# DEVELOPMENT OF GOOD AGRICULTURAL PRACTICE PROGRAMS IN NEW ZEALAND'S FRUIT INDUSTRIES

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## ABSTRACT

*The New Zealand fruit sector has seen rapid uptake of integrated pest management (IPM) followed by integrated fruit production (IFP) then finally good agricultural practice (GAP) programs since the early 1990s. The kiwifruit sector's 'KiwiGreen' program achieved complete adoption by 1997 while the apple IFP program became the minimum production standard by 2000. Both 'KiwiGreen' and IFP led to marked reductions in agrochemical use, in the latter more than a 50% reduction in insecticide use and a 98% reduction in organophosphate insecticide use. These programs formed the basis of sector-wide EurepGAP implementation between 2002 and 2004 and have formed the basis of similar GAP initiatives in other sectors including stonefruits and wine grapes. This paper describes GAP development and benefits for the New Zealand fruit sector.*

Key words: IFP, GAP, fruit crops, agrochemical use, New Zealand

## INTRODUCTION

New Zealand is an island nation located in the South Pacific and its horticultural production areas cover a wide range of subtropical to temperate latitudes. The important subtropical crops include kiwifruit, avocados and citrus, while further south, the important temperate crops include apples, grapes and stonefruit. New Zealand's fresh fruit industry is small by international standards and with a domestic market of just 4 million people the fruit industry's focus has always been dominated by exports. Fruit is exported to over 60 countries with the European Union, UK, USA and Japan being the primary markets. Like all of New Zealand's primary producers, the fruit sector operates in an economic environment that has been subjected to considerable agricultural policy 'free trade' reforms over the last 10 years. The removal of legislation that created and protected 'single desk' export monopolies has resulted in the demise of some, the most notable being the apple exporter ENZA when this sector was de-regulated in October 2001. Annual export returns from fruit crops, including wine are about $US 1 billion and these crops form about 10% of the country's agricultural exports. Apples and kiwifruit represent approximately 80% of the fruit exports with the balance made up from other fresh and processed fruits and wine.

New Zealand's horticultural soils are typically highly fertile and, together with a mild maritime climate, allow for highly efficient crop production. This natural advantage is offset against relatively high labor rates and high transportation costs to distant export markets. For economic sustainability, New Zealand growers must therefore achieve premium prices in high-value international markets by differentiating their products from other lower cost producers. Traditionally the major fruit sectors, kiwifruit and apples, sought to differentiate themselves in international markets through coordinated marketing, high fruit quality and new cultivars. As a significant exporter of primary produce, the New Zealand fruit sectors also have to meet international market expectations for safe produce. In the past, agrochemical issues have usually been limited to meeting residue restrictions for various pesticides set by different markets. However, with the advent of customer assurance programs and more recently

EurepGAP[1] greater emphasis has been placed on all aspects of agrochemical use in our fruit production systems. The export apple and kiwifruit sectors are fully compliant, and in many areas exceed the compliance requirements of EurepGAP. The rapid implementation and compliance with this good agricultural practice (GAP) program was only possible because of the New Zealand fruit sectors' prior development and implementation of integrated fruit production (IFP) programs together with New Zealand's comprehensive food safety, worker safety and environmental legislation.

This paper describes the progressive development and implementation of firstly, IPM (integrated pest management) programs, followed by IFP and subsequently, GAP programs within the New Zealand apple and kiwifruit sectors. The outcomes that resulted from these initiatives are discussed together with the key legislation components that enabled the rapid uptake and compliance of GAP principles throughout the New Zealand export fruit sector.

## DEVELOPMENT OF GAP PROGRAMS IN NEW ZEALAND

### GAP Development within the Kiwifruit Sector

In New Zealand, there are approximately 10,500 ha of kiwifruit and 2,700 growers producing an annual crop of about 250,000 tonnes. New Zealand kiwifruit production accounts for 21% of global production and approximately 33% of the international trade in kiwifruit. Approximately 230,000 tonnes kiwifruit are exported annually and development of gold kiwifruit (ZESPRI™GOLD) has added to the sector's confidence and profitability. New Zealand's kiwifruit growers have, by voluntary agreement, retained their 'single desk' exporter, Zespri International Ltd., that manages all aspects of quality standards, unified marketing and 'industry good' functions.

When kiwifruits were first grown commercially in New Zealand in the late 1960s, there were few pests. As the area planted expanded and the number of international export markets for New Zealand fruit increased, pests became an increasingly significant problem. Consequently, the use of organophosphate (OP) insecticides, to control phytosanitary pests, became increasingly common so that by 1980, many kiwifruit growers were applying insecticides every 3-4 weeks from pre-flowering in November until harvest in May.

Despite an extensive amount of knowledge on the biology of kiwifruit pests and potential control options developed by researchers during the 1980s, it was not until 1992 that this information was integrated into a pest management program that could be used by the industry. The detection of spray residues on New Zealand kiwifruit, while well under the acceptable European Union guidelines (Bull 1993), was essentially being used as a trade barrier in some European markets. The New Zealand Kiwifruit Marketing Board (NZKMB)[2] responded in 1991 by developing a pest management strategy that would enable the production of fruit with no detectable residues. This IPM program, called 'KiwiGreen' focused on pest management and agrochemical issues, was launched in 1992. In the first year just 1% of the national crop was produced using this program but by year two, this reached 8% and thereafter grower uptake of the technology was unprecedented. In 1998, six years after its inception, the total export crop was produced using 'KiwiGreen' (Fig. 1).

