CHAPTER TEN

THE UNRESTRICTED RISK POSED BY *ERWINIA AMYLOVORA*

Introduction

10.1 This chapter initially discusses the scientific evidence on the probability of entry, establishment and spread of *Erwinia amylovora* in Australia from the importation of New Zealand apples. In the draft IRA, BA assessed the probability of entry of *Erwinia amylovora* into Australia as "low", the probability of establishment as "high" and the probability of spread as "high". Accordingly, based on the matrix for combining descriptive likelihoods detailed in Chapter Seven (Table 7.2), BA assessed the overall probability of entry, establishment and spread of *Erwinia amylovora* as "low".

10.2 In turn, the chapter considers the economic consequences of the entry, establishment and spread of *Erwinia amylovora* in Australia. In the draft IRA, BA assessed the economic consequences if *Erwinia amylovora* were to enter, establish and spread in Australia as "extreme". Accordingly, based on the risk estimation matrix in Chapter Seven (Table 7.4), BA assessed the unrestricted risk associated with *Erwinia amylovora* as "moderate".[1] This is shown in Table 10.1 below.

Table 10.1: BA's Unrestricted Risk Assessment of Erwinia amylovora

Probability of: Entry (P1)	**Establishment (P2)**	**Spread (P3)**	**Probability of entry, establishment and spread (P = P1xP2xP3)**	**Economic Consequence (C)**	**Unrestricted Risk (R=PxC)**
Low	High	High	Low	Extreme	Moderate

10.3 Each of the above ratings in the unrestricted risk assessment in the draft IRA was keenly disputed in evidence. In particular, various Australian parties argued that the allocation of a "low" rating by BA to its assessment of the probability of entry of *Erwinia amylovora* understates the risk. By contrast, the New Zealand Government argued that the above ratings considerably overstate the risk.

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1 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, p 93

The Probability of Entry of *Erwinia Amylovora*

10.4 As discussed in Chapter Seven, in the draft IRA, BA assessed the probability of entry of *Erwinia amylovora* into Australia according to two components, each comprising four steps:

a) the likelihood of importation; and

b) the likelihood of distribution.

10.5 In the draft IRA, BA assessed the likelihood of imported New Zealand apples being either infested or infected with *Erwinia amylovora* as "high", but assessed the likelihood of distribution of the bacterium as "low". Accordingly, BA assessed the probability of entry of *Erwinia amylovora* into Australia as "low".

10.6 Importantly, it should be noted that BA's assessment of a "low" probability of entry of *Erwinia amylovora* is based solely upon its assessment of steps 3 and 4 of the distribution pathway. Put simply, BA argued that *Erwinia amylovora* would be unlikely to make the jump from discarded apples to a host in the environment in sufficient numbers to initiate an infection. The four steps of each of the importation and distribution pathways are discussed below.

The Likelihood of Importation

IMPORTATION STEP 1: SOURCE FRUIT

10.7 BA indicated in the draft IRA that if symptomless fruit were sourced from orchards in which *Erwinia amylovora* were present, or from orchards near to a site of active infection, then it would be likely that at least some fruit would either be infested or infected with the bacterium.[2]

Infestation of the Calyx of Fruit

10.8 In the draft IRA, BA nominated infestation of the calyx and stem of New Zealand apples with *Erwinia amylovora* as the major concern. As discussed in Chapter Nine, it is possible for *Erwinia amylovora* to be retained in remnant flower parts at the end of the blossoming period, subsequently being incorporated in the calyx-end of the apple as it matures. *Erwinia amylovora* can remain in this relatively protected niche without damaging the fruit, or producing a visible bacterial colony.[3]

10.9 The possibility that *Erwinia amylovora* may infest the calyx end of immature apples is well established. In this regard, BA cited in the draft IRA Hale *et al* (1987)

2 *Ibid*, p 82

3 *Ibid*, p 77

and Clark *et al* (1993).[4] The Committee obtained these studies and cites their major findings below.

10.10 Hale *et al* (1987) reported that *Erwinia amylovora* may survive epiphytically on immature and mature apple fruit in orchards which are severely infected (75 strikes/tree) with *Erwinia amylovora*, although the severity of infestation declines with maturity:

> Apple orchards with different levels of fire blight were surveyed through the 1984-85 season for the presence of *Erwinia amylovora* on the surface of shoots, flowers and fruits at different stages in development up to full maturity. … In an orchard with 75 infections/trees, *Erwinia amylovora* was detected regularly from shoots, flowers, immature and mature fruit. However, in this orchard the frequency of detection of the pathogen in washings from maturing fruit declined from 50 per cent of fruit sampled for fruitlets to 3 per cent for mature fruits.[5]

10.11 Clark *et al* (1993) isolated *Erwinia amylovora* from the calyx of 21.8 per cent of immature fruit harvested from orchards showing symptoms of fire blight. When orchards without symptoms of fire blight were examined, the rate of calyx infestation was measured between 6.7 per cent and 87 per cent.[6] BA commented

> Differences between the results of Hale *et al* (1987) and those of Clark *et al* (1993), and the surprising range in the rate of calyx infestation for fruit from healthy orchards (Clark *et al*) illustrate that while a range of factors may determine the proportion of apparently healthy fruit infested with *Erwinia amylovora*, all orchards in areas of New Zealand where the disease is endemic represent a potential source of infested fruit.[7]

10.12 In addition to these papers cited in the draft IRA, the Committee notes research by Thomson *et al* (1999) conducted in Utah. Thompson *et al* (1999) indicated that *Erwinia amylovora* was not detected in flower samples in early bloom taken from an orchard with fire blight, but that over a 2-3 day period, the incidence of the bacterium in blooms increased to almost 100 per cent. They attributed this to insect activity:

> *Erwinia amylovora* was first detected on washes of bulked insects caught … on the same day that the bacterium was first detected on the flowers.

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4 *Ibid*, p 81

5 C.N.Hale, E.M.McRae & S.V.Thomson, 'Occurrence of *Erwinia Amylovora* on Apple Fruit in New Zealand', *Acta Horticulturae*, (Vol 217, 1987), p 33

6 R.G.Clark, C.N.Hale and D.Harte, 'A DNA Approach to *Erwinia amylovora* Detection in Large Scale Apple Testing and in Epidemiological Studies', *Acta Horticulturae*, (Vol 338, 1993), p 81

7 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 81

> Flowers on branches covered with nets to exclude insects did not become colonised.[8]

10.13 The possibility that *Erwinia amylovora* may infest the calyx of immature fruit raises the question whether fully mature symptomless apples may also harbour *Erwinia amylovora*. BA indicated in the draft IRA that infestations of *Erwinia amylovora* have been isolated in mature symptomless apple fruit by various researchers including Hale *et al* (1987) (noted above), Sholberg *et al* (1988), van der Zwet *et al* (1990) and McManus and Jones (1995). The Committee obtained these studies and cites their major findings.

10.14 Sholberg *et al* (1988) found that 100 per cent of mature apple leaves and fruit harvested from symptomless apple trees inter-planted with severely blighted trees at four different locations in British Colombia were infested with *Erwinia amylovora*:

> Apple leaves and fruit adjacent to fire blighted Bartlett pear trees at four locations in the Okanagan Valley of British Colombia were monitored for the presence of *Erwinia amylovora* from July 19 to October 15, 1985. All the leaf and fruit samples monitored were contaminated with *Erwinia amylovora* at harvest on September 17.[9]

10.15 Van der Zwet *et al* (1990) conducted a study based on a sample of 620 apples from blighted and healthy orchards in Utah, West Virginia, Washington state and Ontario. They recovered *Erwinia amylovora* from the core of 21 per cent of fruit harvested from within 30cm of visibly blighted fruit, but did not recover *Erwinia amylovora* from fruit harvested from points 60cm or more from fire blight symptoms:[10]

> Endophytic populations of *Erwinia amylovora* were recovered from apples located within 30cm from blighted shoots but not from those 60 or 200cm away. The bacterium was not detected in core tissues of 280 apples sampled from four cultivars collected from apparently healthy trees grown in four regions of North America. Thus, chances for dissemination of *Erwinia amylovora* to areas or countries without fire blight are extremely unlikely when undamaged delicious fruit are harvested a minimum of 100cm from visible blight symptoms or, preferably, from apparently healthy trees located in orchards free of fire blight.[11]

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8 S.V.Thomson, A.C.Wagner & S.C.Gouk, 'Rapid Epiphytic Colonization of Apple Flowers and the Role of Insects and Rain' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p 459

9 P.L.Sholberg, A.P.Gauance & G.R.Owen, 'Occurrence of *Erwinia Amylovora* of Pome Fruit in British Colombia in 1985 and its Elimination from the Apple Surface', *Canadian Journal of Plant Pathology*, (Vol 10, 1988), p 178

10 T. van der Zwet, S.V.Thomson, R.P.Covey, and W.G.Bonn, 'Population Of *Erwinia Amylovora* on External and Internal Apple Fruit Tissues', *Plant Disease*, (Vol 74, 1990), p 714

11 *Ibid*, p 711

10.16 McManus and Jones (1995) reported the infestation of 75 per cent of mature fruit taken from symptomless trees in a severely blighted orchard.[12]

10.17 In its written response to the draft IRA, the New Zealand Government argued that the risk that mature apples harvested from orchards apparently free from fire blight would harbour *Erwinia amylovora* in their calyxes is at most 5 per cent.

