Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol.3, No.15, 2013

Establishing a More Effective Phytosanitary Regulatory System: A Zambian Case Study

Kajarayekha Kenneth Msiska[1*], Hugh Bigsby[1], E. Ruth Frampton[2] and Susan Worner[3]
1.Faculty of Commerce, P.O. Box 85084, Lincoln University, Lincoln 7647, New Zealand
2.Critique Ltd, 587 Springston-Rolleston Road, R D 8, Christchurch 7678, New Zealand
3.Bio-Protection Research Centre, P.O. Box 85084, Lincoln University, Lincoln 7647, New Zealand
*Corresponding author: Kenneth.Msiska@lincolnuni.ac.nz or kajarayekha@yahoo.com

Abstract
Zambia, a landlocked country importing plants and plant products is vulnerable to the trading risks associated with agricultural products. By virtue of its geographical location, traded plants and plant products also transit through the country. Importations and the transit of plants and plant products have the potential for introducing plant pests that affect agricultural production and limit access to export markets. Globally, government institutions, especially National Plant Protection Organizations (NPPOs), play an important role in preventing the introductions of plant pests resulting from international trade. For this reason, Zambia requires an effective phytosanitary regulatory system. One of the essential components of such a system is an internationally acceptable Pest Risk Analysis (PRA) process. In this context, PRA is a systematic evaluation of the risks associated with the movement of plants and plant products in international trade. It is the basis on which scientifically based phytosanitary measures aimed at preventing the introduction of quarantine pests are developed. This paper highlights the essential components of a PRA process and describes a critical assessment of Zambia's phytosanitary system and its capacity to undertake PRAs.
Keywords: National Plant Protection Organization, quarantine pests, phytosanitary measures, Pest Risk Analysis, trade

1. Introduction

National Plant Protection Organizations (NPPOs) worldwide have the responsibility for the development and enforcement of plant quarantine regulations. This is clearly reflected in the International Plant Protection Convention (FAO, 1997), an international treaty administered through the Food and Agriculture Organization of the United Nations (FAO), to which there are 179 contracting parties (FAO, 2013). The purpose of the International Plant Protection Convention (IPPC) is to secure "common and effective action to prevent the introduction and spread of pests of plants and plant products, and to promote appropriate measures for their control". The IPPC also specifies the obligations of the contracting parties relating to the organizational arrangements and responsiblities of their NPPO. Responsibilities, to the best of the ability of the contracting parties, include the conduct of pest risk analysis; the surveillance of growing plants, including both areas under cultivation and wild flora, and of plants and plant products in storage or in transportation; the inspection of consignments of plants and plant products moving in international traffic and, where appropriate, the inspection of other regulated articles, particularly with the object of preventing the introduction and/or spread of pests; the disinfestation or disinfection of consignments of plants, plant products and other regulated articles moving in international traffic, to meet phytosanitary requirements; the issuance of certificates relating to the phytosanitary regulations of the importing contracting party; ensuring through appropriate procedures that the phytosanitary security of consignments after certification regarding composition, substitution and reinfestation is maintained prior to export; the protection of endangered areas and the designation, maintenance and surveillance of pest free areas and areas of low pest prevalence; and training and development of staff. International Standards for Phytosanitary Measures (ISPMs) developed under the auspices of the IPPC provide guidance to contracting parties on how to meet their obligations (FAO, 1997).

Obviously NPPOs require capacity to fulfil obligations under the IPPC. FAO (2012) defines *national phytosanitary capacity* 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". Many developing countries, for example in Africa, lack national phytosanitary capacity (IAPSC, 2013). The lack of capacity hampers the ability of such countries to participate effectively in international trade. Trade, as in international movement of people, commodities and conveyances, carries the phytosanitary risk of introducing and spreading pests when importing plants, plant products and other regulated articles. Pest Risk Analysis (PRA) involves evaluating biological or other scientific and economic evidence to determine whether a pest should be regulated (FAO, 2009) and is an important part of managing phytosanitary risks associated with trade (FAO, 2006)

The PRA process is considered to be one of the key national phytosanitary competencies required by

NPPOs. PRAs assist NPPOs to determine phytosanitary measures, that is, legislation, regulations or official procedures having the purpose to prevent the introduction and/or spread of regulated pests. In general, PRAs are conducted by NPPOs of the importing countries (Griffin, 2000; Lopian & Stephen, 2013) and are initiated for different reasons. These include analysing risk of organisms, pathways or commodities and for the development of new phytosanitary policies or prioritizing of resources. The conduct of PRAs varies in complexity and depends on the resources available (Devorshak, 2012). A framework for undertaking PRAs relating to quarantine pests is provided in two ISPMs, numbers 2 and 11 (FAO, 2004, 2007). Despite this, NPPOs from developing countries often face challenges undertaking PRAs (Ikin, 2002). Zambia is no exception.

