchargements, il est préférable d'avoir un mécanisme de communication bidirectionnel pour les futurs utilisateurs de ces outils. De cette façon, les détails de leur impact pourront être recueillis par des courtes enquêtes, par exemple, mais aussi par des suggestions d'améliorations et des demandes de soutien. Le mécanisme de suivi pourra fournir des données anonymes précieuses comme indicateurs de l'impact de la CIPV et des besoins pour la mise en oeuvre de la NIMP en question.

4. Continuer à affiner et diffuser les outils

Les outils développés dans le projet *Au-delà de la simple conformité* ont été conçus pour les produits agricoles, en se concentrant à la fois sur deux ou trois organismes nuisibles ou ensemble d'organismes nuisibles, et auraient besoin d'une révision ultérieure pour les plantes nuisibles (mauvaises herbes), les graines, ou pour des voies d'introduction d'organismes nuisibles telles que les moyens de transport. D'autres cas doivent être partagés, tout en respectant les exigences de confidentialité. Plus le nombre de cas réels partagés sera grand, plus grand sera le nombre de praticiens qui comprendraient le processus, les outils et leur application.

Les matériaux à ce jour sont tous en Anglais, donc les outils prêts à l'emploi sont moins accessibles aux non-anglophones, bien que l'accent mis sur la représentation graphique rend les résultats compréhensibles dans un contexte multilingue, mais également à un public avec des niveaux d'expertise variés. La traduction des ressources les plus pertinentes compléterait la formation d'experts régionaux, l'utilisation de facilitateurs de chaque région et la diffusion à ceux pour qui l'apprentissage se révèle plus facile à partir d'explications écrites.

Spanish version

Título *Más allá del cumplimiento*: un enfoque sistémico integrado para la gestión del riesgo de plagas en Asia Sudoriental
Organismoencargado de la aplicación Centro Internacional para la Agricultura y las Ciencias Biológicas de Asia Sudoriental (CABI SEA), Universidad de Tecnología de Queensland e Imperial College de Londres
Asociados Organizaciones nacionales de protección fitosanitaria (ONPF) de Filipinas, Malasia, Tailandia, VietNam y de Indonesia (el primer año)
Fecha de inicio 11 de juliode2011
Fecha de finalización (incluidauna prolongación de un año sin costos) 10 de juliode2014
Beneficiarios Filipinas, Malasia, Tailandia, Viet Nam
Presupuesto Valor del proyecto: 904.686 dólares EE.UU. Contribución del STDF: 600.000 dólares EE.UU.

Objetivo fundamental

El objetivo del proyecto era mejorar la aptitud para usar el enfoque sistémico en la subregión del Asia Sudoriental y crear más confianza en este enfoque para aprovechar oportunidades comerciales, utilizandoherramientas innovadoras que fundamentan las decisiones. Para generarmásconfianza en las negociaciones de acceso a los mercadosbasadas eneste enfoque complejo de la gestión del riesgo de plagas, es conveniente utilizar marcos de organización de la información, poner de manifiesto las relaciones causales y representar gráficamente los componentes delagestión del riesgo. Se ha hecho este trabajo para oportunidades comerciales prioritarias que ya son importantes para los países participantes.

Las herramientas ayudan a diseñar y evaluar planes de gestión de riesgos de plagas asociados al comercio. La reflexiónsistemáticanecesaria para aplicar las herramientas, y la información y los razonamientos aportados por los colectivos interesados que utilizan estas herramientas, mejoran la aptitud de los encargados de una determinada cuestión comercial y, por lo tanto, la confianza en un contexto de negociaciones de acceso a los mercados.

