

Pest Risk Assessment: A Zambian Perspective

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Abstract

Zambia is a landlocked developing country in southern Africa. It is an importer and exporter of plants and plant products. These are potential pathways for introducing exotic plant pests that may affect agricultural production and/or limit access to international export markets. In this regard, the National Plant Protection Organization (NPPO) of Zambia is responsible for formulating phytosanitary regulations to ensure risks of introducing exotic plant pests are minimized. For this, the application of Pest Risk Analysis (PRA) is a vital component of any phytosanitary service. PRAs can be data demanding, time consuming and complex. As a consequence, a simplified procedure that aligns Zambia's national phytosanitary capacity and resources has been developed. The procedure has potential to be applied by other developing countries in similar situations. This simplified procedure focuses on the entry, establishment and spread of pests, the consequences of their introduction, and uses readily available data accessible to the NPPO of Zambia in order to facilitate a quicker response. The procedure developed seeks answers to questions which are phrased as closed questions, i.e. an answer is either 'yes' or 'no', avoiding relative descriptive answers such as 'low', 'medium' or 'high'.

Keywords: exotic pests, Pest Risk Analysis, national phytosanitary capacity, developing countries, simplified procedure

1. Introduction

Zambia is a landlocked developing country in southern Africa. The country is involved in international trade through imports and exports of plants and plant products. Some of these are considered potential pathways of different risks for introducing exotic plant pests (FAO, 2009a). International trade coupled with globalization have a role to play in pest introductions and their spread patterns (Hulme, 2009). Exotic plant pests have been known to cause substantial crop losses costing billions of dollars (Oerke, 2006; Pimentel et al., 2001) and equally have had impacts on international market access for plants and plant products (Arcuri, Gruszczynski, & Herwig, 2010; Sansford et al., 2008). Zambia has not been spared from such impacts. For example, in 2008 the export of fresh vegetable produce (Baby Squash and Baby Courgettes) to the USA market faced stringent phytosanitary regulations¹. This was because some of the plant pests present in Zambia were of quarantine importance to the USA (APHIS-USDA, 2008).

The international agreement relating to plant health, the International Plant Protection Convention (IPPC) seeks to prevent the introduction and spread of pests caused through trade of plants and plant products (FAO, 1997). As a signatory to the IPPC, the Plant Quarantine and Phytosanitary Service (PQPS), which is the National Plant Protection Organization (NPPO) of Zambia, like many other contracting parties, is responsible for the formulation of phytosanitary regulations and their application. These phytosanitary regulations arise as outcomes of a Pest Risk Analysis² (PRA). PRA standards exist and these PRAs need to be based on risk elements that will generate phytosanitary regulations that are scientifically justifiable. The governing body established in accordance with the IPPC, the Commission on Phytosanitary Measures (CPM) oversees the development of the International Standards for Phytosanitary Measures (ISPMs). Of the 36 ISPMs developed (as of 10 December 2012), two relate to PRA for quarantine pests: ISPM number 2 which is the *Framework for pest risk analysis* (FAO, 2007) and ISPM number 11 which is a guide for *Pest Risk Analysis for quarantine pests, including analysis of environmental risks and living modified organisms* (FAO, 2004). In general, the PRA process has three generic stages: PRA stage one (Initiation), PRA stage two (Pest Risk Assessment) and PRA stage three (Pest Risk Management). Risk communication though not an obvious stage in the PRA, is recognized as an important interactive process (FAO, 2007). For example, the New Zealand risk analysis procedure clearly shows risk communication as being performed throughout the entire process (Biosecurity New Zealand, 2006). PRAs

¹ As defined in the ISPM No. 5 Glossary of phytosanitary terms "phytosanitary regulation" means official rule to prevent the introduction and/or spread of quarantine pests, or to limit the economic impact of regulated non-quarantine pests, including establishment of procedures for phytosanitary certification (FAO, 2009b).

² As defined in the ISPM No. 5 Glossary of phytosanitary terms "Pest Risk Analysis" means 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, 2009b).

not including the generic stages go against the basic and operational principles established in ISPM number 1 (FAO, 2006).