While market signals provided a strong imperative for change, a key factor contributing to the rapid adoption and expansion of 'KiwiGreen' within the kiwifruit sector was a highly successful implementation process. This process was based on three key elements: the development of a manual, the establishment of a pest monitoring infrastructure and the transfer of the technology to growers. The 'KiwiGreen' manual contained information on the identification and biology of kiwifruit pests, detailed instructions on the procedures for monitoring and recording pest levels, and

[1] EurepGAP is a GAP program that is operated by FoodPLUS Gmbh, a non-profit organization that manages the collaboration between European supermarkets that seek to introduce EurepGAP practices relating to food and environmental safety, worker safety and welfare and product traceability.

[2] Now Zespri International Limited, the sole marketer of New Zealand kiwifruit.

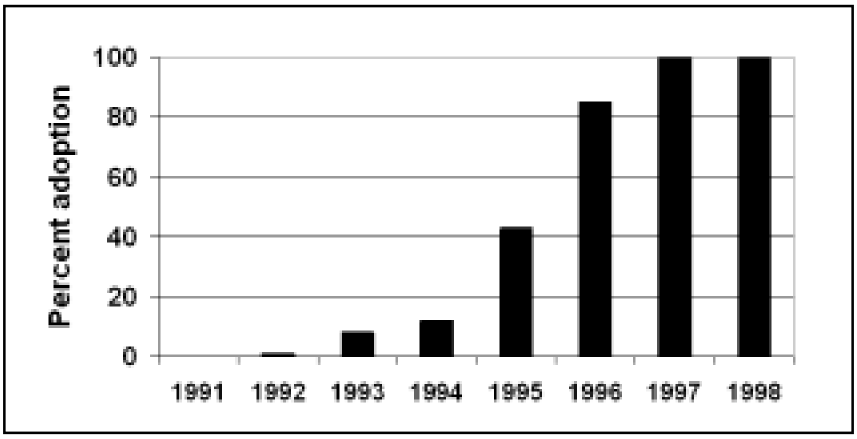

Fig. 1. Adoption of the 'KiwiGreen' IPM program within the kiwifruit sector.

recommendations for pest control when threshold levels were exceeded (McKenna *et al.* 1995).

Monitoring kiwifruit pests requires both expertise and infrastructure. In the first two years of 'KiwiGreen,' trained NZKMB staff supplied this service to growers at no cost and as the program expanded across the industry the NZKMB also undertook licensing and training of pest monitoring facilities. These facilities were often set up by kiwifruit packhousess as an extension of their service to their grower clients. Transfer and adoption of the technology by growers was another critical step in the implementation process. Two field operators were employed by NZKMB and were primarily responsible for providing technical support to the growers in the early years of 'KiwiGreen.' They acted as the link between researchers and the wider industry but in subsequent years, this responsibility was transferred to technical personnel employed by the packhouse/pest monitoring centers. The technique of using field operators was very successful and has since been replicated in other technology adoption processes.

'KiwiGreen' is an example of the successful development and implementation of an IPM program across an entire fruit industry. It was an IPM program driven by commercial need, and which reflects the restraints of producing a high-quality export crop that is free from quarantine pests and pesticide residues. 'KiwiGreen' consists of a documented and audited program of pest control measures that can only be applied in response to a demonstrable need. It was an important precursor to later developments when this program was broadened to encompass all the principles of IFP that became a major component within a broader GAP program called the ZESPRI™System. This system was the basis of the EurepGAP implementation program in the kiwifruit sector in 2002 and today, over 90% of New Zealand's kiwifruit producers that are EurepGAP certified supply crops to Zespri International Ltd.

## Benefits of 'KiwiGreen' and the ZESPRI™System

The benefits of 'KiwiGreen' were primarily to the environment, market access and consumer acceptability. Environmental benefits arise from both the reduced number of sprays and the use of more environmentally benign sprays. Over the last decade, the number of broad-spectrum agrochemicals being applied has decreased from an average of eight per annum in 1980 to just three per annum in 2000. This equates to a reduction of 100 tonnes of pesticide per annum. This has had a positive impact on orchard bio-diversity and has created opportunities for greater use of biological controls. In regions where kiwifruit orchards and urban settlements have to co-exist, this reduction in insecticide use has also alleviated the potential for conflict between the two communities.

The benefits for market access are two-fold. New Zealand kiwifruit typically has residue levels that are less than 5% of the maximum permitted residue levels in destination markets, but perhaps of greater importance are the consumer acceptability benefits. Key customers are now demanding evidence of food safety and environmental integrity in the production of food; without the 'KiwiGreen' program and ZESPRI™System, it is unlikely this demand could be met.

The costs of 'KiwiGreen' versus calendar spraying are similar but the 'KiwiGreen' program has resulted in a shift in spending on pest control. The additional costs of pest monitoring and the use of environmentally benign sprays have been offset by a reduced number of sprays being applied. 'KiwiGreen' has also created significant employment opportunities in the rural regions with the formation of the pest monitoring centers. These centers have become an important point in the technology transfer chain, and most now have their own dedicated technology transfer person whose primary responsibility is information dissemination to grower clients. 'KiwiGreen' has instigated an up-skilling of growers and the industry in general. The technology is now being cited as a key reason behind the increase in organic production that is now about 4% of the total kiwifruit exports.