Antecedentes

La capacidad sanitaria y fitosanitaria es prioritaria para todos los países del Asia Sudoriental y ha sido el foco de atención de las estrategias nacionales y los proyectos de desarrollo. Las organizacionesnacionales de protección fitosanitaria (ONPF) de Filipinas, Malasia, Tailandia y Viet Nam, entre otros países del Asia Sudoriental, participan regularmente en procesos de elaboración de normas, a través de la Convención Internacional de Protección Fitosanitaria (CIPF) y su Organización Regional de Protección Fitosanitaria (ORPF). Todos los países participantes estaban utilizando el análisis de riesgo de plagas descrito en las Normas Internacionales para Medidas Fitosanitarias (NIMF Nº 11) para categorizar y estimar el riesgo de plagas que puede plantear unproducto agropecuario que se propone para importación. Asimismo, están acostumbrados a presentar expedientes informativos para los análisis de riesgo de plagas, a las organizaciones nacionales de protección fitosanitaria del país destinatario de las exportaciones. No obstante, el componente más débil ha sido la fase de gestión del riesgo de plagas, que consiste en una evaluación de opciones de gestión y la selección de la mejor medida fitosanitaria, o la mejor combinación de medidas, que permite conseguir un nivel adecuado de protección en las vías de comercio u otras vías. El Grupo asesor internacional en análisis de riesgo de plagas, entre otros, ha dicho que es un problema mundial. Desde la introducción del análisis de riesgo de plagas armonizado, se ha hecho poco en materia de creación de capacidad para el proceso de toma de decisiones en la fase de gestión del riesgo.

Una donación anterior para la preparación de proyectos (DPP) del Fondo para la Aplicación de Normas y el Fomento del Comercio (STDF) financió un taller en Kuala Lumpur en 2010 para elaborar este proyecto. Los participantes en el taller establecieron que los países querían utilizar el enfoque sistémico descrito en la NIMF Nº 14 *Aplicación de medidas integradas en un enfoque de sistemas para el manejo del riesgo de plagas*. Este sistema les interesaba por varios motivos: preocupaciones técnicas sobre la inocuidad de los alimentos y de los procesos de trabajo de determinados tratamientos (generalmente químicos); la viabilidad de la aplicación de medidas por la falta de infraestructuras, o determinar, por ejemplo, si sería más rentable aplicaruna combinación de medidas a nivel local; y el alto riesgo de perturbación del comercio si solo se usa un tratamiento y los resultados son negativos en algún momento.

También había claramente un desequilibrio de poder en las negociaciones y acuerdos comerciales:las medidas de mitigación del riesgo eran impuestas y no acordadas bilateralmente. Debido a estafalta de experiencia y confianza en la etapa final, las partes contratantes del Asia Sudoriental, y otras muchas, aceptan las propuestas de gestión del riesgo de potenciales interlocutores comerciales sin una negociación eficaz. En una negociación de acceso a los mercados se deberían reconocer medidas equivalentes y establecer medidas proporcionales al riesgo. En este proyecto se elaboraron y probaron herramientas que ayudan a diseñar, evaluar y determinar la eficacia de las medidas de gestión del riesgo de plagas.

Por lo tanto, el espíritu del proyecto era crear una plataforma que los países con menos recursos pudieran utilizar para ir más allá del cumplimiento de las prescripciones de importación, para crear condiciones que permitan analizar y examinar opciones de gestión del riesgo, y acordar opciones proporcionales y mutuamente aceptables.

Resultados

Mayor participación de los colectivos interesados en la preparación de las negociaciones de mercado

Este proyecto propició la participación de los colectivos interesados en el proceso de examen de la conveniencia y la viabilidad de distintos sistemas de gestión del riesgo, en particular gracias a la herramienta de comparación de las medidas de gestión del riesgo en la cadena de producción. Desde el principio del proyecto se consiguió aumentar la confianza de las ONPF en la participación de los colectivos interesados en las conversaciones sobre el enfoque sistémico para el comercio internacional. Había una base de confianza por el uso de las herramientas y el valor de los debates con otras ONPF que se encuentran en situaciones similares. Aunque las ONPF participantes en el proyecto *Más allá del cumplimiento* se habían reunidoen el pasado con colectivos interesados del sector, era la primera vez que estos colectivos podían participar en un tema complejo como el enfoque sistémico. Los asociados de VietNam informaron de la creación de una red formal en la rama de producción de la pitahaya, que no existía antes de este proyecto. Gracias a la sinergia con un proyecto del Organismo Internacional de Energía Atómica (OIEA) y la Organización de las Naciones Unidas para la Alimentación y la Agricultura (FAO) sobre un control global de la zona, se entendió claramente la importancia de una "baja prevalencia de plagas" en las principales áreas de producción y su relación con el enfoque de sistemas, en particular para las moscas de la fruta.