10.18 In support, the New Zealand Government also cited the research by Hale *et al* (1987) noted above. As indicated, Hale *et al* recovered *Erwinia amylovora* from the calyxes of 3 per cent of mature apple fruit harvested from severely blighted orchards, but continued:

> *Erwinia amylovora* was not isolated from the calyx-end or main portion of any of the 300 fruit harvested from orchards where no fire blight symptoms were seen, nor from any of 100 fruit from a lightly infected orchard.[13]

10.19 The New Zealand Government also cited the research by Sholberg *et al* (1988) noted above. The New Zealand Government argued that Sholberg *et al* (1988) isolated *Erwinia amylovora* from apple leaves taken in British Colombia, but not the apples themselves.[14] The Committee acknowledges this argument, although it notes that Sholberg continued:

> All apple (leaf) and pear leaf samples were contaminated with *Erwinia amylovora* on September 17, which coincided with apple harvest. … These results show that *Erwinia amylovora* may be present on symptomless fruit at harvest under certain conditions.[15]

10.20 The New Zealand Government further cited the research of van der Zwet *et al* (1990) noted above. In particular, the New Zealand Government noted that van der Zwet *et al* reported in Table 4 of their paper that *Erwinia amylovora* was detected in the calyxes of only 5 apples from their sample of 620.[16]

10.21 In addition, the New Zealand Government drew the Committee's attention to the study of Clark *et al* (1993), noted above in relation to immature fruit. In relation to mature fruit, Clark *et al* found:

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12 P.S.McManus & A.L.Jones, 'Detection Of *Erwinia Amylovora* by Nested PCR and PCR-Dot-Blot and Reverse-Blot Hybridizations', *Phytopathology*, (Vol 85, 1996), pp 618-623

13 C.N.Hale, E.M.McRae & S.V.Thomson, 'Occurrence of *Erwinia Amylovora* on Apple Fruit in New Zealand', *Acta Horticulturae*, (Vol 217, 1987), p 37

14 Submission 24, pp 11-12

15 P.L.Sholberg, A.P.Gauance & G.R.Owen, 'Occurrence of *Erwinia Amylovora* of Pome Fruit in British Colombia in 1985 and its Elimination from the Apple Surface', *Canadian Journal of Plant Pathology*, (Vol 10, 1988), p 179

16 T. van der Zwet, S.V.Thomson, R.P.Covey, and W.G.Bonn, 'Population Of *Erwinia Amylovora* on External and Internal Apple Fruit Tissues', *Plant Disease*, (Vol 74, 1990), p 714

> Using a sensitive DNA hybridisation method, 60,000 apple fruit calyxes were tested from 10 orchards free of fire blight symptoms and no *Erwinia amylovora* was detected. The orchards were each characterised by a surrounding 250m zone containing no alternative hosts of *Erwinia amylovora* and a 500m zone containing no hosts with fire blight symptoms.
>
> The DNA probe was (also) used to determine the distribution of *Erwinia amylovora* from inoculated blight sources (flowers) showing disease symptoms. *Erwinia amylovora* was not detected in calyxes of either immature or mature apple fruit, even from within 20 cm of these blight sources, in a season not conducive to the spread of the disease over flowering.[17]

10.22 Finally, the Committee also notes follow up research to the above Clark *et al* (1993) paper conducted by Hale *et al* (1996). Hale *et al* conducted research on the spread of *Erwinia amylovora* at the Mt Albert Research Centre, the Horticulture and Food Research Institute, Auckland under conditions more favourable to *Erwinia amylovora*. Echoing the Clark *et al* (1993) study, Hale *et al* stated:

> The DNA probe was used to determine the spread of *Erwinia amylovora* from inoculated blight sources (apple blossoms) showing fire blight symptoms. *Erwinia amylovora* was not detected in calyxes of either immature or mature apple fruit even within 5 cm of these blight sources. The weather was conducive to the spread of the disease over flowering, but all inoculated blossoms and those showing symptoms in adjacent blossom clusters either aborted as flowers or as developing fruitlets.[18]

10.23 Given these various studies, the Committee was also informed by evidence from Prof Aldwinckle. He indicated that *Erwinia amylovora* can be isolated from the calyx of mature fruit, but that it is unlikely to provide a source of inoculum for subsequent transfer of the bacterium.[19]

Epiphytic Infestation of Mature Fruit Surfaces

10.24 The New Zealand Government noted in its submission that BA did not assess the possibility of epiphytic infestation of the surface of fruit, but that in other areas of the draft IRA, BA notes the sensitivity of *Erwinia amylovora* to UV light.[20] This issue is discussed in more detail later in this chapter.

10.25 The Committee notes however the research by van der Zwet *et al* (1990). Van der Zwet *et al* (1990) reported in Table 4 of their paper that *Erwinia amylovora*

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17 R.G.Clark, C.N.Hale and D.Harte, 'A DNA Approach to *Erwinia amylovora* Detection in Large Scale Apple Testing and in Epidemiological Studies', *Acta Horticulturae*, (Vol 338, 1993), p 59

18 C.N.Hale, R.K.Taylor and R.G.Clark, 'Ecology and Epidemiology of Fire Blight in New Zealand', *Acta Horticulturae*, (Vol 411, 1996), p 79

19 Evidence, RRAT, 29 March 2001, p 381

20 Submission 24, p 16

was detected in the stem and on the surface of 15 apples out of their sample of 620 from blighted and healthy orchards in Utah, West Virginia, Washington state and Ontario.[21]

Endophytic Infection of Fruit

10.26 In the draft IRA, BA cited the van der Zwet *et al* (1990), Hale *et al* (1993) and Roberts *et al* (1993) papers as evidence that symptomless fruit obtained from branches 'distant' from a site of infection on the same tree will not be endophytically infected.[22]

10.27 Similarly, the New Zealand Government argued in its written submission that the risk of mature apple fruit being infected (as opposed to infested) with *Erwinia amylovora* is less than 5 per cent, and then only when the fruit is harvested from within 15cm of a blighted shoot.[23]

10.28 In support, the New Zealand government cited in some detail the study of van der Zwet *et al* (1990). Van der Zwet *et al* reported in Table 4 of their paper that *Erwinia amylovora* was detected in the core of 14 apples out of their sample of 620 from blighted and healthy orchards in Utah, West Virginia, Washington state and Ontario. They also reported that *Erwinia amylovora* was recovered from up to 21 per cent of the core sections of fruit harvested from within 15cm of visibly blighted shoots.[24]

10.29 The New Zealand Government suggested that this figure of 21 per cent considerably overstates the likelihood of the presence of *Erwinia amylovora* in the core of apples. Specifically, van der Zwet *et al's* study was based on apples harvested in July and August, rather than the normal harvesting period between late August and early October. As such, they were probably immature apples.[25]

10.30 Further, the New Zealand Government noted that the figure of 21 per cent is only relevant to fruit harvested from within 15cm of severely blighted shoots, and that fruit from elsewhere on the tree would not be infected.[26]

10.31 The Committee also notes research by Roberts *et al* (1989). They evaluated whether *Erwinia Amylovora* was present on/in mature apple fruit harvested from blighted trees grown in Washington state, and whether such fruit poses a phytosanitary risk to countries importing mature apples from there. They found:

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21 T. van der Zwet, S.V.Thomson, R.P.Covey, and W.G.Bonn, 'Population Of *Erwinia Amylovora* on External and Internal Apple Fruit Tissues', *Plant Disease*, (Vol 74, 1990), p 714

22 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 80

23 Submission 24, p 13

24 T. van der Zwet, S.V.Thomson, R.P.Covey, and W.G.Bonn, 'Population Of *Erwinia Amylovora* on External and Internal Apple Fruit Tissues', *Plant Disease*, (Vol 74, 1990), p 714

25 Submission 24, p 12

26 Submission 24, pp 12-13

> *Erwinia amylovora* was not detected in core tissue of aqueous sonicates from 1,500 mature, symptomless fruit harvested from blighted trees of seven apple cultivars grown at five locations in Washington State. … Thus healthy, symptomless apples produced in Washington State are unlikely to harbour detectable populations of *Erwinia amylovora*.[27]

10.32 Finally, the Committee was again informed by the comments of Prof Aldwinckle. He indicated that it is possible that a few cells of *Erwinia amylovora* may exist inside externally healthy looking apples without multiplying and expressing disease symptoms. However, he continued that it is 'almost inconceivable' that the bacterium could exist in the core of consumed apples and then be transported to the flowers of susceptible hosts.[28]

The Presence of Trash with Imported Fruit

10.33 In addition to the above evidence on the infestation/infection of apple fruit, BA also cited in the draft IRA research by van der Zwet and van Buskirk (1984) and Gowda and Goodman (1970) on the presence of *Erwinia amylovora* 'on' trash (symptomless leaves and budwood) associated with apples.[29]

10.34 The New Zealand Government argued in its written submission that BA did not present data in the draft IRA on the likelihood that 'trash' associated with apple fruit may be infected with *Erwinia amylovora*.[30] Similarly, in his written submission, Dr Wimalajeewa also argued that the draft IRA fails to address adequately the risk associated with trash, and that 'infected trash would pose a serious risk if it accompanies fruit'. [31]

10.35 The Committee received conflicting evidence as to whether trash may be a possible avenue for the entry of *Erwinia amylovora* into Australia. In evidence to the Committee, Mr Tancred from Orchard Services suggested that it is 'unavoidable' that some leaves and twigs will pass through sorting and grading during packing.[32] Similarly, Mr Armour from the AAPGA stated:

> I have been packing fruit for 40 years and you just cannot keep it out. The draft IRA mentions some high volume washing equipment New Zealanders

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27 R.G.Roberts & S.T.Reymond, 'Evaluation of Mature Apple Fruit from Washington State for the Presence of *Erwinia Amylovora*', *Plant Disease*, (Vol 73, No 11, November 1989), p 917

28 Evidence, RRAT, 29 March 2001, p 375

29 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 82

30 Submission 24, p 16

31 Submission 28, p 7

32 Evidence, RRAT, 12 February 2001, p 38

> have used on a couple of installations, but there is no requirement in the IRA for them to use it to eliminate trash.[33]

10.36 At the same time however, Prof Aldwinckle indicated in evidence to the Committee that modern grading and packing lines are very efficient in packing clean apples, and that the 'odd leaf' that might get through is a very unlikely source of *Erwinia amylovora* being carried into an uncontaminated area. Large twigs or branches would pose a far higher risk, but would be unlikely to pass modern grading and packing lines.[34]

10.37 In this regard, the Committee visited a large packing house in New Zealand which relies on water sorting, water ducts, sorters, dryers and so on. Following from that visit, the Committee acknowledges that there is a very low probability of large twigs and branches accompanying apples destined for Australia.

Summary of Importation Step 1: Source Fruit

10.38 In summary, the scientific evidence suggests that *Erwinia amylovora* can be systemic in trees which do not express symptoms of fire blight, and can lead to mature fruit being either infected or infested with *Erwinia amylovora*. Accordingly, were apples to be imported into Australia from New Zealand, it must be assumed that a small proportion would be either infested or infected with *Erwinia amylovora*.

10.39 In its written submission, the New Zealand Government acknowledged this, but suggested that the probability of mature fruit destined for Australia being infected would be "negligible", while the probability of mature fruit being infested (either in the calyx or epiphytically) would be "very low".[35]

10.40 The Committee also wishes to record evidence prepared by Dr Stephens from the Queensland Department of Primary Industry. Dr Stephens argued that the research cited above by Hale *et al* (1987), Sholberg *et al* (1988), Roberts *et al* (1989), van der Zwet (1990), Clark *et al* (1993) and Hale *et al* (1996) may underestimate the presence of *Erwinia amylovora*. Dr Stephens argued that the above studies rely upon growth of *Erwinia amylovora* in artificial media (ie nylon membranes) to detect the presence of the bacterium. Dr Stephens continued:

> None of these papers took into account that *Erwinia amylovora* may form a viable, but non-culturable state. If this form occurred, the methodology used in each of these papers is likely to have under-estimated the size of the

33 Evidence, RRAT, 13 February 2001, p 118

34 Evidence, RRAT, 29 March 2001, p 375

35 Submission 24, p 17

> population of *Erwinia amylovora* present in apples derived from symptomless apples.[36]

10.41 In this regard, Dr Stephens indicated that while there are no studies of whether *Erwinia amylovora* can exist in a viable but non-culturable state, he cites 17 international papers which suggest that bacterium can be viable, but not culturable. Dr Stephens continued:

> Should *Erwinia amylovora* be shown to enter this viable, but non-culturable state, then the majority of papers used in the memorandum to justify that symptomless orchards are free of *Erwinia amylovora* have possibly under-estimated the survival of *Erwinia amylovora* in apples and therefore should not be utilised.[37]

10.42 The Committee notes that Dr Stephens is currently undertaking further research on this matter at the University of Queensland.

