HAL

Know-how for Horticulture™

Area-wide management of fruit fly in endemic areas - A feasibility study

Keith Jorgensen

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AH01016

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AREA-WIDE MANAGEMENT OF FRUIT FLY IN ENDEMIC AREAS - A Feasibility Study

Report on Project AH01016

Consultant: Keith Jorgensen

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Glossary

AFFA	Department of Agriculture, Fisheries and Forestry of Australia
AQIS	Australian Quarantine and Inspection Service
AWM	Area-Wide Management of fruit fly
BA	Biosecurity Australia
BFA	Blueberry Farms Australia
CA	Certification Assurance
Caribfly	Caribbean fruit fly (*Anastrepha suspensa*)
FFEZ	Fruit Fly Exclusion Zone
GA	Gibberellic Acid
HAL	Horticulture Australia Limited
HRDC	Horticultural Research and Development Corporation
IPM	Integrated Pest Management
IPPC	International Plant Protection Convention
IPHRWG	Interstate Plant Health Regulation Working Group
Medfly	Mediterranean fruit fly (*Ceratitis capitata*)
MAT	Male Annihilation Technique
MLL	Maximum Larva Load
MPL	Maximum Pest Limit
QA	Quality Assurance
Qfly	Queensland fruit fly, which includes all stages of the species *Bactrocera tryoni*, and related species *B. aquilonis* and *B. neohumeralis*.
SIT	Sterile Insect Technique

1. EXECUTIVE SUMMARY

1. Area-wide management (AWM) is a system for managing the fruit fly population in an area so that economic damage from the pest is reduced for at least part of the year. AWM systems make use of natural controls of fruit fly population and egg laying, such as low winter temperatures and low fruit susceptibility to infestation, combined with appropriate applied controls, ranging from bait sprays to orchard sanitation and eradication of unnecessary sources of infested fruit. Any registered use of a pesticide may be included. A system is considered area-wide if it:

- applies to more than one orchard in an area, or
- includes at least one control measure that is applied outside the crop area.

2. AWM has several advantages over the commonly used method of controlling fruit flies using repeated applications of a broad spectrum systemic insecticide. AWM involves much reduced application of pesticides and generally does not interfere significantly with integrated pest management (IPM) of other fruit pests. AWM also has advantages over post-harvest quarantine treatments with heat, cold or fumigants, because it is generally less expensive, it saves treatment time, and the fruit quality is not affected at out-turn.

3. AWM can be used simply as a means of reducing fruit fly damage, but the greatest benefit is obtained when it is approved as a quarantine measure for market access. Victoria is the only state that has approved AWM as a quarantine measure, and it accepts fruit treated as follows.

(a) Citrus from the Central Burnett, Qld that have been: bait sprayed, harvested between March and August, and inspected for fruit fly infestation.

(b) Blueberries from Corindi (near Coffs Harbour), NSW that have been either: harvested between June and August; bait sprayed, or dimethoate cover sprayed, then inspected for fruit fly infestation.

(c) Cherries from the Young Climatic Fruit Fly Free Zone in NSW, provided a fruit fly outbreak has not been declared in the Zone since the previous winter.

4. These basic AWM systems need to be upgraded to make them more effective, more acceptable to Australian and overseas quarantine authorities, and more reliable. Other systems need to be developed so that more districts can use AWM. These improvements are needed before the current pesticide based quarantine treatments become unacceptable. Developing improved AWM schemes for interstate trade will give Australia the experience needed to negotiate access to export markets using AWM.

5. A wide range of likely components of AWM systems has been investigated to identify those with the highest priority for research and development. In general, those that take advantage of the physiology and behaviour of fruit

flies have the highest potential benefit. Two areas have been recommended for attention in the near future, but there are many others that warrant further work when funds permit. (See Recommendations and Framework for details.)

6. The likelihood of increased acceptance of AWM systems for market access has been discussed with quarantine authorities. They indicated that AWM systems have considerable potential and a lot of benefits, but better techniques for measuring their reliability and effectiveness are needed.

7. The International Plant Protection Convention (IPPC) is developing a Standard for the use for quarantine purposes of an integrated measure for pest risk management, known as a systems approach. An AWM system will be considered for quarantine purposes as all or part of a systems approach. The draft Standard requires a systems approach to have at least two different pest risk measures which act independently, and which cumulatively achieve the desired level of phytosanitary protection. Future AWM systems need to be designed to meet this requirement, or else be combined with another independent measure such as a post-harvest inspection or treatment, in order to provide the fail-safe effect required in a systems approach.

8. It is generally recognised that the effectiveness of AWM systems cannot be measured using the standard techniques used for post-harvest commodity treatments, such as probit 9. However. there are no widely accepted methods for defining the required level of quarantine security for fruit fly, nor for measuring the efficacy of a systems approach. Australia needs to establish an agreed basis for the approval of AWM schemes in order to facilitate the use of AWM in interstate quarantines. The experience gained from evaluating and operating AWM schemes for interstate quarantine purposes will then be useful in export negotiations. Information on these issues is provided.

9. Most AWM schemes will require the involvement of a large majority of the fruit growers and community members in an area in order to achieve the required level of control of the fruit fly population. These comprehensive AWM schemes will require some form of organisation to plan the scheme, obtain support from stakeholders (including different levels of government), coordinate activities, and ensure the effective application of the chosen control measures.

10. The steps involved in establishing a new AWM scheme have been described to provide a framework for growers and others to use. In the planning phase it will be necessary to identify the natural and applied measures to be used; the benefits to be obtained (especially improved market access); the stakeholders and their level of support, and the sources of funds, followed by a realistic assessment of the chance of success. The development phase includes research and development work to test and adjust the selected AWM system, followed by a measurement of the efficacy of the scheme when it is working satisfactorily. A scheme enters the operational phase when it is used for market access, or when stakeholders commit to it because they feel the benefits outweigh the costs.

11. The funding needs of a major new AWM scheme are outlined. While growers can be expected to pay for the measures applied to their own properties, obtaining funding for the off-farm treatments will be more difficult, particularly before market access is obtained. It is desirable that national bodies provide support funds to ensure that early adopters do not have to carry all the costs of developing high standard AWM schemes. Information is provided on establishing a pilot implementation project, including the activities that warrant seed funding. When market access is gained, it may be possible to guarantee financial support by linking each grower's CA accreditation for market access with their continued financial support for the AWM scheme that provides the access.

12. Nine districts in NSW, WA and Qld with potential for AWM have been assessed through on-the-spot discussions with representatives of growers, local authorities and state departments. The districts have been ranked on the basis of their suitability for establishing a successful AWM scheme, and of the national benefit to be gained from the establishment of that scheme. The five districts ranked highest, are: Central Burnett, Corindi, Young, Narromine and Orange.

13. However, the successful establishment of an AWM scheme in a district will depend to a great extent on other factors that cannot be assessed at this time, especially the real level of support from growers, government, quarantine authorities and the community. A method that takes this into account, is recommended for selecting the district(s) to receive pilot implementation funding. This method ensures that each district makes a realistic assessment of the likely success of the AWM scheme and the level of local commitment before applying for seed funds.

2. RECOMMENDATIONS

The recommendations are listed under their chapter heading, in the order they appear in the report.

Future Use Of AWM In Australia

Recommendation 1. Action to improve the effectiveness of AWM, and to implement more AWM schemes and market access protocols should be taken as soon as possible, before the current chemical quarantine treatments for fruit fly become unacceptable.

Use Of AWM For Market Access

Recommendation 2. State quarantine authorities should re-assess the AWM systems approved by Victoria, taking into consideration Victoria's good experience with the produce received over several years, as well as the efficacy data available. If these AWM systems are not acceptable to other states for use in entry conditions, then their quarantine authorities, working through the Interstate Plant Health Regulation Working Group (IPHRWG),

should decide what efficacy standards, additional information and other features are required.

Recommendation 3. Horticulture Australia Ltd (HAL) should organise a workshop or project involving biometricians, researchers and quarantine authorities to develop an agreed method of determining the required level of quarantine security, and to develop a method (or methods) of measuring the efficacy of an AWM scheme (and of other uses of the systems approach), using data relevant to fruit flies in the Australian situation.

Recommendation 4. The Department of Agriculture, Fisheries and Forestry of Australia (AFFA) should identify favourable opportunities for using an AWM system as all or part of the treatment for fruit fly in an export market access protocol. Entry of citrus into the USA may be an appropriate case.

Research Issues

Recommendation 5. Each of the potential areas for research to improve existing measures and develop new measures for controlling fruit fly by AWM should be reviewed in detail. These areas should then be prioritised for research, taking into consideration:

- Existing information from previous studies.
- Anticipated benefits of the target information.
- Likelihood of success.
- Cost of conducting the research.

Recommendation 6. HAL should establish a research project as soon as practicable to determine the most effective methods of applying the male annihilation technique (MAT), and to measure the efficacy of MAT, ideally before it is used in a major AWM scheme.

Recommendation 7. HAL should establish a project to undertake a literature review of the relation between winter temperatures and egg laying, and then if necessary a research project, in order to develop a model to facilitate the use of this natural control in AWM schemes.

ESTABLISHING AN AWM SCHEME

Recommendation 8. HAL should establish an AWM pilot implementation project to develop Australian experience with AWM planning, development and operation. The project should assist one or more appropriate districts to establish a new or improved AWM scheme.

Recommendation 9. State and Commonwealth governments should check whether their Certification Assurance (CA) schemes allow for the accreditation of a grower for an AWM entry condition to be made legally dependent on the grower's continued financial support for the local AWM scheme that allows the fruit to satisfy the AWM entry condition. Amendments to the legislation should be made if required.

Recommendation 10. Because of the costs involved, a full measurement of the efficacy of an AWM scheme should be left until the scheme is operating satisfactorily, and a measurement method has been approved by the prospective importing quarantine authority.

RANKING DISTRICTS FOR AWM IMPLEMENTATION

Recommendation 11. The five districts ranked highest for their suitability to establish a successful AWM scheme and for the national benefit to be gained from the establishment of that scheme, are: Central Burnett, Corindi (near Coffs Harbour), Young, Narromine and Orange.

SELECTING A DISTRICT FOR AN AWM PILOT PROJECT

Recommendation 12. HAL should invite growers interested in establishing a new or improved AWM scheme to apply for seed funding on behalf of their district. Their application should include evidence of thorough planning and of the financial and other commitment by growers, government and other stakeholders to support the plan. The selection of the district(s) to receive implementation project funding should take into consideration this planning and commitment, as well as the suitability of the district for establishing an effective AWM scheme and the national benefits from the district receiving funding.

3. FRAMEWORK FOR IMPLEMENTATION OF AWM

This framework presents the Recommendations in the sequence in which they need to be implemented. The organisations and groups involved in implementing each recommendation are indicated in bold.

1. Action to implement new and improved AWM schemes and market access protocols should be taken as soon as possible, before the current chemical quarantine treatments for fruit fly become unacceptable (See Recommendation 1).

2. **HAL** should develop a research project on MAT (Rec. 6) so that **researchers** can commence work when the current bait spraying project concludes. Information on the best methods of applying MAT, and an assessment of its efficacy are needed before it is included in any major new AWM schemes.

3. An AWM implementation project should be developed by **HAL** (Recs. 8, 12), as soon as practicable, in order to provide **AusHort** funds over 3 years in support of the establishment of at least one new or improved AWM scheme. The project should be advertised, giving at least 1 year's notice before applications close. This will allow time for the **industry** and community in each district to make a realistic assessment of their district's potential, and develop an establishment plan for their proposed AWM scheme. **HAL** can commence advertising this implementation project before the MAT project is finished.

Growers interested in establishing an AWM scheme in their district need to consult with **technical specialists** on the appropriate components to use and the likely efficacy of the proposed AWM scheme. They also need advice from **quarantine authorities** on the likelihood of its acceptance as a basis for market access. They may be able to access funds from **national, state and local industry** sources.

If the growers decide to nominate for the AusHort pilot implementation project funding, they will need to develop an establishment plan for their proposed AWM scheme. Their application should include evidence of thorough planning and of the financial and other commitment by growers, government and other stakeholders to support the plan.

The five districts ranked highest for their suitability to establish a successful AWM scheme and for the national benefit to be gained from the establishment of that scheme, are: Central Burnett, Corindi, Young, Narromine and Orange (Rec 11). However any district should be eligible to apply for funding provided an acceptable establishment plan is submitted.

4. **HAL** should organise a workshop or project (Rec. 3) to develop a method of determining the required level of quarantine security, and a method (or methods) of measuring the efficacy of an AWM scheme (and other uses of the systems approach), using data relevant to fruit flies and plant quarantine within the Australian situation. This would be a follow-up to the plant quarantine statistics review workshop held in Sydney in 1995, funded by the Horticultural Research and Development Corporation (HRDC).

   Establishing an agreed basis for the approval of AWM as a quarantine measure within Australia (Rec. 2) is critical to its implementation and its ultimate use for interstate market access. It is very desirable that some agreement has been reached by the **IPHRWG** before the pilot AWM scheme becomes operational and its efficacy needs to be measured (Rec 10), otherwise the full benefits of AWM cannot be achieved. If agreement is not reached, market access may be limited to one state and growers may be unwilling to fund an AWM scheme when they still need to apply post-harvest treatments for other domestic markets.

5. **State and Commonwealth governments** should be asked to provide advice to **HAL** as to whether their CA schemes allow for the accreditation of a grower for an AWM entry condition to be made legally dependent on the grower's continued financial support for the local AWM scheme (Rec 9). This advice will help districts considering establishing an AWM scheme to determine the reliability of grower contributions once the scheme is operational.

6. **AFFA** should be asked to provide advice to **HAL** whether importing countries and crops identified as export targets by candidate districts in this report are likely to provide opportunities for using AWM for market access (Rec. 4). This advice can be based on existing knowledge. The advice will help **growers** and **HAL** to assess the suitability of a crop and a district for the pilot implementation project.

7. The effect of low temperature on egg laying, and hence on population size, is relevant to most AWM systems. A better understanding of the effect will increase its acceptance as a factor in reducing infestation levels in fruit harvested during cold periods. A literature review followed by research should be organised by **HAL** as funds permit (Rec 7).

8. Other potential areas for research to improve existing AWM measures or develop new measures for controlling fruit fly need to be reviewed in detail then prioritised for research (Rec 5). This review can be conducted as a future **AusHort** funded project. Alternatively, **researchers** can be invited to review individual areas of interest, then submit project proposals for that subject with a funding justification.

4. INTRODUCTION

4.1 Background

4.1.1 Universal interest in AWM

There are several major factors that have lead to an increasing interest throughout the world in managing fruit flies on an area-wide basis rather than on an individual orchard basis.

Consumers throughout the world are becoming increasingly concerned about chemical residues in the food they eat, (even though there are strict controls on the application of agricultural chemicals). There are also community concerns about the release of chemicals (including fumigants) into the environment from both pre- and post-harvest pest control treatments.

As a result, there is increasing use of IPM to control many fruit pests. Growers now need methods of controlling fruit fly that do not destroy the parasites and predators that provide biological control of other pests. They need to avoid the repeated application of broad spectrum systemic insecticides used in the past to control fruit fly. AWM can meet this need.

The rising standard of living and an increasing awareness of the health benefits from eating fruit are increasing the demand for high quality fresh fruit (Hendrichs 1996). Produce often has to be transported large distances to meet out of season demand in developed countries. It also has to be moved across state and national borders and meet quarantine restrictions aimed at preventing the spread of fruit fly.

Many export markets do not approve the quarantine treatments currently used for fruit fly within Australia. The heat and cold treatments that they do accept are expensive to apply, reduce fruit quality at out-turn, and cause delays between harvest and export. Fumigation treatments are under threat of withdrawal.

Scientists have recognised the increasing need for pre-harvest methods of fruit fly control that do not involve the heavy use of insecticides. They have developed methods of control such as bait spraying and male annihilation that are based on the natural behaviour of fruit flies. These controls have been moderately successful when applied to individual orchards, but their effectiveness can be increased by applying them to a large area to maximise their effect on the total population affecting each orchard.

Quarantine authorities are also interested in quarantine measures that are compatible with the needs of consumers and the environment. Some of the existing quarantine treatments for fruit flies involve treating fruit with systemic pesticides and fumigants. Even the fruit supplied to markets that have no fruit fly restrictions is often treated with pesticides to ensure there is no fruit fly infestation.

AWM appears to be a possible alternative quarantine measure, and it has been approved in a small number of instances. However there are problems in developing a wide range of AWM systems suitable for most production situations and in measuring and reaching the efficacy standards required for quarantine acceptance.

4.1.2 National interest in AWM

In Australia, bait spraying has been used in some districts as an alternative to cover spraying for the control of fruit flies for at least 10 years. In a few instances, various combinations of natural and applied control measures have been accepted as effective quarantine measures for fruit fly for interstate trade. It is widely recognised by all stakeholders in the fruit industry that AWM shows promise and needs further development.

A major source of funds for research and development on the control of fruit fly in Australia is provided by AusHort which combines the contributions from several horticulture industry bodies concerned about fruit fly, with matching funds from HRDC.

The AusHort R&D Committee has been receiving an increasing number of requests for increasing amounts of money for research on pre-harvest research on fruit flies. Several of these requests relate to control measures and systems needed for the utilisation of AWM in Australia.

In order to develop a strategic direction for research on pre-harvest control of fruit flies, the AusHort R&D Committee convened a workshop to develop recommendations for future research. The workshop, held in April 2001, was attended by representatives from: all Australian institutions involved in pre-harvest fruit fly research; the fruit industry within the FFEZ and endemic

Medfly and Qfly regions; a range of fruit industries affected by fruit fly; AFFA; the agrochemical industry, and HAL

This workshop recommended, amongst other things, the conduct of a study to develop a framework for research and implementation of AWM of fruit fly in endemic areas. This report is the outcome from that study.

4.2 Terms of Reference

The following terms of reference were provided in the study brief.

- The objective is to develop a framework for implementation of AWM of fruit fly in endemic areas, and to recommend pilot projects, and any required research projects.

