June 2007

Australian Banana Growers' Council Inc

Submission in relation to revised draft IRA Report (2007)

Contents

1 General

1.1 Council and growers' interests

The Australian Banana Growers' Council Inc (**Council**) is the Australian banana industry's peak body representing the interests of Australia's 796 banana growers.

The Council has actively participated as a stakeholder in representing the interests of its members in the import risk analysis for bananas from the Philippines since it commenced in early 2000.

If the Director of Animal and Plant Quarantine determines to allow the importation of bananas from the Philippines subject to the quarantine conditions specified in the revised draft IRA Report (or any other quarantine conditions that do not reduce the risk of the pests under consideration sufficiently to meet Australia's ALOP), and consequently grants an importation permit, the property interests of Australian banana growers would be adversely affected.

Australian banana growers' banana plants would be exposed to the unacceptable risk of damaging quarantine pests and the value of their land and their businesses would be reduced. Each Australian banana grower, and the Council as the peak industry body, consequently has an interest in the proper and lawful conduct of the import risk analysis.

1.2 This submission

This submission is the Council's response to the revised draft IRA Report released by Biosecurity Australia in March 2007.

The Council has made previous submissions to Biosecurity Australia during the course of the import risk analysis for bananas from the Philippines.

The Council relies upon each of those previous submissions without repeating the detail of them in this submission (except that this submission shall prevail to the extent of any inconsistency with a previous submission).

1.3 The Council's scientific and technical consultants

The Council prepared this submission based upon advice from its scientific and technical consultants. Curriculum vitaes of the Council's key scientific and technical consultants are provided in Annexure 4.

1.4 Council's submissions

For the reasons detailed in this submission, the Council makes the following general submissions in respect of the import risk analysis for bananas from the Philippines.

1.4.1 Risk assessment

(a) Method of import risk analysis

The method for assessing the risk of the pests under consideration is deficient in a number of important respects, including the following:

- the IRA Team has failed to consider the total risk of the entry, establishment and spread of all of the pests of concern;

- the IRA Team has failed to properly simulate the restricted likelihood of the entry, establishment and spread of at least Moko and black Sigatoka (and perhaps other pests) which has caused it to significantly underestimate those likelihoods, and consequently the risks of the entry, establishment and spread of those pests;
- the IRA Team appears to have made a computational error in assessing the likelihood of the entry, establishment and spread for black Sigatoka which has caused it to underestimate that likelihood, and consequently the risk of the entry, establishment and spread of black Sigatoka;
- the IRA Team has failed to properly consider uncertainty in the likelihood of the entry, establishment and spread of many of the pests of concern when estimating the risks of the entry, establishment and spread of those pests; and
- the IRA Team has not adopted a conservative approach to import risk analysis but rather has adopted an approach which has caused the IRA Team to underestimate the risks of the pests of concern.

(b) Assessment of risk of entry, establishment and spread

In assessing the risks of the entry, establishment and spread of the pests of concern, the IRA Team has variously:

- made scientifically unsound assumptions which are not supported by reliable scientific and technical information;
- failed to take account of relevant and reliable scientific and technical information; and
- taken account of irrelevant and unreliable scientific and technical information.

As a result of the above deficiencies, the IRA Team has underestimated the risks of the entry, establishment and spread of Moko, black Sigatoka and freckle (and perhaps other pests).

The IRA Team must re-assess the risks of the entry, establishment and spread of the pests of concern.

(c) Risk management and operational framework

The IRA Team has proposed a risk management and operational framework which the Australian banana industry can (and which Biosecurity Australia should) have no confidence will protect Australia from the risks of the entry, establishment and spread of the pests of concern.

In particular, the IRA Team has proposed a risk management and operational framework which:

- is comprised of a series of off-shore risk management measures which are experimental and not practically and technically feasible;
- is comprised of a series of off-shore risk management measures the compliance with many of which will not be able to be verified other than through intensive and ongoing off-shore compliance monitoring;

- relies for its integrity upon critical failures being detected, and corrective action taken, 100 percent of the time;
- relies for its integrity upon the competence, diligence and honesty of a large number of people paid directly or indirectly by Philippine banana industry participants who have no economic or other incentive to act in that manner;
- relies for its integrity upon strong, effective, intensive and ongoing off-shore compliance monitoring and enforcement by BPI in an environment of systemic graft and corruption and in circumstances in which the Australian banana industry (and Biosecurity Australia) can have no confidence that BPI will fulfil those responsibilities professionally and impartially;
- contemplates a limited role for AQIS officers in off-shore compliance monitoring, which is insufficient to give the Australian banana industry any confidence that the proposed risk management regime will be properly monitored and enforced.

2 Method of import risk analysis

2.1 General

The Council commissioned its statistical consultants, Professor Pettitt and Dr Reeves from QUT's School of Mathematical Sciences, to review the methodological aspects of import risk analysis adopted by the IRA Team. Professor Pettitt and Dr Reeves' comments are included in the report (Annexure 2 to this submission).

This chapter of the Council's submission highlights some of the key methodological deficiencies of the import risk analysis. Those issues are discussed in detail in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.2 Failure to consider total quarantine risk

The IRA Team has undertaken stage 1 (pest risk assessment) and stage 2 (pest risk management) of the pest risk analysis separately for each quarantine pest of concern.

However, this approach overlooks an important factor. The quarantine risk associated with the importation of bananas (or indeed any commodity) is associated with the total spectrum of possible pests and consequences. This is because when there are a number of pests to consider, the likelihood that any one pest of the relevant number may establish itself is greater than the likelihood of any particular pest establishing itself.

While the restricted risk of each individual quarantine pest of concern (as assessed by the IRA Team) may individually achieve Australia's ALOP, the total risk associated with the entry, establishment and spread of all of those pests (based on the IRA Team's own restricted risk assessments for those pests) may not. This is of particular concern because the margin by which Australia's ALOP is achieved for some of the individual pests under consideration is small.

The Council considers that the IRA Team's failure to assess the **total** quarantine risk associated with the importation of bananas (being the combined risk of the entry, establishment and spread of all of the quarantine pests of concern) is a significant methodological deficiency.

This issue is discussed further in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.3 Qualitative framework for consequence assessment

The draft IRA Report states (at page 16 of Part B) that a quantitative framework is used to assess the likelihood of entry, establishment and spread, and a qualitative framework is used to assess consequences.

A qualitative framework for assessing consequences is inadequate when combined with a quantitative framework for assessing the likelihood of entry, establishment and spread because:

- it takes no account of the variability or uncertainty in the estimate of the likelihood of entry, establishment and spread;

- it provides for no detailed assessment of consequences using an economic modelling approach where possible as recommended in ISPM 11 (2004);
- it constrains consequences to be considered in a small number of categories, in which widely varying levels of consequence may be considered the same;
- it uses arbitrary rules for combining consequences which systematically underestimate the true consequence by ignoring the additive nature of consequences.

The Council considers that the IRA Team's decision to assess consequences using a qualitative framework is a significant methodological deficiency, and has resulted in the IRA Team underestimating the consequences, and hence the risk, of each of the pests under consideration.

This issue is discussed further in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.4 Modelling uncertainty

2.4.1 Consideration of clustering

The draft IRA Report states (at page 17 of Part B) that clustering is taken into account by using information averaged over a number of years, thus smoothing out any spatial or temporal fluctuations that may occur. However, the sampling methodology and comprehensiveness of any surveys employed are a critical issue if this approach is to be relied upon. Without a comprehensive and extensive sampling or reporting methodology, clusters may be excluded from the averaging process, for example, when averages are computed only from regions or time periods where the pest is not particularly concentrated.

If the averaging process did properly sample the periods of high prevalence, then it would be true that the overall rate at which the pest entered Australia, when multiplied over the time period of a year, would represent the same quantities of infested bananas coming into Australia, with or without clustering. However, this misses the point that in some circumstances due to clustering, a large proportion of this total yearly load of infested produce may arrive concentrated in a small number of shipments, possibly a single shipment, or part of a shipment, rather than spread evenly over the year. The risk associated with such a scenario may be quite different, and should be explicitly considered. Therefore, it is not sufficient simply to use averages which include clustering within the structure of the import risk analysis. The possible existence of and impact of clustering must be assessed for each pest under consideration, and its impact on the risk assessment explicitly considered.

This issue is discussed further in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.4.2 Consideration of 95th percentile

The draft IRA Report states (at page 18 of Part B) that "*the spread of PEES values (based on the 5th and 95th percentile values) is considered by the IRA team in reaching its recommendations*." However, there is no evidence that the IRA Team considered the spread of PEES values in assessing the restricted risk of the individual pests of concern,

where this deliberation is most important and necessary. The 95th percentiles are not reported (and were presumably not considered by the IRA Team) in these cases.

The 95th percentiles of the restricted likelihoods of entry, establishment and spread for the pests of concern have not been reported in the draft IRA report, which in itself represents a significant lack of transparency. However, the 95th percentiles of those restricted risk assessments may be established by using appropriate input values in the spreadsheet model distributed to stakeholders by Biosecurity Australia. The Council's statistical consultants have assessed the 95th percentiles for Moko and black Sigatoka using the methodology described in the report by Professor Pettit and Dr Reeves (Annexure 2 to this submission).

A number of significant methodological concerns arise from that assessment.

Firstly, the median probability of entry, establishment and spread for scenario B of black Sigatoka, with the proposed risk management measures is reported in the draft IRA Report as 1.82E-02 (at page 141 of Part B). Using the relevant input values from the draft IRA Report, the Council was unable to reproduce this figure with the spreadsheet model distributed to stakeholders by Biosecurity Australia. Instead a median probability of entry establishment and spread of 3.13E-02 was found. When combined with the median probability of entry, establishment and spread for scenario A, the overall probability of entry, establishment and spread for black Sigatoka is 6.18E-02, not 4.88E-02 as presented in the draft IRA Report. This substantially exceeds Australia's ALOP. This matter is discussed in detail in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

Secondly, the IRA Team failed to properly simulate the restricted likelihood of entry, establishment and spread for Moko and black Sigatoka, combined over all scenarios. Because adding the medians of the scenarios only approximates the median of the total probability of entry, establishment and spread, that failure caused the IRA Team to significantly underestimate the 50th percentile of the restricted likelihood of entry, establishment and spread by about 15 percent in the case of Moko[1] and up to 30 percent in the case of black Sigatoka, including the error discussed above. This is a significant methodological deficiency.

Thirdly, the restricted risk for Moko[1] and black Sigatoka (based on the input values assessed by the IRA Team) significantly exceed Australia's ALOP if the 95th percentile (rather than the 50th percentile) of the restricted likelihood of the entry, establishment and spread for each of those pests is taken into account.

Fourthly, the percentile of the restricted likelihood of entry, establishment and spread (based on the input values assessed by the IRA Team) at which Australia's ALOP is exceeded is:

- 81 percent in the case of Moko[1]; and

[1] Here we refer to the proposed systems approach for Moko, comprised of the proposed area of low pest prevalence measure (0.06 cases per hectare per year), visual inspection and correction measure and post-harvest (chlorine) treatment measure. Values will differ for the other risk management scenarios, depending on the assessed probability of entry, establishment and spread. However, the same general concern remains valid, that the probability of entry, establishment and spread is so close to the threshold as to provide no certainty that Australia's ALOP has been met.

- 31 percent in the case of black Sigatoka.

This may be interpreted to mean that given the uncertainties and variabilities assumed by the draft IRA Report, there is about a 19 percent chance in the case of Moko[1] and 69 percent chance in the case of black Sigatoka, that Australia's ALOP will be exceeded for those pests of concern.

The Council believes that the IRA Team's failure to give due weight to the 95th (or any other appropriately high) percentiles of the restricted likelihoods of entry, establishment and spread for Moko and black Sigatoka in reaching its recommendations demonstrates a significant methodological failure on the part of the IRA Team. In addition, the 50th percentile reported for the restricted likelihood of entry, establishment and spread of black Sigatoka is either erroneous, or so sensitive to values asserted in the draft IRA Report to equivalently represent the effect of management practices on the probability of Exposure – transfer risk considerations, that no confidence can be placed in Australia's ALOP being met by the proposed management measures.

The Council believes that it is unreasonable, scientifically unsound and dangerous for the IRA Team to recommend permitting the importation of Philippine bananas into Australia based on the IRA Team's restricted risk assessments for Moko and black Sigatoka.

The Council should revise its recommendation to permit the importation of bananas from the Philippines.

The above issues are discussed in detail in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.5 Representing quantitative information

The draft IRA Report (at page 18 of Part B) comments on the use of triangular and uniform distributions to represent estimated model parameters, taking into account the uncertainty about such values, and the necessity of recourse to expert opinion where objective data is not available. In all cases, the distributions selected should be consistent with the available data, and any expert opinion concerning the relevance or applicability of the data or relevant studies. This includes accurately reflecting sampling error when quantities are estimated based on sample surveys.

For the reasons discussed in section 2 below, it appears that on a number of occasions, distributions have been assigned to proportions which are not consistent with sample estimates or their standard errors.

2.6 Qualitative assessment within existing policy

The draft IRA Report (at page 19 of Part B) states that pests which are considered under existing policy have been assessed on a fully qualitative basis.

The descriptive likelihood categories are given only verbal definitions, and the linking of these descriptors to any numerical ranges is (apparently) carefully avoided. The descriptive likelihoods are therefore subject to considerably different interpretations by different people. These qualitative assessments are therefore highly imprecise, and because of this a sensitivity analysis is warranted. This does not appear to have been done in the relevant pest risk assessments.

A large margin of safety should be incorporated into such qualitative assessments due to the imprecision of the likelihood estimates, and the non-quantitative consideration of the relevant factors affecting pest risk. This does not appear to have been done in the relevant pest risk assessments.

2.7 The model in context

2.7.1 Transparency

The draft IRA Report states (at page 20 of Part B) that "*[t]o reach conclusions on the risk and possible risk management measures, the IRA team took into account the outputs of the model, the limitations of the model, and the full range of technical and scientific information available*."

However, transparency demands that when conclusions or recommendations are not supported by the model output, due to some consideration of the model's limitations or other available information, then any such consideration ought to be fully documented.

2.7.2 Conservative approach to risk assessment

The draft IRA Report states (at page 20 of Part B) that "*[t]he methodology (including the matrices used to combine values and determine if the risk associated with a pest achieves the ALOP) reflects Australia's conservative approach on quarantine risk*."

This statement may reflect the IRA Team's intention, but the actuality of the risk assessment methodology does not fulfil this aspiration. For the reasons discussed in 2.4.2, the IRA Team's use of the 50th percentile does not represent a conservative approach to quarantine risk assessment. On the contrary, the IRA Team's use of the 50th percentile implies that the IRA Team is equally averse to overstating risks as it is to understating them. A conservative approach would by definition prefer to overstate risks than to understate risks. This is because the possible costs of overstating a risk would be very small compared to the potentially very significant costs (in terms of the irreversible social, economic and environmental consequences of pest incursions) of making quarantine policy determinations having regard to underestimated risks.

The Council believes that there is very little in-built conservatism in the model for the following reasons:

- the IRA Team expressly states (at page 17 of Part B) that the distributions and values used in the model represent the IRA team's best judgment, based on all available data;
- the IRA Team expressly states (at pages 17 and 18 of Part B) that it has relied upon average values rather than worst case values (out of a stated concern for overestimating risk);
- the IRA Team has relied upon a projected annual volume of trade in Philippine bananas which potentially significantly underestimates the likely annual volume of trade in Philippine bananas (if imports are permitted);
- the IRA Team has relied upon a method for assessing consequences which, for reasons discussed in 2.9.1(a), virtually ensures that the consequences of a pest will be underestimated.

If the IRA Team has undertaken its risk assessments in accordance with the principles described in chapter 3 of the draft IRA Report, then the restricted and unrestricted risk assessments for the pests under consideration will not have been conservatively estimated, but instead, should reflect the IRA Team's best judgement, based on all available data.

Indeed, the Council disputes a large number of the IRA Team's estimates of input values on the basis that those values result in an underestimation of risk. Far from adopting a conservative approach, the Council considers that the risk assessment methodology adopted by the IRA Team together with the IRA Team's assessments of many input values has resulted in an underestimation of risk.

The Council believes that conservatism in assessing risk should be taken into account by considering the 95th percentile (rather than the 50th percentile) of the restricted likelihood of entry, establishment and spread of the pests of concern (or some other high percentile which reflects the appropriate level of conservatism for Australia's risk assessment process).

If that were the case, conservatism in assessing risk would be based on a preparedness to underestimate the risk only five percent of the time (for the 95th percentile), and a preparedness to accept the consequences of doing so at this level. That approach provides a basis to make appropriate provision for the inevitable occasions when risk is indeed underestimated, and consequences follow.

This issue is further discussed in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.8 Probability of entry, establishment and spread

2.8.1 Effect of clustering

The importation and distribution pathways are defined as the change in the proportion of infected/infested clusters from beginning to end of the pathway. In the context of the import risk analysis, considering a year of trade, these proportions are then applied to the yearly volume of trade, to estimate a proportion of infected clusters distributed to the various waste disposal points, and which may then contribute to exposure, establishment and spread.

This approach overlooks that there may be considerable variations in the course of a year, which significantly alters the proportion applying at any particular time, above and below these proportions. The risk assessment methodology assumes that such variations are of no consequence, and that relevant probabilities of exposure and establishment may be evaluated based on the waste from a single banana, multiplied proportionately by the expected number of infected waste bananas in a year.

The assumption is that each single infected banana acts independently, and that there is no synergising effect, for example, from a cluster of waste bananas, discarded, for example, in a home compost heap. This assumption overlooks a possible scenario where the spatial density of discarded infected banana waste may increase substantially for short periods of time, leading to possible changes in infectivity or host resistance.

This possibility must be explicitly considered for each pest of interest, and appropriately incorporated in the model if found to be relevant. The failure of the draft IRA Report to do so means that risks are potentially underestimated.

This issue is discussed further in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.8.2 Parameters

The draft IRA Report states that model parameters are estimated from all available data, including scientific literature, expert opinion, survey data and census data. However, the relative accuracy of these different sources must always be evaluated, and more weight given to more reliable sources of information.

The draft IRA Report states (at page 26 of Part B) that "*[v]arious techniques are used to combine different sources of information and so derive distributions for the value of each parameter that accords with the judgment of the IRA team*". However, these techniques and methodologies are not explicitly discussed or justified.

As a consequence, there can be no confidence that differing sources of information have been combined in a methodologically sound way which recognises their different accuracies and reliabilities. It is asserted (on page 26 of Part B) that parameter estimates are "*the IRA team's best judgment based on all available data*", and while this is a worthy aim, this best judgement should not be presented and accepted at face value, but should be fully and transparently justified. There are numerous instances where the IRA Team falls short of this goal, and these are referred to in individual pest risk assessments.

Three examples from the pest risk assessment for Moko are given below to illustrate this point:

1 In the estimation of factor 1 of Imp2 for Moko, the draft IRA Report states (at page 71 of Part B) that "*[t]his equates to an average of 1.36E–02 cases per hectare per week. Some stakeholders have commented that Moko disease may be more prevalent in the Philippines than indicated by the average value reported by BPI (2002b). Data presented in Part C, Moko datasheet, Incidence of Moko disease in the Philippines indicate that there was a six-fold difference in the minimum and maximum four-week infection rates from 1998–2001. More disease incidences were evident in 2000–2001 than in 1998–1999 and there was evidence of an annual trend in the prevalence of Moko.*"

   However, no indication is given on how these pieces of data were used by the IRA Team to estimate a value for factor 1. Indeed, no value for factor 1 is even reported in the draft IRA Report. This lack of transparency makes it difficult for stakeholders to understand the deliberations of the IRA Team, and to criticise, (if necessary) the conclusions about model values they reach.

2 In the summary of the IRA Team's deliberations on Imp2, the draft IRA Report states (at page 72 of Part B) that "*[a]fter considering all the uncertainties associated with:*

   • *field infection of plants*

• *the numbers of infected plants removed in routine sanitation measures*

• *the variations in incubation and detection periods due to the nature of inoculum and condition of tissue at the time of inoculation*

• *the proportion of fruit clusters that may be infected on bunches harvested from infected plants.*

It was considered that the proportion of harvested clusters that are infected is in the range of 1.00E–05 to 1.00E–03."

However, the reasons for considering that the proportion of harvested clusters infected are as given are not stated in the draft IRA Report. A transparent account of this consideration should include whether the five factors should be multiplied, divided, added, subtracted or otherwise combined. It should include how the maximum and minimum values of the range are obtained. It should include values or ranges for each of the five factors individually. The absence of these details makes the conclusions about Imp2 difficult to understand or criticise by stakeholders, and is a serious lack of transparency.

3 In the estimation of Imp5 for Moko (at page 74 of Part B) the draft IRA Report states that "…*the IRA team has considered the above factors and possible barriers to infection of clean clusters, including the state of harvested fruit and competition with other microflora. The IRA team decided that the proportion of clean clusters that may become infected following contamination in the packing station will be between 1.00E–05 and 1.00E–03.*"

Once again no details of the consideration are given, and the range given is not related in any logical or numeric way to any of the five relevant factors mentioned, none of which are numerically estimated. As a consequence, the figures cited appear to have no documented foundation in the factors mentioned. This lack of transparency shields the IRA Team's deliberations from constructive criticism, and is a serious lack of transparency.

2.8.3 Distribution

The draft IRA Report notes (at page 31 of Part B) that "*[i]t is assumed that the imported bananas would follow the same distribution pattern as Australian bananas that pass through wholesalers…*".

The Council disputes that assumption on the basis that there is no reason why one or more of the major supermarket chains would not deal directly with Philippine suppliers.

There is a possibility that bananas distributed directly to major supermarket chains would result in a higher level of consumer waste than those distributed through wholesalers, who also supply food services and food processors. If that were the case, then the failure to consider bananas distributed directly to major supermarket chains would have caused the IRA Team to underestimate the risk of the pests of concern, given that bananas distributed to food services and food processors represent a lesser risk profile.

The IRA Team should have contemplated that Philippine bananas might be distributed directly to major supermarket chains.

2.9 Consequence and risk

2.9.1 Consequence

(a) Deficiency in methodology

The draft IRA Report lists direct and indirect criteria which are drawn from ISPM 11 (2004), and the magnitude of impact of a pest on each of those criteria is evaluated using the qualitative methodology described in section 6.1.3 of Part B of the draft IRA Report.

There are significant methodological deficiencies with that approach.

Firstly, the method of evaluating the severity of the consequences, based on degree of impact in geographical regions of different sizes is crude and serious anomalies are possible.

Secondly, irrelevant criteria (such as, for example, the direct criteria of impact on human life or health) are included in the analysis. However, the inclusion of irrelevant factors, (which are given a rating of "unlikely to be discernable" at all levels or "A"), in combination with the rules for combining consequences, result in consequences failing to be added. Instead, the largest consequence is selected as the total consequence in most circumstances. This unacceptably ignores that consequences are cumulative across the criteria. Irrelevant factors should at the very least be removed from the analysis to prevent this biasing downwards of the consequence scores. However, it would be preferable to adopt a more sound method for evaluating consequences, in which consequences are allowed to combine additively.

(b) Consequence rules

The decision rules to be adopted in determining the consequences of the entry, establishment and spread of a pest are set out in section 6.1.4 of the draft IRA Report.

The rules effectively result in the consequence of a pest being determined by the direct and indirect criteria with the highest rated impact score. There is no effective consideration that consequences are additive across all criteria.

Therefore, the consequences are biased downwards, and reflect the consequences of only the single most significantly rated criterion. There are only two possibilities for additively combining consequences which are allowed by the rules. The first is if all criteria are at a certain level, the overall consequence is increased to a higher category. This is ruled out because of the inclusion of irrelevant criteria which are always rated at the lowest level ("unlikely to be discernable" or "A"). The second possibility is if two criteria are rated "F", the consequence will be rated "extreme", whereas one criteria at "F" gives a consequence of "high", given the inclusion of irrelevant criteria.

This is a significant methodological deficiency in the method for import risk assessment and results in the consequences of the entry, establishment and spread of the pest of concern being underestimated.

(c) Conclusion

The evaluation of the consequences of the entry, establishment and spread of the pests of concern is superficial and rudimentary, giving undue weight to geographical areas in determining the severity of consequences, and giving equal weight to factors which have

vastly different levels of social, environmental or economic impact. Risks calculated according to the methodology of the draft IRA Report do not correctly add risks together, but merely select the largest risk factor as being the only significant risk. In addition, no account is taken of uncertainty, or variability in the risk determination. As a result, no confidence can be placed in the draft IRA Report's contention that Australia's ALOP can be achieved with the risk management measures proposed.

The IRA Team should have assessed the consequences of the entry, establishment and spread of the pests of concern based on an appropriate economic modelling approach, and these consequences should be added over all categories of impact.

The above issues are discussed further in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

2.10 Risk

Table 6.2 (on page 46 of Part B) combines the median of the likelihood of entry, establishment and spread (restricted or unrestricted) of a pest of concern with the overall consequence assessment for the pest of concern to give an estimate of risk. The assessed risk will either achieve Australia's ALOP or exceed it.

However, risk determination by applying Table 6.2 fails to take into account that the likelihood of entry, establishment and spread of a pest of concern is not known precisely, and that the distribution of PEES values obtained from modelling entry, establishment and spread represents uncertainty about the expected value.

This is especially significant when the median of the PEES is close to a step that if crossed would result in the risk failing to achieve Australia's ALOP. In these cases (for example, the restricted risks for Moko and black Sigatoka), there is significant doubt as to whether Australia's ALOP is met as claimed by the draft IRA Report.

At the very least, the draft IRA Report should report the percentile of the PEES distribution at which the threshold from acceptable risk (achieving Australia's ALOP) to unacceptable risk (exceeding Australia's ALOP) is crossed. In a restricted risk assessment, this represents an estimate of the chance of Australia's ALOP being achieved by the recommended risk management measures.

The Council believes that the estimated chance of Australia's ALOP being achieved by the recommended risk management measures should be considered by the IRA Team in determining whether to recommend permitting imports, rather than whether the median of the PEES distribution achieves Australia's ALOP or not.

3 Banana industry

3.1 Supply of banana fruit and accumulation of banana waste in Australia

3.1.1 Wholesaler turnover and waste

In the AABW survey, 22 of the (apparently) 29 members of AABW responded. However, those members that did respond were mostly the smaller wholesalers as the seven members who did not respond, handle 45 percent of bananas distributed through the Australian wholesale banana system. Only three members who responded were located in grower areas. In item 8 of the AAWB survey report, it is reported that 15 percent of sales were to retailers in grower areas, with 85 percent of sales to retailers in other areas. Due to the under representation of wholesalers in grower areas, these figures will most likely under represent the proportion of sales to retailers in grower areas. Consequently, this proportion cannot be relied upon as the proportion of the trade between grower areas and other areas, as appears to be the case. A safer option is to use the proportion of population in grower and non-grower regions to split the trade in the proportion 80 percent to non-grower areas, and 20 percent to grower areas.

According to the draft IRA Report, 265,000 tonnes of bananas are distributed by the grocery supply chain each year with 45,000 tonnes (17 percent) distributed to wholesalers in grower areas and 220,000 (83 percent) tonnes distributed to wholesalers in other areas. No data is supplied to justify this 17/83 percent split. The population in grower areas is listed as 20 percent (page 48, 7.1, paragraph 1) and if split based on population, it should be 53,000 tonnes (not 45,000) distributed to wholesalers in grower areas and 212,000 tonnes (not 220,000) distributed to wholesalers in other areas.

The AABW survey report indicates that 152,328 tonnes of bananas were distributed by the responding wholesalers which the survey report indicated was 55 percent of all bananas distributed. This therefore equates to a total distribution of 276,960 tonnes (not 265,000) with 55,392 (20 percent) tonnes distributed in grower areas (not 45,000 tonnes).

(a) Sales to food processors

The draft IRA Report states (at page 50 of Part B) that the AABW survey found that about 100 tonnes of bananas were distributed to food processors in grower areas and about 550 tonnes to food processors in other areas.

However, item 7 of the AABW survey report records that a total of 557 tonnes of bananas were distributed to food processors.

As respondents to the survey only distributed about 55 percent of the bananas distributed through the Australian banana wholesale system, the figure of 557 tonnes should be increased proportionately to about 1,013 tonnes (assuming that the same proportion of bananas are sold to food processors for the remaining 45 percent of bananas distributed by wholesalers who did not respond to the AABW survey).

No data is provided in the draft IRA Report to support the IRA Team's estimate of the proportion of bananas distributed to food processors in grower areas (about 100 tonnes or 15 percent) and to food processors in other areas (about 550 tonnes or 85 percent).

The Council believes that the proportion of bananas distributed to food processors in grower areas and to food processors in other areas should be calculated based on the proportion of the population in grower areas (20 percent) and other areas (80 percent). On that basis, about 203 tonnes of bananas would be distributed to food processors in grower areas and about 810 tonnes to food processors in other areas.

The draft IRA Report (at page 51 of Part B) correctly notes that there will be variability in the quantity of bananas purchased by food processors, but fails to acknowledge that lack of precise knowledge should also be represented by a distribution centred on the most likely values. There is no justification given for the range of the triangular distributions specified which, for the reasons discussed above, are based on incorrect values.

(b) Sales to food services

The draft IRA Report states that the AABW survey indicated 650 tonnes were distributed to food services in grower areas and 7,600 tonnes to other areas (total 8,250 tonnes). However, in the AABW survey report only 7,441 tonnes were distributed, and no details were given on the breakdown between grower and other areas. The total reported in the survey must be scaled by 1/0.55 to give the estimated total distribution to food services, as the survey data represents only 55 percent of the wholesale trade. This is 13,529 tonnes, not 8,250 tonnes as used in the draft IRA Report. If the breakdown of 650 to 7,600 is supported by the raw survey data, a fact which remains to be verified as it is not reported in the AABW survey report, then this proportion may also be applied to the estimated total of 13,529, giving a breakdown of approximately 1,050 tonnes in grower areas and 12,479 in other areas.

Triangular distributions are used to model variability, however, they should be centred on the figures 1,050 for grower areas and 12,479 for other areas. These distributions represent variability and also lack of precise knowledge. Lack of precise knowledge is due to sampling variability, due to the incomplete response to the survey, and lack of precision in the questionnaire answers. No justification is given for the range or form of these distributions.

(c) Sales to retailers

The draft IRA Report (at page 51 of Part B) estimates that about 6.8 percent of bananas sold by wholesalers located in grower areas are purchased by retailers in other areas. However, item 9 of the AABW survey report records that all bananas sold by wholesalers located in grower areas were to retailers located in grower areas.

The draft IRA Report (at page 51 of Part B) also estimates that about 4.2 percent of bananas sold by wholesalers located in other areas are purchased by retailers in grower areas. However, item 10 of the AABW survey report records that 4.7 percent of bananas sold by wholesalers located in other areas were to retailers located in grower areas.

The draft IRA Report (at page 51 of Part B) states that triangular distributions were used to model the variation, centred on the modes, with ranges of ±0.2 percent. The modes used are not consistent with the values reported in the AABW survey report, and there is no justification for the range given. The ranges given do not even encompass the percentages reported in the AABW survey report.

With access to the raw data and information on the location and trade of the wholesalers that did not respond to the AABW survey, the precision in the survey figures could be estimated through simulation techniques, and the range and distributional form of these proportions of retail sales could be reasonably estimated. However, the IRA Team has not undertaken that analysis.

(d) Waste from wholesalers

The AABW survey report records that 15 of the 22 AABW members who responded to the AABW survey disposed of 531 tonnes (0.35 percent) of banana waste (an average of 35.4 tonnes per member). Seven of the members that responded to the survey did not dispose of any banana waste.

The draft IRA Report states that 0.3 to 0.4 percent of bananas were disposed of as waste. While that figure is consistent with the average of 0.35 percent reported in the AABW survey report, it is not consistent with the statement in the AABW survey report the "*[l]evels of banana waste for individual AABW members ranged from 0 – 1.5%*".

A distribution with mean of 0.35 percent, ranging from 0 to at least 1.5 percent should have been adopted by the IRA Team. Additional variability over the 1.5 percent is possible.

A uniform distribution with end points of 0.3 percent and 0.4 percent is inappropriate and should not have been adopted by the IRA Team.

The above discussion assumes that each AABW member that responded to the AABW survey reported their waste percentage perfectly accurately. In practice this is unlikely to be the case. Another possible interpretation of the survey results is that the range of responses from zero percent to 1.5 percent represents different 'guestimates' of the same underlying waste percentage. On that basis, a uniform distribution from zero to 1.5 percent might be appropriate.

The draft IRA Report states (at page 51 of Part B) that 90 to 95 percent of banana waste disposed by the AABW members that responded to the AABW survey was disposed of as controlled waste. However, the AABW survey report indicates that in fact only 87 percent was disposed of as controlled waste, with 13 percent (68.6 tonnes) disposed of as "raw waste" (animal feed or untreated compost). A uniform distribution with end points at 90 percent and 95 percent is therefore totally inappropriate and should not have been adopted by the IRA Team.

A distribution centred on the survey figure of 87 percent, with a range adjusted to account for imprecision in the survey results should have been adopted by the IRA Team. The raw survey data, information on the throughput and location of the AABW members that did not respond to the survey and reasonable assumptions about the accuracy of survey responses should allow this imprecision to be estimated. This information is not available to the Council.

The draft IRA Report states (at page 51 of Part B) that "*virtually all empty banana cartons including plastic linings are disposed of through controlled systems*". This statement is clearly incorrect. The AABW survey report records that two of the AABW members out of the 13 that responded to this question re-used the cartons. However no information is given on how many cartons are re-used by these respondents, or whether they also recycle and use municipal tips.

3.1.2 Retail turnover and waste

(a) Sales to food services

The draft IRA Report states (at page 51 of Part B) that a triangular distribution centred on 2.5 percent (for grower areas) and 1.6 percent (for other areas), with a range of $\pm$0.2 percent, was adopted by the IRA Team for retail sales to food services.

This distribution and variation should be consistent with the sampling error in the retail survey. However, no sampling error is reported in the retail survey report, and insufficient information is given to estimate its reliability. Therefore the suitability of this distributional assignment cannot be assessed.

It is plausible that the underlying proportion of sales from retailers to food services is the same for both grower and other areas, with the values given in the retail survey report simply differing through sample variation. On this basis a uniform distribution from at least 1.6 percent to at least 2.5 percent for both grower and other areas would be the most conservative choice that is consistent with the survey data.

(b) Waste from retailers

The draft IRA Report states (at page 52 of Part B) that the "*survey of supermarkets and grocery stores suggests 3.5-4.0% of bananas handled at the retail level were disposed of as waste.*" A uniform distribution with these end points has been adopted to model the proportion of banana waste disposed of by retailers.

The distribution ought to be consistent with the numbers reported in the retail survey report. However, that is not the case. The mean of the uniform distribution assigned is 3.75 percent, substantially lower than the figure of 3.93 percent reported in the retail survey report. To be consistent with the survey data, the mean of the distribution adopted by the IRA Team should be 3.93 percent. In addition, the Council estimates that the standard error of the survey proportion is in the order of 0.5 percentage points (see the report by Dr Reeves which is Annexure 3 to this submission). The distribution adopted by the IRA Team should have a consistent standard deviation. However, that is not the case. The standard deviation of the uniform distribution chosen is 0.144 percentage points, significantly less than our estimate of the standard error in the proportion of bananas disposed of as waste by retailers. These choices will lead to an underestimate of the number of bananas disposed of as waste, and an unwarranted reduction in the variance of the distribution of the probability of entry, establishment and spread.

The draft IRA Report does not comment on the disposal of cartons by retailers. In the retail survey report, cartons from 20 percent of large stores and 43 percent of independent stores were re-used by customers, the store or collected by growers or wholesalers.

3.1.3 Food processors, food services and consumer waste

(a) Waste from food processors

The draft IRA Report states (at page 52 of Part B) that "*[a] high proportion of waste from food processors is used for animal feed, while about 10% of banana waste is discarded through controlled systems…*".

The IRA Team has not provided any data to support the statement.

(b) Waste from food services

The draft IRA Report states (at page 52 of Part B) that "*about 95-100% of the banana waste from food services was discarded through controlled systems*".

The IRA Team has not provided any data to support the statement.

3.1.4 Summary of values used in the model

For the reasons discussed above, the IRA Team should review and adjust the figures contained in Tables 7.1 and 7.2 (at page 53 of Part B).

In addition, the tables do not record that 19 percent of cartons from large stores and 43 percent for independent stores were re-used.

Further, there is no distribution given for the proportion of waste from food processors that goes to controlled facilities. The IRA Team has not presented any justification as to why this figure is known exactly. In the absence of any better information, it should have a uniform distribution centred on 10 percent with a range of at least five percent.

3.1.5 Projected volume of trade in Philippine bananas

The IRA Team has assumed a volume of trade of 105,000 tonnes of bananas, representing about 40 percent of the bananas currently distributed through the Australian wholesale system.

For the reasons discussed above, the IRA Team should review and adjust the figures contained in Tables 7.3 to 7.5 (at page 54 of Part B).

Although the impact of cyclones (such as Tropical Cycle Larry) is referred to as a factor in setting the figure of 105,000 tonnes, this is not adequately addressed. The impact of such a cyclone would be to dramatically reduce the volume of domestically produced bananas and dramatically increase the volume of imported Philippine bananas for a period approaching 12 months. For this period, the risk posed by the imports would be exacerbated, with a much higher volume of trade. This periodic increase should not be averaged out over the inter-cyclonic period, effectively disguising the short period of higher risk.

The figure of 105,000 tonnes is subject to considerable uncertainty, and this value should be represented by a distribution with mean of 105,000 (assuming that this is the best estimate of the volume of trade), and a range extending above and below this figure representing this uncertainty. The failure to represent volume of trade in this way results in an underestimation of the variability in the estimate of the probability of entry establishment and spread, and hence underestimate of the 95th percentiles, as well as possible bias in the 50th percentiles, and falsely increase the percentile at which Australia's ALOP is exceeded. The draft IRA Report asserts that sensitivity analyses

were done with greater and lesser volumes of trade, and considered as part of each pest risk assessment. However, these sensitivity analyses are not reported in any of the pest risk assessments for the risk management measures.

Given that the margin by which the proposed risk management measures exceed Australia's ALOP is very small, relatively small changes in the volume of trade may cause Australia's ALOP to be exceeded for some pests. Hence the lack of these sensitivity analyses provides no confidence that Australia's ALOP can be met for all pests under all possible trade conditions.

3.2 Methods for handling waste

3.2.1 Controlled waste

(a) Proximity of waste to banana plants

The draft IRA Report states (at page 55 of Part B) that 87 percent of municipal tips did not have bananas within one kilometre, but it failed to report that 59.5 percent of municipal tips in grower areas were known to have bananas in the vicinity of the tips (but not necessarily closer than one kilometre).