It is a landlocked country in southern Africa importing plants and plant products. By virtue of its geographical location, traded plants and plant products also transit through the country. To manage the risks associated with importations and the transit of plants and plant products, Zambia requires an effective phytosanitary regulatory system. Its current system lacks capacity and consequently Zambia is looking to improve its system, especially its PRA process.

Previously, Msiska et al. (2013) determined essential risk elements to be incorporated in PRAs by resource-challenged developing countries when undertaking such analyses. The present paper identifies essential PRA process components that are needed for an internationally acceptable PRA system, at the same time matching these with the phytosanitary capacity of Zambia's NPPO, the Plant Quarantine and Phytosanitary Service (PQPS) in the Plant Protection and Quarantine Division (PPQD) of the Zambia Agriculture Research Institute (ZARI) under the Ministry of Agriculture and Livestock (MAL).

2. Materials and methods

2.1 Identifying the essential PRA process components

To identify essential components of a PRA process, a comprehensive review of documented procedures and publicly available PRAs was conducted. Most of the PRAs included in the review were undertaken by NPPOs of developed countries including Australia, New Zealand and the United States of America. One was from a Regional Plant Protection Organization (RPPO), the European and Mediterranean Plant Protection Organization (EPPO). The review focused on the entire PRA process in order to identify key components that could be considered essential by virtue of their influence on the process.

2.2 Identifying Zambia's phytosanitary capacity in relation to the PRA process

Focusing on the components identified through 2.1 above, a questionnaire to accurately define Zambia's phytosanitary capacity was developed. The questionnaire was used to gather information on phytosanitary capacity at the NPPO of Zambia. It included information on: the current PRA process; availability of PRA experts; PQPS staffing; sources of information relevant to PRAs; and laboratory and inspection facilities. The questionnaire was applied at the PQPS head office and Zambia's border ports between November 2011 and May 2012. Border ports were the main airport, the Kenneth Kaunda International Airport (KKIA), Katima Mulilo, Chirundu, Copperbelt, Mwami, Nakonde and Victoria Falls (ZARI, 2009, 2010). While only the PRA process is discussed in the present paper, it is acknowledged that other phytosanitary capacity components are no less important.

2.3 Comparison of the NPPO of Zambia with other NPPOs

The NPPOs of Australia, New Zealand and the United States of America are known for their elaborate and comprehensive PRA processes. Zambia's process was mainly compared to these countries. The comparison centred on the: (i) presence of a PRA unit (Biosecurity Australia, 2011; Biosecurity New Zealand, 2006; FAO, 1997; KEPHIS, 2011); (ii) availability of and access to specialists of various disciplines in relation to plant health (Gray et al., 1998); (iii) peer review (Biosecurity Australia, 2011); (iv) risk communication and consultation procedures (Biosecurity Australia, 2011; Biosecurity New Zealand, 2006); (v) access to published sources of relevant PRA information (Baker & MacLeod, 2003; Hennessey, 2004; Kenis, Rabitsch, Auger-Rozenberg, & Roques, 2007); (vi) availability of risk analysis-related software packages e.g. for risk mapping; (vii) availability of and access to data used to evaluate risk elements (Baker et al., 2009; Rossi, Giosuè, & Bernazzani, 2009).