IMPORTATION STEP 2: PACKINGHOUSE PROCEDURES

10.43 BA indicated in the draft IRA that apples from New Zealand infested with *Erwinia amylovora* would be highly likely to remain so after packing. In particular, BA argued that there is no evidence to suggest that standard packing procedures such as sorting, grading and washing would either detect infestation, or remove bacteria from the calyx-end of infested fruit. In addition, BA stated:

> Research regarding the efficacy of cold storage, as a means of reducing the viability of *Erwinia amylovora* or the number of viable bacteria on fruit, is inconclusive.[38]

10.44 In its written response, the NZ Government disputed BA's claim that research on the efficacy of cold storage as a means of reducing the viability of *Erwinia amylovora* is inconclusive. The New Zealand Government cited Hale and Taylor (1999), who found that after 25 days of cold storage in laboratory conditions, *Erwinia amylovora* was detected in more than 75 per cent of fruit which originally had 10^7 cfu (colony forming units), but only 24 per cent of fruit which originally had 10^5 cfu and less than 10 per cent of fruit which originally had 10^3 cfu. They continued:

> The survival of *Erwinia amylovora* at low concentrations in nutrients broth but not in bacteriological saline or calyxes after cool storage and incubation suggests that nutritional and environmental conditions in apple calyxes are not conducive to the multiplication of the bacteria. The poor survival in

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36 Dr Stephens, 'Why the Majority of Evidence used in the Memorandum to Suggest that Apples Derived from Symptomless Orchards are Free of *Erwinia Amylovora* is Possibly Inaccurate', Correspondence, 15 March 2001

37 *Ibid*

38 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, pp 82-83

> calyxes of both inoculated fruit and fruit from an orchard with fire blight symptoms indicates that cool stored fruit are unlikely to be a major vector for *Erwinia amylovora.*[39]

10.45 The New Zealand Government also cited Sholberg *et al* (1988), who reported a decline in the number of bacteria in the calyxes and stems of apples at 2-4 degrees. They state that:

> Cold storage alone reduced the number of surface-born *Erwinia amylovora* on artificially inoculated Red Delicious apples and reduced the number of bacteria on naturally contaminated Newton apples to levels below detection after storage at 2^0C for 5 months.[40]

10.46 However, in evidence, Prof Aldwinckle suggested that cold storage will not reduce inoculum levels, on the basis that cold storage tends to preserve rather than destroy bacteria cells.[41]

10.47 BA also raised in the draft IRA the possibility that healthy apples could be contaminated in the packinghouse through contact with infested or infected apples, or through contact with contaminated bins.[42] In this regard, van der Zwet *et al* (1990) found that 1 per cent of surface disinfested Rome Beauty fruit, collected from apparently healthy trees, developed fire blight symptoms during a four month cold storage period.[43]

10.48 In response, the New Zealand Government noted in its written submission that BA failed to consider the impact on surface *Erwinia amylovora* populations of immersion of the host apple in water (for at least five minutes) during packing. In this regard, the New Zealand Government noted that during Japanese trials, water treatment was found almost completely to eliminate surface colonies of *Erwinia amylovora*.[44]

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39 C.N.Hale and R.K.Taylor, 'Effect of Cool Storage on the Survival of *Erwinia Amylovora* in Apple Calyxes' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p 142

40 P.L.Sholberg, A.P.Gauance & G.R.Owen, 'Occurrence of *Erwinia Amylovora* of Pome Fruit in British Colombia in 1985 and its Elimination from the Apple Surface', *Canadian Journal of Plant Pathology*, (Vol 10, 1988), p 178

41 Evidence, RRAT, 29 March 2001, p 376

42 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 82

43 T. van der Zwet, S.V.Thomson, R.P.Covey, and W.G.Bonn, 'Population Of *Erwinia Amylovora* on External and Internal Apple Fruit Tissues', *Plant Disease*, (Vol 74, 1990), p 711

44 Submission 24, p 18

10.49 Prof Aldwinckle also indicated that, to his knowledge, the results achieved by van der Zwet *et al* in 1990 with Rome Beauty fruit have not been repeated, in spite of attempts to do so.[45]

IMPORTATION STEP 3: STORAGE AND TRANSPORT

10.50 BA indicated in the draft IRA that there is a high likelihood that apparently healthy apples either infested or infected with *Erwinia amylovora* at the commencement of storage and transport would remain so on arrival in Australia. As before, BA argued that the evidence on the impact of cold storage on various bacteria on fruit is inconclusive.[46]

10.51 In response, the New Zealand Government noted the earlier research of van der Zwet *et al* (1990) on the survival of *Erwinia amylovora* during cold storage. In addition, the New Zealand Government also noted research by Nachtigall *et al* (1985) pointing to the survival of *Erwinia amylovora* in cold storage. Nachtigall *et al* found:

> Under cold storage (0^0C) of apple fruits inoculated and contaminated with *Erwinia amylovora*, the pathogen remained viable for at least 34 weeks; with storage under field conditions, viability decreased to 20 weeks.[47]

10.52 The New Zealand Government argued that Nachtigall *et al* (1985) injected high numbers of the bacteria into the cortex, rather than inoculating the calyx, making the study unrepresentative.[48]

IMPORTATION STEP 4: ON-ARRIVAL INSPECTION

10.53 BA indicated in the draft IRA that it is unlikely that apples infested with *Erwinia amylovora* would be detected during on-arrival inspections because they show no visible disease symptoms. Similarly, apples infected with *Erwinia amylovora* but not showing visible signs of disease would be unlikely to be detected. It would only be likely that infected apples showing visible signs of disease would be detected.[49]

10.54 In this regard, BA further noted that the likelihood of infected apples which were showing visible signs of disease being included in a consignment are relatively low. This is because infected blossoms of fruitlets generally abort on the tree. BA concluded:

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45 Evidence, RRAT, 29 March 2001, p 376

46 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 83

47 M.Nachtigall, W.Ficke, and H.J.Schaefer, 'Model Experiments on the Viability of *Erwinia amylovora*' in Winslow *et al*, *Review of Plant Pathology* (65, No. 2893, 1985), p 326

48 Submission 24, p 19

49 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 83

> When information regarding the low efficacy of on-arrival inspection for 'infested' fruit, and the low likelihood that endophytically 'infected' fruit would be included in a consignment was combined, it was considered virtually certain that apples contaminated at the start of storage and transport would not be detected during routine on-arrival inspection in Australia.[50]

10.55 In its written submission, the New Zealand Government agreed with BA that it is highly unlikely that apparently healthy apples would develop visible symptoms of disease during transport and storage.[51]

10.56 By contrast, Mr Morvell from Environment Australia argued that fruit could begin to develop symptoms during transport to Australia, and could be discarded as rotten fruit, providing a greater risk of distribution of *Erwinia amylovora* by insects.[52]

SUMMARY OF THE LIKELIHOOD OF IMPORTATION STEPS 1-4

10.57 Based on its assessment of the above four importation steps, BA concluded in the draft IRA that the unrestricted importation potential of *Erwinia amylovora* on/in apples from New Zealand is "high". In other words, it is likely that the unrestricted importation of apples from New Zealand would lead to the arrival in Australia of either infected, or more probably, infested fruit.[53]

10.58 In response, the New Zealand Government argued that BA considerably overstates the likelihood of importation of apples harbouring *Erwinia amylovora*, based on a misreading of the literature. Rather, the New Zealand Government argued that the probability of mature symptomless apples sourced from any orchard in NZ being infected or infested with *Erwinia amylovora* is considerably less than 5 per cent, and that this is further reduced by packing, cold storage and transportation:

> When all of these events are considered, New Zealand believes that the importation potential of infected and surface contaminated fruit is "negligible", and that the importation potential of calyx infested fruit is "very low".[54]

10.59 In response to these competing interpretations, the Committee notes that apples from New Zealand will carry *Erwinia amylovora* into Australia. This remains the case even if mature symptomless apples are sourced from orchards showing no visible signs of fire blight, and if the bacterium is adversely affected by cold storage in transport. In the 1998 IRA, BA estimated that 200 million apples could be imported

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50 *Ibid*, p 84

51 Submission 24, p 19

52 Evidence, RRAT, 28 February 2001, p 357

53 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 84

54 Submission 24, p 20

from New Zealand to Australia each year. Even if only 1 per cent of these are infected or infested, this still represents 2 million apples. As stated by Dr Zoller:

> It is true that it may be difficult to bring [*Erwinia amylovora*] in on fruit compared to plants, but there is plenty of evidence in the literature, and it is cited in the draft IRA, that this trade that is being contemplated will allow the bacteria into Australia. The only dispute relates to the bacteria getting from these fruit into a host.[55]

Likelihood of Distribution

DISTRIBUTION STEP 1: STORAGE AND DISTRIBUTION OF APPLE FRUIT

10.60 BA indicated in the draft IRA that apples infested or infected on arrival in Australia would remain so following storage and distribution. In this regard, BA again reiterated that there is no evidence that cold storage and distribution of apple fruit in Australia would lead to a decrease in the number of viable *Erwinia amylovora* bacterium.[56]

10.61 In response, the New Zealand Government again reiterated its argument that cold storage will lead to a reduction in the viability of *Erwinia amylovora* bacterium.[57]

DISTRIBUTION STEP 2: DISCARDED WASTE

10.62 BA indicated in the draft IRA that it is likely that *Erwinia amylovora* would continue to be present in apple waste (skin and apple cores) discarded following human consumption. In addition, the discarding of a certain proportion of whole spoilt apples provides a viable means of distribution for large numbers of *Erwinia amylovora* bacterium.[58]

10.63 In response, the New Zealand Government argued in its written submission that apple peelings and cores disposed of in Australia would most likely be in waste disposal units or land fills. 'Only a small proportion would be discarded into the environment'. In this regard, the New Zealand government cited research by Roberts *et al* (1998). They found that the probability of apple fruit being discarded near a host in Japan was 0.25 per cent:

> An estimate of 0.5 per cent of fruit is discarded or placed in compost piles in Japan. We estimate that about one half of this would be near (0.3km) fair to

55 Evidence, RRAT, 29 March 2001, p 338

56 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 84

57 Submission 24, p 20

58 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 84

> good hosts (eg apples, pear, cotoneaster, mountain ash, hawthorn). Thus P(3) would be 0.0025.[59]

10.64 The New Zealand Government further requested that BA conduct a study of waste disposal patterns, to be incorporated in the final IRA. The Committee endorses this request.