Más confianza en las negociaciones comerciales

El objetivo del proyecto era aumentar la confianza en las negociaciones comerciales y mejorar las aptitudes necesarias. Eldesarrollo de recursos técnicos en el proyecto consiguió aumentar la capacidad del personal competente de las ONPF y de los colectivos interesados para utilizar las herramientas. Con esta mejora de la capacidad para utilizar las herramientas del enfoque de sistemas, también ha aumentado la confianza en las negociaciones. El personal de la ONPF de Filipinas ha ganado confianza para presentarsus propias ideas a las ONPF de sus interlocutores comerciales y pedir que se revisenalgunos acuerdos vigentes que les parecen demasiado restrictivos del comercio. Los asociados tailandeses de la ONPF y del Instituto de Normas ven con interés el enfoque de sistemas como un medio para introducir mejores prácticas de control de tisanópteros en la rama de producción de orquídeas cortadas y para minimizar los problemas asociados a la utilización de metilbromuro. Se trata de un avance enorme en el que se ha superado la ansiedad ocasionada por la necesidad de convencer a los colectivos interesados para que participen plenamente en las actividades de un proyecto, y se ha conseguido un sentimiento de confianza sobre el futuro del comercio con una disminución de intercepciones. En el contexto de Malasia, las mejoras en confianza y aptitudes obtenidas gracias al estudio monográfico han incitado a la ONPF a plantearse la acreditación del enfoque de sistemas como elemento esencial para la producción en el marco de las Buenas Prácticas Agrícolas (BPA).

Más oportunidades para el comercio en un contexto de riesgos fitosanitarios

El componente de gestión del riesgo de plagas de este proyecto podría permitir una mayor apertura a nuevos acuerdos comerciales fitosanitarios basados en enfoques de sistemas. Dada la limitación de capacidades, las economías en desarrollo de la región han abordado las normas internacionales, en particular las relacionadas con la gestión del riesgo de plagas, desde la perspectiva del cumplimiento de las prescripciones del país importador. El establecimiento de un marco sistemático para la aplicación del enfoque de sistemas permitirá al personal fitosanitario y a los responsables del acceso a los mercados entender la parte que desempeña cada medida de gestión en la reducción del riesgo. El proyecto tiene ya efectos concretos para una ONPF, que ha recibido nuevas propuestas comerciales desde que se llevó a cabo este estudio monográfico. El simple hecho de utilizar el método versátil y eficaz para comparar y modelizar las medidas de gestión del riesgo de plagas en el comercio, ha permitido que se aceptara una propuesta de medidas equivalentes en pocas semanas (de Filipinas a Corea). Un marco transparente como este y convenido mutuamente para entender el efecto de cada medida fitosanitaria -o de una combinación de medidas-en la reducción del riesgo estimado puede acelerar las negociaciones comerciales.

Una gestión más eficaz del riesgo de plagas en la región

El producto de este proyecto, con medidas de mitigación de riesgos, puede evitar una serie de problemas comunes en negociaciones de acceso a los mercados y acuerdos comerciales. Unenfoquesistémico, que consiste en una combinación de medidas integradas, puede resolver muchas de estas cuestiones, pero la elaboración y negociación de este enfoque puede ser compleja porque hayincertidumbres estructurales y cuantitativas sobre el sistema. El problema de incertidumbre se puede corregir con modelos probabilísticos; en este proyecto se aplicó un modelo de Punto de Control/Red Bayesiana a una serie de estudios monográficos en el Asia Sudoriental, para sacar conclusiones cuantitativas de la eficacia de las medidas. Aunqueno es imprescindible tener esta herramienta para desarrollar un enfoque sistémico, la experiencia y un examen mundial reciente han puesto de manifiesto que muchas ONPF no tienen experiencia con el enfoque sistémico o no confían en su aplicación. Esta herramienta ha permitido comprender mejor las medidas propuestas de reducción del riesgo, los indicadores alternativos para la reducción del riesgo (por ejemplo, el desempeño de la aplicación de las medidas) y las medidas de comprobación directa (por ejemplo, población reducida de plagas), y ha facilitadocomparaciones de riesgos de plagas similares. Por tanto, ha mejorado la eficacia de la gestión de riesgo de plagas en la región.