3. Results and Discussion

3.1 Essential PRA process components

The IPPC, with particular reference to Article IV which outlines general provisions relating to the organizational arrangements for NPPOs, does not specify the organizational structure of a NPPO (FAO, 1997; Vapnek & Manzella, 2007). Nevertheless, from the review of PRAs and NPPOs' websites, it is apparent that many countries have established PRA units within their agriculture Ministry structure specialising in undertaking risk analyses. This seems to be common in developed countries, for example in Australia (Biosecurity Australia, 2011) and New Zealand (Ministry for Primary Industries, 2013) as well as some developing countries. In Kenya, where the NPPO acknowledged the important role of the PRA process, a PRA unit has been established (KEPHIS, 2011). South Africa (Theyse, 2009) and Jamaica (JIS, 2010) have also recently established PRA units. Establishing a PRA unit within the structure of the government department or Ministry formally acknowledged as the NPPO is recognised as a way to enhance the effectiveness and efficiency in delivering the required PRAs. In reality, most NPPOs receive numerous applications for imports of plants, plant products or other regulated articles, and a dedicated unit is necessary. The NPPO of the USA for instance was processing import applications from 37 countries for more than 90 commodities in 2012 alone (USDA-APHIS, 2012). Equivalent numbers of import applications can present an even bigger challenge to developing countries without an established PRA unit.

From the review, it is clear that collaborating with specialists from relevant plant health fields is an essential component of the PRA process. This involves accessing experts specialised in the various plant health disciplines such as entomology, nematology, pathology and weed science. If not within the established PRA unit, these and other specialists as required, tend to be accessed from universities and/or research institutes. Trust in the PRA process and acceptance of any PRA's outcomes is greatly enhanced by participation of relevant experts in the process. It is therefore in a NPPO's best interest to involve appropriate experts in the process and consult with the wider scientific community. A multidisciplinary approach is essential (Gray et.al., 1998) especially in the analysis of risks associated with commodities and pathways. This is highlighted in Australia in that the Department of Agriculture, Fisheries and Forestry (DAFF) has some 73 scientists (experts) working on import risk analysis (DAFF, pers.comm.), while in the USA, the Animal and Plant Health Inspection Service's (APHIS) Center for Plant Health Science and Technology's (CPHST) Plant Epidemiology and Risk Analysis Laboratory (PERAL) has 36 experts involved in risk assessments (R. Duncan, pers. comm.). These experts are directly involved in the assessment of plant and plant product import applications (USDA-APHIS, 2013).

Access to published sources of PRA-relevant information and the availability of up-to-date data sets (e.g. climate data) form another essential process component for a NPPO. The reviewed PRAs indicated that various published sources of information and data were available to and easily accessed by the NPPOs and EPPO for the purpose of undertaking PRAs. The sources included national pest lists, pest interception records from border ports, surveillance reports, technical research and industry reports, scientific journals and books, climate data and CAB International (CABI) Crop Protection Compendium (CPC). In addition, expert opinion from local and international scientists was obtained. Table 1, showing the number of references cited in some example PRAs, highlights the potential range of information accessed by developed countries. An acceptable PRA results from credible sources of information. It must therefore be assumed that a NPPO will have access to at least some credible information/data sources for the purpose of conducting PRAs. The CABI CPC could be regarded as the single most important and accessible data/information source for developing countries.

Another important component is the peer review process adopted for PRAs. A peer review process should provide a formal objective, if not independent, review of each PRA as documented. In many cases, the process is conducted internally but often relevant external (to the NPPO) scientists and even overseas research institutions or industry stakeholders may be involved (Table 2). For this purpose, NPPOs of countries such as Australia, New Zealand and the USA distribute their PRAs to appropriate experts for formal peer review (Biosecurity Australia, 2011; Biosecurity New Zealand, 2006) prior to, or at the same time as posting the draft PRAs on the NPPO website for consultation and distribution to the potential trading partners for consultation.

Risk communication and consultation is identified as another essential component of a PRA process. Countries such as Australia and New Zealand include in their national risk analysis frameworks risk communication and consultation processes that are both interactive and iterative involving a two-way dialogue (Biosecurity Australia, 2011; Biosecurity New Zealand, 2006). In both countries risk communication and consultation includes the establishment of website links, http://www.daff.gov.au/ba/stakeholder and http://www.biosecurity.govt.nz/biosec/consult where the public, stakeholders or experts can register and follow the PRA work programmes. Stakeholders have been known to provide additional information that contributes to the PRA (Biosecurity Australia, 2002).

