INTEGRATED FRUIT PRODUCTION IN THE NEW ZEALAND PIPFRUIT INDUSTRY.

by

Jonathan W. Wiltshire

A report written for the Primary Industry Council/Kellogg Rural Leadership Programme, 2003.

EXECUTIVE SUMMARY

The Integrated Fruit Production (IFP) programme for pipfruit began in New Zealand in 1996 and by 2001, 100% of export fruit was being produced under IFP. New Zealand IFP guidelines were developed from IOBC principles and matched carefully to local production conditions. The rapid rate of implementing the guidelines was largely attributable to the industry's strong reliance on export markets and the legislated single seller status operating at the time. The implementation of IFP has lead to a 95% reduction in the use of organophosphate insecticides, and a 50% reduction in overall insecticide use. The use of dithiocarbamate fungicides that are disruptive to integrated mite control programmes has been reduced by 50%, and there has been a considerable reduction in the use of residual herbicides. This report looks briefly at the history of IFP and describes both the process of implementation and benefits achieved from the introduction of IFP to the New Zealand pipfruit industry.

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INTRODUCTION

The New Zealand pipfruit industry has a total production of about 525,000 tonnes; of which 320,000 tonnes is exported, 130-150,000 tonnes is processed into juice and other products, leaving 55-75,000 tonnes being sold as fresh fruit on the domestic market (Figure 1). The vast majority of production is aimed at export; domestic market produce is generally a ‘by-product’ of this process. These figures show the strong emphasis on exported product, and as such the need to respond to international market demands. Prior to export deregulation in October 2001, the pipfruit industry had operated under an export monopoly, held by firstly the New Zealand Apple and Pear Marketing Board and latterly ENZA Ltd - a grower owned company. The 2002 selling season saw about 90 exporters of various sizes operating. Traditionally, the phytosanitary requirements of export markets determined crop husbandry practices, and crop protection was aimed at achieving the highest import standard in order that product was acceptable to for all markets.

IFP has been defined by the International Organisation for Biological Control (IOBC) as IFP “.... the economical production of high quality fruit, giving priority to ecologically safer methods, minimising the undesirable side effects and use of agrochemicals, to enhance the safeguards to the environment and human health”. Integrated Fruit Production (IFP) is a production system in which growers have a set of guidelines to follow. Growers monitor all aspects of the production cycle against these guidelines and use thresholds to respond to the findings in accordance with recommended practices. The guidelines influence virtually all the management decisions within the production system with the desired outcome of economic and environmentally sustainable production of safe food.

IFP has evolved from the system of Integrated Pest Management (IPM). This evolution has seen IFP go beyond the emphasis of pest management as seen in IPM, and take a more holistic view of the fruit production process.

The New Zealand Kiwifruit Marketing Board (now Zespri International Ltd) was first to introduce IFP to New Zealand. It was introduced in 1991 in response to spray residues being found on New Zealand Kiwifruit. Although these residues did not exceed European Union guidelines, the presence of residues was used by competitive suppliers to gain market share (Bull 1993). It began as an IPM programme (named ‘Kiwigreen’) and in the late 1990’s broadened to encompass all the principles of IFP and was renamed ZESPRI™GREEN.

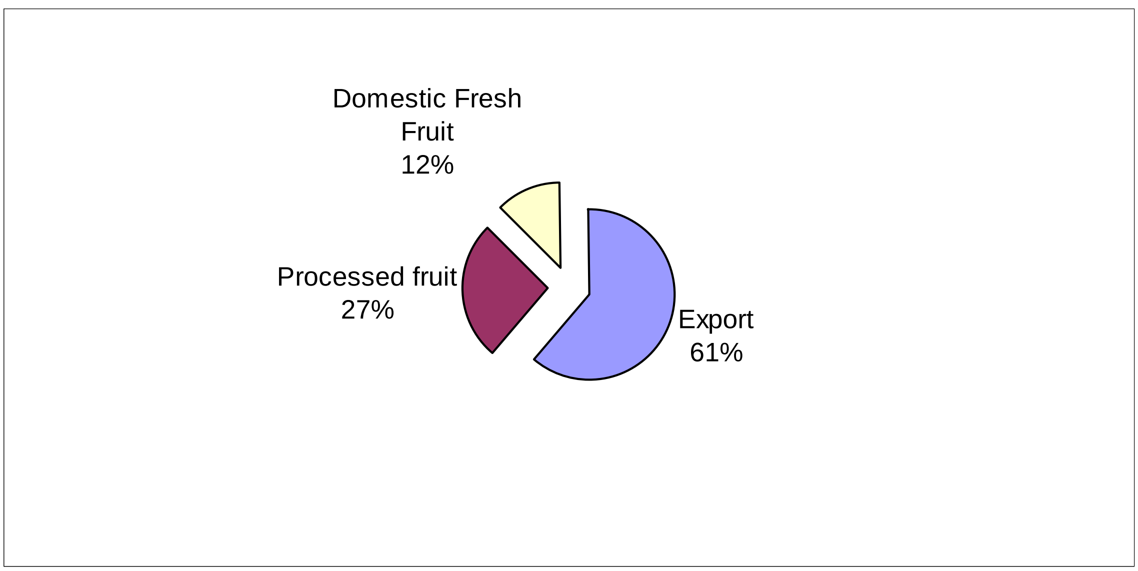
IFP was introduced to the New Zealand pipfruit industry in 1996 and by 2001 all export production was carried out following IFP guidelines. No other country has achieved such rapid uptake of IFP to such a level by industry sectors. Throughout the introductory period and since, there has been no attempt to educate the public at large as to the advantages for consumers and the environment that IFP has delivered.

The purpose of this report is to bring together information that will give those who are not involved in New Zealand pipfruit industry a better understanding of the concepts of IFP and the outcomes that have been achieved to date. This report will investigate the history of IFP, the adoption of IFP in the New Zealand pipfruit industry, a comparison with other countries, the principles of NZPIPFRUIT-IFP, and what benefits have been delivered by the adoption of IFP.

IFP programmes in other fruit industries and/or countries operate on similar principles to that of IFP in the New Zealand pipfruit industry. However the 'mechanics' of delivery and the outcomes can be quite different, therefore any comparisons between countries in this report have been limited to uptake of IFP programmes.

I would like to acknowledge the considerable assistance given by James T.S. Walker (Jim Walker) of The Horticultural and Food Research Institute of New Zealand Ltd in the preparation of this report.

Figure 1. Sales destination of New Zealand pipfruit 2003



The History of Integrated Fruit Production (IFP)

IFP has evolved from production systems known as either Integrated Pest Management (IPM) or Integrated Plant Protection (IPP). IPM emerged in 1959 with the introduction of concepts of economic thresholds, economic levels and integrated control by V.M. Stern, R.F. Smith, R. van den Bosch and K.S. Hagen. The introduction of these concepts by Stern *et al* occurred following centuries of man manipulating plant pests and diseases using cultural, biological, physical and chemical control. The term Integrated Pest Management was introduced in 1967 by R.F Smith and R. van den Bosch.