Recomendaciones

1. Intercambiar información y experiencias positivas sobre la utilización del enfoque sistémico en el comercio

El hecho de que pocos interlocutores comerciales comparten sus planes operativos y de gestión, pese a la creciente publicación de los análisis de riesgo de plagas en los que se basan, contribuye al desconocimiento y la poca aceptación de la NIMF Nº 14 y del enfoque sistémico, y la falta de confianza en ese enfoque. Además, actualmente no existeun mecanismo para compartir experiencias positivas sobre la aplicación de la NIMF Nº 14 y el enfoque sistémico. Para empezar, se podría crearuna base de datos global en la que se expongan de manera detallada casos de comercio concluidos satisfactoriamente con el enfoque sistémico. La aplicación de combinaciones de medidas ha permitido una parte importante del comercio durante décadas. Siesta NIMF no se aplica suficientemente es porque no se informa bien sobre ese comercio a las ONPF.

2. Divulgar los resultados del proyecto*Más allá del* cumplimiento

Losenlaces a la página de los recursos fitosanitarios son esenciales para hacer conocer estas cuestiones, pero esta actividad no puede ser pasiva. Se deberíapromocionar de manera activa el material del proyecto*Más allá del cumplimientoy* compartirlo con otros proyectos y cursos de formación sobre la gestión de riesgos. Se deberían consultar otras iniciativas en la materia, para armonizar la reflexión sobre los conceptos básicos y reunir todas las herramientas útiles para su uso en el futuro. Nadie asume esta función actualmente. Podría hacerlo el personal de la Secretaría de la Convención Internacional de Protección Fitosanitaria (CIPF) encargado de la aplicación, si la Comisión de Medidas Fitosanitarias (CMF) lo aprueba.

Una forma eficaz de divulgar las herramientas del proyecto *Más allá del cumplimiento* sería formar a personas de contacto en las ONPF, las ORPF y otras organizaciones competentes, para que actúen como expertos y facilitadores en cada región. Todo el proceso de preparación de las negociaciones de acceso a los mercados exige un apoyo continuo y prolongado, a imagen de la integración de la herramienta y el proceso de evaluación de la capacidad fitosanitaria (ECF) en la región, pero con apoyoa nivel central.

Otra ventaja es que se tendría una sola persona de contacto que respaldaría el uso de los conceptos para otros temas en el país o la región, como la inocuidad de los alimentos, la sanidad animal o aplicaciones similares. No obstante, incluso con experiencia, sería aconsejable crear una red de contactos regulares con los desarrolladores de esta herramienta. En los últimos años se han adoptado sistemas deredes bayesianas para varias aplicaciones de sanidad vegetal. Las herramientas del proyecto *Más allá del cumplimiento* ya están adaptadas después de años de pruebas. Si las ideas, las hipótesis y lasexperiencias en las que se basan las herramientas del proyecto *Más allá del cumplimiento* no se toman en consideración debidamente, la adopción de otras aplicaciones del método de red bayesiana podría resultar más confusa que esclarecedora.

3. Hacer posible el seguimiento de las repercusiones del proyecto *Más allá del cumplimiento*

Está previsto que las herramientas figuren en el sitio Web del STDFo en la página de recursos fitosanitarios, pero quienes quieran probarlas sin un facilitador necesitarán sistemas de comunicación y rastreo, por ejemplo un sistema de licencias (utilizado por la FAO en el anterior desarrollo de programas informáticos), o exigir el registro para poder descargar las herramientas y utilizarlas. Si bienescierto que un mecanismo de rastreo puede informar sobre el número de descargas, es preferible tener un mecanismo de comunicación en los dos sentidos para los futuros usuarios de las herramientas. Así se podría recopilar información pormenorizada de susrepercusiones mediante breves encuestas, porejemplo, y se podrían recibir sugerencias de mejoras y peticiones de ayuda. Asimismo, se puede diseñar un mecanismo de rastreo que permita obtener, de forma anónima, datos valiosos para los indicadores de los efectos de la Convención Internacional de Protección Fitosanitaria (CIPF) y la evaluación de necesidades de aplicación de las NIMF.