## The Future of ZESPRI™ System

Since the industry-wide adoption of 'KiwiGreen' in the late 1990s, pesticide use in kiwifruit has not changed dramatically. The average number of organophosphate and fungicide sprays applied per annum remains at 3 and <1 respectively. 'KiwiGreen' is a dynamic crop production program and the industry aims to make further reductions, but this will depend on the development of alternative control strategies, particularly for armored scale insects and sclerotinia disease. While the focus remains on seeking a more diverse range of sustainable pest control options for managing both primary and secondary pests, the entire production process is considered under the GAP principles embodied within the ZESPRI™System. This includes all chemical inputs, as well as broader environmental and production issues such as canopy, ground cover and waste management. The demands of key customers for safe fruit that has been produced using environmentally sound practices are likely to become even more stringent in the future. This will ensure that the ZESPRI™System will continue to be developed and enhanced as the major component of the kiwifruit sector's comprehensive GAP program.

## GAP Development within the Apple Sector

In New Zealand, there were approximately 11,000 ha of apples and 950 growers producing an apple crop of about 500,000 tonnes in 2005. Approximately 325,000 tonnes of these apples were exported but this is expected to decline as the sector is under considerable economic pressure with increasing international competition and declining profitability. The New Zealand crop is just less than 1% of global production but approximately 5% of international trade in apples. In the 2004-2005 season, there were approximately 86 companies exporting apples from New Zealand and, since the demise of its export monopoly, ENZA now accounts for about 30% of the export volume. Since deregulation in 2001, a grower-owned company, Pipfruit New Zealand Inc., has managed the 'industry good' functions (industry information, market access, research and development) on behalf of growers.

The apple sector expanded rapidly in the 1980s, growth that was buoyed by strong markets for the New Zealand-developed apple varieties, 'Royal Gala' and 'Braeburn.' Other sector strengths that encouraged growth included the management of fruit quality and the integrated marketing strategy that single-desk exporting provided New Zealand apple growers. With fruit exported to more than 60 international markets, there was little restraint on agrochemical use outside of the legal requirements. The exporter paid premiums to growers who could supply fruit that met the challenging market access demands for fruit free of all phytosanitary pests. Growers applied broad-spectrum insecticides regularly and were reluctant to adopt IPM programs or reduce their use of pesticides because of the risk to market access and export market premiums.

By the late 1980s, the New Zealand sector's market access strategy was unsustainable and had led to increasing problems with insecticide resistance in some insect pests of quarantine significance including leafrollers and mealybugs. In the mid-

1990s, it became evident that the crop protection practices were also becoming increasingly unacceptable in major European markets where there was an increasing demand for greater assurance over food safety and environmentally responsible production systems. In 1995, ENZAFRUIT International Ltd. responded to these initiatives from UK supermarkets by initiating the development of a national IFP program for apples as part of its strategy to maintain market premiums for New Zealand apples. It established a national Pipfruit IFP Committee to set standards, develop documentation and facilitate implementation. New Zealand's IFP principles for apple production were based on European IOBC[3] guidelines and was defined 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 program was based on continuous improvement and was developed through a structured decision-making process. ENZA provided leadership of a committee that included technical experts, growers, consultants, consumers, the environment and the agrochemical industry (Batchelor *et al.* 1997).

The Pipfruit IFP Manual was developed in 1995 by ENZA under the leadership of the newly formed Pipfruit IFP Committee. The manual initially focused on the key crop protection issues but 15 technical subcommittees were formed covering all aspects of apple production (Table 1). These technical subcommittees reviewed European-based IFP guidelines (Avilla 1995) and, with extensive industry consultation (growers, agrochemical companies, field consultants, regional authorities and environmental groups), identified changes that were appropriate for apple production in New Zealand. These chapters formed the basis of the IFP Manual and provided growers with the guidelines for apple production and identified where changes were required to existing production practices.

Many of the existing practices were already consistent with good orchard management and required little additional effort for growers to become compliant with IFP. The major changes that were required largely affected the existing use of agrochemicals and included the following:

- implementing crop monitoring and recording systems;
- developing pest and disease thresholds for justified pesticide use;
- maximizing biological control by eliminating broad-spectrum insecticide use;
- developing and using fungicide resistance management strategies; and
- minimizing risks to groundwater by eliminating residual herbicide use.

The focus for the apple sector's IFP program was therefore driven by fundamental changes in the approach to crop protection and the agrochemical issues arising from this change.

## Implementation of IFP

ENZA played a key role in the implementation of IFP throughout New Zealand's apple sector.

Table 1. The structure and functions of the New Zealand apple industry's IFP program during the development and implementation phase

| New Zealand Pipfruit Integrated Fruit Production Committee (1996-2000) | | | |
|---|---|---|---|
| Committee Representation | | Technical Subcommittees | |
| ENZA (Chair) | | Pest management | Site and rootstock |
| Research | | Disease management | Soils and nutrition |
| Growers | IFP Standards | Weed management | Tree management |
| Agrochemical | IFP Manual | Spray application | Water management |
| Environment | IFP Implementation | Pesticide effects | Environment |
| Consumer | | Technology transfer | Cleaner production |
| Consultancy | | Regulatory | Industry operations |

[3] International Organisation of Biological Control.

It provided a framework for rapid and widespread adoption of IFP and also financial and logistical support. IFP required fundamental changes to crop protection. Growers faced increased risks of lost fruit value while ENZA faced more complexity in managing the phytosanitary and market access risks that IFP presented to its marketing operations. The risks were managed by step-wise adoption and continuous validation of the IFP recommendations. It required close collaboration between applied crop protection scientists, a smaller group of growers operating a pilot IFP program and ENZA to develop logistical solutions to manage the implementation risks.