There are some notable points on the historic timeline of pest management (Dent D.R.).

- 2500 BC — First records of insecticides e.g. the Sumerians were using sulphur compounds to control insects and mites.
- 200 BC — The Roman, Cato the Censor advocated oil sprays for pest control.
- 300 AD — First record of the use of biological controls (predatory ants) in citrus orchards in China. Colonies of the predatory ants were set up with bamboo bridges between trees to control caterpillar and beetle pests.
- 1000-1300 — Date growers in Arabia seasonally transported cultures ofpredatory ants from nearby mountains to oases to controlphytophagous ants that attack date palms. First known example of movement by man of natural enemies for the purpose of biological control.
- 1750-1880 — Agricultural revolution in Europe. Crop protection became more extensive and international trade promoted the discovery of the botanical insecticides pyrethrum and derris.
- 1880 — First commercial spraying machine.
- 1890's — Introduction of lead arsenate for insect control.
- 1896 — First selective herbicide, iron sulphate, was found to kill broad leaf weeds.
- 1899-1909 — Breeding programme that developed varieties of cotton, cowpeas water melon resistant to Fusarium wilt.
- 1930 — Introduction of synthetic organic compounds for plant pathogen control.
- 1950's-60's — Widespread development of resistance to DDT and other pesticides
- 1959 — Introduction of concepts of economic thresholds, economic levels and integrated control by V.M. Stern, R.F Smith, R. van den Boschand K.S. Hagen.

- 1960 First insect sex pheromone isolated, identified and synthesis in the gypsy moth.
- 1962 Publication of "Silent Spring" by Rachel Carson.
- 1963 K.E.F. Watt introduced systems science to pest management.
- 1967 Introduction of the term Integrated Pest Management by R.F. Smith and R. van den Bosch.
- 1986-1987 Germany, Indonesia, Philippines, Denmark and Sweden all make IPM official policy.
- 1993 Greater than 504 insect species are known to be resistant to at least one formulation of insecticide and at least 17 species of insect are resistant to all major classes of insecticide. 150 fungi and other plant pathogens are resistant and several plant pathogens are resistant to nearly all systemic fungicides used against them. Five kinds of rats are known to resistant to the chemicals used against them. Resistance to herbicides has been documented in over 100 weed biotypes and 84 species (Cate and Hinkle 1994).

The underlying principles and concepts of IFP originated in IPP/IPM in western Europe in the late 1950's but did not experience much growth until the late 1980's (Dickler and Schäfermeyer, 1991). It was around this time that the International Organisation for Biological Control (IOBC) developed their definition of IFP.

The South Tyrol region of Italy is acknowledged as having first introduced a widespread IFP programme for pipfruit. This programme is considered to have largely influenced the development of other programmes throughout pipfruit growing regions of the world. IFP programmes for the production of pipfruit now exist in all of the major producing nations of the world.

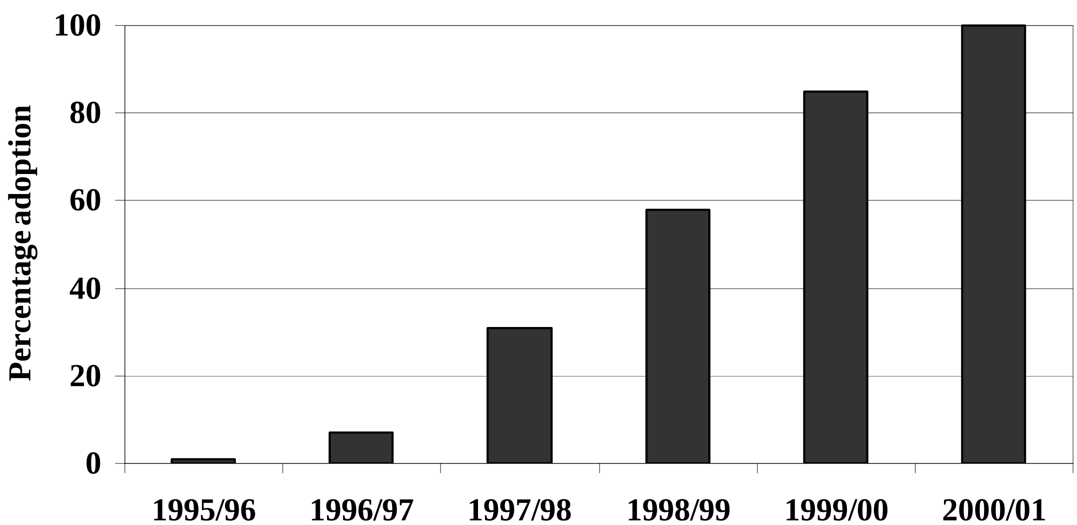
IFP has taken the concepts developed in IPM/IPP past the point of simple pest management and takes a holistic view of the entire production system. It should be noted that there is a wide variance between counties and regions in both the extent of the production system covered and the descriptive nature of guidelines. It is therefore not possible to state that the effects and outputs of all IFP programmes will deliver the same result. Some IFP programmes are limited to pest and diseases guidelines, whereas others extend to site selection, rootstock/variety selection, soil water management, nutritional management, and under-storey sward management.

IFP IN THE NEW ZEALAND PIPFRUIT INDUSTRY

Adoption of IFP

IFP was introduced to the New Zealand pipfruit industry in 1996 by ENZA. It was introduced in response to demands placed on ENZA by United Kingdom supermarkets that requested fruit should be produced using an IFP programme. These requests were the catalyst for the urgent development of an IFP programme which would match New Zealand's growing conditions. There was initial reluctance from growers to adopt what was seen as an expensive high-risk programme. Growers had become accustomed to a programme of low-cost, 'old chemistry' insecticides and fungicides, however the uptake of IFP grew rapidly as growers were made aware of the benefits and successes (Figure 2).

Figure 2. The rate of adoption of IFP by New Zealand Pipfruit industry.



Development of the IFP Programme

Development of an IFP programme for pipfruit commenced in 1995 with the establishment of a national IFP-Pipfruit Committee. The programme principles were based on European IOBC guidelines and IFP was defined for New Zealand pipfruit as: "The economic production of market quality fruit, giving priority to sustainable methods that maintain consumer confidence and are the safest possible to the environment and human health". The programme was developed as a 'living' document and has continued to be modified as required. A formal structured process was established to develop, analyse and report progress. ENZA staff provided leadership of a committee (Figure 3) that included technical experts, growers, consultants, consumers, the environment, and the agrichemical industry (Batchelor *et al*. 1997).

The first draft of the NZ Pipfruit IFP Manual was prepared in early 1996 by a small team of ENZA personnel and scientists under the leadership of a newly formed NZ Pipfruit IFP Committee. The manual initially focused on the key crop protection issues but 15 technical sub-committees were formed covering all aspects of apple production including: pests, diseases, chemical effects database, site selection and rootstocks, tree under-storey, water and soil management, environmental quality, cleaner production, training, extension and regulatory (agrichemical and market access) functions.

