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**Factors That Influence Grower Adoption and  
Implementation of the ENZA Integrated Fruit  
Production Programme**

**A thesis presented in partial fulfillment of the requirements for the  
degree on Masters of Applied Science in Agriculture - Horticulture  
Systems and Management at Massey University.**

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## ABSTRACT

To maintain market access to the key pipfruit export markets of Europe and the UK ENZAFRUIT New Zealand LTD has set a target of 100 percent grower adoption of the ENZA Integrated Fruit Production programme (ENZA-IFP) by the year 2001. In 1996 eighty eight growers had adopted the programme out of a total of 1650 growers nationally, hence the adoption rate required to meet this target is very steep. However, little is known about New Zealand growers' attitudes towards the ENZA-IFP programme, or the factors that may influence the programme's adoption.

Interviews of randomly selected IFP and non-IFP growers were held in Hawke's Bay and Nelson during August 1997. The purpose of the interviews was to determine the factors that influence the adoption of the ENZA-IFP programme, identify differences between IFP and non IFP growers, and identify themes of technology transfer methods that may encourage grower adoption of the ENZA-IFP programme. The results of the IFP and non-IFP case study research were cross compared, then compared and contrasted with the factors identified in the reviewed literature.

The key reasons the IFP growers had adopted the ENZA-IFP programme were for philosophical and environmental factors. Market access was also a key motivating factor. Financial factors, perceived risk, and poor communication were the key factors hindering adoption for the non-IFP growers. The main financial factors were loss of the USA supply programme incentive and a lack of financial incentives to adopt IFP. Perceived risk was in the form of a perceived increase in pest and disease damage and resulting financial loss.

To reach ENZA's target of 100 percent grower adoption by 2001, growers need both clear guidelines on how this is going to be met and financial incentives over the transition period to motivate adoption.

IFP technologies that bring direct financial benefits to growers, have a participatory technology transfer system, have a low level of complexity and perceived risk, and fit with a growers current production system and resources are likely to be adopted more readily.

**Keywords:** Integrated Fruit Production, Adoption, Implementation  
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## **CHAPTER ONE: INTRODUCTION**

To maintain market access to the key pipfruit export markets, the New Zealand Apple and Pear Marketing Board has set a target of 100 percent grower adoption of Integrated Fruit Production programme by the year 2001. In 1996, eighty eight growers had adopted the programme out of a total of 1650 growers nationally, hence the adoption rate required to meet this target is very steep.

The purpose of this research was to identify factors that influence grower adoption and implementation of Integrated Fruit Production and identify technology transfer processes that may enhance adoption.

### **1.1 ENZA Integrated Fruit Production (ENZA-IFP <sup>1</sup>)**

ENZA-IFP is 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. It is a programme based on continuous improvement” (NZ-IFP Standards, 1996).

ENZA-IFP was introduced to New Zealand pipfruit growers as a pilot programme in the 1996/97 season by ENZAFRUIT New Zealand (International), the marketing arm of the New Zealand Apple and Pear Marketing Board. ENZA-IFP is a way of producing fruit in which broad spectrum chemicals are reduced or eliminated and replaced with new, more selective chemicals. Natural enemies of pests are used in conjunction with these more benign chemical insecticides. Pest and disease monitoring, the use of action thresholds, and alternative methods of control are key components of the ENZA-IFP programme. It is called ‘integrated’ because as well as pest and disease control, all aspects of producing the crop must be carried out in an environmentally sensitive way, from planting to postharvest handling (Bachelor *et al*, 1997).

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<sup>1</sup> The ENZA-IFP programme was referred to as the NZ-IFP until the 1998/99 season.