Many developed countries with a commitment to plant health and other aspects of biosecurity, for example, Australia, New Zealand and the USA, have prepared their own set of risk analysis procedures. These often include detailed and complex steps beyond what is set out in the ISPMs (Biosecurity Australia, 2011; Biosecurity New Zealand, 2006; USDA, 2000). Furthermore, these procedures tend to form the basis of training in risk analysis offered to developing countries. Developing countries generally lack capacity and resources to routinely follow such procedures (Ikin, 2002). Nonetheless, a recent study on PRAs conducted by the developed countries indicated that their procedures, though different in approach, are in compliance with the IPPC (Burgman, Mittinty, Whittle, & Mengersen, 2010). The level of complexity of a PRA may vary. It can be short (e.g. Anderson & Cannon, 2012) as long as relevant risk elements that influence entry, establishment and spread of a pest are considered and adheres to the framework and guidelines of the ISPMs (Baker & MacLeod, 2003). Considering these requirements and the constraints on the resources of developing countries, we propose in this study a relatively simple PRA procedure for the NPPO of Zambia that focuses on stage two (Pest Risk Assessment) as defined in ISPM number 11 (FAO, 2004).

2. Materials and methods

2.1 Risk elements

The risk elements used in the simplified procedure were identified and selected after a detailed review of PRAs conducted by NPPOs of various developed countries, including Australia, New Zealand and the USA as well as one of the Regional Plant Protection Organizations (RPPO), the European and Mediterranean Plant Protection Organization (EPPO). The review focused on all the different steps of stage two of the PRAs, thus, entry, establishment, spread and consequences. Some of the PRAs reviewed are shown in Table 1.

2.2 Pest List and Pest Categorization

Risk elements identified from ISPM number 11 and the reviewed PRAs to be of particular importance were applied to organisms that had characteristics of a quarantine pest³. The quarantine pests were determined after conducting the first part of pest risk assessment which is referred to as pest categorization. This was done by compiling a pest list, thus, listing pests on an identified pathway, determining what pests are present in Zambia on the crop and a possible pest list from the exporting country. Organisms that were categorized as quarantine pests were subjected to a detailed Pest Risk Assessment. The main sources of information for pest list compilation for Zambia were the CABI Crop Protection Compendium CD ROM, CABI on-line subscription (CABI, 2007, 2012) and records on pests in Zambia (Mukuka, Sumani, & Chalabesa, 2002; PQPS, 2011; Raemaekers, Nawa, Chipili, & Sakala, 1991; Vernon, 1983). The principles for pest categorization were based on ISPM number 11 (FAO, 2004) even though an importing country may determine how it wishes to organize the information considered for pest categorization (2007a).

2.3 Development of a PRA Procedure for Zambia

Having reviewed the PRAs, a relatively simple procedure for the NPPO of Zambia was developed. The procedure uses a closed question approach with 'yes' or 'no' responses rather than a descriptive approach that applies ratings or scores of, 'low', 'medium' or 'high', 'very unlikely' to 'very likely' as conducted by most developed countries. All answers in this procedure are justified, indicating the information that led to each decision and all reference materials documented.

Two case studies were conducted. One case study applied a descriptive approach using ratings and the other applied the relatively simple procedure reported here.

3. Results and Discussion

3.1 The Risk Elements used in Pest Risk Assessments

A comprehensive list of risk elements to consider in PRAs appears in the ISPMs (FAO, 2004, 2007). From these ISPMs and the reviewed PRAs, a number of risk elements were identified as more important and consistently used. When evaluating these risk elements, NPPOs of the developed countries use a descriptive approach with some countries attaching numerical values, such as 1, 2 or 3. The numerical values for each risk element are then summed to provide an estimate of overall pest risk (e.g. USDA, 2000). In the absence of proper guidance on the usage of scores or ratings, this approach is a challenge for biosecurity personnel in a developing country like Zambia. Misinterpretation of the meaning of these ratings or scores could cause Plant Health Inspectors (PHIs), who are current risk assessors in Zambia, to select arbitrarily high ratings or scores because of lack of data and expertise evaluating the various risk elements. The result would be the formulation of indefensible phytosanitary

³ As defined in the ISPM No. 5 Glossary of phytosanitary terms, "quarantine pest means" 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, 2009b).

regulations and possible challenges from potential trading partners. In other words, the assessment of the risk elements depends on a series of factors such as availability and accessibility of relevant data and expertise, and the national phytosanitary capacity⁴. National phytosanitary capacity is key to effective plant protection service delivery (FAO, 2012).