These technical sub-committees reviewed European-based IFP guidelines (Avilla 1995) and identified where change appropriate to New Zealand's fruit production practices was required. They each produced guidelines as chapters for the IFP Manual and developed appropriate objectives for change to production practices. Some of these objectives were to:

- eliminate organophosphate (OP) insecticide use
- maximise biological control through the use of selective pest management products
- minimise the use of dithiocarbamate fungicides that were disruptive to European Red Mite and Two-spotted Spider Mite biological control
- develop and use fungicide resistance management strategies
- minimise risks to ground water by eliminating residual herbicide use

Other objectives were developed that related to soil management, water management and environmental quality, but many of these practices were already widely used by growers as part of good orchard management without necessarily being documented. The major focus during the early development phase for New Zealand Pipfruit IFP was strongly driven by the insect, disease and weed management decisions, and the agrochemical issues arising from their control. As the programme developed, other guidelines such as those for water management and soil management were introduced.

Figure 3. The structure and function of the New Zealand Pipfruit IFP programme through the implementation phase in the New Zealand apple industry.

New Zealand Pipfruit Integrated Fruit Production Committee (1996)

Committee Representatives			**Technical Sub-Committees**	
ENZA (Chair)			Pest mgt.	Site and rootstock
HORTRESEARCH			Disease mgt.	Soil mgt./nutrition
Growers	(10)	IFP Standards	Weed mgt.	Water mgt.
Agrochemical	(1)	IFP Manual	Spray Application	Tree & crop mgt.
Environment	(1)	IFP Implementation	Pesticide effects	Environment
Consumer	(1)		Training	Cleaner Prodn.
Consultancy	(1)		Regulatory	Industry Ops.

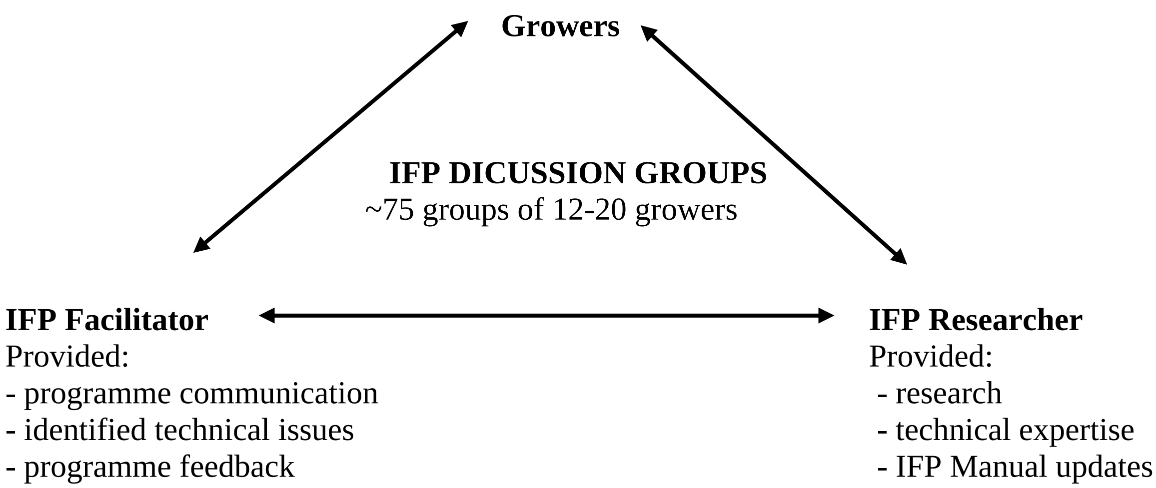
Training and support for IFP

A tripartite model was considered at the outset as the most appropriate method for the communication and introduction of new crop protection practices that were intended to extend industry-wide within a five year time period. Initially consultants were invited to undertake professional training to become IFP facilitators. This consisted of training in discussion group facilitation skills and technical pest and disease management issues.

Discussion groups (Figure 4) formed the basis of the technology transfer model; each facilitator operated 1-3 groups, with each group consisting of 12-20 growers. These groups were required to meet at least 3 times annually but many groups meet more regularly during the initial rollout of IFP.

Facilitators and their discussion groups were supported by extension scientists (entomologists and plant pathologists) who attended at least one of their meetings annually. Any issues arising with IFP recommendations could also be directed to supporting scientists who supplied comprehensive information (Email) back to all facilitators who in turn relayed the question and response to growers (Email or fax) in all of the discussion groups. Growers were paid to belong to discussion groups and most enjoyed this form of contact because it stimulated a broader exchange of ideas between growers and the transfer of technical information. During the maximum period of IFP adoption (1999-2000) there were up to 75 discussion groups operating nationally.

Figure 4. The model for technology transfer during the implementation of IFP by the New Zealand apple industry.



Industry structure and support for IFP adoption

ENZA played a key role in the industry-wide implementation of IFP in New Zealand. It provided a framework for rapid and widespread adoption of IFP due to market requirements, through financial and logistical support. The significance of the changes being imposed on growers and the timeline for this change required teamwork between many players within the industry.

Fundamental changes to crop protection presented growers with higher risks of lost fruit value while increasing the complexity of ENZA's marketing operation and threatening established industry market access arrangements. These risks were managed on a step-by-step basis with continuous analysis of the success of the IFP recommendations. It required close collaboration between crop protection scientists, a small group of growers operating the pilot IFP programme and ENZA to develop solutions to minimise the risks and maximise the benefits. This required expert knowledge, development of effective and practical methods of pest monitoring and a degree of trust by growers.

The use of industry information helped to reduce the risks and maintain grower confidence throughout the early stages of IFP development. Any loss of confidence during the IFP implementation process by these 'early adopter' growers threatened the wider adoption by more conservative growers who were sceptical of the need for IFP.

ENZA's monopoly over export sales allowed them to signal and implement change but many growers were also eager to move away from OP insecticides and adopt new 'grower friendly' and 'environmentally friendly' fruit production. Growers were paid a small financial incentive of NZ$0.25 per carton for their IFP production that covered the seasonal cost of pest and disease monitoring (~NZ$200/ha). Funding for this came from the pooled returns paid to growers so that once adoption reached 85% the incentive was changed to a $NZ0.75 per carton penalty for non-IFP fruit. This, together with the increasing grower confidence in the IFP recommendations, led to rapid completion of industry-wide adoption by the 2000-01 season.

The most critical point in the IFP programme implementation was the first two seasons when any failure in the relatively untested pest and disease management procedures threatened to destroy grower confidence in the entire programme. ENZA undertook to reduce the risk to growers by targeting and segregating fruit both in the orchard and in the post harvest processes. Mitigating activities included:

- increasing expenditure in IFP crop protection research
- introducing a transitional IFP programme with a lower market access risk
- segregating the IFP crop to manage the market access risks
- developing new post-harvest dis-infestation methods.

To manage these risks during the transitional period towards full IFP production, the national crop was segregated into at least three different pest management programmes. Markets where IFP production was a requirement (e.g. UK and EU) served as the IFP development programme where pest risks could be effectively managed within existing quarantine pest requirements.