## 1.2 The New Zealand Pipfruit Industry

The pipfruit industry is one of New Zealand's most important horticultural sectors. Fresh pipfruit accounted for 28% of New Zealand's horticultural export earnings in 1997, while kiwifruit accounted for 30.5% (Statistics New Zealand 1997). Pipfruit exports in 1996/97 totalled \$519.7 million, with the five year average being \$523.9 million per year. The average number of export cartons produced over the last eight years was 13.79 million per year. Approximately 66% has been exported to Europe, 17% to the Americas, 16% to Asia/Russia, and 1% to other countries (New Zealand Apple and Pear Board, 1997). However, New Zealand's pipfruit exports represent less than 2% of total world pipfruit production. The key competitors are Southern Hemisphere producers Chile, South Africa, and Argentina.

The New Zealand Fruit Growers Federation (1997) estimated that 1650 growers are growing 14 000 ha of pipfruit in New Zealand. During the 1996/97 season, 16.1 million cartons were exported from New Zealand. This production came mainly from Hawke's Bay (7.7 million cartons 1996/97), Nelson (5.1 million cartons 1996/97), and Canterbury (1 million cartons 1996/97). Smaller volume are also received from other areas including Marlborough, Otago, Waikato, Wairarapa, and Gisborne.

The predominant varieties grown by volume are Braeburn (42%), Royal Gala (25%), and Fuji (10%). However, emphasis is being placed on the development of new varieties such as Pacific Rose™ and Pacific Beauty™. The purpose of this is to help the New Zealand industry maintain its position in the market as the top producer of varieties which can demand price premiums over competitors.

### **1.2.1 The New Zealand Apple and Pear Marketing Board**

In 1948, legislation was passed to establish the NZ Apple and Pear Marketing Board (NZAPMB). The NZAPMB initially had the statutory right and responsibility to accept and market all fruit that met their grade standards for both the export and domestic markets. In 1993 the domestic market was deregulated, but the above statutory requirement continued for all export pipfruit. Third parties can apply to the NZAPMB for a consent to export pipfruit to specific market segments not currently supplied by the NZAPMB's marketing arm. The mission statement of the NZAPMB is to 'maximise sustainable export returns to New Zealand and pipfruit growers' (NZAPMB, 1997).

### **1.2.2 ENZAFRUIT New Zealand (International)**

ENZAFRUIT New Zealand (International) (hereafter referred to as ENZA) is the export marketing arm of the NZAPMB. ENZA's role has changed over the years from an organisation that was closely linked to growers, providing technical support, infrastructure and marketing of all pipfruit production. It has gradually divested itself of some 'onshore' activities, passing them on to packhouses, private coolstores and consultants. ENZA's key role now is setting export production standards, ensuring those standards are met, and marketing the fruit.

### **1.3 Evolution of New Zealand Pipfruit Pest and Disease Management from Calendar Spraying to Current 'Best Practices'**

The successful management of pests and disease is required to meet the phytosanitary requirements of importing countries, consumer requirements and to minimise economic fruit loss. In the absence of pest and disease management practices, almost total crop loss would be expected with current pipfruit varieties.

### **1.3.1 Calendar-based spraying**

Stewart (1997) described the 1950's and 1960's as the golden age of pesticides where effective fungicides and insecticides were introduced to the horticulture industry. Spray programme recommendations from that era included applications of DDT, parathion, malathion, and oils for arthropod pests; and copper, sulphur products and organic dithiocarbamates for disease management. Spray application technology also developed rapidly at this time and the tractor driven airblast sprayer replaced hand guns. Stewart cited two major problems associated with pesticides: (1) the build up of resistance to pesticides over time; and (2) the majority of pesticides affected other organisms besides the target pest or disease.

During the 1980's pest and disease spray programmes predominantly followed a 'calendar spray approach' regardless of pest and disease pressure and generally resulted in minimal crop losses (<3%) (Manktelow 1997). However this success was based on extensive pesticide use. Most spray applications were made at high water volumes using an airblast sprayer. The average water rate was 3000 l/ha, compared to an average of 2000 l/ha today..