The use of pest risk maps is a recent advance in the PRA processes adopted in some developed countries. Risk maps provide very clear visual representation of relative levels of risk estimated in the area. Some countries/regions with the necessary resources have incorporated risk maps into their PRAs, for example, the USA (USDA-APHIS, 2010) and EPPO (Strauss, 2010). Although research on risk maps continues (Baker et al., 2012; Magarey et al., 2011; Worner & Gevrey, 2006), the generation of risk maps is not considered to be priority component in the PRA process, especially in developing countries.

3.2 Zambia's phytosanitary capacity

Survey results showed that, like many other developing countries, Zambia's phytosanitary capacity faces challenges in relation to the PRA process. The Zambian NPPO does not have staff specifically dedicated to conducting PRAs and a PRA unit is not established in its structure. In reality, PHIs located at the border ports conduct adhoc analyses of the risks of imported plants and plant products at the same time they complete inspections. Although there is no unit in PQPS, ZARI recognizes the potential importance of having a PRA unit. The establishment of a PRA unit in head office with staff specialising in pest risk analyses would likely increase efficiency and effectiveness of Zambia's PRA process.

As it is, Zambia's NPPO, PQPS, has a staff comprising 26 PHIs in total (as of June 2012) to undertake all the functions of a NPPO outlined in the IPPC. This total number includes PHIs from Head Office, border ports and inland check points. As indicated above, the 26 PHIs' work tends to be focused on import and export inspections of plants and plant products.

The current limited capacity in the PQPS is exacerbated by the limited availability and accessibility to other experts in ZARI. Help from scientists in other sections of PPQD and other divisions in ZARI is accessed occasionally. The absence of specialists dedicated to the PRA process has resulted in delays in formulating phytosanitary measures. Table 3 shows the number of plant health specialists potentially available to Zambia's NPPO, distinguishing between in-house staff and those in other sections of PPQD at Head Office as at June 2012.

The survey identified that the major source of information used for PRAs by the Zambian NPPO staff was the CABI CPC CD ROM (CABI., 2007). Staff from within the NPPO as well as other sections of the PPQD sometimes provided relevant data. Despite internet being available, its use was found to be limited due to its erratic and slow connectivity. Consequently searches for relevant scientific information for many PRAs were not undertaken. Furthermore, Zambia's pest list is compiled using pest records from field manuals, field guides, check lists and reports from the annual seed crop inspections conducted by the NPPO of Zambia. As seen in Table 4, published records are not updated very often.

As a matter of course, objective if not independent peer review of draft PRAs prior to wider consultation are not consistently undertaken. This compromises consistency in the Zambia's current PRA process.

Risk communication and consultation channels are not clearly defined even though the NPPO of Zambia from time to time communicates with stakeholders on phytosanitary matters that affects them. Given the absence of a functional website, communication and consultation with the public, stakeholders or interested scientists is via email.

3.3 Comparison of Zambia's NPPO with other NPPOs

As described in 3.2 above, the effectiveness of Zambia's phytosanitary regulatory system is severely constrained by its present lack of capacity in a number of key areas. These include the lack of a suitably staffed PRA unit within the NPPO, lack of data/information relevant to conducting PRAs and the lack of available plant health specialists able to contribute directly to PRAs, peer review and/or be consulted on completed PRA documents. Such areas can be viewed as PRA process enabling elements. The NPPOs of Australia, New Zealand and USA, those countries reviewed as part of this work, are very well resourced comparatively in these areas. Although not directly comparable due to different organisational structures, the USA for instance has a dedicated unit related to phytosanitary risk analyses - the CPHST has 36 experts involved risk assessments, while Zambia has none.

In addition, these NPPOs have an established PRA procedure in place (Biosecurity Australia, 2011; Biosecurity New Zealand, 2006; USDA-APHIS, 2000). Notably, the NPPO of Zambia has no such procedure for the conduct of PRAs presently. Having a national PRA procedure ensures consistency and transparency in the process. Limitations on the availability of relevant PRA data and specialists at the NPPO of Zambia led to recent work undertaken by Msiska et al. (2013), where a PRA procedure that better matches its phytosanitary capacity was devised.

4. Conclusion

There is little doubt that Zambia's PRA process needs to be improved. The phytosanitary capacity of its NPPO is lacking and ideally, will require significant injection of funds in the long term. Nevertheless, in the absence of additional funding improvements could be made to its PRA processes. The effectiveness of any NPPO's phytosanitary regulatory system is highly dependent on its capacity to undertake PRAs (FAO, 2006).