Item 10 of the LGA survey report records that the distance of banana plants from municipal tips is unknown for about 40 percent (32 of the 79) municipal tips in grower areas. The Council notes that the responses to that question might have been different if the survey question had been differently worded. The relevant question was: *"If banana plants (commercial or wild) grow within one km of the municipal tip, list the nearest approximate distance that banana plants are located from each tip".* As the question says within one kilometre some councils may not have reported plants just over a kilometre from the tip. If the distance was listed at say two kilometres, the number is likely to have been much higher.

Of interest was the reporting of bananas being in the vicinity (greater than one kilometre) of four municipal tips in the "Non banana region". This underlines the high non-response to this question in non-grower areas, so that the survey figures cannot be relied upon. The draft IRA Report states (at page 55 of Part B) that it is improbable that banana plants would occur within one kilometre of municipal tips in non-grower areas, but there is no factual foundation or reasoning given for this assertion.

This is discussed further in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

3.2.2 Uncontrolled consumer waste

(a) Disposal practices

The draft IRA Report states (at page 55 of Part B) that "*[d]ata suggests that 60–80% of households which compost food waste at home used closed systems such as worm farms, compost bins or tumblers. The remaining 20–40% of composted food waste most likely remains exposed – for example, in compost heaps.*"

However, the data that supports those assertions is not referenced, and the above figures are not supported by the LGA survey report.

The draft IRA Report indicated that 20 to 40 percent of household compost remains exposed. This appears to be an underestimate as closed systems are more difficult to use as the units need to be turned regularly (daily). A figure of 70 to 80 percent would be more appropriate for waste exposed for at least a period of time after disposal from the house.

(b) Proximity of waste to banana and heliconia plants

In the draft IRA Report, it is claimed that only 2.1 million tourists visit Queensland each year. But according to the Tourism Tropical North Queensland, Tourism Fact File, October 2006, more than 2.3 million tourists visited North Queensland alone during 2005/06. This would suggest that total visitors to Queensland would be far higher than the 2.1 million quoted in the report. The IRA Team should have assessed the waste disposal patterns of tourists.

3.2.3 Other uncontrolled waste

The draft IRA Report states (at page 56 of Part B) that "*[a] figure of 1.00E–06 was used for the proportion (in grower areas) of other uncontrolled waste that might be discarded near commercial banana plantations*".

However, this other uncontrolled waste is disposed of primarily as stock feed, according to the retailer survey report. It seems much more likely than one in one million that there will be stock fed with waste bananas in the vicinity of a commercial banana plantation.

3.3 Density of banana and heliconia plants

3.3.1 Bananas in home gardens

(a) Grower areas

The IRA Team appears to assume that home gardens will have only one mat (being one stem plus one or more suckers). Banana plants multiply rapidly and unless constant attention is given to bananas a number of stems and clumps quickly develop. The Council believes that it is highly unlikely that home gardens will have only one mat, and that it is highly likely that home gardens will have considerably more mats.

(b) Other areas

The draft IRA Report states (at page 57 of Part B) that 70 to 80 percent of gardens in other areas would be prone to frost and therefore, apparently, would not be suitable for growing bananas.

The draft IRA Report also states (at page 57 of Part B) that 0.2 to1.5 percent of home gardens in other areas have banana plants. However, it also reports that up to five percent of homes in Sydney have banana plants. The IRA Team's assumption is not consistent with the estimated figures for Sydney. Using the end points of the two ranges, as suggested, would entail a uniform distribution up to five percent, not 1.5 percent.

4 Moko

4.1 Introduction

Most of the biological information relied upon by the IRA Team for the risk assessment for Moko was drawn from published literature on the life cycle, epidemiology, and control of the Moko pathogen. The primary focus for most of that research was an understanding of the pathogen and the disease in subsistence and commercial production, to assist disease management or control. Very little research that is specific to the survival of the pathogen throughout the importation, distribution and exposure scenarios is presented. As a result, many of the model input values determined throughout the risk assessment are based on untested assumptions. The overall conclusions, therefore, are only as reliable as the validity of those assumptions assuming the risk assessment methodology is otherwise valid.

4.2 Biology

4.2.1 Dispersal mechanisms

(a) Insect transmission

It is acknowledged in the draft IRA Report (at page 66 of Part B and page 43 of Part C) that insects play a role in the dispersal of Moko disease. This dispersal is more common on cultivars with a portion of their genome derived from *Musa balbisiana* (BB genome). This, coupled with the removal of the male flower bud after emergence of the last female hand will limit (but not eliminate) the spread of the bacterium in commercial banana plantations (but not home gardens and other plant communities), as indicated in the draft IRA Report (at pages 66 and 67 of Part B).

Nevertheless, information provided by BPI supports the view that the role played by insects is likely to be significant. In the document entitled "*Philippines' response to the clarificatory questions raised by RAP under PBPM 2002/08 – 20 March 2002*" (2002b), the distribution of Moko in plantations was described as random, and BPI was asked if this distribution was explained by insect transmission. BPI did not address the question directly, but responded that Moko was prevented from causing problems in commercial Cavendish plantations surrounded by native cooking bananas by using a series of five control measures (bunch injection, bunch spraying, bagging, de-belling and de-flowering), all of which are designed to prevent insect transmission of the pathogen.

The random distribution of infection is strongly suggestive of insect transmission of the Moko bacterium in commercial plantations. The other accepted modes of transmission (movement of plant material, mechanical spread and leaching) would not produce a random distribution of infection.

The fact that Philippine banana growers implement routine control measures to prevent insect transmission demonstrates that insect transmission plays an important role in the transmission of the disease.

Considering the importance of insect transmission of the Moko bacterium, the Council is surprised that the probability of entry, establishment and spread (PEES) attributed to

Scenario A (insect transmission) by the IRA Team is far less – by a factor of about 10^6 – than that attributed to the other three scenarios considered.

The Council believes that the low value of PEES for Scenario A can be attributed to the IRA Team's assessments of the following three factors:

- the IRA Team's assessment of a proximity radius of 30 metres for scenario A as part of its assessment of 'Exposure – proximity considerations';
- the IRA Team's assessment that about 100 bacterial cells would adhere to an insect as part of its assessment of 'Exposure- transfer by insects (Scenario A)'; and
- the IRA Team's assessment that bacteria would not survive in waste for more than five days as part of its assessment of 'Exposure – transfer by inspects (Scenario A)'.

For the reasons discussed later in this chapter, the Council believes that the IRA Team has significantly underestimated each of those factors.

(b) Survival in waste

The IRA Team estimated (on page 68 of Part B) that the Moko bacterium would not survive in waste for more than five days under field conditions.

The IRA Team notes that while fruit is intact, bacteria will most likely remain viable, as they are protected from prevailing physical and biological factors including the effects of temperature, desiccation, radiation and competing and predatory micro-organisms. Then, as disposed waste decomposes:

- the activity of antagonistic microbiota will increase and the viability of bacterial cells is likely to decline; and
- the available nutrients that support the Moko bacteria will decrease.

The IRA Team apparently assumes that not only will the waste not remain intact for more than five days, but the processes of competition and nutrient depletion will also be completed to the point that the population will be reduced from 10^6 to zero cells per gram of tissue over a five day period.

The Council believes that the IRA Team has significantly underestimated the period for which bacteria will survive in discarded waste for the reasons discussed below.

<u>Waste will survive intact for more than five days</u>

The period that waste survives intact will depend on several factors including:

- the type of waste disposed (whole fruit, crown tissue, peel, pulp);
- the ripeness of the waste at the time of disposal;
- the environment into which the waste is discarded; and
- the prevalence of insects and animals that might consume the waste.

To gain an idea about how long waste survives in a tropical environment, the Council arranged for a number of pieces of waste to be exposed in a banana plantation. The various treatments were:

- Treatment one : Single banana peeled and placed with pulp and peel. Placed inside a small wire cage.
- Treatment two: Cluster of bananas containing 3 bananas (not peeled), placed inside a small wire cage.
- Treatment three: Peel from 2 banana fruits.
- Treatment four: Pulp of two banana fruits.
- Treatment five : Peel of one banana fruit.

The main observations from this small pilot study (Piper, personal communication) were:

- The waste survived for differing periods (apparently, largely depending on the type of the waste disposed).
- Three days after placement of the fruit and peels in the banana plantation, there was still sound, off-white plant tissue present in all treatments, although breakdown had commenced. By day seven there was still sound tissue in treatments two, three and five, however by day nine sound plant tissue was only present in treatments two and three. On day 10 sound tissue was still present in treatment two and three, however, the trial was terminated at this time and samples removed for microscopic examination. It is considered that sound tissue may have been present in the field for one to two further days had the trial continued.
- After 10 days of exposure in the banana plantation, the largest quantity of sound plant tissue was observed in the neck of one of the fruit from treatment two. Vascular strands were clearly visible in the sectioned neck of this fruit. This suggests that the crown and the necks of attached fruit are the parts of the banana waste which would remain in the environment for the longest period of time and thus provide protection and nutrition for any bacteria present in the tissues.
- A small amount of sound, off-white tissue was also present in a piece of skin in treatment three after 10 days. This sound tissue was only a very thin layer beneath the surface of a single piece of skin.

Clearly, a lot of the tissue remained intact for longer than five days. In the small pilot study, tissue was considered to be “sound tissue” if its retained its off-white colour. Browning in banana fruits results from oxidation of phenolic compounds, and is not necessarily indicative of breakdown caused by the action of other microbes. Judging from the photographs of the trial, most of the tissue remained essentially intact (that is, not disintegrating) for much longer than five days.

<u>Bacterial populations would not decline to zero in such a short time frame</u>

While the fruit remains intact, the bacterial population is more likely to increase than decrease because it exists in a nutrient-rich, protective and incubative environment. This has not been taken into account by the IRA Team.

The ability of the pathogen to survive in the competitive and nutrient poor environments as the tissue decays has been underestimated. The IRA Team assumes (on page 68 of

Part B) that the nutrient source in fruit waste diminishes with time and that bacteria will die off quite quickly as the plant tissue decomposes. That assumption is in direct contradiction to information presented in the pest data sheet for Moko (at page 43 of Part C) where it is noted that the decay of infected tissue leads to the release of bacteria into the soil "*which greatly increases the inoculum potential*".

Later, on pages 46 and 51 of Part C it is noted that the bacterium can survive for 12 to 18 months in the soil environment. This information presented in Part C supports the view that this pathogen is likely to survive in the face of microbial competition and low-nutrient conditions. It does not support the view that the population would collapse within a few days in decaying waste.

A study by Subandiyah *et al.* (2006) with the blood disease bacterium (a close relative of *R. solanacearum*) supports this hypothesis that the Moko pathogen would survive for a long period in banana waste. That pathogen survived in banana fruit buried in soil for at least one month. Continuation of the experiments (unpublished results) showed that when 200 grams of infected banana fruit was chopped up and mixed with one litre of soil, the bacterium is able to infect a susceptible cultivar planted in the soil six months later. This demonstrates that the pathogen was able to survive for a long period in banana fruit in a tough competitive environment, and suggests that the Moko pathogen would survive in waste for so long as the waste exists which, for the reasons discussed above, is likely to be significantly longer than five days.

The Council concludes that the Moko pathogen would certainly last as long as the waste remains intact, plus a further period after the waste ceases to remain intact while the tissue decays. The period cannot be estimated with precision, because it is dependant upon a range of factors, but will be significantly longer than the period of five days assumed by the IRA Team.

For the purposes of the import risk assessment, the IRA Team should have assumed that the bacteria would survive in waste for at least 20 days.

4.3 Imp2 – Incidence of Moko within an infected plantation

4.3.1 Factor 1 – The proportion of plants detected with Moko symptoms each week

The IRA Team has relied upon prevalence data supplied by the Philippines Department of Agriculture for the years 1998 to 2001 in the document entitled "*Philippines' response to the clarificatory questions raised by RAP under PBPM 2002/08 – 20 March 2002*" (2002b). As noted in previous submissions to the IRA Team, the Council has the following serious concerns about the use of those data in the assessment of factor 1 of Imp2:

- the reporting period (four years) is far too short to enable a proper assessment of the highest-likely prevalence of Moko, which shows substantial variations in prevalence from year to year;
- the geographic area from which the data are drawn is unspecified and therefore, it is impossible to ascertain whether it relates to the whole or part of the proposed export area or to the proposed export area at all;

- the data are average prevalence data and therefore, it is certain that the prevalence of Moko in some plantations will at times be substantially higher than the average prevalence data;
- the data are averaged over a number of years. The average prevalence in any particular year may be substantially above this average figure; and
- the data are not supported by any survey data and therefore are not able to be audited or verified.

It is of concern that the IRA Team continues to rely upon those data (which are now six years old) for the purposes of the import risk assessment, particularly given that in this draft IRA Report it appears to acknowledge the validity of at least some of the concerns previously expressed by the Council about those data.

The IRA Team should have sought recent verifiable pest survey data from the Philippines so that it could make a sensible, informed assessment of the highest likely prevalence of Moko in export plantations.

The Council considers that IRA Team's continued reliance upon the data supplied by the Philippines Department of Agriculture has caused it to significantly underestimate factor 1 of Imp2.

A significant issue with continuing to rely upon data supplied by the Philippines Department of Agriculture is that they do not enable the IRA Team to assess whether the area of low pest prevalence measure proposed for Moko is a feasible measure.

A detailed discussion of the statistical aspects relating to factor 1 of Imp 2 is provided by in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

4.3.2 Factor 5 – The proportion of clusters that are infected in a bunch of an infected plant

The IRA Team estimated factor 5 of Imp2 as being within a range of 15 to 100 percent. The Council agrees with the upper value in the range, but not the lower value.

The lower value of 15 percent is based on research reported by Soguilon (2003a). The IRA Team noted (at page 72 of Part B) that Soguilon (2003a) did not report on the proportion of fingers from which the Moko bacterium was cultured, and further noted that it is unlikely that the bacterium was isolated from all fingers on apparently infected hands.

All parts of a susceptible banana cultivar such as Cavendish may be invaded by the Moko pathogen (Thwaites *et al* 2000). If the pathogen invades the bunch through the pedicel, there are no impediments to invasion of all fingers. If Soguilon (2003a) did not isolate Moko from all fingers of the infected hands (we do not know if she did or not), it was probably because the isolation/detection method used was not sufficiently sensitive. The method used by Soguilon (2003a) to isolate the bacterium involved placing a 1 cm^2 piece of tissue into 10 millilitres water for 30 minutes followed by streaking of only a loop full (10 to 20 µl) of suspension onto the selective medium. The ability of the bacterium to ooze from the vasculature of the tissue is affected by the initial concentration of the pathogen and occurs most effectively when the bacteria are in high numbers. If the pathogen was present in low numbers in the infected tissue, the number of bacterial

cells oozing from the tissue during the period the tissue was in isolation water would be very low. The IRA Team itself notes (on page 44 of Part C) that "*[i]nfected fruit, peduncles or fruit stalks immersed in water may not always show the presence of bacterial ooze*" and Soguilon (1994) showed that if the "*peduncle or fruit stem immersed in water did not show bacterial ooze, streaking a loopful of suspension onto TZCA failed to recover bacteria*". As a consequence, it is probable that the isolations undertaken by Soguilon (2003a), by plating a diluted solution of the bacterial cells which oozed out of infected plant material, underestimate the presence of the pathogen in fingers from infected hands.

Consequently, the Council believes that IRA Team should have assessed the probability of factor 5 for Imp2 as being within the range of 75 to 100 percent.

4.3.3 Imp5 – Contamination during packing

Having considered the factors that might lead to contamination of clean clusters during routine packing and processing, the IRA Team, in the absence of information to quantify the value, decided that Imp 5 would be between 1.00E-05 and 1.00E-03.

The Council considers that these values are too low, for two reasons. Firstly, it is known that a mechanical instrument such as a machete or de-handing knife, is an effective device for transmitting the Moko pathogen from one plant to the next. A de-handing knife that has just sliced 8 or 9 hands from a symptomlessly infected bunch would be fully "loaded" with inoculum and would be expected to inoculate at least the top three hands – perhaps nine or more clusters – from the next bunch. As the vascular tissue is severed, the inoculum would be drawn into the crown tissue, effectively protecting it from adverse environmental conditions and ensuring infection.

Secondly, banana bunches release a large volume of sap after hands are severed from the peduncle. In a study conducted by the Queensland Department of Primary Industries and Fisheries to determine the depletion rate of chlorine, an average of 7.5 millilitres of sap was released from each half hand in 10 to 12 minutes, most within the first few minutes. A bunch released approximately 130 millilitres. This test was conducted in March, when sap flow was reduced compared to mid-summer conditions. Sap release in the Philippines would be expected to be higher than 130 millilitres per bunch. As discussed in section 4.5.1(b) below, symptomlessly infected banana bunches are likely to contain at least 10^6 bacterial cells per millilitre. Each infected bunch could release over 10^8 cells into the first de-handing tank. The hands from the next bunches would be placed directly into this highly concentrated inoculum supply, and it would be reasonable to expect that perhaps the next 50 hands would be inoculated before the bacterial solution was diluted or inactivated.

The Council believes that for the above reasons, the value given for Imp5 should be 1.00E-4 to 1.00E-02.

4.4 Exposure – proximity considerations

4.4.1 Distance of transfer for Scenario A

The IRA Team (at page 76 of Part B) adopted a proximity radius of 30 metres for Scenario A, based on its assumption that an insect would lose any contaminating bacteria at either its first or second resting place after contamination, and that the flight

range of an insect between resting stops would be less than 15 metres. The IRA did not provide any evidence to support its assumptions.

Statistical consequences of treating a model value as if it were precisely known, when indeed it is not precisely known, are discussed in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

For the reasons discussed below, the Council believes that the IRA Team has, in the absence of any supporting information, significantly underestimated the proximity radius for Scenario A.

Loss of bacteria by insects

Although there are no data on the length of time that the Moko bacterium may remain on the outer surface of an insect, it is reasonable to extrapolate from reported information on the spread of the apple firebight pathogen (*Erwinia amylovora*).

It has been demonstrated that honey bees are able to disseminate *E. amylovora* for up to 48 hours (Sabatini *et al* 2006). Clearly, given such a long dissemination period, the bacteria survived past the first or second resting places.

Dr Joel Vanneste of HortResearch New Zealand has developed a bacterial biological control agent (*Pantoea agglomerans*) against *E. amylovora*. Research by Dr Vanneste provides additional insight into transfer of bacteria by insects (for example Vanneste *et al* 1996). Dr Vanneste used bees to carry *P. agglomerans* to flowers to protect stigmas against *E. amylovora* infection. He found that very few bacteria are carried on the feet of insects, but large numbers are carried on body hairs, particularly on the abdomen. These are then progressively brushed off during bodily contact with plant parts such as flowers. The likelihood of bacteria being brushed off the body is much greater when an insect is actively 'working' a flower than when simply resting on a leaf or stem. Dr Vanneste also noted that the insects are quite capable of picking up bacteria from contaminated soil in the vicinity of decomposing infested material.

Although the system is different for Moko and bananas, this work provides a strong indication that bacteria transferred on insects are unlikely to be totally removed at the first or second resting stops.

Distance between resting stops will vary greatly between insects

The IRA Team (at page 66 of Part B) assumes that the insects involved in the dispersal of the Moko bacterium would be bees, wasps and flies. The following insects or insect groups have also been observed in association with banana fruits or flowers in banana plantations in north Queensland by Richard Piper (personal communication).

Name of Insect	Decayed Fruit/Flowers	Comments
Atherigona orientalis, Muscidae	Yes/yes	Common in warmer months medium sized fly (approx. 3mm long)
Drosophila spp., Drosophilidae	Yes/yes	Small flies (2-3mm) common in warm weather – breed in enormous numbers in fallen bunches

Name of Insect	Decayed Fruit/Flowers	Comments
		and in banana scrap heaps.
Silba sp., Lonchaeidae	Yes/yes	Small flies commonly observed at banana scrap heaps and on banana flowers.
Banana Stalk Fly, Long Leg Fly *Telostylinus lineolatus* Family Neriidae	Yes/yes	Medium sized fly (4-5mm) common on bunches and rotting bunches.
Various beetles	Yes/?	Staphylinids and Hydrophilids are commonly found associated with rotting bananas in scrap heaps. Uncertain of whether flowers are visited however potential exists to transfer bacteria to other situations in the plantation such as trash around plants.

Honeybees have been recorded flying up to 12.8 kilometres from the hive (Eckert, cited in Grout, 1973). Honeybees were observed feeding on ripening bananas in fallen bunches after cyclone Larry when available sources of sugars were limited. It is feasible that such sources might be visited at other times when floral sources are limited (Piper, personal communication). Honeybees effectively distribute microbial biocontrol agents such as *Trichoderma harzianum* at least 200 metres from the hive (Shafir *et al* 2006).

Drospophilid flies are capable of flying distances as great as 26 kilometres and certainly capable of flying beyond 30 metres (Coyne et al.,1987).

Although it is not clear how far individual insects fly between rests, many of the insects associated with banana flowers and fruit have strong flying abilities and the distances between rests could reasonably be expected to significantly exceed 15 metres.

Conclusion

For the purposes on this draft IRA Report, IRA Team should have assumed a proximity radius of at least 2 kilometres.

4.4.2 Proportion of waste near each exposure group

(a) Controlled Waste

Grower areas

The draft IRA Report states (at page 76 of Part B) that "*[a]veraged over all the controlled waste facilities in grower areas, the IRA team considered that no more than a proportion of 8.74E–05 of the waste would be within 30 m of the plants at the facility and no more than 1.00E–09 could be within 5 m".* These figures are inconsistent with the local area survey data (BA February 2006). The survey results are consistent with a rate of up to 13 percent of tips with bananas growing on site. Assuming that tips on average cover an area of 0.25 square kilometres, the proportion of waste within 30 metres of a single on site banana plant may be as high as 1.47E-03 (=0.13×30×30×π/2.5E05), not 8.74E-05 as asserted. In fact, the proportion is likely to be greater, as one would expect that more than one banana plant would be growing at the tip.

Likewise, the proportion of banana waste within five metres of a banana plant growing at a tip may be as high as 4.08E-05 (=0.13×5×5×π/2.5E05), not 1.00E-09 as asserted.

The figures provided by the Council above are based on an analysis of the survey data (BA February 2006) and are significant departures from those assumed by the IRA Team, the first by a factor of 17, the second by a factor of 40,000.

For this reason, the Council believes that the import risk assessment for Moko should be revised taking the above figures into consideration.

Other areas

The draft IRA Report states (at page 76 of Part B) that no banana plants grow at controlled waste facilities in other areas, and bases the import risk assessment for Moko on that assumption.

However, that assumption is not supported by the local area survey (BA February 2006). In that survey, only four out of 54 respondents had knowledge of the distance banana plants grew from the facility, the rest not knowing. Out of those four, none reported bananas growing at the tip itself. This does not provide a basis to conclude that bananas do not grow at tips in other areas. The datum, zero out of four, is consistent with a rate from zero up to 44 percent of tips with bananas. In addition, those four respondents had knowledge of bananas growing in the vicinity of a tip, albeit not at the tip itself.

Therefore it is reasonable to conclude that bananas do grow in the vicinity of tips in other areas, and that in a small proportion of them, there will be bananas growing at the tip itself. To estimate what this proportion may be, the Council notes that in grower areas, the ratio of facilities with banana plants to those where bananas were known to be in the vicinity but greater than one kilometre away, was found to be 2/45. As a rough estimate, that ratio can be applied to the 4/54 of tips in other areas known to have banana plants growing in the vicinity, to get a proportion of 0.3 percent of tips where banana plants grow at the tip.

The Council notes that there are considerable uncertainties in this figure, and that it could be much higher.

The import risk assessment for Moko is deficient because it does not correctly consider that there is likely to be a small proportion of controlled waste facilities in other areas where banana plants are growing at the tip, and should revise its import risk assessment for Moko to take this into account.

(b) Uncontrolled consumer waste

The draft IRA Report states that a proportion of 5.6E-06 of uncontrolled consumer waste is discarded on or within 30 metres of commercial banana plantations, and that 3.1E-06 is discarded on or within five metres of a commercial banana plantation. These figures appear to reasonably estimate average quantities, however no consideration is given in the modelling that these estimates are subject to considerable uncertainty. The effect of using these figures in the model as if exactly known, is to underestimate the uncertainty associated with the final estimate of the probability of entry establishment and spread. For this reason, these quantities should be represented by distributions with averages given as above, and ranges appropriately chosen to reflect the uncertainty in these figures.

(c) Other uncontrolled waste

The IRA Team estimates (at page 76 of Part B) that 1E-06 of other uncontrolled waste is disposed of near commercial banana plantations. However no justification is provided for this figure in either chapter seven or nine of the draft IRA Report.

This figure is not known precisely, and should be represented as a distribution with an appropriate mean and range, as discussed above. The value of 1E-06 does not seem to take into consideration that the bulk of uncontrolled waste is disposed of as stock feed, and that this activity is likely to situate a considerably higher proportion of waste in the vicinity of commercial banana plantations.

(d) Scenario D

The draft IRA Report specifies a number of figures representing maximum values. There is considerable uncertainty associated with these figures, which is not adequately represented in the model.

4.4.3 Probability of banana and heliconia plants being within a 30 metre circle (Scenario A)

(a) Home gardens

The draft IRA Report states (at page 77 of Part B) that between 6.39E–01 and 7.70E–01 is the probability of at least one plant within a 30 metre radius in grower areas.

This is consistent with Poisson probabilities based on mean rates of 1.02 to 1.47 clumps per 30 metre radius. These rates are in turn consistent with 360 to 520 banana mats and heliconia clumps per square kilometre as reported in chapter 7 (at page 59 of Part B). For other areas, the range 1.18E–02 and 6.88E–02 which is specified as the probability that bananas or heliconias are within a 30 metre radius, is consistent with Poisson probabilities based on the rates 4.2 to 25.2 per square kilometre reported in chapter 7 (at page 59 of Part B).

However, for the reasons discussed in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission), these rates are erroneous, resulting from an incorrect

calculation procedure. The correct calculation results in a rate of between 10.2 and 61.2 per square kilometre, or 2.88E-02 to 1.73E-01 per 30 metre radius.

Treating these as Poisson rates gives probabilities of finding one or more plants within the 30 metre radius of 2.84E-02 to 1.59E-01.

The import risk assessment should be revised to include the correct calculation procedure.

4.4.4 Probability of banana and heliconia plants being within a 5 metre circle (Scenarios B and C)

(a) Home Gardens

As discussed in section 4.4.3(a) above, the calculation of the density for banana and heliconia plants in home gardens in other areas is erroneous, giving erroneous values for the probability that hosts will be inside a five metre radius in home gardens in other areas.

IRA Team have assessed the value as being from 3.30E–04 to 1.98E–03. However, if the IRA Team has correctly calculated this probability (as discussed in section 4.4.3(a) above) the IRA Team would have assessed the probability as being from 7.99E-04 to 4.80E-03.

4.4.5 Probability of asymptomatic carrier hosts being within a 30 and 5 metre circle (Scenarios A, B and D)

The IRA Team has assessed (at page 78 of Part B) the probability of asymptomatic carrier hosts being within a 30 metre or five metre radius as one for grower areas, and 0.1 for other areas.

This second figure is incorrect, as it is derived from consideration of climatic conditions suitable for the survival of Moko pathogen in the asymptomatic hosts. The draft IRA Report states (at page 78 of Part B) that "*[t]aking temperature and the population density and area into account, the IRA team estimated that about 10% of the readily accessible parts of other areas would be suitable for the survival of Moko in asymptomatic carrier hosts".*

The only consideration that should have been considered by the IRA Team was whether the asymptomatic carrier hosts are within the 30 or five metre distance, and considering the ubiquitous nature of the asymptomatic hosts, this should be a probability of one in other areas, just as it is in grower areas.

The suitability of areas for the survival of Moko due to environmental considerations (such as temperature) is properly considered under the probability of establishment. Indeed, the draft IRA Report reduces the probability of establishment in other areas for just that reason, where it states (at page 91 of Part B) that "*[t]he establishment of Moko in the other areas is less likely to be successful than in grower areas. The climate during cooler periods of the year could lower the likelihood of establishment of the pathogen in these areas. On this basis, the establishment value for each of the exposure groups was considered to be of Uniform distribution with a minimum of 0.5 and a maximum of 0.8."*

Similarly, the population density of the other areas is an irrelevant factor and should have no bearing on the calculation of the probability of carrier hosts being within the relevant 30 or five metre radius of discarded waste. The only factor of relevance is the density of asymptomatic hosts. It is not clear how "area" has been taken into consideration in the deliberations of the IRA Team, though it is clear that any consideration of area will be methodologically incorrect, as the only factor of relevance is the density of hosts.

4.5 Exposure – transfer considerations

4.5.1 Exposure – transfer by insects (Scenario A)

(a) Factor 2 – Availability of Moko bacterial cells

For the reasons discussed in section 4.2.1(b) above, the Council believes that bacteria in an infected cluster would remain viable after the waste is discarded for considerably longer than the five days estimated by the IRA Team.

(b) Factor 3 – Contamination of insects with bacteria

The IRA team (at page 81 of Part B) considered that "*the dose adhering to an insect would be about 100 bacterial cells*", but failed to provide any logic to support this estimate.

The number of cells carried would depend on the concentration in the ooze, and the volume adhering to the insect. The concentration of bacteria in ooze from plants showing visible symptoms is reported (at page 67 of Part B) to be in the range of 10^8 to 10^{10} cells per gram of tissue or more, and, if no ooze is visible, lower. The concentration considered likely for asymptomatic tissue was 10^6 cells per gram of tissue. Given that bacterial ooze is likely to occur due to incubation of the bacteria in the infected material in suitable environmental conditions, it will potentially contain up to 10^{10} cells per millilitre as does the bacterial ooze from plants infected with the pathogen *Erwinia amylovora* (Beer, 1979). If the volume of ooze collected by the insect was 10^{-6} litres (one microlitre) and the concentration 10^{10} cells per millilitre, the number of cells would be 10,000. If the volume was 10^{-5} litres and the concentration was 10^{10} cells per millilitre, the number would be 100,000. This latter figure is credible because it has been estimated that insects can carry up to 10^5 *E. amylovora* cells per insect (Miller and Schroth, 1972).

For these reasons, the Council believes that the dose adhering to insects should be expressed as a range with the most likely value 10,000 cells to take into account the range of concentrations and volumes most likely to be collected.

(c) Factor 4 – Transfer of bacteria to cause infection of a host

The IRA Team's estimate of factor 4 relies upon the following two assumptions:

- an insect will carry an infective load of about 100 bacterial cells; and
- the insect will deposit those bacterial cells at the first or second resting stops, which will happen within a 30 metre radius of the infected waste.

For the reasons discussed in sections 4.5.1(b) and 4.4.1 above, the Council believes that the IRA Team has significantly underestimated those values.

The IRA Team's reliance upon those underestimated values has caused the IRA Team to significantly underestimate factor 4.

4.5.2 Exposure – transfer by leaching (Scenario B)

(a) Factor 2 – Availability of Moko bacterial cells

For the reasons discussed in section 4.2.1(b) above, the Council believes that bacterium in an infected cluster would remain viable, after the waste is discarded for considerably longer than the five days estimated by the IRA Team.

The Council believes that waste held in a garbage bin would be subjected to higher temperatures which, rather than reducing the availability of the bacteria, would likely result in increased bacterial growth and oozing from the tissue after three to 14 days (Soguilon *et al*. 1994a).

The Council believes that the IRA Team has underestimated factor 2, and should revise its assessment.

(b) Factor 3 – Bacteria must wash from waste

The IRA Team concluded (at page 85 of Part B) that the number of bacterial cells washed into soil would be between 1,000 and 10,000 per rain incident, and up to 100,000 over the five day period the bacteria is expected to remain viable. These conclusions were based on assumptions about the number of bacteria likely to be present, the amount of rainfall needed to wash bacteria into the soil, the number of days in which that rainfall would occur, and the period over which the bacteria would remain viable.

The Council disputes the conclusion, on the following grounds:

- For the reasons discussed in section 4.5.1(b) above, it is probable that the bacteria in an asymptomatically infected banana (containing 10^6 to 10^8 bacterial cells per gram of tissue) discarded in a grower area could multiply to reach levels of 10^{10} cells per gram of tissue and start to ooze, therefore releasing 10^{10} cells per millilitre of ooze into the soil.
- For the reasons discussed in section 4.5.2(a) above, that bacterium would remain viable after the waste is discarded for considerably longer than the five days estimated by the IRA Team.
- The IRA Team apparently assumes that five millimetres or greater of rain is required to wash bacteria from the surface of waste into soil. However, the IRA Team has not provided any justification for that assumption. The Council believes that much less free water (either as rain, dew or irrigation water) is required to wash the bacteria into the soil. If, as is likely, one millimetre of rain is sufficient to wash the bacterial into the soil then the average number of days for rainfall greater than one millimetre increases from 50 to 75 to 100 to 125 in grower regions. (http://www.bom.gov.au/climate/map/raindays/rain1mm.png).
- In dry periods, bananas are irrigated, thus providing more days in which one (or five) millimetres is received.

Considering the above factors, the Council believes that up to 10^{10} viable bacteria could be washed from a piece of infected waste into the soil over the period that the bacteria in an infected cluster would remain viable after the waste is discarded.

(c) Factor 4 – Transfer of bacteria to cause infection of a host

The IRA Team assumes (at page 85 of Part B) that Moko will generally be dispersed, rather than be present in aggregates on the basis that the bacteria belonging to the *R. solanacearum* complex do not form coherent aggregates.

However, the IRA Team states (at page 46 of Part C) that "*Exopolysaccharides encapsulating R. solanacearum race 2 cell aggregates also aid in the survival of bacterial cells due to prevention of water loss…*".

It is clear that cells of the Moko pathogen do form aggregates which are well adapted to survive in soil. Those aggregates are likely to remain viable for long periods of time and will be able to contact roots in larger concentrations than if they were dispersed (Morris and Monier 2003).

The Council believes that the bacteria will contact a root of a susceptible host in high numbers and will transfer to it.

Because the IRA Team has erroneously assumed that the Moko bacteria washed from waste will be generally dispersed, rather than being present in aggregates, it has underestimated the likelihood of factor 4 for each host type. The IRA Team should revise its assessment of factor 4 for each host type.

4.5.3 Exposure – Transfer by cutting, mowing and slashing (Scenario D)

(a) Factor 3 – Transfer of bacteria from infected banana waste to a cutting blade/cord

For the reasons discussed in section 4.5.2(a) above, the Council believes that bacterium in an infected cluster would remain viable after the waste is discarded for considerably longer than the five days estimated by the IRA Team.

The Council believes that the IRA Team has underestimated factor 3 and should revise its assessment of factor 3.

(b) Factor 4 – Transfer of bacteria to cause infection of asymptomatic carrier hosts

The IRA Team has assumed (at page 90 of Part B) that "*most bacteria on the cut surface will be present as larger pieces of plant material or macerated xylem vessels rather than pure cells or groups of cells.*"

The IRA Team has not provided any justification for that assumption. If the cutting blade or whipper snipper cord cuts through the infected waste, bacterial cells would adhere to the blade or cord and could then contact the cut surface of the asymptomatic host in the same way that an infected machete will lead to spread of the pathogen in a banana plantation.

That erroneous assumption appears to have caused the IRA Team to significantly underestimate factor 4.

The Council believes that the IRA Team has underestimated factor 4 and should revise its assessment of factor 4.

4.6 Spread

Although "soil and water" are indicated as a method of dispersal of the Moko bacterium, the IRA Team has failed to give due weight to the importance of flood and irrigation water as mechanisms of dispersal. This is despite these dispersal mechanisms being identified in Appendix 5 (pages 42 to 43 of Part C) of the draft IRA Report.

The justification for including flooding as a specific mechanism is provided in research from Brazil reported by Coelho Netto and Nutter (2002) and Coelho Netto and Nutter (2003). Moko levels in Brazil were many times higher in flood-affected areas when compared with non-flooded areas. The failure to consider flooding as a dispersal mechanism in its own right is serious, as flooding occurs regularly in the wet tropical areas of Tully and Innisfail where most of the Australian industry is based.

4.7 Consequences

4.7.1 Direct impact

(a) Plant life or health

The Council agrees the direct impact of Moko on plant life and health will be at least "significant" at the "regional" level.

(b) Any other aspect of the environment

The IRA Team assessed that the direct impact of Moko on other aspects of the environment would be unlikely to be discernible at all levels.

The Council disagrees with this assessment, for the following reasons.

- the draft IRA Report (at page 35 of Part C) states that diploid bananas are considered hosts of the Moko pathogen.
- three native banana species are endemic to Australia: two of the three are rare or endangered, and the third occurs in close proximity to cultivated bananas;
- the Moko pathogen would be readily spread by insects, a range of animals (including feral pigs) that inhabit tropical north Queensland, and in flood water;
- the IRA Team has incorrectly assumed that Moko would not infect native banana species without providing any cogent reasons for doing so;
- Moko infects and kills cultivated banana species, and would be expected to infect and kill native banana species;
- native banana species contribute to the heritage values of the Wet Tropics World Heritage Area, but this value has not been assessed and therefore not taken into account in assessing the environmental impacts of Moko.

The Council has significantly underestimated the direct impact of Moko on the environment. The IRA Team should revise its assessment of the direct impact of Moko on native banana species, particularly having regard to their conservation status and their contribution to the heritage values of the Wet Tropics World Heritage Area.

4.7.2 Indirect impact

(a) Communities

The IRA Team has assessed the impact on communities as “highly significant” at the “local” level.

However the IRA Team has not properly considered the full range of economic and social impacts of Moko disease on communities, and as a consequence, has underestimated the indirect impact on communities.

The horticulture industry is the main driver of economic activity in the Johnstone and Cardwell Shires in north Queensland. The banana industry accounts for approximately 80 percent of the total horticulture outputs within that region.

The banana industry is labour intensive, and is a major source of employment in banana growing communities for both the local population and backpacker tourists. Importantly, the banana industry employs a high proportion of the unskilled workers (including a large number of indigenous workers) who would otherwise be unlikely to find employment in the region.

Bananas are an intensive crop that, in addition to labour, require a high level of farm inputs, direct service providers and associated support services that are utilised consistently throughout the year.

As a consequence, the banana industry has a major influence on the economic viability of the local business community including transport, farm input suppliers, cold chain logistics, accommodation, labour suppliers and service providers.

In the event of a Moko incursion, economic viability of banana growing communities will be significantly affected for a period that would depend upon the severity of the incursion, the duration of intrastate and interstate quarantine restrictions, and the success of eradication. A Moko incursion that cannot be eradicated will have a sustained and irreversible impact on the economic viability of banana growing communities.

Tropical Cyclone Larry demonstrates, at least to some extent, the significant economic impact that a Moko incursion that cannot be eradicated would have on banana growing communities. However, the economic impacts of a Moko incursion that cannot be eradicated would be expected to be much more severe for banana growing communities than the economic impact of Tropical Cyclone Larry because:

- the economic impacts of Tropical Cyclone Larry reduce over time;
- cyclone recovery activities had a stimulatory effect on those communities.