### **1.3.2 Evolution from calendar-based spraying**

The introduction of Integrated Fruit Production (IFP) represents a culmination of changes in pest and disease management practices that began in the 1960's. From then on there has been a progressive introduction of perceived 'better practices' to improve pest and disease management and reduce pesticide use. In New Zealand, this change has been driven by issues such as:

- pesticide resistance. Seven key pipfruit pests have developed resistance to one or more pesticides (Stewart 1997);
- pressure by Government and the public to reduce and target pesticide use;
- a decreased level of pesticide acceptance by consumers; and
- a reduction in chemical residue tolerances.

For New Zealand growers, this reduction in residue tolerances has led to restricted

use, or complete bans on use, of some pesticides. For example, restricted use of the fungicide Captan from 1996 because of concerns for market access in some countries (Manktelow pers comm 1998).

In California, recent changes in State Government legislation include increasing the re-entry period for the organophosphate azinphos-methyl to 45 days (Walker, pers comm 1999). Restrictions such as these have major implications for growers who rely on agrichemicals for pest control, and have thus created demand for alternative methods and new softer products that meet legislative, market, and phytosanitary conditions.

Current examples of 'better practices' that have evolved to meet the changing industry include: (1) improved spray application technology with the introduction of sprayer calibration, Tree Row Volume (TRV)<sup>2</sup>, and reduced water rates to minimise spray runoff and drift; (2) integrated pest management practices such as integrated mite control (IMC), integrated pest management (IPM) programmes, and the development of target-specific pesticides, for example insect growth regulators (IGR). The IGR tebufenozide targets only *Lepidoptera spp.* pests leaving other pests and predators unharmed.

### **1.3.3 Integrated Pest Management (IPM)**

There has been extensive research into developing Integrated Pest Management (IPM) systems in apples, especially in relation to insect and mite pests (Croft 1983, Whalon and Croft 1984). The term IPM has several interpretations. In the United States, IPM refers to the integrated management of pests and diseases, soil, water use, and weed management (Koeher 1997). In other programmes IPM may only refer to the management of an arthropod pest. However, all IPM programmes aim to minimise pesticide use and target its use to the most appropriate target and time (Stewart 1997). Despite extensive research into IPM technologies, and although IPM

systems may offer desirable improvements over current management practices, there has been relatively little success in widespread implementation and adoption (Wearing 1988, Fenemore and Norton 1985).

#### **1.3.4 IPM in New Zealand**

The first IPM technology to be implemented in New Zealand pipfruit crops was Integrated Mite Control (IMC). IMC was first trialed on commercial orchards in 1975-77 (Wearing 1978) and was based on work done by the Department of Scientific and Industrial Research (DSIR). It was introduced due to the increase in the resistance of European Red Mite (ERM) and Two Spotted Mite (TSM) to miticides. Miticides alone were proving unsustainable as a method of controlling ERM. An IMC approach involves the introduction of insecticide-resistant predator mites (*Typhlodromus pyri* and *Phytoseilus persimilis*) to the orchards, plus the use of selective miticides once a threshold level of ERM or TSM are exceeded. Any miticide applications are timed to the appropriate life-cycle stage of ERM and TSM (Stewart 1997).

IMC was developed in isolation from disease management programmes (Stewart 1997). However, some fungicides, particularly metiram and mancozeb, disrupt IMC as they are toxic to the predator mites (Walker 1989). During the 1980's and 1990's these fungicides have been favoured for Black Spot (*Venturia inaequalis*) control due to a reduction in fruit russet problems. However, for an IMC approach to be successful there is a need to avoid or reduce the number of applications of these fungicides. During the 1990's there has been an introduction of a number of new fungicides that have been promoted as 'predator mite friendly' (Manktelow, 1997). IMC is now widely adopted by New Zealand pipfruit growers. Average miticide use has reduced from 3.8 applications per year in 1975-76 (Stewart 1997) to less than one per season in 1997-98.

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<sup>2</sup> TRV is a technology for measuring the volume of a tree and calculating the volume of water required in order to spray the trees adequately, while minimising spray drift and excessive runoff (Manktelow 1997).