- The project is limited to AWM of fruit fly in horticultural crops falling under the umbrella of HAL.

- The project includes management of all fruit flies of economic concern to horticulture.

- Project recommendations are to include requisite facets of technological implementation, industry implementation and government implementation.

4.3 Assumptions

The fruit flies of current economic importance to Australia are Medfly and the Qfly group (which includes the species *Bactrocera tryoni*, and related species *B. aquilonis* and *B. neohumeralis*).

The FFEZ is not an endemic area.

Market access will be a high priority outcome from the establishment of an AWM scheme.

Allocation of AusHort funding for the establishment of AWM schemes should be based on the benefit to the national horticultural industry rather than on the benefit to the local industry.

4.4 Conduct of the Study

Face-to face meetings to obtain information for this study were held with a wide range of persons from the following groups. Their names, locations and organisations are listed in Appendix 3.

- Researchers on fruit fly in the relevant state departments of Queensland, New South Wales, and Western Australia.
- Researchers on fruit fly in universities and other organisations.
- Plant protection consultants experienced in fruit fly management.
- Interstate quarantine representatives on IPHRWG from the states of New South Wales, Victoria, South Australia and Tasmania.

- Staff involved with fruit fly monitoring and eradication in New South Wales, Victoria and Western Australia.
- Staff involved with horticultural research, extension and regulation in endemic fruit fly districts in Queensland, New South Wales and Western Australia.
- Staff involved with export quarantine matters relating to hosts of fruit fly and with fruit fly management, in AQIS, Biosecurity Australia and the Office of the Chief Plant Protection Officer within AFFA.
- Persons involved in export marketing of Australian cherries and apples.

Other persons in Australia and overseas were contacted by telephone and e-mail.

The following districts that are candidates for implementation of AWM, were visited and meetings were held with available grower representatives, local council members and staff, and state Department of Agriculture staff involved in monitoring, research and extension.

- Young, Orange, Tumut, Batlow, Narromine and Corindi, NSW.
- Central Burnett, Qld.
- Collie River and Serpentine, WA.

A wide range of literature was read, including research reports and review publications relevant to area-wide management of fruit fly in Australia and overseas.

The information obtained was combined with the consultant's previous experience in dealing with research, extension and plant quarantine matters concerning fruit fly to develop this report and its recommendations.

5. ATTRIBUTES OF AREA-WIDE MANAGEMENT

5.1 Definition of Terms

It is necessary to clarify what is meant by *area-wide management* (AWM) in this report, since the term means different things to different people.

5.1.1 Terms used in the literature

Hendrichs (1996) identified three broad strategies for dealing with tephritid fruit fly pests.

1. ***Orchard population management*** involves each farmer managing the pest in his orchard according to the means and degree he sees fit. This strategy can consist of single measures such as chemical or cultural control, through to sophisticated systems with an IPM approach.
2. ***Area-wide population management*** involves similar methods to those in the first strategy. However these pre-harvest suppression measures are applied by growers in a coordinated approach, over wider, mostly commercial areas, and they attempt to produce fruit free of fruit fly.

3. ***Total population management*** is also an area-wide approach; but it addresses the pest population of a whole region, including commercial, urban and non-cultivated areas, in a more definite way. Grower organizations and other authorities may join in large and systematic campaigns. The objective may be fruit fly suppression; however, in view of the complex effort, the campaigns are mostly directed at eradication or exclusion.

Lindquist (2000) used the term ***area-wide control*** for a system to reduce a pest population to a non-economic level over a large area by attacking the entire insect population in the target area. This area-wide approach encourages the use of specialised methods, such as: sterile insect technique, MAT, inundative release of parasites, mating inhibitors, chemical and biological insecticides, large-scale trap cropping, and treatment of alternative hosts on public land and in private gardens. Some of the examples given are aimed at eradication of the pest.

Salema (2000) preferred an AWM system that used an IPM approach because it minimises the damaging effects of pesticides on biological control, and reduces community concerns about environmental damage and chemical residues He used the term ***area-wide integrated pest management*** for a system that involves more than just extending local IPM strategies to large areas. It also involves regional strategies such as the large scale spatial distribution of the pest in cultivated and non-cultivated areas, and its temporal distribution in the planning of treatment applications. This system, he indicated, is central to the effective integration of the sterile insect technique with other pest control technologies.

5.1.2 Terms used in this report

Area-wide management (AWM). None of the above references defines area-wide management or any similar term in a way that meets the proposals for using AWM in Australia, so a specific definition has been developed.

In this report, the term *area-wide management* (AWM) is used for a system of managing the fruit fly population in an area so that economic damage from the pest is reduced for at least part of the year. The objective is to minimise the infestation of commercial fruit, not necessarily to minimise the population of fruit flies throughout the area. The eradication of a fruit fly species from an area is not an objective.

The system may include one or more components, which may be natural controls of fruit fly infestation or applied controls. An applied control measure may include any registered use of a chemical.

In order to warrant the descriptor of *area-wide*, an AWM system needs to either:

- apply to more than one orchard in the same area, or
- include at least one component control measure that is applied outside the boundaries of the orchard or crop area that is suffering the economic damage.

Cover sprays with broad spectrum insecticides are sometimes used in an AWM system when the fruit fly population rises too high close to harvest. These occasional cover sprays ensure that the fruit are free from fruit fly as required for market access.

AWM can be used simply as a means of controlling fruit fly to produce undamaged fruit for market. In appropriate situations it may be effective enough to be approved as a quarantine measure for market access.

System. Because there are many different natural and applied components for AWM, there are many possible combinations that can be used. The particular combination used will depend on the natural factors that influence fruit fly damage in the area, and the particular control measures that are chosen to further reduce that damage. Each combination is a different *system*.

Scheme. Because of the area-wide nature of AWM systems, their operation usually requires several people and needs some kind of organisation. The combination of a particular AWM system applied to a particular area of land using a particular organisation can be referred to as a particular AWM *scheme*.

5.2 Components of AWM Systems

An AWM system can involve many components, some natural to the area, and some applied by farmers or other members of the community. In general, the greater the effectiveness of the natural components in an area, the easier it will be to achieve the desired level of fruit fly management. The following list of components has been developed to assist with research and planning for an AWM system for fruit fly. Some of the applied components are part of future trends in fruit fly management (Aluja 1996) and are still in the early stages of research.

5.2.1 Natural components

Climatic conditions. Low temperatures can reduce and even eliminate temporarily the fruit fly population in an area. High temperatures and low humidity may be similarly effective with Medfly. Low temperatures can reduce and even prevent egg laying by Qfly.

Alternative hosts. The smaller the quantity of fruit of native and feral hosts available for breeding, the smaller the population of fruit flies.

Crop fruit susceptibility. The infestation level in a fruit crop is affected by such factors as: skin resistance to ovipositor penetration, flesh characteristics (acidity, dryness), and stage of ripeness.

Crop plant attractiveness. The infestation level in a fruit crop may be affected by such factors as: the attractiveness of the plant due to the shelter it

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Alternative hosts. The smaller the quantity of fruit of native and feral hosts available for breeding, the smaller the population of fruit flies.

Crop fruit susceptibility. The infestation level in a fruit crop is affected by such factors as: skin resistance to ovipositor penetration, flesh characteristics (acidity, dryness), and stage of ripeness.

Crop plant attractiveness. The infestation level in a fruit crop may be affected by such factors as: the attractiveness of the plant due to the shelter it

provides, the microflora on its leaves, or the height above ground at which the fruit occur.

5.2.2 Applied components

Removal of unmanaged host plants. Destroying unmanaged host plants in urban, orchard and non-crop locations (with the agreement of the landholder) eliminates many fruit fly breeding sites.

Management of host plants in all orchards. Persuading all fruit growers in an area to adopt the AWM system reduces the total fruit fly population.

Management of host plants in urban areas. Persuading householders in urban areas to manage fruit fly hosts on their property, particularly those fruit harvested in winter and spring, such as grapefruit, loquat and mulberry, helps reduce the fruit fly population at critical times.

Fruit sanitation. The collection and disposal of unpicked and fallen fruit from urban and commercial host plants reduces the material in which fruit fly can breed.

Treatment of infested fruit. Simple methods of disinfesting or destroying infested fruit found in orchards, packing sheds, home gardens and the fruit marketing system can reduce the number of larvae from local and external sources that complete their life cycle in the area.

Bait sprays. Regular application of bait sprays to all host trees, commencing several weeks prior to harvest and finishing at the end of harvest, reduces the population of both male and female fruit flies.

Male annihilation technique (MAT). Placing an array of blocks, pads etc containing a male fruit fly lure and a suitable insecticide in an infested area, reduces the population of males, and this may reduce female fertilisation, egg laying and the total fruit fly population.

Sterile insect technique (SIT). Releasing a high population of sterilised male fruit flies within a small area over an extended period can reduce the number of females producing fertile eggs, and so reduce the total fruit fly population.

Male replacement. Simultaneous treatment with MAT and SIT using sterile males that have been fed on a male lure and are therefore not responsive to the MAT has been proposed (Hendrichs 1996). Both MAT and SIT are expensive but may still be worthwhile at a critical time in the breeding cycle.

Biological Control. Native parasitoids help to control the population of fruit flies and their numbers can be increased by controlled breeding and release. Parasitoid augmentation at critical times and in critical locations where other treatments are restricted, such as urban areas, may be useful (Sivinski 1996).

Simultaneous release of parasitoids and sterile males has been suggested to maximise the effect on the fruit fly population (Barclay 1987).

Cover sprays. Applying systemic chemical sprays to fruit trees when fruit is susceptible to infestation can prevent egg laying and larval development. Disruption of other pests is minimised if the cover sprays are only applied over a short period.

Treatment of over-wintering sites. Identifying sites where fruit flies congregate over winter and treating the area to kill the fruit flies may reduce the spring population in nearby orchards.

Trap plants. Growing, in or near the orchard, plant species in which fruit flies congregate, may allow more efficient control of the congregating fruit flies with baits, MAT etc.

Quarantine. Establishing a legislated quarantine that restricts the entry of host fruit into the AWM area can reduce the amount of infested fruit brought into the area. This can delay the fruit fly build up after winter, and in some cases reduce the total population in the area.

Establishing legislation that requires the collection and disposal of waste fruit from fruit markets and fallen fruit from host trees in the area, may restrict the local breeding of fruit flies at critical times.

Gibberellin. Applying gibberellic acid (GA) to grapefruit reduces the attack of Caribfly (Greany 1989; Greany et al. 1987). GA sprays have been used to delay rind maturity in mandarins in Queensland and may have some benefits on Imperial and late-picked Murcott mandarins.

Bioelectrostatics. Male insects can be attracted to a trap where they come in contact with an electrostatic powder mixed with an insecticide or spores of an entomo-pathogenic fungus. The particles adhere to the body of the insect and slowly kill it. Particles may also be transferred to females during attempted mating. The patented technology has been used for a cockroach trap and research is underway on fruit flies (Howse and Underwood 2000).

5.3 Other Elements Used in AWM Schemes

Several other elements also need to be established before an AWM scheme can be developed.

Area. The area to which an AWM scheme will apply, needs to be carefully assessed during the testing and development of the appropriate AWM system. The area should be no larger than necessary, but large enough to include any unmanaged fruit fly sources that impact on the proposed fruit production area.

During testing of the efficacy of a proposed AWM scheme it will be important to check its efficacy across the proposed area to determine which orchards can comply with the market access standards established by the importing

state or country. The whole scheme area is likely to lose market access if any part of the area fails to comply.

Timing. The weeks or months during which an AWM scheme can reliably produce the desired level of fruit fly management also needs to be determined by research so that marketing arrangements can be planned. Understanding the timing of changes in the population and physiology of fruit flies will be important in the application of control measures.

Monitoring. Some method of monitoring the progress of an AWM scheme through the year will be useful for checking that the required standard of effectiveness will be met at harvest. In many cases this will be by trapping to monitor the fruit fly population. It could also be by monitoring the temperature or other factors that control the infestation levels in fruit.

5.4 Managing a Scheme

Operating an effective AWM scheme requires a high level of coordination between the people responsible for various aspects of the program. This includes growers, technical advisers, local government, state government, the fruit marketing industry, local residents and travellers. The success of the program will depend heavily on the continued support of all stakeholders, not just on the effectiveness of the control measures involved.

Some organisational structure will be needed, such as a coordinating committee, made up of representatives of the major stakeholders. Its role will include the following.

- Work with the technical specialists in developing a practical, effective, and economically sound program.
- Obtain funding for its responsibilities.
- Obtain commitment from the stakeholders (in writing from critical businesses).
- Organise information sources and training for the people involved in applying treatments.
- Monitor progress.
- Investigate problems and overcome them where possible.
- Maintain support for the AWM scheme by publicising its benefits and its progress.

The managing organisation will be most effective if has its own funding source and its own support staff who can provide independent information on the above issues.

5.5 Benefits of AWM

Interest in AWM has increased in recent years because it can offer several benefits over currently used methods of producing fruit that is free of fruit fly.

5.5.1 Chemical residues

AWM allows fruit fly infestation to be controlled with minimal application of broad spectrum insecticides. It takes advantage of the natural controls of fruit

fly and makes maximum use of treatments that manipulate their physiology and behaviour. Broad spectrum insecticides are applied only when their use is unavoidable.

5.5.2 Fruit quality

Many overseas markets will only accept fruit from the Australian mainland if it has been treated with heat, or cold, or fumigation, to ensure it is free of fruit fly. These treatments adversely affect the quality of the fruit, as well as being expensive and time consuming to apply.

In appropriate situations, AWM is able to provide fruit that is free of fruit fly at the time of harvest, and can be exported without delay, at reduced cost and with improved quality compared with fruit that has to be post-harvest treated.

5.5.3 Integrated pest management

Many fruit crops are now grown under a system of IPM, which allows pests to be controlled efficiently with minimum use of chemicals. Growers need methods of controlling fruit fly that do not interfere with the biological controls being used on other pests. AWM can fulfil this need provided there is minimal use of broad spectrum insecticides.

5.5.4 Market access

The fruit industry in Australia needs to expand its access to overseas markets in order to increase the financial returns to individuals and the Australian economy. New quarantine treatments for fruit fly are needed that will be acceptable to importing authorities. Appropriate AWM systems can meet that need.

5.6 Difficulties with AWM

AWM schemes are complex, and the difficulties in their operation need to be recognised.

5.6.1 Overall management

Managing an AWM scheme will be complex because there are many components, many stakeholders, and many responsibilities of the managing organisation, including:

- the collection and evaluation of monitoring data,
- the application of pressure to stakeholders who are failing to meet their commitment,
- decisions on what short-term and long-term adjustments need to be made to applied components, and
- decisions on whether a specified market access criterion will be met at harvest.

5.6.2 Stakeholder support

Many of the important treatments in an AWM scheme are applied by the fruit growers, but some growers may not have a direct interest in the success of the scheme. An AWM scheme that provides access to an overseas market

will appeal to many growers, but access to a domestic market will appeal to almost all growers, large and small.

Some components are under the control of non-grower members of the community who may feel they receive little direct benefit. Some householders are very wary of any chemicals applied on, or near their property. The various levels of government will have many other demands on their limited resources. They will need encouragement from voters or evidence of good economic benefit from the scheme to continue support over many years.

The level of support from stakeholders will be influenced by their personal assessment of the effectiveness of the AWM scheme, and the commercial or other benefits it provides to themselves and their community. It will also depend on the ability of the coordinating committee to keep all stakeholders aware and motivated.

5.6.3 Local quarantine measures

State legislation can be introduced to establish a local quarantine area covering the area of the AWM scheme. The legislation can prohibit stakeholders and others from transporting fruit fly or allowing fruit fly to develop to maturity on their property. It can also require all producers to contribute funds to support a local scheme that benefits them.

However in this era of individual rights, governments are loath to undertake such regulation. They need to be convinced that the benefit to the community will outweigh the costs to the individuals affected by the restrictions, plus the costs to the government in implementing the legislation. The cost of publicising quarantine restrictions and ensuring that everyone complies with them can be very high.

5.6.4 Funding

Growers in an AWM scheme will usually be expected to fund their own on-farm treatments. The managing organisation will also require funds for its activities, including in some cases monitoring the fruit fly population across the managed area. Some growers may be unwilling to contribute, even if there is a net benefit to them. It may be necessary to make the accreditation for market access dependent on a grower's continued financial support for the AWM program.

5.6.5 Weather conditions

The weather is a critical component that cannot be controlled. Market access protocols that use an AWM system based on weather conditions will need to allow for weather that is warmer (or cooler) than normal to ensure reliability of access. Reliable access is needed for orderly marketing.

Any long-term increase in winter temperatures is likely to reduce the effectiveness of AWM in existing districts. However, if global warming should eventuate, Qfly distribution will also change (Sutherst et al 2000) and AWM will then be needed in those areas where fruit flies have become endemic due to the temperature changes.

5.6.6 Knowledge of fruit fly biology

The effectiveness of many of the controls in an AWM system is dependent on the physiology and behaviours of fruit fly. Existing knowledge of these complex systems is not complete, so decisions sometimes have to be made on limited information.

5.6.7 Differences between districts

Because of the differences between districts in weather, crops, alternate hosts, urban areas, etc, an AWM system that works in one area will not necessarily be effective in another district. It will probably be necessary to conduct confirmatory research for each candidate scheme before market access is granted.

5.6.8 Reliability

The effectiveness of a complex system involving natural processes is likely to be more variable than a simple post-harvest physical treatment. Importing countries may require evidence over several harvests that an AWM scheme can reliably meet the market access conditions.

6. FUTURE USE OF AWM IN AUSTRALIA

The degree to which AWM will be used in the future will depend on the relative strength of the forces encouraging its use, and the forces discouraging its use.

6.1 Driving Forces

There are many factors encouraging Australian growers to adopt AWM of fruit fly rather than continue with individual orchard management.