It is suggested that improvements in the effectiveness of Zambia's phytosanitary regulatory system could be achieved by restructuring the NPPO, utilising some of its in-house, tertiary qualified personnel in Head Office to focus on PRAs by applying the newly-developed PRA procedure (Msiska et al., 2013). This proposal would mean that PRAs are undertaken centrally at Head Office only. As a consequence, NPPO staff undertaking PRAs would be better located to access other PPQD plant health specialists who may be able to contribute to the PRAs.

In addition, it is proposed that clarifying the inspection roles of border staff and establishing clearer communication channels with PHIs located at the border ports would enable them to respond consistently to Head Office directives relating to phytosanitary measures required for plant and plant product imports. The outcomes from the PRA process would also enable inspection efforts to target higher risk plant and plant product imports, better utilising the limited inspection capacity of Zambia's NPPO.

5. Acknowledgements

The authors wish to thank the New Zealand Ministry of Foreign Affairs and Trade for awarding a Commonwealth Scholarship to the senior author to undertake the research described in this paper. We also wish to thank the staff at the Zambia Agriculture Research Institute (ZARI), particularly those in the Plant Quarantine and Phytosanitary Service (PQPS), the NPPO of Zambia for their cooperation and support during field work in Zambia.

References

Baker, R., & MacLeod, A. (2003). Pest risk assessments: tools, resources and key challenges Symposium conducted at the meeting of the Identification of risks and management of invasive alien species using the IPPC framework, 22-26 September, Braunschweig, Germany Retrieved from http://www.fao.org/docrep/008/y5968e/y5968e00.htm#Contents

Baker, R. H. A., Battisti, A., Bremmer, J., Kenis, M., Mumford, J. D., Petter, F., . . . Sun, J. H. (2009). PRATIQUE: a research project to enhance pest risk analysis techniques in the European Union. *Bulletin OEPP/EPPO Bulletin, 39*, 87–93.

Baker, R. H. A., Benninga, J., Bremmer, J., Brunel, S., Dupin, M., Eyre, D., . . . Kriticos, D. J. (2012). A decision-support scheme for mapping endangered areas in pest risk analysis. *EPPO Bulletin, 42*(1), 65-73.

Biosecurity Australia. (2002). *Final IRA Paper: Importation of bulk maize from USA*: Department of Agriculture, Fisheries and Forestry (DAFF), Commonwealth of Australia. Retrieved from http://www.daff.gov.au/__data/assets/pdf_file/0012/20901/rev_dft_ira_maize.pdf

Biosecurity Australia. (2008). *Draft Import Risk Analysis Report for Fresh Unshu Mandarin Fruit from Japan*. Retrieved 11.11, 2012,from http://www.daff.gov.au/__data/assets/pdf_file/0008/747827/Unshu_mandarin_from_Japan_Draft_IRA_Report.pdf

Biosecurity Australia. (2011). *Australian Government Department of Agriculture, Fisheries and Forestry 2011, Import Risk Analysis Handbook 2011, Canberra*. Retrieved 06.07, 2012,from http://www.daff.gov.au/__data/assets/pdf_file/0012/1897554/import-risk-analysis-handbook-2011.pdf

Biosecurity New Zealand. (2006). *Risk Analysis Procedures Version 1*. Retrieved 01.03, 2012,from http://www.biosecurity.govt.nz/files/pests/surv-mgmt/surv/review/risk-analysis-procedures.pdf

Biosecurity New Zealand. (2008a). *Import Risk Analysis: Fresh Citrus Fruit (7 species) from Samoa* Policy and Risk Biosecurity, Ministry of Agriculture and Forestry, New Zealand. Retrieved from http://www.biosecurity.govt.nz/files/biosec/consult/draft-ra-citrus-samoa-subs.pdf

Biosecurity New Zealand. (2008b). *Import Risk Analysis: Litchi (Litchi chinensis)fresh fruit from Australia*. Retrieved 08.11, 2012,from http://www.biosecurity.govt.nz/files/regs/imports/risk/aus-litchi-ra.pdf

CABI. (2007). *Crop Protection Compendium – CD ROM edition*: Wallingford, Oxfordshire OX10 8DE, UK: CABI Publishing.