4. Seguir afinando y divulgando las herramientas

Las herramientas desarrolladas en el proyecto *Más allá del cumplimiento* han sido diseñadas para mercancías, centrándose cada vez en dos o tres plagas o grupos de plagas, y habrá que adaptarlas a los casos de vegetales que son plagas (malas hierbas), semillas o vías de entrada, por ejemplo los medios de transporte. Se deberíandar a conocer otros casos, respetando siempre todas las prescripciones de confidencialidad. El aumento delnúmero de casos reales comunicados permitirá a todas las partes entender mejor el proceso, las herramientas y su aplicación.

Como todos los materiales disponibles están redactados en inglés, los usuarios que no sean angloparlantestendrán más dificultades con las herramientas listas para su uso, aunque se ha puesto un gran énfasis en la presentación gráfica para que el resultado sea comprensible para personas que hablan otros idiomas o tienen distintos niveles de conocimientos especializados. La traducción de los materiales más importantes complementaría la formación de los expertos regionales, las consultas de los facilitadores de cada región y la divulgación a quienes les resulta más fácil entender explicaciones presentadas por escrito.

Appendix 2: Relevant International Standards for Phytosanitary Measures

Most-relevant ISPMs

ISPM 2	*Framework for pest risk analysis* (originally adopted in 1995, revised in 2007)
ISPM 4	*Requirements for the establishment of pest free areas* (adopted in 1995)
ISPM 5	*Glossary of phytosanitary terms* (updated as needed) – Supplement 1 *Guidelines on the interpretation and application of the concept of official control for regulated pests* (2012) – Supplement 2 *Guidelines on the understanding of potential economic importance and related terms including reference to environmental considerations* (2003) – Appendix 1 *Terminology of the Convention on Biological Diversity in relation to the Glossary of phytosanitary terms* (2009)
ISPM 11	*Pest risk analysis for quarantine pests* (originally adopted in 2001, revised in 2004 and 2013)
ISPM 14	*The use of integrated measures in a systems approach for pest risk management* (adopted in 2002)

ISPM 15 *Regulation of wood packaging material in international trade* (originally adopted in 2002, revised in 2009, Annex 1 and 2 revised in 2013)

ISPM 24 *Guidelines for the determination and recognition of equivalence of phytosanitary measures* (adopted in 2005)

Texts of adopted ISPMs are available at: *www.ippc.int/core-activities/standards-setting/ispms*

ISPM 14: The use of integrated measures in a systems approach for pest risk management – Annex 1

This annex is a prescriptive part of the standard.

ANNEX 1: critical control point system

A critical control point system would involve the following procedures:

(1) determine the hazards and the objectives for measures within a defined system

(2) identify independent procedures that can be monitored and controlled

(3) establish criteria or limits for the acceptance/failure of each independent procedure

(4) implement the system with monitoring as required for the desired level of confidence

(5) take corrective action when monitoring results indicate that criteria are not met

(6) review or test to validate system efficacy and confidence

(7) maintain adequate records and documentation.

An example of this type of system is practised in food safety and is termed a Hazard Analysis Critical Control Point (HACCP) system.

The application of a critical control point system for phytosanitary purposes may be useful to identify and evaluate hazards as well as the points in a pathway where risks can be reduced and monitored and adjustments made where necessary. The use of a critical control point system for phytosanitary purposes does not imply or prescribe that application of controls is necessary to all control points. However, critical control point systems only rely on specific independent procedures known as control points. These are addressed by risk management procedures whose contribution to the efficacy of the system can be measured and controlled.

Therefore, systems approaches for phytosanitary purposes may include components that do not need to be entirely consistent with critical control point concept because they are considered to be important elements in a systems approach for phytosanitary purposes. For example, certain measures or conditions exist or are included to compensate for uncertainty. These may not be monitored as independent procedures (e.g. packhouse sorting), or may be monitored but not controlled (e.g. host preference/susceptibility).

Appendix 3: Glossary of Terms

All definitions in this table are from the 2015 version of: ISPM 5 *Glossary of phytosanitary terms*. IPPC, FAO, Rome.