Quarantine-sensitive markets (largely USA and Taiwan) were supplied from the low risk, conventional OP-based programme, while variants of the IFP programme were tested and refined to meet these specific market requirements. This involved the development of post-harvest procedures, e.g. modified controlled atmosphere storage regimes and apple washers in packhouses, to reduce the probability of quarantine actionable pests in export fruit.

During IFP implementation, the apple sector could not differentiate conventional and IFP fruit production without creating problems with international customers. If on one hand IFP was 'clean, green and safe' then by default non-IFP fruit must be 'dirty and unsafe'. To reduce this risk ENZA did not identify IFP fruit by either separate branding or packaging materials. As a consequence, the New Zealand apple industry moved progressively and almost unnoticed (both domestically and internationally) to widespread adoption of IFP within 5 years.

Subsequent to deregulation of the industry the programme is administered by a wholly owned subsidiary of Pipfruit Growers New Zealand Inc (PGNZI), New Zealand Pipfruit Ltd, which is a grower-owned company. PGNZI is currently investigating how growers may capitalise on the benefits of IFP in both export and domestic markets.

Agrichemicals and IFP

Two objectives of New Zealand Pipfruit IFP programme were to reduce the use of OP insecticides and to reduce the reliance on dithiocarbamate fungicides, both of which are harmful to Integrated Mite Control (IMC) programmes.

Dithiocarbamates have a negative effect on the population of mite predators. With few drivers for the introduction of new products, the agrichemical industry continued to supply those products which had become the 'backbone' of pest management since the mid 1960's. IFP required the use of selective 'soft' pesticides but in 1996 there was only one selective insecticide available, Mimic (tebufenozide), and few developments in new fungicidal chemistry.

As a monopoly exporter, ENZA was in a position of influence and used its position to target the removal of certain pesticides while encouraging agrichemical companies to register new selective and 'soft' products. All non-selective insecticides, (e.g. organophosphates and carbamates), were marked for removal from the IFP programme as were residual herbicides, due to the risk of contaminating water supplies with their continued use.

Coupled with the reduction in use of dithiocarbamates, more robust resistance management strategies were developed for other fungicides, particularly those shown to be already at risk of resistance development. In an attempt to encourage growers to choose selective and 'soft' products, a points system was developed. It was proposed that a crop should only accumulate a given number of points in a growing season. All pesticides were allocated points, with the 'softest', most selective products having low points attached, and broad spectrum products such as OP's having a high point value (Walker *et al* 1997).

There was opposition to this system from both growers and agrichemical companies. Growers were concerned that accumulated points may be linked to fruit value, as a crop with a high point value might be considered to be less 'clean' and safe than a crop with low accumulated points. Agrichemical companies were concerned that growers would make choices based on small points differences rather than choosing the product most suitable.

Development of Guidelines and a Manual for IFP

The technical sub-committees shown in Figure 3 were set up in 1996 to develop guidelines for each facet of IFP. The initial emphasis was placed on pest and disease monitoring and selective agrichemical use. By 1998, most of the sub-committees had developed their respective chapters for a manual and these were distributed to growers as they became available.

The manual is considered to be a 'living' document, and each section is reviewed annually, taking into account feedback from growers and scientists. Any changes that are needed are drafted, sent out to industry representatives for evaluation, then printed and sent out to all growers. As instigator of the programme, ENZA undertook this process until the industry was deregulated, at which time the programme management was taken over by New Zealand Pipfruit Ltd.

The IFP manual in 2003 includes the following sections as information for growers:

- (A) Pests
- (B) Diseases
- (C) Site, Rootstock, Variety, Planting system and production management
- (D) Soil management
- (E) Water management
- (F) Weed and shelter management
- (G) Spray application technology.

Each section contains minimum IFP requirements, recommended practices, fact sheets and an optional self-audit page. The guidelines for pests are based around pheromone trapping of two major moth pests, visual monitoring of other pests and pest interceptions at packing. Disease guidelines are based around visual monitoring and disease presence at packing. Considerable scientific research has been conducted into the phenology of pests and diseases and other sections are based on on-going research.

In addition to the IFP manual, growers are supplied with an IFP 'pack' each year that includes a wall chart which summarises the IFP manual details and places them in chronological order, an agrichemical export spray wall chart giving pre harvest intervals, a spray application record book and a field notebook for recording monitoring activities.

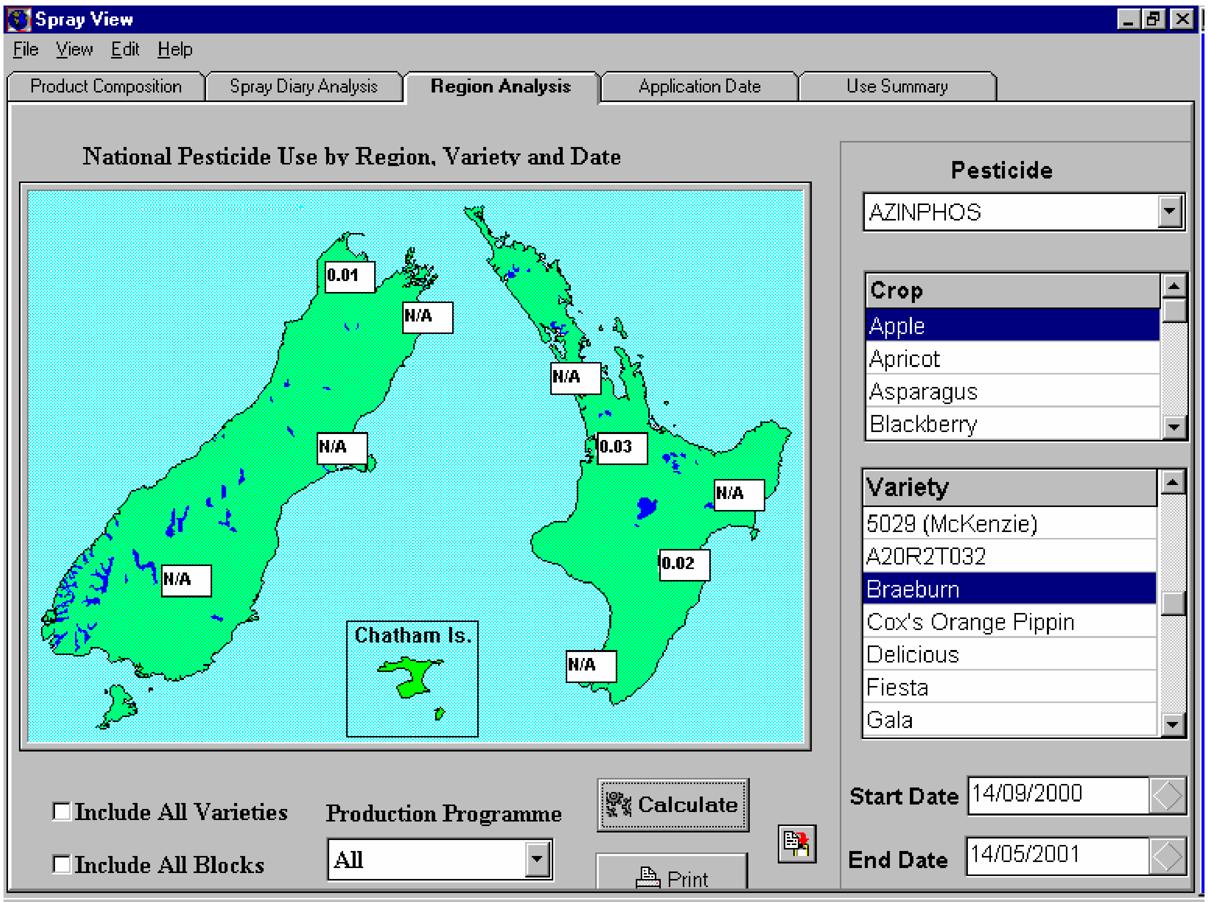
Furthermore, growers are kept informed by e-mail bulletins, newsletters and have access to the New Zealand Pipfruit Ltd website.