Devorshak, C. (2012). Types and application of Pest Risk Analysis. In C. Devorshak (Ed.), *Plant Pest Risk Analysis: Concepts and Applications* (pp. 83-94). Wallingford, Oxfordshire, OX10 8DE, UK: CABI International.

FAO. (1997). *New Revised Text for the International Plant Protection Convention (IPPC). FAO, Viale delle Terme di Caracalla, 00153 Rome, Italy*. Retrieved 04.03, 2013,from https://www.ippc.int/sites/default/files/documents/20130603/13742.new_revised_text_of_the_international_plant_protectio_201304232117en_2013060311%3A04_65.4%20KB.pdf

FAO. (2004). *Pest risk analysis for quarantine pests including analysis of environmental risks and living modified organisms: ISPM No. 11*. FAO, Rome, Italy.

FAO. (2006). *Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade: ISPM No. 1*. FAO, Rome, Italy.

FAO. (2007). *Framework for pest risk analysis: ISPM No. 2*: FAO, Rome, Italy.

FAO. (2009). *Glossary of phytosanitary terms: ISPM No. 5*: FAO, Rome, Italy.

FAO. (2012). *International Plant Protection Convention (IPPC) National Phytosanitary Capacity Development Strategy*. Retrieved 05.03, 2013,from http://www.ippc.int/file_uploaded/1359386736_02IPPC_CapacityDevelopment_e.pdf

FAO. (2013). *Signatories to the International Plant Protection Convention*. Retrieved 19.09, 2013,from http://www.fao.org/fileadmin/user_upload/legal/docs/4_004s-e.pdf

Gray, G. M., Allen, J. C., Burmaster, D. E., Gage, S. H., Hammitt, J. K., Kaplan, S., . . . Nyrop, J. P. (1998). Principles for Conduct of Pest Risk Analyses: Report of an Expert Work hop. *Risk Analysis, 18*(6), 773-780.

Griffin, R. (2000). *National Phytosanitary Capacity for WTO Members and Contracting Parties to IPPC*. Retrieved 13.03, 2013,from http://www.fao.org/docrep/003/x7354e/x7354e08.htm

Hennessey, M. K. (2004). Quarantine Pathway Pest Risk Analysis at the APHIS Plant Epidemiology and Risk Analysis Laboratory. *Weed technology 18* (1), 1484 doi:10.1614/0890-037X(2004)018[1484:QPPRAA]2.0.CO;2

IAPSC. (2013). *The African Union: Inter-African Phytosanitary Council's Project*. Retrieved 11.12, 2012,from http://rea.au.int/en/RO/IAPSC

Ikin, R. (2002). *Pest Risk Analysis in developing countries, capability and constraints*. Retrieved 25.04, 2013,from http://www.spc.int/lrd/index.php?searchword=BOB+IKIN&ordering=&searchphrase=all&Itemid=371&option=com_search

JIS. (2010). *Pest Risk Analysis Unit, Ministry of Agriculture and Fisheries, Jamaica* Retrieved 17.08, 2013,from http://www.jis.gov.jm/news/103-agriculture-fisheries/22473-MinAgriFish-dr-tufton-opens-pest-risk-analysis-unit

Kenis, M., Rabitsch, W., Auger-Rozenberg, M. A., & Roques, A. (2007). How can alien species inventories and interception data help us prevent insect invasions? *Bulletin of Entomological Research 97*, 489–502 doi:10.1017/S0007485307005184

KEPHIS. (2011). *Annual Financial Statements & Reports*. Retrieved 09.09, 2012,from http://www.kephis.org/2010%202011%20KEPHIS%20%20Annual_report.pdf

Lopian, R., & Stephen, C. (2013). *International Trade and Invasive Alien Species*. Retrieved 22.07, 2013,from http://www.phytosanitary.info/sites/phytosanitary.info/files/STDF_International%20trade%20and%20Invasive%20Alien%20Species.pdf

Magarey, R. D., Borchert, D. M., Engle, J. S., Colunga-Garcia, M., Koch, F. H., & Yemshanov, D. (2011). Risk maps for targeting exotic plant pest detection programs in the United States. *EPPO Bulletin, 41*(1), 46-56.