Technology transfer was based on discussion groups. Fruit industry consultants were trained to become IFP facilitators with a focus on technical issues surrounding pest and disease management. Each facilitator operated one to three discussion groups, each consisting of 12-20 growers. These groups were required to meet at least three times annually but many groups met more regularly during the initial roll-out of IFP crop protection practices. Issues arising with IFP recommendations were directed to supporting scientists who supplied information back to all facilitators and growers. Growers paid to belong to discussion groups and during the implementation, there were up to 75 groups operating nationally.

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. ENZA provided substantial logistical and financial support to encourage and promote the rapid adoption of IFP. Growers were paid a small financial incentive of US$0.18 per carton for their IFP production that covered the seasonal cost of pest and disease monitoring (~US$140/ha). Funding for this came from the pooled returns paid to growers so that once adoption reached 85% the incentive was changed to a $US0.53 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 (Fig. 2).

The most critical point in IFP program implementation was the first two seasons when any failure of new pest and disease management procedures threatened to undermine grower confidence in the program. Considerable effort was directed by ENZA towards minimizing these risks. Markets where IFP production was a requirement (e.g., UK supermarkets) served as the development program for IFP where pest risks could be effectively managed within the context of quarantine requirements. Quarantine-sensitive markets (e.g., USA) were supplied from the known low-risk, conventional program, while IFP procedures were tested and refined to meet challenging phytosanitary requirements. This

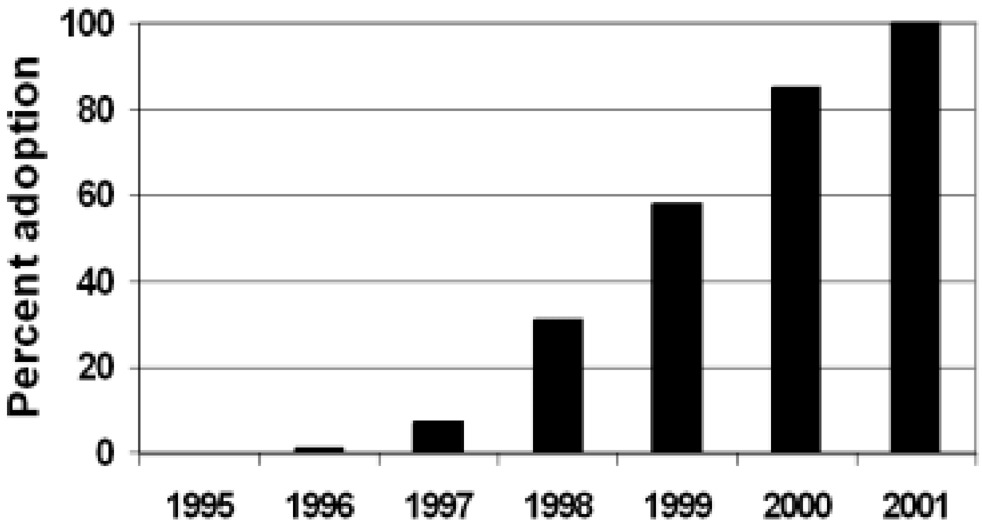


Fig. 2. Adoption of the IFP within the New Zealand apple sector.

involved the development of postharvest disinfestation procedures such as modified controlled atmosphere storage regimes and the introduction of apple washing technology in packhouses, to reduce the probability of quarantine actionable pests in export consignments.

During IFP implementation, the apple sector could not differentiate between conventional and IFP fruit production without creating supply problems within its global customer base. To reduce this risk, ENZA did not uniquely identify IFP production 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.

## Documentation for IFP

In its current form, the IFP Manual is comprehensive with 15 chapters covering all aspects of the fruit production system, from orchard site selection to cleaner production systems for packhouses. Pest and disease management is the most dynamic part of the IFP program with regular changes to sampling methods, pest thresholds, new product availability and market-acceptable residue tolerances. Pipfruit New Zealand Inc. manages the IFP Manual with annual program reviews and updating of chapters as required.

Few growers now use the manual, preferring to access new information from the annual IFP WallChart. This contains the key crop protection procedures including pest and disease monitoring and control thresholds. Apple growers can also access software through the Pipfruit New Zealand Inc. website to assist their pest and disease management decisions. An agrochemical WallChart of registered pesticides and their withholding periods for all major markets is also supplied to registered growers. This ensures industry-wide compliance with responsible agrochemical use and is backed up by fruit residue testing conducted by independent laboratories as part of a national program to monitor residues on apples.

A pest identification guide, together with a spray diary and field notebook for standardized recording of monitoring information, is supplied to growers to assist crop monitoring. With the introduction of EurepGAP in 2002, growers were well placed for the increased level of documentation and auditing required for compliance with this GAP program.

## The Benefits of IFP

The implementation of IFP resulted in a significant reduction in pesticide use in New Zealand apple production (Fig. 3). OP insecticide use has declined by 98% and residual use is largely associated with the lack

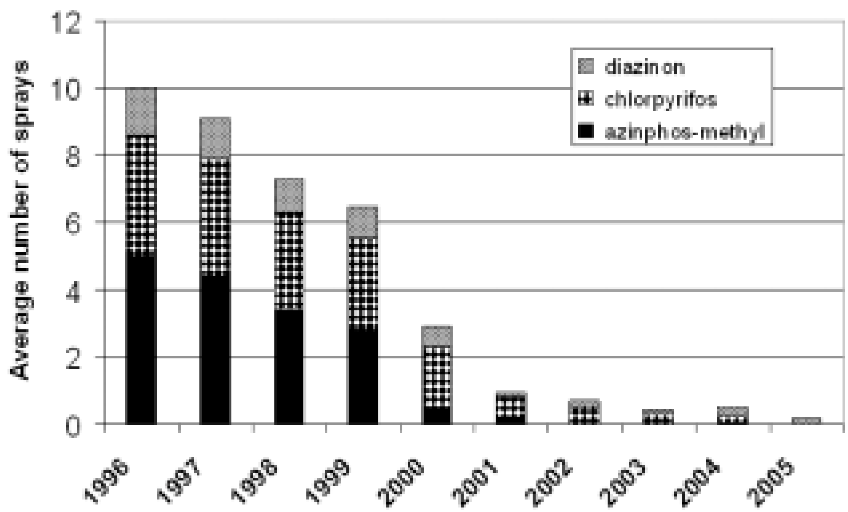


Fig. 3. The decline in organophosphate insecticide use on the New Zealand apple crop occurring under increasing IFP pest management.