Other IPM technologies used in New Zealand include the use of pheromone mating disruption for the control of leafroller pests, which was introduced in response to the development of leafroller resistance to organophosphates. Pheromone traps to monitor leafroller activity in the orchard is also an accepted successful IPM technology (Walker 1998). These traps assist with the timing of spray applications to target peak egg laying periods.

## **1.4 Market Driven Production Technologies**

In an increasingly competitive market place various customers have placed differing product requirements on ENZA. To meet different customer requirements ENZA has developed a number of supply programmes. These programmes include the US Code of Practice, the ENZA-IFP programme, the Japan and the Taiwan programmes. For growers to supply fruit to these programmes they must comply with certain production practices, developed to meet customer specifications.

For the 1997/98 season 932 growers produced an estimated 3 million cartons, 21% of total submissions, for the US export supply programme and 361 growers produced 1.9 million cartons meeting ENZA-IFP standards, 13% of total submission.

### **1.4.1 The USA supply programme**

Prior to the introduction of ENZA-IFP there were two key programmes, the US Code of Practice and conventional production. The US Code of Practice targeted the USA market specifically, while the conventional programme was for all other markets, predominantly Europe. A specific conventional programme is not prescribed by ENZA, each grower determines what pest and disease management strategy to follow. This programme has generally been a calendar-based organophosphate insecticide programme and a calendar-based fungicide programme (ENZA Express, August 1998).

For New Zealand pipfruit to be exported to the United States, the United States Department of Agriculture (USDA) and MAF inspectors must pre-clear the fruit in New Zealand. An entire block (minimum 12500 cartons) is rejected if an actionable quarantine pest is sighted during inspection (NZAPMB Quality Growers Manual, 1994). The actionable quarantine pests are the New Zealand native leafroller species (*Epiphyas postvittana*, *Ctenopseustis spp.*, *Planotortrix spp.*), the mealy bug species *Pseudococcus similans*, *Nysius spp*, and *Graphania spp.*

To minimise the risk of quarantine failure to the USA, ENZA introduced the USA Code of Practice (US-COP) in 1995. In order for fruit to be acceptable by ENZA for the USA supply programme, growers must: comply with a prescribed pesticide spray programme; have their spray operator accredited with GROWSAFE certification; calibrate their sprayers; have a minimum of one orchard quality controller trained in the US-COP; and their fruit supplied to ENZA in the previous season must have been free of quarantine actionable pests.

To minimise the risk of orchard blocks failing to meet the USDA standards, growers must apply an organophosphate insecticide programme on a regular scheduled basis (Batchelor, 1997). In order to compensate for the additional costs and risk, and to help ensure growers produce fruit for this market, growers are currently paid an incentive of approximately \$1.00 per carton for all cartons that meet the US-COP standards and size criteria. In contrast to this, European regulators are seeking reduced pesticide applications, however no premiums or incentives are paid for such product (Cross 1996).

Growers can segregate their orchards into blocks and supply more than one programme. For example, during the pilot phase of the ENZA-IFP programme a number of growers trialed IFP on one part of their orchard and implemented the US-COP on another.

**Table 1.1** Number of growers involved in ENZA supply programmes

	<b>ENZA-IFP</b>	<b>IFP-USA</b>	<b>US-COP<sup>3</sup></b>	<b>Conventional</b>
<b>1995/96</b>	0	0	900	750
<b>1996/97</b>	88	0	900	640
<b>1997/98</b>	361	99	932	250
<b>1998/99</b>	567 <sup>4</sup>	315	774	100

#### **1.4.2 The ENZA-IFP programme**

The ENZA-IFP programme was introduced to growers by ENZA to maintain market access to the markets in the UK and Europe. These markets purchase approximately 25% of New Zealand pipfruit and some have specified that New Zealand pipfruit must be produced following an integrated production system (Batchelor 1997). The Fresh Produce Consortium (FPC), a group of retailers in the UK, have developed a FPC Code of Practice designed to meet UK legislative requirements of food safety and pesticide usage. To comply with these regulatory requirements, this group has requested that New Zealand pipfruit be produced under more environmentally favorable conditions, such as are achieved with IFP.