10.65 The New Zealand Government also argued that BA failed in the draft IRA to consider pathways other than discarded waste for the distribution of *Erwinia amylovora* in Australia. Notably, BA did not consider the smuggling pathway. In the 1998 IRA, AQIS assessed the likelihood of *Erwinia amylovora* being introduced through smuggling as one instance in every 663 years.[60]

10.66 Aside from the discarding of apple cores in the environment, various parties also identified alternative pathways for the distribution of *Erwinia amylovora* in Australia. In particular, the AAPGA argued that *Erwinia amylovora* could also be distributed by the use of whole apples as stock feed, and through repacking of fruit by Australian growers. These pathways are described below:

a) Import ➔ wholesale ➔ not sold ➔ whole fruit sent to mixed farm as stock feed ➔ insects transport the bacterium to host.

b) Import ➔ transport to Australian grower for storage ➔ repacked waste discarded at orchard ➔ insects transport the bacterium to host.[61]

10.67 In this regard, the AAPGA highlighted that questions 10-12 of the BA scientific questionnaire sent to international scientists on 27 January 2000 focused on discarded apple cores following human consumption as the sole means of distribution of *Erwinia amylovora*, when there are potentially other means. Similarly, the TAPGA written submission states:

> The questions asked of scientists did not specifically include possible "high risk" scenarios. An example is: if fire blight infected apples were purchased by a consumer and then discarded on a compost heap with the associated large number of insects present in humid, moist weather conditions, and the compost heat was in close proximity to a flowering roseacia plant, apple or pear tree, what are the chances of infection?[62]

10.68 Likewise, the APGASA argued in its supplementary written submission that too much consideration has been given to the disposal of a single apple core in the

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59 R.G.Roberts, C.H.Hale, T.van der Zwet, C.E.Miller & S.C.Redlin, 'The Potential for Spread of *Erwinia Amylovora* and Fire Blight via Commercial Apple Fruit: A Critical Review and Risk Assessment', *Crop Protection*, (Vol 17, No 1, 1998), p 25

60 Submission 24, pp 9-10

61 Submission 33, p 26

62 Submission 17, p 9

environment, and not enough to the process of repacking in Australia and the disposal of 'waste' fruit.[63] As stated in hearings by Mr Ranford from the APGASA:

> A scenario that AQIS and BA never really picked up in their whole consideration is that of product being brought in by an agent, that agent finding that it is not up to the quality, getting it repacked and, in that case, discarding that repacked material—a scenario that is more likely to occur in this particular region than any other. In the draft IRA, BA only ever looked at one scenario: the single piece of fruit that might be thrown out.[64]

10.69 Given this evidence, the Committee notes the suggestion of Dr Zoller that the draft IRA does not study all the mechanisms for the transfer of *Erwinia amylovora* to a suitable host in Australia, but nevertheless assumes that such transfer has a low likelihood. 'I do not really believe that that conclusion is necessarily justified'.[65]

DISTRIBUTION STEP 3: EXPOSURE TO THE ENVIRONMENT

10.70 BA cited in the draft IRA research that *Erwinia amylovora* is a 'relatively fragile' bacterium, prone to damage by several environmental factors including desiccation, heat, competition, UV radiation, humidity and production of antibiotics by other micro-organisms. It is also suggested that phenols produced by decaying fruit have a deleterious effect on the bacterium, a result consistent with the decline in the numbers of *Erwinia amylovora* as apples mature on the tree.[66]

10.71 Accordingly, BA noted in the draft IRA that under warm and moist conditions, *Erwinia amylovora* discarded into the environment on apples is likely to be quickly eliminated by the depletion of nutrients and by competing saprophytic micro-organisms. Conversely, under hot and dry or cold and dry conditions, 'elimination of *Erwinia amylovora* is more likely to result from a direct physical temperature and moisture effect'. BA continued:

> When this information is combined, it is clear that the likelihood that *Erwinia amylovora* would survive in the environment for a sufficient period, and be able to either multiply or persist in sufficient numbers to be transferred to a host in a receptive state is low.[67]

10.72 In response, the New Zealand Government agreed with BA in its written submission that the number of *Erwinia amylovora* in/on discarded fruit will decline rapidly upon exposure to the environment.[68]

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63 Submission 26A

64 Evidence, RRAT, 15 February 2001, p 216

65 Evidence, RRAT, 29 March 2001, p 386

66 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 85

67 *Ibid*, p 86

68 Submission 24, pp 21-22

10.73 In support, the New Zealand government cited Hale and Taylor (1999), who were unable to recover *Erwinia amylovora* from fruit exposed to room temperature for 14 days following a 25 day period in cold storage. Hale and Taylor state:

> Populations of *Erwinia amylovora* did not increase to levels detectable by PCR in fruit which were cool stored and then incubated at room temperature (20^0C) for 14 days to simulate likely retail conditions.[69]

10.74 Similarly, the Committee was given evidence by Mr Veens from MAFNZ during its visit to New Zealand that as an apple core degrades, phenols are produced that rapidly degrade the *Erwinia amylovora* bacterium. He also indicated that UV radiation will kill *Erwinia amylovora* within 4-5 hours.[70]

10.75 However, in his written submission to the Committee, Dr Wimalajeewa argued that BA overstates the role of UV radiation in reducing the level of epiphytic infestations in the calyx, where the *Erwinia amylovora* bacterium are protected from UV radiation.[71]

10.76 In addition, Dr Wimalajeewa cited research by Thomson that *Erwinia amylovora* can survive in the soil amidst intense competition from other saprophytic micro-organisms, and still act as a source of inoculum. The Committee discounts this possibility, on the basis of Thomson's research cited below:

> Studies conducted in 1932, prior to the availability of good selective media or identification techniques, suggested that *Erwinia amylovora* may survive in non-sterile soil for a few weeks but long-term survival is not considered likely. … Soil cannot be totally overlooked as a source of inoculum, but it seems unlikely that *Erwinia amylovora* would be splashed from soil into flowers or on to shoot tips. This type of dispersal would be more likely in tree nurseries, where foliage is close to the soil.[72]

10.77 Similarly, Prof Aldwinckle discounted the survival of *Erwinia amylovora* in the soil, and indicated that he is not aware of any research indicating that infection can result from a transmission of *Erwinia amylovora* from the soil to blossoms or to the shoots of trees.[73]

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69 C.N.Hale and R.K.Taylor, 'Effect of Cool Storage on the Survival of *Erwinia Amylovora* in Apple Calyxes' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight,* (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p 139

70 Meeting between the Committee and officials from MAFNZ and MFATNZ, Wellington, 15 May 2001

71 Submission 28, pp 7-9

72 S.V.Thomson, 'Epidemiology of Fire Blight' in J.L.Vanneste (ed), *Fire Blight: The Disease and its Causal Agent, Erwinia Amylovora,* (CABI Publishing), p 16

73 Evidence, RRAT, 29 March 2001, p 381

DISTRIBUTION STEP 4: VECTORS AND OTHER MEANS OF TRANSFER

10.78 BA indicated in the draft IRA that it is extremely unlikely that viable *Erwinia amylovora* would be transferred from either infested or infected apple tissue to an appropriate site on a susceptible host. Accordingly, BA conservatively assigned a "low" likelihood to this step.[74]

10.79 The Committee notes below the evidence on the role of insects, inoculum levels and infection pathways in the transfer of *Erwinia amylovora* to a suitable host.

Insects

10.80 BA noted in the draft IRA that there are no known vectors specific to *Erwinia amylovora* in Australia. Accordingly, BA argued that the most likely means of transfer of the bacterium from a contaminated source to a receptive host is by insects. In this regard, BA cited its earlier research in the 1998 IRA that mechanical transfer of *Erwinia amylovora* from an apple core to a suitable host has a probability between 1 in 1,000 and 1 in 10,000. The basis for this argument is that foraging insects such as bees are unlikely to visit discarded apple cores.[75]

10.81 Mr Ivess from MAFNZ also made this point during the Committee's visit to New Zealand. Mr Ivess noted that there are no natural vectors for *Erwinia amylovora,* and that the likelihood that insects will crawl into the calyx of infested apples discarded into the environment and then visit a susceptible host is very very low.[76]

10.82 By contrast, Agriculture Western Australia argued in its written submission that the draft IRA does not appear to give sufficient consideration to the transfer of *Erwinia amylovora* by insects and mites. Agriculture Western Australia notes that van der Zwet and Kiel (1979) nominated insects and mites from 77 genera as agents for the spread of *Erwinia amylovora*, especially within orchards:[77]

> AGWEST concludes that insects sometimes successfully transmit the disease, and other times do not. The unpredictable variability of successful disease transmission by insects introduces an element of doubt sufficient to reduce confidence that the entry potential is negligible ie that the vectoring of fire blight by insects present on the fruit is an event that would almost certainly not occur.[78]

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74 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 86

75 *Ibid*

76 Meeting between the Committee and officials from MAFNZ and MFATNZ, Wellington, 15 May 2001

77 T.van der Zwet & H.L.Keil, 'Fire Blight – A Bacterial Disease of Rosaceous Plants', United Stated Department of Agriculture Handbook No 510 (1979)

78 Submission 52, p 12

10.83 In addition, the AAPGA argued in its written submission that Australia hosts a number of native insects including Calliphorids (blowflies), Tephritids (fruit flies) and Muscids (bushflies) capable of spreading *Erwinia amylovora*. As an example, Queensland fruit fly (*Bactrocera tryonii)* is a bacterial feeder which visits both sources of bacterial decay as well as fruit and leaves.[79]

10.84 Finally, the Committee notes that in Chapter Eleven, it discusses the potential for other pests (insects and mites) associated with apple fruit from New Zealand to act in the transfer of *Erwinia amylovora*. These are pests that live in the calyx, but emerge at some stage in their life cycle.