of alternative insecticides for control of woolly apple aphid (*Eriosoma lanigerum*). IFP recommendations reduced the average number of insecticides applied with 55% fewer applications in 2004 than were used 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 the IFP program. The OP insecticides have been largely replaced by one pre-flowering and two to four post-flowering applications of selective insecticides depending on pest-monitoring results. Some of the previously important pests (leafrollers and mealybugs) have decreased in significance as a consequence of the enhanced role of biological control under IFP management.

New Zealand's wet springs and mild climate limite the potential for major reductions in fungicide use but its use has still declined by 32% since the introduction of IFP disease management guidelines (Fig. 4). The greatest decrease occurred with dithiocarbamate fungicides (e.g., mancozeb); the use of this group, that disrupted biological control of pest mites, has declined by 74%. Other objectives of the IFP disease management focused on adherence to fungicide resistance management guidelines (e.g., demethylation inhibitor fungicides and dodine). New Zealand apple growers have ready access to monitored weather data and disease risk prediction systems for control of the primary disease, apple blackspot (*Venturia inaequalis*). This information is available by either downloading weather data from a comprehensive regional network of weather stations and running MetWatch™ (computer-based decision-support software) for disease risk prediction or by subscribing to a fax service providing similar information on disease risks.

Use of residual herbicides has declined under IFP guidelines and by 2001, herbicides were no longer used by ~75% of growers. In 2005, residual herbicide use was just 3% of total herbicide use which has also declined with a trend for reduced width of the in-row weed-free strip so that the area under herbicide management in orchards is now less than 30% of the planted area. The revegetation of the herbicide strip in mid and late summer is encouraged to allow the recovery of naturally high soil organic matter to promote earthworm activity and other soil fauna involved with the degradation of leaf litter hosting over-wintering black spot ascospores.

## INFORMATION MANAGEMENT TO SUPPORT GAP – THE APPLE MODEL

The use of pipfruit spray diary information was a key tool in the development of the IFP program (Walker *et al.* 2001). Since the early

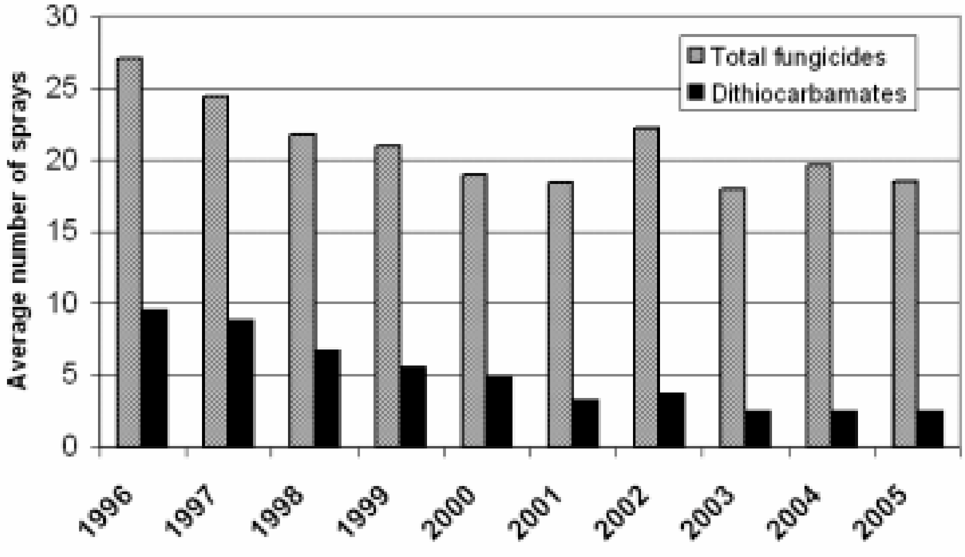


Fig. 4. The change in fungicide use on Hawke's Bay (NZ) apples since 1996 under IFP disease management guidelines.

1980s, ENZA has gathered and entered all apple growers' spray diary information into a mainframe computer database to ensure that growers used only registered products on their crops and that their use was legal and complied with the required agrochemical withholding periods. In the early 1990s, ENZA allowed selected researchers access to this data to investigate growers' use of agrochemicals to better manage the market access and phytosanitary risks. PC-based spray diary databases were created and spray diary analysis tools were developed, as described by Manktelow *et al.* 2001. The use of fruit sector industry information was an important factor in developing the IFP crop protection recommendations. More than 15 years of spray diary database records are available for analysis by authorized researchers and includes full records of agrochemical use from every grower, production site and apple variety block throughout New Zealand.