In Zambia, the NPPO has access to limited data and expertise. Considering these constraints, the following risk elements were found to be more important and are the focus of the simplified procedure: (i) **Entry of pest**: pest association with a pathway and presence/absence of PHIs at the designated border ports of Zambia to detect pests of concern. Escape or detection of pest during border inspections depends on the availability of trained staff and capacity to undertake appropriate inspections (Ebbels, 2003). The inability to detect a pest during inspections at the border may constitute a high risk of a pest to enter the importing country (USDA, 2000); (ii) **Establishment of pest**: host range and suitability of climate. Data on all potential hosts are available at the NPPO of Zambia and in the case of climate suitability, data on temperature is readily available and accessible. Temperature has been the most studied abiotic factor for establishment (Peacock, 2005). While there are other factors that could potentially influence establishment of pests (Simberloff, 1989), data on these may not be readily available or accessible to the NPPO of Zambia and any collaborating partners, therefore impeding their evaluation; (iii) **Spread of pest**: distribution of host(s) and intended use of the plant or plant product. Data on these two risk factors were available and accessible to the NPPO of Zambia; and (iv) **Consequence**: qualitative assessment of the economic importance of potential hosts in Zambia, as well as looking at the impact caused by the pest in its area of origin.

To provide a well-structured and documented procedure, consideration of the relevant risk elements have been incorporated into decision steps for a simplified PRA procedure for Zambia shown in Table 2. For greater clarity and user-friendliness of the procedure, Figure 1 offers more detailed guidance on what to do next after a “yes or “no” response.

3.2 Applying the simplified Pest Risk Assessment procedure

Tables 3 and 4 provide a summary of the Pest Risk Assessment case study results using the descriptive “developed country” approach and the simplified Zambian procedure to imported maize (*Zea mays*) seed for sowing from South Africa, respectively. The reported pest list on maize as pathway contained 419 organisms. Of these, 257 were found in South Africa and 140 in the Zambia (CABI, 2007; 2012). Seven organisms were categorized as quarantine pests for the PRA area which is Zambia. The simplified procedure is wholly qualitative. In effect, most PRAs conducted are based on a qualitative approach (Schrader et al., 2010) although quantitative approaches exist as well (Griffin, 2012a). The descriptive approach, as experienced in the case studies (Table 3 and 4), can be problematic. For example very limited data on economic consequences led to a “low” rating for *Acidovorax avenae* while “high” rating for *Haematonectria haematococca*. It can be difficult to identify boundaries separating the ratings (e.g. low, medium, high) causing inconsistency in the process. Inconsistencies that can arise with the descriptive approach have been acknowledged previously (Baker et al., 2009; Devorshak, 2012; Griffin, 2012b; Schrader et al., 2010). In contrast, the simple procedure was easy. Notably, the results from the two approaches produced similar conclusions about the pests. In particular, the conclusion that phytosanitary regulations for *Acidovorax avenae* were not justified. This result comes from the pest not being likely to cause any economic consequences in the PRA area. In addition, both approaches concluded that establishment potential for *Ditylenchus dipsaci* was unlikely in the entire PRA area, but that the pest was still considered for phytosanitary regulations because of its high potential economic consequences. This study has shown that even very simple, rapid PRA procedures can provide phytosanitary regulations that are scientifically justified.

4. Conclusion

It is apparent from this research, that the challenges in conducting PRAs are not only confined to the developing countries like Zambia. Developed countries too continue to make efforts to ensure that PRAs are more user friendly and straightforward (Baker et al., 2009).

The comparative assessment in this study indicates that the simplified procedure would provide the NPPO of Zambia with scientifically based evidence for applying phytosanitary regulations. The procedure is easy to apply, straightforward and user-friendly, and avoids the burden of misinterpretation of the levels of risk through ratings or scoring. A desirable outcome is that the more rapid and simple PRA procedure described here will be adopted by the NPPO of Zambia.