In the event of a Moko incursion that cannot be eradicated (and therefore needs to be actively controlled), the increased workload, higher labour and farm input costs and loss of security would undoubtedly result in contraction of the banana industry with many growers leaving the industry (and banana growing communities) for more economically secure livelihoods. The impact on communities is not limited to a simple analysis of indirect economic impacts. An incursion of Moko which is not able to be eradicated in a major banana growing region will have significant and irreversible social impacts on banana growing communities.

The Council believes that the impact on communities should have been assessed as "highly significant" at the "regional" level.

4.7.3 Overall consequences for Moko

For the reasons discussed above, the Council believes the overall consequence of Moko should be "high".

4.8 Risk management for Moko

4.8.1 General considerations

(a) Verification of the efficacy of proposed measures for Moko

In assessing the restricted risk for Moko, the IRA Team has assumed that each of the proposed measures will have a particular level of efficacy. However, the actual efficacy of those measures is unknown by the IRA Team.

The IRA Team has made it clear that "*verification of effectiveness of measures is required*" (at page 97 of Part B) and that "*there are combinations of risk management measures that, subject to verification and validation, would achieve Australia's ALOP*" (at page 104 of Part B).

While, for the reasons discussed below, the Council disputes the estimated efficacy and feasibility of the proposed risk management measures for Moko, if those measures are to be implemented, it is critical that the efficacy of each of the proposed measures is independently verified prior to the commencement of trade using scientifically and statistically appropriate experimental protocols.

In the case of Moko, the draft IRA Report states that verification is required for the following matters:

- in the case of the proposed areas of low pest prevalence measure, whether the proposed inspection methodology will achieve the required efficacy (page 267 of Part B);
- in the case of the proposed visual inspection and corrective action measure:
    - the efficacy of visual inspection for detecting 80 percent of Moko-infected bunches, based on the elimination of all bunches that show visible signs of vascular discolouration from processing (page 100 of Part B);
    - the ability of inspectors to detect visible symptoms of vascular discolouration with an effectiveness of at least 95 percent of all cases (pages 268 and 270 of Part B);
- in the case of the proposed post harvest treatment measure, the efficacy of the proposed chlorine treatment (20 ppm chlorine for 25 minutes) under practical field application (in both permanent and mobile packing stations) to reduce the risk of new fruit infection in wash water by 90 percent for Moko (pages 101 and 271 of Part B).

Each experimental protocol for the verification of the risk management measures must be subject to stakeholder review and consultation.

4.8.2 Areas of low pest prevalence

(a) Applicability of using areas of low pest prevalence

The IRA Team proposes that an "*area of low pest prevalence (ALPP) … be established and maintained following the guidelines described in ISPM No. 22: Requirements for the establishment of areas of low pest prevalence (FOA 2005a).*"

ISPM No. 4: Requirements for the establishment of pest free areas sets out requirements for the establishment of "pest free areas" which are established on an "area" basis. An "area" is a "country, part of a country or all or parts of several countries" (*ISPM No. 5: Glossary of phytosanitary terms*). By contrast, *ISPM No. 10: Requirements for the establishment of pest free places of production and pest free production sites* sets out requirements for the establishment of "pest free places of production" and "pest free production sites".

ISPM No. 22 sets out requirements for the establishment of "areas of low pest prevalence" which, like pest free areas, are established on an "area" basis.

No international standard has been adopted which sets out requirements for the establishment of 'low pest prevalence places of production' or 'low pest prevalence production sites'.

Clearly, the factors which are relevant to the establishment and maintenance of a "pest free area" are different to the factors relevant to the establishment and maintenance of "pest free places of production" and "pest free production sites". This is evidenced by the fact that the different international standards have been adopted for each of those matters.

Similarly, the factors relevant to the establishment and maintenance of "areas of low pest prevalence" are different to the factors relevant to the establishment and maintenance of 'low pest prevalence places of production' or 'low pest prevalence production sites'.

Consequently, it is not correct for the IRA Team to suggest that areas of low pest prevalence could be maintained and established following the guidelines described in ISPM No. 22 because that international standard does not establish guidelines for the establishment and maintenance of areas of low pest prevalence on a place of production or production site basis.

There is no international standard that specifically provides guidelines for the establishment of areas of low pest prevalence on a place of production or production site basis.

However, there are a range of international and regional standards (including ISPM No. 22) which are relevant to, and provide some guidance as to the matters to be considered in, establishing and maintaining areas of low pest prevalence on a place of production or production site basis.

(b) No distinction between pest free areas, pest free places of production and pest free production sites

The IRA Team has provided very sensible and cogent reasons for its conclusion that pest free areas, pest free places of production and pest free production sites are not

technically feasible management options.

The Council believes that the proposed area of low pest prevalence measure is not technically feasible for the very same reasons that the IRA Team concluded that the pest free areas, pest free places of production or pest free production sites are not technically feasible. This is particularly the case given the very low prevalence levels (0.06 or 0.005 cases per hectare per year) proposed by the IRA Team for the areas of low pest prevalence measure. These very low prevalence levels are not only difficult to maintain over a long period of time, but are also difficult to measure with an acceptable level of confidence.

(c) Establishment of pest prevalence

If the proposed area of low pest prevalence measure is to be implemented, the pest prevalence of the area of low pest prevalence must be demonstrated over a period of at least 12 months prior to the commencement of exports.

The pest prevalence must not be established by relying on historical pest prevalence data retained by Philippine growers (as has been suggested by representatives of Biosecurity Australia). It must only be established in reliance on pest surveys undertaken using an inspection methodology approved by AQIS.

(d) Average level of pest prevalence

The IRA Team has specified (at page 267 of Part B) that "*[t]he average level of low pest prevalence for Moko will not exceed 0.06 cases per hectare per year*".

Calculations of average pest prevalence should be based on a suitably sized area, having regard to the statistical considerations discussed in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission), in particular, the necessity of responding quickly to increases in pest prevalence.

(e) Minimum size of areas of low pest prevalence – biological considerations

North American Plant Protection Organisation Regional Standards for Phytosanitary Measure (RSPM) No 20: Guidelines for the establishment, maintenance and verification of areas of low pest prevalence for insects states that "*[t]he dimensions of an area of low pest prevalence will depend upon the biology of the pest and inherent characteristics of the production area.*"

The most important biological consideration relevant to the establishment of an area of low pest prevalence for Moko disease is that Moko is a highly contagious pathogen that is able to be rapidly transmitted over substantial distances through the movement of plant material, equipment, insects and soil and water.

The draft IRA Report acknowledges (at page 99 of Part B) that there are currently "*no restrictions on, for example, the movement of planting material, banana fruit or contaminated machinery within the Philippines*" and "*there is no means of restricting insect transmission*".

Moko disease is widely distributed in the proposed export area in cultivated and uncultivated bananas. Regular control measures are currently required to maintain the disease at its current level of prevalence. It is axiomatic, therefore, that if an area of low pest prevalence is to be established for Moko, it will be within a broader area of much

higher disease prevalence, and that there will be a very strong tendency, through the range of natural and human dispersal mechanisms, for the disease to enter the area of low pest prevalence.

As the size of an area of low pest prevalence is reduced from a country, to part of a country to a single plantation or to a block within a plantation, the impact of surrounding areas of high disease prevalence becomes increasingly significant, and the use of areas of low pest prevalence as a risk management option becomes increasingly compromised.

The IRA Team states (at page 99 of Part B) that "*[a]n area of low Moko disease prevalence could be a place of production (a banana plantation managed as a single unit) or a production site (a designated block within a plantation)"*.

For the reasons discussed in section 4.8.2(a) above, there is no relevant international standard that provides guidelines for the establishment of areas of low pest prevalence on a place of production or production site basis.

However, a number of international and regional standards provide guidance on factors relevant to the establishment of an area of low pest prevalence on a place of production or production site basis.

ISPM No. 10 states (in section 1.1):

> *"The concept of a pest free place of production can be applied to any premises or collection of fields operated as a* ***single production unit****. The producer applies the required measures to the entire place of production.*
>
> *Where a definite proportion of a place of production can be managed as a separate unit within a place of production, it may be possible to maintain the site pest free. In such circumstances, the place of production is considered to contain a pest free production site."*

The term "place of production" is defined in ISPM No. 5 to mean:

> *"Any premises or collection of fields operated as a single production or farming unit. This may include production sites which are separately managed for phytosanitary purposes"*

The minimum area in which pest freedom is be established and maintained for the purposes of ISPM No. 10 is an single production unit.

NAPPO RSPM No. 20 makes clear that that concept is directly applicable to the establishment of an area of low pest prevalence on a place of production or production site basis.

Therefore, the Council contends that the minimum area which should be considered for the purposes of the proposed area of low pest prevalence measure is a single production unit.

The document entitled "Philippine bananas Import Risk Analysis: Outcomes of a meeting between the Philippines, Biosecurity Australia, the risk analysis panel and technical working groups" states:

> *An individual farming area is considered to be a 200 to 300 hectare area*

around a packhouse. Due to distance constraints the packhouse only packs fruit from this area.

A packing station area is made up of the blocks from which fruit packed in the packing station is sourced. The packing station area is typically determined by the network of cableways radiating from the packing station along which fruit from surrounding blocks is transported to the packing station. Operational procedures including phytosanitary controls, horticultural practices, drainage works, harvesting and packing are managed on a packing station by packing station basis.

Consequently, the Council believes that the minimum area for the proposed area of low pest prevalence measure should be a single packing station area because each packing house area is managed as a single production area for phytosanitary purposes. Because blocks are not separately managed as a single production unit for phytosanitary purposes (but rather as part of a packing station area), the Council believes that it is inappropriate for blocks to be established as areas of low pest prevalence.

(f) Minimum size of areas of low pest prevalence – statistical considerations

The Council refers to detailed discussion in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission) in relation to the statistical considerations for the minimum size of areas of low pest prevalence.

For the reasons discussed in that report, an area of low pest prevalence for Moko must be established based on a minimum area which may statistically be demonstrated to allow a small increase in disease prevalence to be immediately detected with high probability, having regard to the prescribed level of pest prevalence. The lower the prescribed level of pest prevalence, the larger the area of low pest prevalence must be.

(g) Requirement for buffer zones to be established

ISPM No. 10 provides (in part):

> ***1.1 Application of Pest Free Place of Production and Pest Free Production Site***
>
> *…*
>
> *Where the biology of the pest is such that it is likely to enter the place of production or production site from adjacent areas, it is necessary to define a buffer zone around the place of production or production site within which appropriate phytosanitary measures are applied. The extent of the buffer zone and the nature of the phytosanitary measures will depend on the biology of the pest and the intrinsic characteristics of the place of production or production site.*
>
> *…*
>
> ***1.2 Distinction between a Pest Free Place of Production or Pest Free Production Site and a Pest Free Area***
>
> *…*

A pest free area is much larger than a place of production, includes many places of production and may extend to a whole country or parts of several countries. A pest free area may be isolated by a natural barrier or an appropriate usually large buffer zone. A pest free place of production may be situated in an area where the pest concerned is prevalent and is isolated, if at all, by creating a buffer zone in its immediate vicinity.

…

2.1.2 Characteristics of the place of production or production site

The basic definition of a "place of production" should be satisfied (i.e. operated as a single production or farming unit). Depending on the pest concerned and local circumstances, a place of production and production site as well as the buffer zone, as appropriate, may also require some of the following additional characteristics:

- *location at a sufficient distance from possible sources of pest infestation, with appropriate isolation (advantage being taken of physical features that can act as barriers to pest movement)*
- *clear delimitation, with officially recognized boundaries - access to the buffer zone (if appropriate)*
- *absence, in the place of production or production site of hosts of the pest other than those meeting the conditions for export*
- *absence in the buffer zone (if appropriate) of hosts of the pest or adequate control of the pest on these hosts.*

…

2.3 Buffer Zone Requirements

In appropriate cases, the establishment and maintenance of a pest free place of production or pest free production site include procedures related to the buffer zone associated with the place of production or production site.

The extent of the buffer zone should be determined by the NPPO, on the basis of the distance over which the pest is likely to spread naturally during the course of the growing season. Monitoring surveys should be conducted at adequate frequency over one or more growing seasons. The action to be taken, if the pest is detected in the buffer zone, will depend on the requirements of the NPPO. The pest free status of the place of production or production site may be withdrawn or appropriate control measures may be required in the buffer zone. In any case, access for surveys or control measures should be verified in advance. If appropriate, adequate procedures may be established to support the assurance that pest freedom is maintained (local reporting/notification and publicity, local regulation, control/elimination of detected pests).

ISPM No. 22 provides (in part):

3.1.2 Geographic description

*The NPPO should describe the ALPP with supporting maps demonstrating the boundaries of the area. Where appropriate, the description may include the places of production, the **host plants in proximity** to commercial production areas, as well as natural barriers **and/or buffer zones** which may isolate the area,*

3.1.4.1 Surveillance activities

Surveillance data should be collected and documented … in any areas of the proposed ALPP, and any associated buffer zones …"

While NAPPO RSPM No 20 provides guidelines for the establishment and maintenance of areas of low pest prevalence for insects, it provides guidance for the establishment of areas of low pest prevalence for pests such as Moko which are capable of long range transmission (including by insects). NAPPO RSPM No. 20 provides (in part):

Background

…

Low pest prevalence can be applied to large geographic areas, smaller places of production such as a block of contiguous orchards, and individual production sites. This is feasible provided that compliance with the established population threshold is achieved and maintained. Areas of low pest prevalence must be isolated by a natural barrier or protected with buffer zones where continuous effective phytosanitary actions can be applied.

1.1 Geographic description

1.1.1 Describe the proposed ALPP, with supporting maps demonstrating boundries of area, places of production, location of host plants in proximity to commercial production areas, and isolation of the area by a natural barrier (Appendix B).

1.1.2 In the absence of an isolating natural barrier, describe, with supporting maps and documentation, the buffer zone adjacent to the ALPP.

The requirement for the establishment of a buffer zone around an area of low pest prevalence is supported by the guidance provided by ISPM No. 10, ISPM No. 22, and NAPPO RSPM No. 20.

The IRA Team has not recommended the establishment of buffer zones adjacent to areas of low pest prevalence.

The Council considers that an area of low pest prevalence measure for Moko could not function effectively without the establishment of buffer zone because the Moko bacterium is capable of long range transmission and is likely to be present at a high prevalence in the areas surrounding areas of low pest prevalence (such as in adjacent small holdings and in feral bananas surrounding the plantation).

A buffer area must be managed to the same standard as the area of low pest prevalence or must be maintained free from all hosts.

4.8.3 Visual inspection and corrective action

(a) Verification of assumed efficacy of proposed measure

The IRA Team has assumed that the proposed visual inspection and corrective action measure will detect 80 percent of Moko-infected bunches.

However, the IRA Team has no basis for assuming that the proposed visual inspection and corrective action measure will have that efficacy.

The IRA Team states (at page 100 of Part B) that "*BPI would be required to demonstrate the efficacy of visual inspection for detecting 80% of Moko-infected bunches, based on the elimination of all bunches that show visible signs of vascular discolouration from processing.*"

The IRA Team has not specified how BPI would be required to demonstrate the efficacy of the proposed visual inspection and corrective action measure.

The Council argues that the following principles should be adopted in considering protocols for, and the results of, investigations demonstrating 80 percent efficacy:

- The investigations must be conducted using fruit that have either been naturally or artificially infected in the field.
- The incidence of infection must be established using a method that reliably demonstrates the presence of the pathogen. The pathogen should be detected using either culture-based or molecular-based tests.
- The bunches must be symptomlessly infected. Symptomless in this sense means that no external symptoms are present in the plant or the bunch.
- The method of defining vascular discoloration must be quantifiable. As indicated (at page 100 of Part B), discoloration ranges from cream or yellow through to reddish-brown, brown or black. In particular, the method must clearly define the earliest stage of discoloration which would be the easiest to miss.
- The experimental design must be such that the results can be statistically analysed to demonstrate 80 percent efficacy with a 95 percent level of confidence.

(b) Demonstration of the efficacy of visual inspection as a proposed measure

In addition to demonstrating that visual inspection will reduce the incidence of Moko-infected bunches by 80 percent, BPI is required (at page 268 of Part B) to demonstrate that inspectors have the ability to detect visual symptoms with an effectiveness of 95 percent of all cases.

The Council argues that the following principles should be adopted when considering protocols for demonstrating 95 percent efficacy.

- All inspectors must be trained using naturally infected bunches.
- The range of vascular discoloration must be defined.

- The testing procedure should show that inspectors are capable of competently distinguishing disease free from the early stages of discoloration – cream and light brown – to the required level.
- 95 efficacy must be demonstrated using an appropriate statistical method, such as triangle testing.
- The results of testing must be recorded in a form that can be audited.

4.8.4 Post-harvest treatment

(a) Difficulty with post-harvest chlorine treatment in commercial practice

The Council has previously advised the IRA Team that it believes that chlorine treatment would be ineffective under commercial conditions because it is practically (although not technically) impossible to continuously maintain the required chlorine concentration for the required time in commercial wash tanks due to a range of factors, the most important being the inactivation of chlorine by organic matter (primarily sap and plant material) introduced into wash tanks with bananas.

The report of Dr Ian Muirhead in Annexure 2 of the Council's previous submission discussed difficulties with the use of chlorine as a post-harvest treatment for bananas under commercial conditions. Those comments remain valid.

Further experimental research undertaken by the Queensland Department of Primary Industries and Fisheries examined the feasibility of maintaining 20 ppm active chlorine concentration under commercial conditions in Australia. That research confirmed that the concentration could be maintained only with great difficulty by:

- starting with a chlorine concentration much higher than 20 ppm;
- continually monitoring the chlorine concentration; and
- adding very large quantities of chlorine to compensate for loss from inactivation by sap and presumably other causes.

That research confirmed the Council's previous comments in relation to the practical difficulties with the use of chlorine as a post-harvest treatment for bananas under commercial conditions.

The Council remains of the view that the Philippines will not be able to maintain the required chlorine concentration for the required time under commercial conditions.

(b) Verification of assumed efficacy of proposed measure

The IRA Team has assumed that the proposed post-harvest treatment will reduce the risk of new fruit infections by 90 percent.

However, the IRA Team has no basis for assuming that the proposed post-harvest treatment measure will have that efficacy.

The draft IRA Report states (at page 271 of Part B) that "*BPI would need to demonstrate the efficacy of chlorine treatment under practical field application to reduce the risk of new fruit infection in wash water by 90% for Moko*" and (at page 101 of Part B) that the efficacy would need to be demonstrated "*at both their fixed and mobile packing stations*".

The draft IRA Report notes (at page 49 of Part B) that "*[s]ome highland producers use mobile packing stations to de-hand and process bananas to the packed carton stage in the field" and that it "constitutes about 10% of plantations*". However, the minutes of the meeting between the Philippines, Biosecurity Australia, the risk analysis panel and technical working groups in April 2002 note that "*[t]he use of mobile packing stations is increasing in Philippine plantations, with a target of 40% of fruit being packed in these units.*" The issue of mobile packing stations is therefore significant.

The IRA Team has not specified how BPI would be required to demonstrate the efficacy of the proposed post-harvest treatment for Moko. In this regard, it is important to note that while all permanent packing stations and mobile packing stations may be broadly similar in configuration, no two permanent packing stations or mobile packing stations will have the same configuration. Minor differences in the configuration of packing stations can have significant impacts on the efficacy of the proposed post-harvest treatment measure for Moko. For example:

- the volume of water, and consequently treatment time, may vary;
- replenishment of water in both the dehanding and flotation tanks may occur at different rates;
- addition of other compounds such as alum may vary;
- the method of adding and maintaining chlorine solutions may vary.

Consequently, verification of the efficacy of the proposed post-harvest treatment measure in a permanent packing station and a mobile packing station does not mean that it will be efficacious in every permanent packing station or mobile packing station. The efficacy of the measure will need to be verified on a packing station by packing station basis.

Regardless of whether the packing station is mobile or fixed, there are two aspects that need to be demonstrated by experimental research in order to demonstrate efficacy of the proposed post-harvest treatment measure.

Firstly, it must be demonstrated that the required concentration of chlorine (20 ppm) can be continuously maintained under commercial conditions for the required time (25 minutes) in both a permanent packing station and a mobile packing station.

Secondly, it must be demonstrated that the proposed chlorine treatment (20 ppm for 25 minutes) is able to reduce the risk of new fruit infections by 90 percent.

Different experimental protocols will need to be developed for each aspect.

The Council believes that the following high-level principles will need to be considered when preparing protocols and undertaking experiments to verify the efficacy of the proposed post-harvest treatment measure:

1 Biological efficacy must be demonstrated using the Moko pathogen.

2 The research must be done under actual commercial packing conditions, operating at full capacity. It would be unacceptable to use small scale, laboratory or other artificial systems because these are meaningless in the commercial context.

3 The pH must be recorded and demonstrated to remain in the band width that is acceptable for sanitising chlorine treatments, that is pH 6.5 to 7.5, throughout the entire packing session.

4 The equipment used to measure and monitor chlorine concentrations must be of acceptable standard and accurately calibrated.

5 The chlorine concentration must be shown to be maintained, by whatever method is chosen, to remain above the required minimum concentration (20 ppm) throughout the entire packing session.

6 The required minimum immersion time (25 minutes) must be shown to be reached or exceeded for all clusters or hands, including the first treated in a session.

7 Efficacy must be demonstrated by production of written test results, chemical or biological, automatic or manual.

8 The required efficacy must be shown to be repeatable, as demonstrated by appropriate statistical analysis.

5 Black Sigatoka

5.1 Introduction

Most of the biological information relied upon by the IRA Team for the risk assessment for black Sigatoka was drawn from published literature on the life cycle, epidemiology, infection and control of the black Sigatoka pathogen. The primary focus for most of that research was an understanding of the pathogen and the disease in subsistence and commercial production, to assist disease management or control. Very little research is presented that is specific to the survival of the pathogen through the importation, distribution and exposure scenarios. As a result, many of the likelihoods/proportions determined throughout the risk assessment are based on untested assumptions. The overall conclusions, therefore, are only as reliable as the validity of those assumptions assuming the risk assessment methodology is otherwise valid.

5.2 Biology

5.2.1 Host plants

The IRA Team states (at page 105 of Part B) that two cultivars of the native banana species *M. acuminata* subsp*. banksii* have been recorded as susceptible to black Sigatoka in Cameroon (Carlier *et al* 2000) but that the susceptibility of *M. jackeyi* and *M. fitzalanii* to black Sigatoka is unknown.

There are data that demonstrate that *M. acuminata* subsp*. banksii* is susceptible to black Sigatoka in our geographic region. In a trial conducted in Papua New Guinea in 1999-2000 after the wet season (May 2000), *M. acuminata* subsp. *banksii* was recorded as having a youngest leaf spotted (YLS) rating of 5.0 and 9.5 leaves, and a black Sigatoka reaction of 'susceptible' (RA Peterson, personal communication). In the same study, Williams was recorded as having a YLS rating of 4.0 and 8.9 leaves, with a black Sigatoka reaction of 'highly susceptible' (RA Peterson, personal communication). Virtually all of the leaves on *M. acuminata* subsp*. banksii* infected during the wet season had fallen from the plant by October (RA Peterson, personal communication).

While the exact host range of the Philippines' strains of the black Sigatoka pathogen is unknown, it is reasonable, for this purposes of this risk analysis and in the absence of information to the contrary, to assume that all three native banana species are susceptible to it.

For the above reasons, the Council believes that the IRA Team should have assumed that all three native banana species are susceptible to black Sigatoka.

5.2.2 Dispersal

(a) Survival of fertile pseudothecia

The draft IRA Report notes (at page 106 of Part B) that "*[f]ertile pseudothecia can survive for twenty-one weeks or more in leaf lesions if kept dry, but repeated wetting and drying leads to maturation and depletion of ascospore reserves within 4 – 8 weeks*".

The Council disagrees with this statement because research by Gauhl (1994) and Peterson *et al* (2000) demonstrates that fertile pseudothecia of *Mycosphaerella* species survive for periods exceeding 21 weeks under both wet and dry conditions.

The consequences of assuming a four to eight week period for maturation and depletion of ascospore reserves is that the values assigned (at page117 of Part B) to factor 2 (pest availability) and factor 3 (release of spores) of the 'Exposure - transfer considerations' assessment are underestimated.

(b) Distance of aerial ascospore and conidial dispersal

The draft IRA Report notes (at page of 106 Part B) that ascospores and conidia can disperse black Sigatoka over many kilometres when inoculum is abundant but that it may spread over only short distances when inoculum is limited. The IRA Team assumes a dispersal range of 30 metres and relies upon Carlier (2004) for that assumption.

The Council does not agree that 30 metres is a reasonable estimate of the range of dispersal of ascospores or conidia from discarded banana waste for the purposes of the import risk analysis for the reasons described below.

Reliance on Carlier (2004):

Carlier (2004) provides no data to support the 30 metre dispersal range. Carlier (2004) refers only to unpublished results from a study conducted (presumably) by Abadie of dispersal from an inoculum source in an isolated plantation during a period corresponding to one sexual cycle (about four weeks). No data of any kind are presented. No details are provided about the source or quantity of inoculum or climatic conditions (rainfall, wind conditions or temperature). It would be expected that other studies conducted in other conditions would give different results.

Given the importance of the distance of spore dispersal to the import risk analysis for black Sigatoka, the IRA Team should not have assumed a dispersal distance of 30 metres based solely on one study, particularly an unpublished study that cannot be reviewed. The Council believes that the IRA Team's assumption is unreasonable, scientifically unsound and dangerous.

Evidence of dispersal distance

There is strong evidence that individual ascospores can spread in a single step over distances that vastly exceed 30 metres. Examples include:

1 Meredith *et al.* (1970) planted pared corms of 'Gros Michel' in a location approximately one kilometre downwind of a diseased plantation of 'Gros Michel' (the only diseased bananas in the vicinity). Within two months the corms had germinated and produced young shoots, the lower leaves of which had numerous black Sigatoka lesions. Clearing and microscopic examination of the younger leaves showed numerous germinated ascospores of black Sigatoka on the surfaces, particularly the lower surface. Ascospores were also trapped in that location using a Hirst spore trap and identities were confirmed by transferring single spores from the trap slides to agar and allowing cultures to develop.

2 Burt *et al* (1998) reported, based on spore trapping using rotorod traps, that ascospores may be transported at least five kilometres and possibly over 40 kilometres. Gauhl (1994) reported that volumetric spore traps were more suitable than the rotorods mainly used by Burt and colleagues for studying airborne levels of ascospores. Even with volumetric spore traps, spore concentration calculations "were always lower than the actual ones" because trapping efficiency was affected by wind velocity. Gauhl's research suggests that the distances quoted by Burt et al (1998) may be underestimates of the true dispersal distances.

3 Local evidence demonstrates spread over large distances from sources with low inoculum levels. During the recent black Sigatoka outbreak in the Tully Valley, the pathogen spread over distances far greater than 30 metres in single steps (Peterson, RA 2002). The following records are particularly relevant because they arose from Australian conditions and the disease levels at some of the infection sites were very low.

On the plantation which the incidence and intensity of disease symptoms indicated was the original site of infection, the spread from plants with the most severe symptoms (being a clump of plants of about 12 stems behind a building) ranged from 30 metres to the west to 250 metres to the east and 300 metres to the south east. Sugarcane was growing between the originally infected plants and the other blocks of bananas.

The distances between the 25 infested sites (13 managed commercial blocks and 12 non-managed blocks of plants) were:

- 3 sites <1km apart
- 11 sites 1-2 km apart
- 7 sites 2-5km apart
- 4 sites >5km apart (1 x 7km, 2 x 8km, and 1 x 16km)

4 During the program developed to demonstrate area freedom from black Sigatoka after the recent outbreak and eradication campaign in the Tully Valley, yellow Sigatoka became established on susceptible sentinel plants at least one to two kilometres from plantations or non-commercial banana sites. This information is particularly relevant because it demonstrates spread from sources with extremely low levels of inoculum (Peterson 2003). Black Sigatoka is known to spread at least as effectively as the yellow Sigatoka pathogen.

5 As part of the process to demonstrate area freedom following the recent black Sigatoka outbreak in Tully, models were developed to predict the likelihood of spread and establishment from undetected remnants of the black Sigatoka population (Jorgensen *et al* 2004). It was noted that "The rate of deposition of spores that spread by the wind over a long distance depends on the weather conditions at the time. For the model, an average value was assumed that corresponded to about half of spores being deposited out of the air by 2 km and most of the spores being deposited by 20 km". Clearly, the model recognised that long distance spread could occur from a single remnant

source. It predicted, for example, that 0.2 lesions would have developed on susceptible host plants 5-10 km from the source when only 9 lesions were present at the source. The model, which was designed for Australian (north Queensland) conditions, supports the view that 30 metres is likely to be a dangerous underestimate of spread from low populations of black Sigatoka.

6 Burt *et al* (1997) detected conidia of the black Sigatoka pathogen in rotorod traps set at a height of three metres, about 0.5 to one metre above the canopy. There was a positive correlation between the number of conidia detected and wind speed, demonstrating that conidia as well as ascospores are wind-borne and could be involved in long distance spread far greater than 30 metres.

Statistical considerations

Figure 6.3 (on page 64 of Part C) describes the exponential distribution of dispersal distances from a point source, apparently based on Carlier (2004). However wind-borne dispersal of airborne ascospores is unlikely to have a dispersal distance following an exponential distribution. Recent models of wind-borne dispersal of pollen and fungal spores indicate that exponential dispersal characteristics are inadequate, and that power laws with much greater probability in the tails may better model dispersal for distances up to several kilometres (Shaw *et al* 2006). Similar considerations are expected to apply to the dispersal of black Sigatoka ascospores.

The draft IRA Report mistakenly assumes that the probability of dispersing beyond 30 metres is negligible, because of the small number of spores in question. This logic is misconceived, as each ascospore will have the same probability of dispersing over any given distance range. As discussed above, this probability is non-negligible as black Sigatoka has been quite readily spread by ascospore dispersal over distances of several kilometres. Whether the spore was produced as part of a large or small concentration of inoculum is immaterial to its behaviour once it becomes airborne. Therefore, these small but non-negligible probabilities must be considered by the IRA Team. When considered in the context of the importation of very large volumes of bananas and the proportion of waste contaminated with leaf trash producing ascospores, these small probabilities which the IRA Team assumes are negligible become of significant concern, and must be given significant weight by the IRA Team.

Conclusion

There is ample evidence that black Sigatoka ascospores will be readily dispersed much further than 30 metres from a point source of low inoculum levels. This evidence has either not been taken into account or has not been given sufficient weight by the IRA Team.

The value that is chosen for airborne dispersal of the black Sigatoka pathogen has a profound effect on the outcome of the import risk analysis for black Sigatoka. It is scientifically unsound (as well as being wrong) to assume such a short dispersal distance, particularly given that it only takes one successful ascospore discharged from discarded banana waste for black Sigatoka to become established on a suitable host.

A dispersal distance of at least two kilometres for aerial ascospore dispersal would be more appropriate than 30 metres. The IRA Team should revise its assessment of the distance of the dispersal of a black Sigatoka spores from banana waste.

(c) Distance of secondary dispersal

The IRA Team assumed (at page 107 of Part B) that the range of secondary dispersal of ascospores and conidia by water and animals is not more than two metres.

While a dispersal of two metres may be appropriate as an estimate of scatter by a single raindrop hitting a spore mass under still conditions, it does not take account of wind-driven droplets or aerosols created during heavy, driving rain and dispersal of these droplets and aerosols by air currents. Indeed, wind-driven droplets and aerosols are not considered anywhere in this draft IRA Report. This is a case where, in the absence of data, a realistic judgement has not been made. A secondary dispersal distance of at least 30 metres would be more appropriate than two metres to take into account the effect of wind on splash dispersal.

The Council also disputes the untested assumption that insect dispersal of black Sigatoka spores will not exceed two metres. The IRA Team has assumed that insects will disperse the Moko bacterium 30 metres (at page 76 of Part B) (however, for the reasons discussed in section 4.4.1 above, the Council disputes that estimation). There is no reason why the insect dispersal distance for the Moko bacterium will be materially different to the insect dispersal distance for black Sigatoka spores. In the absence of experimental data, the IRA Team should have assumed the insect dispersal distance for black Sigatoka spores would not be materially different to the insect dispersal distance for the Moko bacterium.

5.2.3 Risk scenarios

(a) Scenario A – contamination with infected plant material

The Council notes that the number of pieces of leaf material found in the study conducted by Peterson *et al* (2006) have been incorrectly quoted with respect to the breakdown between suppliers. The results of that study are summarised below:

- 16 pieces were found in 3,987 clusters or 3.9 tonnes of fruit examined.
- Plant material was present in cartons from both suppliers. Two pieces were found in the 30 cartons from supplier one, and 14 in the 321 cartons from supplier two.
- The daily inspection figures for contamination give an indication of the variation between suppliers (two), and packing facilities (57).
- The proportion of clusters containing leaf material varied from 1/46 (11 in 513) on day one to zero (zero in 1407) on day four.
- The number of pieces of leaf material varied from zero to 3.7 per packing facility.
- The proportion of cartons containing leaf material varied from 0 to 13.9 percent, with zero to 0.3 pieces per carton or zero to 0.023 pieces per cluster.

Peasley (2005) detected two pieces of leaf material in one carton examined.

Overall, leaf material was present in exported fruit originating from all three of the suppliers examined in those two studies.

(b) Rejected risk scenario

The IRA Team considered the following two risk scenarios:

- contamination with infected leaf material (Scenario A);
- contamination with spores (Scenario B).

While the IRA Team has noted (at page 105 of Part B) the research of Fullerton (2006) and Cedano *et al* (2000) which demonstrates that fruit of Cavendish banana and plantain are infected by the black Sigatoka pathogen, the IRA Team did not consider endophytic infection as a risk scenario for black Sigatoka. This is presumably because the existence of pseudothecia has not been reported in fruit lesions.

The Council believes that the IRA Team should have considered endophytic infection as a risk scenario for black Sigatoka.

Fullerton and Casonato (2006), working with fruit in Samoa, demonstrated that the black Sigatoka pathogen could be found in the skin of symptomless, green-mature banana fruit. A subsequent pilot study in New Zealand confirmed the presence of the pathogen in the skin of fruit imported to New Zealand from the Philippines. The later study, made on ripe fruit obtained from Auckland supermarkets, demonstrated that the pathogen could survive within the skin of the fruit during importation (Imp1 to Imp8) into Australia and distribution within Australia (Dist1).

Although the development of pseudothecia in fruit lesions has not yet been demonstrated, there is a high probability that it does occur. The Council considers that the reason that the complete pathway has not yet been reported is that it has not been investigated through appropriate research. Presumably this is because, until now, there has been no pressing reason for such research to have been undertaken.

Also, there is an inconsistency in how the IRA Team has dealt with the infection of floral remnants attached to fruit and endophytic infection of fruit. In neither case has infection been shown to lead to the development of pseudothecia. However, the IRA Team considered floral infection under Scenario A (apparently accepting that there is a high chance of exposure to infection/infestation) but failed to consider endophytic fruit infection.

The Council considers that it is unsafe for the IRA Team to ignore the possibility of endophytic fruit infection. The IRA Team should revise the import risk analysis for black Sigatoka having regard to the endophytic fruit infection risk scenario.

5.3 Scenario A – Contamination with infected plant material

5.3.1 Importation – contamination with infected plant material

(a) Imp2 – Contamination level within an infected plantation

The Council makes the following comments in relation to the IRA Team's assessment of factors 3 and 4 in respect of leaf material for Imp2 of Scenario A.

Factor 3 – The proportion of leaf material pieces on contaminated clusters that are infected with black Sigatoka

The draft IRA states (at page 110 of Part B) that an average of 10 to 12 of the youngest leaves remain free of black Sigatoka.

However, figure 6.4 (at page 65 of Part C) does not support the statement that first symptoms generally appear on leaves 10,11 or 12. This is because the data used to develop the figure refer to the youngest leaf with **initial spots**, not first symptoms. Figure 6.1 (at page 56 of Part C) shows that the lowest spot category defined by Meredith and Lawrence (1969) is equivalent to stage 4 in the system used by Foure (1987) to describe symptom development. A period of at least two to four weeks (depending on the growth rate of plants and climatic conditions) would be expected between "first symptoms" and "first spot stage".

For these reasons, the Council argues that **first symptoms** would be most likely be present on leaves as young as six to eight. This suggests that the value assigned by the IRA Team for factor 3 (10 to 20 percent of the leaf infected) is too conservative. A more realistic value would be within the range of 40 to 70 percent. The IRA Team should revise its assessment of this factor.

Factor 4 – The proportion of leaf pieces infected with black Sigatoka that contain fertile pseudothecia

The IRA Team assumed (at page 110 of Part B) that:

- no more than 10 percent of the total pseudothecia produced in infected leaf tissue still remain fertile at the time of harvest; and
- between 50 to 90 percent of leaf pieces would bear no pseudothecia at the time of harvest, while the remainder would bear from one to 20 fertile pseudothecia each.

The Council believes that the first assumption is an underestimate of the actual position and the second assumption is an overestimate of the actual position. In two separate trials to monitor ascospore release from banana leaf tissue containing *Mycosphaerella* species, vast numbers of ascospores have been caught for at least 12 weeks after the leaves were removed from the plant. Using the black Sigatoka pathogen, Gauhl (1994) recorded "very many spores (>500)" from 1cm^2 pieces of leaf with 14 week old lesions and "many spores (250-500)" at 20 weeks. This is inconsistent with the view that no more than 10 percent of perithecia remain fertile at harvest.

Peterson *et al* (2000) investigated the level of ascospore release from pieces of leaf tissue removed from leaves naturally infected by *M. musicola*. The number of ascospores released was far too numerous to count, especially in the first two weeks. Instead, the numbers of 5 x 5mm squares marked on the plates (maximum 100 pieces) that spores were recorded in were counted. Ascospores were detected in most squares in the first two to six weeks. Ascospores occurred in 70 of 100 squares (70 percent) at 12 weeks from samples simulating leaves hanging on the plants in the field. These leaf pieces had been exposed to wetting and drying cycles. This is also strong evidence that pseudothecia would not suffer large drops in viability, as assumed by the IRA Team, within the time frame and under the conditions that would be experienced in the field up to packing.

For the reasons discussed above, the Council believes that factor 4 has been underestimated and should have been estimated to be least forty to seventy percent. The IRA Team should revise its assessment of this factor.

Conclusion

For the reasons described in this section, the Council believes that the IRA Team has underestimated the likelihood of Imp2 for Scenario A.

(b) Imp3 – Contamination by infected plant material during harvest and transport

The IRA Team assessed (at page 112 of Part B) the proportion of clean clusters from infected plantations that become contaminated with plant material bearing fertile pseudothecia of black Sigatoka during harvest and transport to the packing station as zero.