- Market demand is increasing for minimal pesticide residues in fruit.
- The risk that chemical based quarantine treatments will be withdrawn is increasing
- Growers need to manage fruit fly using IPM so that the control of other pests is not disrupted.
- Managing fruit fly using IPM methods on individual orchards is only effective in some districts and for part of the year.
- Managing fruit fly using IPM methods on individual orchards is not effective enough for some quarantine authorities.
- AWM provides methods for controlling the total fruit fly population affecting an orchard.
- AWM can utilise control measures that are too large scale for individual orchards.
- AWM systems are beginning to be accepted as quarantine treatments for market access.
- A systems approach that combines a moderately effective AWM system with another treatment can be accepted as a quarantine treatment for market access.
- Irradiation treatments, if approved, will require fruit that is virtually free of fruit fly at harvest, since irradiation prevents fruit fly from developing into fertile adults rather than killing them at the egg or larval stage.

- Australia needs to increase its access to overseas fruit markets.

6.2 Restraining Forces

However, the full potential of AWM is not currently available to Australian growers for many reasons including the following.

- The level of knowledge on the physiology and behaviour of Qfly and Medfly is only moderate.
- The ability to trap and monitor female Qfly adults is very low.
- The available techniques for controlling fruit fly are relatively expensive because they have to be re-applied frequently.
- There is limited experience in using AWM for market access.
- There is almost no experience with conducting a major AWM scheme that involves numerous stakeholders.
- An efficient method of proving the efficacy of an AWM scheme to the satisfaction of a quarantine authority has not been established, and existing methods are expensive because they require very large samples.

Conclusions

There is a strong need for AWM of fruit fly in Australia in order to develop sustainable production systems, meet consumer demand for minimal pesticide residues and maintain market access.

The adoption of AWM is being held back by the efficacy of the available control measures and monitoring methods, and by the lack of an agreed basis for the approval of AWM as a quarantine measure.

Recommendation

Recommendation 1. *Action to improve the effectiveness of AWM, and to implement more AWM schemes and market access protocols should be taken as soon as possible, before the current chemical quarantine treatments for fruit fly become unacceptable.*

7. USE OF AWM FOR MARKET ACCESS

AWM provides several benefits, such as reduced crop losses and better fruit quality, even when supplying local markets without fruit fly restrictions. However to recover the costs of operating a large AWM scheme, it is desirable that the scheme is accepted as a basis for market access.

7.1 Current Examples

At this stage of development, very few market access protocols involving AWM or similar systems have been approved. The following are three examples used for interstate market access in Australia. Victoria, the importing state, has had no problems with fruit fly in produce certified under these protocols, or in samples taken at the market. A scheme from the USA is also included as an example of AWM being used for export to Japan.

7.1.1 Young, NSW - stone fruit

Stone fruit grown and packed within the *Young Climatic Fruit Fly Free Zone* may enter Victoria with certification under ICA-23-1, provided there has not been a declared outbreak (5 flies trapped within 14 days within 1 km, or a gravid female or larva) since the previous winter. In practice, only cherries are able to be harvested before the first outbreak each season.

This AWM scheme is based on weather conditions reducing the population below the outbreak level in winter. The population is maintained low by the spring weather assisted by control measures applied by the Young Shire Council to the town area.

Bait spraying of street trees was conducted for several years, but in 2001 concerns were expressed by some local residents and the NSW Environmental Protection Agency. Future methods of controlling fruit fly in the town and the establishment of a Young district fruit fly management committee are under consideration.

The New South Wales Department of Agriculture maintains an array of approx 30 traps at 400 m intervals in urban areas and 60 traps at 1 km intervals in orchard areas of the Young Climatic Fruit Fly Zone.

In 2001, sufficient flies were trapped to declare an outbreak in October so no fruit could be sent under this protocol. In previous years, the first declared outbreak has not occurred until at least mid December, which allowed cherries to be sent to Victoria.

This protocol was approved by Victoria after consideration of:

- the NSW Dept of Ag trapping records from 1993 to 1998,
- the low susceptibility of cherries to fruit fly infestation, and
- the experience prior to 1996 when cherries were allowed entry from Young without treatment.

7.1.2 Corindi, NSW – blueberries

Blueberries grown by Blueberry Farms Australia (BFA) at Corindi NSW are allowed entry to Victoria, from May 30 to Aug 15 without any sprays.

Blueberries grown in NSW are allowed entry to Victoria under certification for ICA-31, on the basis of a fruit fly control treatment consisting of EITHER,

- bait sprays applied every 7 days to all blueberry bushes and other host fruit plants on the property from the time the blueberry fruit begin to ripen until the completion of harvest, OR,
- dimethoate cover sprays applied at 21, 14 and 7 days prior to first harvest and then every 14 days to all blueberry and raspberry bushes in the block for any block in which fruit is grown for certification under this treatment,

AND each lot of treated fruit is inspected after harvest and packing, and is :

(i) found free of live fruit fly; and
(ii) not over-ripe.

This protocol consists of an AWM system that includes the option of changing from bait sprays to cover sprays if the fruit fly population rises too high.

This AWM system is based on weather conditions reducing the population to a low level in winter. In recent years, an array of MAT blocks has also been established with four per ha within the berry plantings, and a line of blocks at 20 m intervals just outside the perimeter of the berry production area.

The fruit fly population is monitored with an array of traps, 30 inside the BFA area and 30 outside, with some on the plateau, and some on the eastern escarpment. BFA uses the weekly trapping results to select the appropriate fruit fly spray option (no sprays / bait sprays / cover sprays).

In general, bait sprays are applied to berry fruiting areas at 7 day intervals from August to harvest, provided trap counts remain low. However, if rain interrupts baiting or trap counts exceed 40 flies/trap/week near a block being harvested, dimethoate cover sprays may be used on that block at 14 day intervals. Dimethoate sprays can be used more on rabbiteye than on other blueberry types because rabbiteye are less susceptible to the pests whose control is disrupted by cover sprays (light brown apple moth and mealy bug). Dimethoate is not applied until pollination is finished in late September, to avoid killing bees.

The entry protocol was approved by Victoria after consideration of:

- the NSW Dept of Ag trapping records from 1993 to 1998, and
- the low susceptibility of blueberries to fruit fly infestation.

7.1.3 Central Burnett, Qld – citrus

Citrus fruit grown and packed in the Central Burnett district may enter Victoria with certification under ICA-28, provided they have been:

- harvested from March 1 to August 25, and
- bait sprayed every 7 days from 12 weeks prior to harvest, and
- grown on an orchard that has been monitored for fruit fly from 12 weeks prior to harvest, and
- inspected after harvest and found free of fruit fly infestation.

This scheme does not use insecticide cover sprays to control fruit fly because of their adverse effect on IPM for other citrus pests.

The system is based on low temperatures reducing the population below the outbreak level in winter, and also restricting egg laying from March 1 to August 25. Bait spraying is applied in all citrus orchards registered for ICA-28 to reduce the fruit fly population in autumn and maintain the control pressure throughout the winter period. Fruit fly trapping in those orchards is used to monitor the effectiveness of the scheme.

This protocol was approved by Victoria for the 1999 season, after consideration of:

- the results of a QDPI research program from 1997 to 1999 to determine the level and timing of infestation in four citrus cultivars under this system, and
- the Victorian experience over the ten years prior to 1999, when citrus from the Central Burnett entered after treatment with only a bait spray program.

Market access occurs in the period from March to August when there is a very low chance of fruit fly survival in Victoria due to low temperatures and low availability of host fruit.

7.1.4 Florida – grapefruit

Two certification procedures are available, both based on a fly-free period and the very low susceptibility of citrus fruit to Caribfly (Riherd 1993). They are accepted by Japan, California and Texas.

The first procedure involves no baiting. The trapped areas must be more than 120 ha and more than 4.8 km from residential or other areas where Caribfly hosts grow. Trapping involves 15 McPhail traps per square mile, cleared weekly. If two flies are trapped within 2.4 km in 30 days, the area within 2.4 km of the detection is withdrawn.

The second procedure requires baiting. The minimum production area is 16 ha, plus a buffer zone of 90 m which must be free of preferred host plants such as guava. The area must be at least 0.8 km from residential or other areas where Caribfly hosts grow. Hosts within these areas must be baited. The citrus area and buffer must be aerially baited with protein/malathion every 7-10 days, commencing 7 days prior to harvest. The citrus area has 15 traps per square mile. If a Caribfly is trapped in the area after baiting begins, access for the whole area is lost.

7.2 Potential for AWM to Replace Other Entry Conditions

Most of Australia's major export markets for fruit require freedom from fruit fly. The following entry conditions are under pressure, and AWM is a potential replacement.

7.2.1 Area freedom in the FFEZ

Absolute area freedom has been difficult to maintain in some of the eastern areas of the Fruit Fly Exclusion Zone (FFEZ) because of continual incursions. Regaining freedom is expensive and slow. Market access may be lost for the whole of the season until absolute freedom can be proved, even though the risk of infestation is negligible. If market access for these situations could be re-negotiated on the basis of AWM, including the effect of low temperature on egg laying, exports may be maintained during the cooler months of each re-eradication phase.

7.2.2 Fumigation

Use of methyl bromide to fumigate fruit is under review because of its effect on the protective ozone layer. Disinfestation with heat or cold is an expensive replacement, and it reduces fruit quality.

7.3 Factors Affecting Approval of AWM for Market Access

There is increasing recognition throughout the world of the need to use sustainable area-wide methods of pest management rather than intensive chemical based methods of pest control. This attitude is extending to quarantine authorities and is being encouraged by the International Plant Protection Convention (IPPC) and the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement).

However obtaining market access approval for an AWM system remains more difficult than for a single post-harvest treatment, such as cold, heat or a chemical. The following are some issues that can affect the approval of a complex system for market access. They need to be considered when establishing an AWM scheme in order to increase the likelihood of its approval by quarantine authorities.

7.3.1 Using a systems approach

The IPPC has made considerable progress in developing an *International Standard on Integrated* Systems *for Pest Risk Management (Systems Approaches)*. This Standard should be consulted and its recommendations followed wherever possible, when developing an AWM scheme, as quarantine authorities will prefer a scheme that conforms to a systems approach, or that can be included in a systems approach.

A recent draft of the Standard (Anon 2001) defines a systems approach as: *the integration of different pest risk measures, at least two of which act independently, and which cumulatively achieve the desired level of phytosanitary protection.*

7.3.2 Dependent and independent measures

This draft (Anon 2001) describes independent measures as those that act alone to reduce pest risk, while dependent measures require effective implementation of one or more other measures. The draft Standard does not require that each independent measure must individually achieve the desired level of phytosanitary protection. However it is reasonable to expect that each independent measure alone should be able to achieve sufficient control to provide a fail-safe effect within the system.

At the current stage of development of AWM for fruit flies, it is not clear which measures will be accepted as being independent. That will depend on the evidence provided by the exporting quarantine authority that two components act independently and each is capable of producing acceptable control of the infestation level. It will also depend on the level of control that the importing quarantine authority requires.

For instance, in some situations and with some fruit fly species, bait spraying and MAT may each be capable of achieving sufficient control,. In other circumstances, both measures may be required together to achieve the desired level of control. This latter case would be an example of two or more dependent measures being combined together to form an independent measure.

The requirement to have at least two independent measures must be met if the fruit fly control system is to be classed as a systems approach. If it is not achieved within an AWM system, it will be necessary to include another independent measure to form a larger AWM system, or else apply an independent measure separately, such as a post-harvest measure.

A wide range of measures can be integrated in a systems approach, including cultural practices, field treatments, post harvest disinfestations, inspection and other procedures. Likewise, procedures such as pest surveillance, trapping and sampling can also be components of a systems approach. Measures that do not kill pests or reduce their prevalence but reduce their potential for entry or establishment can be important elements of a systems approach. Examples include designated harvest or marketing periods, restrictions on the maturity, colour, hardness or other condition of the commodity, the use of resistant hosts, and limited distribution at the destination.

7.3.3 Quantitative and qualitative methods for evaluation

The evaluation of a systems approach may use quantitative and/or qualitative methods (Anon 2001). Quantitative methods for evaluating the efficacy of measures may be appropriate where suitable data are available. In other instances, qualitative methods may be more suitable. For example, quantitative methods are usually used for determining the efficacy of treatments that kill or remove pests but a qualitative assessment may be considered more appropriate where efficacy is based on expert opinion.

The efficacy of independent measures that may be used to reduce pest risk can be expressed in different ways (for example: mortality, reduction in infestation, host susceptibility).

The overall efficacy of a systems approach is based on the combination of the efficacy of required independent measures (Anon 2001). Wherever possible this should be expressed in quantitative terms with a confidence interval. For example, efficacy for a particular situation may be determined to be no more than five infested fruit from a total population of one million fruit with 95% confidence. Where such calculations are not possible or are not done, the efficacy may be expressed in qualitative terms such as high, medium, and low.

7.3.4 The required level of quarantine security

One of the major problems limiting the quarantine approval of AWM systems (and of the systems approach generally) is how to determine the required level of quarantine security. It is generally agreed that a probit 9 assessment is not appropriate for all fruit fly treatments (Landholt et al 1984). There is

little, if any, experience with the use of alternative quantitative methods to assess a systems approach. This problem was discussed at an international workshop in Sydney in 1995 to consider plant quarantine statistics.

Liquido et al (1996) pointed out at that workshop that, in order to express the overall efficacy of the systems approach, a 'common currency' is needed when estimating plant pest risk. The endpoint chosen for the risk assessment affects how risk can be expressed throughout the assessment. They provide the following examples of risk assessment endpoints.

- Frequency of entry (that is, number of pests entering per unit time).
- Probability of entry (for example, probability of pest entry per unit of commodity imported).
- Frequency or probability of establishment.
- Frequency or probability of pest outbreaks.

The most appropriate of these endpoints for fruit fly is the probability of an outbreak. This will take into account the probabilities of introducing a mating pair, of their survival to mature adults, of their mating following dispersal, and of the survival and mating of their progeny. These are very real considerations for fruit flies, especially for Qfly because the adults disperse over a moderate distance, thus reducing mating, and the survival of all stages is adversely affected by low temperatures. Some current AWM schemes for Qfly have market access only in autumn and winter when temperatures are likely to be low in the importing states and host fruit is not readily available.

Baker et al (1990) have proposed a maximum pest limit (MPL) which is defined as the maximum number of immature fruit flies that may be present in consignments imported during a specified time to a specified location. It is recommended for use as a measure of quarantine security for fruit imports into New Zealand.

These authors provide methods to calculate the probability of having a surviving pair in a shipment, including an allowance for the clumping of fruit fly eggs due to several eggs being laid together in a fruit. There is also a method for determining the number of fruit that must be cut and inspected with no pest detected (dead or alive) to prove that the maximum allowable infestation level is not exceeded (Liquido et al. 1996; Couey and Chew 1993).

Baker et al (1990) considered mainly the risk of introducing a mating pair, including the clumping effect. Subsequent papers by Baker et al (1993) and Whyte et al (1996) revised the MPL model by including factors that affect establishment. They provide a quantitative method for calculating the probability of establishment of a pest, taking into consideration the following factors.

Factors affecting the number of survivors from an infested host.

- The average number of individuals per infested host.
- Natural survival on the host, following parasitisation etc.
- Survival in transit, affected by temperature and other stresses on the larvae.

- Survival at the disposal site, affected by predation, exposure etc.
- Transmission to a new host, likely to be a high rate due to the mobility of fruit flies.

Factors affecting whether conditions will be suitable for survival.

- Disposal of the host in a high risk area, such as a garden, rather than a kitchen waste disposal or as household garbage taken to a municipal disposal site where it is compacted and securely covered.
- The suitability of the climate at the time of introduction, for larval growth and pupal development.
- The availability of a new host, with fruit at a stage suitable for infestation.

Factors affecting whether the existence of a mating pair will produce an outbreak.

- The likelihood of a mating pair meeting up and successfully mating, affected by the dispersal of infested fruit throughout the area, the likelihood of several fruit being disposed of together, the number of eggs in a piece of fruit, and the dispersal behaviour of the individual species.

This method provides a more realistic assessment of the probability of establishment than the original paper. However there is another factor specific to fruit flies that needs to be added.

- The likelihood of a mating leading to an outbreak.

Meats et al (2001) indicate that most detections of fruit flies in Australian area free zones, involve the trapping of very few flies and 18 % of Medfly and 71 % of Qfly infestations that are detected are not classified as outbreaks and die out without any treatment.

It would also be more practicable if the criterion for acceptance of produce from an AWM system was measured as the maximum larva (and egg) load (MLL) per quantity of host produce received at that location, rather than the MPL. The MLL is the maximum number of fruit fly larvae (and eggs) per million pieces of fruit permitted in fruit from any systems approach scheme that is sold for local consumption at that location, such as a town or city area.

The MPL has the disadvantage that it is the number of pests that may be present in consignments imported *during a specified time to a specified location* (such as Auckland airport). This would be difficult to apply in practice because of the continual change in arrival volumes.

It is necessary to take into consideration the fact that all the eggs or larvae in fruit sold at a wholesale market are unlikely to pupate and emerge as adults at the same site. The eggs and larvae in the fruit are unlikely to be released until the fruit is unpacked out of the cartons at the place of final retail sale or consumption. This means that the emergence of any resulting adults and their dispersion by flight will occur throughout the urban area.

Similarly, fruit received at a central market for transhipment to another city or town are unlikely to produce adult fruit fly in the market city, since the fruit would only be removed from the packaging at the final destination.

Baker et al (1990) do make some allowance for the dissemination of commercial produce to a large number of retailers and consumers. Their recommended MPL unit is the number of live larvae entering New Zealand *per day* (rather than per week or per month), on the basis that there is a very remote chance that larvae arriving on separate days will later emerge as adults at the same location and time.

In each state of Australia, the number of fruit from AWM schemes that are distributed per square kilometre for local consumption in country cities and towns will usually be less than in the capital city. Therefore once the MLL has been calculated for the capital, the same figure can be applied state-wide. The MLL may differ between states in proportion to the number of fruit from AWM schemes that are purchased per day for consumption in each square kilometre of each capital.