Birds and other Animals

10.85 Aside from insects, Mr Veens from the QFVG also suggested that flying foxes and bats can act in the distribution of *Erwinia amylovora* over long distances.[80] Similarly, Mr Green from the South Australian Pome Fruit Improvement Committee suggested that lorikeets, which are nectar feeders, act in the distribution of the bacterium.[81]

10.86 In response, Mr Ivess from MAFNZ noted that New Zealand scientists have no evidence of the spread of *Erwinia amylovora* by birds, and that the only evidence New Zealand scientists have of spread of *Erwinia amylovora* over long distances is via propagation materials.[82]

Inoculum Levels

10.87 BA noted in the draft IRA that should *Erwinia amylovora* be successfully transferred by an insect to a suitable host, field studies have shown that $>10^4$ cfu of *Erwinia amylovora* are required to initiate an infection/infestation of apple and cotoneaster blossoms. Furthermore, the rate of development is slower at low ($>10^4$) rather than high ($>10^{5-6}$) doses of inoculum.[83]

10.88 In this regard, BA cited Dr Wimalajeewa as suggesting that the likelihood that an apple core with a low number of bacteria (< 100) would act as a source of inoculum is negligible.[84]

10.89 The Committee noted in Chapter Six that BA misquoted Dr Wimalajeewa on this matter. Rather, Dr Wimalajeewa indicated that an apple core with a low number

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79 Submission 33, p 29

80 Evidence, RRAT, 12 February 2001, p 53

81 Evidence, RRAT, 15 February 2001, p 230

82 Meeting between the Committee and officials from MAFNZ and MFATNZ, Wellington, 15 May 2001

83 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 88

84 *Ibid*

of bacteria (< 100) would be unlikely to act as a source of inoculum in hot and dry environmental conditions with few receptive hosts.[85]

10.90 The New Zealand Government also noted published research indicating that there must be sufficient numbers of bacteria present to initiate an infection:

> Bacterial multiplication is time-and-climate dependent, and a low dose such as that likely to be present on an infested apple fruit ($<10^2$ colony forming unit) is very unlikely to be sufficient to result in an infection of a host.[86]

10.91 Mr Ivess from the Ministry of Foreign Affairs and Trade in New Zealand (MFATNZ) reiterated this evidence during the Committee's visit to New Zealand. Mr Ivess indicated that successful distribution of *Erwinia amylovora* under appropriate climatic conditions requires as a minimum approximately 10,000 colony forming units. By contrast, when harvested, infested mature apples may contain at most 10 to 100 colony forming units.[87]

10.92 This evidence was also presented to the Committee by Dr Zoller, who noted that the greater the number of bacteria transported to a host, the greater the likelihood that that host will become infected. Theoretically, even one cell can cause an infection under the right conditions, but in reality it is generally accepted that a greater dose of inoculum is required to start an infection.[88]

10.93 That said, the Committee is also aware of research suggesting that even low doses of inoculum can potentially be sufficient to initiate an infection. Dr Steiner states:

> The fire blight pathogen, *Erwinia amylovora*, is a competent epiphyte capable of colonising and multiplying on the surfaces of plants. Furthermore, it makes little difference whether the plants colonised are susceptible or resistant to fire blight.
>
> At moderately warm temperatures in the 65-75^{o}F range, the bacterium has the potential to double every 20-30 minutes. One bacterium gives rise to 1 trillion cells with just 31 divisions which occur within just 2-3 days.

10.94 The Committee also notes that arguments related to the survivability of *Erwinia amylovora* in the environment are partly premised on the assumption that an insect will visit discarded apple tissue only after a considerable period of exposure, allowing for a substantial decline in the number of *Erwinia amylovora.* However, it is

85 Evidence, RRAT, 13 February 2001, p 148

86 Submission 24, p 23

87 Meeting between the Committee and officials from MAFNZ and MFATNZ, Wellington, 15 May 2001

88 Evidence, RRAT, 29 March 2001, p 397

equally possible that an insect may visit discarded apple tissue before significant reduction in bacterial cell numbers begins.[89]

10.95 In addition, Dr Zoller indicated in evidence that certain insects may be directed to discarded apple cores on the ground by a chemical link, rendering the longevity of the bacteria harboured by discarded apples less important.[90]

Infection Pathways

10.96 The Committee was also presented with evidence during this inquiry that the draft IRA focuses expressly on flowers as the main pathway for the infection of apple trees. However, various parties such as Environment Australia and Agriculture Western Australia submitted that this ignores other pathways of entry such as via the stomata of leaves and the lenticels of the fruit.[91]

10.97 For example, Agriculture Western Australia argued that while the majority of *Erwinia amylovora* infections are initiated on blossoms, infections can also be initiated on young shoots via hydathodes, lenticels, trichomes and other natural openings. As a result, *Erwinia amylovora* infection can be initiated at any time of the year, and not necessarily only at blossom time.[92]

10.98 Environment Australia also cited research that *Erwinia amylovora* can survive on pollen in hives for at least one week, and two weeks in honey, increasing the chance of being spread by bees to susceptible hosts.[93]

SUMMARY OF THE LIKELIHOOD OF DISTRIBUTION STEPS 1-4

10.99 BA concluded in the draft IRA that the distribution potential of *Erwinia amylovora* in Australia is "low", based on steps 3 and 4 in the distribution pathway.[94] By contrast, the New Zealand Government argued that this estimation considerably overstates the likelihood of distribution.[95]

Summary of the Probability of Entry

10.100 Based on a "high" probability of importation, but a "low" probability of distribution, BA assessed the probability of entry of *Erwinia amylovora* into Australia

89 Submission 28, p 9

90 Evidence, RRAT, 29 March 2001, p 398

91 Submission 43, pp 6-7

92 Submission 52, p 37

93 Submission 43, p 10

94 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, pp 86 - 87

95 Submission 24, p 24

on New Zealand apples as "low".[96] Essentially, BA acknowledged that if New Zealand apples are imported into Australia, *Erwinia amylovora* will reach this country, but that the likelihood that the bacterium will take steps 3 and 4 of the distribution pathway and be transferred to an appropriate site on a susceptible host is very low.[97]

10.101 That said, the Committee notes two instances where international trade in fruit has been identified as the cause of the spread of *Erwinia amylovora* globally. First, Lelliott (1959) attributed the entry of *Erwinia amylovora* into Great Britain from the USA either to crates carrying apple fruit or the apples themselves. Secondly, Anon (1966) indicated that the entry of fire blight into Hawaii from the US mainland was attributed to a shipment of Bartlett pears.[98]

10.102 In support of its position, BA cited the following published opinion of several fire blight experts:

a) *Roberts et al (1989)*: Mature, health apple fruit do not appear to be an ecologically suitable substrate for survival of *Erwinia amylovora*. Thus, healthy, mature apple fruit, even when harvested from blighted trees, are unlikely to harbour *Erwinia amylovora* populations and therefore are unlikely to pose a phytosanitary risk to areas free from fire blight.[99]

b) *van der Zwet (1990)*: (As cited earlier) The chances for the dissemination of *Erwinia amylovora* to areas or countries without fire blight are extremely unlikely when undamaged delicious fruits are harvested a minimum of 100 cm from visible blight symptoms, or preferably from apparently healthy trees located in orchards free of fire blight.[100]

c) *van der Zwet (1994)*: International dissemination of fire blight has taken place by wind, probably by birds, and by movement of budwood. It has been suggested that fruits may be involved, but there

96 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 87

97 Evidence, RRAT, 12 February 2001, p 75

98 T.van der Zwet, 'The Various Means of Dissemination of the Fire Blight Bacterium *Erwinia Amylovora*', *EPPO Bulletin*, (No 24, 1994), p 212

99 R.G.Roberts & S.T.Reymond, 'Evaluation of Mature Apple Fruit from Washington State for the Presence of *Erwinia Amylovora*', *Plant Disease*, (Vol 73, No 11, November 1989), p 920

100 T. van der Zwet, S.V.Thomson, R.P.Covey, and W.G.Bonn, 'Population Of *Erwinia Amylovora* on External and Internal Apple Fruit Tissues', *EPPO Bulletin* , (24, 1994), p 209

is international disagreement whether measures should be taken to protect against this pathway of dissemination.[101]

d) *Roberts et al (1998)*: The low epiphytic fitness of *Erwinia amylovora* on apple fruit, the low incidence of viable *Erwinia amylovora* populations on mature apple fruit, and the lack of documented pathway by which susceptible host material could become inoculated and infected from fruit-borne inoculum all support the view that movement of *Erwinia amylovora* via commercial apple fruit is highly unlikely.[102]

10.103 BA also indicated that its assessment of a "low" probability of entry was confirmed in personal communications from experts consulted during preparation of the draft IRA. These experts were asked the question 'What is the risk of introducing fire blight via trade in apple fruit to countries free from it?' (question 26 of the scientific questionnaire):

a) *Prof Herb Aldwinckle*: Extremely low, with no safeguards – zero with reasonable safeguards.

b) *Dr Larry Pusey*: This has never been known to occur. The probability is near zero. Mature commercial apple fruit is not a pathway for transport of *Erwinia amylovora*.

c) *Dr Tom Deckers*: Very low.

d) *Dr Jean-Pierre Paulin*: Probably very low, but different from zero.[103]

10.104 That said, the Committee also notes the following responses to question 26 not cited in the draft IRA:

a) *Zeller*: High: Especially with infected plant material.

b) *Wimalajeewa*: whether the *Erwinia amylovora* bacterium enter Australia in low numbers or in high numbers, in or on apples or propagating material there, there will always be a certain amount of risk.

10.105 In its written response to the draft IRA, the New Zealand Government assessed the probability of entry as "negligible" based on a "very low" importation

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101 T.van der Zwet, 'The Various Means of Dissemination of the Fire Blight Bacterium *Erwinia Amylovora*', *EPPO Bulletin*, (No 24, 1994)

102 R.G.Roberts, C.H.Hale, T.van der Zwet, C.E.Miller & S.C.Redlin, 'The Potential for Spread of *Erwinia Amylovora* and Fire Blight via Commercial Apple Fruit: A Critical Review and Risk Assessment', *Crop Protection*, (Vol 17, No 1, 1998), p 19

103 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, pp 88-89

potential and "negligible" distribution potential. Similarly, the Committee notes the comment of Mr Ivess from MAFNZ during the Committee's visit to New Zealand:

> We are not saying that apples will not allow *Erwinia amylovora* to enter Australia … but in mature fruit, the concentration will be far too low for it to be able transfer to a susceptible host and establish.[104]

10.106 The New Zealand Government cited the following research:

a) *Smith et al* (1997): It is widely accepted that fruits present an insignificant risk in practice;[105]

b) *Thomson* (1992): It seems very remote that contaminated fruit could be responsible for establishing new outbreaks;[106] and

c) Schroth *et al* (1974): The risk of disseminating fire blight bacterium on symptomless mature apples is considered negligible.[107]

10.107 In this regard, Mr Ivess argued that the majority scientific position is that apples are not a vector for *Erwinia amylovora*. While Mr Ivess accepted that there are some scientists who do not support this position, he suggested that this is the case in any field of research, and that such scientists tend to be 'at the end of the continuum' of scientific research.[108]

10.108 The Committee acknowledges this argument, although it notes that most international research on fire blight is conducted in countries where *Erwinia amylovora* is endemic. In such countries, infested apples are a relatively insignificant source of inoculum. Rather, the disease is far more likely to spread via other avenues, making the study of the spread of *Erwinia amylovora* via trade in apple fruit irrelevant. However, for countries such as Australia which do not have fire blight, trade in apple fruit is the only source of inoculum.