That assessment is based on the IRA Team's assumption (at page 112 of Part B) that "*[t]here is no opportunity for pieces of plant materials with black Sigatoka to contaminate clusters during harvest and transport to the packing station*", apparently on the basis that bunch covers are 100 percent effective at protecting fruit from contamination.

However, bunch covers used in the Philippines are manufactured with perforations to allow gas exchange. Bunch covers may be cut or accidentally torn after bagging during the growing period (due to normal activities such as assessing fruit maturity) and during harvest and transport (see the minutes of the meeting between the Philippines, Biosecurity Australia, the risk analysis panel and technical working groups in April 2002). During a study tour of Philippine banana plantations in 2000, Len Collins and Ian Muirhead noted that this was a frequent occurrence. Rips and holes in bags provide an entry point for contamination of the fruit by water-borne and airborne plant material during the growth cycle, harvest and transport to the packing station.

In addition, all bags, except those used in Bukidnon, are open at the bottom (see the minutes of the meeting between the Philippines, Biosecurity Australia, the risk analysis panel and technical working groups in April 2002). Those bunch covers that are not tied to prevent the bunch covers from being lifted by the wind, would also be subject to contamination by water-borne and airborne plant material during harvest and transport to the packing station (particularly the lower hands). If fungicide sprays are to be applied to bunches at two to three week intervals for the control of freckle (see page 163 of Part B), then it is expected that bunch covers will not be tied.

Contamination of bunches by soil and plant material is acknowledged by the IRA Team (at page 112 of Part B) and is demonstrated by Peasley (2005) (at page 108 of Part B) and by Peterson et al (2006). If bunch covers are wholly effective at preventing contamination of fruit as assumed by the IRA Team, then how could that contamination have occurred (unless it occurred in the two week period after bunch emergence but prior to bagging)?

In the previous draft IRA Report (2004), the IRA Team (at page 84) assumed that fruit would be exposed to water-borne and airborne contamination through holes in bunch covers. The Council cannot understand on what basis the IRA Team has departed from that assumption.

For the above reasons, the Council believes that the IRA Team has underestimated the likelihood of Imp3 for Scenario A and should revise its assessment of Imp3.

(c) Imp5 – Contamination by infected plant material during packing

The IRA Team assumes (at page 112 of Part B) that except on rare occasions, clean clusters will not be contaminated with more than one piece of tissue dislodged from a cluster contaminated with leaf material.

If, as the IRA Team assumes for Imp 4, 50 to 90 percent of contaminating leaf material is removed by packing station procedures, there is the potential for this material to be spread to other clusters. Importantly, leaf tissue dislodged from a cluster may contaminate more than one other cluster.

Also, the IRA Team has failed to consider that packing stations are open structures located within banana plantations and that therefore, there is a real and significant likelihood of airborne plant material entering the packing station and contaminating clean clusters. This possibility is acknowledged by the Philippines (see the minutes of the meeting between the Philippines, Biosecurity Australia, the risk analysis panel and technical working groups in April 2002).

For the above reasons, the Council believes that the IRA Team has underestimated the likelihood of Imp5 for Scenario A and should revise its assessment of Imp5.

5.3.2 Distribution

(a) Dist1 – Infected plant material remaining after distribution

The draft IRA Report states (at page 113 of Part B) that "*the IRA team considered that up to 10% of the most lightly infected plant fragments would become totally infertile at this stage and the remaining plant fragments would typically retain 1–16 fertile pseudothecia per fragment".*

This statement is inconsistent with the IRA Team's estimate of 0.9 for the proportion of contaminated clusters remaining contaminated with fertile pseudothecia. The 10 percent figure relates to only the most lightly infected plant fragments, with the rest of the plant fragments remaining infected. Given that the most lightly infected plant fragments make up only a small proportion of infected plant fragments, Dist1 should be much closer to one than to 0.9.

In the absence of detailed information, the IRA Team should have assessed the Dist1 as being one.

5.3.3 Exposure – proximity considerations

(a) Proportion of waste near each exposure group

For the reasons discussed in section 5.2.2(b) above, the Council believes that the IRA Team has significantly underestimated the dispersal range for black Sigatoka ascospores. As a consequence of underestimating the dispersal distance of black Sigatoka ascospores, the IRA Team has underestimated the proportion of each type of waste that is discarded near each exposure group.

The Council believes that the IRA Team should revise its assessments of the proportion of each type of waste that is near each exposure group, having regard to a more appropriate dispersal distance for black Sigatoka ascospores.

This issue is discussed further in the report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission).

(b) The likelihood that a host plant in an exposure group would be within the dispersal distance of black Sigatoka ascospores from waste

For the reasons discussed in section 5.2.2(b) above, the Council believes that the IRA Team has significantly underestimated the dispersal range for black Sigatoka ascospores. The Council considers that the IRA Team should have assumed a dispersal distance of at least two kilometres.

As a consequence of underestimating the dispersal distance of black Sigatoka ascospores, the IRA Team has underestimated the likelihood that a host plant in an exposure group would be within the dispersal distance of black Sigatoka ascospores from waste.

The Council believes that the IRA Team should revise its assessments of the likelihood that a host plant in an exposure group would be within the dispersal distance of black Sigatoka ascospores from waste, having regard to a more appropriate dispersal distance for black Sigatoka ascospores.

5.3.4 Exposure – Transfer considerations

(a) Factor 2 – pest availability

The draft IRA Report states (at page 117 of Part B) that factor 2 concerns the likelihood that pseudothecia on a plant fragment will mature and produce ascospores.

The Council has assumed that 50 percent of fertile pseudothecia would mature in grower areas and 20 percent in other areas, on the basis that the temperature in grower areas is more suitable for the maturation of pseudothecia than in other areas.

This factor does not concern production of new pseudothecia, only maturation of existing pseudothecia to the point where ascospores would be produced if suitable weather conditions exist (which is addressed in factor 3). There seems to be no good reason to assume that the viability of pseudothecia would be reduced significantly during this period, or that only half (in grower areas) or one-fifth (in other areas) of existing pseudothecia will mature.

The ability of existing fertile pseudothecia to mature will depend on environmental conditions, and the time available.

With respect to time, the Council disputes the use of a four to eight week period because research by Gauhl (1994) and Peterson *et al* (1998) demonstrates that fertile pseudothecia survive for periods exceeding 21 weeks under both wet and dry conditions. This is ample time for immature pseudothecia to mature.

The main consideration is therefore likely to be environmental conditions. Pseudothecia are unlikely to develop during transit or storage due to the low temperatures. Therefore the maturation process will only recommence after the debris finds its way into the

natural environment and is subjected to normal wetting and drying cycles. Pseudothecia in leaf fragments in clusters at the time of exposure will be at different stages of maturity, and maturation will occur progressively. It is well-known that pseudothecia of *Mycosphaerella* species do not mature all at the same time. Stover (1980) observed ascospore release from leaf debris for up to 23 days as pseudothecia progressively matured. Using computer-controlled environment chamber studies, Mondal *et al.* (2003) demonstrated progressive maturation of pseudothecia in *M. citri.*

With respect to temperature, even considering the growth information provided in figure 6.2 in Part C, eight weeks would be sufficient time for most or all pseudothecia present in leaf tissue to progressively mature in the grower areas. Moisture would not be a limiting factor, as there would be many rainfall events in eight weeks, and a period of only 24 hours is needed for each new batch of ascospores to mature and be ready for release (Meredith *et al* 1973, Gauhl 1994). The likelihood would be even higher for 21 weeks in grower areas. For other areas that may be cooler, the likelihood would be lower, but 20 percent is still too low an estimate.

For the above reasons, the Council considers that factor 2 should be at least 75 percent for grower areas and 50 percent for other areas.

The report by Professor Pettitt and Dr Reeves (Annexure 2 to this submission) discusses issues associated with ascribing exact values to model quantities (where precise information is not known), and discusses the IRA Team's assessment of factor 2 as an example.

(b) Factor 3 – Release of spores

The IRA Team assumes (at page 117 of Part B) that the chance that a significant wetting event leading to spore release will occur in the four to eight week period after waste is discarded is 20 to 40 percent.

For the reasons discussed in section 5.2.2(a) above, the Council disputes the IRA Team's reliance upon the four to eight week period because research by Gauhl (1994) and Peterson *et al* (2000) demonstrates that fertile pseudothecia survive for periods exceeding 21 weeks under both wet and dry conditions.

The release of ascospores from mature pseudothecia is largely controlled by moisture. Gauhl (1994) reported that any rainfall event (even less than one millimetre), and Meredith *et al* (1973) and Gauhl (1994) reported that even heavy dews, are sufficient for spore release. The main growing areas in north Queensland and northern New South Wales have rainfall events exceeding one millimetre on average over 125 and 100 days per year respectively (http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/rndays.cgi). Therefore, the Council considers that the chance of at least one sufficient wetting event occurring during the four to eight week period after waste is discarded would be almost 100 percent in grower areas and no less than 70 percent in other areas.

For that reason, the Council believes that the IRA Team has underestimated the likelihood of factor 3 and should revise its assessment of that factor.

(c) Factor 4 – Spores settle on host

<u>Factor 4A – Number of ascospores that become airborne from each plant fragment</u>

The IRA Team assumes (at page 118 of Part B) that no more than 10 to 30 percent of released ascospores from a leaf fragment would become airborne.

That assumption is based, in the absence of more comprehensive research, on the data provided in Burt *et al* (1999). The Council disputes that estimate for the following reasons:

1 Reliance upon Burt et at (1999)

The claim attributed to Burt *et al* (1999) that only two to six percent of ascospores are ejected into the air from each mature pseudothecium is highly questionable. It appears to have been derived by a calculation from the statement by Burt *et al* (1999) that only 4.5 ascospores were released per perithecium, and the IRA Team's statement (at page 60 of Part C) that there may be 10 to 27 asci per *M. musicola* perithecium, and that it is likely that *M. fijiensis* will have similar number of asci. It is unsafe to place reliance on those assumptions.

The figure of 4.5 ascospores which is derived from Burt *et al* (1999) was determined by counting the total number of perithecia located in the $1cm^2$ piece of necrotic tissue and then counting the number of ascospores ejected from each piece of tissue. There was however, no assessment on how many of these perithecia were mature or how many of the asci contained mature ascospores. This is supported by their findings that there were significantly more ascospores ejected from tissue from leaves with a disease rating of five (greater than 50 percent necrotic tissue) compared to tissue from leaves with a disease rating of three (between 16 to 33 percent necrotic tissue) which under normal conditions would be a younger leaf with newer lesions. Also, the study was undertaken over a 16 day period (4 x 4 stages), thus recording only a proportion of ascospores released (given that Gauhl (1994) demonstrated ascospore release for the 20 or more weeks from necrotic leaf tissue).

2 No justification for five-fold factor

While the IRA Team acknowledged (at page 118 of Part B) that the figures from Burt *et al* (1999) might underestimate ascospore release, it only allowed a five-fold increase in its calculations to reflect the underestimation. There is no justification for the use of that factor. The Council believes that it would have been more logical for the IRA Team to use a factor of 10, rather than five, because the study period was approximately two weeks and spores can be released over 20 or more weeks.

3 Other studies suggest more efficient ascospore release

Acceptance of a discharge efficiency as low as two to six percent denies the evolved biological advantage of forcible discharge of ascospores. One of the reasons for the biological success of the black Sigatoka pathogen is its ability to project prodigious numbers of ascospores beyond the boundary layer. Stover (1980), for example, reports up to 33,000 black Sigatoka ascospores/m^3 air over a 24 hour period in Hawaii. While there was no measure of the numbers of pseudothecia contributing to that spore load, the huge numbers of

ascospores suggest a substantially more efficient discharge mechanism than that estimated from Burt *et al* (1999).

Gauhl (1994) recorded "very many spores" emitted from 1cm^2 squares of infected leaf material and Peterson *et al* (2000) reported too many ascospores to count from 5 x cm infected squares of leaf material, indicating that far more than only two to six percent of ascospores are released.

4 Spore traps underestimate actual ascospore numbers

The IRA Team should have taken into account that spore numbers reported from spore traps, regardless of the type used, generally underestimate the actual number of spores in the atmosphere. Gauhl (1994) reports that volumetric spore traps, whilst the most efficient, may underestimate spore levels by more than 75 percent.

For the reasons discussed above, the Council believes that the IRA Team has underestimated the proportion of released ascospores that would become airborne. The Council considers that the IRA Team should have assumed that at least 50 percent of released ascospores become airborne.

The Council believes that the IRA Team should revise its assessment of factor 4A.

Factor 4B – Area of host surface relative to the area of the proximity zone

The IRA Team's assessment of factor 4B relies on its assumption about the dispersal distance of ascospores. For the reasons discussed in section 5.2.2(b) above, the Council believes that the IRA Team has significantly underestimated the dispersal range for black Sigatoka ascospores. The Council considers that the IRA Team should have assumed a dispersal distance of at least two kilometres.

The Council believes that the IRA Team should revise its assessment of factor 4B for each exposure group, having regard to a more appropriate dispersal distance for black Sigatoka ascospores.

5.3.5 Establishment

(a) Factor 1 – surface moisture

The IRA Team estimated (at page 119 of Part B) a value of between 30 and 70 percent for factor 1.

The IRA Team's assessment of factor 1 is based on a consideration of the number of days receiving more than five millimetres per day, yet no evidence is given to justify the use of a threshold level of five millimetres of rain per day. The need for wet conditions from germination to entry into the leaf is not continuous and can be accumulated over a number of periods of leaf wetness by rain, dew or irrigation water. Germination does not require a high level of wetness (such as the five millimetres assumed by the IRA Team) in a single day.

The IRA Team should revise its assessment of factor 1.

5.4 Scenario B – Spore contamination

5.4.1 Importation – contaminated bananas

(a) Imp3 – Contamination of black Sigatoka during harvest and transport

The Council refers to its comments in section 5.3.1(b) above in relation to Imp 3 for Scenario A.

For the reasons discussed in that section, the Council believes that the IRA Team has underestimated the proportion of clean clusters that become contaminated with spores of black Sigatoka during harvest and transport to the packing station.

5.4.2 Exposure – proximity considerations

(a) Proportion of waste near each exposure group

For the reasons discussed in section 5.2.2(b) above, the Council believes that the IRA Team has significantly underestimated the secondary dispersal range for black Sigatoka spores. The Council considers that the IRA Team should have assumed a secondary dispersal distance of at least 30 metres.

As a consequence of underestimating the secondary dispersal distance of black Sigatoka spores, the IRA Team has underestimated the proportion of each type of waste that is discarded near each exposure group.

The Council believes that the IRA Team should revise its assessments of the proportion of each type of waste that is near each exposure group, having regard to a more appropriate secondary dispersal distance for black Sigatoka spores.

(b) The likelihood that a host plant in an exposure group would be within the secondary dispersal distance of black Sigatoka spores from waste

For the reasons discussed in section 5.2.2(b) above, the Council believes that the IRA Team has significantly underestimated the secondary dispersal range for black Sigatoka spores. The Council considers that the IRA Team should have assumed a secondary dispersal distance of at least 30 metres.

As a consequence of underestimating the secondary dispersal distance of black Sigatoka spores, the IRA Team has underestimated the likelihood that a host plant in an exposure group would be within the secondary dispersal distance of black Sigatoka spores from waste.

The Council believes that the IRA Team should revise its assessments of the likelihood that a host plant in an exposure group would be within the secondary dispersal distance of black Sigatoka spores from waste, having regard to a more appropriate secondary dispersal distance for black Sigatoka spores.

5.4.3 Exposure – transfer considerations

(a) Factor 3 – Release of spores

The report by Professor Pettitt and Dr Reeves which (Annexure 2 to this submission) provides comment on two aspects of Exposure Scenario B. The following discussion should also be taken into account when re-considering factor 3.

The values assigned by the IRA Team to release of spores are based on three assumptions – the likelihood that at least some rain or supplementary irrigation might occur, the proportion of spore that would b lifted into the air, and the number of spores on the fruit surface. The Council considers that the values have been underestimated, for the following reasons:

- The likelihood of at least some rain is based on the number of days in which 5 mm or precipitation would be expected. No justification is provided for the arbitrary use of 5 mm. The main growing areas in north Queensland and northern New South Wales have rainfall events exceeding one millimetre on average over 125 and 100 days per year respectively (http://www.bom.gov.au/cgi-bin/climate/cgi_bin_scripts/rndays.cgi). A shower delivering 1 mm would also produce droplets that would disperse spores. Although the droplets from 1 mm shower would be fewer than from 5 mm, the number of spores lifted by each would most likely be higher, as the spore concentration in the water film would be higher. Also, rainfall above 5 mm would produce a lot more droplets than allowed for in the calculations.
- The IRA Team assumes that no more than 1% of 100 viable spores would be lifted into the air. There is no foundation for either of these assumptions – they appear to be the best estimates of the IRA Team. Given that the assumptions have a high degree of uncertainty surrounding them, it is equally reasonable to approach the subject by considering that the viable spores on the surface of the fruit will almost certainly be subjected to one and probably several rainfall or irrigation events during the period that the wast is exposed, and that there is a very good chance – perhaps 50% - that these spores would be released by splash.

5.5 Establishment

The Council refers to its comments in section 5.3.5(a) above.

5.6 Consequences

For the reasons discussed in the above sections, the Council considers that the methodology adopted by the IRA Team for the assessment of consequences is deficient and has resulted in an underestimation of the consequences of black Sigatoka.

Notwithstanding the deficiency in the consequence assessment methodology, the Council comments below on factors relevant to the assessment of the consequences for black Sigatoka.

5.6.1 Direct consequences

(a) Plant life or health

The IRA Team assessed (at page 131 of Part B) the likely direct impact of black Sigatoka in terms of plant life or health as being “significant” at a “regional level”.

The Council disputes that assessment for the following reasons.

Impact on commercial banana plants

The IRA Team assumes (at page 130 of Part B) that in Australia, the effects of black Sigatoka would be minimised by fungicidal sprays and leaf sanitation measures already used against established diseases such as yellow Sigatoka and leaf speckle.

However, the fungicidal sprays and leaf sanitisation measures already used against established diseases fall well short of what would be required to effectively manage black Sigatoka. The maximum number of fungicidal sprays currently used in north Queensland is twenty per year (Len Collins, personal communication). This is less than the number of fungicidal sprays required to manage black Sigatoka in the Philippines (more than 45 sprays per year). In north Queensland, plants are de-leafed about four to six times per year to manage established leaf diseases while in Central America and the Philippines plants are manicured/pruned on a weekly basis to manage black Sigatoka.

The IRA Team's assumption is not supported by the experience in Central and South America. Programs for yellow Sigatoka were in place in both Honduras and Costa Rica when black Sigatoka first became introduced in the 1970s. Romero and Guzman (2006) report that black Sigatoka caused production losses of 40 to 50 percent in both Honduras and Costa Rica within three to five years of introduction and that it still causes production losses of 10 to 15 percent even after the introduction of significantly enhanced disease management practices.

The following examples, extracted from a report of a study trip by Ian Muirhead and Len Collins in 1995, demonstrate further the magnitude of losses which occurred in the 1990s in Honduras and Costa Rica, even in commercially managed plantations that were using enhanced spray programs (42 or more sprays per year in Costa Rica), vastly increased levels of de-leafing and the best scientific information available at the time:

- Dr Harry Stover in Honduras reported that five million bunches were lost in 1992 from Black Sigatoka. The fruit were simply unmarketable. The loss would have approached US$50 million.
- Ronald Romero from CORBANA in Costa Rica noted a loss of 50 million boxes worth US$6 each – or a total of US$300 million – in 1993.
- One independent grower in Costa Rica reported a loss of 200,000 bunches from a 540 hectare plantation in 1994 (an individual loss of US$I million), followed by a need to cut at 11 weeks instead of 13 weeks for a period of three months, thereby increasing the loss through reduced yield. He also needed to greatly increase the level of deleafing in the plantation.

As noted by the IRA Team (at page 130 of Part B), the direct effects of black Sigatoka have to be considered in the context of existing horticultural practices for control of pests and diseases. The IRA Team does not appear to have taken that principle into account. The Council is concerned that the IRA Team has not appreciated how profoundly different the impact of black Sigatoka is from yellow Sigatoka, even though it refers (at page 131 of Part B) to a yield of loss of 38 percent for plantains and even greater yield loss for bananas if control measures fail. The scenario that should be under consideration for assessing the direct effect of black Sigatoka on plant life and health is therefore black Sigatoka infection without effective disease control.

Experience shows that while most plants in an infected plantation without effective disease control will retain enough leaves to fill a bunch, the number of functional leaves at harvest is generally less than three or four. This is below the number acceptable for commercial grade fruit. There is a higher chance of premature fruit ripening. Fruit must consequently be cut thinner, as occurred in Honduras and Costa Rica.

Because of the high spore loads produced on leaves of the plant crop, ratoon crop suckers are heavily infected from an early age. Without an effective spray program, they will seldom have more than five or six functional leaves at bunch emergence and most will have no green leaves at the end of a 'normal' bunch filling period (about 12 weeks). As time progresses, many bunches break out at the throat of the plant and fall to the ground. Others remain attached but fingers will never reach harvest size. None will be suitable for commercial sale because the fruit, when ripened, lacks flavour and has a 'sticky' texture. In the absence of effective control measures, plantations normally fail completely at the first ratoon crop (RA Fullerton, personal communication).

The Council believes that, with the current level of spray control and deleafing used for yellow Sigatoka, yield losses would be closer to 100 percent than 38 percent.

Under the current control measures for established leaf diseases, commercial plantations would be expected to be completely out of commercial production within 18 months after infection.

Impact on backyard banana plants

Because the majority of backyard banana plants are not subject to any kind of disease management, infected backyard banana plants would produce very little if any edible fruit within two years.

It is anticipated that many backyard banana plants would ultimately be removed because they would become unproductive.

Impact on native banana species

The IRA Team assumes (at page 131 in Part B) that it is very unlikely that native banana plants would be infected by black Sigatoka because of their limited distribution and isolation from other native and commercial bananas.

The Council strongly disputes that assumption. *M. acuminata* subsp. *Banksii* occurs throughout north Queensland and is commonly found on and adjacent to commercial banana plantations.

Assuming, for the reasons discussed in section 5.2.1 above, that native banana species are susceptible to black Sigatoka, it would be expected that if black Sigatoka established in a commercial banana plantation, it would establish and spread in the population of native banana species.

Conclusion

For the reasons discussed above, the IRA Team has significantly underestimated the direct impact of black Sigatoka on plant life or health.

The IRA Team should have estimated the impact of black Sigatoka on plant health and life as being "highly significant" at the "regional level".

5.6.2 Indirect impact

(a) Control or eradication

The IRA Team assessed (at page 131 of Part B) that the indirect impact of controlling and/or eradicating black Sigatoka would be significant at the regional level.

That assessment is based largely on comparison of the cost of eradicating the recent outbreak in the Tully Valley, and an assessment of the likely additional control costs if an eradication attempt fails.

In the event of a new outbreak, it is likely that another eradication campaign would be attempted. The success of the previous campaign provides an indication that another campaign might also be successful. However, global experience evidences that black Sigatoka is almost impossible to eradicate if established. The Council believes that the following three factors strongly contributed to the success of the eradication of the recent outbreak of black Sigatoka in the Tully Valley:

- the disease was discovered relatively soon after it established;
- at the time the disease was discovered, it was restricted to one discrete area; and
- weather conditions did not favour the rapid spread of the disease.

The combination of those three factors is unlikely to be repeated. Without the combined influence of those three factors, it would be expected that a future program to eradicate a future outbreak of the disease would be much more significant undertaking than the previous eradication program and would cost considerably more than the previous eradication program (which cost well over $20 million). Consequently, the Council believes that it is not appropriate for the IRA Team to assume that the cost of the program to eradicate black Sigatoka from the Tully Valley is indicative of the cost that might be incurred to eradicate black Sigatoka in the event of a future outbreak.

In the event that an eradication program following an outbreak is unsuccessful, banana growers would need to adopt significantly increased numbers of fungicidal sprays and intensified de-leafing. The Council believes that number of spays would at least double and the de-leafing cycle would likely increase from four to six times per year by at least 10 extra rounds of de-leafing per year (which is a lower level of disease control than is currently undertaken in the Philippines and Central America to manage black Sigatoka).

The estimate of the likely cost accepted by the IRA Team is $1,650 per hectare per year. The Council believes that cost grossly underestimates the costs of attempting to control the disease, given the likely increase in control measures. The Council estimates that the cost of the additional control measures would be at least double that accepted by the IRA Team, and that it might even be higher depending on the actual number of sprays and de-leafing rounds required, and due to other factors including additional costs associated with labour shortages, problems with fungicidal resistance and more expensive systemic fungicides. For the reasons discussed above, the IRA Team has significantly underestimated the cost of control or eradication.

The IRA Team should have estimated the impact of control or eradication as being “highly significant” at the “regional level”.

(b) Domestic trade

Black Sigatoka restrictions

The IRA Team (at page 132 of Part B) assumes that restrictions on fruit could disrupt national marketing arrangements for a short time after the initial detection of the disease in an area, but would be no more than currently exists for outbreaks of black Sigatoka that have occurred previously.

The movement restrictions imposed following the outbreak of black Sigatoka in the Tully Valley in 2001 are indicative of the movement restrictions which would be expected to be imposed in the event of a further incursion of black Sigatoka.

Immediately following the detection of the disease in the Tully Valley, there was complete disruption to the national marketing arrangements as bananas from north Queensland were prohibited from entering the banana producing areas of south Queensland, New South Wales and Western Australia. This complete prohibition was later relaxed after the extent of the infestation was determined and quarantine zones (50 kilometres) were established. From that time, fruit could then travel around the southern Queensland areas and through the western areas of New South Wales to Victoria, South Australia and Tasmania. After the Tully Banana Quarantine Area was established and disease levels (all leaf diseases) in the area were substantially reduced, fruit from outside the area was allowed into the Sydney market and fruit from the Tully Valley into the markets in the non banana states. It was not until February 2005, when New South Wales accepted that black Sigatoka had been eradicated, that all movement restrictions where removed.

However, because all previous outbreaks to date have been successfully eradicated (including the outbreak in the Tully Valley), the domestic trade impacts which arose from those outbreaks represents a best case scenario. If a black Sigatoka outbreak occurred again in the northern Queensland production area, there is no guarantee that eradication would be successful. As discussed in this section above, there were at least three factors that favoured eradication during the last outbreak, and which might not be repeated. In the event that eradication is unsuccessful, it is expected that New South Wales and Western Australia would maintain ongoing movement restrictions to protect their domestic banana industries, and these restrictions would be expected to continue for as long as the New South Wales and Western Australian growing areas remain free from the disease.

For the above reasons, the IRA Team has significantly underestimated the domestic trade effects of black Sigatoka. The Council considers that the domestic trade effects of a black Sigatoka outbreak which could not be eradicated (the most likely scenario) would be “highly significant” at the “regional level”.

(c) Environment

Increased fungicidal use

An outbreak of black Sigatoka in north Queensland would result in the need for new and different types of fungicides, applied more frequently (at least double the current frequency) in the Great Barrier Reef Catchment adjacent to the Great Barrier Reef World Heritage Area.

Part of the eradication program following the detection of black Sigatoka in the Tully Valley in 2001 involved the weekly application of fungicides, including systemics. The registration of one of the newer systemics (trifloxystrobin) was fast-tracked through the National Registration Authority. Because of the sensitivity of chemical use in catchments associated with the Great Barrier Reef, the Great Barrier Reef Marine Park Authority (GRMPA) was consulted. Approval for the increased numbers of fungicidal applications and use of alternative products was granted only for a 12 month period, on the condition that any extension was dependent on results of sampling for residue levels/contamination in the Tully and Murray River systems.

It is expected that if the frequency of fungicide application had to be dramatically increased as part of an eradication or control program for black Sigatoka in north Queensland, then additional and costly environmental protection measures would be required to be implemented before the fungicides would be permitted for use. The significant cost of implementing those additional environmental management measures would be directly borne by the Australian banana industry.

There is also a very real risk that additional fungicides and/or increased fungicide applications might not be permitted due to potential impacts on the Great Barrier Reef Marine Park Authority and World Heritage areas.

Impact on native bananas

For the reasons discussed in section 5.2.1 above, the Council believes that all three native banana species should be considered susceptible to black Sigatoka for the purposes of the import risk analysis.

M. acuminata subsp*. banksii* is the most common of the three listed species

Musa jackeyi is currently listed as rare, and has been nominated by K.R. McDonald as endangered under the *Nature Conservation Act 1992* (Qld). An extract from the nomination states:

> *Musa jackeyi has had significant reduction in preferred rainforest habitat on the coastal lowlands of the Wet Tropics bioregion with loss of rainforest habitat to agriculture and expanding rural residential and urbanisation. The species may be mistaken as feral populations of the cultivated banana (Musa acuminata) and killed to prevent banana diseases being harboured. Introduced diseases and insect pests can affect cultivated banana plantations as well as native banana species.*
>
> *Musa jackeyi is held in culture at the DPI Maroochy Research Station. It was formerly grown at South Johnstone Research Station but was removed when Black Sigatoka was identified in commercial plantations in the Tully area in 2002.*

As indicated in the nomination for *M. jackeyi*, native banana species are likely to be adversely affected by exotic diseases and eradication programs associated with a disease outbreak. The degree of threat is related to the severity of, the distance from, and the duration of an outbreak. Ascospores can travel many kilometres from sites of heavy infection, and the disease could be spread within the population from plant to plant. Feral bananas would also be a source of inoculum. It would be expected that if

black Sigatoka established in a commercial banana plantation, it would establish and spread in the population of native banana species.

The IRA Team has failed to properly consider the environmental impacts of black Sigatoka by failing to properly consider the significant potential impacts of the disease on nature conservation, biodiversity and heritage values of the Wet Tropics World Heritage Area.

Amenity

It is expected that most infected backyard banana plants would become unproductive, and ultimately be removed.

In addition to the loss of backyard banana plants and yield (discussed in section 5.6.1(a) above), the inability to grow backyard banana plants due to black Sigatoka would result in a significant loss of amenity for those people that currently grow backyard banana plants or might wish to grow backyard banana plants in the future.

Conclusion

For the reasons discussed above, the IRA Team has significantly underestimated the environmental impact of black Sigatoka.

The IRA Team considers that the environmental impact of a black Sigatoka outbreak in north Queensland would be “highly significant” at the “regional level”.

(d) Communities

The horticulture industry is the main driver of economic activity in the Johnstone and Cardwell Shires in north Queensland. The banana industry accounts for approximately 80 percent of the total horticulture outputs within that region.

The banana industry is labour intensive, and is a major source of employment in banana growing communities for both the local population and backpacker tourists. Importantly, the banana industry employs a high proportion of the unskilled workers (including a large number of indigenous workers) who would otherwise be unlikely to find employment in the region.

Bananas are an intensive crop that, in addition to labour, require a high level of farm inputs, direct service providers and associated support services that are utilised consistently throughout the year.

As a consequence, the banana industry has a major influence on the economic viability of the local business community including transport, farm input suppliers, cold chain logistics, accommodation, labour suppliers and service providers.

In the event of a black Sigatoka incursion, economic viability of banana growing communities would be significantly affected for a period that would depend upon the severity of the incursion, the duration of intrastate and interstate quarantine restrictions, and the success of eradication. A black Sigatoka incursion that cannot be eradicated would have a sustained and irreversible impact on the economic viability of banana growing communities.

Tropical Cyclone Larry demonstrates, at least to some extent, the significant economic impact that a black Sigatoka incursion that cannot be eradicated would have on banana

growing communities. However, the economic impacts of a black Sigatoka incursion that cannot be eradicated would be expected to be much more severe for banana growing communities than the economic impact of Tropical Cyclone Larry because:

- the economic impact of Tropical Cyclone Larry reduced over time;
- cyclone recovery activities had a stimulatory effect on those communities.

In the event of a black Sigatoka incursion that cannot be eradicated (and therefore needs to be actively controlled), the increased workload, higher labour and farm input costs and loss of security would undoubtedly result in contraction of the banana industry with many growers leaving the industry (and banana growing communities) for more economically secure and less stressful livelihoods. The impact on communities is not limited to a simple analysis of indirect economic factors. An incursion of black Sigatoka which is not able to be eradicated in a major banana growing region will have significant and irreversible social consequences for those communities with a high dependence on the banana industry.

The IRA Team has not properly considered the full range of economic and social consequences of black Sigatoka on communities, and as a result, has underestimated the indirect impact on communities.

5.6.3 Overall consequences for black Sigatoka

For the reasons discussed above, the IRA Team has underestimated the overall consequences of black Sigatoka.

Having regard to the methodology adopted by the IRA Team for determining the overall consequence of a pest, the Council considers that the IRA Team should have assessed the consequence of black Sigatoka as being “high”.

5.7 Risk management for black Sigatoka

5.7.1 Verification of the efficacy of proposed measures for black Sigatoka

In assessing the restricted risk for black Sigatoka, the IRA Team has assumed that each of the proposed measures will have a particular level of efficacy. However, the actual efficacy of those measures is unknown by the IRA Team.

The IRA Team has made it clear that “verification of the effectiveness of the measures is required” (see page 133 of Part B) and that “the efficacy of the proposed systems approach would need to be verified by commercial trials, including inspection of fruit samples for black Sigatoka infected leaf and floral material and testing the efficacy of post-harvest disinfestation treatment in reducing the level of contamination of banana clusters with viable conidia and ascospores following incubation at optimal conditions for symptom expression” (see page 142 of Part B).

While, for the reasons discussed below, the Council disputes the estimated efficacy and feasibility of the proposed risk management measures for black Sigatoka, if those measures are to be implemented, it is critical that the efficacy of each of the proposed measures is independently verified prior to the commencement of trade using scientifically and statistically appropriate experimental protocols.

In the case of black Sigatoka, the draft IRA Report states that verification is required for the following matters:

- in the case of the proposed areas of low pest prevalence measure, whether the proposed inspection methodology will achieve the required efficacy (page 267 of Part B);
- in the case of trash minimisation, the efficacy measures must be verified by inspection of at least 3000 processed clusters at the packing station for extraneous leaf or floral material (see page 270 of Part B)
- in the case of post harvest disinfestation treatments, DPI will be required to nominate a post-harvest disinfection treatment for approval by AQIS and provide data on its efficacy in reducing the level of contamination of banana clusters with conidia and ascospores of the black Sigatoka fungus (see page 271 of Part B).

Each experimental protocol for the verification of the risk management measures must be subject to stakeholder review and consultation.

5.7.2 Areas of low pest prevalence

(a) Applicability of using areas of low pest prevalence

The Council refers to its comments in section 4.8.2(a) above.

The principles discussed in that section in relation to Moko are equally applicable to black Sigatoka.

(b) No distinction between pest free areas, pest free places of production and pest free production sites.

The Council refers to its comments in section 4.8.2(b) above.

The principles discussed in that section in relation to Moko are equally applicable to black Sigatoka, particularly given that plants infected with black Sigatoka display subtle symptoms of the disease in the early stages of infection, and the presence of the pathogen may be masked by other foliar diseases.

(c) Establishment of pest prevalence

If the proposed area of low pest prevalence measure is to be implemented, the pest prevalence of the area of low pest prevalence must be demonstrated over a period of at least 13 weeks prior to the commencement of exports.

The pest prevalence must not be established by relying on historical pest prevalence data retained by Philippine growers (as has been suggested by representatives of Biosecurity Australia). It must only be established in reliance on pest surveys undertaken using an inspection methodology approved by AQIS.

(d) Minimum size of areas of low pest prevalence – biological considerations

The Council refers to its comments in section 4.8.2(e) above.

The principles discussed in that section in relation to Moko are equally applicable to black Sigatoka, particularly given that black Sigatoka is able to be transmitted over very long distances through the movement of spores.

(e) Requirement for buffer zones to be established

The Council refers to its comments in section 4.8.2(g) above.

The principles discussed in that section in relation to Moko are equally applicable to black Sigatoka, particularly given that black Sigatoka is able to be transmitted over very long distances through the movement of spores and will be present at a high prevalence in areas surrounding registered areas of low pest prevalence.

(f) Description of "case"

The draft IRA Report notes (at page 135 of Part B) that the "*IRA Team agrees that visible symptoms of black Sigatoka at all weekly inspections shall not exceed 1% (of stage 1 or stage 2 lesions) of the leaf area per leaf, or a leaf with more advanced disease symptoms, (necrosis) or one or more leaves showing both sets of symptoms.*"

By contrast, IRA Team notes (at page 267 of Part B) the that "*[a] case for recording black Sigatoka is defined as any mat with:*

- *a leaf with visible symptoms of black Sigatoka (stage 1 or stage 2 lesions) exceeding 1% of the leaf area per leaf;*
- *a leaf with more advanced disease symptoms (necrosis); or*
- *one or more leaves showing both sets of symptoms.*"

The description of the first criterion in the first of the above paragraphs is not consistent with the description of the first criterion in the second of the above paragraphs. We assume that the description of the first criterion in the second of the above paragraphs is the intended description of that criterion for the purposes of the draft IRA Report.

The third criterion (being "one or more leaves showing both sets of symptoms") in each of the above paragraphs is redundant, as a mat with leaves that satisfy the first or second criteria is already a 'case'.

(g) Pest surveys and sampling strategy

<u>Sampling strategy</u>

The area of low pest prevalence measure is wholly reliant upon pest surveys (by way of field inspections) to accurately assess the prevalence of black Sigatoka in the areas of low pest prevalence.

Accordingly, the sampling strategy for pest surveys must be designed to favour the detection of black Sigatoka if it is present in an area of low pest prevalence.

It is expected that there will be zones within the area of low pest prevalence in which the incidence of black Sigatoka will be higher. For example, it is expected that the incidence of black Sigatoka closer to the borders of areas of low pest prevalence because of the closer proximity to unmanaged hosts and in areas adjacent to sites of previous incursions.

The sampling strategy for pest surveys must be designed to favour detection of black Sigatoka in those zones in which it is expected to occur at a higher incidence, although it must also require random sampling across all parts of an area of low pest prevalence to detect unexpected events.

Given that the purpose of sampling is to assess the presence and prevalence of black Sigatoka in areas of low pest prevalence, it is not sensible to argue that targeted sampling is biased and will result in an overestimation of the prevalence of black Sigatoka in an area of low pest prevalence.

The Council believes that the proposed inspection methodology and sampling strategy must be subject to stakeholder review and consultation.

Inspection methodology

The draft IRA Report states (at page 267 of Part B) that "*BPI must provide details of the proposed inspection methodology including an analysis showing that the proposed methodology will achieve the required efficacy in advance of commencement of exports*".

Inspecting for stages one and two of black Sigatoka is a specialised procedure which must be performed by appropriately skilled inspectors. Lesions, particularly stage one, cannot be seen unless the observer is within a metre of the leaf, and uses transmitted light (through the leaf). This can only be done using a ladder. The inspection methodology must address practical issues including:

- the identification of each of the different stages of infection;
- the methodology for calculating the area of a leaf infected;
- the use of ladders and other aids to ensure the thorough inspection of plants.