The collection of data and its use in refining IFP

For many years, growers have been required to keep detailed records of all spray applications in the form of a diary. This information was collected and analysed by ENZA to ensure grower compliance with legislation relating to registered chemicals and to check adherence to pre-harvest intervals. The use of this and subsequent pipfruit spray diary information (now collected by New Zealand Pipfruit Ltd) was a key tool in the development of the IFP programme (Walker *et al* 2001).

This same information was used to create a database and analysis software as described by Manktelow *et al* (2001). An example of software developed is 'Spray View' (Figure 5). Spray View was developed as a tool to analyse differences in agrichemical use between both growers and regions. It has played a key role in understanding changing chemical use patterns as IFP developed, and, when this information was coupled with data on pest and disease incidence on orchard and in packhouses, an understanding of effectiveness of the IFP programme was gained.

Figure 5. Software developed for analysis of changes in agrochemical use in New Zealand during the transition to IFP, showing the average number of azinphos methyl applications regionally on Braeburn apples in 2000-01.



To ensure that other key information was collected in a standardised format, a field notebook was developed and is distributed to growers each year. This notebook allows for the collection and presentation of pheremone trap-catch data and visual monitoring of pests and diseases in a systematic format for later use in analysis and research.

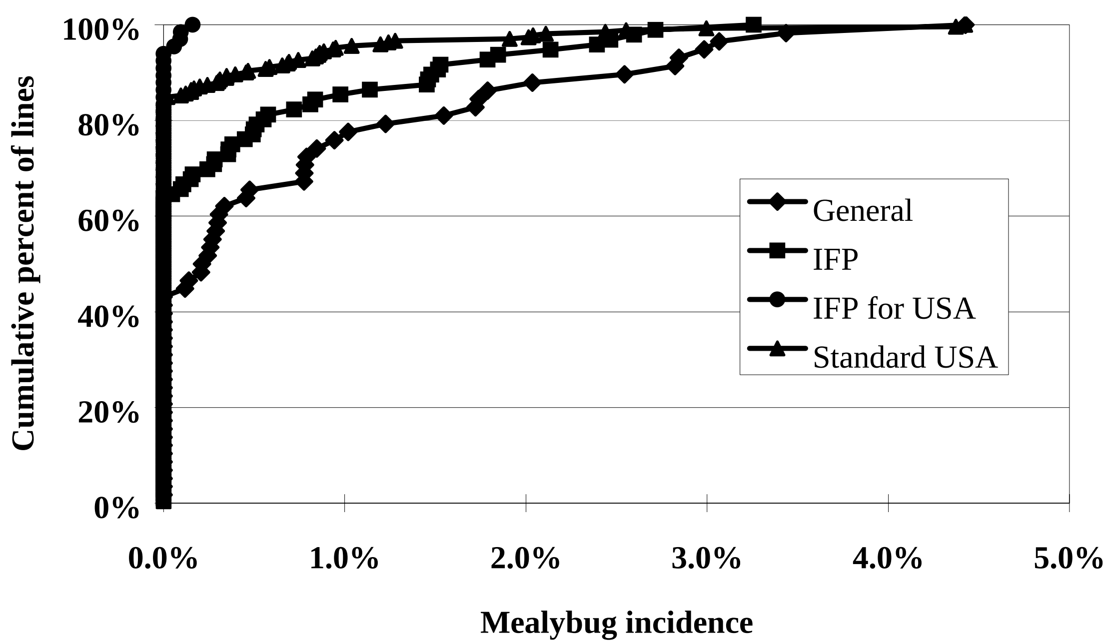
Other software tools such as 'Trap Entry' have been developed to analyse trap-catch data on a grower and regional basis, and such tools have been used for determining the reliability of pest control, particularly those with phytosanitary market access consequences e.g. codling moth control.

These large databases of growers' pheromone trap information were also used to formulate control thresholds (Bradley *et al* 1998) for the primary leafroller pest, lightbrown apple moth (*Epiphyas postvittana*). They enabled analysis of the market access risks by comparing individual orchard and regional variations in trap catch, and predicted insecticide use for different threshold values against the expected frequency of insecticide use needed to achieve acceptable control.

Another valuable source of data was from packhouses. A number of packhouses throughout the country provided information on the defects in lines of growers' fruit at packing. Samples of fruit rejected during fruit grading from known volumes of packed fruit were analysed to determine the actual incidence of defects in each line of fruit.

Access to such records for approximately 15% of the national crop allowed comprehensive analysis of IFP programme performance and was used to evaluate and modify control thresholds if required. This data often highlighted grower issues with implementation or understanding of the IFP recommendations and allowed IFP researchers to focus on those growers, or behaviours, where the pest or disease outcomes were unacceptable (Figure 6). It also provided information for fine-tuning of phytosanitary market access pest-risk profiles leading to the establishment of four different production programmes that operated during the transition towards a national IFP pipfruit programme.

Figure 6. The use of reject fruit analysis during packing to determine the impact of four production programmes; general (non-specific), IFP, IFP-USA with standard (OP-based) programme, on the risk of mealybug presence in lines of fruit at harvest.



Access to these large volumes of linked data: from field pest monitoring, agrochemical use and fruit quality at harvest, allowed comprehensive evaluation of new IFP recommendations. More importantly, it provided an excellent mechanism for identifying problems or issues with IFP, and for new solutions to be developed for inclusion in revisions to IFP programme documentation. This information was particularly important during the implementation period, and each year provided the basis for IFP Review Meetings where pest or disease management problems were assessed and new strategies developed.

This process has continued and still provides the basis of the fruit sector's own review of its agrochemical and market access performance. Although the NZ apple industry was deregulated in 2001, and there were 86 exporters of apples in the 2002 season, sharing of industry data (spray diaries, monitoring records and packhouse fruit quality) still continues for the purpose of IFP development and market access support.