10.109 Finally, the Committee notes that during the conduct of its inquiry, the Committee contacted directly Prof Aldwinckle and Dr Zoller. Prof Aldwinckle indicated to the Committee that mature, healthy appearing apples are not a means of entry of *Erwinia amylovora* into an uncontaminated area. He suggested that it would

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104 Meeting between the Committee and officials from MAFNZ and MFATNZ, Wellington, 15 May 2001

105 D.Smith, G.Beattie & R.Broadley (eds), *Citrus Pests and their Natural Enemies: Integrated Pest Management in Australia*, (Brisbane, Department of Primary Industries and Horticultural Research and Development Corporation, 1997)

106 S.V.Thomson, 'Dissemination of Bacteria Antagonistic to *Erwinia Amylovora* by Honey Bees', *Plant Disease*, (Vol 76, 1992)

107 M.N.Schroth, S.V.Thomson, D.C.Hildebrand & W.J.Moller, 'Epidemiology and Control of Fire Blight', *Annual Review of Phytopathology*, (Vol 12, 1974). Cited in Submission 24, p 26

108 Meeting between the Committee and officials from MAFNZ and MFATNZ, Wellington, 15 May 2001

be possible to initiate an infection using young fruit that was obviously infected and oozing bacteria, but that this is not what is being proposed.[109]

10.110 By contrast, Dr Zoller indicated that he did not think that it is a difficult undertaking for *Erwinia amylovora*, which would inevitably be bought into Australia on apples from New Zealand, to find a suitable host and begin an epidemic in Australia. 'What bothers me is the fact that this step has been classified as "low"'.[110]

> The only dispute relates to the bacteria getting from these fruit into a host. … To me, we do not know enough about it. That is all you can say. You cannot say whether or not it is a high or a low likelihood. You can say that there is a lot of uncertainty and you can say that we have not studied this step.[111]

10.111 The Committee accepts that the majority of international scientists suggest that mature apples are not a vector for the transfer of *Erwinia amylovora*. That said, the Committee is of the opinion that the potential for *Erwinia amylovora* to enter into Australia requires further research. The Committee makes a number of recommendations in this regard in Chapter 16.

The Probability of Establishment of *Erwinia Amylovora*

10.112 BA indicated in the draft IRA that the probability of establishment of *Erwinia amylovora* in Australia following its entry is "high". In support of this argument, BA noted that there are a number of cultivated plants in the Rosaceae family which are hosts of *Erwinia amylovora* and occur widely in private gardens, parks and so forth in Australia. These hosts would likely be available throughout the year, although at different times of the year.[112]

10.113 In this regard, various parties also highlighted the widespread distribution of hawthorn bush in Australia. For example, Mrs Armour from the Gippsland Fruit Growers' Association notes that hawthorn bush is widespread in the Gippsland.[113] Similarly, Ms Williams from the Tasmanian Department of Primary Industries, Water and Environment noted that Tasmania has an 'abundance of hawthorn'.[114] Mr Green from the SA Pome Fruit Advisory Committee indicated that hawthorn is very prevalent in the Adelaide Hills, particularly the foothills.[115]

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109 Evidence, RRAT, 29 March 2001, p 383

110 Evidence, RRAT, 29 March 2001, p 386

111 Evidence, RRAT, 29 March 2001, p 338

112 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, p 88

113 Evidence, RRAT, 13 February 2001, p 156

114 Evidence, RRAT, 14 February 2001, p 183

115 Evidence, RRAT, 15 February 2001, p 228

10.114 In relation to hawthorn bush, the Committee notes research by Berrie and Billing on hawthorn as a host of *Erwinia amylovora* in English pear and apple orchards. They write:

> Diseased hawthorn trees or hedges have sometimes been important sources of fire blight inoculum for pear and apple trees in English orchards. Outbreaks of blossom blight have occurred when there was warm weather during bloom and the flowering times of diseased hawthorns and of healthy pears and apples overlapped.[116]

10.115 In its written submission, the AAPGA also noted that there are a number of native Australian *Rosaceous* family species widely distributed throughout temperate Australia which could potentially host *Erwinia amylovora*. [117] These plants include:

Rubus hillii -	Queensland bramble
Rubus rosifolius -	Rose-leaf bramble
Rubus parvifolius -	Small-leaf bramble
Geum urbanum -	Common avens
Aphanes australiana -	Australian piert
Aphanes pentamera -	Five-part piert
Acaena anserinifolia -	Bidgee-widgee
Acaena echinata -	Sheep's burr
Acaena agnipila -	Sheep's burr
Acaena ovina -	Sheep's burr

10.116 In this regard, Environment Australia observed that the draft IRA is almost silent on the impact of *Erwinia amylovora* on native species. Environment Australia noted that of at least 17 native flora species of Rosaceae in Australia, at least one, *Aphanes pentamera* (Five-part piert), is listed as threatened and could be lost through the introduction of *Erwinia amylovora*.

10.117 BA also noted in the draft IRA that there are many similarities between regions of Australia, where suitable *Erwinia amylovora* hosts are found, and regions of New Zealand from which apples carrying *Erwinia amylovora* are likely to be sourced. Accordingly, BA suggests that *Erwinia amylovora* could be as successful in establishment here in Australia as it has been in New Zealand.[118]

10.118 In response to these arguments, the New Zealand Government assessed the probability of establishment of *Erwinia amylovora* in Australia as "moderate" rather than "high". It noted that if *Erwinia amylovora* were to become established in

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116 A.M.Berrie & E.Billing, 'Hawthorns as a Source of Fire Blight Inoculum in English Pear and Apple Orchards' in W.G.Bonn (ed), *Seventh International Workshop on Fire Blight*, (Acta Horticulturae No 411, International Society of Horticultural Science, 1996), p 35

117 Submission 33, p 53

118 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 89

Australia, it would most likely be in metropolitan areas where the majority of apples are consumed. This raises the possibility that infections would be removed through pruning or detection and eradication activities. In support, the New Zealand Government cited the eradication of *Erwinia amylovora* from the Royal Botanic Gardens in Melbourne, after it had apparently been present for some time.[119]

The Probability of Spread of *Erwinia Amylovora*

10.119 BA indicated in the draft IRA that if *Erwinia amylovora* became established in a population of susceptible hosts, it would be likely to spread among the major pome fruit producing regions of Australia. Accordingly it assessed the probability of spread of *Erwinia amylovora* as "high".[120]

10.120 In support, BA noted that pollinating insects are the most likely means of spread of *Erwinia amylovora.* In particular, bees may carry the bacterium for more than 4kms, before depositing it on the stigmatic surfaces of blossoms. In addition, other insects or birds may also spread the disease, as may contaminated tools and machinery. [121]

10.121 Similarly, Mr Cartwright from PIRSA stated his opinion in hearings that it would be very difficult to confine the spread of *Erwinia amylovora* nationally if it were ever to become established in a commercial production area anywhere in Australia. He attributed this to the high number of vectors and alternative hosts in Australia.[122]

10.122 In response, the New Zealand Government argued that the probability of spread of *Erwinia amylovora* would be "moderate" rather than "high". In particular, it noted that the draft IRA does not consider activities that would be undertaken to prevent the spread of the bacterium if it were detected:

> There seems to be a view that a single introduction of fire blight will result in the disease instantaneously spreading to all pome fruit growing areas of Australia. Even under favourable circumstances the spread would take many years. For example, fire blight appears to have been present in the Royal Melbourne Botanic Gardens for a number of years without spreading.[123]

10.123 Similarly, the Western Australian Fruit Growers' Association raised the possibility that although containment of the disease within a particular apple-growing district of Australia would be unlikely to succeed, spread of the disease between apple

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119 Submission 24, p 27

120 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 90

121 *Ibid*, pp 89-90

122 Evidence, RRAT, 15 February 2001, p 259

123 Submission 24, p 27

growing regions of Australia might be prevented. This would require quarantine restrictions on movement of plant materials between regions.[124]

10.124 A number of factors in the spread of *Erwinia amylovora* were highlighted to the Committee during its inquiry. These are discussed below.

Climate

10.125 The incidence and severity of fire blight outbreaks increase with higher temperatures and humidity. In this regard, BA noted in the draft IRA that the apple-growing regions of Australia are located in high-rainfall areas, and that during the blossom period, temperatures in these areas are generally higher than the threshold required for the multiplication of *Erwinia amylovora*.[125]

10.126 Similarly, Dr Zoller indicated in evidence that the spread of *Erwinia amylovora* through a new orchard can occur in just one day at optimum temperatures of between 75^{o} and 85^{o} Fahrenheit, in conjunction with significant insect activity. At the same time, above 95^{o} Fahrenheit, the bacterium rapidly die, and treatment of orchards can be discontinued.[126]

10.127 Given this evidence on the impact of temperature and climate, the Committee notes the research of Roberts (1991) conducted in the various apple-growing regions of Australia using the MaryBlight Model for predicting fire blight outbreaks. Roberts predicted that each region has eight or more potential infection days a year, more than in either Utah in the USA or New Zealand.[127]

10.128 The Committee also notes that during its tour of apple growing regions of Australia, representatives from every region claimed that their region's climate made that region especially susceptible to fire blight:

a) Queensland: Mr Tomasel from the Queensland Fire Blight Task Force noted that the MaryBlight model predicts that up to 18 potential infection periods can occur in the Granite Belt around Stanthorpe each year. These infection periods are generally associated with strong winds and rain, or hail, during the spring when apple plants are flowering.[128]

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124 Submission 42A, p 14

125 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 90

126 Evidence, RRAT, 29 March 2001, p 389, 397

127 W.P.Roberts, 'Using Weather Records and Available Models to Predict the Severity of Fire Blight should it Enter and Establish in Australia', *OEPP/EPPO Bulletin*, (Vol 21, 1991), cited in evidence, RRAT, 13 February 2001, p 125

128 Evidence, RRAT, 12 February 2001, p 70

b) NSW: Mr Ashton from the Batlow Branch of the NSW Farmers Federation indicated that in the Batlow region they use CougarBlight forecasting model (a derivative of the MaryBlight model). It predicted that in October 2000, the Batlow region had 15 days of low infection potential, four days of moderate infection potential, one day of high infection potential and four days of severe infection potential.[129]

c) Victoria: Ms Reynolds from AAPGA noted research on the Goulburn Valley conducted using the CougarBlight forecasting model which indicated that in Ardmona and Cobram in the Goulburn Valley, 17 per cent and 32 per cent of days posed either a high or extreme risk of fire blight spread.[130]

d) Tasmania: Mr Salter from the TAPGA noted in evidence that Tasmania has a high rainfall in springtime, when fire blight is most active, giving Tasmania 'as high a degree of … susceptibility as anywhere'.[131]

e) South Australia: Plummers BV Orchard noted in its written submission that in the past year in the Adelaide Hills, there was a long blossoming period (26 September to 23 October 2000), during which time the temperature regularly climbed over 18^0C (12 of 28 days), and it rained on 4 days.[132]