In addition, the weekly pest inspection must occur prior to the weekly de-leafing activities carried out in the plantation.

Any inspection methodology must be subject to stakeholder review and consultation prior to approval by AQIS.

Statistical aspects

The draft IRA Report specifies (at page 267 of Part B) that "*[t]he level of pest prevalence for black Sigatoka would be demonstrated by weekly surveys with a case rate below 0.1% for a minimum of 3000 inspected mats*."

If an area of low pest prevalence measure is to be implemented for black Sigatoka, registered plantations must be immediately suspended from export to Australia if the pest prevalence exceeds the accepted level of low pest prevalence. The registered plantation must remain suspended at least until the area of low pest prevalence is re-established.

To have confidence that the case rate in a registered plantation is below 0.1 percent, a 95 percent credible interval for the case rate based on the observed number of cases, should have an upper bound of 0.1 percent or less. Because of the large sample size, and the small number of cases, a Jeffreys credible interval for a binomial proportion would be appropriate. 95 percent credible intervals for zero, one and two cases detected in 3000 mats are tabulated below.

Cases	Case Rate, Lower Bound	Case Rate, Upper Bound
0	1.64E-07	0.000837
1	3.6E-05	0.001557
2	0.000139	0.002137

95% Jeffreys credible intervals for a binomial proportion based on a sample of 3000 mats.

Observing zero cases in a sample of 3000 mats is therefore required to ensure that the case rate is below 0.1 percent, with 95 percent probability. Observing one or more cases in 3000 mats signals that the case rate cannot confidently be asserted to be below 0.1 percent, and should result in immediate suspension of the registered plantation unless the case rate can be shown to be less than 0.1 percent.

A statistically valid approach would be to increase the sample size substantially, by, for example, examining an additional 3000 mats. Then the total sample size would be 6000 mats. 95 percent credible intervals for 0,1 and 2 cases detected in 6000 mats are tabulated below.

Cases	Case Rate, Lower Bound	Case Rate, Upper Bound
0	8.18E-08	0.000419
1	1.8E-05	0.000779
2	6.93E-05	0.001069

95% Jeffreys credible intervals for a binomial proportion based on a sample of 6000 mats.

If no further cases were found, then one observed case in a sample of 6000 mats provides a 95 percent credible interval upper bound of 0.078 percent, and the case rate could be asserted to be below the 0.1 percent threshold with confidence.

However, if any further cases are found, then the registered plantation should be suspended for at least a 13 week period until the prescribed level of low pest prevalence can be re-established.

(h) Scenario A – contamination with infected plant material

The IRA Team has assumed that the area of low pest prevalence measure for black Sigatoka would reduce factor 4 of Imp2.

Leaf material

The IRA Team (at page 135 Part B) estimates that the proposed area of low pest prevalence measure will result in 90 to 99 percent of infected plant material containing no fertile pseudothecia. The stated reasons are firstly that the lesions will be less advanced and less intense (that is, a small amount of leaf tissue will be covered by disease symptoms) and secondly, that as a result of the heterothallic nature of the fungus, fewer pseudothecia will be produced.

Factor 4 relates to the proportion of already-infected plant material that contains fertile pseudothecia, not the proportion of leaf tissue that will be infected (which is already

taken into account under factor 3). In considering factor 4, the IRA Team should not have had regard to its assumption "*that a small amount of leaf area will be covered with disease symptoms*". The issue for consideration under factor 4 is whether **already-infected** leaf pieces that develop fertile perithecia will be reduced by the area of low pest prevalence measure, and to what extent.

The black Sigatoka pathogen is a heterothallic fungus, but as the inoculum is airborne and therefore mixed, lesions on any leaf would have originated from spores from a range of sources ensuring that pseudothecia and ascospores would be formed. Whilst there might be an effect from the area of low pest prevalence measure because the lesions in these leaf pieces are at an earlier stage of maturity, this effect would be small. As discussed in section 5.3.4(a)above, the time frame under consideration (assumed by the IRA Team as being four to eight weeks) is more than sufficient time for the pseudothecia in infected leaf material to mature.

For the reasons discussed above, the IRA Team has significantly overestimated the reduction in factor 4 for leaf tissue as a result of the area of low pest prevalence measure. The IRA Team should revise its assessment.

(i) Scenario B – spore contamination

The IRA Team assumes (at page 136 of Part B) that the level of black Sigatoka spores on export bananas harvested from an area of low pest prevalence will be reduced by at least 90 percent, compared with fruit harvested from plantation that are not subject to that risk management measure.

There are absolutely no data of any kind to support the assumption that management methods proposed for an area of low pest prevalence will achieve a 90 percent reduction in spores on the fruit.

The Council believes that the assumption is unreasonable, scientifically unsound and dangerous given that:

- airborne ascospores are transmitted many kilometres from heavily-infected plantings;
- the proposed area of low pest prevalence measure does not contemplate the use of buffer zones; and
- registered plantations will, in most cases, be located in close proximity to heavily infected cultivated, backyard or feral bananas.

The IRA Team acknowledges that the assumption is also dependent upon the cleaning of packing station and equipment to remove potential contamination from previous lots, and that only fruit sourced from areas of low pest prevalence is processed together. Again, it is unreasonable to assume that packing stations and equipment will, in practice under commercial conditions, be able to be cleaned sufficiently to materially decrease the level of spore contamination.

For the above reasons, the Council believes that the level of black Sigatoka on export bananas will not be reduced by at least 90 percent as assumed by the IRA Team.

In addition, the IRA Team has failed to consider contamination from leaf material which is removed during de-leafing activities. The removal of diseased leaf material during de-

leafing activities will not prevent the further development of lesions in the excised leaf material. Leaf tissue can remain green on the ground for at least a week under moist conditions. In wet weather when leaf dehydration would be low, stage 2 symptoms would progress to produce conidia and continue to develop to more advanced lesions. If the infection is at stage 3 at the time the leaf is excised, the lesions would continue to develop to the 'spot' stage (that is, with a dead centre, being stages 4,5 and 6) within a week and the fungus would continue to develop and form pseudothecia and ascospores, as at that point development is no longer dependent on live plant tissue. As a consequence leaves with symptoms from stage 2 onwards will continue to contribute to the spore load in the plantation if discarded within the plantation.

The development of black Sigatoka lesions in excised leaf material on the ground is confirmed by experience in Central America where manicuring is practised (stage 3 and above lesions). Samples of leaf tissue with stage 5/6 lesions are routinely collected for fungicide sensitivity testing from diseased leaf tissue which is discarded on the ground during de-leafing activities.

Although removal of diseased leaf material from the plantation is contemplated (at page 137 of Part B) as a component of the trash minimisation measure, the removal of diseased material is not specified as a component of the trash minimisation measure in Chapter 20 of the draft IRA Report.

If diseased leaf tissue removed during de-leafing activities is not required to be removed from the plantation, then it is absolutely certain that the level of black Sigatoka on export bananas will not be reduced by at least 90 percent as assumed by the IRA Team.

5.7.3 Trash minimisation

(a) Scenario A – contamination with infected plant material

Leaf material

The IRA Team has assumed (at page 137 of Part B) that the proposed trash minimisation measure for black Sigatoka would reduce factor 1 of Imp2 by between one-fifth and one-quarter of the unrestricted volume.

That IRA Team has no data or evidence to support that conclusion.

The plantation and packing station procedures which the IRA Team proposes be implemented as part of the trash minimisation procedures (other than the removal of pruned leaves from a plantation) are apparently already largely routine practices in the Philippines, at least according to statements made to L Collins and I Muirhead on a study tour of Philippine plantations in 2000 and statements contained in the following documents:

- Answers to RAP's list of questions [with answers to clarificatory questions raised by RAP under PBPM 2002/08];
- Report of Visit of Chairs of Technical Working Groups to the Philippines in August 2001; and

- Philippine bananas Import Risk Analysis: Outcomes of a meeting between the Philippines, Biosecurity Australia, the risk analysis panel and technical working groups.

The recent study by Peterson *et al* (2006) of cartons of Philippines bananas imported into New Zealand demonstrates that the current routine plantation and packing station procedures are not effective in preventing trash from entering cartons on clusters. The additional benefits conferred by the enforced application of largely existing measures is likely to be marginal at best.

The Council strongly disputes the IRA Team's contention that the implementation of practices and procedures which are already largely routine in the Philippines would reduce the unrestricted value of factor 1 of Imp2 for leaf material to the significant extent assumed by the IRA Team. The IRA Team should revise its assessment.

Floral material

The IRA Team has assumed (at page 137 of Part B) that the proposed trash minimisation measure for black Sigatoka would reduce factors 1 and 2 of Imp2 for floral material.

However, for the reasons discussed in relation to leaf material above, the Council strongly disputes the IRA Team's contention that the implementation of practices and procedures which are already largely routine in the Philippines would reduce the unrestricted value of factors 1 and 2 of Imp2 for floral material to the significant extent assumed by the IRA Team. The IRA Team should revise its assessment.

(b) Scenario B – spore contamination

The IRA Team has assumed (at page 138 of Part B) that "*[t]he level of black Sigatoka spores on export bananas with lower levels of leaf and floral material will be reduced by 80-90%*".

The Council notes that the proposed trash minimisation measures are already largely routine practices in the Philippines (as discussed above) and are intended to reduce the level of trash which might contaminate fruit. They will have limited impact on the level of spore contamination of fruit and as such, could not possibly reduce the level of spore contamination on export bananas to the extent assumed by the IRA Team.

It appears that the IRA Team may have made an error in copying and amending text in relation to the proposed area of low pest prevalence measure from page 138 of Part B. Alternatively, the IRA Team may have made an error in assessing the impact of the proposed trash minimisation measure assuming the existence of the proposed area of low pest prevalence measure.

In any event, IRA Team has grossly overestimated any possible reduction in the unrestricted value for factor 3 of the 'Exposure-transfer' assessment which might result from the implementation of the proposed trash minimisation measure.

(c) Verification inspections

The draft IRA Report specifies (at page 137 of Part B) that "*[t]he efficacy of trash minimisation measures …. could be verified by inspection at the packing station. Visual inspection is advised to be undertaken using a 3000 unit (cluster) inspection (to provide*

a 95% confidence level that no more than 0.1% of the clusters are contaminated with infected plant material)."

The draft IRA Report does not specify how regularly the verification inspection is to occur. To verify compliance with the trash minimisation measure on an ongoing basis, the Council contends that the verification inspection should be conducted on samples selected at random from each lot (as described on page 217 of Part B).

To have 95 percent confidence that the contamination rate in a 3000 cluster sample is below 0.1 percent, because of the large sample size, and the small number of cases, a Jeffreys cretible interval for a binomial proportion would be appropriate. 95 percent credible intervals for 0, 1 and 2 pieces of contaminating material detected in 3000 clusters are tabulated below.

No. of pieces of contaminating material	Contamination Rate, Lower Bound	Contamination Rate, Upper Bound
0	1.64E-07	0.000837
1	3.6E-05	0.001557
2	0.000139	0.002137

95% Jeffreys credible intervals for a binomial proportion based on a sample of 3000 clusters.

Observing zero pieces of contaminating material in a sample of 3000 clusters is therefore required to ensure that the contamination rate is below 0.1 percent, with 95 percent probability. Observing one or more pieces of contaminating material in 3000 clusters signals that the contamination rate cannot confidently be asserted to be below 0.1 percent, and should result in immediate suspension of the registered plantation until the case rate can be shown to be less than 0.1 percent.

A statistically valid approach would be to increase the sample size substantially, by, for example, examining an additional 3000 clusters. Then the total sample size would be 6000 clusters. 95 percent credible intervals for zero, one and two pieces of contaminating material detected in 6000 clusters are tabulated below.

No. of pieces of contaminating material	Contamination Rate, Lower Bound	Contamination Rate, Upper Bound
0	8.18E-08	0.000419
1	1.8E-05	0.000779
2	6.93E-05	0.001069

95% Jeffreys credible intervals for a binomial proportion based on a sample of 6000 clusters.

If no further pieces of contaminating material are found, then one observed piece of contaminating material in a sample of 6000 clusters provides a 95 percent credible

interval upper bound of 0.078 percent, and the contamination rate could be asserted to be below the 0.1 percent threshold with confidence.

However, if any further pieces of contaminating material are found, the registered plantation must be suspended for at least a 13 week period.

5.7.4 Post-harvest treatment

(a) Difficulty with post-harvest treatment in commercial practice

The IRA Team has assumed (at page 138 of Part B) that "*[t]he level of contamination of banana fruit with black Sigatoka spores could be reduced by at least 90% by a post-harvest disinfestation treatment with an effective fungicide*".

The IRA Team's assumption appears to be based on research by Gasparotto (2000). However, the research conducted by Gasparotto (2000) did not relate to commercial practice, and provides only an indication that fungicides might be effective.

In commercial practice, the efficacy of a fungicide depends on many factors, the most important of which are dose rate, exposure time, degree of coverage of the fruit's surface, presence of interfering substances such as banana sap and dirt, and so on. There is also the issue of "stripping", the process by which the fungicide concentration is reduced by the passage of fruit at a rate exceeding the reduction in the dip volume.

Fungicides applied post-harvest to bananas are generally used to reduce the incidence of crown rot, and are most often applied to the crown surfaces using as spray system as trays proceed along the packing line. However, that method of application would not give sufficient coverage to reduce the level of contamination by ascospores of the black Sigatoka pathogen.

(b) Verification of assumed efficacy of proposed measure

The draft IRA states (at pages 270-271 of Part B) that "*BPI will be required to nominate a post-harvest disinfection treatment for approval by AQIS and provide data on its efficacy in reducing the level of contamination of banana clusters with conidia and ascospores of the black Sigatoka fungus*". This should also include endophytic infections that are established within the skin of the fruit.

The IRA Team has required BPI to demonstrate the efficacy of chlorine treatment under practical field application to reduce the risk of new fruit infections in wash water by 90 percent for Moko.

The IRA Team acknowledges (at page 138 of Part B) that "*[c]ommercial scale experiments would be required to verify efficacy of a nominated fungicide against black Sigatoka conidia and ascospores present on banana fruit harvested from naturally infected plants in commercial plantations*".

Given that the IRA Team acknowledges the need for demonstrate the efficacy of the nominated fungicidal treatment, the IRA Team should require BPI to demonstrate the efficacy of the fungicidal treatment under practical field application to reduce the risk of new fruit infections in wash water by 90 percent for black Sigatoka.

The Council believes that the following high-level principles will need to be considered when preparing protocols and undertaking experiments to demonstrate the efficacy of the proposed post-harvest treatment measure:

1 The type of disinfestation treatment must be nominated in advance by BPI.

2 The efficacy of the treatment must be demonstrated under actual packing conditions, operating at full capacity.

3 It would not be sufficient to demonstrate that fungicidal solutions kill spores *in vitro*, or on artificial surfaces, or on small numbers of fruit treated under laboratory or other artificial conditions. Such tests are useful only for providing a guide to the possible efficacy in commercial practice.

4 The test must involve exposure of actual conidia, ascospores and endophytic infections of black Sigatoka present from naturally infected plants, and the measurement of viable spore numbers and endophytic infections before and after treatment. This requires the use of appropriate culturing, molecular or microscopic methods.

5 The test must be conducted in such a way that the results can be statistically analysed for significance between treatments at a 95 percent level of confidence, or greater.

6 If the test involves treatment of water in washing and flotation tanks, the following issues need to be addressed:

- the likely effect of stripping over the time period of a typical packing session; and
- the effects of contaminants including banana sap and soil and organic matter.

6 Freckle

6.1 Introduction

Most of the biological information relied upon by the IRA Team for the risk assessment for freckle was drawn from published literature on the life cycle, epidemiology, infection and control of the freckle pathogen. The primary focus for most of that research was an understanding of the pathogen and the disease in subsistence and commercial production, to assist disease management or control. Very little research is presented that is specific to the survival of the pathogen throughout the importation, distribution and exposure scenarios. As a result, many of the model input values determined throughout the risk assessment are based on untested assumptions. The overall conclusions, therefore, are only as reliable as the validity of those assumptions assuming the risk assessment methodology is otherwise valid.

6.2 Biology

6.2.1 Dispersal

(a) Infected leaf material risk scenario

The IRA Team acknowledges that infected leaves may lead to the spread of freckle but assumes (at page 145 of Part B) that "*in the context of this analysis, the spread of freckle on infected plant material is relevant when estimating the probability of spread after establishment has occurred, but not when estimating the probabilities of importation, distribution and establishment.*"

This is despite the IRA Team assuming in the previous draft IRA Report (2004) that leaf trash associated with fruit may carry viable perithecia or pycnidia.

The IRA Team has rejected the infected leaf material risk scenario out of hand without providing any scientifically defensible justification for its (revised) assumption that it is not a risk scenario for freckle.

The Council strongly disputes the IRA Team's rejection of that risk scenario.

Leaf material is known to be present in cartons of Philippines bananas exported to New Zealand (Peterson *et al* 2006, Peasley 2005). As acknowledged by the IRA Team (at page 145 of Part B), infected leaves are known to transmit *G. musae.*

The IRA Team has assessed that pycnidia of *G. musae* on fruit are likely to survive during the entire packing, transport and distribution network. There is no reason why pycnidia on leaf fragments would be any different.

Therefore, it is scientifically unsound and dangerous for the IRA Team not to consider the infected leaf material risk scenario for freckle.

It is also inconsistent for the IRA Team to assesses the risk scenario involving infected leaf material for the black Sigatoka pathogen but ignore an analogous risk scenario for freckle.

The IRA Team's failure to assess the infected leaf material risk scenario for freckle has resulted in the IRA Team significantly underestimating the likelihood of the entry, establishment and spread, and therefore the risk, of freckle.

(b) Role of ascomata and ascospores

The IRA Team assumed (at page 145 of Part B) that the ascospore stage of *G. musae* is not relevant to the importation pathway for Philippine bananas, apparently on the basis that the teleomorph has not been observed on fruit in Taiwan or at all in the Philippines.

The absence of the teleomorph on leaves in the Philippines is an untested assumption. The IRA team's logic appears to be based on the observation that the ascal state is present in Taiwan, which has a cooler climate, and that therefore the warmer Philippines temperatures are unsuitable for its development. This is despite the IRA Team acknowledging (at page 74 of Part C) that the situation is unclear. The lack of records of the ascal stage in the Philippines does not constitute proof of its absence.

Detailed studies such as those conducted in Taiwan (Cheung 1984, for example) have not been conducted in the Philippines, presumably because Philippine scientists have had no pressing reason to search for the sexual state.

However, there is no obvious reason why the sexual state would not develop at least in the cooler areas of the Philippines (such as Bukidnon), or in particular seasons.

If the development of the sexual state is temperature dependent, there is no reason why it would not develop in leaf material or fruit during transport to Australia or storage in Australia.

The IRA Team's dismissal of the ascospore stage of *G. musae* has resulted in the IRA Team significantly underestimating the likelihood of the entry, establishment and spread, and therefore the risk, of freckle.

(c) Secondary dispersal distance

The IRA Team acknowledges (at page 145 of Part B) that the secondary dispersal distance of conidia of the freckle pathogen is not known, but assumes a secondary dispersal distance of two metres.

The Council has disputed the use of a two metre secondary dispersal distance for conidia of the black Sigatoka pathogen on the basis that relevant information on dispersal distance, the importance of wind-driven rain and the potential for significant spread by insects have not been taken into account. The Council disputes the two metre secondary dispersal distance for conidia of the freckle pathogen for the same reasons.

The Council believes that the IRA Team has significantly underestimated the secondary dispersal distance for conidia of the freckle pathogen.

6.2.2 Risk scenarios

(a) Development of pycnidia from conidia after harvest

The IRA Team assumes (at page 146 of Part B) that "*no more than 0.01% of fruit contaminated with conidia post-harvest will develop pycnidia before banana waste decomposes.*"

The IRA Team has not presented any information to support that assumption.

For the reasons discussed in section 6.3.3 below, the Council considers that 0.01 percent is an underestimate of the number of fruit that could develop pycnidia following post-harvest infection.

(b) Contaminated leaf pathway not considered

For the reasons provided under section 6.2.1(a) above, the IRA Team's failure to assess the infected leaf material risk scenario for freckle has resulted in the IRA Team significantly underestimating the likelihood of the entry, establishment and spread, and therefore the risk, of freckle.

6.3 Importation

6.3.1 Imp2 – Incidence of freckle within an infected plantation

The IRA Team has assessed (at page 147 of Part B) the proportion of clusters coming from infected plantations that are actually infected with freckle at the time of harvest as being within the range of one percent to 30 percent.

The Council asserts that the upper value of this range should be higher than 30 percent, because the figures provided by Allen (2006), which are the only figures available, show that 100 percent of clusters in one of the four lots inspected have freckle lesions, with between one and 23 lesions per finger.

The IRA Team has noted that it is "*significant that two* [of four] *lots* [inspected by Allen (2006)] *were apparently free of disease*". The Council asserts that, in terms of risk, it is the high incidence observed by Allen (2006) in one of four lots examined (25 percent) that this is significant.

However, it is acknowledged by the IRA Team (at page 146 of Part B) that symptom development may occur in fruit after arrival and distribution in Australia. For that reason, visual inspection in retail outlets cannot provide evidence of its absence of infection, it can only provide evidence of infection as it is conceivable that symptoms had not yet developed in those lots apparently disease free. As such, the IRA Team should not have placed such significance on the two of four lots that were apparently disease free.

The Council believes that the IRA Team should revise its assessment of Imp2 for freckle.

6.3.2 Imp3 – Contamination by freckle during harvest and transport

For the reasons discussed in section 5.2.3(b) for black Sigatoka, fruit may be contaminated with infected plant material during harvest and transport.

6.3.3 Imp5 – Contamination during packing

The IRA Team has assumed (at page 148 of Part B) that clusters developing pycnidia as a result of post-harvest infection would not exceed 0.01 percent, on the basis "*that it is very unlikely that any pycnidia will develop on banana waste infected in the post-harvest period*".

This is an untested assumption. Pycnidia with mature conidia develop after three weeks from inoculation (Meredith 1968). Those of *G. bidwillii*, a related fungus that the IRA Team has relied upon as a guide to the biological behaviour of *G. musae*, develop in 12 days at 26.5°C and 19 days at 15°C. The period from packing to consumption would be more than 21 days. This comprises packing, transport to wharves, loading of ships (one to two days at 25 to 30°C); shipping (five to 10 days at 13 to14°C); unloading, inspection in Australia (one to three days at 14 to 18°C), ripening (five to 10 days at 17 to 22°C), retail outlets (four to six days at 18 to 24°C) and household (2 to 5 days at 23 to 27°C) and waste disposal (at least 10 days at 23 to 30°C). There is adequate time within the biologically active temperature range for the pycnidia to develop between harvest and disposal.

In addition, clusters would be subject to contamination from infected plant material in the packing station from water used to hose the bunches "*to remove dirt, leaf trash etc*" as well as from infected plant material in contaminated flotation tanks.

The Council believes that the IRA Team has significantly underestimated Imp5, and should revise its assessment of Imp5.

6.4 Distribution

6.4.1 The number of infected clusters at each waste point

As discussed in section 6.3.1 above, the Council asserts that the number of infected clusters is an underestimate, and is based on untested assumptions.

The only known data on the incidence of freckle in Philippine bananas was provided by Allen (2006), who reported up to 100 percent infection of clusters in one of four lots examined in a supermarket. The full figures are not disclosed in the draft IRA Report, but the average appears to be in the vicinity of 27 percent. The total number of infected clusters listed in Table 11.1 is 9.8 million or less than 10 percent of the annual volume of trade estimated by the IRA Team.

If 27 percent of fruit is infected (and that is likely to be an underestimate), about 27 million clusters would be expected to be infected each year (assuming an annual volume of trade of 105,000 tonnes).

6.5 Exposure – proximity considerations

For the reason discussed in section 6.2.1(c) above, the Council believes that the IRA Team has significantly underestimated the secondary dispersal distance for conidia of the freckle pathogen.

6.5.1 Proportion of waste near each exposure group

For the reason discussed in section 6.2.1(c) above, the Council believes that the IRA Team has significantly underestimated the secondary dispersal distance for conidia of the freckle pathogen.

6.6 Consequences

6.6.1 Direct impact

(a) Plant life or health

The Council notes that the direct impact of freckle on plant life or health is to be considered in the context of existing pest management practices.

Freckle damages the fruit skin, downgrades fruit quality and reduces market acceptance. It is expected that freckle will be more severe in the cooler subtropical areas such as southern Queensland and northern New South Wales.

In those areas, only four to six fungicidal sprays are currently applied at monthly intervals for foliar diseases and, based on the experience in Taiwan, these would not be efficacious at controlling freckle. Without significant increases in the numbers of fungicidal sprays and de-leafing, freckle would spread unchecked and the direct effect would be severe, not only in hot spots but across the entire region.

The effect of freckle on the health of native banana species bananas has been dismissed by the IRA Team, apparently on the basis that freckle does not kill infected plants. As discussed in sections 5.2.1 and 5.6.2(c) for black Sigatoka, two of the three species are rare or endangered, and the third, *M. acuminata* subsp. *banksii*, occurs close to commercial banana plantations in north Queensland. *M. acuminata* subsp. *banksii* is susceptible to freckle and there is no reason to assume that the other two species would be different.

Even though freckle may not kill plants outright, continual loss of leaves during periods conducive to disease development would reduce the fitness of native banana populations and would provide a selection pressure that could, over a period of time, could endanger those species. The Council notes that native banana species contribute to the world heritage values of the Wet Tropics World Heritage Area.

The Council believes that the likely impact in terms of direct impact on plant life or heath of freckle would be “significant” at the “regional level”.

6.6.2 Indirect impact

(a) Control or eradication

The Council contends that the cost of control and eradication has been underestimated with respect to the subtropical banana industry.

The following points were not given sufficient weight by the IRA Team:

- In subtropical growing areas of Australia, only four to six sprays are currently applied each year and ‘green’ de-leafing (removal of disease leaves) is not practiced. In subtropical growing areas, de-leafing refers to the removal of dead hanging leaves.

- A spray program to control freckle in the subtropical growing areas would be expected to require sprays at two to three week intervals during moist periods. Thus a two to three fold increase in the number of sprays to 10 to 12 per year would be required to control freckle effectively and to prevent significant downgrading of the fruit.
- 'Green' de-leafing would be required at least four to six times each year.
- Cost increases for a control program would be likely to exceed $1,200 per hectare per year.
- Based on the current economics of banana production, an increase in production costs of $1,200 per hectare per year would make banana production in the subtropics non-viable. A collapse of the subtropical banana industry would result in the loss of livelihood for approximately 1,200 growers (ABGC 2005) and approximately 2,500 jobs.

The Council notes that the application of additional fungicidal sprays would be a contentious issue in northern New South Wales where, in many instances, population areas are in close proximity to banana plantations.

The Council believes that the likely impact in terms of the cost of eradication and control for freckle would be "significant" at a "regional" level.

(b) Communities

The Council contends that the effect on the communities has been underestimated, particularly with respect to the subtropical banana industry.

The added production costs and reductions in fruit quality as a result of freckle could result in the demise of the subtropical banana industry in south east Queensland and north east New South Wales. There are 1,200 growers in subtropical growing areas and an estimated 2,500 banana workers. Much of the land used by plantations is very steep and unsuitable for any other forms of agriculture.

The impact of freckle on communities (and in particular, its impact on the subtropical banana industry) would be "significant" at the "regional" level.

6.6.3 Overall consequences for freckle

For the reasons discussed above, the IRA Team has underestimated the overall consequence of freckle.

Having regard to the rules for determining the consequences of freckle in section 6.1.4 of Part B, the Council considers that the IRA Team should have assessed the consequences of freckle as "moderate".

6.7 Unrestricted risk

For the reasons discussed above, the IRA Team has underestimated the unrestricted risk of the entry, establishment and spread of freckle.

6.8 Risk management for freckle

6.8.1 Verification of the efficacy of proposed measures for freckle

In assessing the restricted risk for freckle, the IRA Team has assumed that each of the proposed measures will have a particular level of efficacy. However, the efficacy of each of those individual measures being proposed is unknown by the IRA Team.

The IRA Team has made it clear (at page 165 of Part B) that "*the effectiveness of the proposed systems approach would need to be verified by commercial trials, including inspection of fruit samples for freckle following incubation at optimal conditions for symptom expression*".

For the reasons discussed below, the Council disputes the estimated efficacy and feasibility of the proposed risk management measures for freckle, but if those measures are to be implemented, it is critical that the efficacy of each of the proposed measures is independently verified prior to the commencement of trade using scientifically and statistically appropriate experimental protocols.

- In the case of freckle, the draft IRA Report states that verification is required for the following matters:
- in the case of the proposed areas of low pest prevalence measure, whether the proposed inspection methodology will achieve the required efficacy (page 267 of Part B);
- in the case of the proposed fungicide bunch sprays measure, the efficacy of the proposed spray schedule must be demonstrated (see page 268 of Part B);
- in the case of the systems approach, the efficacy must be verified by commercial trials before commencement of exports that would include inspection of fruit samples for freckle disease following incubation at optimal conditions for symptom expression (see page 268 of Part B)

Each experimental protocol for the verification of the risk management measures must be subject to stakeholder review and consultation.

6.8.2 Areas of low pest prevalence measure

(a) Applicability of using areas of low pest prevalence

The Council refers to its comments in section 4.8.2(a) above.

The principles discussed in that section in relation to the proposed area of low pest prevalence measure for Moko are equally applicable to the proposed area of low pest prevalence measure for freckle.

(b) No distinction between pest free areas, pest free places of production and pest free production sites.

The Council refers to its comments in section 4.8.2(b) above for Moko.

The principles discussed in that section in relation to area freedom measures for Moko are equally applicable to area freedom measures for freckle, particularly given that plants infected with freckle display subtle symptoms of the disease in the early stages of infection, and the presence of the pathogen may be masked by other foliar diseases.

(c) Establishment of pest prevalence

If the proposed area of low pest prevalence measure is to be implemented, the pest prevalence of the area of low pest prevalence must be demonstrated over a period of at least 13 weeks prior to the commencement of exports.

The pest prevalence must not be established by relying on historical pest prevalence data retained by Philippine growers (as has been suggested by representatives of Biosecurity Australia). It must only be established in reliance on pest surveys undertaken using an inspection methodology approved by AQIS.

(d) Minimum size of areas of low pest prevalence – biological considerations

The Council refers to its comments in section 4.8.2(e) above for Moko.

The principles discussed in that section in relation to the minimum size of areas of low pest prevalence for Moko are equally applicable to the minimum size of areas of low pest prevalence for freckle, particularly given that freckle is able to be transmitted over very long distances through the movement of spores.

(e) Requirement for buffer zones to be established

The Council refers to its comments in section 4.8.2(g) above.

The principles discussed in that section in relation to the establishment of buffer zones for Moko and black Sigatoka are equally applicable to the establishment of buffer zones for freckle, particularly given that freckle is able to be transmitted over very long distances through the movement of spores and will be present at a high prevalence in areas surrounding areas of low pest prevalence.

(f) Pest surveys and sampling strategy

<u>Sampling strategy</u>

The area of low pest prevalence measure is wholly reliant upon pest surveys (by way of field inspections) to accurately assess the prevalence of freckle in the areas of low pest prevalence.

Accordingly, the sampling strategy for pest surveys must be designed to favour the detection of freckle if it is present in an area of low pest prevalence.

It expected that there will be zones within the area of low pest prevalence at which the incidence of freckle will be higher. For example, it is expected that the incidence of freckle will be higher closer to the boarders of areas of low pest prevalence because of the closer proximity to unmanaged hosts and in areas adjacent to previous incursions.

The sampling strategy for pest surveys must be designed to favour detection of freckle in those zones in which it is expected to occur at a higher incidence, although it must also require random sampling across all parts of an area of low pest prevalence to detect unexpected events.

Given that the purpose of sampling is to assess the presence and prevalence of freckle in areas of low pest prevalence, it is not sensible to argue that targeted sampling is biased and will result in an overestimation of the prevalence of freckle in an area of low pest prevalence.

The Council believes that the proposed inspection methodology and sampling strategy must be subject to stakeholder review and consultation.

Inspection methodology

The draft IRA Report states (at page 267 of Part B) that "*BPI must provide details of the proposed inspection methodology including an analysis showing that the proposed methodology will achieve the required efficacy in advance of commencement of exports*".

Inspecting for infection of freckle is a specialised procedure which must be performed by appropriately skilled inspectors. Early lesions cannot be seen unless the observer is within a metre of the leaf. This can only be done using a ladder. The inspection methodology must address practical issues including:

- the identification of the different symptoms of infection;
- the use of ladders and other aids to ensure the thorough inspection of plants.

In addition, the weekly pest inspection must occur prior to the weekly de-leafing activities carried out in the plantation.

Any inspection methodology must be subject to stakeholder review and consultation prior to approval by AQIS.

Statistical aspects

The draft IRA Report specifies (at page 267 of Part B) that "*the level of the pest prevalence for freckle would be demonstrated by weekly surveys with a case rate below 0.1% for a minimum of 3000 inspected mats*."

If an area of low pest prevalence measure is to be implemented for freckle, registered plantations must be immediately suspended from export to Australia if the pest prevalence exceeds the accepted level of low pest prevalence. The registered plantation must remain suspended at least until the area of low pest prevalence is re-established.

To have confidence that the case rate in a registered plantation is below 0.1 percent, a 95 percent confidence interval for the case rate based on the observed number of cases should have an upper bound of 0.1 percent or less. Because of the large sample size, and the small number of cases, a Jeffreys credible interval for a binomial proportion would be appropriate. 95 percent credible intervals for zero, one and two detected in 3000 mats are tabulated below.

Cases	Case Rate, Lower Bound	Case Rate, Upper Bound
0	1.64E-07	0.000837
1	3.6E-05	0.001557
2	0.000139	0.002137

95% Jeffreys credible intervals for a binomial proportion based on a sample of 3000 mats.

Observing zero cases in a sample of 3000 mats is therefore required to ensure that the case rate is below 0.1 percent, with 95 percent probability. Observing one or more cases in 3000 mats signals that the case rate cannot confidently be asserted to be below 0.1 percent, and should result in immediate suspension of the registered plantation until the case rate can be shown to be less than 0.1 percent.

A statistically valid approach would be to increase the sample size substantially, by, for example, examining an additional 3000 mats. Then the total sample size would be 6000 mats. 95 percent credible intervals for zero, one and two cases detected in 6000 mats are tabulated below.

Cases	Case Rate, Lower Bound	Case Rate, Upper Bound
0	8.18E-08	0.000419
1	1.8E-05	0.000779
2	6.93E-05	0.001069

95% Jeffreys credible intervals for a binomial proportion based on a sample of 6000 mats

If no further cases were found, then one observed case in a sample of 6000 mats provides a 95 percent credible interval with an upper bound of 0.078 percent, and the case rate could be asserted to be below the 0.1 percent threshold with confidence.

However, if any further cases are found, then the registered plantation should be suspended for at least a 13 week period until the prescribed low pest prevalence is re-established.

(g) Management practices

The IRA Team states (on page 161 of Part B) that "*[i]ndividual banana plantations in the Philippines can be maintained virtually free from freckle disease symptoms through the use of various management practices including*" the specified management practices.

If that statement was true, then the export plantations in the Philippines would be virtually free of the disease because all of the specified management practices are already routinely used in export plantations to control foliar diseases such as black Sigatoka and freckle. The observation that freckle is widespread in the Philippines and the detection of freckle by Allen (2006) in fruit exported to New Zealand evidences that those plantations in the Philippines cannot be maintained virtually free of the disease by those management practices.

6.8.3 Fungicide bunch sprays

(a) Verification of efficacy of proposed measure

The IRA Team has assumed (at page 163 of Part B) that the proposed bunch sprays measure would reduce:

- Imp2 by 70 to 90 percent; and
- Imp5 by one tenth.

The IRA Team has no basis for assuming that the proposed fungicide bunch sprays measure will achieve that degree of efficacy.

The IRA Team states (at page 268 of Part B) that "*[b]efore exports can begin, BPI must nominate a spray schedule and provide data on its efficacy in reducing the level of freckle infection on banana bunches. The effectiveness of the proposed systems approach must be verified by commercial trials before commencement of exports that would include inspection of fruit samples for freckle disease following incubation at optimal conditions for symptom expression*".

Biosecurity Australia and AQIS should adopt the following principles when assessing protocols for, and results of, any experimental work undertaken to demonstrate the efficacy of the proposed bunch sprays measure:

1 The experimental protocol must be designed to demonstrate that the proposed fungicide bunch sprays will reduce the proportion of infected clusters by 70-90 percent.

2 The disinfestation treatment nominated by BPI must be a complete protocol including the chemicals to be used, adjuvants if necessary, frequency of application and method of application.

3 The efficacy of the program must be demonstrated under field conditions. It must demonstrate that not only are conidia prevented from germinating and establishing infections, but also the chemicals must be sufficiently systemic to penetrate the skin of the banana fruit and destroy any infections that may have developed before the sprays are applied.

4 The test must demonstrate the "kick-back" properties of the chemicals against infections that have established in the fruit between applications.

5 The efficacy tests need to be conducted under conditions that ensure sufficient spores as well as infection are present. This could be achieved by applying spores to all parts of bunches and holding the bunches under conditions conducive to the establishment of infection (moist periods or inside a non-perforated bunch cover) and applying the sprays at set periods (up to 3-4 weeks) after the spores are applied. The inoculated and sprayed bunches would need to be allowed to develop as per commercial practices. After harvest, the bunches need to be held under appropriate conditions to maximise the opportunity for conidia to infect, and for prior infections into detectable freckle lesions.

6 The tests must be conducted as fully replicated trials and the results must be statistically analysed for significance between treatments at at least the 95 percent confidence level.

7 The method of application must include a system to apply the spray under the bunch covers to ensure all fruit surfaces including the areas where the fingers touch are treated. In Central America the ends of the bunch covers are tied to prevent the wind lifting the covers and exposing the bunches to wind borne contamination by leaf trash. The system to be used in the Philippines must also prevent the bunch covers lifting and exposing the bunch covers to air

borne contamination but must also allow access to the bunches each two to three weeks to apply the sprays to all parts of the bunches.

(b) Feasibly of proposed measure

The IRA Team's statement (at page 163 of Part B) that "*….the principles and practices of application are well understood*" is incorrect.

Presently, bunches are sprayed three to four times at two to three day intervals before bunches are covered (BPI 2002). No attempt is made to spray bunches once covered.

The Council believes that there will be significant practical difficulties, under commercial conditions, associated with applying fungicide sprays evenly over all of the fruit surfaces of covered bunches.

7 Arthropods

7.1 General

The Council comments below on the IRA Team's consequence assessment and proposed risk management measures for:

- armoured scales;
- mealybugs; and
- spider mites.