New Zealand Pipfruit Ltd requires all growers who wish to be part of the IFP programme to register each of their orchards annually. A condition of this registration is that growers submit field notebook information to New Zealand Pipfruit who audit about 90%. Auditing of spray diaries is carried out by independent organisations and the majority of this information is also passed on to New Zealand Pipfruit. The primary role of spray diary audits is to ensure grower compliance with pre harvest intervals. Growers whose diaries comply are issued with a compliance certificate prior to harvesting of fruit. When combined with residue testing programmes, this system gives a high level of confidence that New Zealand fruit will be within the maximum residue levels set by importing countries.

Compliance with government legislation

As a significant exporter of primary produce, the New Zealand pipfruit industry has to meet international market expectations for safe produce. The industry has monitored growers' agrichemical compliance through the collection and analysis of spray diary information for over 20 years.

This self-regulating activity is underpinned by legislation including The Resource Management Act (RMA, 1991) that provides local government with further control of growers' agrichemical use. The Act is to promote the sustainable management of natural and physical resources and places significant focus on the environmental effects resulting from discharges to land, air or water. Enforcement is an issue in relation to avoidance of spray drift, or "agrichemical trespass".

More recently, the Hazardous Substance and New Organisms (HSNO) Act is new legislation aimed at protecting the environment and the people in it, by controlling the use of hazardous substances and/or the introduction of new organisms.

The Environmental Risk Management Authority (ERMA), which was established under the HSNO Act, is responsible for deciding if new organisms and hazardous substances can be introduced into New Zealand. It manages any risks to the environment and public health and safety by placing controls on their use. The 74 regional authorities within New

Zealand enforce this legislation. These authorities are required to develop local policies and plans under the RMA to protect sensitive environments and avoid any adverse consequence of land use. For example, in the Hawke's Bay region, the Regional Council has sought to protect the main aquifer from agrichemical contamination from pesticide leaching and can issue compliance orders and prosecute offenders.

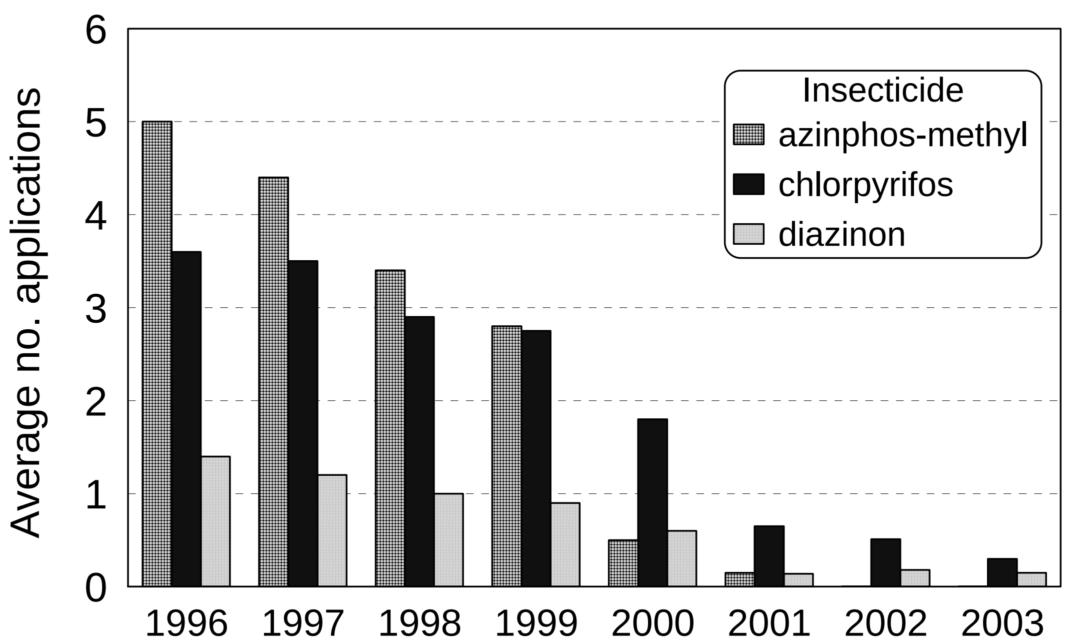
This legislation also requires all applicators of pesticides to be trained regularly and hold a current GROWSAFE applicator's certificate in the safe use and application of agrichemicals. The GROWSAFE certificate is issued after applicator has demonstrated a working knowledge and understanding of NZ 8409:1995 AGRICHEMICAL USERS' CODE OF PRACTICE. Furthermore all pipfruit growers are required to have crop sprayers calibrated annually by approved calibrators.

RESULTS/BENEFITS

Agrichemical use

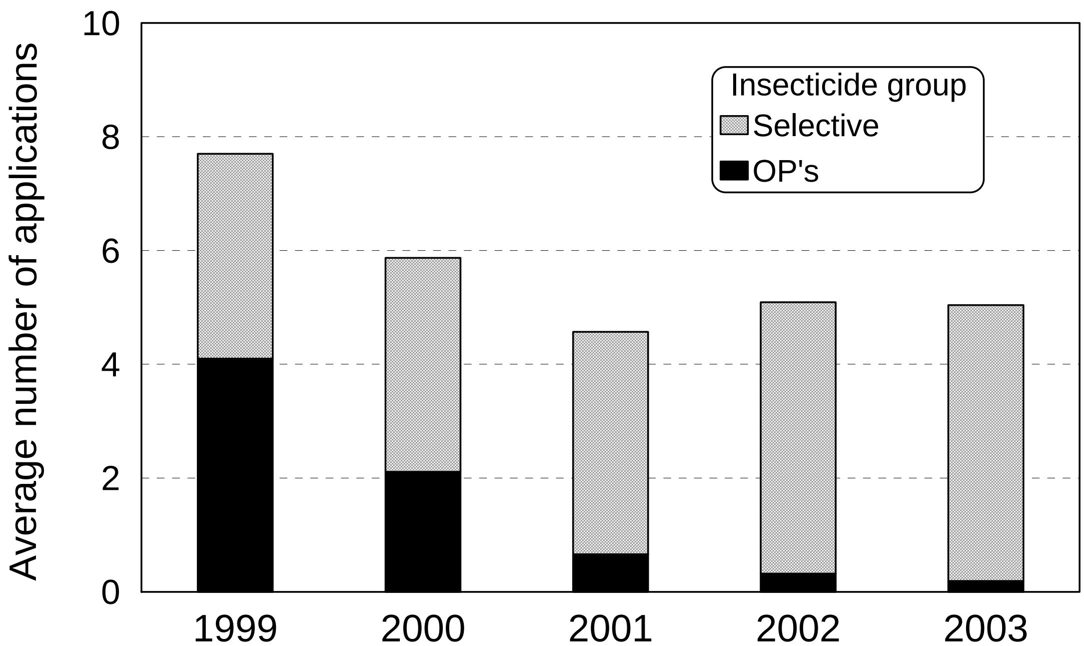
IFP recommendations in pipfruit have all but eliminated OP insecticide use on apples in New Zealand (Figure 7); use has declined by 95% and will soon be eliminated completely. The remaining use of OP's is largely associated with the control of woolly apple aphid (*Eriosoma lanigerum*) due to either agrichemical disruption (linked to carbaryl use in fruitlet thinning) or variable and inconsistent performance of the parasitoid *Aphelinus mali*.