10.129 In contrast with Australia, Mr Tancred from Orchard Services suggested that New Zealand has a considerably cooler climate, especially during spring. In addition, New Zealand does not have as great a likelihood of hail which damages the fruit and leaves them vulnerable to infection, whereas Australian apple growing regions are in the cooler, higher regions where it is more likely to hail.[133]

10.130 The Committee was also informed by evidence provided by Dr Wimalajeewa. Dr Wimalajeewa indicated that he has been monitoring the climate in the Sacramento Valley in California for the last 9 years using data sent to him by Dr Zoller. That data shows that the climate in the Sacramento Valley is very similar to that in the Goulburn Valley. With that in mind, Dr Wimalajeewa noted:

> In June 1991, I visited a number of pear orchards in the Sacramento Valley, and what I saw there was very, very frightening. What I saw was not an isolated attack; it is a regular occurrence there. Pear growing in Sacramento

129 Evidence, RRAT, 9 March 2001, p 376

130 Evidence, RRAT, 13 February 2001, p 124

131 Evidence, RRAT, 14 February 2001, p 172

132 Submission 4, p 2

133 Evidence, RRAT, 12 February 2001, p 36

> Valley has become unprofitable because of fire blight. Growers have to practise very serious pruning of trees, cutting out up to 300 fire blight strikes per year per tree. Spraying of orchards was incredibly heavy, with up to 25 sprays put on per year. At the time of my visit, fire blight control was costing the growers there $A4,500 per hectare per year, whereas the total cost at that time in the Goulburn Valley for disease and pest control was only $A765 per hectare per year.[134]

Varieties

10.131 In recent times, the Australian apple industry has introduced a number of new varieties of apples, notably Pink Lady and Royal Gala, which command premiums on the retail market due to their quality. At the same time however, these newer apple varieties are particularly susceptible to fire blight.[135]

10.132 The Committee notes in particular that the Pink Lady, Gala, Jonathan and Jonagold apple varieties are the most susceptible to fire blight. By comparison, Golden Delicious are less susceptible, while some varieties such as Red Delicious are largely resistant (although they may still act as hosts for the bacterium). Bartlett (duchess) pears are also highly susceptible to fire blight.[136]

Rootstock

10.133 Over the past 20 years, the apple industry in Australia has introduced new dwarfing rootstocks. Dwarfing rootstocks limit the height of apple trees to about 2m. By comparison, New Zealand growers do not use dwarfing rootstocks. Apple trees in New Zealand grow up to 6m high.

10.134 The use of dwarfing rootstocks is to achieve a greater yield per hectare. Dwarfing rootstocks allow for an increase in tree density (more trees per acre) and a reduction in the use of pesticides. In addition, rootstock trees start producing fruit earlier.[137]

10.135 There are a range of dwarfing rootstocks of apple plants including the G30, M7, M7A, MARK, Ottowa 3, B9, B491, MM106, M111, M9 and M26 (Malling 26 Malling 9 varieties). However, the most commonly used rootstocks in Australia are the M9 and M26 varieties.

10.136 In its written submission, the APGASA indicated that at least 75% of apples planted in the last 5 years in South Australia were on the M9 and M26 dwarfing rootstocks.[138] Similarly, the Batlow Branch of the NSW Farmers' Federation noted

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134 Evidence, RRAT, 13 February 2001, p 142

135 Submission 7, p 6. See also Submission 27, p 2

136 Evidence, RRAT, 12 February 2001, p 56. See also Submission 27, p 2

137 Submission 2, p 1

138 Submission 26A, p 14

that the district around Batlow produces 40,000 tonnes of apples per year, with most of the product from young trees of the Gala, Braeburn, Fuji and Pink Lady varieties using the M9 and M26 rootstocks.[139]

10.137 Given the widespread use of the M9 and M26 rootstocks in Australia, the Committee is aware of extensive research indicating that apple trees grown on these rootstocks are particularly vulnerable to fire blight.

10.138 For example, research by Travis *et al* (1999) entitled 'The Susceptibility of Apple Rootstocks and Cultivars to *Erwinia Amylovora*', rated in order the rootstocks most susceptible to fire blight as M26, Ottowa 3, M9, B9, G30, MARK, G16 and M7.[140]

10.139 Similarly, Steiner (1998) writes in 'Problems in Managing Fire Blight in High Density Orchards on M-9 and M-26 Rootstocks':

> What makes fire blight a truly significant problem in high density orchards planted on either the M26 or M9 rootstock is a phenomenon called "rootstock blight". … We have seen rootstock blight in the field and reproduced it in the greenhouse on other rootstocks such as M7A and M111, but the rootstock cankers that developed are never as aggressive as they are on M26 and M9 and rarely kill trees.[141]

10.140 Finally, in an article on 'The Fire Blight Epidemic in Southwest Michigan', Longstroth (2000) writes:

> Common dwarfing rootstocks such as M26 and M9 are very blight susceptible. "Rootstocks can become infected by direct infection of rootstock suckers at the base of the tree or where bacteria travel **symptomlessly** through the trunk into the roots. Such a systemic movement from a minor infection can result in tree death.
>
> Attempting to remain competitive, orchardists replaced outdated mature orchards with high-density systems. Many of the new premium varieties that were planted….were all susceptible as were the dwarfing rootstocks they were planted on. Now Fire Blight is destroying the investment and effort of the past decade.[142]

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139 Submission 14, p 1

140 J.W.Travis, J.L.Rytter & K.D.Hickey, 'The Susceptibility of Apple and Rootstocks and Cultivars to *Erwinia Amylovora*' in M.T.Momol & H Saygili, *Proceedings of the Eighth International Workshop on Fire Blight*, (Acta Horticulturae No 489, International Society of Horticultural Science, 1999), p 235

141 P.Steiner, 'Problems in Managing Fire Blight in High Density Orchards on M-9 and M-26 Rootstocks', Paper presented at the Annual Meeting of the Virginia/West Virginia State Horticultural Societies, (Roanoke, Virginia, January 12 1998). http://www.caf.wvu.edu/kearneysville/articles/steinerhort1.html

142 M.Lonstroth, 'The Fire blight Epidemic in Southwest Michigan', http://www.msue.msu.edu/vanburen/fb2000.htm, p 14

Summary of the Probability of Spread

10.141 On the basis of the evidence cited above, the Committee is of the opinion that should *Erwinia amylovora* become established and spread throughout the apple growing regions of Australia, its effect on the industry could be greater than the effect of *Erwinia amylovora* in New Zealand. This is based on two important considerations, the warmer (and possibly wetter) climate in Australia, and the widespread use of M9 and M26 rootstocks in Australia.

10.142 In evidence, Prof Aldwinckle also stated his opinion that the incidence and severity of fire blight in New Zealand is not particularly high, when compared to Michigan and New York state in the US, and that conditions in Australia are favourable to fire blight.[143]

The Overall Probability of Entry, Establishment and Spread of *Erwinia Amylovora*

10.143 Based on a "low" probability of entry, a "high" probability of establishment and a "high" probability of spread, BA assessed the unrestricted risk of entry, establishment and spread of *Erwinia amylovora* into Australia via trade in New Zealand apples as "moderate".[144]

10.144 As before, the critical element in this assessment of a "moderate" unrestricted risk posed by *Erwinia amylovora* is BA's assessment of the probability of entry as "low", in turn based on a "low" probability of *Erwinia amylovora* passing steps 3 and 4 in the distribution pathway.

10.145 In comparison, the AAPGA assessed the unrestricted risk associated with *Erwinia amylovora* as "extreme", based on a "high" probability of entry, a "high" probability of establishment and an "extreme" probability of spread.[145] Similarly, Dr Wimalajeewa assessed the probability of entry, establishment and spread as "high", "moderate" and "high" respectively, and accordingly reached an overall probability of entry, establishment and spread of "moderate":

> In the light of this assessment, the combined probability rating of "low" in the draft IRA for entry, establishment and spread is clearly an understatement.[146]

10.146 The Committee also notes that in evidence, Mr Morvell from Environment Australia suggested that the risk posed by *Erwinia amylovora* is 'considerably higher than "low" or "negligible"':

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143 Evidence, RRAT, 29 March 2001, p 379

144 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 95

145 Submission 33, p 25

146 Submission 28, p 11

> It is rather difficult for us to give a measure of where the risk lies. It would probably be inappropriate for us to do that because we have not done the risk assessment. However, we have said that the risk assessment that has been undertaken was inadequate for the purpose and the decision making that will be taken in the future. It has probably underestimated the risk quite significantly.[147]

10.147 By contrast to these positions, the New Zealand Government assessed the unrestricted risk associated with *Erwinia amylovora* as "negligible", based on a "negligible" probability of entry, a "moderate" probability of establishment and a "moderate" probability of spread. The New Zealand Government continued:

> This assessment falls within Australia's ALOP as expressed in Table 6 of the draft IRA and no phytosanitary measures are necessary to manage this level of risk.[148]

10.148 In response to these competing arguments, the Committee reiterates its opinion that the unrestricted risk associated with the entry, establishment and spread of *Erwinia amylovora* requires further research.

10.149 On a separate matter, the Committee also notes that the draft IRA gives very little consideration to the effect of *Erwinia amylovora* on the Australian pear industry, which is concentrated the Goulburn Valley in Victoria.[149] This is despite BA's acknowledgment in the draft IRA that pear plants are more susceptible to fire blight than apple plants.[150]

10.150 In this regard, various parties claimed in hearings that New Zealand does not have a pear industry because of the presence of *Erwinia amylovora*. In response, the New Zealand Government argued that the reason why apple growing is more popular that pear growing in the New Zealand is because apples provide a greater financial return.[151]

The Findings of the 1998 IRA

10.151 During the conduct of the inquiry, several parties compared the findings of the draft 2000 IRA with the finding of the 1998 IRA. In the 1998 IRA, AQIS indicated that New Zealand's claim that mature apple fruit, free of trash, are not a vector for *Erwinia amylovora* was not adequately demonstrated, and that the New Zealand proposal did not provide the level of protection required by Australia.