7.2 Armoured scales

7.2.1 Consequences

(a) Direct impact

Plant life or health

The IRA Team assessed the impact of armoured scales on plant life or health as "significant" at the "district" level.

Armoured scales have an extremely wide host range affecting commercial horticultural crops and ornamental plants. They also threaten important genera of native plants including *Musa*, *Acacia, Ficus, Grevillea* and *Eucalyptus* which are not only widely distributed but also an integral part of the unique Australian landscape. These genera are known hosts or are recorded hosts in the families to which they belong.

It not possible to reconcile the IRA Team's assessment of "significant" at a "district" level (which means that it would be "unlikely to be discernable" at a "national" level) with the reasons stated by the IRA Team for that assessment.

Given that potential hosts are widely distributed throughout Australia and that the effects of armoured scales would be expected to be severe on a range of hosts, the Council believes that the IRA Team should have assessed the direct impacts of armoured scales on plant life and health as "significant" at least at the "regional" level.

Any other aspects of the environment

The IRA Team assessed that the impact of armoured scales on "other aspects of the environment" would be "significant" at the "district" level.

However, the IRA Team has failed to consider that the impact of armoured scales on susceptible native plant species (referred to above) would also consequently adversely impact on the ecosystems in which those plant species exist.

The Council believes that the IRA Team should have assessed the direct impacts of armoured scales on other aspects of the environment as "significant" at least at the "regional" level.

(b) Overall consequences

The Council concludes that, as a result of the impacts that should be assigned to the criteria listed above, the overall consequences of the entry, establishment and spread of armoured scales should be at least “moderate”.

7.2.2 Unrestricted risk

Because the IRA Team significantly underestimated the consequences of armoured scales, the Council considers that the IRA Team should have assessed the unrestricted risk of armoured scales as being moderate.

7.2.3 Risk management

The IRA Team has recommended a pre-clearance inspection and corrective action measure for armoured scales or, alternatively, an on-arrival visual inspection and corrective action measure.

The IRA Team has stated that inspected samples must be free from armoured scales. The Council assumes that this must be taken to mean free from all armoured scales (whether live or dead) as the presence of dead armoured scales suggests a high likelihood that live armoured scales may be present in non-inspected cartons. In any event, it is not clear how inspectors would determine whether armoured scales are dead or alive.

7.3 Mealybugs

7.3.1 Consequences

(a) Direct impact

Plant life or health

The IRA Team assessed the impact of mealybugs on plant life or health as “significant” at the “district” level.

Mealybugs have an extremely wide host range affecting commercial crops. They also threaten important genera of native plants including *Musa*, *Acacia, Ficus, Grevillea* and *Eucalyptus* which are not only widely distributed but also an integral part of the unique Australian landscape.

It not possible to reconcile the IRA Team’s assessment of “significant” at a “district” level (which means that it would be “unlikely to be discernable” at a “national” level) with the reasons stated by the IRA Team for that assessment.

Given that potential hosts are widely distributed throughout Australia and that the effects of mealybugs would be expected to be severe on a range of hosts, the Council believes that the IRA Team should have assessed the direct impacts of mealybugs on plant life or health as “significant” at least at the “regional” level.

Any other aspects of the environment

The IRA Team assessed that the impact of mealybugs on “other aspects of the environment” would be “significant” at the “district” level.

However, the IRA Team has failed to consider that the impact of mealybugs on susceptible native plant species (referred to above) would impact adversely on the ecosystems in which those plant species exist.

The Council believes that the IRA Team should have assessed the direct impacts of mealybugs on other aspects of the environment as "significant" at least at the "regional" level.

(b) Indirect impact

Control or eradication

The IRA Team has assessed the cost of control or eradication of mealybugs as "significant" at the "local" level.

Given the large number of commercial plant species that may be impacted by mealybugs, the Council believes that the IRA Team should have assessed the cost of control or eradication of mealybugs as "significant" at least at the "regional" level.

Domestic trade

The IRA Team has assessed the impact of mealybugs on domestic trade as "significant" at the "local" level.

However, if as is assumed by the IRA Team, intrastate and interstate restrictions would be placed on the sale and movement of a range of fruit (including citrus, mangoes and bananas) following an incursion of mealybugs, the impacts would be significant and would extend beyond the district level.

The Council believes that the IRA Team should have assessed the impact of mealybugs on domestic trade as "significant" at least at the "regional" level.

(c) Overall consequences

The Council concludes that, as a result of the impacts that should be assigned to the criteria listed above, the overall consequences of the entry, establishment and spread of mealybugs should be at least "moderate".

7.3.2 Unrestricted risk

Because the IRA Team significantly underestimated the consequences of mealybugs, the Council considers that the IRA Team should have assessed the unrestricted risk of mealybugs as being "moderate".

7.3.3 Risk management

The IRA Team has recommended a pre-clearance inspection and corrective action measure for mealybugs or, alternatively, an on-arrival visual inspection and corrective action measure.

The Council has no confidence that inspection by AQIS in the Philippines will have the required effect.

In the previous draft IRA Report (2004), an augmented pre-clearance and on-arrival inspection regime was not considered to reduce the restricted risk of mealybugs sufficiently to achieve Australia's ALOP. In that report, the IRA Team considered

insecticidal treatment to be the only measure that would reduce the restricted risk of mealybugs sufficiently to achieve Australia's ALOP.

The IRA Team has not provided any scientific or technical basis for revising its assessment.

Mealybugs are cryptic organisms and as such there is a very high likelihood that they will be hidden and not detected during a standard 600 unit inspection.

The Council cannot understand how, given the high level of interceptions of live mealybugs in New Zealand, Japan and South Korea from Philippine bananas, the decision has been reached to rely upon a standard 600 unit inspection regime as the only risk management measure for mealybugs.

Pineapples from the Philippines, Thailand, Sri Lanka and the Solomon Islands are subject to infestation with several species of mealybugs including *Dysmicoccus neobrevipes* and *Pseudococcus jackbeardsley*. The Council notes that the probability of entry, establishment and spread was assessed as high for mealybugs on Philippine bananas. For the same species on pineapple, the probability of entry, establishment and spread was assessed as moderate. However, for pineapples, on-arrival methyl bromide fumigation, as well as a range of other risk management measures is required to manage the risks of mealybugs. The likelihood of mealybugs avoiding detection in the case of pineapples is not materially different to the likelihood of mealybugs avoiding detection in the case of bananas.

In the case of mangosteen imports from Thailand, because targeted cleaning and airbrushing failed to remove insects and weed seeds, the Council understands that mandatory fumigation is now required as a standard risk management measure for mangosteen. This only occurred after six out of 48 consignments had not failed a standard phytosanitary inspection (Alan Zappala, May 2007, personal communication). Such a situation should not be allowed to occur with bananas where, in the absence of an effective risk management regime, very large volumes of infested bananas will enter Australia.

The Council believes that a standard 600 unit pre-clearance or, alternatively, on-arrival inspection will inspection will not reduce the restricted risk of mealybugs sufficiently to achieve Australia's ALOP. The IRA Team should revise its restricted risk assessment for mealybugs.

7.4 Spider mites

7.4.1 Consequences

(a) Direct impact

The IRA Team assessed the impact of spider mites on plant life or health "significant" at the "district" level.

Spider mites have an extremely wide host range affecting commercial crops and native plant species.

Given that potential hosts are widely distributed throughout Australia and that the effects of spider mites would be expected to be significant on a range of hosts, the Council

believes that the IRA Team should have assessed the direct impacts of spider mites on plant life or health as “significant” at least at the “regional” level.

(b) Overall consequences

The Council concludes that, as a result of the impacts that should be assigned to the criteria listed above, the overall consequences of the entry, establishment and spread of spider mites should be at least “moderate”.

7.4.2 Unrestricted risk

Because the IRA Team significantly underestimated the consequences of spider mites, the Council considers that the IRA Team should have assessed the unrestricted risk of spider mites as being “moderate”.

8 Risk management and draft operational framework

8.1 Introduction

The Council has commented above on the efficacy and feasibility of the risk management measures proposed by the IRA Team for the pests that it has assessed as having an unrestricted risk exceeding Australia's ALOP.

The Council comments below on the proposed risk management and operational framework proposed by the IRA Team. However, those comments should not be relied upon as evidencing agreement by the Council that the proposed risk management measures:

- would have the efficacy assumed by the IRA Team;
- would reduce the restricted risks of the pests of concern sufficiently to achieve Australia's ALOP; or
- are feasible.

8.2 The risk standard for assessing the operational framework

The import risk analysis undertaken by the IRA Team is properly directed to managing rather than eliminating risk. It takes a risk management approach, which includes the assessment of likelihoods of entry, establishment and spread for the pest of concern if the risk management measures proposed by the IRA Team are implemented.

However, in assessing the impact of the implementation of those proposed risk management measures the IRA Team simply assumes that the measures will be implemented. There is no allowance in the import risk analysis for any risk arising from a failure to accurately and consistently apply the proposed risk management measures in respect of every consignment of bananas.

The failure to take into account the risk of inaccurate or inconsistent application of the proposed risk management measures is itself a significant methodological error in the import risk analysis.

That failure makes it essential that the proposed risk management and operational framework provides a very high level of assurance as to the accurate and consistent application of each of the proposed risk management measures in respect of every consignment of bananas to be exported from the Philippines to Australia.

Unless the accurate and consistent application of each measure is almost certain the assessment of the effect of each proposed risk management measure is overstated.

Further, in numerous cases the impact of that overstatement will be very substantial. Failures to detect Moko, black Sigatoka or freckle through a failure to apply one of the proposed risk management measures will lead to the very high risk of importation of a cluster of infection within a consignment – giving rise to high levels of risk which it is acknowledged cannot be adequately assessed or described by use of the model which averages likelihoods across all trade that occurs within a year.

The draft IRA Report acknowledges (at page 263 of Part B) that "*critical failures may occur and immediate action would be required to address these failures to meet Australia's requirements.*"

The Council agrees that "critical failures" can and will occur. However, unless the operational framework ensures that immediate action can and will be taken in every such case, Australia's requirements cannot be met. Detection that a critical failure has occurred does not change the character of any critical failure. Immediate action must follow.

Thus, it is seen that the import risk analysis methodology depends upon there being an operational framework which ensures the detection of 100 percent of critical failures in the application of measures in sufficient time for "immediate action" to be taken.

Given the nature of the proposed risk management measures, a "critical failure" need not be a serious and/or sustained non-compliance with the proposed risk management measures. Minor instances of non-compliance with the proposed risk management measures on an infrequent or even one-off basis would result in the proposed risk management measures ceasing to achieve the level of efficacy assessed by the IRA Team, resulting in the restricted risk of the pests under consideration exceeding Australia's ALOP.

For example, the IRA Team has assessed the restricted likelihood of black Sigatoka as being 4.88E-02. Consequently, the restricted likelihood of black Sigatoka only achieves Australia's ALOP by a very small margin (1.2E-03). If the efficacy of a proposed risk management measure is reduced even marginally by a minor non-compliance with one of the proposed risk management measures (such as failure of the proposed post-harvest treatment measure), the restricted risk of black Sigatoka could (and would in all likelihood) exceed Australia's ALOP.

8.3 Compliance with proposed risk management measures

The IRA Team has recommended that a systems approach be adopted to reduce the restricted risk of Moko, black Sigatoka and freckle sufficiently to achieve Australia's ALOP.

The recommended systems approach for Moko includes:

- a proposed area of low pest prevalence measure;
- a proposed visual inspection and correction measure; and
- a proposed post-harvest treatment measure.

The recommended systems approach for black Sigatoka includes:

- a proposed area of low pest prevalence measure; and
- a proposed post-harvest treatment measure.

The recommended systems approach for freckle includes:

- a proposed area of low pest prevalence measure; and
- a proposed fungicide bunch spray measure.

The operational framework proposed for assuring the accurate and consistent application of each of those measures is a suite of cascading audits under which:

- pest surveys will be conducted by persons accredited by BPI. It is unclear who will be responsible for paying for the pest surveys – either in the immediate sense of employing the surveyors, or in the ultimate sense of carrying the economic cost of those surveys. However, it seems that individual Philippine banana growers will be responsible for the cost of surveys of their own plantations/blocks (possibly as the immediate employers or principals of the pest surveyors);
- BPI would audit "pest survey records"; and
- AQIS might (or might not) audit "pest survey records".

Audit is a tool directed to the management and not the elimination of risk. It necessarily occurs after the fact. The Council comments on audits in more detail below.

The key problems with the proposed risk management and operational framework which lead to its failure to meet the risk standard required of it are:

- it provides very substantial economic incentives for those who will have principal responsibility to implement it to not comply with it;
- it provides no realistic risk of economic or other penalty to those same people for any detection of a failure to comply;
- it provides no adequate mechanism to counter those economic incentives; and
- its proposed audits are predominantly of records – which could be expected to be faulty or falsified in any case in which the economic incentives referred to above lead to non-compliance. It is a trite principle of audit practice that audits of records do not and cannot provide assurance as to the control environment in which the records are produced.

The efficacy of the proposed risk management measures will be wholly reliant upon actions undertaken by BPI (and its accredited persons) and Philippine plantation and packing station workers. In particular:

- the efficacy of the proposed area of low pest prevalence measures for Moko, black Sigatoka and freckle will be wholly reliant upon the accuracy and integrity of the proposed weekly pest surveys to be carried out by persons accredited by BPI;
- the efficacy of the proposed visual inspection and correction measure for Moko will be wholly reliant upon the accuracy and integrity of the inspection regime to be carried out by Philippine plantation and packing station workers;
- the efficacy of the proposed post-harvest treatment measures for Moko and black Sigatoka will be wholly reliant upon the proper implementation of the post-harvest treatments by Philippine packing station workers; and
- the efficacy of the proposed bunch spray measure for freckle will be wholly reliant upon proper implementation of the bunch spray regime by Philippine plantation workers.

If Philippine plantation and packing station workers fail to comply with the proposed risk management measures or BPI (or its accredited persons) fails to properly perform its responsibilities then the proposed risk management measures will not have the efficacy assumed by the IRA Team.

8.4 Proposed risk management measures open for avoidance

The proposed risk management measures are not part of current standard commercial practice in the Philippines and compliance with them would impose a significant initial and ongoing financial and operational burden on individual Philippine banana growers.

On the other hand, the economic benefit of permission to export to Australia, which will be gained by individual Philippine banana growers who are able to demonstrate compliance with the operational framework, would be significant.

The gap between what is required to demonstrate compliance and what is in fact required to comply is the space in which the operational framework provides strong economic incentives for non-compliance.

For example, compliance with the proposed areas of low pest prevalence measure for Moko requires a weekly inspection of a grower's registered plantation/block to identify diseased plants and, in the event that the level of disease exceeds the prescribed pest prevalence, the reporting of that fact. That reporting would lead to the suspension of the plantation/block from exporting to Australia for at least 12 months.

Thus compliance involves the significant cost of weekly inspections, and in the event that the prescribed level of pest prevalence is exceeded, the very substantial cost of the registered plantation/block being suspended from exporting to Australia.

On the other hand, that which is required to demonstrate compliance is the creation and maintenance of a set of records of weekly inspections – a task that could be undertaken by a person who never leaves the room in which the records are created and without any inspection actually ever occurring. Perhaps more likely, that is a task that could be performed after the conduct of thorough and time consuming surveys or after the conduct of cursory surveys.

Similarly, in the event of the prevalence of a pest exceeding the prescribed pest prevalence, one of the options sufficient to demonstrate compliance is the non-recording of that fact in the pest survey records. The only consequence for a banana grower of a detection through audit of that failure to record would be the consequence which would flow in any event if proper recording and reporting has occurred – the suspension of the registered plantation/block from exports to Australia for a period of at least 12 months.

In these circumstances, a Philippine banana grower who chose to engage a surveyor who conducts thorough surveys in preference to one who conducts cursory surveys would be acting in a wholly economically irrational manner (assuming both surveyors were prepared to create records in similar terms).

If Australia was to require the application of the areas of low pest prevalence measure on a regional basis there would be a powerful compliance force at work because those risk management measures would affect the ability of the industry in the region as a whole to export to Australia. Any non-compliance by one Philippine banana grower in the region would put at risk the economic benefits available to all other banana growers

in the region. The banana industry in the region would have an overriding incentive to ensure compliance (and the nature of rural industry is such that industry participants would find out if there was systemic non-compliance occurring). Importantly, in those circumstances, the banana industry in the region would form a constituency of the regulator which would support more effective monitoring and compliance.

However, because the proposed areas of low pest prevalence measure and the other proposed risk management measures are based on individual plantations/blocks there is no opportunity for the operation of externalities of that kind when it comes to an individual grower assessing the balance of incentives and risk which he/she or it faces. As such, if a non-compliance is detected, its impact will be isolated to the individual plantation/block. In that circumstance, the operational framework proposed leaves each Philippine banana grower with a powerful economic incentive to be seen to comply with the risk management measures; a strong incentive not to in fact comply with the risk management measures if, for example, there be a risk that compliance will result in the detection of an infestation; and no incentive to care at all what his/her or its neighbour might do.

The Council is concerned that the operational framework has been developed based on approaches that might have been effective in contexts where it was in the interests of industry participants generally that there be compliance. Because that is not the case here, the proposed risk management and operational framework needs to be reconsidered.

In the absence of intensive continuous and effective ongoing compliance monitoring, the Council strongly believes that there is a very real likelihood that Philippine banana growers would seek to avoid complying with the proposed risk management measures.

The likelihood of non-compliance occurring undetected is very high given that non-compliance with many of the proposed risk management measures will not be able to be detected through pre-clearance inspections in the Philippines or on-arrival inspections in Australia (as discussed below). Those aspects of the framework provide no basis for assurance of the accurate or consistent application of the framework.

8.5 No ability to inspect for non-compliance

Pre-clearance inspections in the Philippines and on-arrival inspections in Australia provides an opportunity to remove fruit from the export pathway which has been compromised by non-compliance with certain of the proposed risk management measures. For example, fruit which is contaminated with trash due to non-compliance with the trash minimisation measure for black Sigatoka may be detected through pre-clearance and on-arrival inspections.

However, non-compliance with the following proposed risk management measures for the pests of concern will not be able to be detected through pre-clearance and on-arrival inspections:

- the proposed area of low pest prevalence measure for Moko, black Sigatoka and freckle;
- the proposed visual inspection and correction measure for Moko;

- the proposed post-harvest treatment measure for Moko and black Sigatoka; and
- the proposed fungicide bunch spray measure for freckle.

As such, pre-clearance and on-arrival inspection will not be able to detect non-compliance with:

- any of the proposed risk management measures for Moko and freckle; and
- two of the three proposed risk management measures for black Sigatoka.

As a consequence, any fruit which is compromised by non-compliance with any of the above risk management measures which is not immediately detected and removed from the export pathway at the time of the non-compliance will continue through the entire export pathway (including pre-clearance and on-arrival inspections) undetected.

The integrity of the proposed risk management regime therefore requires intensive and ongoing compliance monitoring and corrective action so that fruit which is compromised by non-compliance with the proposed risk management measures can be immediately detected and removed from the export pathway.

8.6 The risks to compliance

In the assessment of a systems approach it is fundamental to identify the key areas of potential weakness and to identify how, and to what extent, the controls proposed will address those weaknesses.

The proposed risk management measures require competence, diligence and honesty from a large number of workers engaged or paid directly or indirectly by Philippine banana industry participants including those who will conduct pest surveys, those who will implement plantation based measures and those who will implement packing station based measures.

While the proposed accreditation of surveyors by BPI may address competence, there is nothing in an accreditation system that could address diligence or honesty. On the other hand, as discussed above, those who will employ surveyors, or who will pay the costs of employing surveyors, will be Philippine banana growers and if acting rationally, Philippine banana growers will not want surveyors to act honestly.

There is nothing in the proposed risk management and operational framework which would assure the competence, diligence or honesty of those engaged in implementing the proposed risk management measures.

In addition, because there will be no Philippine banana industry participants whose interests will be served by achieving compliance, there will be strong economic and political forces continuously at work to provide powerful incentives to BPI and its political masters to obfuscate its dealings with AQIS where to be transparent would harm Philippine banana industry participants.

If that were to occur Australia could hardly complain, let alone take decisive action. After all, in the conduct of the import risk analysis, Biosecurity Australia has requested information from BPI (as the Philippine's national plant protection organisation) in relation to key aspects of the import risk analysis. In many instances, the requests

related to technical and biological information which was specific to Philippine banana production and was only within the knowledge of BPI and/or the Philippine banana industry. In accordance with the Philippine Government's international obligations, it would be expected that BPI would have cooperated to the fullest extent possible in providing that information and acted fairly and in good faith in doing so. That has not been the case. Critical information requested by Biosecurity Australia has not been provided by BPI. Information which has been provided on a number of key issues has been incomplete, inaccurate and misleading or deceptive. In many instances, information provided by BPI on key issues has been constructed with the objective of advancing the commercial interests of the Philippine banana industry rather than contributing to the body of scientific knowledge and opinion relevant to the pest risk analysis. This conduct is exemplified by BPI's responses to the IRA Team's list of questions and subsequent clarificatory questions.

There is no reason to think that dealings under the operational framework will be any different – when the economic incentives created by it would support a continuation of a lack of transparency.

The same set of forces will also be at work to undermine the diligence, if not honesty, of officers of BPI in the discharge of their functions under the operational framework.

The Philippines is ranked 121 out of 163 countries (with a score of 2.3 – 2.8 out of 10) in the most recent Corruption Perception Index (2006) published by Transparency International. That ranking places the Philippines in the bottom 10 of country rankings. Graft and corruption is acknowledged as being a very serious problem in the Philippines (including by the Philippines Government). In an environment in which graft and corruption is common place, there is a very real risk that the integrity of the risk management regime will be prejudiced by graft and corruption of BPI officials.

The consequences of BPI officials turning a blind eye to non-compliance for whatever reason would be no less damaging to the integrity of the risk management regime than BPI officials actively engaging in graft and corruption.

The Council is strongly opposed to the establishment of a risk management regime which relies, for its integrity, on strong and effective compliance monitoring and enforcement but which, in the context of an operational framework which provides inadequate incentives for compliance and in an environment of systemic graft and corruption, imposes the responsibility for compliance monitoring and enforcement on BPI. The Australian banana industry can have no confidence (nor should the Australian Government) that BPI will fulfil its responsibilities professionally and impartially.

What is more, even if BPI were to conduct itself with complete diligence and honesty it is highly doubtful that the operational framework would or could deliver what is required of it – because an audit approach cannot assure consistent and accurate administration by pest surveyors and plantation and packing station workers when those people are economically dependant on Philippine banana growers.

8.7 Involvement of AQIS

The draft IRA Report contemplates that AQIS will have a role in off-shore compliance monitoring and enforcement.

However, that role appears to be limited to:

- an audit function; and
- pre-clearance inspection (at least for the initial period of trade).

8.7.1 Audit

The draft IRA Report contemplates the following audit role for AQIS:

- audit of delegated risk management procedures (see page 264 of Part B);
- audit of the Philippine operating manual and work plan on their production, processing and certification system (see page 265 of Part B);
- field audits to measure compliance with plantation registration, block identification, disease management/monitoring, records management and the administration of areas of low pest prevalence and accreditation requirements (see page 265 of Part B);
- audits to measure compliance, such as trash minimisation in registered plantation/blocks, packing station responsibilities, traceability, labelling, segregation and production security, BPI/agency inspection and certification processes and other procedures relevant to identified quarantine pests (see page 265 of Part B);
- audit of participants in BPI certification arrangements (see page 265 of Part B);
- audits of records relating to operation under standard commercial practice (see page 266 of Part B);
- audits of records relating to weekly disease control and plantation monitoring and spray diaries (see page 266 of Part B);
- audit of records relating to the replacement of damaged bunch covers (see page 266 of Part B);
- audit of proposed inspection methodology for the area of low pest prevalence measure (see page 267 of Part B);
- audit of BPI's documented criteria in relation to appointment of accredited persons for plantation inspections (see page 267 of Part B);
- audit of pest survey records (see page 267 of Part B);
- audit of vascular inspection records (see page 268 of Part B);
- audit of trash minimisation procedures (see page 268 of Part B);
- audit of documented system for application of post-harvest treatment for Moko and black Sigatoka (see page 271 of Part B);
- audit of documentation in relation to maintenance of good hygiene on the packing line (see page 271 of Part B); and
- audit of composite sampling procedures (see page 271 of Part B).

The draft IRA Report contemplates that AQIS will have a role in conducting field audits and compliance auditing. The draft IRA Report notes (at page 265 of Part B) that

"*[a]udits may be conducted at the discretion of AQIS during the entire production cycle and also as a component of any pre-clearance arrangement*".

While it is not completely clear from the draft IRA Report, it appears that AQIS's role will be limited to performing field audits and compliance audits on an ad hoc basis from time to time, and that much of AQIS's audit activity will involve paper audits of records and procedures.

For the reasons discussed above, the integrity of the proposed risk management regime requires strong and effective off-shore compliance monitoring and enforcement. That compliance monitoring and enforcement must be conducted intensively and on an ongoing basis.

For the reasons discussed above, BPI cannot be relied upon to conduct that compliance monitoring and enforcement.

If the proposed risk management measures are to be implemented in the form proposed, on-the-ground AQIS inspectors must be responsible for conducting compliance monitoring and enforcement, as well as other critical activities such as weekly plantation inspections.

AQIS's "audit" role must be directed at detecting instances of non-compliance at the time of the non-compliance and removing any compromised fruit from the export pathway.

AQIS on-the-ground inspectors must be directly involved in verifying compliance with the proposed risk management measures through the real-time audits of the implementation of the proposed risk management measures in both plantations and packing stations.

AQIS audits should not occur on an ad hoc basis but should occur intensively on an ongoing basis for so long as a plantation/block remains registered to export fruit to Australia.

Importantly, it is not sufficient for AQIS to rely upon paper audits of records as verification for compliance with the proposed risk management measures because:

- records can be falsified;
- it is not possible for AQIS in verifying that the records (for example, pest survey records) to accurately record the matters to which they relate (for example, pest prevalence);
- a paper audit can only verify whether record maintenance requirements have been complied with; and
- even if a paper audit was able to identify non-compliance with a proposed risk management measure, because of the delay between the occurrence of the non-compliance and the time of conducting the paper audit, it would be unlikely that AQIS could take action to remove compromised fruit from the export pathway.

8.7.2 Weekly plantation inspections

The draft IRA Report contemplates that AQIS would have a limited role in conducting field audits to measure compliance with the area of low pest prevalence measure for Moko, black Sigatoka and freckle and in conducting paper audits of pest survey records.

While it is not completely clear from the draft IRA Report, it appears that the draft IRA Report contemplates that AQIS will conduct field audits on an ad hoc basis from time to time. For the reasons discussed above, paper audits of pest survey records provide no verification of the level of pest prevalence in a plantation.

That level of AQIS involvement in such a critical aspect of the area of low pest prevalence measure for Moko, black Sigatoka and freckle is not sufficient.

For the reasons discussed above, weekly plantation inspections should not be conducted by BPI (or persons accredited by BPI) but should be conducted by AQIS on-the-ground inspectors or by persons accredited by AQIS (not BPI) and under the direct supervision of AQIS on-the-ground inspectors.

Accredited persons would need to be independent of Philippine banana growers and would need to be appropriately qualified to conduct field inspections.

8.7.3 Pre-clearance inspections

The draft IRA Report contemplates that AQIS will be involved in conducting pre-clearance inspections for "the initial trade" (see pages 218, 231, 242 and 260 of Part B) or "for at least [the] initial trade" (see pages 272 and 274 of Part B). The draft IRA Report also contemplates that "*[t]he need for pre-clearance would be reassessed after experience had been gained following significant trade*" (see page 272 of Part B).

The draft IRA Report states (at page 273 of Part B) that "*[u]nder pre-clearance arrangements, AQIS officers would be involved in plantation inspections for Moko, black Sigatoka, freckle and other quarantine pests, in direct verification of packing station procedures, and in fruit inspections*".

It is not clear what level of involvement it is proposed that AQIS on-the-ground inspectors will have in directly verifying compliance with the proposed risk management measures under the pre-clearance arrangements during the initial period of trade.

It appears that even under the pre-clearance arrangements, AQIS on-the-ground inspectors will have limited involvement in direct verification of the proposed risk management measures.

For the reasons discussed above, AQIS on-the-ground inspectors must:

- directly verify compliance with the proposed risk management measures through the conduct of real-time audits in plantations and packing stations on an intensive and ongoing basis; and
- undertake weekly plantation inspections (or must directly supervise persons accredited by AQIS to undertake those inspections).

It is not acceptable to place a limit on the time in which AQIS will be involved in the direct verification of compliance with the proposed risk management measures as has

been proposed for pre-clearance inspections. That involvement must continue for so long as imports are permitted from the Philippines.

8.8 An alternative systems approach

The proposed risk management and operational framework is both experimental and deficient because it seeks to control the implementation of risk management measures based on individual plantations/blocks which themselves are experimental.

In so doing, the proposed risk management and operational framework fails to address the fundamental economic drivers of behaviour and consequently will create a system much more likely to be honoured in the breach than by compliance.

If the proposed risk management and operational framework is not to be fundamentally altered by the IRA Team it is necessary to reconsider the design of the proposed risk management measures.

If the risk management measures were designed so that the whole banana industry in a region (say Mindanao) had an interest in compliance by each banana grower within the region, the risks of non-compliance by individual banana growers and all those economically dependant on them would be substantially reduced.

Similarly, in that circumstance, BPI would have a structural and ongoing reason to perform its role with greater diligence and integrity.

Annexure 1

Additional references

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Annexure 2

Report by Professor Pettitt and Dr Reeves

Annexure 3

Report by Dr Reeves

Analysis of the Wholesaler, Retailer, and Local Government Area Surveys conducted by Biosecurity Australia in relation to Banana IRA.

Dr Robert Reeves
School of Mathematical Sciences
Queensland University of Technology
June 2007

1 Survey Report on the Distribution and Waste Disposal of Bananas by the Association of Australian Banana Wholesalers

1.1 General

The AABW survey report is available from the Biosecurity Australia website, and is entitled “Association of Australian Banana Wholesalers survey, BA January 2006”.

We make comments below under the headings reported in the survey report.

1.2 Item 1 - Survey Participation

The survey report states that 22 of the 29 members of AABW participated. Only three were in banana growing areas. This appears to be an under representation of wholesalers in the banana growing regions. On population terms, we would expect 4 or 5 wholesalers, Thus proportions purporting to divide various retail or waste streams between grower and non-grower areas will tend to be biased in favour of non-grower areas. This assessment is reinforced by Item 8 of the survey report, which states that 15% of sales went to retailers in grower areas, which on population grounds we would expect to be close to 20%.

1.3 Item 2 - Bananas Sold in past financial year

The survey report states that 152,328 tonnes of bananas were sold in 2004-05 by the 22 respondents. AABW estimates this to be 55% of the trade, so an estimate of the total trade would be 155,328/0.55=276,960 tonnes. No information is given on the distribution of trade amongst the respondents. Such information could be used to estimate the distribution of trade over the respondents, and assuming the same distribution for the non-respondents, a variance could be assigned to the estimated total tonnage. It is not possible to perform this simple calculation without access to the raw data. This information should have been provided in the survey report so that the summary data given can be correctly interpreted in terms of its precision. The Council notes that the figures apply to the financial year 2004-05, and that total trade will vary from year to year, but that over time the total trade will tend to increase with population growth, all other factors being equal.

1.4 Item 3 - Bananas disposed of as waste

The survey report states that 0.35% of the 152,859 tonnes purchased by the 22 respondents was disposed of as waste. When applied to the total banana trade, this figure will be subject to sampling error, which should be estimated. The figure of 0.35% is presumably calculated by multiplying the percentage reported by the tonnes of bananas sold by each respondent, and totalling across all respondents, to get the total tonnage disposed of as waste, and then dividing by the total tonnage sold. The survey report also states that answers ranged from 0% to 1.5%, with seven of the respondents reporting no waste.

A problem with these figures is that there is no indication how accurately each respondent estimated their percentages of waste. One possible interpretation is that the variation from 0% to 1.5% may represent differences in accuracy of the assessment methods each respondent used, while the underlying waste percentage is much the same for each retailer. On this basis, the percentage of bananas wasted should be given a distribution ranging between 0% and 1.5%. A uniform distribution would be the most conservative choice here. On this basis, the bananas wasted by the wholesalers would range from 0 to 2,293 tonnes, with an average of 1,146 tonnes. This is more than twice the tonnage reported in the survey analysis as wasted.

A further point that should be noted is that the survey asks for the amount of tonnes sold in the financial year, not the number of tonnes purchased as implied in the survey report against this item. Presumably, the tonnes sold does not include the bananas that are wasted. Thus the tonnes of waste for each wholesaler will be under estimated, as it should be a percentage of a higher figure. The correction is simple. The tonnes sold for each wholesaler should be multiplied by p/(100-p), where p is the percentage of waste, to get the tonnes wasted for each wholesaler.

1.5 Item 4 - Disposal points of banana waste

The survey report gives the percentages of waste disposed of in four different ways, municipal waste collection, green waste collection, raw material or other. Once again, we have no information on how accurately each respondent was able to gauge these percentages. The survey report treats these percentages as perfectly accurate in order to calculate the tonnes of banana waste disposed of in each of three categories. Presumably, there were no respondents disposing of waste in the “other” category. Presumably, the seven respondents who reported no waste in question 1 did not answer this question! If they did, then this reinforces the comments against Item 3, that the percentages quoted may not be very accurate. A similar question mark can be placed over the conclusion that 87% of banana waste is sent to municipal tips. Presumably, this figure is arrived at by calculating the tonnage sent to a municipal tip by each respondent, multiplying two estimated percentages of unknown accuracy, by the tonnes of bananas handled, adding these tonnages together, and dividing by the total tonnage of bananas handled. The report gives no information on the variation between respondents in the percentage of waste that goes to municipal tips. Any such variation may reasonably be interpreted to include uncertainty on the part of the respondents in estimating these percentages. Thus the true percentage of banana waste disposed of to municipal tip or through organic waste collection could substantially differ from the quoted 87%. However, without more information, including the raw survey data, it is not possible to

say by how much. The proportion of uncontrolled waste may differ substantially from the 13% quoted for the same reasons.

1.6 Item 5 - Disposal of empty banana cartons

The report concludes that 62% of cartons were disposed of through recycling. However, this figure refers to the number of respondents, not the number of cartons! The survey reports that 8 out of 13 respondents to this question (62%) used recycling to dispose of cartons. This represents only half of the respondents to the survey, which itself represents only an estimated 55% of the domestic trade. This figure could vary considerably depending on the habits of the non-respondents to this question, and to the survey overall.

1.7 Item 6 - Disposal of plastic lining from empty banana cartons

The survey report says that 83% of the plastic lining from cartons was disposed of at the municipal tip. However, this refers to the practices of the respondents, with 10 out of 12 respondents reporting this practice. Once again, considerable variation is possible as the relative volume of trade handled by each respondent is not reported, and less than half the respondents answered this question.

1.8 Item 7 - Sales distribution of bananas

Item 7 in the survey report gives the breakdown in terms of total tonnes sold to retailers, food services, and food processors. Presumably, the proportion reported by each respondent for each destination is multiplied by their answer to question 5 (tonnes sold last financial year), and the total for each destination reported as a percentage of the total tonnage. We do not know if there is any variation in the proportions between the different respondents, and any such variation may indicate uncertainty in knowledge of these proportions as well as actual variation in destination. The percentages given are therefore likely to be subject to substantial imprecision, which should be estimated before the figures are used for modelling purposes.

1.9 Item 8 - Bananas sold to retailers by AABW members

The Survey Report states that 15% of sales were to retailers in grower areas, and 85% to retailers in the other areas. These figures are based on the answers to question 8 (proportion of sales to grower/other areas), and question 5 (tonnes sold in last financial year). The accuracy of the reported figures will depend on how accurately the proportions in question 8 are reported by the respondents, and how accurately the tonnes sold are reported in question 5. No information is provided in the report on these matters. These figures are likely to give substantial bias when applied to the overall trade, due to the under representation of wholesalers in the grower areas, as noted against item 1. The Council considers that an 80% - 20% split, based on population levels, is more appropriate in the absence of more complete survey data.

1.10 Item 9 - Bananas sold to retailers by AABW members located in the grower areas

The figures given in the survey report would appear to follow a similar procedure to that discussed above to find tonnages distributed to retailers in grower areas and non-grower areas, and express this as a percentage of the total tonnage. However applying these

figures to the entire trade assumes (i) that the proportions are known and reported perfectly accurately, (ii) that the tonnes sold by each wholesaler is known precisely and reported accurately, and (iii) that the 45% of the domestic trade unaccounted for follows the same pattern as in the survey. None of these assumptions is likely to be perfectly true, and there may be considerable variation. The reasons have been discussed in previous points.

1.11 Item 10 - Bananas sold to retailers by AABW members based in the other areas.

The same comments as for item 9 apply here.

2 Survey Report on the Distribution and Waste Disposal of Bananas by Retailers in Australia

2.1 General

The retail survey report is available from the Biosecurity Australia website, and is entitled “Retailer survey, BA February 2006”.

The survey of retailers has similar problems to the above survey of the wholesalers, in that the precision including sampling variation in the figures and percentages given is not reported. It is clear that not all respondents answered all questions, and that there is great variation in the volumes of bananas handled by different respondents. When these figures are used in modelling banana distribution, sample variation should be taken into account. Where possible, when distributional details are given, we have estimated the sample variation and other causes of imprecision and discussed it against individual items below, using the same headings as the survey report.

2.2 Item 1 - Survey participation

It is very difficult to get full response to a survey. However, it is also very important to safeguard against bias due to non-response. The non-responders should be examined to see if there is any pattern to the non-response which could introduce bias. For example, different rates of non-response between grower and non-grower areas could indicate a possible bias, as could different rates of non response between major chain stores and independent retailers. Bias could also be introduced if non-responders tend to be smaller operators, or have lower turnover, or indeed if they tend to be larger operators with greater turnover. Use of the survey results in modelling banana distribution should allow for possible non-response bias unless it can be shown to be minimal.

2.3 Item 2 - Bananas purchased – major chain stores

The survey report states that an average of 148 cartons per week was bought by major chain stores. However, the sampling variation in this figure is not reported. A conservative estimate may be made from the range of responses reported, from 8 to 400 cartons. Assuming a normal distribution centred on the sample mean, with three times the standard deviation given by the difference between the sample mean and the lower range, we can work at the standard error of the quoted average. The approximate standard deviation is (conservatively) (148-8)/3 = 46.7. The sample size is 95, so the standard error is $47/\sqrt{95} = 4.8$ cartons per week. Since the distribution is long tailed to the right, the standard error is likely to be actually greater than this estimate – this requires access to the raw data to more precisely determined.