Figure 7. The decline in organophosphate insecticide use on the New Zealand apple crop occurring under increasing IFP pest management.



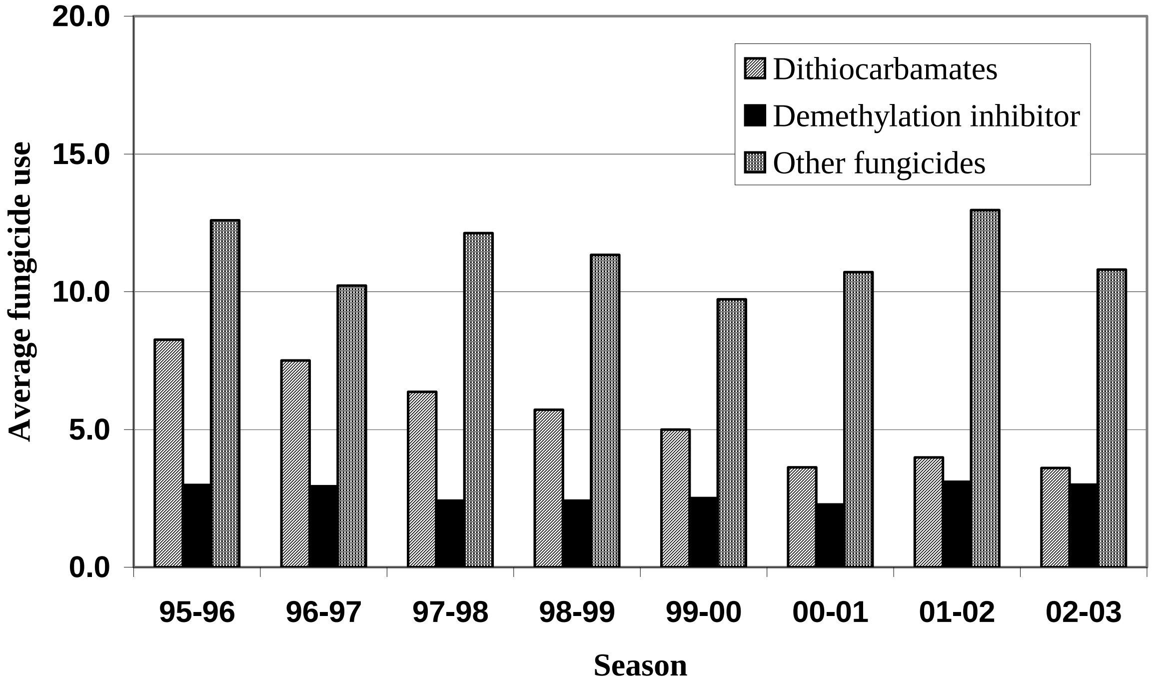
IFP recommendations in pipfruit have also reduced total insecticide use, with 50% fewer applications of insecticide for insect control nationally in 2003 than in 1996. This was achieved through the implementation of pest monitoring systems, pest thresholds and the greater role for biological control under the selective pest management operating in NZ IFP. OP insecticides have been largely replaced by one application pre-flowering and two to four applications post-flowering of selective insect growth regulators (IGR's), depending on pest monitoring results (Figure 8). At this level insect control appears stable and should remain so, because effective insecticide resistance strategies are in place and are underpinned by resistance monitoring of leafrollers, the major target group.

Figure 8. The decline in insecticide use on NZ apples in Hawke's Bay since 1999 and the increasing use of selective pest management under IFP.



New Zealand's wet springs and mild climate has resulted in only relatively small decreases in fungicide use under IFP disease management guidelines (Figure 9). Growers enjoy ready access to monitored weather data and disease risk prediction software for control of the primary disease: apple black spot (*Venturia inaequalis*). This information is available by either downloading weather data from a comprehensive regional network of weather stations and running MetWatch™ software for disease risk prediction, or by subscribing to a fax service providing similar information on disease risks.

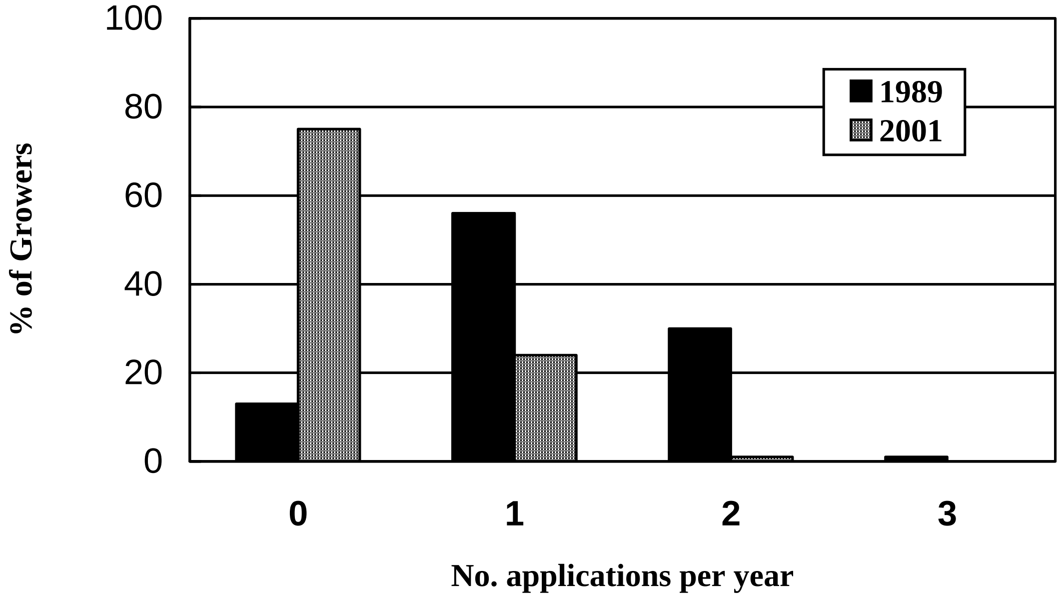
Figure 9. The change in fungicide use on NZ apples in Hawke's Bay since 1996 under IFP disease management guidelines.



The major objectives of the IFP disease management have been achieved. These focussed on reducing the use of mite-disruptive dithiocarbamate fungicides (to less than four applications per season by 2000, Figure 9), and adherence to fungicide resistance management guidelines (e.g. demethylation inhibitor fungicides and dodine) (Manktelow *et al.* 1997). In a desire to reduce their fungicide use, many growers did so at the expense of effective disease management, and have begun to heed calls to ensure that they do not reduce use below justifiable levels of fungicide use.