It may be necessary for the MLL to be reduced when additional schemes start to supply the same location in the same months, thus increasing the number of AWM system fruit sold per unit area. The MLL may also need to take into consideration the fruit flies that emerge as a result of other imported fruit that has received other quarantine treatments, and fruit that has entered illegally. The MLL may need to vary from month to month in relation to changes in local factors that alter the risk of an outbreak in the importing state. It is possible that the clumping effect from several eggs in one fruit will over-ride these factors.

Unfortunately, determining the MLL is likely to be a reasonably complicated process, but there seems to be no other way to establish a logical basis for deciding the required efficacy of a systems approach. Some of the knowledge needed for the calculations is already available, or can be estimated, but other information may need to be researched.

The Australian experience used to recommend the size of the suspension zones for Qfly or Medfly on the basis of trapping results (Meats et al 2001) may be useful in predicting the number of fruit flies allowed per square kilometre before an outbreak is likely.

Developing an agreed method of setting a standard for the quarantine security for an AWM scheme will require input from all relevant researchers, biometricians and quarantine authorities. The IPHRWG will need to be involved in establishing a recommended method for interstate quarantine purposes.

Deciding the required level of efficacy for each market will ultimately be the prerogative of the quarantine authority of the importing state or country. However there is a need for transparency and negotiation on technical grounds.

7.3.5 Measuring the efficacy of an AWM scheme

Once the required level of quarantine security has been decided, and an AWM scheme is in operation, measuring the efficacy of a scheme can commence. This requires calculating or measuring the larvae and egg load of produce that is prepared as for marketing under the scheme.

With some AWM schemes, it may be possible to measure the efficacy of the components and calculate the overall efficacy. However many AWM schemes will have one or more components that are difficult to assess quantitatively. In these cases, it may be possible to use a computer based Monte Carlo simulation technique (Vose, D. 1996) to predict the efficacy level of the scheme and its probability, using whatever information is available on each component.

If this approach is not effective or acceptable, it will be necessary to measure the overall efficacy of the AWM scheme by measuring the level of infestation in large samples of produce, then calculate the efficacy with a confidence interval. This is an expensive exercise because of the large numbers of fruit that have to be inspected to detect the low levels of infestation involved.

7.3.6 Attitude of the importing authority

Countries that have had experience with using the systems approach and AWM for their own pest problems are more likely to agree to entry conditions based on AWM. USA and New Zealand are in this category. USA and Australia also have counter seasonal production for many crops, and this has already presented opportunities for reciprocal acceptance of imports of fruit such as citrus.

7.3.7 Reliability of the system

One of the major concerns of importers is the continued reliability of an AWM system, year after year. The inclusion of a method for assessing the progress of the system prior to harvest, such as population monitoring, will provide confidence that system breakdowns will be detected before produce is exported.

7.3.8 Experience with an AWM system for quarantine

Quarantine authorities are reluctant to be the first to accept an AWM system until there is a body of experience. Therefore, Australia needs to concentrate its efforts in improving two or three AWM schemes that are used for interstate market access and that involve crops with a good chance of gaining export market access under an AWM system.

After these schemes have demonstrated their continued efficacy over several seasons on one domestic market, they should be ready for acceptance on all domestic markets. That will provide the breadth of experience needed to negotiate their approval with an overseas quarantine authority.

7.3.9 Consultation with the importing quarantine authority

The quarantine authority of the state or country that is the proposed market for the produce should be consulted during the development of the AWM scheme. Certainly a full assessment of the overall efficacy of an AWM scheme should not be made until relevant quarantine authorities have commented on the general acceptability of the AWM system used in the scheme.

7.4 Combination with Other Treatments

Other treatments that provide good control of fruit fly infestation can be combined with AWM into a systems approach in which AWM and the other treatment provide the necessary two independent measures. The following are possible treatments to combine with AWM.

7.4.1 Pre-harvest treatments

Netting. Enclosing fruit trees in fine mesh netting will prevent infestation provided the enclosure is fitted with a system for reliably excluding fruit flies during access to the trees for harvesting.

Fruit bagging. In some circumstances it is economically feasible to bag fruit to prevent infestation.

7.4.2 Post-harvest treatments

Fruit inspection. Inspection of harvested fruit for signs of infestation can allow infested fruit to be removed, provided the symptoms of infestation are reasonably obvious.

Irradiation. Most fresh commodities do not tolerate the irradiation doses necessary for a rapid 100 % kill. The currently recommended doses allow some survivors, although these insects will not complete development or will be sterile (Hallman 1996). The larvae may still cause quality and quarantine problems, so good pre-harvest control of fruit flies using AWM is also needed.

Heat and cold disinfestation. Treatments with shorter exposure times or less severe temperatures may be acceptable in combination with AWM. Fruit damage and treatment costs would be reduced.

Conclusions

Australian quarantine authorities need to continue to be involved in the IPPC efforts to facilitate the use of the systems approach and AWM systems in market access quarantine.

Fruit growers will be more likely to use AWM systems when all states accept them for quarantine purposes, so that they no longer need to maintain post-harvest treatment facilities for market access to some states.

State quarantine authorities need to work on the barriers to the use of the systems approach and AWM systems in interstate quarantine protocols in order to allow expertise with these techniques to be developed in Australia.

There is a critical need for a realistic method of establishing the efficacy of an AWM scheme that can be used as a basis for quarantine approval of the scheme. One possible method, the Maximum Pest Limit (MPL) does not cover all the factors that affect the probability of fruit fly larvae in a quantity of traded fruit producing an outbreak in the area in which the fruit is disposed. A practical and logical measure of efficacy needs to be developed and a possible approach is suggested.

The progress made at the plant quarantine statistics review workshop held in Sydney in1995 in relation to Pest Risk Assessment and Pest Risk Management for the Systems Approach needs to be followed through to establish an agreed basis for the approval of AWM as a quarantine measure. HAL or SCARM may provide funds.

AFFA needs to work with overseas quarantine authorities that are likely to accept AWM and the systems approach, in order to identify their critical requirements.

Recommendations

Recommendation 2. *State quarantine authorities should re-assess the AWM schemes approved by Victoria, taking into consideration Victoria's good experience with the produce received over several years, as well as the efficacy data available. If these AWM schemes are not acceptable to other states for use in entry conditions, then their quarantine authorities, working through the Interstate Plant Health Regulation Working Group, should decide what efficacy data, additional information and other features are required.*

Recommendation 3. *HAL should organise a workshop or project involving biometricians, researchers and quarantine authorities to develop an agreed method of determining the required level of quarantine security, and to develop a method (or methods) of measuring the efficacy of an AWM scheme (and of other uses of the systems approach), using data relevant to fruit flies in the Australian situation.*

Recommendation 4. *AFFA should identify favourable opportunities for using an AWM system as all or part of the treatment for fruit fly in an export market access protocol. Entry of citrus into the USA may be an appropriate case.*

8. RESEARCH ISSUES

Many potential areas for research are available to improve existing measures and develop new measures for controlling fruit fly in AWM. A large number are listed in the section titled *Components* in the chapter *Attributes of AWM systems.* It is beyond the scope of this project to review them in detail, but a limited assessment has indicated the following issues have some priority.

8.1 Fruit Fly Biology

8.1.1 Temperature control of population

The effect of low temperature in reducing the fruit fly population is basic to most AWM systems. Some research data is available but a summary of the effect of lethal temperatures and degree day exposures, including a simple model, would allow predictions of winter survival rates to be made.

8.1.2 Temperature control of egg laying

Reduced egg laying in winter is an important component of AWM systems that involve winter harvested fruit. The 'breeding gap', when reproduction is prevented by a period of daily maximum temperatures below 20 deg C, is also important in reducing the over-wintering fly population in most AWM systems (Yu 2001). There may be several processes by which low temperature reduces egg laying, including the following.

- Hastening the death of fertilised females that emerged in summer.
- Causing the resorption of eggs by mature females.
- Reducing the egg laying activity of flies with fertile eggs, without resorption.
- Delaying the maturation rates of autumn-emerged adults.
- Reducing the egg laying of autumn-emerged adults.

These processes may respond differently to temperature, so that the net effect on egg laying may differ between locations with different temperature regimes. It is possible that the response of flies to temperature effects may differ between the north and south of Australia, due to selection pressure (Yu 2001). A better understanding of these effects may allow a model to be developed that will allow the risk of egg laying in winter to be predicted from daily temperature measurements.

This will allow districts to be identified in which the effect of winter temperature on egg laying can be a useful component of an AWM system. Better understanding will also increase the acceptance by importing quarantine authorities of AWM systems that include this physiological effect.

8.1.3 Parents of the spring population

It has been suggested that in very cold districts, all adult flies are killed in a cold winter, and introduced flies are the source of the spring population. However, evidence in recent years from early spring trapping suggests that over-wintering flies may be the source. Microsatellite analysis may identify the source of these early spring flies (Yu et al 2001). This would assist with planning an AWM scheme to delay these outbreaks.

8.1.4 Cause of spring peak in population

In some subtropical areas, a rapid increase in trapped flies and egg laying occurs in early spring. Understanding the cause(s) of this rise may help with its control and allow the winter market access period to be extended. Possible causes are the synchronized maturation of over-wintering adults so that they become responsive to lures, or the synchronized emergence of new adults.

8.1.5 Movement of adults

Better understanding of the patterns and distances of fruit fly movement would facilitate the detection of sites where fruit flies affecting orchards breed, and sites where they over-winter.

8.1.6 Effective female lure

Developing an effective female lure for Qfly would allow more meaningful population monitoring, especially when MAT is being applied. It could also be used in a female annihilation technique. However, developing a female lure may require a lengthy research program.

8.2 Applied Components

8.2.1 Male annihilation

MAT shows some promise as a useful control measure, because an application remains effective for several weeks and can be used in urban areas where even bait spraying is regarded with suspicion. However it needs further development before it can be used most effectively.

Aspects that require research include: the most effective placement of pads within trees and within the treated area, their concentration per hectare or per hundred metres (as a barrier), and the exposure time before they need replacement. Male lures for Qfly and Medfly that are effective over greater distances would be an advantage, but developing them is likely to require considerable research.

Methods of using MAT without compromising male trap monitoring are also needed. It may be possible to use MAT in the summer and autumn to reduce the fruit fly population that is able to over-winter. The pads are then removed during the harvest times in winter and spring, to allow male trapping to be used to monitor the population to meet market access protocols.

8.2.2 Control of over-wintering flies

Understanding the location of over-wintering sites and the responsiveness of over-wintering flies to baits and lures will allow more effective control at this critical time.

8.2.3 Baits and bait application

Improving the effectiveness of baiting and developing a bait station system could reduce baiting costs. A research project funded by AusHort/HAL is currently underway to fine-tune several aspects of bait application.

8.2.4 Controls for organic growers

Control measures suited to organic growers need to be identified, to allow all producers to support their local AWM scheme.

Conclusion

Many potential areas for research are available to improve existing measures and develop new measures for controlling fruit fly in AWM. A limited assessment has indicated that the following issues have a high priority.

- MAT. It can be used in many situations but the most effective application methods have not yet been identified by research.
- Low temperature control of egg laying. A better understanding of this natural control will allow it to be used in a wider range of districts and be accepted more easily for market access.

Recommendations

Recommendation 5. *The potential areas for research to improve existing measures and develop new measures for controlling fruit fly by AWM should be reviewed. These areas should then be prioritised for research, taking into consideration:*

- *Existing information from previous studies.*
- *Anticipated benefits of the target information.*
- *Likelihood of success.*
- *Cost of conducting the research.*

Recommendation 6. *HAL should establish a research project as soon as practicable to determine the most effective methods of applying MAT, and to measure the efficacy of MAT, ideally before it is used in a major AWM scheme.*

Recommendation 7. *HAL should establish a project to undertake a literature review of the relation between winter temperatures and egg laying, and then if necessary, a research project, in order to develop a model to facilitate the use of this natural control in AWM schemes.*

9. ESTABLISHING AN AWM SCHEME

There are many issues to be considered before trying to establish an AWM scheme. It will be less expensive in the long run to spend sufficient time considering all aspects of an effective scheme, than to rush into a scheme that fails. The following comments are provided to assist growers considering an AWM scheme, although of course every situation will be unique.

Careful planning will be needed, followed by a developmental phase to set up and test the scheme, and finally an operational phase to maintain and steadily improve the scheme. Funding will be a critical issue at all stages. Establishing a new AWM scheme on the foundation of one that is already achieving some market access will obviously need less time and have less risk of failure than establishing a whole new scheme.

9.1 Planning Phase

The first step should be to establish a planning group with representatives from at least the growers, the local authority and state government. Other

stakeholders such as householders and other farmers should be invited to join, or at least be consulted if they don't join. The planning group should assess the situation realistically and consider all relevant factors, including the following before deciding whether a local AWM scheme is feasible.

Benefits. The benefits of the AWM scheme need to be important enough to motivate both the growers and the other stakeholders. Identifying a worthwhile benefit for each stakeholder group is an advantage in winning their support. It may be that only growers of one crop will obtain a market access benefit, but other growers and all householders will also benefit from reduced fruit losses.

Market access issues. Current or future market access provides the strongest motive for support and helps all benefiting growers to commit to supporting the AWM scheme. If market access is currently based on fruit fly management, this can provide a good basis from which to design an AWM scheme. If not, then development work will be needed to assess the level of fruit fly management that can be achieved. The quarantine authorities of the local state, and of the importing state or country need to be consulted to ensure their support and anticipate their needs. They are unlikely to approve a scheme until there is some evidence of its efficacy.

Area. The boundaries of the area to be managed needs to be considered. It can depend on many factors, including

- the crop(s) for which market access is proposed,
- the areas of the crop(s) that can meet the access requirements, and
- important fruit fly breeding sites, both urban and rural, that affect the crop areas.

Natural components. The natural factors that influence the fruit fly population and egg laying in the area need to be listed and their mode of action identified where possible.

Applied components. In most cases, general knowledge on fruit fly management and local experience will indicate the main components to apply. However, all possible applied components need to be considered for their potential use in the area. For each component, the most efficient and effective methods of application need to be identified, along with the stakeholders responsible for applying it and the costs involved.

Local quarantine measures. The benefits and costs involved with local quarantine restrictions need to be discussed with state quarantine authorities. In most cases, legislation will not be introduced to enforce compliance unless cheaper methods, such as an education campaign, have been tried. The knowledge gained from this advisory approach will be useful in designing acceptable legislated requirements.

Monitoring. The type and extent of monitoring (on-farm or area-wide), and the responsible party (growers or government) needs to be decided in

consultation with the quarantine authorities. Monitoring can be a major cost if the whole area has to be trapped continually.

Responsibilities. The detailed responsibilities of each stakeholder group (growers, local government, state government, householders, fruit marketers etc) need to be documented.

Commitment. The commitment of all stakeholders is essential for success. Written commitment should be obtained from all major stakeholders to clarify their commitment and maximise their motivation when funds and action are required.

Management organisation. An organisation needs to be identified or proposed that will set up and then manage the AWM scheme. Ideally, this will include a management committee made up of representatives from the major stakeholder groups to facilitate communication and improve coordination. The management organisation may also employ a manager for the scheme (and other staff), on a full or part-time basis, who is answerable to the management committee.

Communication. An effective communication system using most forms of media will be needed to promote the system initially and then to maintain support from all stakeholders.

9.1.1 Funding

The principal source of funding for the planning stage is likely to be the local grower organisation, supported perhaps by other local sponsors. Fortunately the costs should be low since growers, and government staff are likely to provide advice and assistance without charge. The method of funding the development and operational phases of the scheme need to be planned during this phase. Options for funding these phases are discussed in the sections below.

9.2 Development Phase

The second step is the development phase in which the proposed components of an AWM scheme are researched, tested and adjusted to suit the local conditions. This can take one or more years depending on the information already available, and the complexity of the system. In most cases it will be essential for the management organisation to become operational in this period in order to develop its experience and management systems. The efficacy of the scheme will need to be tested at the end of the development phase in order for it to be accepted for market access.

Research and development. The amount of research and development needed will depend on the uniqueness of the scheme. Widely used control measures such as bait sprays may need little development work.

All proposed control measures should still be tested however on a small scale with a few local operators before being recommended generally, if they have not been used locally before. This small scale testing is necessary to check

their efficacy in the local situation, to identify any problems such as phytotoxicity or incompatibility with other orchard practices, and to identify the most efficient and effective methods for applying the control measures.

Technical support. State governments may provide research and extension staff and monitoring services if the scheme is likely to produce good economic benefits to the district and the state. The availability of a pest management consultant in the district will ensure that growers have access to one-on-one advice.

Training. The procedures for each operation and the responsibilities of all operators need to be documented before training can begin. Thorough hands-on training is essential for all growers, treatment applicators, trapping staff etc.

Quality Assurance. If the AWM scheme is going to be used for market access, some form of quality assurance (QA) is essential to ensure that all procedures are carried out correctly all the time. Some procedures will be documented and audited as part of the CA systems used for domestic and export quarantine control. Others may need to be part of the QA system operated by the local AWM organisation to ensure that required standards are maintained.

Efficacy of the AWM scheme. Ideally, the existing level of fruit fly management should be monitored for at least a year to provide a bench mark for assessing the benefits of a new AWM scheme. In some cases, adequate monitoring data will already be available.

In most cases, the efficacy of the final scheme will need to be assessed before it is accepted by a quarantine authority. This is likely to be an expensive exercise. It is therefore best left until the whole AWM scheme is finalised and operating satisfactorily, and an acceptable assessment method has been negotiated with the importing quarantine authority.

9.2.1 Funding

Seed funds will be needed for the development phase in which the AWM scheme is set up, tested and adjusted. These can come from local funding sources or a mixture of local and outside sources. It may be difficult to force all growers to contribute funds before the new scheme starts to provide market access. However it is possible that many growers will contribute voluntarily to help the scheme start. Their support will be a good indication of their commitment to AWM and their confidence that the scheme will work.