2.4 Item 3 - Bananas purchased – independent retailers

As per our comments above against item 2, the sampling error here would be at least in the order of 1 carton per week $(24/3)/\sqrt{99}$, and very likely considerably more due to the long tail to the right.

2.5 Item 4 - Source of bananas – major chain stores

The survey report states that 89% of bananas sourced by major chain stores came through their supermarket distribution chains. Once again, the sampling error is not estimated or addressed. The variance in the tonnes of bananas sourced through the supermarket distribution chains will be in the order of 0.89× 0.89×95× 47 ×47=166,226 tonnes^2, assuming each store's trade is independent. This is a standard deviation of 408 cartons per week, or more. This represents approximately 3% of the 14,059 cartons per week reported. We expect, however the figure of 89% to be less sensitive to sampling variability, as the variation in the total cartons in the denominator of the percentage will be highly correlated with the variation in the numerator. The degree of accuracy will depend on the accuracy of the survey responses to questions 2 (percentages of bananas obtained from different sources) and 4 (cartons of bananas bought per week), as well as the sample variability.

2.6 Item 5 - Source of bananas - independent retailers

The survey report states that 67% of bananas sourced by independent retailers come through the wholesale system. However, this figure is subject to the same provisos as reported above. Any inaccuracies in reporting both the proportions sourced from the various supply chains, and the numbers of cartons sold per week may be reflected by inaccuracies in this percentage. Even if retailers keep exact figures on the number of cartons bought, this may not be on a weekly basis, they may have a monthly or an arbitrary buying cycle. In the context of a phone interview these figures may be subject to considerable approximation. Corresponding inaccuracies will apply to the other proportions reported.

2.7 Item 6 - Sales distribution of bananas

We note that this breakdown is based only on 151 stores. Presumably 49 stores provided no response to this question. One possible interpretation is that those respondents didn't know the answer to this question. We note that this high level of non-response may introduce significant bias into the figures.

2.8 Item 7 - Bananas disposed of as waste by store location

The survey report states that 4.43% of bananas were disposed of as waste in grower areas, and that 3.50% were disposed of as waste in other areas. A simulation based on:

- estimated normal standard deviations (see comments on Items 2 and 3);
- normal reporting error in the number of cartons sourced per week with a standard deviation of 3.3%;
- reported waste percentages varying as per the histogram given in item 10;
- and the actual waste percentages differing from the reported percentages normally with a standard deviation of 3.3 percentage points, but constrained to be between 0 and 0.25,

reports that the difference between the actual and reported proportions has a standard deviation of about 0.5%. On this basis, the proportions reported for grower and other areas would not be significantly different, and the overall proportion would have an

accuracy of no more than plus or minus about 1.5%. Thus there is no solid basis to use different proportions in grower and non-grower areas, based on the survey data.

2.9 Item 8 - Bananas disposed of as waste by store type

The survey reports that 4.11% of bananas are disposed of as waste by major chain stores, and 2.91% by independent retailers. The simulation analysis made of item 7 also applies here, thus there is no solid basis to assume that these proportions reflect more than the sampling variation associated with reasonable levels of inaccuracy in reporting proportions and cartons per week in the survey, rather than any real difference in the proportion of waste generated by the different categories of retailer.

2.10 Item 9 - Bananas disposed of as waste by stores

This section reports a distribution of the percentage of bananas discarded as waste. This distribution should be used in the modelling of the banana distribution network rather than an average percentage. Indeed, such distributions could have easily been reported for the other percentages reported in the survey. The use of such distributions rather than average percentages correctly represents variation.

2.11 Item 10 - Disposal points of banana waste – all stores

This section reports that 92.5% of banana waste is disposed of through a municipal tip or collected as organic waste. The assumed calculation is to calculate the quantity of cartons disposed of as waste at each retailer, and multiply this by the percentage disposed of to the municipal tip added to the percentage disposed through organic waste collection. This is then divided by the total number of cartons disposed of as waste to give the percentage figure. Given that there will be reporting inaccuracies in the reported percentages and cartons of bananas sold per week, a simulation is used to explore the variation to be expected in the quoted percentage. The simulation is as per Item 7 and Item 8, with the addition that the true percentages of waste reported as municipal, organic collection, animal feed and other are drawn from a Dirichlet density, with averages the average reported values. The reported percentages of municipal and collected organic waste are then drawn from normal densities centred on the draws for the true percentages, with standard deviations of 0.0033, subject to the reported percentages being less than 100%. This assumes that reported values will be within 1% of the true values, which seems a very conservative estimate. The simulation shows that we may expect the standard deviation of the error in the overall percentage of controlled waste to be about 0.44%. It may possibly be much larger, depending on the real relationships between true and observed values, and the distribution of the waste destination proportions, which was conservatively estimated for the purposes of the simulation. Thus the actual percentage of banana waste to controlled waste may vary from the quoted average by up to plus or minus 1% or more.

Access to the raw data would allow a better simulation using the histogram of reported percentages, as for the percentage of waste, as these figures may well under represent the standard errors.

2.12 Items 11 and 12 - Disposal points of banana waste – grower areas, other areas

The survey report records that the percentage of banana waste being directed to the controlled waste stream (municipal tips and organic waste collection) is 95% in grower areas and 90% in other areas. Simulation as reported in discussion if Item 10 gives a standard deviation in the error of these estimates of about 0.65%. There is thus some justification for modelling the proportion of waste diverted to controlled waste differently in grower and other areas. These proportions individually are accurate to within no more than about plus or minus 2%, and possibly considerably more.

2.13 Item 13 - Disposal of used banana cartons

The survey report states that *"[u]sed banana cartons were mainly disposed of through cardboard recycling, irrespective of store type"*. This statement is not corroborated by the data presented in the report. The associated table shows that 79 out of 100 major chain stores use cardboard recycling while 42 out of 100 independent retailers use cardboard recycling. That this difference is statistically significant can easily be confirmed by calculating standard errors based on binomial assumptions. In the case of the proportion of major chain stores using cardboard recycling, the standard error is $\sqrt{(0.79\times(1-0.79)/100)} = 0.041$, or approximately 4 percentage points. In the case of independent retailers, the standard error is given by $\sqrt{(0.42\times(1-0.42)/100)}=0.049$, or approximately 5 percentage points. Other categories of disposal include re-use by customer, or combinations of re-use by the store or customer, and cardboard recycling. These categories should not be included as cardboard recycling, as firstly, we do not know the proportions of cardboard which are re-used, and which are recycled. Nor do we know the ultimate destination of those which are re-used. Customer re-use may be taking purchases home in a box, and then discarding the cardboard box in general waste. Store re-use, may include usage for a short period of time, and then discarding into general waste, or cardboard recycling.

2.14 Item 14 - Disposal of plastic lining from used banana cartons

The survey report states that plastics were disposed of mainly through plastic recycling or the municipal tip. This conclusion is well founded, however the pattern of disposal differs between the major chain stores and independent retailers, with the emphasis on the recycling for the major chain stores, and the emphasis on the municipal tip for the independent retailers.

3 Survey Report on the Waste Disposal Practices of Local Government Areas in Australia

3.1 General

As we comment above, the LGA survey report does not report any standard errors with its results. When results from the survey are used in modelling banana waste distribution, these standard errors should be taken into account. Where possible, we comment below on the standard errors of estimated quantities, but note that this is not always possible due to lack of information.

3.2 Item 1 - Survey participation

We note that the non-response rate differed between grower and non-grower regions. This non-response may introduce bias into the results overall, and particularly in the non-grower areas where the non-response was much higher.

3.3 Item 2 - Household food waste disposed to municipal tips

The Survey Report states that 91% of LGAs dispose of 100% of their household food waste to the municipal tip. The others used up to 100% as input in bio-waste processing for methane or compost production. This figure should not be interpreted as 91% of household food waste goes to a municipal tip, due to the greatly differing sizes of municipalities. The standard error associated with this estimate of 91% may be estimated from $\sqrt{((p(1-p)/n)}$, assuming a binomial distribution for whether all food waste is disposed of to municipal tips or not, in this case $\sqrt{((0.91(1-0.91)/80)} = 0.032$ or 3.2 percentage points. When grower and other areas are considered separately, the percentages and standard errors are shown in the table below:

	Grower Area	Other Area
Proportion 100% municipal tip	87.8%	94.9
Standard error	4.7 percentage points	3.5 percentage points

Under this assumption, there is no basis for concluding that the proportions are different between the two areas.

3.4 Item 3 - Households that compost household food waste at home

The survey results should be viewed with extreme caution. Not only was the response rate very low, the response showed considerable variability, consistent with the respondents having very little reliable information to answer this question. The survey reports average proportions as 14.4% and 17.4% in grower and non-grower regions respectively, and 16.2% overall. It is likely that the reported averages significantly underestimate the true proportions, as the most reliable responses (three LGAs who had conducted surveys) all give percentages which are between two and three times these

percentages. For modelling purposes, reliance should be based on these survey data, rather than the unreliable guesstimates which are averaged to give the reported percentages.

3.5 Item 4 - Food waste composted at home

The survey reports that 55% of food waste is composted at home by households in each LGA. However the non-response rate (81 of 88) for this question was very high. The likely explanation is that the majority of respondents had no information upon which to make a reply. The responses varied widely, across almost the full range, from 5% to 100%, and the mean (0.55) is consistent with the mean of a uniform distribution across this range. This pattern is consistent with an explanation of ignorance about the question amongst responses. Therefore little or no reliance should be placed on these figures as they are likely to reflect lack of knowledge amongst the respondents rather than the actual percentage composted by composting households.

3.6 Item 5 - Municipal tips operating in LGAs

The survey report gives the figures 1.47, 1.54 and 1.50 as the average number of tips per municipal area in banana regions, other regions, and overall, respectively. We may estimate standard errors for these figures by treating the number of tips per LGA as Poisson distributed with mean estimated by the averages given. Estimates of the standard errors are $\sqrt{(1.47/49)}=0.173$, $\sqrt{(1.54/39)} = 0.199$, and $\sqrt{(1.50/88)}= 0.131$ on this basis. Thus there is no basis for concluding that the averages are different between banana and non-banana areas, and the overall figure should be used (accounting for sampling error) in both regions.

3.7 Item 6 - Throughput of municipal tips

The survey report records an average value of 38,508 tonnes for the annual throughput for each municipal tip, with figures of 33,898 tonnes and 43,982 tonnes for banana growing and non-banana growing regions respectively. The expression is misleading, as what is reported is the total yearly throughput averaged over all municipal tips. The average throughput of each municipal tip may be defined in different ways which do not necessarily correspond with the figure quoted. It is not possible to comment on the standard error or otherwise on the accuracy of these figures as no information is given on the distribution of the survey responses. The raw data should be examined in order to assess the standard errors and to determine whether the figures quoted for the different regions are significantly different.

3.8 Item 7 - Covering rate of municipal tips

The survey report states that *"88% of waste in municipal tips in Australia was covered at least once per day"*. This statement is not strictly true, as it must refer only to the tips in the local government areas which were sampled. Assuming a representative sample, this figure will be subject to sampling error. Further examination of the table in this item, and question 6 shows that the statement should in fact state that "88% of municipal tips in the sample covered their waste at least once per day". Thus any reliance made on the statement given in the survey report would be in error if sampling variation was not also considered. This represents an estimate of a proportion – which seems to be estimated by summing the throughput across tips under the category of rate of covering, and

dividing by the total throughput across all tips. The accuracy of this figure thus depends on the accuracy with which the throughput is known for each tip; whether there are any errors involved in categorizing the rate of covering, and sampling error. We are unable to comment on the accuracy of this figure based on the information given in the report, as no details of the distribution of tip throughputs is provided, nor any information provided on the accuracy of throughput figures – which one may expect to contain both natural variation, and uncertainty due to lack of precise knowledge.

3.9 Item 8 - Covering rate of municipal tips – grower areas

The survey report states that *"87% of waste in municipal tips in the grower areas was covered at least several times per week".* The accuracy of this figure cannot be assessed due to lack of relevant information in the survey report, as explained above against item 7.

3.10 Item 9 - Covering rate of municipal tips – other areas

The survey report states that *"98% of waste in municipal tips in the other areas was covered at least several times per week"*. The accuracy of this figure cannot be assessed due to lack of relevant information in the survey report, as explained above against item 7.

3.11 Item 10 - Distance of banana plants from municipal tips

The survey report states that 13% of municipal tips in grower areas had banana plants growing within one kilometre. However this 13% is an unreliable estimate due to the large number of respondents who reported this as unknown. The approximate standard error for this proportion based on binomial probabilities is given by $\sqrt{(p(1-p)/n)}$, where p is the estimated proportion (0.13), and n is the number in the sample, (47), giving a standard error of 4.9 percentage points. Thus this percentage could be as high as 23%.

The survey report states that 4% of tips have banana plants growing at the tip, based on 2 tips out of 47. The approximate standard error is again $\sqrt{(p(1-p)/n)}$, in this case giving a standard error of nearly 3 percentage points. This percentage may therefore be as high as 10%.

Because of the high rate of non-response, these estimates may be significantly biased, and this should be considered in making use of the data.

No valid conclusion may be drawn about percentage of banana plants close to the tips in non-grower areas, due to the very high percentage of respondents who said they didn't know.

Annexure 4

Council's scientific and technical consultants

Ian Muirhead

Tertiary qualifications

B Agr Sc (Qld) 1969

M Agr Sc (Qld) 1975

PhD (Syd) 1980

Professional appointments and experience

1994 -2006 – Employed by Muirhead Consulting Pty Ltd to provide professional services to government, industry and research and development organisations. Major projects during the last 8 years include:

Client	Date	Project title
Australian Banana Growers' Council	2000-2007	Scientific advice on application for banana imports from the Philippines
Horticulture Australia	2006	Strategies for developing alternatives to the current use of methyl bromide for strawberry runner production in Australia
Steering Committee – CRC for National Plant Biosecurity	2005	External consultant – bid for a CRC in National Plant Biosecurity
Grains Research and Development Corporation	Nov 2003	Scoping study for a CRC in Plant Biosecurity
Plant Health Australia Ltd	Apr-Sept 2003	Guidelines for establishing Pest Free Areas for Australian Quarantine
Australian Banana Growers' Council	Sept 2003	Study tour of the banana industries in Ecuador, Costa Rica, Panama and Brazil
Australian Banana Growers' Council	April 2003	Review of Industry Development Manager Position
Plant Health Australia /ABGC	April 2003	Biosecurity plan for the Australian Banana Industry
CRC for Tropical Plant Protection	Jan-Dec 2002	Acting Chief Executive Officer
Australian Banana Growers' Council	Oct 2002	Pest Risk Analyses for Bananas from the Philippines
Horticulture Australia Ltd	Aug-Dec 2002	Review of the Effectiveness of the Avocado R and D program (Member of a team led by Harley Juffs and Associates)
Plant Health Australia	March 2002	Co-author of report on "Assessment of the current status of the human resources involved in diagnostics of plant pests and

Client	Date	Project title
		diseases in Australia"
Grains Research and Development Corporation	March 2002	Review of the Northern Barley Improvement Program
Horticulture Australia Limited	Dec 2001	Prepared case for avocado market access to the United States
Grains Research and Development Corporation	June 2001	4.5 years as Panel Member and Deputy Chair, Northern Panel
Australian Quarantine and Inspection Service	April 2001	Leader of project on Pest Risk Assessment for 10 commodities for the Northern Australian Quarantine Strategy (involves UQ, QDPI, CRC for Tropical Plant Protection)
Queensland Fruit and Vegetable Growers	Dec 2000	Apples from New Zealand - response to Import Risk Analysis
Australian Banana Growers' Council	Feb 2000	Study tour of the banana industry in the Philippines
CAB International	June 1999	Book chapter - "Fungal Diseases of Banana Fruit"

Whilst employed by the Queensland Department of Primary Industries (QDPI)

1993 Acting Regional Director, South Region, QDPI for 6 weeks
1993 Appointed Acting Coordinator, Plant Protection Unit, QDPI, Indooroopilly
1992 Appointed Acting Director, Division of Plant Protection, QDPI, Indooroopilly
1986 Appointed Director, Plant Pathology Branch, QDPI, Indooroopilly
1984 Appointed Assistant Director, Plant Pathology Branch, QDPI, Indooroopilly
1978 Appointed Senior Plant Pathologist, Plant Pathology Branch, QDPI
1969 Appointed Plant Pathologist, Plant Pathology Branch, QDPI.

Areas of expertise

Research in postharvest plant pathology -Over 20 years' experience in researching the causes and control of postharvest diseases of all fruits and vegetables, particularly tropical and subtropical fruits.

Policy on plant protection - Responsibility for more than 8 years for advising QDPI and the Minister for Primary Industries on all matters of plant health policy.

Plant quarantine **-** Experience with managing plant quarantine outbreaks including chrysanthemum white rust, moko and black Sigatoka diseases of banana, exotic fruit flies, spiralling white fly over a 10 year period from the mid 1980's. Contribution to Australian policy through Plant Health Committee, Northern Australian Quarantine Strategy, and specific working groups and task forces.

Plant protection for the banana industry - Experience in all aspects from research to regulation, particularly as Chair of the Banana Industry Protection Board which works closely with industry on control of diseases such as bunchy top and Fusarium wilt (Panama disease). This work involved action at the district, state, national and international levels.

Management of research, regulatory and extension staff - Ten years' experience in all aspects of management from specific responsibility for up to 100 plant protection staff at the Indooroopilly research laboratories, general responsibility for the entire Agricultural research complex at Indooroopilly (up to 400), overall responsibility for all plant pathology staff in Queensland to responsibility for a short period in 1994 for all staff in the south-east region while acting Regional Director. Responsibilities included strategic planning, priority setting, advising senior management, staff development, and day-to-day management.

Registration and regulation of agricultural chemicals - Over 10 years' experience with all aspects of chemical registration and regulation including research on efficacy and use of individual products. Responsibility through membership of the Agricultural Requirements Board for registration of fungicides, insecticides, herbicides and animal health products. Experience and responsibility for aspects of spray drift and secondary environmental effects of pesticide use through Chairmanship of the ACDC Board in Queensland.

Membership of Boards, Committees etc

- Chair, Agricultural Chemicals Distribution and Control Board (1990-1994). The Board controls spray drift and associated issues.
- Chair, Banana Industry Protection Board (1992-94). The Board protects the $200m Qld banana crop from pests and diseases through regulation, research and extension.
- Board member, Co-operative Research Centre for Tropical Plant Pathology (1992-94) Representative for QDPI in this collaborative venture involving four research organisations and one commercial partner.
- Departmental representative, Plant Health Committee (PHC) 1992-94. An Australian body advising the Commonwealth Government on plant protection policy.
- Member, Agricultural Requirements Board (1986-1994). A State body which registered all pesticides (plant and animal) for use in Queensland, and advised the Commonwealth on registration policy and efficacy of individual products.
- Member, Seed Certification Committee (1984-92). Involved with quality control in seed production.
- Chair, Indooroopilly Managers' Committee, Agricultural Research Laboratories, Indooroopilly (1991-1994). General management of a research complex containing 3-400 staff).
- Member, Departmental Agricultural and Veterinary Chemical Coordinating Committee (1994). A committee designed to facilitate communication between all Departmental groups on agricultural chemical issues.

- Member, Institutional Biosafety Committee (1992-94). A QDPI committee responsible for maintaining Australian standards in handling genetically engineered organisms.

Other professional contributions

- Chair, Organising Committee, Seventh Australasian Plant Pathology Society Conference held in Brisbane in 1989.
- Member of the Editorial Panel, Australian Journal of Agricultural Research, 1986-92.

Overseas travel

- Ecuador, Coast Rica, Panama, Brazil Sept 2003 – Report for the Australian Banana Growers' Council
- Philippines - Feb 2000 - Report for the Aust Banana Growers' Council
- Papua New Guinea - 1995 - Review of quarantine for AQIS
- **Honduras, Costa Rica, Colombia and Ecuador - .Report for Aust Banana Growers' Council**
- United Kingdom, Thailand, Malaysia, Singapore, Philippines and China - prior to 1994 - professional duties for QDPI.

Publications

Nineteen scientific papers in refereed journals, three theses, two book chapters, 5 conference proceedings and many unpublished consulting reports. A detailed list is available on request.

Robert W. Reeves B.E. Ph.D.

PO Box 176

Mount Nebo, Q, 4520

r.reeves@qut.edu.au

ph: (07) 3864 2827 (BH)

ph: (07) 3289 8020 (AH)

Teaching Experience

- ⇒ "Surveying Mathematics One", (2003,2004 – School of Mathematical Sciences, QUT)
- ⇒ "Networks and Distributed Computing", (1997 and 1998, School of Electrical Engineering, QUT) JAVA programming, Internet infrastructure, including encryption standards and methods, network security .
- ⇒ "Geomatics" Principles of Photogrammetry (1998 - Department of Geographical Sciences and Planning at the University of Queensland) – Geometric optics, camera models, collinearity equations, matrix representations, coordinate systems, rotation, scaling, translation, 3D reconstruction, Ground Control Points, aerial triangulation.
- ⇒ Unix and C for Engineers (1999, School of Electrical Engineering, QUT) – Introduction to the Unix operating system, common commands, shells, shell scripts, introduction to C programming, compiling, debugging and running C programs under Unix, makefiles etc.
- ⇒ Engineering Computing 1 (1999, School of Electrical Engineering, QUT) – Root finding, numerical integration, numerical differentiation, optimisation, regression, ray tracing, digital representation and accuracy, solution of equation systems, algorithms in C.
- ⇒ Undergraduate and post graduate supervision
  - Currently associate supervisor for PhD (Gareth Ridall) and Masters by research (Marie Forrester) projects for School of Mathematical Sciences
  - Database Prototype for Remote Sensing Images with Content Based Access Capability (For the International Space University – Masters project).
  - Matching Accuracy with JPEG Compression. (School of Electrical Engineering – Honours thesis)
  - Calibration of Low Cost Video Cameras. (School of Electrical Engineering – Honours thesis)

Professional History

School of Mathematical Sciences, Queensland University of Technology, Brisbane

August 2001 – Present

- **Lecturer in Statistics** *January 2005 – Present*
  - ⇒ Research into methods for intractable normalizing constants
  - ⇒ Examine PhD, Honours and Masters thesis
  - ⇒ Supervision of Post graduate and honours students
  - ⇒ Preparing and delivering lectures in statistics and engineering mathematics
  - ⇒ Consulting in Risk Analysis for Apple and Pear Australia, Australian Banana Growers Council, And Australian Prawn Farmers Association.

- **Post Doctoral Fellow** *August 2001-December 2004*
  - ⇒ Supported by ARC grants (Pettitt and Mengersen; Pettitt and Turner) and QUT Postdoctoral fellowship.
  - ⇒ Investigate normalizing constant approximations for autologistic model. (Contribution to research published in the Journal of the Royal Statistical Society, Series B)
  - ⇒ Extend method for models with covariates.
  - ⇒ Developed forward recursion approach to autologistic model normalizing constant computations. Suitable for lattices with rows up to about 15. Research accepted for publication in Biometrika.
  - ⇒ Collaboration with Professor Jesper Moller of Aalborg University in Denmark on auxiliary variable method for eliminating normalizing constants from Metropolis Hastings ratios. Publication currently under review by Biometrika.
  - ⇒ Approximate Bayesian computation developed for application to bioinformatics sequence problems. A research assistant under my supervision (funded by new researcher grant) is currently developing software to test and develop methodology.
  - ⇒ Hierarchical spatial modeling of archeological soil phosphate data. Forward Recursion methods developed for Markov Random Field layer, and integrated into an MCMC analysis. Research to be presented at the Australian Statistical Society Conference in July.
  - ⇒ Hierarchical modeling and fusion of Terrain Data. Bayesian hierarchical models developed, MCMC techniques and normalizing constant methods ready to apply. Work to be completed by October 2004.
  - ⇒ Perfect Sampling algorithms for autologistic and Potts model implemented as part of auxiliary variable Metropolis Hastings method.
  - ⇒ Unofficial convenor of the Bayes Interest Group – organizing regular seminars on Bayesian statistics, help to organize and run workshops, help to run monthly book discussions.
  - ⇒ Member of Science Faculty Equity Committee, oversee school equity programs (Bursaries, photocopy card scheme).
  - ⇒ School Seminar series coordinator.

Center for Vision Research, York University, Toronto

August 1999- July2001

- **Post Doctoral Fellow**
  - ⇒ Multi-partner academic, government and industry collaborative project "Extraction of Features from Remote-Sensed Imagery for a Search and Rescue Synthetic Vision Database". Partners include Ontario Centre for Research in Earth and Space Technology, PCI Geomatics, and the Canada Centre for Remote Sensing
  - ⇒ Liase with academic, government and industry colleagues in collaborative research
  - ⇒ Organise and execute GPS field survey
  - ⇒ Acquire and process remote sensing imagery – orthorectification, geo-referencing, classification using PCI geomatics software
  - ⇒ Write research software to assess accuracy of terrain data – PCI, C, Unix shell scripts
    - ⇒ Digital Elevation Models are assessed against a sample of Differential GPS surveyed points. Tests for Gaussianity and covariance between sample points. Confidence intervals established for bias and standard deviation
  - ⇒ Develop Bayesian approach to the fusion of multiple terrain data sets – Experimental Software in C

⇒ Measurement model, sensor model, blur matrix, covariance matrix, multivariate Gaussian error model, issues of scale, Markov priors, thin-plate and membrane constraints as Baysian Priors, Experimental determination of constraints and covariance.

⇒ Estimation of terrain semi-variogram and covariogram

⇒ Classical semi-variogram and covariogram estimation, investigation of the bias and standard deviation of the classical estimator through error surface simulation studies, least squares determination of covariance function in log domain, experimental software written in C.

⇒ Geo-referencing and ortho-rectification of Remote Sensing imagery, including Landsat 7, Radasat, Spot 4, and aerial photographs

⇒ Use of commercial software (PCI) for aerial triangulation

⇒ Use of commercial software (PCI) for classification of multispectral imagery, and production of Digital Terrain Models from aerial photography and satellite imagery

⇒ Investigate problem of planimetric offsets when fusing data from disparate sources

⇒ Least squares matching of DEM with Spot heights, computation of variance Vs. planimetric shift

⇒ Implement experimental software (C, Java, Scilab, Matlab PCI EASI/PACE)

⇒ Supervision of research assistant in conducting experimental work, processing remote sensing images, and writing up results for publication

Space Centre for Satellite Navigation, Queensland University of Technology

March 1995 – July 1999

- **Senior Research Assistant (January 1999 – July 1999)**

⇒ Robust estimation and image matching

⇒ Detection of discontinuities through robust estimation, choice of constraints in least squares problems. Experimental software suite written in Matlab.

⇒ Ray tracing for photogrammetric matching experiments

⇒ Production of artificial stereo imagery of known terrain using computer graphics ray tracing approaches. Use of "Radiance" ray tracing software.

- **Post Graduate Studies (Ph.D. awarded 13th August 1999)**

⇒ Effect of image compression on accuracy of Digital Terrain Models produced with commercial digital photogrammetry software (Virtuozo).

⇒ A series of experiments conducted by comparing DTMs made with compressed images to those made with uncompressed images at a range of JPEG compression ratios.

⇒ Digital image compression, digital photogrammetry, image processing, and stereo image processing.

⇒ image matching algorithms developed, tested, implemented and published (Matlab, C, Java)

⇒ Least squares image matching combined with Discrete Cosine Transform encoding found to provide considerable savings in computational effort, by allowing the reduction in size of the normal equations to 10% or less, without loss of accuracy. Experimental least squares image matching software written in Java and Matlab.

⇒ Symmetric convolution found to be unsuitable for compressed domain image matching. Experimental software in C.

⇒ scientific and technical research skills, problem analysis, creative solutions with mathematical tools.

⇒ discovered new shift, scale and differentiate properties of Discrete Cosine Transform.
  ⇒ The DCT is treated as a Fourier cosine series, which admits of a continuous domain interpretation of the DCT coefficients, allowing above properties to be defined.
⇒ transform mathematics, discrete mathematics, matrices, sampling theory.
⇒ Texture based segmentation
⇒ Content-based access for image databases
  ⇒ Prototype content based access database developed by master's project student under my supervision.

- **Technical Project Manager (March 1996 – August 1997)**
  ⇒ coordinated, planned, and executed a collaborative research project with industry partner (Virtuozo).
  ⇒ effect of compression on image matching and 3D reconstruction analysed.
  ⇒ internationally published research results.
  ⇒ leadership responsibility for the imaging and photogrammetry research group.
  ⇒ setting scientific direction, establishing and maintaining an atmosphere of healthy cooperation and collaboration, and maintaining and developing partnerships with other institutions and private industry.

Microsoft Development Laboratory

June 1994 - January 1995

- **Software Engineer**
  ⇒ client consultation, requirements analysis, system design and development.
  ⇒ 'C/C++', Visual Basic, MS Access, SQL, ODBC.
  ⇒ as team member, designed, documented and developed an industrial data ware house application.
    - interface specification.
    - control module design and coding (C/C++).
  ⇒ trouble shoot Windows NT network installations.

Telstra (Telecom Australia)
September 1989 – August 1993

- **Software Engineer, System Administrator**
  ⇒ software development, commercial R & D (C, Drift 4GL).
  ⇒ knowledge collection for phone system sales expert system.
  ⇒ network traffic study for customer service centre
    - designed and installed traffic statistic collection software (Drift 4GL).
  ⇒ designed, and managed the installation of a Local Area Network.
  ⇒ developed and implemented IT Strategy in consultation with senior management.
  ⇒ reconfigured problematic Unix system for trouble free operation.
  ⇒ designed and implemented operations monitoring software.
  ⇒ successfully computerised fault reporting and monitoring system.
  ⇒ large and small project team experience, staff supervision.
  ⇒ designed and coded hard disk auditing software prior to commercial availability.
  ⇒ set-up and configure hardware and software for network PCs.
  ⇒ User training and support for Windows, Unix.

Education

- Ph.D. in Electrical Engineering, Queensland University of Technology (awarded 13th August 1999)
- Bachelor of Engineering (elec) with Honours 2A, University of Queensland, 1989
- Graduate Certificate in Mathematical Sciences, QUT, 2004

Awards

- Dean's Award for academic excellence in Graduate Certificate in Mathematical Sciences, 2004
- QUT Postdoctoral Fellowship
- QUT Postgraduate Research Award (PhD scholarship)

Memberships

Dr Reeves is a council member of the Queensland Branch of the Statistical Society of Australia, a fellow of the Royal Statistical Society, and a member of the Institute of Mathematical Statistics.

Consulting

Dr Robert Reeves has held the position of lecturer in statistics at the School of Mathematical Sciences at Queensland University of Technology since January 2005. Prior to this time he held a number of post-doctoral positions at QUT and the University of York, Toronto, Canada. He has extensive experience commenting on methodological issues associated with import risk assessment, having been involved in methodological assessments of the IRA for import of Apples from New Zealand, on behalf of Apple and Pear Australia, in both June 2004, and March 2006. He was also involved with the methodological review of the IRA for import of bananas from the Philippines in September 2004, and again in June 2007. He has also provided advice to the Australian Prawn Farmers Association on methodological aspects of the IRA process.

Research Projects

Dr Reeves is a chief investigator on the ARC Linkage project "Novel statistical analysis for traffic modeling", in conjunction with Queensland Transport and Professor Tony Pettitt of Queensland University of Technology.

Publications

C.A. McGrory, D.M. Titterington, R. Reeves, A.N. Pettitt, 2007. Variational Bayes for Estimating the Parameters of a Hidden Potts Markov Random Field. Statistics and Computing. In Press.

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Reeves, R., Lu, Y., & Friend, M. 1998. Softcopy Photogrammetry with JPEG Compressed Images. ISPRS Commission II Symposium, Data Integration: Systems And Techniques, Cambridge UK, 13th - 17th July 1998

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Lu, Y., Reeves, R., Kubik, K., 1997. Stereo Image Matching Using Probability Relaxation. Geospatial Information Age, ACSM-ASPRS Annual Convention, April 7-10, Seattle, Washington, USA

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Theses Examined

Epidemic models and inference for the transmission of hospital pathogens. Marie Forrester. 2006.

Mathematical and Statistical Modelling of Infectious Diseases in Hospitals. Emma McBryde. 2006.

Statistical Methods for Longitudinal Data. Thu Tranh. 2006.

Design, Maintenance and Methodology for Analysing Longitudinal Social Surveys, Including Applications. 2007. Nathan Domrow (Masters)

Random Effects In Regression Models For Correlated, Overdispersed And Zero-Inflated

Multivariate Count Data. 2007. Candice Hincksman. (Honours)

Personal Details

Nationality: Australian

Marital Status: Married

Date of Birth: 1-7-62

Referees

Professor Jesper Møller, Ph.D., D.Sc.
Department of Mathematical Sciences,
Aalborg University,
Fredrik Bajers Vej 7G, DK-9220
Aalborg, Denmark.
Phone: +45 96358863 (direct call), +45 96358080 (switchboard).
Fax: +45 98158129.
Email: jm@math.auc.dk.
URL: http://www.math.auc.dk/~jm

Mr Kevin Jones
Lecturer in Surveying
School of Design and Built Environment

Ph: 3864 2418
k.jones@qut.edu.au

Dr Peter Baker

Statistician,

CSIRO Mathematical and Information Sciences,
Queensland Bioscience Precinct,
306 Carmody Rd,
ST LUCIA QLD 4067,
Australia.
E-mail: Peter.Baker@csiro.au
Telephone: +61 7 3214 2210
Fax: +61 7 3214 2900

Additional Referees can be provided on request

DR MARK FEGAN

Curriculum Vitae

PERSONAL DETAILS

Date of Birth: 18 July 1964
Nationality: Australian
Work Address: School of Molecular Microbial Sciences
The University of Queensland
St Lucia, Q 4072
Phone 07-3365-9150
Fax 07-3365-4699
E-mail m.fegan@uq.edu.au

QUALIFICATIONS

Doctor of Philosophy in Microbiogy
Awarded 1992
Department of Microbiology, The University of Queensland, Australia
"*Pseudomonas aeruginosa* and cystic fibrosis"

Bachelor of Science Honours Degree (Class I)
Graduated 1987, Department of Microbiology, The University of Queensland, Australia

Bachelor of Science (Microbiology Major)
Graduated 1986

EMPLOYMENT HISTORY:

2005-Present	**Lecturer**, School of Molecular and Microbial Sciences, , The University of Queensland
2000 – 2005	**Lecturer**, Cooperative Research Centre for Tropical Plant Pathology, The University of Queensland, in the area of Plant Bacteriology
1993 – 1999	**Research Officer**, Cooperative Research Centre for Tropical Plant Pathology. Plant Bacteriologist. Development of molecular diagnostic systems for the bacterial plant pathogens *Ralstonia solanacearum* *Xanthomonas arboricola* pv. *pruni* *Clavibacter xyli* subsp. *xyli* *Burkholderia andropogonis* *Acidovorax avenae* *Pseudomonas* sp. causing bacterial stunt of cotton Clarification of the genetic diversity and phylogenetic relationships of plant pathogenic bacteria
1992 – 1993	**Postdoctoral Fellow,** UQ-CSIRO Plant Pathology Unit, The University of Queensland.Research into genetic diversity and development of probes to track the potential biocontrol agent *Metarhizium anisopliae*
1991 – 1992	**Research Fellow**, Department of Microbiology and Infectious Diseases, The University of Calgary, Alberta, Canada. Research into the pathogenic mechanisms of *Pseudomonas pseudomallei*

PROFESSIONAL MEMBERSHIPS

Member, Australian Society of Microbiology (MASM) Since 1993
Member, American Society for Microbiology since 1995

PROFESSIONAL SKILLS

- **Leading research** teams.
- **Undergraduate teaching** in the areas of Plant Bacteriology, Molecular diagnostics, Microbial diversity, Microbial Ecology, Genomics and Bioinformatics, Microbial Biotechnology
- **Postgraduate research training** of PhD, Masters and Honours students
- Participation in the development and presentation of **conferences and workshops**
  - Member of the scientific organising committee for the 3rd International Bacterial Wilt Symposium
  - Invited keynote speaker at the 3rd and 4th International Bacterial Wilt Symposia
  - Member of the organising committee for the 12th International Conference on Plant Pathogenic Bacteria to be held on Reunion Island in 2010
- Knowledge and experience of OGTR PC2/PC3 and quarantine QC2/QC3 laboratory conditions/practices
- Ability to **communicate and liaise** with industry bodies and scientific co-workers involved in a research project

RESEARCH INTERESTS INCLUDE:

- Technology leading to detection and identification of plant pathogenic microorganisms in the environment
- Ecology, Epidemiology and tracking of plant pathogenic microorganisms
- Genetic Diversity and Phylogenetic analysis of microorganisms

RESEARCH FUNDING

Year	Title of Grant, Contract or Project	Granting Agency	Amount $
2005-2008	Diagnosis and management of wilt diseases of banana in Indonesia	ACIAR	884,623
2003-2004	Development and delivery of diagnostic tests – PCR diagnostic tests for *Acidovorax avenae* subsp. *citrulli* in cucrbits	CRC for Tropical Plant Protection	20,000
2003-2004	DNA diagnostics to protect horticultural industries in Northern Australia – Blood disease and moko disease of banana	CRC for Tropical Plant Protection	20,000
1999-2000	Development of diagnostic tests for R. solanacearum race 2	AQIS	40,000
2002-2003	Development and delivery of diagnostic tests – PCR diagnostic tests for Acidovorax avenae subsp. citrulli in cucrbits	CRC for Tropical Plant Protection	20,000
2002-2003	DNA diagnostics to protect horticultural industries in Northern Australia – Blood disease and moko disease of banana	CRC for Tropical Plant Protection	20,000

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Fegan, M., P. Francis, A. C. Hayward, G. H. G. Davis and J. A. Fuerst. 1990. Phenotypic conversion of *P. aeruginosa* in cystic fibrosis. *Journal of Clinical Microbiology* **28:**1143-1146.

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Subandiyah, S., A. C. Hayward and **M. Fegan**. 1991. Fingerprint analysis of DNA fragments of *Pseudomonas solanacearum* E. F. Smith isolates. *Ilmu Pertanian (Agricultural Science)* **4:** 351-360.

Fegan, M., J. M. Manners, D. J. Maclean, J. A. G. Irwin, K. D. Z. Samuels, D. E. Holdom and D. P. Li. 1993. Random Amplified Polymorphic DNA markers reveal a high degree of genetic diversity in the entomopathogenic fungus *Metarhizium anisopliae* var. *anisopliae*. *Journal of General Microbiology* **139:** 2075-2081.

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Opina, N. L., J. N.Timmis, **M. Fegan**, and A. C. Hayward. 1995**.** Development of probes and primers for detection of *P. solanacearum*. *Philippine Phytopathology* **31:** 143-144.