Additional project definitions appear in Chapter 4.

compliance procedure (for a consignment)	Official procedure used to verify that a consignment complies with phytosanitary import requirements or phytosanitary measures related to transit [CEPM, 1999; revised CPM, 2009]
efficacy (*treatment*)	A defined, measurable, and reproducible effect by a prescribed treatment [ISPM 18, 2003]
entry (*of a pest*)	Movement of a pest into an area where it is not yet present, or present but not widely distributed and being officially controlled [FAO, 1995]
free from (*of a consignment, field or place of production*)	Without pests (or a specific pest) in numbers or quantities that can be detected by the application of phytosanitary procedures [FAO, 1990; revised FAO, 1995; CEPM, 1999]
interception (*of a pest*)	The detection of a pest during inspection or testing of an imported consignment [FAO, 1990; revised CEPM, 1996]

monitoring	An official ongoing process to verify phytosanitary situations [CEPM, 1996]
pathway	Any means that allows the entry or spread of a pest [FAO, 1990; revised FAO, 1995]
pest	Any species, strain or biotype of plant, animal or pathogenic agent injurious to plants or plant products. Note: In the IPPC, plant pest is sometimes used for the term pest [FAO, 1990; revised FAO, 1995; IPPC, 1997; revised CPM, 2012]
pest free area	An area in which a specific pest is absent as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained [FAO, 1995; revised CPM, 2015]
pest free place of production	Place of production in which a specific pest is absent as demonstrated by scientific evidence and in which, where appropriate, this condition is being officially maintained for a defined period [ISPM 10, 1999; revised CPM, 2015]
pest free production site	A production site in which a specific pest is absent as demonstrated by scientific evidence, and in which, where appropriate, this condition is being officially maintained for a defined period [ISPM 10, 1999; revised CPM, 2015]
pest risk (*for quarantine pests*)	The probability of introduction and spread of a pest and the magnitude of the associated potential economic consequences [ISPM 2, 2007; revised CPM, 2013]
pest risk (*for regulated non-quarantine pests*)	The probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact [ISPM 2, 2007; revised CPM, 2013]

pest risk analysis (*PRA*)	The process of evaluating biological or other scientific and economic evidence to determine whether an organism is a pest, whether it should be regulated, and the strength of any phytosanitary measures to be taken against it [FAO, 1995; revised IPPC, 1997; ISPM 2, 2007]
pest risk assessment (*for quarantine pests*)	Evaluation of the probability of the introduction and spread of a pest and the magnitude of the associated potential economic consequences [FAO, 1995; revised ISPM 11, 2001; ISPM 2, 2007; revised CPM, 2013]
pest risk assessment (*for regulated non-quarantine pests*)	Evaluation of the probability that a pest in plants for planting affects the intended use of those plants with an economically unacceptable impact [ICPM, 2005; revised CPM, 2013]
pest risk management (*for quarantine pests*)	Evaluation and selection of options to reduce the risk of introduction and spread of a pest [FAO, 1995; revised ISPM 11, 2001]
pest risk management (*for regulated non-quarantine pests*)	Evaluation and selection of options to reduce the risk that a pest in plants for planting causes an economically unacceptable impact on the intended use of those plants [ICPM, 205; revised CPM, 2013]I
pest status (in an area)	Presence or absence, at the present time, of a pest in an area, including where appropriate its distribution, as officially determined using expert judgement on the basis of current and historical pest records and other information [CEPM, 1997; revised ICPM, 1998]
place of production	Any premises or collection of fields operated as a single production or farming unit. [FAO, 1990; revised CEPM, 1999; revised CPM, 2015]

point of entry	Airport, seaport, land border point or any other location officially designated for the importation of consignments, or the entrance of persons [FAO, 1995; revised CPM, 2015]
quarantine pest	A pest of potential economic importance to the area endangered thereby and not yet present there, or present but not widely distributed and being officially controlled [FAO, 1990; revised FAO, 1995; IPPC, 1997]
required response	A specified level of effect for a treatment [ISPM 18, 2003]
systems approach	A pest risk management option that integrates different measures, at least two of which act independently, with cumulative effect [ISPM 14, 2002; revised ICPM, 2005; revised CPM 2015]
treatment	Official procedure for the killing, inactivation or removal of pests, or for rendering pests infertile or for devitalization [FAO, 1990, revised FAO, 1995; ISPM 15, 2002; ISPM 18, 2003; ICPM, 2005]

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