Funding bodies such as AusHort, and state and national grower organisations may provide seed funds if they are convinced that implementing the AWM scheme will provide national or state benefits.

9.3 Operational Phase

The AWM scheme becomes operational when it is used for market access or when its on-going operation is assured because stakeholders feel that the

overall benefits of the scheme outweigh its costs. There will be many issues to deal with after the AWM scheme commences, in maintaining and improving the scheme, and in dealing with the stakeholders involved.

Management organisation. The effectiveness of the organisation managing the AWM scheme will be critical to its success. It needs to maintain the support of all stakeholders, yet at the same time deal with those that do not fulfil their agreed obligations.

Improving the AWM system. It is very desirable that the AWM scheme undergoes continuous improvement to increase its effectiveness and reliability. This will maintain existing market access and help with access to new, more demanding markets.

9.3.1 Funding

An on-going source of funds will be needed. Even if some support is provided by government, the growers receiving a private benefit from an AWM scheme will be expected to provide a large share of the funding to operate it.

The major benefit to growers will be access to markets that accept fruit grown under the AWM scheme. Certification of their produce is usually done under a CA scheme operated by their state (for interstate markets) or the Commonwealth (for export markets). It may be possible to link each grower's accreditation under a CA scheme with their financial support of the AWM scheme.

In Western Australia, the *Agriculture Produce Commission Act* 1988 makes provision for producers of agricultural produce to be required to fund industry services, including local fruit fly baiting schemes (Broughton 2000). A *producer* is defined as *anyone who produces any quantity of agricultural produce, whether for sale or not.* A formal poll of fruit tree owners is taken and if approved, a fee for service becomes compulsory and is collected with the shire rates.. A Community Baiting scheme operates in the towns of Harvey, Brunswick Junction and Yarloop but this scheme is outside the Act and contributions are voluntary.

Legislation could be introduced in other states to ensure that benefiting producers contributed to their local AWM scheme if the situation warranted it and the state government supported it.

Conclusions

Establishing a major AWM scheme is a complex exercise that requires a high level of organisation and commitment by the growers and other stakeholders.

The first district(s) to implement a major AWM scheme will provide a benefit to all fruit industries, particularly if their scheme initiates the acceptance of AWM for access to export markets. It is desirable that AusHort and other funding bodies provide financial support to the early adopters of AWM.

The continuing operation of an AWM scheme will be dependent on a continuing source of funding. It is very desirable that each grower's market access under an AWM entry condition is dependent on their continued financial support for their local AWM scheme.

Recommendations

Recommendation 8. *HAL should establish an AWM pilot implementation project to develop Australian experience with AWM planning, development and operation. The project should assist one or more appropriate districts to establish a new or improved AWM scheme.* (See Rec. 12 for further details.)

Recommendation 9. *State and Commonwealth governments should check whether their CA schemes allow for the accreditation of a grower for an AWM entry condition to be made legally dependent on the grower's continued financial support for the local AWM scheme that allows the fruit to satisfy the entry condition. Amendments to the legislation should be made if needed.*

Recommendation 10. *Because of the costs involved, a full measurement of the efficacy of an AWM scheme should be left until the scheme is operating satisfactorily, and a measurement method has been approved by the importing quarantine authority.*

10. RANKING DISTRICTS FOR AWM IMPLEMENTATION

This report provides information on nine districts that are candidates for the use of AWM to control of fruit flies. This is not intended to be an exclusive list of potential areas. The nine districts have been assessed to identify whether they have the basic ingredients necessary for an AWM scheme. The districts have then been ranked according to their suitability for inclusion in an AWM pilot implementation project.

10.1 Details of Candidate Districts

The nine districts have been grouped according to:

- the fruit fly species involved,
- the likely basis for market access,
- the likely crop for market access under AWM, and
- the length of time between winter and harvest during which the fruit fly population can increase.

Qfly – Population is below outbreak level at time of harvest

1. Young, NSW – cherries
2. Orange, NSW – cherries
3. Tumut, NSW – stone fruit
4. Batlow, NSW – apples

Qfly – Population is low and egg laying is restricted by host resistance

5. Corindi, NSW – blueberries

Qfly – Population is low and egg laying is restricted by winter temperatures

6. Central Burnett, Qld – citrus
7. Narromine, NSW – citrus

Medfly – Population is low and egg laying is restricted by winter temperatures

8. Collie River, WA – citrus
9. Serpentine, WA – citrus

Information on each of the nine districts is provided in Appendix 1 at the end of the report.

10.2 Criteria for Ranking Districts for AWM Implementation

The following criteria have been used to assess:

- the feasibility of each candidate district establishing a successful AWM scheme, and
- the expected benefit to national knowledge from the establishment of that scheme.

Climate adverse to fruit fly infestation for at least part of the year. Natural control of fruit fly by low winter temperatures provides an important basis for an area-wide management scheme. The lower the temperatures and the more extended the cold period, the greater the effect.

Major crop is harvested when fruit fly infestation rate is lowest. Crops harvested in winter receive maximum benefit from the effect of low temperatures on egg laying and fruit fly population, with the effect reducing as crops are harvested through spring and into summer. Winter marketing in Australia also reduces the risk to importing states because the fruit are imported when the risk of fruit fly establishment is low due to both low temperatures and low host fruit availability.

Major crop has low inherent susceptibility to fruit fly infestation. The susceptibility of a fruit type to infestation is an important factor in achieving minimal infestation at harvest. Susceptibility may be affected by skin resistance to infestation, flesh resistance to larval development, crop plant attractiveness for shelter, etc. Current assessments are qualitative.

Few uncontrolled sites of fruit fly breeding. The presence in a district of sites where fruit fly breeding is not controlled, reduces the level of control on the fruit fly population, and increases the risk of infestation of commercial crops. Uncontrolled sites include unmanaged orchards, urban areas, feral hosts and native hosts.

Benefit to District from area-wide management of fruit flies. The strength of grower and community support for area-wide management will be dependent on the financial benefits achieved, and the major benefits will come from gaining access to domestic and overseas markets with fruit fly restrictions. Districts have been assessed on their likelihood of retaining and obtaining market access based on AWM

Reliability of the area-wide management system in meeting future market access conditions. It is important that the system used to achieve a low rate of infestation is reliable, so that the approved market access conditions can be met year after year. Sudden loss of market access is very disruptive to orderly marketing. Applied treatments such as bait sprays and MAT technique are generally quite reliable in the cooler months. Low winter temperatures are moderately reliable. Quarantine measures to prevent the entry of fruit fly into small quarantine districts are likely to have low reliability unless the districts are very isolated.

Benefit to national knowledge on AWM. If national bodies contribute to the implementation of an AWM scheme, they will be seeking maximum increase to the national experience on establishing and operating AWM schemes. More experience is likely to come from districts with a variety of stakeholders and several growers than from districts with single growers. Most knowledge will come from schemes that are likely to obtain quarantine approval for interstate or export market access.

10.3 Ranking of districts for AWM Implementation

Each district has been rated on a scale of 1 = very poor to 5 = very good for each of the criteria. Comments on the ratings for each district are provided in Appendix 1 at the end of the report. The district ratings are summarised in Table 1.

Table 1. Ranking of districts for their suitability to establish a successful AWM scheme, and for the national benefit to be gained from the establishment of that scheme.

CRITERIA DISTRICT	Climate Adverse	Harvest Time	Crop Susc'y	Sites Un-controlled	Local Benefit	Reliabil-ity	National Benefit	TOTAL
C Burnett	4	5	3	3	5	5	5	30
Corindi	3	4	5	4	5	5	2	28
Young	4	4	4	2	5	4	5	28
Narromine	4	4	3	3	4	4	4	26
Orange	5	3	4	2	4	3	5	26
Burekup	4	3	3	3	3	3	4	23
Batlow	5	1	3	3	1	5	4	22
Tumut	4	1	1	3	3	2	4	18
Serpentine	4	2	3	3	2	3	1	18

10.4 AWM Implementation Proposals

The proposed AWM systems for the top five districts are as follows.

10.4.1 Central Burnett, Qld

Crop and pest. Citrus, Qfly

Current AWM components. Natural: winter temperatures reduce population and restrict egg laying; small population of native and feral hosts; moderate

crop susceptibility. Applied: weekly bait spraying on orchards; orchard sanitation. Monitoring in orchards registered for ICA-28

Possible additional AWM components. MAT in and around orchards, in urban areas and in other major breeding sites; all orchardists in the area adopting all AWM control measures; treatment of over-wintering sites; disinfesting or destroying infested fruit found in orchards, packing sheds, home gardens and the fruit marketing system; destroying unmanaged host plants in urban and non-crop locations (with landholder agreement); monitoring in all orchards and major breeding areas.

Current basis for market access based on AWM. To Victoria: fruit fly population low due to bait spraying and cold; egg laying restricted by cold; post-harvest inspection of fruit; market access ceases after 25 August which has been identified by research as the time when egg laying is likely to commence. Market access is restricted to the climatic area in which this research has been conducted.

Possible future basis for market access. Interstate: fruit fly population low due to bait spraying, MAT, cold and off-farm controls; egg laying restricted by cold and controls to prevent population rise in spring; post-harvest inspection of fruit. Overseas (USA): as for interstate, possibly combined with a post-harvest treatment of moderate efficacy.

10.4.2 Corindi, NSW

Crop and pest. Blueberries, Qfly

Current AWM components. Natural: winter temperatures reduce population; small population of native and feral hosts; low crop susceptibility. Applied: weekly bait spraying or dimethoate cover sprays; orchard sanitation; MAT in and around blueberry plantings. Monitoring in areas in and outside the blueberry plantings.

Possible additional AWM components. Winter temperatures may restrict egg laying; MAT in other major breeding sites; all growers of host crops in the area adopting all AWM control measures; treatment of over-wintering sites; disinfesting or destroying infested fruit found in orchards, packing sheds, home gardens and the fruit marketing system; destruction of unmanaged host plants in urban and non-crop locations (with landholder agreement). Monitoring in all orchards.

Current basis for market access based on AWM. To Victoria: fruit fly population low due to cold and bait spraying; infestation restricted by low host susceptibility, cold, and dimethoate cover sprays; post-harvest inspection of fruit.

Possible future basis for market access. Interstate: fruit fly population low due to cold, MAT and bait spraying; egg laying restricted by cold, low host susceptibility, and controls to prevent population rise in spring; post-harvest inspection of fruit. Overseas: as for interstate, possibly combined with a post-harvest treatment of moderate efficacy.

10.4.3 Young, NSW

Crop and pest. Cherries, Qfly

Current AWM components. Natural: winter temperatures reduce population; low crop susceptibility. Applied: low level of baiting in urban areas.

Monitoring in orchard and urban areas to determine whether fruit flies are at outbreak level.

Possible additional AWM components. Spring temperatures may restrict egg laying; MAT in and around orchards, in urban areas and in other major breeding sites; weekly bait spraying on orchards in autumn, winter and spring; all growers in the area adopting all AWM control measures; treatment of early outbreaks due to over-wintering flies and introductions; disinfesting or destroying infested fruit found in orchards, packing sheds, home gardens and the fruit marketing system; destruction of unmanaged host plants in urban and non-crop locations (with landholder agreement); publicity to reduce entry of infested hosts by householders and fruit marketers. Increased monitoring in orchard and urban areas; monitoring in areas outside the orchards to detect early outbreaks due to over-wintering sites and introductions.

Current basis for market access based on AWM. To Victoria: fruit fly population below outbreak level.

Possible future basis for market access. Interstate: fruit fly population low; egg laying restricted by cold and controls to prevent population rise in spring; isolated sub-districts treated as separate districts for outbreak assessment. Overseas (Taiwan): as for interstate, possibly combined with a post-harvest treatment of moderate efficacy.

10.4.4 Narromine, NSW

Crop and pest. Citrus, Qfly

Current AWM components. Natural: winter temperatures reduce population; small population of native and feral hosts; moderate crop susceptibility. Applied: bait spraying on some orchards. Monitoring on some orchards

Possible additional AWM components. Winter temperatures may restrict egg laying; MAT in and around orchards, in urban areas and in other major breeding sites; all orchardists in the area adopting all AWM control measures; treatment of over-wintering sites; orchard sanitation; disinfesting or destroying infested fruit found in orchards, packing sheds, home gardens and the fruit marketing system; destruction of unmanaged host plants in urban and non-crop locations (with landholder agreement); reducing entry of infested hosts by householders and fruit marketers. Monitoring in all orchards and major breeding areas.

Current basis for market access based on AWM. Nil

Possible future basis for market access. Fruit fly population low due to bait spraying, MAT, cold and off-farm controls; egg laying restricted by cold and controls to prevent population rise in spring; post-harvest inspection of fruit. Overseas: as for interstate, possibly combined with a post-harvest treatment of moderate efficacy.

10.4.5 Orange, NSW

Crop and pest. Cherries, Qfly

Current AWM components. Natural: winter temperatures reduce population; low crop susceptibility. Applied: no specific treatments. No recent monitoring in orchard or urban areas.

Possible additional AWM components. Spring and early summer temperatures may restrict egg laying; MAT in and around orchards, in urban areas and in other major breeding sites; weekly bait spraying on orchards in

autumn, winter and spring; all growers in the area adopting all AWM control measures; treatment of early outbreaks due to over-wintering flies and introductions; disinfesting or destroying infested fruit found in orchards, packing sheds, home gardens and the fruit marketing system; destruction of unmanaged host plants in urban and non-crop locations (with landholder agreement); publicity to reduce entry of infested hosts by householders and fruit marketers. Increased monitoring in orchard and urban areas; monitoring in areas outside the orchards to detect early outbreaks due to over-wintering and introductions.

Current basis for market access based on AWM. None

Possible future basis for market access. Interstate: fruit fly population low; egg laying restricted by cold and controls to prevent population rise in spring. Overseas (Taiwan): as for interstate, possibly combined with a post-harvest treatment of moderate efficacy.

Recommendation

Recommendation 11. *The five districts ranked highest for their suitability to establish a successful AWM scheme, and for the national benefit to be gained from the establishment of that scheme, are: Central Burnett, Corindi, Young, Narromine and Orange.*

11. SELECTING A DISTRICT FOR AN AWM PILOT PROJECT

The effective implementation of AWM in a district depends, however, on more than the apparent suitability of the district. Establishing an AWM scheme will be a time consuming and expensive exercise for the local growers and others, and their dedication to making it work will be critical to its success.

Its success will depend on the real level of support for an AWM scheme from growers, the local community and state government. This support cannot be measured at this early stage. Growers interested in establishing an AWM scheme need to consider the factors involved in its success and undertake a thorough planning process. They should then assess the actual level of local support for the proposed scheme before deciding whether to nominate their district for an AWM pilot implementation project.

11.1 Seed Funding for an AWM Pilot Project

The need for seed funding to provide financial support for the early adopters of AWM has been covered in the previous chapter on ESTABLISHING AN AWM SCHEME. The details of a project to provide seed funding for the implementation of a pilot AWM scheme also need to be addressed.

11.1.1 Phases of establishment that need to be funded

The first phase in establishing an AWM scheme is the planning phase which should not need seed funding. The applicants should have considered most of the planning steps in sufficient detail to determine the general feasibility of the scheme prior to submitting their application. Some of the more complex issues such as the long-term methods of managing and funding the scheme

may need more detailed planning and this can be funded as part of the development phase.

The development phase covering 2 to 3 years will benefit from external funding. It is the critical stage in which the proposed components of an AWM scheme are researched, tested and adjusted to suit the local conditions. It also includes measuring the efficacy of the scheme, which will be needed for a market access application.

The final operational phase should not need project funding as the scheme needs to be self funding by the time it enters that phase. However some provision for bridging funds may be required.

11.1.2 Activities that need to be funded

It is reasonable to expect that growers will pay for the treatments they apply to their own properties, such as bait spraying, MAT and fruit fly trapping. This will ensure that at least these measures can be funded when the scheme becomes operational.

However, the application of these treatments to the non-orchard areas is appropriate for external funding, as this broad area application is unique to a full AWM scheme, as distinct from the fruit fly management systems currently in place.

It will take at least a year of full area-wide trapping to identify the major fruit fly breeding and congregation sites within the managed area, and record the timing of population changes. Existing trapping records will assist, but may not be accurate, comprehensive or current enough to provide a sound basis for establishing a scheme. Testing various control measures and measuring their effect on the fruit fly population can take at least another 2 years.

Implementation funds will also be needed for setting up and testing methods for managing the AWM scheme, including the management structure, communication with stakeholders, collection of funds from stakeholders, and obtaining market access approval. For each of these aspects, several different options will need to be assessed before a particular method is selected and tested. The pilot district should be required to document the selection process used and the experience with the method chosen. This information will be useful to other districts when they need to make similar decisions.

As an example of the complexity in managing an AWM scheme, there are many possible options for collecting funds from benefiting growers. A contribution rate can be set per unit area of crop plants harvested, per unit of crop sold on any market, or per unit sold into a market for which the access is dependent on the AWM scheme, or a combination of these. Many factors, including who is responsible for calculating and auditing individual contributions, will need to be considered.

The greatest need that an organisation responsible for establishing a pilot AWM scheme is likely to have is people with the ability and time to investigate and document these options and to organise the scheme on a day-to-day basis. It is appropriate for implementation funds to be used to employ staff to undertake work for the local AWM organisation during the development phase. Ideally, one such person would later become the manager/coordinator of the scheme.

11.1.3 Sources of seed funds

All growers benefiting from an AWM scheme, even those not receiving a market access benefit, may be expected to pay for treatments applied on their property. Growers receiving a market access benefit may be expected to pay for monitoring on their property and to contribute to the general costs of the AWM scheme including off-farm monitoring and treatments, publicity and other management costs.

External sources of funds and services can include the following.