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Opina, N., F. Travner, G. Hollway, J.-F. Wang, T.-H. Li, R. Maghirang, **M. Fegan**, A. C. Hayward, V. Krishnapillai, W. F. Hong, B. W. Holloway and J. N. Timmis. 1996. Development of species and strain-specific DNA probes and PCR primers fro Identifying *B. solanacearum* (Formerly *Pseudomonas solanacearum*). *Asia Pacific Journal of Molecular Biology and Biotechnology*. **5**: 19-30.

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Wen A, **M. Fegan**, A. C. Hayward, S. Chakraborty and L. I. Sly. 1999. Phylogenetic relationships among members of the *Comamonadaceae*, and description of *Delftia acidovorans* (den Dooren de Jong 1926 and Tamaoka et al. 1987) gen. nov., comb. nov. *International Journal of Systematic Bacteriology* **49**: 567-576.

Suryadi, Y., M. Machmud and **M. Fegan**. 1999. DNA primers derived from RAPD products for differentiation of biovars of *Ralstonia solanacearum*. *Hayati* **6**: 34-39.

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Facelli E, C. Taylor, E. Scott, **M. Fegan**, Geert Huys, R. Emmett, D. Noble and M. Sedgley (2005). Identification of the causal agent of pistachio dieback in Australia. *European Journal of Plant Pathology*. **112**, 155-165.

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Fegan, M. (2006). Plant pathogenic members of the genera *Acidovorax* and *Hebaspirillum*. In *Plant-Associated Bacteria*. Edited by S. S. Gnanamanickam. Springer, Dordrecht. pp. 671-702.

CONFERENCE PRESENTATIONS:

Fegan, M*., P. Francis, A. C. Hayward, G. H. G. Davis and J. A. Fuerst. 1988. Phenotypic Change in *Pseudomonas aeruginosa* from Cystic Fibrosis. Annual Meeting, Australian Society for Microbiology, Canberra, ACT

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Mills, L.M., T. M. Leaman*, D. S. Teakle, **M. Fegan** and P. W. J. Taylor. 1994. *Clavibacter*-like bacteria found as endophytes of grasses in Australia. International Society of Sugar Cane Technologists Pathology Workshop, Brisbane, Queensland.

Fegan, M*., G. R. Smith, S. Roberts, R. Van de Velde, D. S. Teakle, and A. C. Hayward. 1994. Detection of *Clavibacter xyli* subsp. *xyli* in ratoon stunting disease: a DNA-based approach. International Society of Sugar Cane Technologists Pathology Workshop, Brisbane, Queensland.

Taghavi, M., **M. Fegan** and C. Hayward*. 1994. Phenotypic and molecular approaches to strain differentiation in *Pseudomonas solanacearum*. Groundnut bacterial wilt in Asia: proceedings of the third working group meeting. ICTISAT.

Taghavi, M*., **M. Fegan**, L. I. Sly and C. Hayward. 1995. Diagnosis of *Burkholderia (Pseudomonas) solanacearum* and related bacteria with specific primers and polymerase chain reaction. 10th Biennial Australasian Plant Pathology Society Conference, Lincoln University, New Zealand.

Fegan, M*, M. Taghavi, L. I. Sly and A. C. Hayward. 1996. Phylogeny, diversity, and molecular diagnostics of Ralstonia solanacearum. Annual Meeting, Australian Society for Microbiology, Lincoln NZ

Fegan, M*., M. Taghavi, L. I. Sly and A. C. Hayward. 1997. Phylogeny, diversity, and molecular diagnostics of *Ralstonia solanacearum*. Second International Bacterial Wilt Symposium, Guadeloupe.

Fegan, M*., G. Hollway, A. C. Hayward and J Timmis. 1997. Development of a diagnostic tests based on the polymerase chain reaction (PCR) to identify strains of *Ralstonia solanacearum* exhibiting the biovar 2 phenotype. Second International Bacterial Wilt Symposium, Guadeloupe.

Henderson, J*., **M. Fegan**, G.C. Graham, B.J. Croft, G.R. Smith, R.G. Dietzgen, R.J. Henry, A.C. Hayward, D.S.Teakle, P.J. Whittle and D.J. Maclean. 1997. Detection of ratoon stunting disease in sugarcane using PCR-ELISA. P211, Summaries, Australasian Plant Pathology Society, Eleventh Bienniel Conference, Perth, Western Australia.

Fegan, M., G.C. Graham, B.J. Croft, R.J. Henry, D.J. Maclean, R.G. Dietzgen, A.C. Hayward, D.S. Teakle, J. Henderson, P.J.L. Whittle and G. Smith*. 1997. PCR-ELISA: a new sensitive test for ratoon stunting disease. International Society of Sugar Cane Technologists. 5th ISSCT Pathology and 2nd Molecular Biology Workshops, Umhlanga Rocks, KwaZulu Natal, South Africa.

Raghuwanshi, A*., **M. Fegan**, C. Hayward, L.I. Sly. 2000. Characterisation and molecular detection of a potential bacterial stunt of cotton pathogen. Abstract Book, p. 95. Ninth International Congress for Culture collections, 23-28 July, Brisbane

Raghuwanshi, A*., **M. Fegan**, C. Hayward, L.I. Sly. 2000. Characterisation and molecular detection of a potential bacterial stunt of cotton pathogen. Australian Society for Microbiology, Cairns, 8-13 July. Microbiology Australia 21(3), Melbourne, Vic. P4.21, A149

Prior, P*. & **Fegan, M**. (2002). Unravelling the Musa subgroups of *Ralstonia solanacearum* using multiplex PCR. In 3rd International Bacterial Wilt Symposium, pp. 85. White River, South Africa, 4-8 February.

Fegan, M*. & Prior, P. (2002). How complex is the "*Ralstonia solanacearum* species complex". In 3rd International Bacterial Wilt Symposium, pp. 88. White River, South Africa, 4-8 February.

Prior, P* & **Fegan, M**. (2004). Recent Developments in the Phylogeny and Classification of *Ralstonia solanacearum*. ISHS 1st International Symposium on Tomato Diseases and 19th Annual Tomato Disease Workshop, Orlando, Florida, USA. 20-24 June.

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Fegan, M*. (2005). Bacterial wilts of banana: Quarantine threats to the Australian banana industry. Sixth Australian Banana Industry Congress, Cairns, Australia, 10-13 February 2005

Prior, P.*, Guidot, A., Boucher C. & **M. Fegan** (2006). Keynote Presentation: Unravelling the *Ralstonia solanacearum* species complex. 11th International Conference on Plant Pathogenic Bacteria, Edinburgh, Scotland 10-13 July.

Subandiyah, S.*, Hadiwiyono, Nur, E., Wibowo, A., **Fegan, M**. and Taylor, P. (2006). Survival of the blood disease bacterium of banana in soil. 11th International Conference on Plant Pathogenic Bacteria, Edinburgh, Scotland 10-13 July.

Fegan, M.*, Tan, P., Dass S. and Sly, L. I. (2006). Development of a PCR-based molecular diagnostic test for the banana blood disease bacterium. 11th International Conference on Plant Pathogenic Bacteria, Edinburgh, Scotland 10-13 July.

Fegan, M.* and Prior, P. (2006). Keynote Lecture: Sub-specific characterisation and development of molecular diagnostic tests for members of the *R. solanacearum* species complex. The 4th International Bacterial Wilt Symposium, York, England 17-20 July.

Subandiyah, S.*, Edy, N., Hadiwiyono, Widada, J., **Fegan, M**. and Taylor, P. (2006). Diversity of blood disease bacterium of banana and a virulence study. The 4th International Bacterial Wilt Symposium, York, England 17-20 July.

Bagsic-Opulencia, R., Raymundo, A.K. and **Fegan, M.*** (2006). Development of a PCR- based molecular diagnostic test for *R. solanacearum* Phylotype II Sequevar 3 strains causing bacterial wilt of banana. The 4th International Bacterial Wilt Symposium, York, England 17-20 July.

Das, R. N., Sly, L.I. and **Fegan, M.*** (2006). Molecular diversity of moko disease causing strains of *Ralstonia solanacearum*. The 4th International Bacterial Wilt Symposium, York, England 17-20 July.

Hayward, A.C. and **Fegan, M.*** (2006). Fruit rots of banana caused by *Ralstonia solanacearum* race 2: questions of nomenclature, disease dissemination and control. The 4th International Bacterial Wilt Symposium, York, England 17-20 July.

Nouri, S., **Fegan, M.*** and Bahar, M. (2006). Evaluation of the diversity of *Ralstonia solanacearum* isolates causing disease of potato in Iran and the first report of biovar 2T in Iran belonging to phylotype II of the *R. solanacearum* species complex. The 4th International Bacterial Wilt Symposium, York, England 17-20 July.

Anthony Nicholas PETTITT

Qualifications	:	1969 BSc (Hons)(Nott'm)
		1972 MSc (Nott'm)
		1974 PhD (Nott'm)
Current Appointments	:	Head, School of Mathematical Sciences and Professor,
		Queensland University of Technology (QUT) (on leave)
	:	Professor of Applied Statistics, Lancaster University, UK.

Recent Employment History

1989 – 2007	:	Head, School of Mathematical Sciences and Professor
1987 – 1989	:	Principal Research Scientist, CSIRO Division of Maths & Stats, and Biometrics Unit.

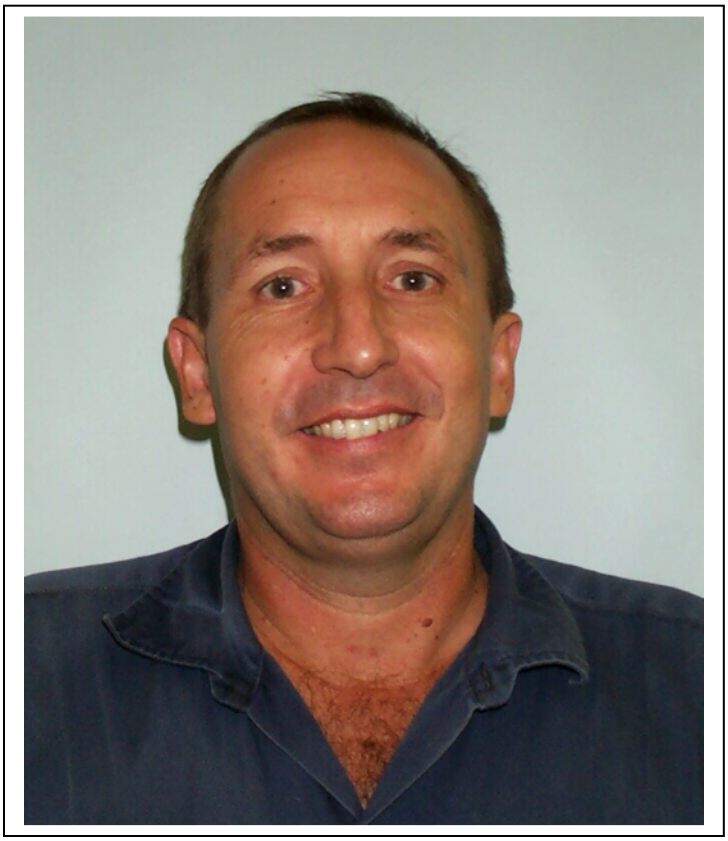
Recent Highlights

- Published over 80 papers in high ranking internationally refereed journals in theoretical and applied statistics such as Biometrika, Journal Royal Statistical Society Series B, Biostatistics, Applied Statistics, Biometrics, Statistics & Computing, covering such topics as Bayesian statistics and hierarchical models, reliability and survival analysis, control charts and statistical monitoring, transmission of diseases, motor unit number estimation.
- One (1999 – mid 2002) of the three co-editors of the journal of *Biometrics*, a highly rated refereed international journal publishing statistical theory related to biological sciences.
- Since 1993 holder of five Australian Research Council Large/Discovery Grants as principal investigator, nine ARC SPRIT /Linkage/Collaborative Grants (six as principal investigator).
- Member of ARC's Large Grants and Fellowships Physics and Maths sub-panel 1998-2000; member ARC's Special Research Centre panel 1999; Member ARC Expert Panel, Maths, Information and Computer Sciences, 2001.
- Member of New Zealand Higher Education Performance Based Research Funding maths, information and computer sciences assessment panel, 2003.
- Invited keynote speaker for Australasian Biometrics conference December 2001; invited speaker for the Statistical Society of Australia Conference 2002, 2004,2006. Invited participant in the Isaac Newton Institute Workshop, Cambridge UK , 30 October – 2 November, 2006.
- Organiser of invited sessions for Statistical Society of Australia Conference 2000, and International Biometrics Conferences, July 2002, July 2004, July 2006. Chair, scientific committee, Biometrics 2007, Coffs Harbour, NSW.
- Co-author of a paper on motor unit number estimation read to the Royal Statistical Society, London, November, 2006 (only 9-10 papers are read each year)

- Principal supervisor of sixteen completed PhD theses and four masters theses. Current principal supervisor of three PhD students two under examination) and two masters students. External examiner of recent PhD theses of Monash, Wollongong, Melbourne, Adelaide, Queensland universities
- Acted as expert witness for Australian Pork Ltd vs Director of Quarantine, Federal Court, Sydney, December 2004 giving advice on import risk assessment.
- On going expert advice (April 2004 onwards) on import risk assessment of apples from New Zealand (draft IRAs 2004 and 2005) to Apple & Pear Australia Ltd and as a consequence to Biosecurity Australia.
- On going expert advice (April 2004 onwards) on import risk assessment (draft IRA 2004) of bananas from Philipines to Australian Banana Growers Ltd.

RESUMÉ

RICHARD PIPER



PERSONAL DETAILS

NAME:	Richard George Piper
RESIDENTIAL ADDRESS:	Lot 1, Cowley Beach Rd, Cowley Beach 4871 Qld Australia
POSTAL ADDRESS:	P.O. Box 166 Mourilyan 4858 Qld Australia
TELEPHONE NUMBER:	0417 644 660 (W) 07 4065 4975 (H)
FACSIMILE NUMBER:	07 4065 4991
E-MAIL ADDRESS:	richard@saspl.com.au
WEB SITE:	www.saspl.com.au
DATE OF BIRTH:	19 August 1958
MARITAL STATUS:	Married with 2 children aged 12 and 16 years
LANGUAGES:	English, limited French

EDUCATION AND QUALIFICATIONS

1984	Graduate Diploma in Plant Protection with Distinction Qld Agricultural College, Lawes. RNA Prize in Plant Protection, Qld Agricultural College Outstanding Achievement Award
1982	***Bachelor of Science (Hons)*** University of Queensland, St Lucia Graduated with First Class Honours in Entomology (taxonomy) Journal article published from this study
1979	***Bachelor of Science*** University of Queensland, St Lucia Majors in botany (plant pathology and taxonomy) and entomology (all subject areas). F.A. Perkins Prize in Entomology.
1976	***Senior Certificate*** and ***Junior Certificate*** completed at Church of England Grammar School, East Brisbane ***Awarded First Prize in Queensland Science Contest (1975) for a project on marine invertebrates.***

WORK HISTORY

1993 – Current	Self-employed agricultural consultant. Research Director of Scientific Advisory Services Pty Ltd

Responsibilities include:

- Providing independent source of advice to growers and other clients on plant protection. This has led to pesticide reduction, increased fruit yield and quality as well as increased profitability for growers.
- Environmental officer in charge of maintaining ISO14001 accreditation for a number of large banana farms.
- Performing efficacy and residue trials on a number of plant protection chemicals (including bifenthrin, carbofuran, chlorpyrifos, fipronil, oxamyl and spinosad) leading to successful registration and label changes for some of these products.
- Consulted with Innisfail Papaw and Other Fruit Grower's Association on the preparation of " A Submission for the Approval of High Temperature Forced Air Disinfestation Treatment for Papaw Fruit Produced within the North Queensland Quarantine Area for Papaya Fruit Fly" (1996) This protocol has been accepted by all Australian states.
- Prepared "Position Paper on Tropical Fruit Crops in Relation to the Papaya Fruit Fly in North Queensland" (1996) for local State member, Mr. M. Rowell for the information of members of the Qld State Parliament.
- Appeared on behalf of Australian Banana Growers Council at Senate Inquiry into Biosecurity Australia's handling of the banana IRA for Philippine bananas at Parliament House, Brisbane in 2005
- Facilitating increased grower understanding of integrated pest management techniques.
- Clients have included individual growers, government agencies (QDPI), private industry (eg. Bayer CropSciences, Rhone Poulenc, Dow, Du Pont, FMC, Cyanamid, Chiquita, Chep, Coles) and industry bodies (Qld Fruit & Vegetable Growers Organisation and Australian Banana Growers Council).
- Developing a successful company web site that has fostered business and international networking.
- Successfully negotiating sponsorship from private companies, industry and government organisations for production of information material (posters).
- Production of large colour wall posters on plant protection in a range of crops.
- As the sole operator of this business, responsible for all aspects of running a business including financial management, preparing quotations, maintaining good customer relations, providing reliable service to customers, advertising and promotion, maintaining an office, laboratory and 4WD vehicle.

1990 – 1993	Entomologist Qld Department of Primary Industries South Johnstone Research Station

Responsibilities included:

- Development of integrated pest management in bananas.
- Significantly contributed to an increased understanding of pest/predator population dynamics in banana plantations.
- Increased grower awareness of integrated pest management practices to banana growers through field days, meetings, magazine articles and other methods.
- Prepared faunal inventories for banana plantations in north Queensland and south-east Queensland.
- Co-authored a book on integrated pest management in bananas.

1988 – 1990	Research Assistant University of Sydney, Army Malaria Research Unit (AMRU) under Dr A. Sweeney based at Cowley Beach, Qld

Responsibilities included:

- Collection and processing of diseased larval mosquitoes through northern Australia.
- Identification of an alternative copepod host for a disease of mosquito larvae. Described a new species of microsporidian parasite and its life cycle. Results published.
- Established records of a number of diseases of mosquito larvae in northern Australia.
- Provided a regular supply of mosquito larvae and micro-crustaceans to AMRU laboratory in Sydney.

1984 – 1988	Entomologist Qld State Health Department, Vector Control Unit, Cairns

Responsibilities included:

- Education, monitoring and control of mosquitoes across Queensland.
- Raised public and local government awareness of methods of integrated mosquito management.
- Conducted a research project on rice field mosquitoes at Mareeba. This confirmed mosquito breeding in the rice fields did not directly cause the biting nuisance in the town area. Results published.
- Conducted studies on biting and resting habits of adult mosquitoes in the Torres Strait Islands. This study led to the abolition of annual household insecticide spraying and subsequent lifestyle improvement for the communities.
- Prepared and conducted training courses for mosquito control personnel.

INTERNATIONAL EXPERIENCE

November 2006	Consultant to Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture Insect and Pest Control Section, Austria. Travelled to Vienna, **Austria** and worked with Division entomologists to prepare posters on old and new world screwworm flies. Work in progress
Dec 2005	Consultant entomologist to Australian Banana Growers Council on a project in **New Zealand** to examine various aspects of banana fruit quality.
2002	Collaborating with the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture Insect and Pest Control Section, Austria to produce wall posters featuring major fruit fly pests of the world.
Jan 2000	Consultant entomologist on a fact finding team organised by the Australian Banana Growers Council, which visited banana-growing areas in the **Philippines**. Assessed pest problems in view of possible banana fruit imports from this country.

Responsibilities include:

Provision of resource material on banana pests and fruit flies for quarantine agencies throughout the world.

Private travel: Brazil, Singapore, Thailand, Hawaii, United Kingdom, New Zealand, Sweden, Taiwan, Hong Kong, France, Germany, and Austria.

SUNDRY EXPERIENCE

1982

Full-time assistant at Alan Fletcher Research Station, Sherwood. Qld Department of Lands working with entomologist, Mr. B. Wilson.

Responsible for maintenance of food plants and insect colonies (bruchid beetles and pyralid moths), and host testing for potential weed bio-control agents.

1980 – 1981

Research Assistant

University of Queensland Entomology Department working with Professor D. Kettle on pathogens of blood sucking flies.

Work involved preparation of specimens for light and electron (transmission & scanning) microscopy. Described 3 new species of microsporidian parasites of mosquito larvae.

During University Studies- Vacation work (3 months)

Assistant to entomologist, Mr. A. Allwood

Northern Territory Department of Primary Industries

Work involved:

Regular fruit collection at a number of field sites.

Rearing and identification of any fruit flies present in samples.

Preparation and submission of a written report upon completion.

Casual jobs at Dandy Bacon, several plant nurseries, Rothwell's Menswear and BCC.

SKILLS ACQUIRED

Effective Communication and Teamwork:	Demonstrated through: Liaison with growers on plant protection issues on their farms. Communication with technical and R& D staff of

	chemical companies on joint trial work, Maintenance of close working relationships with government scientists engaged in tropical fruit research, Delivering informal presentations to company staff and farmer groups on work undertaken.
***Personnel Management*:**	Demonstrated through: Effective management of casual technical assistants employed periodically, as well as work experience students. Awareness of Occupational Health and Safety obligations and issues.
Technical Skills:	Demonstrated through: Ability to communicate effectively with a range of technical and non-technical clients. Trial protocol preparation, establishment and monitoring of efficacy and residue trials for agricultural chemicals. Prepare written reports on trial work in a suitable format for presentation to the National Registration Authority for Agricultural and Veterinary Chemicals. Safe and responsible use of agricultural chemicals – Chem Cert accredited 2002. Preparation of educational posters on pest management. Photography both macro- and micro-photography. Routine ELISA testing of banana leaves for leaf disease. Qld Ambulance Service First Aid Certificate. Preparation of biological samples for histology and electron microscopy.
Time and Project Management:.	Attended Day Timers course 2000. Developed autonomous time management to ensure trial and monitoring work is undertaken in conjunction with timely verbal and written reporting to grower and chemical company clients.
Information Technology	Demonstrated through:

Competent use of software packages including:

- Excel (data spreadsheet, graphics)
- Word (report writing),
- Outlook Express (email),
- Powerpoint (presentations),
- Statistix (data analysis),
- Pagemaker (desktop publishing) and
- Front Page (web page design)

Use of the internet for research and communication.

Vehicle/Machinery Use:

Demonstrated through:

- Open driving licence,
- Speedboat licence.
- Competent operator of tractors, 4 wheel motorbikes,
- Able to safely use and calibrate pesticide application equipment.

PUBLICATIONS

Books:

Bananas - Insect and Mite Management, (1994) Pinese, B. & Piper, R. (1994) DPI, Brisbane.

Refereed Journals:

An *in vitro* study into the effects of glyphosate on *Sclerorium rolfsii*. (2007) Australasian Plant Disease Notes 2:23-24

Distribution of anopheline mosquitoes in northern Australia. (1996) Cooper, R.D., Frances, S.P., Waterson, D.G., Piper, R.G. and Sweeney, A.W. J. American Mosquito Control Association 12: 656-663

Life cycle of a new species of *Duboscqia* (Microsporida: Thelohaniidae) infecting the mosquito *Anopheles hilli* and an intermediate host, *Apocyclops dengizicus* . (1993) Sweeney, A.W., Doggett, S.L. and Piper, R.G. J. Invertebrate Pathology 62: 137-146

Mosquitoes from ricefields at Mareeba, north Queensland, Australia. (1992) Kay, B.H., Piper, R.G., Falk, P.E., Battistutta, D., Fanning, I.D. and Lisle, A.T. General and Applied Entomology 24: 19-32

Life cycle of *Amblyospora indicola* (Microspora:Amblyosporidae), a parasite of the mosquito *Culex sitiens* and of *Apocyclops* sp. copepods. (1990) Sweeney, A.W., Doggett, S.L. and Piper, R.G. J. Invertebrate Pathology 55: 428-434

Larval aggregation in *Aedes vigilax* (Skuse) (Diptera: Culicidae) (1988) Piper, R.G. Australian Entomological Magazine 15: 119-121

Light and electron microscope studies on three new species of Microsporidia from saltmarsh mosquitoes in Australia (1988) Kettle, D.S. and Piper, R.G. European J. of Protistology 23: 229-241

Escape behaviour of insects on fire blackened tree trunks in East Gippsland. (1987) Piper, R.G., Olden,G.A. and Traill E.H. Australian. Entomological Magazine 14:31-33

The male genitalia of some Australian Rhyparochromini (Hemiptera: Lygaeidae) Piper, R.G. (1985) J. Australian Entomological Society 24: 45-56

Conference Papers:

Management of burrowing nematodes in bananas using pseudostem injection of Vydate L. (2001) Pattison, A, Versteeg, V., McQuinn, D, Mathews, N., Farnsworth, W. & Piper, R. Plant Pathology Conference Cairns.

Integrated pest management in bananas and papaws in north Queensland. (1992) Australian Association of Agricultural Consultants. National Convention (Invited speaker)

Water impoundments and their implications for the development of northern Australia (1986) Barker-Hudson, P., Piper, R. and Kay, B. Proceedings of Fourth Symposium Arbovirus Research in Australia

Conferences Attended Recently

7th International Symposium on Fruit Flies of Economic Importance (Bahia Salvador, Brazil September 2006) Held a trade display.

International Congress of Entomology (Brisbane, 2004) Held a trade display. Joint paper on Banana pest management.

Banana Congress (Townsville 4-7 June 2003) Held a trade display.

6th International Symposium on Fruit Flies of Economic Importance (Stellenbosch, South Africa 6-10 May 2002) Held a trade display.

Posters:

"Moscas de la Fruta Consideradas Plagas en el Mundo" – International Atomic Energy Agency /FAO sponsor. (2 poster set in Spanish)

"Fruit Fly Pests of the World" (2002) – International Atomic Energy Agency/FAO sponsor. (2 poster set in English)

"Pests and Beneficials of Papaya in Australia" (2001) - Papaya growers of Queensland (QFVG) sponsor.

"Fruit Flies of Australia 2" (2000) - Pest management company sponsor.

"Banana Bell Injection" (1998) - Agrichemical company sponsor.

"Fruit Flies of Australia" (1996) - Banana grower sponsor.

"Insect and Mite Pests of Bananas in Australia" (1994) - Agrichemical company sponsor.

A visual representation of all posters available on company web site: www.saspl.com.au

Have also produced posters on Invasive Weeds of Micronesia (set of 6 posters) and a Quarantine poster for Micronesian ports/airports (SPC, Micronesia), in addition to photography for posters on banana packing and fruit quality (Chiquita) and sugarcane grubs (Bayer CropSciences).

VIDEOS

"Philippines Study Tour 2000" (2000) for Australian Banana Growers Council

Regent promotional video.

Alexander Farm, Daintree produced for the Queensland Department of Primary Industries & Fisheries.

INTERESTS AND HOBBIES

Secretary and Treasurer Officer Cowley Beach Rural Fire Brigade

Member of Cowley Beach Sporting and Development Association.

Member of Entomological Society of Queensland

Member of Australian Entomological Society

Family, fishing/boating, bee keeping including pollination services, , camping, bushwalking, tropical vegetable, fruit and ornamental gardening, photography (Macro- video and still), travel, plant propagation.

REFEREES

Mr. Bruno Pinese,

Senior Entomologist ,

Queensland Department of Primary Industries

Mareeba

07 4048 4600

Mr. Allan Melita

Banana Grower

Boogan

07 4064 2289

CURRICULUM VITAE

Name:	**Ronald Allan Peterson**
Languages spoken:	English
Profession:	Plant Pathology
Educational qualifications:	Bachelor Agricultural Science (B.Ag.Sc.);
	Masters Agricultural Science (M.Ag.Sc.)
Professional memberships:	Australian Plant Pathology Society;
	Pacific Association of Tropical Phytopathology.

Specialist areas of expertise:

- Thirty seven (37) years (1967-2004) with the Queensland Department of Primary Industries, principally as a Plant Pathologist working with diseases of horticultural crops.
- Two (2) years (2005-2007) as a Consultant (Plant Pathology) principally with the Australian Banana Growers Council.
- Tropical and subtropical fruit and plantation crops, in particular bananas, papaws, mangoes, avocados and exotic tropical fruits.
- Vegetable crops in the dry tropics, in particular tomatoes, capsicums, melons, cucumbers and other cucurbits.
- Over thirty (30) years experience with banana diseases in particular with the Sigatoka diseases.
- With yellow Sigatoka, principally control programs (chemical, cultural, integrated management programs), fungal resistance management (detection methodology, development of anti-resistance strategies) and prediction systems (biological and climatic) to reduce chemical usage and optimise levels of control.
- With black Sigatoka, principally disease identification, development of contingency plans, exclusion strategies (surveillance, 800km buffer zone, training of local groups, growers) development of and operation of eradication strategies (9 outbreaks eradicated in Cape York), and resistance assessments of banana cultivars in Torres Strait Islands (BIPB/HRDC) and as part of international programs in Tonga, Western Samoa, Cook Islands and Papua New Guinea (ACIAR, INIBAP, IMTP, BIPB).
- Participated in early black Sigatoka eradication programs at Bamaga (1981) and upper reaches of Pascoe River (1991), managed the eradication programs at Bloomfield (1993), Weipa (1996), Daintree (1997) lower reaches of Pascoe River (1998) and the reinfestation at Bamaga (1999). Technical advisor at the upper Daintree (2000), technical manager at Tully 2001-02 and technical supervisor to the QFVG "Black Sigatoka Area Freedom Program", Tully (2002-03), Chairman of the Technical Working Group (pathologists from each banana state) to the Black Sigatoka "Area Freedom" Program May 2002 to May 2003.
- Other banana diseases; participated in the identification, surveillance for and eradication of bacterial wilt of Heliconia (race 2, Moko in bananas), identification of diseases new to north Queensland (rust, southern Cordana leaf spot, Cladosporium leaf spot).
- Papaw diseases; root disease complex (*Phytophthora palmivora* and *Pythium* sp) and fungal diseases of leaves and fruit (black spot, brown spot, powdery mildew).
- Mango diseases; flower and fruit diseases.

- Peanut diseases; soil borne diseases.
- Fusaruim wilt diseases of tomato, ginger, banana, cucurbit and heliconia, including race identification, screening for resistance, chemical control (fumigants), physical control measures (solarization) and cultural strategies (rotation).
- General disease identification and diagnoses in both the field and laboratory, especially fungal diseases of horticultural crops.
- Quarantine issues - contingency plans (black Sigatoka, coffee rust), eradication programs (black Sigatoka and Moko of bananas and citrus canker), quarantine breach surveys (downy mildew and boil smut of maize, black spot and ring-spot of papaw, ergot of sorghum, and Cercospora blotch and sunblotch of avocado) and disease inspection at North Queensland Quarantine houses.

Publications:

- At least 65 publications in Scientific, QDPI, Industry, Plant Health Australia literature.
- Recent publications revellent to the IRA Import Risk Assessment for bananas from the Philippines:
  - Peterson, RA. (1997). Black Sigatoka Control in Banana (HRDC FR024). Final report to Horticulture Research and Development Corporation, Banana Industry Protection Board and Queensland Fruit and Vegetable Growers.
  - Peterson, RA., (1999). Black Sigatoka Exclusion Strategies (HRDC FR538), Banana Replacement Program (HRDC FR550). Final Report to Horticulture Research and Development Corporation, Banana Industry Protection Board and Queensland Fruit and Vegetable Growers.
  - Peterson, RA., (2001). Report on the "II International seminar on black Sigatoka and its combat" and visits to CORBANA and banana plantations in Costa Rica). Horticulture Research and Development Corporation, Queensland Fruit and Vegetable Growers and the Department of Primary Industries, Queensland.
  - Peterson, RA., (2002). Black Sigatoka Eradication-Controlled Management Program - Tully Banana Production Area 2001-02. Department of Primary Industries, Queensland.
  - Peterson, R., Treverrow, N., Kumar, S., Pitkethley, R. and Tree, C., (2003). Agreed Protocol to demonstrate Black Sigatoka Area Freedom for the Tully Banana Production Area. Department of Primary Industries, Queensland.
  - Peterson, RA., (2003). Black Sigatoka Area Freedom Program 2002-2003, for the Tully Banana Production Area. Department of Primary Industries, Queensland.
  - Peterson, RA., (2006). Report on the "International Congress - Management of black Sigatoka in banana and plantain for Latin America and the Caribbean", San Jose, Costa Rica, and visits to CORBANA St Rita laboratory and 28 Mila Research Station and commercial banana plantations and packing sheds. Australian Banana Growers Council.
  - Peterson, RA., Grice, KRE., and Wunch A. (1998). Report on the survival of *Mycosphaerella musicola*. Queensland Horticulture Institute, Department of Primary Industries, Queensland.
  - Peterson, RA., Grice, K. and De La Rue, S. (2003). Management of *Mycosphaerella* leaf spot diseases in Australia. Pp 271-276 in "Proceedings of the 2nd International workshop on Mycosphaerella leaf spot diseases", Costa Rica. Eds Jacome et al, INIBAP, Montpellier, France.
  - Peterson, RA., Grice KRE. and Goebel, R. (2005). Eradication of black leaf streak disease from banana-growing areas in Australia. Infomusa 14:2:7-10.
  - Peterson, RA., Piper, R. and Poljak, M. (2006). Inspection of Philippine bananas in New Zealand. Report prepared for the Australian Banana Growers Council.
  - Henderson, J., Grice, K., Pattemore, J., Peterson, R. and Aitken, E. (2002). Improved PCR-based detection of Sigatoka disease and black leaf streak disease in Australian banana

crops. Pps 59-64, in "Proceeding of the 2nd International workshop on *Mycosphaerella* leaf spot diseases", Costa Rica 2002 . Eds Jacome, L. et al, INIBAP Montpellier France.

- Jorgensen, K., Cannon, R. and Peterson, R., (2004). Pest Free Area Guidelines: A case study – Tully Banana Black Sigatoka. Report prepared for Plant Health Australia Ltd and Australian Government Department of Agriculture, Fisheries and Forestry.
- Lindsay, S., Vawdrey, L., Peterson, R., Reeves, R. and Petit, A. (2005). Research Report - Exp 1-Determining the depletion rate of available chlorine, in the presence and absence of alum, in a commercial banana packing facility; Exp 2- Determining replenishment and monitoring strategies for maintaining 20 ppm available chlorine in a commercial banana packing facility. Conducted by the Department of Primary Industries and Fisheries, Queensland for Australian Banana Growers Council.

Curriculum Vitae

Dr. Robert A. FULLERTON

Qualifications

Diploma of Horticulture (Hons). Queensland Agricultural College.

B. Ag. Sc (Hons). University of Queensland.

PhD (Plant Pathology). University of Queensland.

Current position

Science Leader Applied Plant Pathology, Bioprotection Group, The New Zealand Horticulture and Food Research Instituted Ltd (HortResearch), Mt Albert Research Station, Auckland, New Zealand.

Background and Experience

35 years experience in applied plant pathology in HortResearch and its predecessor organisations, the New Zealand Department of Scientific and Industrial Research (DSIR) Plant Diseases Division, and DSIR Plant Protection

Currently

Activities within New Zealand have focussed on disease problems of temperate fruit (e. g. kiwifruit, apple, citrus, grape), vegetable (particularly onions) and arable (wheat oats) crops. Through a 30+ year association with horticulture in the Pacific Island Countries, have been involved with subsistence and commercial scale production of most food and export crops throughout the region.

Other Roles and Responsibilities

1977-1992. Scientist-in-Charge, Totokoitu Research Station, Cook Islands.

A long-term Regional Development Assistance project funded by the New Zealand government supporting crop development programmes in citrus, pineapples, banana, papaya, coffee, vanilla, taro and vegetables in Cook Islands, Niue, Samoa and Tonga.

1991-1994. Project Manager, New Zealand/Cook Islands Fruit Fly Disinfestation Project.

A NZ$1.5m project for the development and commercial introduction of heat treatment technology for fruit fly disinfestation of papaya as an alternative to EDB fumigation

1996-1998. Project Coordinator, New Zealand/Government of Tonga Fruit Fly Disinfestation Project. Installation of a heat treatment facility to allow market access to the New Zealand market for Tonga papaya and vegetable industries.

1999-2002. Project leader. Plant pathology (taro leaf blight) component of the AusAID/SPC Regional Taro Conservation and Utilisation Project - development of selection methods for blight resistant genotypes in Papua New Guinea/ Samoa.

2001-2003. Project leader. Samoa Agricultural Mentoring Project. A capability building programme for Samoan researchers in Plant Protection.

2001. Team leader. Analysis of prospects for commercial fruit and vegetable production in Vanuatu.

2002. Consultant. Review of the Research and Development Programme of the Cook Islands Ministry of Agriculture.

2004. Design and presentation of Tonga In-Country Training Programme

'Pest and Disease Recognition and Control' - Tongatapu, Vava'u and Ha'apai.

2005. 'Training of trainers' for the course 'Pest and Disease Recognition and Control' on behalf of Secretariat for the Pacific Community, Tonga.

Experience relevant to banana black leaf streak

Bananas were a major export crop for the Pacific Island Countries of Cook Islands, Samoa and Tonga throughout the 1970s and up to the mid-1980s. The single greatest threat to production was black leaf. Accordingly there was a significant research focus on its control, particularly by fungicides. Milestones in that initiative for which I was personally responsible were:

- Identification of resistance to benzimidazole fungicides (benomyl, carbendazim) in Samoa in 1979 and subsequently in Tonga (1985) and Cook Islands (1987) and withdrawal of these fungicides from control programmes in the region.
- Demonstrated efficacy of the triazole fungicides for control and the adoption of propiconazole (Tilt) (alternated with mancozeb) as the mainstay of control throughout the region.
- 1980. Evaluation of germplasm from the Jamaica banana breeding programme for resistance to black leaf streak in Cook Islands. Identification of the diploid parent Paka and its tetraploid progeny T8 (subsequently known as Tu8) as being highly resistant.
- 1989. Observation of the field breakdown of resistance in Paka and T8, isolation and confirmation of a new strain virulent on Paka
- 1992. Demonstration of pathogenic variability in *Mycosphaerella fijiensis*, and identified strains with virulence on Paka and juvenile Calcutta 4 (the latter the principal source of resistance in breeding programmes in Honduras, Caribbean and West Africa.

Over that period worked in close collaboration with a range of international organisations including, CIRAD, INIBAP, IITA, ACORBAT, FHIA and CATIE.

1998. Invited participation in the meeting of the International Musa Improvement Group, Doula, Cameroon, Africa.

2000. Invited participation in the international meeting of the International Musa Improvement Programme. Bangkok, Thailand.

1998-2000. Co-chairman, Sigatoka Working Group, ProMusa, International Musa Improvement Group.

2002. Invited speaker and member of an expert panel on banana Sigatoka diseases, XV International Meeting of the Asociación para le Cooperación en Investigación de Banana en el Caribe y América Tropical (ACORBAT), Cartagena de Indias, Columbia 22 Oct-2 Nov 2002.

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Contact Details

Dr Bob Fullerton

Science Leader - Applied Plant Pathology

HortResearch

Mt Albert Research Centre

Private Bag 92169

Auckland 1142

New Zealand

Ph. 61 9 8154200 Ext 7311

Fax. 61 9 8154201

Mob. 0275581942

Email. rfullerton@hortresearch.co.nz