Software was developed to analyze regional and grower variations in pesticide use, which helped to diagnose control issues with IFP, monitor growers' adherence to IFP guidelines and measure progress towards the agrochemical goals for IFP. Since deregulation of the apple sector in 2001, independent auditing agencies have responsibility for collection and entry of spray diary information. Growers can now access electronic spray diaries that are compliant with the traceability requirements of EurepGAP and this has reduced the time for both data entry and diary clearance. The diary can be e-mailed and the information is fully transferable between different exporters and the sector's own agency Pipfruit New Zealand Inc. This agency now monitors sector compliance with regulations concerning agrochemical use, trace-backs relating to market access performance and the further refinement of IFP crop protection recommendations.

All agrochemical applications in the apple sector must be justified. Linked and traceable data is required to justify all agrochemical applications for either pest or disease management. All spray diary and crop monitoring records are in duplicate and contain reference numbers linking the 'monitored event' to the 'agrochemical action.' IFP growers are required to use insect sex pheromone traps at prescribed densities to monitor pest populations and respond with insecticide only when trapping shows that pest thresholds are exceeded. Most growers supply duplicate copies of these monitoring records to Pipfruit New Zealand Inc. for a review of compliance with IFP guidelines. If the production site is registered for a specific export market with a regulatory phytosanitary compliance program, then these records must be supplied to an independent verification agency for audit against program criteria.

A standardized format for pest monitoring records, the field notebook, also enabled the use of monitoring data collected by either growers or crop monitoring services. Typically, this information included disease assessments and pheromone trap data. This data was important to identify the effectiveness of pest monitoring procedures and appropriateness of the IFP treatment thresholds by examining changes in pest and/or disease activity. The use and transfer of this information continue to develop throughout New Zealand's apple sector and is largely driven by increasing market demands for justification and traceability of all agrochemical inputs (Fig. 5). Queries can now be done across linked databases of the apple sector's crop monitoring records (e.g., pheromone traps) and spray diary records. Postharvest packing and exporting companies also supply information on fruit quality at harvest, including reject analyses, so that unsatisfactory pest or disease control can be linked back to monitoring records and the subsequent crop protection responses. These records typically cover ~15% of the packed export volume and allowed for detailed analysis of IFP program performance and annual updating of the IFP pest risk management procedures.

Protocols for electronic transfer of information throughout the New Zealand fruit industry are managed by the joint agency PIITSA[4]. Standard codes are maintained for information pertaining to all major crops including codes for apple varieties, all agrochemicals including foliar fertilizers and supplements, fruit quality standards and packing information including market identifiers. This provides an open framework for software

[4] Produce Industry Information Technology Standards Association.

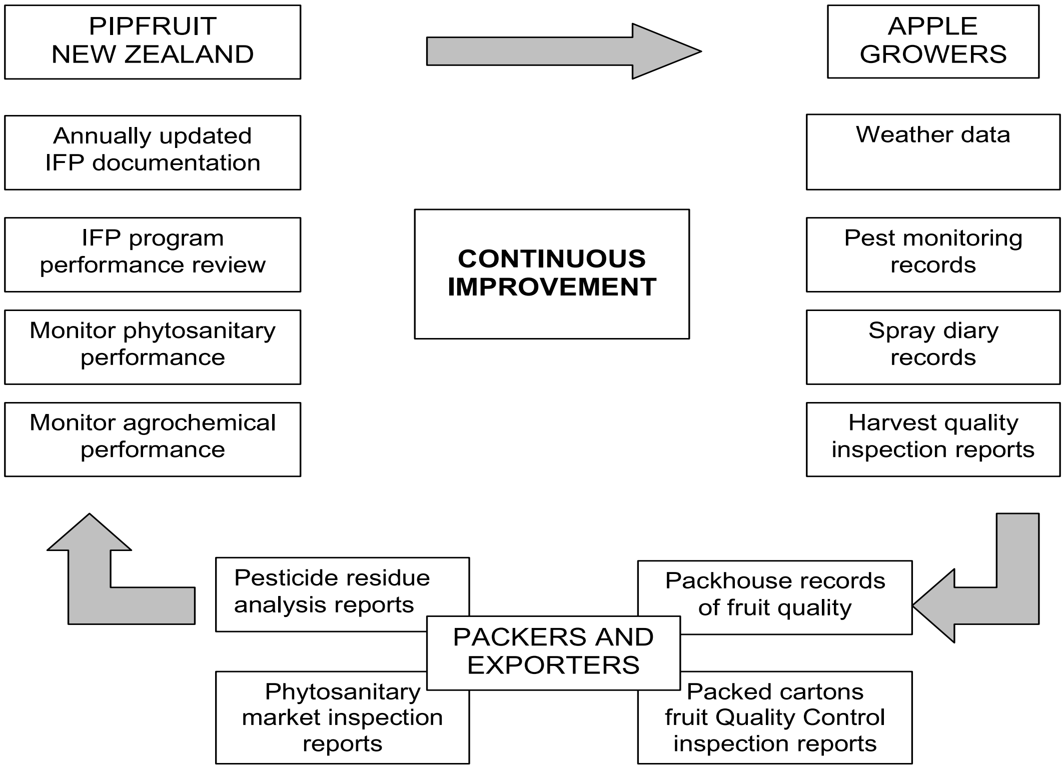


Fig. 5. Sources of information and information flow to support IFP and GAP within the New Zealand apple sector.

development and ensures the rapid and consistent transfer or sharing of important crop and marketing information.

Access to aggregated spray diary information for the entire apple sector was very important in developing the IFP guidelines. The use of specialist software made it easy to identify inconsistencies between regions and growers in the application of IFP guidelines. This allowed researchers and IFP facilitators to focus technology transfer activities to address these issues. It also allowed comparisons of fruit quality where growers had followed either high or low agrochemical use scenarios and, in many instances, was used to encourage lower agrochemical use without compromising either fruit quality or market access. This information is used annually to review the IFP program and its key performance indicators such as grower adherence to fungicide resistance management guidelines.