- AusHort, through a project to encourage the implementation of improved AWM schemes for the benefit of the national horticultural industry.
- National and state industry organisations that see a benefit to their crop industry.
- Local crop research and development funds.
- State governments, by providing seed funds or services, such as monitoring.
- Local councils, by providing services such as eradication of unwanted alternate hosts, control measures in urban and public areas, and publicity. Some of the resources used may come from Commonwealth employment schemes etc.
- Sponsors such as local businesses that identify a benefit.

11.2 Selecting the pilot district

Any district should be eligible to apply for funding under a national AWM implementation project, not just those investigated in this project, although they are the most likely. It would be useful to fund two districts differing in size, pest species, crop etc, but the available funds will probably only allow support for one pilot scheme at a time.

Each applicant should provide a plan for their proposed AWM scheme, that covers the issues identified in the section of this report titled: ESTABLISHING AN AWM SCHEME. A budget showing the costs and income from all proposed funding sources should be included in the plan. Evidence of the level of commitment of growers, local authorities, relevant government departments, and other stakeholders to support the plan should also be provided.

The selection of the district(s) to receive project funding should be based on the plan (including the budget), the level of commitment, an independent assessment of the suitability of the district for an AWM scheme, and the benefit to Australia from its establishment.

Conclusion

The selection of a district to receive financial support for the implementation of an AWM scheme needs to take into consideration the demonstrated commitment of the local growers and community to support it, as well as both the district's general suitability and the national benefit.

The awarding of funding to districts on a competitive basis will provide a good basis for establishing an AWM scheme because it:

- forces a thorough local assessment of each proposed scheme,
- motivates growers and other stakeholders to commit themselves to supporting their local AWM scheme in order to help their district win the implementation support funds,
- provides funds for independent support staff to help the management committee in the critical establishment phase when it may not have the complete support of all stakeholders,
- provides funds for a thorough investigation of control measures and monitoring in the area before the scheme becomes operational,
- provides funds for testing the efficacy of the scheme to meet the requirements of quarantine authorities, and
- encourages state and national quarantine authorities to provide guidance to the selected pilot scheme(s).

Recommendation

Recommendation 12. *HAL should invite growers interested in establishing an AWM scheme to apply for seed funding on behalf of their district. Their application should include evidence of thorough planning and of the commitment by growers,* government *and other stakeholders to support the plan. The selection of the district(s) to receive implementation project funding (Rec. 8) should take into consideration this planning and commitment, as well as the suitability of the district for establishing an effective AWM scheme and for receiving national funding.*

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13. Appendix 1. CANDIDATES FOR AN AWM PILOT PROJECT

13.1 Central Burnett, Qld – citrus

District information

Fruit fly pest species. Qfly.

Location of the production area. The Central Burnett district includes the towns of Gayndah, Mundubbera and Eidsvold in the Burnett River valley. It is approximately 270 km north west of Brisbane, 70 km long and 12 km wide.

Climate. Hot, moderately wet summers and cool, dry winters. This is the coolest citrus district in Queensland, with some frosts.

Topography. Most orchards are located along the high banks of the Burnett River and its tributaries, and are irrigated with water from the river. A few are on elevated, well drained sites away from the river.

Fruit crops in size order. Citrus: mandarins (Imperial, Murcott, Hickson, Ellendale), Navel orange, lemons, Valencia orange, grapefruit.
Peaches, nectarines, avocado, mango.

Industry structure. The district includes 71 citrus orchards with a total area of approx 2000 ha. Thirty four growers supply fruit to Gayndah Packers, a cooperative. The other growers pack and market their own fruit in moderate to large packing sheds.

Uncontrolled breeding sites. A large stonefruit orchard at Mundubbera (part of the Tumut Farms group) was neglected in the 2001/2002 season. It is now on the market and is expected to be run as a commercial orchard in the future. There are some untreated fruit trees in the towns and a few feral fruit trees along the streams.

Population of urban areas. The approx populations are: Gayndah 2500, Mundubbera 2000 and Eidsvold 500.

Shortest distance from an orchard to an urban area. Two orchards are within the Gayndah town limits. Three orchards are within one kilometre ofthe town limits of Mundubbera.

Support of urban population for fruit fly management. Residents of Gayndah and Mundubbera have many links with the citrus industry and have shown interest in reducing fruit fly problems.

Current control program. Baiting is part of a well established IPM program implemented in approximately 98% of the citrus orchards in the district.

Weekly protein bait spraying commences in January for early maturing citrus cultivars and continues until mid-September for late maturing cultivars. Orchard sanitation is also practised on most orchards.

Current trapping program. Twelve citrus growers in the district are accredited for ICA-28 (Pre-harvest Bait Spraying and Inspection of Citrus) for market access to Victoria. Their orchards are trapped each year from 12 weeks prior to the first harvest of fruit until the end of harvesting. Most other orchardists in the district employ local crop consultants to monitor their citrus pests including fruit fly. Research projects carried out by QDPI and local crop consultants between 1997 and 2000 provided extensive trapping data in orchards and non-orchard areas.

Current trapping results. Extensive trapping data obtained by crop consultants over many years show that the general pattern of fruit fly population changes in the district is: April, May - low; June to August - very low; September, October - very high; November to March - high. The trap count categories are: very low: <10, low: <50; moderate: <100; high: <500; very high: >500 Qfly / trap / week.

Current access for citrus to fruit fly sensitive markets. To Victoria (since 1999) for fruit certified for pre-harvest baiting and post-harvest inspection and harvested from March 1 to August 25 (ICA-28).
To Victoria, South Australia, and Tasmania for fruit given a post-harvest dimethoate dip or flood spray treatment (all year).
To Japan for fruit given a cold treatment.

Target markets using AWM. Victoria: with the winter access period extended to the end of the Murcott season in September.
South Australia, Western Australia and Tasmania. Acceptance of an AWM systems approach by these states would allow all growers to use that treatment exclusively, as they would no longer need a chemical post-harvest treatment facility. USA, Asia.

Other benefits of AWM. More effective fruit fly control
Reduced intensity of crop baiting thereby reducing: disruption to IPM, incidence of bait phytotoxicity, overall chemical usage, and cost of production.

Support & funding for AWM trials. Gayndah and Mundubbera Shire Councils have indicated general support for area-wide management.
The grower - funded Central Burnett Horticulture Committee, which financially supported fruit fly management research from 1997 to 2000, is strongly in favour of further research and any program that would lead to improved fruit fly management across the entire district.
The Citrus Committee of the Queensland Fruit and Vegetable Growers Association may also support further research.

Local fruit fly management committee. A local committee could be formed that includes representatives of growers, Councils and the Qld DPI.

Local pest consultant. Three pest consultant businesses with a total of 13 staff provide pest monitoring advice to citrus growers.

Dept of Ag support. Research support is provided by the following QDPI staff: Dr Annice Lloyd and Ed Hamacek from Brisbane, Dan Smith and Chris Freebairn from Nambour and Bob Shaw from Gayndah. Peter Wishart at QDPI Gayndah provides extension services to Central Burnett citrus growers.

Evaluation as a pilot area for AWM

Climate adverse to fruit fly infestation for at least part of the year. Low temperature reduces the fruit fly population in winter and provides a good start for maintaining a low population during the rest of the year. Low temperatures also restrict egg laying so that fruit infestation is almost non-existent in winter even though fruit flies are present.

Major crop is harvested when fruit fly infestation rate is low. Harvesting of the major citrus cultivars occurs in the following winter months: Imperial mandarin, Navel orange and some lemons from April to June; Hickson and Ellendale mandarins in June and July, Murcott mandarin in late July and early August.

Major crop has low inherent susceptibility to fruit fly infestation. Citrus fruit have a moderate susceptibility to fruit fly infestation, except for lemons which have a very low susceptibility. Citrus trees have a high attractiveness as shelter for fruit flies, which assists in control with bait sprays.

Few uncontrolled sites of fruit fly breeding. Only a few orchards need to improve their fruit fly control. The urban areas are small. QDPI research in 1999 showed that there are few feral hosts and very few alternate wild hosts in the Central Burnett.

Benefit to District from AWM of fruit flies. Continued access to the Victorian market based on AWM is very important. Extension of access to the end of the Murcott season would increase the benefits. Acceptance of AWM by all states would mean that all growers would use ICA-28 certification and post-harvest treatment equipment would not be needed. It would also provide more assurance of future access than chemical treatments. Access to new export markets like USA may be possible with AWM, or AWM plus a post-harvest treatment.

Reliability of the AWM system in meeting future market access conditions. The AWM system will be based on winter temperatures controlling both the fruit fly population and egg laying, plus further control of the fruit fly population with bait sprays and other applied treatments such as MAT. The reliability of this system is likely to be high.

Benefit to national knowledge on AWM. Considerable experience will be obtained in establishing and operating an AWM scheme involving many growers, several councils and several towns which will be of benefit to all

districts. Knowledge gained on an AWM system for citrus may be directly applicable to other districts such as Narromine, Bourke and the coastal Burnett. Publicity from the operation of an AWM system using IPM principles will give consumers good news on minimal pesticide use. Negotiations with domestic and export quarantine authorities will provide information on the issues to be considered in developing other AWM systems.

13.2 Corindi, NSW – blueberries

District information

Fruit fly pest species. Qfly

Location of the production area. The candidate district centres on the 250 ha blueberry and raspberry plantings of BFA on the Corindi Plateau, approx 40 km north of Coffs Harbour.

Climate. Subtropical with several frosts per year in low areas due to the moderate elevation of the plateau.

Topography. An undulating plateau on the eastern edge of the escarpment, approx 10 km from the Pacific coast.

Fruit crops in size order. Blueberry, raspberry, avocado.

Industry structure. BFA manages the production, packing and marketing of all except 2 ha of the 250 ha planted with berry fruits in the Kathleen Drive and Range Road area. BFA owns most of the plantings, with the remainder still owned by individual investors.

Uncontrolled breeding sites. A one hectare abandoned blueberry block containing some surviving plants, and another block managed by the owner are located within the BFA area and come under the influence of the fruit fly controls applied by BFA. An avocado orchard on the plateau 1.5 km from BFA blueberries, and a separate blueberry planting below the plateau, receive commercial fruit fly controls applied by their owners.

Population of urban areas. Approx 5000 in the urban area that extends from Corindi Beach south to Woolgoolga.

Shortest distance from an orchard to an urban area. Four km down the escarpment.

Support of urban population for fruit fly management. No particular support.

Current control program. Male annihilation blocks of cuelure/maldison are dispersed at four per hectare within the plantings, and at 20 m intervals around the perimeter of the treated area.
Protein hydrolysate/maldison bait sprays are applied to cropping areas every 7 days from August to harvest. Dimethoate cover sprays are applied every 14 days when BFA decide that bait sprays are not likely to be sufficiently effective. A change to cover sprays is made if rain disrupts bait application, or if trap counts exceed 40 flies per week, but not until after pollination is finished in late September. Dimethoate can disrupt the biological control of light brown apple moth and mealy bug. It is therefore used more on the rabbiteye type which is less susceptible to these pests than are other blueberry types.

Current trapping program. An array of 30 traps inside the BFA area and 30 traps outside, some on the plateau, and some on the eastern slope.

Current trapping results. The current control program produces a trap count (in general terms) of: April, May - low; June to August - very low; September to March - moderate to very high, depending on the year.
The trap count categories are: very low: <5; low: 5-20; moderate: 20-40; high: 40-100; very high: >100 Qfly / trap / week.

Current access for blueberries to fruit fly sensitive markets. To Victoria, on the basis of either:

- winter access from May 30 to Aug 15 without any sprays, or,

under ICA-31:

- bait sprays twice weekly, or
- dimethoate cover sprays applied 21, 14 and 7 days before harvest then every 14 days.

To Japan, on the basis that blueberry is not a legislated host of Qfly in Japan, and there have been no infestations in imported fruit.

Target markets using AWM. Victoria, South Australia, Western Australia and Tasmania. USA, Taiwan, Korea.

Other benefits of AWM. Eliminate need for dimethoate cover sprays which encourage outbreaks of other pests such as mealy bugs and light brown apple moth.

Support & funding for AWM trials. Local Council: unlikely.
Local grower association: not existent.
Local individual growers: BFA has accommodated trial work in the past.
Local FF management committee: BFA and NSW Dept of Ag research staff currently work as a fruit fly management committee with respect to BFA.

Local pest consultant. No local IPM pest consultant. A local technician trained by NSW Dept of Ag is now paid by BFA to conduct trapping for fruit fly management.

Dept of Ag support. Research projects and associated trapping up to June 2001 have been managed by John McDonald and Andrew Jessup of NSW Dept of Ag.

Evaluation as a pilot area for AWM

Climate and other factors reduce the fruit fly population. Low temperatures reduce fruit fly population in winter and provide a good start for maintaining a low population during the rest of the year.

Major crop is harvested when fruit fly infestation rate is low. Blueberries are harvested from September to February with major exports from October to December when the fruit fly population is starting to build up.

Major crop has low inherent susceptibility to fruit fly infestation. Blueberries have a low susceptibility to fruit fly infestation due to their moderate skin resistance to infestation and the low attractiveness of the plant as shelter for fruit flies.

Few uncontrolled sites of fruit fly breeding. There are few uncontrolled sites such as untreated orchards, urban areas, feral hosts and native hosts in close proximity to the BFA plantings.

Benefit to District from AWM of fruit flies. Continued market access of Corindi blueberries to Victoria and Japan is very important to the continued success of BFA. This is very dependent on the continuation of successful AWM of fruit flies without affecting integrated management of other pests.

Reliability of the AWM system in meeting future market access conditions. The AWM system is based on the low fruit fly population that develops in winter being kept low until December by the applied treatments of bait sprays, cover sprays and the male annihilation technique. The reliability of this system is likely to be high.

Benefit to national knowledge on AWM. Useful experience will be obtained on establishing and operating an AWM system involving a small number of growers and a local council which will be of benefit to other districts. Knowledge gained on an AWM system for berry fruits may be applicable to other districts. Negotiations with domestic and export quarantine authorities will provide information on the issues to be considered in developing other AWM systems.

13.3 Young, NSW – cherries

District information

Fruit fly pest species. Qfly.

Location of the production area. The town of Young is approx 400 km south west of Sydney. Half of the district's fruit production comes from orchards within 10 km of the town. The rest comes from localities such as Wombat, Wirrimah, Maimuru and Kingsvale located up to 20 km from town.

Climate. Hot, summers and cold winters with several frosts. Annual rainfall of 660 mm, mostly from June to October.

Topography. The town of Young is in a hollow with an elevation of 430 metres Most orchards are on the elevated areas (approx 500 m) around it, and the remainder are on more distant elevated areas with suitable well drained soil.

Fruit crops in size order. Cherries, plums, peaches, nectarines and grapes.

Industry structure. The district produces approx 50 % of Australia's cherries from an estimated 1500 ha of orchards operated by 45 growers. There are 12 large private cherry packers that pack and market their own and other grower's fruit. A cooperative dries and markets prunes.

Uncontrolled breeding sites.
There are moderate numbers of untreated fruit trees in neglected orchards and roadsides. Orchard hygiene is a problem on some properties.

Population of urban areas. Approx 8,500 persons live in the town and 12,500 in the district.

Shortest distance from an orchard to an urban area. Some orchards are immediately adjacent to residential areas and most orchards are contiguous with other orchards. There are several moderately isolated districts.

Support of urban population for fruit fly management. Bait spraying of street trees was conducted for several years but in 2001, concerns were expressed by some local residents and the NSW Environmental Protection Agency about this spraying. Future methods of controlling fruit fly in the town and the establishment of a Young district fruit fly management committee are under consideration.

Current control program. Bait spraying has been conducted on street trees in the town. No specific orchard treatments have been necessary as fruit fly populations have been low in most years during the main harvest periods, and cherries are moderately resistant to infestation.

Current trapping program. The New South Wales Department of Agriculture maintains an array of approx 30 traps at 400 m intervals in the urban areas and 60 traps at 1 km intervals in orchard areas.

Current trapping results. In 2001, sufficient flies were trapped in October to declare an outbreak (5 flies within 1 km within 14 days). In previous years, the first outbreak was not declared until at least mid December.

Current access for cherries to fruit fly sensitive markets. To Victoria, under ICA-23, provided that a fruit fly outbreak has not been detected in the Young district (town or orchard) since the previous winter.
To Taiwan, provided fruit is fumigated with methyl bromide and stored at less than 1 deg C for14 days.

Target markets for cherries using AWM. Victoria, under the current, or a revised protocol (perhaps based on separate sub-districts around Young); South Australia, Western Australia, Tasmania.
Taiwan, avoiding, if possible, the current fumigation and cold treatments that damage fruit quality.
Japan, but this market requires 30 mm cherries.
USA, provided the fruit are fumigated with methyl bromide for light brown apple moth. This market requires 26 mm cherries so new cultivars would need to be grown. South Korea.

Other benefits of AWM. Further reduction in fruit infestation, particularly in stone fruit for non-fruit fly sensitive markets.

Support & funding for AWM trials. Young Shire Council is treating the town area for fruit flies. The local growers and packers have a fruit fly fighting fund that may be able to support local research.

Local FF management committee. A committee of growers, Dept of Ag and the Shire Council could be formed.

Local pest consultant. There is no pest monitoring service. Sales representatives from rural suppliers provide advice on pest control.

Dept of Ag support. Brett Dalliston from Young provides a fruit fly trapping service to the district. Sue Marte provides extension services to Young growers.

Evaluation as a pilot area for AWM

Climate and other factors reduce the fruit fly population for at least some time. Low temperatures can reduce the fruit fly population in winter to very low numbers. This provides a good start for maintaining a low population during the cool spring months. Infested fruit brought in by travellers and commercial fruit suppliers may also add fruit flies that increase the rate of build-up after winter.

Major crop is harvested when fruit fly infestation rate is low. Harvesting of cherries occurs in November and December when the fruit fly population has been low in previous years. In 2001, the population was already moderate in October and continuing to build up.

Major crop has low inherent susceptibility to fruit fly infestation. Cherries have a low susceptibility to fruit fly infestation, particularly when they are turgid. Infestation increases when the fruit soften due to dry conditions.