Ministry for Primary Industries. (2013). *The Ministry for Primary Industries: Our structure*. Retrieved 23.07, 2013,from http://www.mpi.govt.nz/about-mpi/our-organisation/our-structure

Msiska, K. K., Bigsby, H., Worner, S. P., & Frampton, E. R. (2013). Pest Risk Assessment: A Zambian Perspective. *Journal of Biology, Agriculture and Health, 3*(8), 105 -112.

Mukuka, J., Sumani, A. J., & Chalabesa, A. (2002). *Agricultural Field Insect pests of Zambia and their management*. Mount Makulu, Chilanga, Zambia: Plant Protection and Quaratntine Division, Soils and Crops Research Branch

PQPS. (2011). *Plant Quarantine and Phytosanitary Service, annual report, Zambia Agriculture Research Institute, MACO, Chilanga, Zambia.*

Raemaekers, R. H., Nawa, I. N., Chipili, J., & Sakala, A. (Eds.). (1991). *Revised checklist of plant diseases in Zambia.* . Mount Makulu Central Research Station, Department of Agriculture, Chilanga Zambia: General Adiministration for Developemnt Co-operation, Brussels, Belgium.

Rossi, V., Giosuè, S., & Bernazzani, R. (2009). *Pest risk assessment in the European Community: inventory of data sources. SCIENTIFIC REPORT submitted to EFSA*. Università Cattolica del Sacro Cuore, Via E. Parmense 84, 29100 Piacenza, Italy. Retrieved from http://www.efsa.europa.eu/3B6DC99D-89D8-4374-BB7E-E9DF3DEEBBAE/FinalDownload/DownloadId-4A1209E0E71DB59F8148593317C7D7E2/3B6DC99D-89D8-4374-BB7E-E9DF3DEEBBAE/en/supporting/doc/29e.pdf

Strauss, G. (2010). Pest risk analysis of Metcalfa pruinosa in Austria. *Journal of Pest Science, 83*(4), 381-390. doi:10.1007/s10340-010-0308-3

Theyse, M. (2009). *Developement of an effective phytosanitary regulatory information management systems framework for WTO SPS complaince.* . MSc. Thesis, University of Pretoria, South Africa.

USDA-APHIS. (2000). *Guidelines for Pathway-Initiated Pest Risk Assessments, Version 5.02. Animal and Plant Health Inspection Service, US Department of Agriculture, Riverdale, Maryland*. Retrieved 13.12, 2012,from http://www.dpm.ifas.ufl.edu/plant_pest_risk_assessment/ALS6942_docs/CRA_Guidelines_5_02.pdf

USDA-APHIS. (2002). *Importation of Fresh Commercial Citrus Fruit: Clementine (Citrus reticulata Blanco var. Clementine) Mandarin (Citrus reticulata Blanco) and Tangerine (Citrus reticulata Blanco) from Chile into the United States*. Retrieved 08.09, 2011,from https://web01.aphis.usda.gov/oxygen_fod/fb_md_ppq.nsf/d259f66c6afbd45e852568a90027bcad/c409e35a1313bd0a85256e5f005a4345/$FILE/0062.pdf

USDA-APHIS. (2010). *Qualitative analysis of the pest risk potential of the brown marmorated stink bug (BMSB), Halyomorpha halys (Stål), in the United States*. Retrieved 17.05, 2013,from http://www.michigan.gov/documents/mda/BMSB_Pest_Risk_Potential_-_USDA_APHIS_Nov_2011_344862_7.pdf

USDA-APHIS. (2012). *Current In-Progress PPQ Risk Analyses as of July 23, 2012*. Retrieved 16.06, 2013,from http://www.aphis.usda.gov/import_export/plants/plant_imports/downloads/PRAlist.pdf

USDA-APHIS. (2013). *Drafting a Risk Assessment*. Retrieved 16.06, 2013,from http://www.aphis.usda.gov/import_export/plants/plant_imports/process/analysis.shtml

USDA. (1991). *Pest Risk Assessment on the Importation of Larch from Siberia and the Soviet Far East*. United States Department of Agriculture, Forest Service, Riverdale, Maryland. Retrieved from http://www.fs.fed.us/foresthealth/publications/pest_risk_assmt_far_east_content.pdf

Vapnek, J., & Manzella, D. (2007). *Guidelines for the revision of national phytosanitary legislation. FAO Legal papers online # 63*. Retrieved 11.09, 2012,from http://www.fao.org/fileadmin/user_upload/legal/docs/lpo63.pdf

Vernon, M. (1983). *Field guide to important arable weeds of Zambia*. Mount Makulu Central Research Station, Department of Agriculture, Chilanga Zambia: Printed by Balding and Marshall Limited, England.