In addition, the procedure presented here has potential to be applied by other developing countries with similar

⁴ As defined by FAO, “national phytosanitary capacity” is 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 (FAO, 2012).

operational constraints to those of the NPPO of Zambia. Although the procedure is not comprehensive, it does use risk elements identified as being important in the ISPMs and it utilizes readily available and accessible data as well as expertise. In short, it aligns with Zambia's national phytosanitary capacity. The procedure does not appear to compromise the PRA outcome. It is hoped that the procedure will be tested and used by other NPPOs of developing countries to assist in the formulation of scientifically justified phytosanitary regulations that facilitate safe international trade of plants and plant products.

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Table 1. Pest Risk Analyses reviewed

NPPOs/RPPO	Pest Risk Analyses
Australia	Import Risk Analyses: (1) Final Import Risk Analysis of the New Zealand request for the access of apples (<i>Malus pumila</i> Miller var. <i>domestica</i> Schneider) into Australia (AQIS, 1998); (2) Cherry fruit (<i>Prunus avium</i>) from South Australia into Western Australia (Biosecurity Australia, 2001); (3) Import Risk Analysis for the importation of bulk maize (<i>Zea mays</i> L.) from the USA (Biosecurity Australia, 2002);
New Zealand	Import Risk Analyses: (1) Import Risk Analysis for fresh citrus fruits from Samoa (Biosecurity New Zealand, 2008); (2) Litchi from Australia (Biosecurity New Zealand, 2008a); (3) Import Risk Analysis Onions (<i>Allium cepa</i> Liliaceae) Fresh Bulbs for Consumption from China (Biosecurity New Zealand, 2009).
USA	Import Risk Analyses: (1) Importation of Fresh Commercial Citrus Fruits from Peru into the United States (USDA, 2002);
EPPO	Pest Risk Analyses: (1) Pest Risk Analysis for <i>Pepino mosaic virus</i> in the EU (Werkman & Sansford, 2010);

Table 2. Decision steps for a simplified PRA procedure for Zambia

Entry of pest 1. Is the pest likely to accompany the pathway? (YES/NO) If YES - proceed to 2, if NO - stop 2. Is the pest likely to escape detection during phytosanitary inspection at border port? (YES/NO) If YES - proceed to 3, if NO - stop
Establishment of pest 3. Are the major or alternate hosts to the pest present in the PRA area? (YES/NO) If YES – proceed to 4, if NO – stop 4. Are the climatic conditions in the PRA area suitable for pest establishment in comparison to areas where the pest presently exists? (YES/NO) If YES – proceed to 5, if NO - stop
Spread of pest 5. Is the host widespread and the intended use of the pathway in the PRA area known? – Proceed to 6
Consequences 6. Is the pest known to have economic consequences in its present geographical range? (YES/NO) If YES - proceed to 7, if NO stop 7. Are there likely to be economic consequences from the pest if it enters, establishes and spreads in Zambia? (YES/NO) – proceed to 8
8. Summary of risk and list any major areas of uncertainty related to the assessment – proceed to stage 3

Table 3. Summary of the outcome of each pest using the descriptive approach

	<i>Delia platura</i>	<i>Cochliobolus lunatus</i>	<i>Haematonectria haematococca</i>	<i>Pyricularia setariae</i>	<i>Acidovorax avenae</i>	<i>Ditylenchus africanus</i>	<i>Ditylenchus dipsaci</i>
Entry	High	High	High	High	High	High	High
Establishment	High	High	High	High	High	High	Medium
Spread	High	High	High	High	High	High	High
Consequence							
- Economic	High	High	High	High	Low	High	High
- Environment	n.d*	n.d	n.d	n.d	n.d	n.d	n.d

*no data

Table 4. Summary of the assessment for each pest using the decision making steps and decisio support flowchart illustrated in Table 2 and Figure 1

Flow chart	<i>Delia platura</i>	<i>Cochliobolus lunatus</i>	<i>Haematonectria haematococca</i>	<i>Pyricularia setariae</i>	<i>Acidovorax avenae</i>	<i>Ditylenchus africanus</i>	<i>Ditylenchus dipsaci</i>
Entry			<i>n.d*</i>				
Escape detection	Yes	Yes		Yes	Yes	Yes	Yes
Establishment			<i>n.d*</i>				
-Availability of host	Yes	Yes		Yes	Yes	Yes	Yes
-Suitability of climate	Yes	Yes		Yes	Yes	Yes	Yes (Not entire PRA)
Spread			<i>n.d*</i>				
-Host range - Intended use (\)	Yes	Yes		Yes	Yes	Yes	Yes
Consequences			<i>n.d*</i>				
-Economic	Yes	Yes		Yes	No	Yes	Yes
-Environment	<i>n.d*</i>	<i>n.d*</i>		<i>n.d*</i>		<i>n.d*</i>	<i>n.d*</i>