Few uncontrolled sites of fruit fly breeding. There is a high level of uncontrolled sites, including untreated orchards, urban areas and feral hosts.

Benefit to District from AWM of fruit flies. Maintaining market access to Victoria is very important to Young cherry growers because of the size of that market and the lack of a convenient post-harvest treatment. Market access to Taiwan based on area-wide management of fruit flies would allow cherries to be supplied in better condition than with fumigation plus cold treatment. Area-wide management would also have the benefit of achieving good fly control without disrupting the integrated management of other fruit pests.

Reliability of the AWM system in meeting future market access conditions. Current market access to Victoria is based on the effect of low temperatures in reducing the fruit fly population in the whole Young district below the outbreak declaration level in winter, then keeping the population below the outbreak level through spring until at least mid December. This system failed in 2001, and nearly did so in 93/94 and 97/98 so its current reliability is only moderate. It may be possible to improve the AWM system by adding bait sprays and reducing the entry of infested fruit into the Young district to keep the population low. Other market access conditions worth evaluating are that spring temperatures may be low enough to restrict egg laying, or that some sub-districts are sufficiently isolated for their fruit fly population to be assessed separately. These improvements and options would require further investigation.

Benefit to national knowledge on AWM. Useful experience will be obtained on establishing and operating an AWM system involving many growers, a local council and an urban area which will be of benefit to other districts. Knowledge gained on an AWM system for deciduous fruits may be directly applicable to other districts such as Batlow, Tumut and Orange. Negotiations with domestic and export quarantine authorities will provide information on the issues to be considered in developing other AWM systems.

13.4 Narromine, NSW – citrus

(Bourke is in a similar situation to Narromine. It is equivalent in area, but the production is increasing, with a smaller number of growers)

District information

Fruit fly pest species. Qfly.

Location of the production area. The Narromine district is in the Macquarie River valley around the town of Narromine (35 km west of Dubbo) and extending 40 km to the north-west. The district includes 8 citrus orchards with a total area of approximately 270ha.

Climate. Hot, moderately dry summers and cool, dry winters, with several frosts per year.

Topography. Most orchards are located along the banks of the Macquarie River, or one of its tributaries, and are irrigated with water from the stream. A few are on elevated, well drained sites away from the river. The dry climate and open plains provide some barrier to the movement of fruit flies from other areas. Narromine is 236 m above sea level.

Fruit crops in size order. Citrus: Valencia and Navel orange, grapefruit, mandarins (Ellendale, Imperial), limes, lemons.
Stone fruit (peaches, nectarines); avocado.

Industry structure. Seven growers supply fruit to the cooperative packing house in Narromine. The other grower takes his fruit to Sydney for packing.

Uncontrolled breeding sites. A 6 ha orchard on the river is currently neglected.

Population of urban areas. The approx population of Narromine is 3500.

Shortest distance from an orchard to an urban area. The stone fruit orchard is 3 km from Narromine town.

Support of urban population for fruit fly management. Narromine Shire Council conducts baiting on street trees in the town.

Current control program. On citrus orchards, bait sprays are applied every 7 days from late August. Valencias may be harvested up to April.

Current trapping program. Some of the citrus growers have used traps to monitor fruit fly in their orchards in the past year.

Current trapping results. Indications are that low levels (1 to 10 Qfly per trap per week) were recorded from August to December.

Current access to fruit fly sensitive markets. Navel and Valencia oranges have access to Japan provided they undergo cold disinfestation. Navels and valencias were exported to the non-quarantine markets of Singapore and Hong Kong in 2001.

Target markets using AWM. USA, Japan.

Other benefits of AWM. Reduction in bait spraying.

Support & funding for AWM trials. Narromine Shire Council will continue town baiting and education.
Local growers would consider a financial contribution and would continue to fund treatments on their own orchards.

Local fruit fly management committee. A committee could be formed to coordinate fruit fly management.

Local pest consultant. None available.

Dept of Ag support. Lou Revelant at Griffith provides extension services on citrus at Narromine.

Evaluation of the district as a pilot area for AWM

Climate and other factors reduce the fruit fly population for at least some time. Low temperature reduces fruit fly population in winter and provides a good start for maintaining a low population during the rest of the year. Winter temperatures may also be restricting egg laying until August.

Major crop is harvested when fruit fly infestation rate is low. Navel orange is harvested in the period prior to August during which egg laying may be restricted. Grapefruit and Valencia orange are harvested after August, when the fruit fly population and egg laying increases.

Major crop has low inherent susceptibility to fruit fly infestation. Citrus fruit have a moderate susceptibility to fruit fly infestation, except for lemons that have a high resistance to infestation. Citrus trees have a high attractiveness as shelter for fruit flies which may assist in control with bait sprays.

Few uncontrolled sites of fruit fly breeding. The currently neglected citrus orchard will need to come under control and the stone fruit orchard will need monitoring before full area-wide management can be implemented.

Benefit to District from AWM of fruit flies. Obtaining access to other states and to new and existing export markets will have a moderate advantage. Improved AWM would have the benefit of achieving good Qfly control without disrupting the integrated management of other citrus pests.

Reliability of the AWM system in meeting future market access conditions. An AWM system at Narromine would be based on the effect of winter temperatures in restricting fruit fly population and probably egg laying (yet to be proven). It would be backed up by bait spraying, fruit hygiene and other measures. The reliability of the total system, particularly in the winter harvest period, is likely to be good.

Benefit to national knowledge on AWM Useful experience will be obtained on establishing and operating an AWM system involving several growers, a local council and a town which will be of benefit to other districts. Knowledge gained on an AWM system for citrus may be directly applicable to other districts such as Bourke. Negotiations with domestic quarantine authorities

will provide information on the issues to be considered in developing other AWM systems.

13.5 Orange, NSW – cherries

District information

Fruit fly pest species. Qfly.

Location of the production area. The city of Orange is located approx 210 km west-north-west of Sydney. The district's fruit production areas are located within 15 km of the city mainly to the south-west (around Nashdale), south and north.

Climate. Hot, summers and cold winters with several frosts. Annual rainfall of 950 mm, with a peak from June to October.

Topography. The district has a high elevation, with the city of Orange at 920 metres and the orchards on more elevated areas up to 1050 m. The orchards are located on suitable soils (mostly on basalt flows from Mt Canobolas) and are irrigated from farm water storages.

Fruit crops in size order. Apples, cherries, nectarines, plums, peaches, and grapes.

Industry structure. There are 10 large private fruit packers that pack and market their own and other growers fruit. A cooperative business processes apples.

Uncontrolled breeding sites. There are moderate numbers of untreated fruit trees in neglected orchards and roadsides.

Population of urban areas. Approx 35,000 persons live in the city.

Shortest distance from an orchard to an urban area. There are some orchards immediately adjacent to urban areas, and many orchards are contiguous with other orchards.

Support of urban population for fruit fly management. The Orange City Council and Cabonne Shire Council are not involved in urban fruit fly management. It was not possible to assess the community interest in area-wide management. There is a moderate level of home garden fruit production.

Current control program. Specific orchard treatments for fruit fly are not usually required for cherries and apples, as the fruit are able to meet market requirements in Sydney and other non-fruit fly quarantine markets. Some control of fruit fly is probably achieved by low spring temperatures and sprays applied for other pests such as codling moth.

Current trapping program. There is no trapping program conducted by the NSW Dept of Ag or by growers.

Current trapping results. No recent results available. The last trapping program was conducted about 10 years ago.

Current access for apples and cherries to fruit fly sensitive markets. Apples have access to interstate markets such as Victoria, after a post-harvest cold storage treatment under ICA-7 (Cold Treatment).
Cherries are exported to Taiwan after fumigation with methyl bromide and storage at less than 1 deg C for 14 days.

Target markets for apples and cherries using AWM. Victoria and South Australia.
Taiwan, without the need to apply the fumigation and cold treatments that damage fruit quality.
USA, provided the fruit are fumigated with methyl bromide for light brown apple moth. This market requires 26 mm cherries so new cultivars would need to be grown.
South Korea

Other benefits of AWM. Reduction in fruit infestation for susceptible fruit such as stone fruit for non-fruit fly sensitive markets.

Support & funding for AWM trials. The city and shire councils have not been approached. A local research and development fund is available, based on contributions from processing fruit. Some local growers may fund treatments on their own properties but not all would see a commercial benefit to themselves.

Local FF management committee. A committee of growers, Dept of Ag and the Councils could be established.

Local pest consultant. A private consultant provides pest monitoring services.

Dept of Ag support. Richard Landon, Regulatory Inspector and Jeremy Bright, District Horticulturist provide regulatory and extension advice. Graham Thwaite provides R&D support on entomology to deciduous fruit industries.

Evaluation as a pilot area for AWM

Climate and other factors reduce the fruit fly population for at least some time. Low temperatures can reduce the fruit fly population in winter to very low numbers. This provides a very good start for maintaining a low population during the cool spring months.

Major crop is harvested when fruit fly infestation rate is low. Harvesting of cherries occurs in December and January when the fruit fly population may

still be low. Apples are harvested in late summer and autumn, when the population is rising.

Major crop has low inherent susceptibility to fruit fly infestation. Cherries have a low susceptibility to fruit fly infestation, particularly when they are turgid. Infestation increases when the fruit soften due to dry conditions.

Few uncontrolled sites of fruit fly breeding. There is a moderate level of uncontrolled sites including untreated orchards, urban areas and feral hosts in the Orange district.

Benefit to District from AWM of fruit flies. Obtaining market access to Victoria for cherries would be only a moderate advantage to Orange growers because of the size of their existing markets.
Market access to Taiwan based on AWM of fruit flies would allow cherries to be supplied in better condition than with fumigation plus cold treatment.
AWM would also have the benefit of achieving good fruit fly control without disrupting the integrated management of other fruit pests.

Reliability of the AWM system in meeting future market access conditions. An AWM system in the Orange district would be based on the natural effect of low temperatures in reducing the fruit fly population in winter. There is insufficient trapping data from recent years to know how reliable the weather and other factors will be in keeping the population below outbreak level until after cherry harvest finishes.

Benefit to national knowledge on AWM Useful experience will be obtained on establishing and operating an AWM system involving many growers, several councils and a major urban area which will be of benefit to other districts. Knowledge gained on an AWM system for deciduous fruits may be directly applicable to other districts such as Batlow, Tumut and Young. Negotiations with domestic and export quarantine authorities will provide information on the issues to be considered in developing other AWM systems.

13.6 Collie River, WA – citrus

District information

Fruit fly pest species. Medfly.

Location of the production area. Burekup town is near Bunbury, approx 160 km south of Perth. The candidate district includes eight citrus orchards within 5 km of the town, seven are to the east and one to the south.

Climate. Hot, dry summers; cool, wet winters. This is one of the coolest citrus districts in WA with several frosts each year.

Topography. Most orchards are located along the banks of a 2 km stretch of the Collie River, and use water from a channel irrigation scheme. Low hills provide some barrier to the movement of fruit flies from surrounding areas.

Fruit crops in size order. Citrus: oranges (Navel), mandarins (Imperial, Murcott), grapefruit. Stone fruit: plums, apricots.

Industry structure. Four orchards are run on a full-time basis, and five on a part-time. Three orchards pack and market their own fruit.

Uncontrolled breeding sites. One part-time orchard does not receive regular bait sprays.

Population of urban areas. Approx 300 persons live in Burekup town.

Shortest distance from an orchard to an urban area. Two growers are 1 km from the town, the rest are 3-5 km from town.

Support of urban population for fruit fly management. No particular support and no town baiting scheme at present.

Current control program. On citrus orchards: bait sprays and fruit hygiene. On plums: cover sprays as required.

Current trapping program. The WA Dept of Ag has maintained 39 Lynfield traps in the district for the past 4 years.

Current trapping results. The current control program produces a trap count (in general terms) of: June to September - very low; October to December - moderate; January to March - high; April to May - low.
The trap count categories are: very low: <2, low: 3-5 ; moderate: 6-10; high: 11-20; very high: >20 Medfly/trap/week.

Current access for citrus to fruit fly sensitive markets. Nil.

Target markets using AWM. New South Wales, Asia.

Other benefits of AWM. Further reduction in fruit infestation may be possible.

Support & funding for AWM trials. Dardanup Shire Council is considering promoting town baiting to encourage fruit production in the area.
The citrus council of the WA Fruit Growers Association is supportive of a trial in the Collie River area.

Local FF management committee. There is currently no local committee.

Local pest consultant. Brian Shervington conducts pest monitoring on grapes etc at Donnybrook.

Dept of Ag support. Drs Francis De Lima and Sonya Broughton from South Perth currently provide research and trapping services to the district. Gavin

Foord provides extension services to all WA citrus growers. Alec McCarthy, the citrus project manager is located at Bunbury.

Evaluation as a pilot area for AWM

Climate and other factors reduce the fruit fly population for at least some time. Low temperature reduces fruit fly population in winter and provides a good start for maintaining low population in the rest of the year.

Major crop is harvested when fruit fly infestation rate is low. Harvesting of Imperial mandarin and some lemons occurs from June to August followed by Murcott mandarins from August to November when the fruit fly population is starting to build up. Navels are harvested from September to November, Valencias are harvested from November onwards, when the fruit fly population is at its highest. Grapefruit is harvested from August to March.

Major crop has low inherent susceptibility to fruit fly infestation. Citrus fruit have a moderate susceptibility to fruit fly infestation, except for lemons that have a very low susceptibility. Citrus trees have a high attractiveness as shelter for fruit flies, which may assist in control with bait sprays.

Few uncontrolled sites of fruit fly breeding. There are some uncontrolled sites such as untreated orchards, urban areas and feral hosts in the Collie River area. Stone fruit orchards (plums, apricots) may be a risk.

Benefit to District from AWM of fruit flies. No current market access is based on AWM of fruit flies and there is a low likelihood of that being achieved in the near future, as reciprocal access between interstate markets on the basis of AWM for fruit flies may be counter-productive to the interests of WA citrus growers. Improved AWM of fruit flies would have the benefit of achieving good Medfly control without disrupting the integrated management of other citrus pests.

Reliability of the AWM system in meeting future market access conditions. The AWM system is based on the low fruit fly population that develops in winter being kept low into summer by the applied treatments of bait sprays. The reliability of this system is likely to be moderate.

Benefit to national knowledge on AWM Good experience will be obtained on establishing and operating an AWM system involving several growers, a local council and a town. This will be of benefit to all districts. Knowledge gained on an AWM system for Medfly on citrus may be applicable to other districts in Western Australia. Negotiations with domestic and export quarantine authorities may or may not eventuate.

13.7 Batlow, NSW – apples

District information

Fruit fly pest species. Qfly.

Location of the production area. The town of Batlow is approx 100 km west-south-west of Canberra, and 23 km south of Tumut, near the north-west corner of the Kosciuszko National Park. The orchards are mainly located within 10 km of the town.

Climate. Warm summers and cold winters with several frosts. Annual rainfall is 1300 mm, with a distinct winter peak.

Topography. The district has a high elevation, with the town of Batlow at 775 metres and most orchards on slightly more elevated areas of the plateau. The orchards are planted on well-drained basaltic soils.

Fruit crops in size order. Apples, stone fruit.

Industry structure. The Batlow Fruit Cooperative Ltd is by far the biggest packer, but there are three moderate sized private fruit packers, two of apples and one of stone fruit.

Uncontrolled breeding sites. There are several neglected orchards and some with an orchard hygiene problem.

Population of urban areas. Approx 1100 persons live in the town of Batlow.

Shortest distance from an orchard to an urban area. Some orchards are immediately adjacent to residential areas and most orchards are within 10 km of the town.

Support of urban population for fruit fly management. The Shire Council would be prepared to bait spray in Batlow if it is warranted. There is expected to be a moderate level of support from urban residents for area-wide management because of their close connection with the fruit industry.

Current control program. Specific orchard treatments for fruit fly are not usually applied to apples at Batlow as the fruit are able to meet market requirements in Sydney and other non-fruit fly quarantine markets. Low spring temperatures and sprays applied for other pests such as codling moth provide moderate control of fruit fly.

Current trapping program. The NSW Dept of Ag has maintained an array of approx 60 traps spread through urban and orchard areas from Gundagai to Tumbarumba with 10 in the Batlow district. This program ceased in April 2001.

Current trapping results. Recent trapping data has not been written up, so the date of the first outbreak each year (5 flies within 1 km within 14 days) is not available. The 1990 to 1995 data shows no flies trapped in the Batlow district over that period, although some have been trapped in recent years.

Current access for apples to fruit fly sensitive markets. Apples have access to interstate markets such as Victoria, after a post-harvest cold storage treatment under ICA-7 (Cold Storage). Untreated apples may be taken, under secure transport arrangements, into Victoria for a cold treatment, provided the orchard at Batlow has been monitored for fruit fly and treated if required under a Victorian Compliance Agreement procedure.

Target markets for apples using AWM. Victoria and South Australia. The Batlow Coop is not seeking export markets as there is strong domestic demand for all its production.

Other benefits of AWM. None.

Support & funding for AWM trials. The shire council has not been approached for support. The Batlow Cooperative is considering conducting a small trapping program at its own expense, starting in the current season.

Local FF management committee. A committee of growers, Dept of Ag and the Councils could be established.

Local pest consultant. The Cooperative provides a local pest monitoring service on a fee-for-service basis.

Dept of Ag support. Peter Treloar at Tumut has provided a fruit fly trapping service to the district up to 2001. Extension support is provided by Julie Brien, District Horticuturist, Tumut.

Evaluation as a pilot area for AWM

Climate and other factors reduce the fruit fly population for at least some time. Low temperatures reduce the fruit fly population in winter to very low numbers and perhaps to nil in very cold years. This provides a good start for maintaining a low population during the cool spring months. Because of its remoteness, there is a low risk of infested fruit being brought in by travellers and commercial fruit suppliers.

Major crop is harvested when fruit fly infestation rate is low. Harvesting of apples occurs in autumn when the fruit fly population may be increasing.