Allowing researchers access to packhouse information on the defects in lines of growers' fruit at harvest allowed very comprehensive analysis of the IFP program 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 behaviors, where the pest or disease outcomes were unacceptable. It also provided information for fine-tuning the phytosanitary market access pest-risk profiles to be established for four different production programs that operated during the transition towards a national IFP pipfruit program. This played an important role in reducing the significance of mealybugs found during domestic inspections of consignments intended for the USA market where there were phytosanitary issues with the New Zealand mealybug species.

## Monitoring Grower Compliance with IFP

New Zealand IFP requires all growers to be registered and submit crop protection records for independent auditing. Records include field notebooks of pest and disease monitoring records and spray diaries. Pipfruit New Zealand Inc. audits up to 90% of field notebooks for the purpose of IFP program management (e.g., market access and research needs). Independent agencies (e.g., AgriQuality) audit all spray diaries to ensure that fruit does not have unacceptable pesticide residues (i.e., unregistered products or withholding period violations). Auditing of spray diaries is completed before crops are taken into inventory by packhouses and, if acceptable, cleared diary certificates are issued as part of export pre-clearance procedures. Any violation requires a targeted residue sample, otherwise, the process is either random or full testing of all growers' fruit submissions.

## EUREPGAP IMPLEMENTATION

New Zealand's kiwifruit and apple growers adopted EurepGAP as a commercial necessity in 2002. Prior implementation of the 'KiwiGreen' program in kiwifruit and the IFP program in apples meant that New Zealand growers were well placed to meet EurepGAP requirements, especially on sections dealing with the justification and safe use of agrochemicals. Other aspects included in the ZESPRI™System or IFP, on water and fertilizer use, understorey management and conservation within the orchard environment, assisted New Zealand growers to meet and often exceed, EurepGAP requirements. In the apple sector, growers are either individual members of a EurepGAP certification program or are members under a supply group Produce Marketing Organisation (PMO) usually linked to a packing facility or supply group while most kiwifruit growers belong to a supply group PMO.

Pipfruit New Zealand Inc., together with Zespri International Ltd., and the vegetable sector's industry body (VegFed) have formed the New Zealand EurepGAP Technical Users Group. These New Zealand organizations have been formally recognized by FoodPLUS, the organization administering the EurepGAP regulations for accredited produce suppliers.

### Product Traceability

Both the kiwifruit and apple sectors have comprehensive product tracking procedures that are complete from the vine or tree to the retailer. Each sector manages a registration process so that all production sites that are uniquely numbered: 'K' numbers for kiwifruit and 'R' numbers for apples. These systems allow unique production site identification and product traceability. This number is included on all subsequent information relating to crop production and inputs are traceable to the management areas and variety blocks within the production site. Information includes all pest monitoring records and spray diaries, and throughout harvest procedures (e.g., agrochemical residue tests, picking bin labels). These numbers are used throughout cool storage, fruit grading and packing and provide the grower with crop defect reports and analyses of final fruit quality in packed cartons. In the apple sector, the use of this code makes it easy to trace-back any situation where phytosanitary inspections find consignments that are not compliant with market requirements. Because all packed cartons are labelled with their unique production site code, all information relating to the production and packing of that fruit can be readily compiled for any analysis or reporting requirements. In short, the history of the fruit is fully known when the carton is opened by the buyer overseas and can be traced through industry systems back to the production site and any production and postharvest activities associated with the fruit's management.

### Postharvest Procedures

The New Zealand fruit sector is also compliant with British Retail Consortium (BRC) requirements. BRC operate a series of Global Standards created to ensure international standardization of produce supplied to BRC members. This organization represents all classes of retailers in the UK, from large supermarket chains to smaller independent retailers. The standards that are implemented for New Zealand's export fruit crops include the BRC Global Standard for Food and BRC Global Standard for Packaging. All major fruit-packing operations are fully compliant with BRC Food and Packaging standards in addition to the appropriate sections in EurepGAP's general regulations for fruits and vegetables.

## The Role of Government Legislation

As significant exporters of produce to international markets, New Zealand's major fruit sectors have had to meet international market expectations for safe produce. The apple sector has monitored growers' agrochemical 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' agrochemical use. The Act is to promote the sustainable management of natural and physical resources and focuses on the environmental effects resulting from discharges to land, air or water. Enforcement is an issue in relation to avoidance of spray drift or "agrochemical trespass."

The legislation is enforced within New Zealand by the 74 regional authorities who are required to develop local policies and plans under the RMA to protect sensitive environments and avoid any adverse consequence of land use. In the Hawke's Bay region (a major apple and wine production area) the Regional Council has sought to protect the main aquifer from agrochemical contamination through pesticide leaching and can issue compliance orders and prosecute offenders. This legislation is enforced by local authorities and requires that growers notify the owners of adjacent properties in advance of any intended spray application. Growers must also post public signage ahead of spray applications and take drift-mitigating measures such as avoidance of adverse conditions, time of application and establishment of shelter trees. There is debate over the practicality of spray 'buffer zones' around horticultural properties because the proposed size of such zones (up to 150 m) would have a profound effect on the economic viability of many fruit and vegetable producers.