*no data

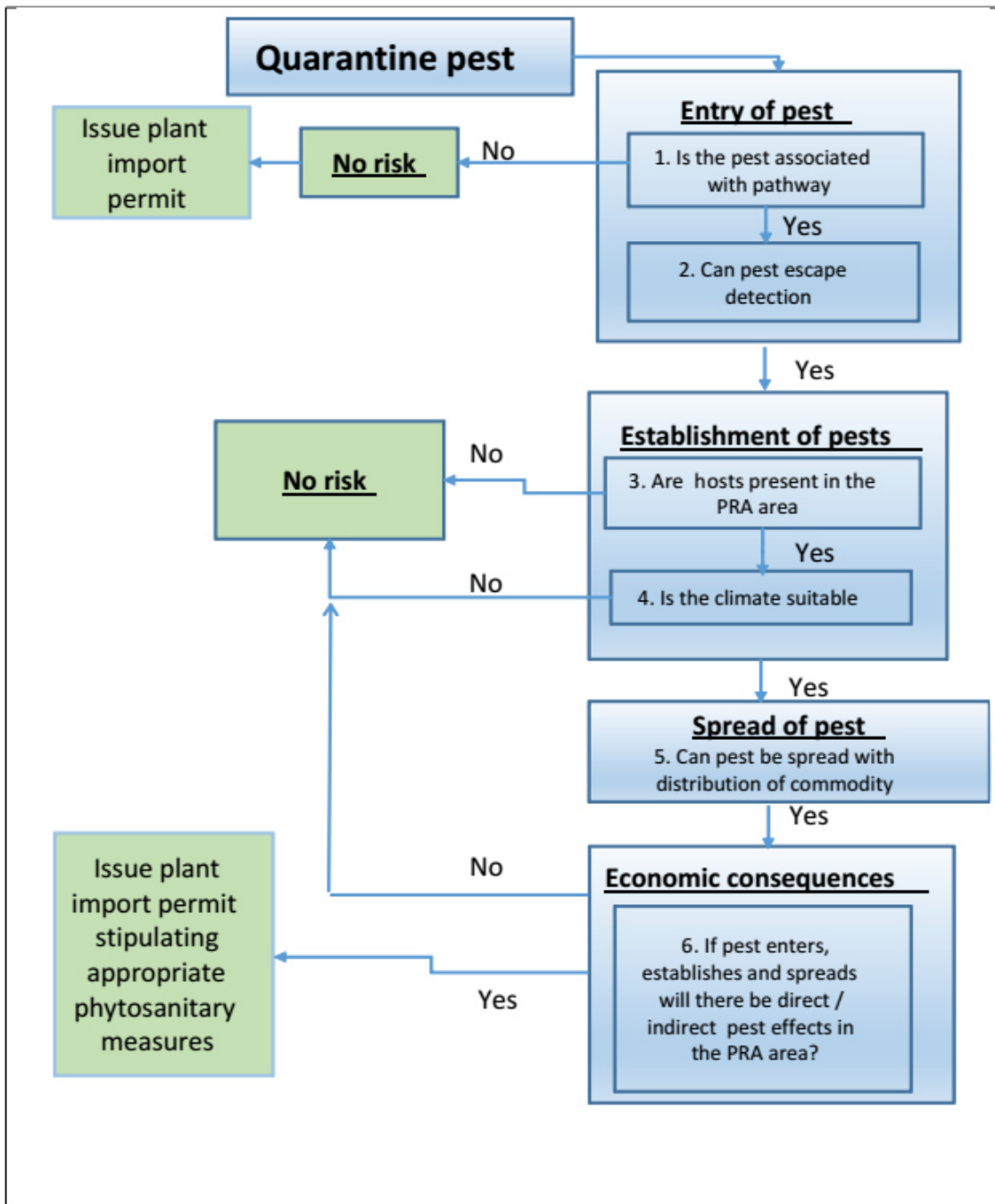


Figure 1. Decision support flowchart for a simplified PRA procedure for Zambia