Major crop has low inherent susceptibility to fruit fly infestation.
Apples have a low to moderate susceptibility which may be influenced by cultivar and condition of the fruit.

Few uncontrolled sites of fruit fly breeding. There is a moderate level of uncontrolled sites including untreated orchards, and urban areas in Batlow.

Benefit to District from AWM of fruit flies. Obtaining market access to Victoria for early season apples and access to export markets would be only a moderate advantage to Batlow growers because of the strong demand from their existing domestic markets. AWM would have the benefit of achieving

good fruit fly control without disrupting the integrated management of other fruit pests.

Reliability of the AWM system in meeting future market access conditions. An AWM system in the Batlow district would be based on the natural effect of low temperatures in reducing the fruit fly population in winter and maintaining it low in the rest of the year. The district is not prone to re-infestation from outside the district. This system should have a high reliability.

Benefit to national knowledge on AWM Useful experience will be obtained on establishing and operating an AWM system involving many growers, a local council and a town which will be of benefit to other districts. Knowledge gained on an AWM system for deciduous fruits may be applicable to other districts such as Orange, Tumut and Young. Negotiations with domestic quarantine authorities will provide information on the issues to be considered in developing other AWM systems.

13.8 Tumut, NSW – stone fruit

District information

Fruit fly pest species. Qfly.

Location of the production area. The town of Tumut is approx 90 km west of Canberra, near the north-west corner of the Kosciuszko National Park. The district's orchards are mainly located within 15 km of the town.

Climate. Warm summers and cold winters with numerous frosts. Average annual rainfall is 900 mm with a slight winter peak.

Topography. The town of Tumut is on the banks of the Tumut River at an elevation of 290 metres Most orchards are in the valley which is surrounded by hills and ranges.

Fruit crops in size order. Peaches, nectarines, plums and apples.

Industry structure. There are approx 12 growers, some with orchards at Batlow also. They pack and market their own fruit.

Uncontrolled breeding sites. A large stone fruit orchard (part of Tumut River Farms) has 20 ha of neglected plums. The peach and nectarine blocks are currently managed by a lessee but the plums are uncontrolled. There are some uncontrolled fruit trees in home gardens.

Population of urban areas. Approx 6,300 persons live in Tumut town, and 12,500 in the Tumut Shire.

Shortest distance from an orchard to an urban area. Some orchards are immediately adjacent to residential areas.

Support of urban population for fruit fly management. The Tumut Shire Council is prepared to bait street trees in the town. There is moderate support from town residents.

Current control program. Until two years ago, the Shire Council conducted bait spraying on street trees in the town with financial support from growers, and preparations are being made to resume. Growers need to apply bait sprays and cover sprays to stone fruit orchards to produce a saleable crop.

Current trapping program. The NSW Dept of Ag has maintained an array of approx 60 traps spread through urban and orchard areas from Gundagai to Tumbarumba with 10 in Tumut town and 2 at Tumut Plains. This program ceased in April 2001.

Current trapping results. Recent trapping data has not been written up, so the date of the first outbreak each year (5 flies within 1 km within 14 days) is not available. The 1990 to 1995 data shows a low population in the Tumut district with the first flies trapped in February.

Current access to fruit fly sensitive markets. Post-harvest dipping of stone fruit and cold storage treatment of apples are used for market access to Victoria.

Target markets using AWM. Victoria, South Australia, Western Australia, and Tasmania.

Other benefits of AWM. Reduction in fruit infestation for non-fruit fly sensitive markets.

Support & funding for AWM trials. Tumut Shire Council and growers have provided funds for town baiting in the past.

Local FF management committee. A committee of growers, Dept of Ag and the Shire Council has been planned.

Local pest consultant. There is no pest monitoring service.

Dept of Ag support. Peter Treloar at Tumut has provided a fruit fly trapping service to the district up until 2001. Extension services are provided by Julie Brien, District Horticulturist, and entomology R&D is provided from Orange.

Evaluation as a pilot area for AWM

Climate and other factors reduce the fruit fly population for at least some time. Low temperatures can reduce the fruit fly population in winter to very low numbers. This provides a good start for maintaining a low population during the cool spring months. However infested fruit brought in by travellers and commercial fruit suppliers may introduce fruit flies that increase the rate of build-up after winter.

Major crop is harvested when fruit fly infestation rate is low. Harvesting of stone fruit occurs in summer when the fruit fly population is highest.

Major crop has low inherent susceptibility to fruit fly infestation. Stone fruit have a high susceptibility to fruit fly infestation.

Few uncontrolled sites of fruit fly breeding. There is a moderate level of uncontrolled sites, including untreated orchards (provided the current level of management of the Tumut River Farms continues), urban areas and feral hosts in the Tumut district.

Benefit to District from AWM of fruit flies. Obtaining market access to interstate markets on the basis of AWM is important to Tumut stone fruit growers because of the size of those markets. AWM would also have the benefit of achieving good fly control without disrupting the integrated management of other fruit pests.

Reliability of the AWM system in meeting future market access conditions. An AWM system for the Tumut district would be based on the effect of low temperatures in reducing the fruit fly population in the whole district in winter. The population would then need to be kept below the outbreak declaration level through summer until the end of the stone fruit season. This would be difficult to achieve reliably, even with a program of bait sprays and a quarantine on the entry of infested fruit. These improvements would require further research.

Benefit to national knowledge on AWM. Useful experience will be obtained on establishing and operating an AWM system involving several growers, a local council and a moderate urban area which will be of benefit to other districts. Knowledge gained on an AWM system for deciduous fruits may be directly applicable to other districts such as Batlow, Orange and Young. Negotiations with domestic quarantine authorities will provide information on the issues to be considered in developing other AWM systems.

13.9 Serpentine, WA – citrus

District information

Fruit fly pest species. Medfly.

Location of the production area. The candidate district centres on a single isolated orchard with 14 ha of fruit trees on Scarp Rd, Serpentine, which is approx 50 km south of Perth. The citrus committee of the WA Fruit Growers Association prefers this location for future research on Medfly management.

Climate. Hot, dry summers; cool, wet winters with a few frosts.

Topography. The orchard is in a small valley in the Darling Ranges escarpment. It is bounded by the Serpentine Falls National Park to the north, state forest to the east and south, and grazing land to the west.

Fruit crops in size order. Citrus: Valencia and Navel oranges, lemon, Imperial mandarin, Marsh grapefruit. Stone fruit: plums.

Industry structure. A single orchard, the property of Geoffrey Fawcett, grower and packer. Fruit is also occasionally packed for other commercial orchardists.

Uncontrolled breeding sites. No nearby breeding sites are known, but Medfly has become a greater problem in the orchard in recent years.

Population of urban areas. Serpentine has approx 1000 residents.

Shortest distance from an orchard to an urban area. Serpentine town is approx 10 km from the orchard. Karnet prison farm is 3 km east, and an orchard with 30 citrus and 200 stonefruit trees is 3 km south

Support of urban population for fruit fly management. No particular support.

Current control program. A bait spray is applied from mid October, weekly to mid June, then fortnightly to rest of year, subject to weather.

Current trapping program. The WA Dept of Ag has maintained 8 traps in the orchard for the past 7 years.

Current trapping results. The current control program produces a trap count (in general terms) of: June to October - very low; November to December - moderate; January to March - high, but depends on seasonal conditions; April to May - moderate. The trap count categories are: very low: <2; low: 3-5; moderate: 6-10; high: 11-20; very high: >20 Medfly/trap/week.

Current access for citrus to fruit fly sensitive markets. Nil.

Target markets using AWM. New South Wales. Any overseas market that is profitable.

Other benefits of AWM. Reduced infestation and resulting crop loss of late-harvested Valencias.

Support & funding for AWM trials. The Citrus Council of the WA Fruit Growers Association has indicated its preference for this orchard for future research on fruit fly management.

Local FF management committee. None proposed.

Local pest consultant. No local pest monitoring consultant.

Dept of Ag support. Drs Francis De Lima and Sonya Broughton from South Perth currently provide research and trapping assistance to the orchard.

Gavin Foord provides extension services to all WA citrus growers. Alec McCarthy, the citrus project manager is located at Bunbury.

Evaluation as a pilot area for AWM

Climate and other factors reduce the fruit fly population for at least some time. Low temperature reduces fruit fly population in winter and provides a good start for maintaining a low population during the rest of the year.

Major crop is harvested when fruit fly infestation rate is low. Harvesting of Imperial mandarin and some lemons occurs from June to August. Grapefruit are harvested from September to December and Navels from August to November when the fruit fly population is starting to build up. The main crop of Valencia is harvested from January to May on this orchard, when the fruit fly population is at its highest.

Major crop has low inherent susceptibility to fruit fly infestation. Citrus fruit have a moderate susceptibility to fruit fly infestation, except for lemons that have a very low susceptibility to infestation. Citrus trees have a high attractiveness to shelter fruit flies which may assist control with bait sprays.

Few uncontrolled sites of fruit fly breeding. There are few uncontrolled sites such as untreated orchards, urban areas, feral hosts and native hosts in close proximity to the Fawcett orchard.

Benefit to District from AWM of fruit flies. No current market access is based on AWM of fruit flies and there is a low likelihood of that being achieved in the near future, as reciprocal access between interstate markets on the basis of AWM for fruit flies may be counter-productive to the interests of WA citrus growers. Improved AWM of fruit flies would have the benefit of achieving satisfactory Medfly control without disrupting the integrated management of other citrus pests.

Reliability of the AWM system in meeting future market access conditions. The AWM system is based on the low fruit fly population that develops in winter being kept low into summer by the applied treatments of bait sprays. The reliability of this system is likely to be moderate.

Benefit to national knowledge on AWM Little experience will be obtained on establishing and operating an AWM system involving several growers, local councils and urban areas. Knowledge gained on an AWM system for Medfly on citrus may be applicable to other districts in Western Australia. Negotiations with domestic and export quarantine authorities may or may not eventuate.

14. Appendix 2. SUMMARY FOR USE IN AN INDUSTRY MAGAZINE

The Future for Area-wide Management of Fruit Fly

How can AusHort best facilitate the implementation of Area-wide Management (AWM) of fruit flies? This is one of the questions the AusHort R&D Committee has been asking, to ensure that the maximum benefit will be obtained from future funding in this area.

The committee recognises that it needs to take a strategic planning approach in awarding funding for pre-harvest fruit fly management. To do this it needs to understand the benefits and problems of AWM, and the issues affecting its use in market access.

In particular, what research is most likely to improve the effectiveness of AWM systems, and which districts are most likely to establish viable AWM schemes that will provide information of maximum benefit to the Australian horticultural industry.

To obtain answers to these questions, Horticulture Australia Ltd commissioned a feasibility study of AWM. AusHort is currently considering the report from the consultant, Keith Jorgensen.

AWM offers several advantages over the common method of controlling fruit fly that involves repeated sprays of wide spectrum systemic insecticides. AWM allows fruit fly to be controlled with minimum use of insecticides, so that the parasites and predators of other pests are not significantly affected. This allows growers to use IPM methods to control all their fruit pests.

AWM also allows growers to produce their fruit with minimal release of pesticides into the environment and with minimum residues in their fruit. This increases market demand and satisfies community concerns.

What does area-wide management involve? AWM is a system for managing the fruit fly population in an area so that economic damage from the pest is reduced. It makes full use of natural control factors such as low temperatures and low host susceptibility to infestation, as well as applied control measures such as bait sprays. A system can be considered area-wide if it applies to several orchards in an area, or includes at least one control measure that is applied outside the crop area.

What research is needed? The male annihilation technique is a promising control measure for some species, but it needs to be investigated to determine the best methods of applying it, and to measure how effective it is in controlling Qfly and Medfly. It may then be included in new AWM systems.

The relation between winter temperatures and egg laying also needs modelling and possibly further research. This will allow predictions to be

made of the likely fruit infestation rate in winter, and the population growth rate in winter in districts that are marginal for fruit fly breeding.

Which districts are the most suitable for establishing an AWM scheme? The consultant investigated nine districts in New South Wales, Western Australia and Queensland. The top five districts identified are: Central Burnett (citrus), Corindi, near Coffs Harbour (blueberries), Young (cherries), Narromine (citrus), and Orange (cherries).

This ranking was based on their suitability for establishing a successful AWM scheme and on the national benefit to be gained from establishing that scheme. However, the real level of support for possible AWM schemes from growers, the local community and government could not be measured at this early stage.

Mr Jorgensen therefore recommended that the AusHort R&D committee should invite growers interested in establishing a new or improved AWM scheme in these or any other district to apply for seed funding. Their application should include evidence of thorough planning and of the commitment by growers and other stakeholders to support their plan. The selection of the district to receive the implementation funding should take into consideration the planning and commitment, as well as the suitability of the district for an AWM scheme and for receiving national funding.

The consultant's report contains considerable information to assist growers interested in planning an AWM scheme. It includes comments on the factors involved in the success of a scheme and its acceptance for market access, the steps in planning and establishing an AWM scheme, and a very complete list of the natural and applied components that can be included.

15. Appendix 3. PERSONS INTERVIEWED

Researchers on fruit fly in the state departments

Queensland
Ed Hamacek, Indooroopilly
Dr Annice Lloyd, Indooroopilly
Dan Smith, Nambour
New South Wales
Andrew Jessup, Gosford
John Macdonald, Orange
Western Australia.
Dr Sonya Broughton, South Perth
Dr Francis De Lima, South Perth

Researchers on fruit fly in other organisations

Griffith University
Prof Dick Drew
University of Queensland
Prof Bill Kitching (by telephone)

University of Sydney
Dr Alan Clift
Dr Alfie Meats
Merryl Robson
US Dept of Agriculture
Dr Bob Mangan (by e-mail)

Plant protection consultants in fruit fly management

Cecily Draper, Crop Protection Specialist, Golden Mile Orchard, Mundubbera
Brian Gallagher, Director, Citrus Monitoring Services P/L, Gayndah
John Owen-Turner, Horticultural Consultant, Burrum Heads
Dan Papacek, Director, Integrated Pest Management P/L, Mundubbera
Malcolm Wallis, Citrus IPM consultant, Mundubbera

State representatives on IPHRWG

New South Wales
Doug Hocking (by telephone)
Victoria
Dr Pat Sharkey, Knoxfield
South Australia
David Cartwright, Lenswood
Tasmania
Danny Reardon, Hobart
Western Australia
Rowland Gwynne (by telephone)

Staff involved with fruit fly eradication

New South Wales
Bernie Dominiak, Orange
Bob Paton, Orange
Nigel Phillips, Wagga Wagga
Victoria
Richard Gardiner, Melbourne
Western Australia
Bill Woods, South Perth

Staff involved with research, extension and regulation

Queensland
John Chapman, Nambour (by telephone)
New South Wales
Dr Colin Bower, Orange
Delia Dray, Orange
Colin Foster, Orange
Richard Walker, Orange
Dr Philip Wright, Orange
Western Australia
Gavin Foord, Citrus Industry Development Officer

Staff involved with export quarantine matters

AQIS
Drue Edwards, Canberra
David Letham, Canberra
Brian Tucker, Canberra
Biosecurity Australia
Rob Duthie, Canberra
Dr Adrian Harris, Canberra
Dr T K Lim, Canberra
Carol Quashie-Williams, Canberra
Office of the Chief Plant Protection Officer
Dr Mike Cole, Canberra
Dr Paul Pheloung, Canberra

Persons involved in export marketing

Kevin Baddiley, AAPGA, Hobart
Andrew Green, Exec Officer, Citrus Board of SA, Adelaide
David Minnis, 888 exports, Melbourne

Persons involved in candidate districts

Young, NSW
Michael Batinich, Grower
Geoff Cartwright, Young Fruitgrowers Cool Stores
Geoff Clark, Grower
Scott Coupland, Grower, NSW Cherry Growers
Brett Dalliston, Regulatory Officer, NSW Ag
Anthony Hill, Young Shire Council
Garry Inwood, Young Shire Council
Chris Manchester, Mayor, Hardon Shire
Sue Marle, Dist Horticulturist, NSW Ag
John Walker, Mayor, Young Shire
Orange, NSW
David Gartrell, Chairman, Appledale Processors Coop, Orange
Tim Hall, Chairman, Towac Fruit Export Coop
Tumut and Batlow NSW
Darrell Ashton, Grower
Johnson Bowden, Grower
Loren Curtis, Grower
Peter Ellison, Tumut Shire Council
Brett Livermore, Tumbarumba Shire Council
Danny O'Sullivan, Grower
Peter Treloar, Regulatory Officer, NSW Ag
Corindi, NSW
Gary Wright, Farm Manager, BFA
Central Burnett, Qld
Chris Benham, Grower, Mundubbera
John Bowen, Ranger, Gayndah Sire Council
Billie-Jea Jacobs, Weeds Officer, Mundubbera Shire Council
Allen Jenkin, Grower, Mundubbera

Craig Meyer, Grower, Mundubbera
Doug McIvor, Mayor, Mundubbera Shire
Frank Robinson, Grower, Gayndah
Ian Shepherd, Grower, Gayndah
Andrew Tebbit, Crop Supervisor, Golden Mile Orchard, Mundubbera
Peter Trott, Grower, Mundubbera
Darrell Wallis, Chairman, Central Burnett Horticulture Committee, Mundubbera (by telephone)
Peter Wishart, Extension Officer, QDPI, Gayndah

Narromine, NSW

Maryanne Bower, Narromine Shire Council
Trevor Clark, Grower, Narromine
Marty Havercroft, Mayor, Narromine Shire
Tom McKeon, Grower, Narromine
Ruth Mitchell, Narromine Shire Council
Allan Sly, Weeds Officer, Narromine Shire Council
Chris Walsh, Weeds Officer, Narromine Shire Council

Collie River and Serpentine, WA

Greg Beales, Chairman, Citrus Committee, WAFGA
Geoffrey Fawcett, Grower, Serpentine
Steve Foster, Grower, Swan Valley
Robert McEwan, Executive Officer WAFGA, Perth
Peter Tomasovich, Grower, Swan Valley

16. Acknowledgements

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