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147 Evidence, RRAT, 28 February 2001, p 359

148 Submission 24, p 28

149 Submission 29, p 3

150 Biosecurity Australia, *Draft Import Risk Analysis on the Importation of Apples from New Zealand*, October 2000, p 58

151 Submission 24, p ii

10.152 In response to this issue, BA argued that it continues to regard apples from New Zealand as a vector for *Erwinia amylovora*, but that it has implemented a range of protocols in the draft 2000 IRA, as requested by New Zealand, to reduce the probability of *Erwinia amylovora* reaching Australia:

> The government's position on this has **not** (BA's emphasis) changed: the management measures set out in the draft IRA focus on ensuring that orchards producing apples for export to Australia do not have evidence of fire blight.
>
> Excluding the possibility of infected fruit being imported significantly reduces the likelihood that fire blight could become established in Australia due to imports of apple fruit from New Zealand.[152]

The Economic Consequences of *Erwinia Amylovora*

10.153 BA estimated in the draft IRA that in a worst case scenario, the entry, establishment and spread of *Erwinia amylovora* in Australia could lead to a 50 per cent reduction in pear production and a 20 per cent reduction in apple production in the major producing areas of Australia. The Australian Bureau of Statistics estimated the gross value of Australia's pome fruit industry in 1998 at $272.7 million. Commercial losses arising from fire blight would thus be substantial.[153]

10.154 BA further noted in the draft IRA that no country has successfully eradicated fire blight, unless it has been detected at an early stage and confined to a limited area. This was the case in the recent detection of *Erwinia amylovora* in the Royal Melbourne Botanic Gardens, although even this outbreak caused disruption to commercial trade and economic loss.[154]

10.155 Given these considerations, BA assessed the overall economic consequences if *Erwinia amylovora* were to reach Australia as "extreme".[155] The Committee raises a number of issues below.

Loss of Production

10.156 The commercial costs from *Erwinia amylovora* arise partly from the substantially increased costs involved in additional surveillance activities, implementation of sanitation and control measures and reduced production.

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152 Biosecurity Australia, 'Draft IRA on New Zealand Apples – An Overview' http://www.affa.gov.au/docs/market_access/biosecurity/plant/nzappov.pdf, pp 1-2

153 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, pp 91-92

154 *Ibid*, pp 92-93

155 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 93

10.157 In evidence, Dr Zoller noted that he had visited apple growing regions of Australia such as the Goulburn Valley, and indicated his belief that such areas would be devastated by the arrival of fire blight. He suggested that even allowing for the most modern management techniques, the learning curve would be so steep that many mistakes would be made.[156]

10.158 In addition, *Erwinia amylovora* may also lead to the loss of trees themselves. In this regard, Mr Ashton from the Batlow Branch of the NSW Farmers' Federation suggested that replanting apple trees in the Batlow district would cost at least $10,000 per hectare, in addition to the loss of income over the intervening 5 years before they reached maturity.[157]

10.159 Given these considerations, the AAPGA cited a study 'The Potential Impact of Fire Blight on the Australian Apple and Pear Industry: A Socio-Economic Study'. This paper was prepared by Corporate Strategy Consulting for the AAPGA in January 1997. Briefly, the study found that the nation-wide impact of fire blight would be:

a) For Growers: $98 million revenue loss in 1997 with total losses of $827 million over the period 1997-2002; and

b) For the Australian economy: $25 million lost export revenue in 1997 with a total loss of $183 million over the period 1997-2002. Job losses of 1,377 in 1997 and total losses of 2,484 jobs over the period 1997-2002.[158]

10.160 Further, the AAPGA noted that these figures are likely to underestimate the impact today, given that they are in 1997 dollars, and that the industry has grown since 1997, especially in the Goulburn Valley.[159]

10.161 In response to these estimates, the New Zealand Government disputed claims that *Erwinia amylovora* could lead to a 20 per cent decline in apple production, and a 50 per cent decline in pear production. In particular, the New Zealand Government noted that New Zealand has a successful apple industry despite the presence of *Erwinia amylovora*.

Loss of International Market Share and Australia's Clean Image

10.162 The commercial costs from *Erwinia amylovora* also arise from loss of access to markets in pome fruit producing countries where *Erwinia amylovora* is absent. For example, the South Australian Pome Fruit Improvement Committee noted that Australia trades on its 'clean green' image in the international market place, but that

156 Evidence, RRAT, 29 March 2001, p 393

157 Evidence, RRAT, 9 March 2001, p 377.

158 Submission 33, appendix 7, p 120

159 Submission 33, p 32

this would be lost with the introduction of chemical controls of *Erwinia amylovora* in Australia.[160]

10.163 In this regard, the Committee notes evidence presented by Mr Salter from the TAPGA that Tasmania is the only state in Australia that is free of fruit fly. Accordingly it is able to export to Taiwan under much less stringent protocols than other states. Tasmania is the only Australian state exporting apples to Japan.[161]

10.164 In response, the New Zealand Government noted that New Zealand has access to international markets such as the EU, Malaysia, Singapore, Indonesia, Hong Kong, the UK, Taiwan and India, and that 'none of these countries impose restrictions on apples from countries where fire blight occurs'.

Impact on Communities

10.165 Given the potential economic impact of *Erwinia amylovora*, BA also noted that the establishment of *Erwinia amylovora* in Australia would substantially effect the lives of people both directly and indirectly associated with the pome fruit industry. This would include direct losses of employment and cash flow to local communities, and flow-on effects.[162]

10.166 As an example, the Committee received a combined submission from the Victorian Apiarists' Association and Crop Pollination Association on behalf of the beekeeping industry in Australia. The submission noted that bees are efficient pollinators of food crops, and that currently 38,300 managed bee-hives are contracted for pollination across Victoria from August to November each year. In particular, there are:

- 7,000 hives contracted in the Goulburn Valley region;
- 5,000 hives contracted in the outer Melbourne region;
- 4,500 hives contracted in the Murray Valley region;
- 1,000+ hives contracted in the Harcourt Valley;
- 300+ hives contracted in the Bacchus Marsh region;
- plus orchards further down into Gippsland, as well as other smaller orchard areas.

10.167 Given this, the Victorian Apiarists' Association and Crop Pollination Association raised their concern that the incursion of *Erwinia amylovora* into Australia could necessitate the destruction of these healthy hives as part of a

160 Submission 2, p 1

161 Evidence, RRAT, 14 February 2001, p 169

162 Biosecurity Australia, Draft Import Risk Analysis on the Importation of Apples from New Zealand, October 2000, p 93

quarantine response, leading to a decline in honey production. Australia is currently the world's fourth largest exporter of honey. In addition, other industries which depend on managed bees for pollination would also suffer.[163]

10.168 Similarly, the Eastern Metropolitan Fruitgrowers' Association noted that the Goulburn Valley accounts for 87 per cent of Australia's pear production, and 25 per cent of Victoria's rural output. A reduction of production in the order of 25 per cent owing to the introduction of *Erwinia amylovora* could lead to the loss of one or both of the canneries (Ardmona and SPC) in the Goulburn Valley, with associated losses of employment and social upheavals.[164] The submission from the Eastern Metropolitan Fruitgrowers Association concluded that:

> This new application [by New Zealand for access to the Australia market] should also be rejected as the one of 1998 was because it is just not worth the risk. The economic consequences are too enormous to contemplate as the economic and social damage would be almost Australia wide.[165]

10.169 The Committee visited the Ardmona canning factory in Shepparton, and took evidence from the CEO of Ardmona, Mr Taylor. Mr Taylor indicated that Ardmona and SPC, the two canning factories in Shepparton, generate sales of $415 million a year, of which approximately $120 million is in exports, and together employ 2,900 people. In the case of Ardmona, it adds tremendous value, buying approximately $30 million in fruit a year, and generating $160 million of sales.[166]

10.170 Importantly, Mr Taylor indicated to the Committee that the preferred juice for packing canned fruit is pear juice, due to its relatively bland qualities. Accordingly, Mr Taylor suggested that if *Erwinia amylovora* were introduced to the Goulburn Valley, and pear production in particular were to decline due to the susceptibility of pear plants to *Erwinia amylovora*, there could be a significant impact on the canning industry.[167]

10.171 In response to these concerns for the broader community, the New Zealand Government noted in its written submission that BA's measurement of 'societal values' and 'social wellbeing' in the draft IRA goes beyond the WTO *Guidelines for Pest Risk Analysis* (FAO, 1996), which requires that the impact of a pest be expressed solely in economic terms:

> AFFA has indicated that economic impact can also be expressed as the impact on 'societal values' or 'social wellbeing', however these terms have not been defined. At no point has AFFA indicated that any survey has been

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163 Submission 12, p 3

164 Submission 1, pp 1-2

165 Submission 1, p 2

166 Evidence, RRAT, 13 February 2001, pp 138 - 139

167 Evidence, RRAT, 13 February 2001, p 139

> undertaken to define 'societal values' of the potentially affected areas nor what the Australian populace considers to be a state of 'wellbeing'. … We suggest that AFFA has not conducted such research and that any assessment of impact on these criteria is completely subjective and in no way complies with the international guideline for assessment of economic impact.[168]

10.172 The New Zealand Government further argued that the economic consequences of the establishment of *Erwinia amylovora* in Australia are probably at most "moderate". In other words, the impact would be likely to be recognised at a national level, significant within the affected geographic regions, and highly significant to directly affected parties.[169]

The Unrestricted Risk Posed by *Erwinia Amylovora*

10.173 As above, BA assessed the risk that *Erwinia amylovora* would enter, establish and spread in Australia on apples from New Zealand as "low", and the economic consequences as "extreme". Accordingly, BA assessed the unrestricted risk associated with *Erwinia amylovora* as "moderate" according to Table 10.2 below.

Table 10.2: BA's Unrestricted Risk Assessment of Erwinia amylovora

Probability of: Entry (P1)	**Establishment (P2)**	**Spread (P3)**	**Probability of entry, establishment and spread (P = P1xP2xP3)**	**Economic Consequence (C)**	**Unrestricted Risk (R=PxC)**
Low	High	High	Low	Extreme	Moderate

10.174 By contrast, the AAPGA assessed the unrestricted risk associated with *Erwinia amylovora* as "extreme".[170] This is shown in Table 10.3 below:

Table 10.3: AAPGA's Unrestricted Risk Assessment of Erwinia amylovora

Probability of: Entry (P1)	**Establishment (P2)**	**Spread (P3)**	**Probability of entry, establishment and spread (P = P1xP2xP3)**	**Economic Consequence (C)**	**Unrestricted Risk (R=PxC)**
High	High	Extreme	Extreme	Extreme	Extreme

Source: Submission 33, p 25

168 Submission 24, p 9

169 Submission 24, p 28

170 Submission 33, p 25

10.175 By contrast with these positions, the New Zealand Government assessed the unrestricted risk to Australia from *Erwinia amylovora* as "negligible", based on a "negligible" probability of entry, establishment and spread, and a "moderate" economic consequence. This is shown in Table 10.4 below.

Table 10.4: New Zealand Government's Unrestricted Risk Assessment of Erwinia amylovora

Probability of: Entry (P1)	**Establishment (P2)**	**Spread (P3)**	**Probability of entry, establishment and spread (P = P1xP2xP3)**	**Economic Consequence (C)**	**Unrestricted Risk (R=PxC)**
Negligible	Moderate	Moderate	Negligible	Moderate	Negligible

Source: Submission 24