This legislation also requires all applicators of pesticides to be trained regularly and hold a current GROWSAFE™ applicators certificate showing that they have undergone training in a national education framework (NZQA)-approved training course in the safe use and application of agrochemicals. The GROWSAFE™ program trains, audits and approves trainers and is administered by the New Zealand Agrochemical Education Trust (NZAET). NZAET also develops courses on agrochemical education and is the 'proprietor' of the New Zealand Standard NZS8409 Management of Agrochemicals. This document was originally developed as the founding document for GROWSAFE™, The New Zealand Code of Agrochemical Practice. This was adopted by Standards New Zealand as a national standard in 1995 and it has been revised and updated regularly (1995, 1999 and 2004).

The Hazardous Substance and New Organisms (HSNO) Act 1996 is a legislation aimed at protecting the environment and the people in it by controlling the use of hazardous substances and 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. All pesticides registered for use on crops in New Zealand are controlled under this legislation and ERMA manages any risk to the environment and public health and safety by placing controls on their use. Agrochemicals are invariably identified as hazardous substances and the HSNO conditions are forwarded to the product proprietor and Agricultural Compounds and Veterinary Medicines group (ACVM) of the New Zealand Food Safety Authority (NZSFA) to facilitate registration. ACVM is responsible for the registration of agrochemicals and the conditions or restrictions on their manufacture, import, transport with the Land Transport Safety Authority that affect sale, storage, use and disposal.

HSNO legislation requires that users of agrochemicals have received 'Approved Handler' training. This is an additional requirement to GROWSAFE™ training and covers all aspects of transport, tracking and storage of all hazardous substances including agrochemicals. In the kiwifruit sector, many growers use contractors who are GROWSAFE™-trained and 'Approved Handlers' to apply agrochemicals required for crop protection. In the apple sector, most growers or their staff are directly involved with agrochemical applications and must be GROWSAFE™-trained and 'Approved Handler'-certified. Apple growers are required to have their airblast sprayers calibrated and, while there are no standards defining application rates or volumes per hectare, all growers are encouraged to use 'best practice' guidelines.

## DISCUSSION

The ZESPRI™System for the New Zealand kiwifruit sector and IFP for the apple industry became de facto national standards for GAP in export fruit crops by 2001. Growers and exporters are comfortable with the agrochemical use and market access performance of these programs. Both sectors have substantially reduced their reliance on the use of broad-spectrum, highly toxic pesticides and are close to achieving the elimination of these from their respective GAP programs. Crop protection in both sectors is largely based on pest and disease monitoring with threshold-based responses to infection events or pest activity. Under IFP management, the apple sector has achieved the greatest reduction in agrochemical use with number of insecticide applications having declined by over 50% while fungicide has declined by over 30%. The apple sector is still reliant on agrochemicals, in particular, fungicides that are necessary for the management of wet-weather diseases. Despite these marked decreases in agrochemical use, the market performance of the apple sector has improved; phytosanitary pest detections during inspection of export consignments have decreased by approximately 50%.

New Zealand apple growers are very supportive of IFP, with 94% following the program while 6% are now involved with organic apple production. They feel their IFP program 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 program 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 such as IFP discussion groups.

GAP implementation allowed the New Zealand fruit sectors to quickly adopt the EurepGAP program when this became a market requirement in 2004. More than 90% of kiwifruit and apple growers and their production are now EurepGAP-certified, largely because the mandatory practices, procedures and documentation were already part of their IFP program requirements. Recent New Zealand legislation controlling all aspects of agrochemical use, environmental law and work place safety, further assisted the sectors' rapid compliance with EurepGAP. Meeting these requirements has been relatively expensive for some growers with new capital investment in technology for cleaner production systems such as bunding in spray filler areas and safe disposal systems for unwanted pesticides, among other things. Despite these additional costs of compliance with EurepGAP, New Zealand growers have not benefited financially from it as European fruit buyers do not consistently demand that all suppliers of produce be compliant with EurepGAP requirements.

IFP in apples was the catalyst for development in other sectors. A program for process stonefruits was initiated by Heinz Wattie's Ltd. This program for process crops subsequently provided the basis of a pilot IFP program ('SummerGreen') for fresh market crops of peaches, nectarines, apricots and cherries that commenced in 1999. Since the introduction of 'SummerGreen,' insecticide use in the stonefruit sector has decreased by 10-20% on export crops and approximately 60% on domestic crops but more importantly, selective pesticides make now constitute 40-60% of the pest management program. There has been no significant reduction in fungicide use for control of diseases (e.g., brown rot, Monilinia fructicola) but IFP guidelines for resistance management are now widely used.

The New Zealand Sustainable Winegrowing Program (SWNZ®) commenced in 1995 as an Integrated Winegrape Production (IWP) program based on grower interest in IFP developments in the New Zealand fruit industries. A working group comprising of grower, industry and industry specialist representatives was established and developed a pilot IWP scheme based on a self-audit score card. This was implemented in 1995 on a trial basis with five vineyards and by 1997-1998, membership had risen to 120 vineyards. In the 2005 season, there were 436 vineyard members of the SWNZ® program. Members are present in all of the production areas and membership collectively represents more than 60% of the national vineyard area. One of the more significant recent developments has been the extension of the vineyard scheme through to the winery. A pilot program began with four wineries in 2001 and has now grown to 51 winery members.

GAP practices are now an integral part of New Zealand fruit sectors' production programs. The initial leadership for IPM and IFP programs shown by Zespri and ENZA provided growers with the confidence, technology transfer and logistical support to change to their production systems. Most sectors now have IFP or GAP programs and are following similar implementation models; including avocados, persimmons, citrus and even New Zealand's fledgling olive industry. New Zealand's export fruit growers will always continue to be at the leading edge of either customer assurance programs or GAP. With just 4 million domestic consumers and reliance on distant markets, they simply have no choice but to supply premium fruit quality from environmentally responsible production programs.

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