Werkman, A. W., & Sansford, C. E. (2010). *Pest Risk Analysis for Pepino mosaic virus for the EU. Deliverable Report 4.3. EU Sixth Framework Project Project PEPEIRA*. Retrieved from http://www.fera.defra.gov.uk/plants/plantHealth/pestsDiseases/documents/pepinoMosaic.pdf

Worner, S. P., & Gevrey, M. (2006). Modelling global insect pest species assemblages to determine risk of invasion. *Journal of Applied Ecology, 43*, 858-867.

ZARI. (2009). *Annual report: Zambia Agriculture Research Institute (ZARI): Mt. Makulu Central Research Station, Ministry of Agriculture and Cooperatives. Retrieved from* Retrieved 11.12, 2012,from http://www.zari.gov.zm/media/annual_report_2009.pdf

ZARI. (2010). *Annual report: Zambia Agriculture Research Institute (ZARI): Mt. Makulu Central Research Station, Ministry of Agriculture and Cooperatives. Retrieved from* Retrieved 11.12, 2012,from http://www.zari.gov.zm/media/annual_report_2010.pdf

Table 1. Number of sources of information cited as reference materials by some reviewed PRAs

NPPO/RPPO	**Pest Risk Analyses**	**Estimated number of references cited**
Australia	IRA for the importation of bulk maize (*Zea mays* L.) from the USA (Biosecurity Australia, 2002)	54
	Draft Import Risk Analysis Report for Fresh Unshu Mandarin Fruit from Japan (Biosecurity Australia, 2008) .	440
New Zealand	IRA for fresh citrus fruits from Samoa (Biosecurity New Zealand, 2008a)	200
	Litchi from Australia (Biosecurity New Zealand, 2008b)	95
USA	Pest Risk Assessment on the Importation of Larch from Siberia and the Soviet Far East (USDA, 1991)	127
	Importation of Fresh Commercial Citrus Fruits from Chile into the United States (USDA-APHIS, 2002)	300
EPPO	Pest Risk Analysis for *Pepino mosaic virus* in the EU (Werkman & Sansford, 2010);	97

Table 2. Peer reviews of some reviewed PRAs

NPPOs	Reviewed PRA	Peer review of the PRA	
		Internal	External
Australia	Importation of bulk maize (*Zea mays* L.) from the USA (Biosecurity Australia, 2002);	Risk Assessors of Agriculture, Fisheries and Forestry of Australia (AFFA)	-Risk Analysis Panel that consisted of private consultants and professors from universities; -Eminent Scientist Group (ESG)
New Zealand	Importation of fresh citrus fruits from Samoa (Biosecurity New Zealand, 2008a).	Risk Assessors of the Ministry of Agriculture and Forestry (MAF) now the Ministry for Primary Industries (MPIs	Scientists from Landcare Research in New Zealand -Tropical Plant Pests Research Unit of the U.S. Pacific Basin Agriculture Research Center in Hawaii.
USA	Importation of Fresh Commercial Citrus Fruits from Chile into the United States (USDA-APHIS, 2002).	USDA-APHIS	University of California

Table 3. Number plant health specialists available to Zambia's NPPO
(Head Office as at June 2012)

	Entomology	**Nematology**	**Mycology**	**Virology**	**Weed Science**	**Postharvest**	**Economists**
NPPO (PQPS)	2	1	4	0	0	0	0
Other sections of PPQD	6	1	1	3	1	2	0

Table 4. Sources of pest records for Zambia

Discipline	**Reference material**	**Author and Year**
Weed science	Field guide to important arable weeds of Zambia.	Vernon (1983)
Plant diseases	Revised checklist of plant diseases in Zambia.	Raemaekers et al. (1991)
Entomology	Agricultural field insect pests of Zambia and their management.	Mukuka, Sumani & Chalabesa (2002)
General	CABI Crop Protection Compendium CD ROM	CABI (2007)
Other	Seed crop inspection reports	PQPS (2011)