The use of residual herbicides has declined under IFP guidelines. In 2001, they were not used by approximately 75% of growers (Figure 10). Use of residual herbicide has continued to decline, particularly in established orchards with effective light competition from larger trees common in NZ orchards. The width of the in-row weed-free strip has also declined and, in most orchards the area under herbicide management, is now less than 30% of the planted area.

Figure 10. The decline in residual herbicide use in NZ apple orchards between 1989 and 2001 that occurred under IFP weed management guidelines.



The re-vegetation of the herbicide strip in mid and late summer is encouraged, to allow the recovery of naturally high soil organic matter and to promote activity of earthworms and other soil fauna involved with the degradation of leaf litter which would otherwise host over-wintering black spot ascospores. More recently, there has been a research focus on the role of the understorey vegetation in both pest management and the enhancement of biological control. Many growers have experimented with different plant species for the enhancement of orchard bio-diversity, but the primary benefits of biological control to IFP production have largely occurred by the change to selective pest management, rather than from changes to understorey management.

DISCUSSION

There have been no serious pest or disease management issues during implementation of the apple IFP programme throughout the main fruit growing regions of New Zealand (Walker *et al.* 1997b and 1998). Leafroller and codling moth control have been excellent in most orchards, and instances where damage has been higher than anticipated, have usually been associated with growers not following IFP recommendations. This has included the use of products below recommended rates, inadequate spray coverage, and improper use or maintenance of pheromone traps. Extensive fruit quality monitoring programmes, together with annual reviews of pesticide use and IFP programme recommendations, have allowed refinements to pest and disease recommendations that are now widely accepted by growers.

New Zealand Pipfruit IFP - an evolving production standard

IFP became a national export standard for the New Zealand apple industry in the 2000-01 season, and most growers and exporters are comfortable with the agrichemical use and market access performance of the programme. At the same time, new signals are emerging from the UK and EU customers, including pre-emptive cancellation of the use of specific pesticides. Some exporter groups have responded to these customer signals by the exclusion of specific pesticides, while others have attempted to avoid these issues by supplying ‘residue-free’ fruit to their supermarket buyers. IFP in New Zealand will continue to evolve to meet customer requirements and will likely target residue-free production as a future strategy.

More recently, Euro-Retailer Produce Working Group-Good Agricultural Practice (EUREPGAP®) market requirements have presented new challenges for IFP growers. Although many of the EUREPGAP® mandatory practices and procedures are embodied in the existing NZ Pipfruit IFP programme, the need to have improved documentation over a wider range of production practices has made orchard management more complex. Meeting EUREPGAP® requirements has also been relatively expensive for some growers, with new capital investment needed in technology for cleaner production systems e.g. bunding in spray filler areas and safe disposal systems for unwanted pesticides etc.

Many NZ pipfruit growers are now EUREPGAP® registered, or are in the process of gaining accreditation. This will increase as more growers become familiar with compliance and the market advantage that this registration confers. Some exporters have required their growers to become accredited for the 2003 crop, while others have indicated that their cut-off is the 2004 crop. ENZA has encouraged its suppliers by paying a NZ$0.20 per carton premium to all growers that are accredited.

New Zealand apple growers feel their IFP programme contains desirable elements of worker and environmental safety, with significant potential consumer and marketing benefits for their fruit, although these are largely understated. Most growers like the IFP programme because they consider it safer for themselves and their families. Other benefits include improved access to technical information for growers and access to other growers’ experiences through IFP Discussion Groups.

COMPARISONS WITH OTHER COUNTRIES

As previously stated it is inappropriate to compare the guidelines of IFP programmes between countries, as a wide variance in climatic conditions and pest and disease pressure has necessitated different tactics to successfully implement IFP. However it should be noted that there is considerable collaboration within the international science community in an attempt to refine the concept of IFP. The IOBC convenes an Integrated Fruit Production conference annually.

It is perhaps appropriate though to compare the rate and/or level of uptake of IFP in pipfruit production:

- Italy, South Tyrol Region: It is considered that the concept of IFP was first applied in this region. IFP started in 1989 and by 1991 87% of apple production was under IFP (Survey on 10 years of integrated fruit production in South Tyrol)

- Poland: IFP started in 1991. In 1999 approximately 13% of table apples were being produced under IFP guidelines (Niemczyk, E.).

- Brazil: In 1999 Brazil had 25ha of apples in a research and development programme on IFP (Valdenbenito-Sanhueza, R.M. and da Silva Protas, J. F.). This represents a fraction of total productive area.

- New Zealand: IFP introduced to the pipfruit industry in 1995 and by 2000 100% of export production was under IFP.

These comparisons show that the rate and level of adoption of IFP in the New Zealand pipfruit industry has been quite remarkable. It is probable though that the New Zealand industry was advantaged by its legislated, single exporter status.

CONCLUSIONS

Since the introduction of the first pipfruit IFP programme in the South Tyrol region of Italy, similar programmes have been successfully introduced in many other growing regions of the world. The goal, by definition, of producing environmentally and economically sustainable pipfruit is being achieved within these programmes, and at the same time, important food safety issues have been addressed. Within IFP production systems, 'soft' selective pesticides are being used on a 'need' basis as opposed to the 'scorched earth' programmes conventional production.

The adoption of the pipfruit IFP programme in New Zealand is notable for both the rate of uptake by growers and for the extension to 100% of export production in a five-year time frame. There can be little doubt that this exceptional achievement was largely possible due to a number of factors:

- At the time of IFP introduction, the New Zealand export pipfruit industry operated in a legislated single seller environment. ENZA, a co-operative and the 'single desk' marketer, was able to impose significant influence on the growing community by offering logistical, technical and fiscal support. ENZA was an enthusiastic promoter of IFP to ensure industry sustainability.

- The pipfruit industry, with around 60% of its production exported, is heavily exposed to the requirements of international markets. In the mid to late 90's, these markets began a move toward 'good agricultural practice' (GAP), food safety and traceability philosophies, leaving New Zealand pipfruit growers with no choice but to comply.

- New Zealand has world-leading scientists who are committed to research and development in the pipfruit industry. Without this enthusiasm and commitment, it is doubtful that the implementation of IFP would have been so successful.

The introduction of IFP has collectively delivered significant benefits to consumers, the environment and growers. These benefits will continue to increase over time as technology continues to deliver new solutions.

- Under the IFP programme consumers are being offered safer food. The IFP programme offers produce to the consumer that has been treated with fewer and safer pesticides.

- The New Zealand IFP programme extends beyond the use of pesticides to the concepts of the encouragement of environmental sustainability, including the managed utilisation of scarce resources such as water.

- The introduction of IFP has been a key driver for chemical companies to invest in the research and development of new safer products. New products must meet the requirements of being safer for the consumer more environmentally sustainable and safer for the grower if they are to be commercially successful.

- Growers have been able, through the adoption of IFP, to meet stringent international market requirements both in respect to food safety and 'good agricultural practice'.

The current 'NZ PIPFUIT IFP' programme is a 'living' document that has the ability to evolve so that future food safety and sustainability issues are addressed.

The New Zealand pipfruit IFP programme has been good for consumers, the environment and growers.

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