The predominant reason for this change from conventional pipfruit production to an IFP programme is market demand (retailer and consumer). The market not only wants fruit that has been produced within pesticide label recommendations, but also has been produced in a system that considers the environment, growers, and consumers (Ball 1997). Additional reasons for IFP include an international trend towards reduced agrichemical use and the threat of pest and disease resistance to agrichemicals.

ENZA, together with HortResearch and the national NZ-IFP committee, developed the pilot ENZA-IFP programme based on European guidelines in 1996

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<sup>3</sup> Estimates only as no registration process. Includes also fruit produced for the Japan and Taiwan programme

<sup>4</sup> Some growers were registered for both ENZA-IFP and IFP-USA. The total number of growers combined was 782.

(Batchelor 1997). The pilot ENZA-IFP programme was implemented commercially in 1996/97 with 88 orchards involved nationally. In 1997/98 361 orchards were involved. By 1998/99 567 growers were involved. The target is for 900 growers to be involved in the 1999/2000 season with 80%<sup>5</sup> of the total crop produced under ENZA-IFP, and then 100% grower adoption of IFP by the year 2001 (ENZA Express, August 1998). Hence, the adoption rate required is very steep.

In Europe, the development of IFP followed on from IPM programmes. In addition to integrated pest and disease management, European IFP programmes also cover:

- Site, rootstock, cultivar and planting systems selection
- Soil management and tree nutrition
- Orchard understorey management
- Tree training and management
- Safe and efficient and spray application technology
- Crop management
- Eliminating pollution of the fruit from outside sources
- Maintaining habitat diversity, land sustainability and conservation of resources
- Maintaining fruit quality (post-harvest)
- Disposal of waste
- Employment standards

The ENZA-IFP programme was modeled on the European IFP guidelines and technical subgroups were set up to cover all aspects of pipfruit production and produce an IFP grower manual (Batchelor, 1997). The chapter titles in the manual are:

1. Pest Management
2. Disease Management
3. Site, Rootstocks, Varieties, Planting Systems and Production Management

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<sup>5</sup> The target of 80% of total crop is the total of ENZA-IFP and IFP-USA production.

4. Spray application Technology
5. Weeds and Understorey Management
6. Water Management
7. Tree Training
8. Orchard Environment Quality
9. Industry Operations
10. Cleaner Production
11. Workshop, Training, and Auditing
12. Pesticide Rating System
13. Marketing Intelligence, and Regulatory

To date growers have only implemented the pest and disease management practices of the ENZA-IFP programme. Two more sections were introduced during 1998, namely Site, Rootstocks, Varieties, Planting Systems and Production Management and Spray Application Technology.

Since the 1997/98 season, growers in the ENZA-IFP programme have been paid an additional \$0.25 per carton for export fruit over and above the ENZA payment per carton. The reasons for this included that they incurred additional costs, that they had to change some orchard practices, they were ineligible for the USA premium, and they had additional risk exposure while trialing a new programme. ENZA has indicated that some financial incentive will be paid over the transitional phase of the ENZA-IFP programme. However, they have also stressed that this is an adoption incentive not a market premium (ENZA Express, August 1998). Pipfruit produced under IFP does not receive higher prices than conventionally produced fruit in overseas markets. ENZA have stated that the incentive for New Zealand growers to adopt IFP is continued market access for their fruit (Batchelor 1997).

### **1.4.3 The IFP-USA programme**

In 1997/98 the USA-transitional programme was introduced, as a method to incorporate ENZA-IFP techniques without compromising the USA supply programme (ENZA Express, October 1997). The programme involved growers implementing technologies used in the IFP programme such as pheromone trap monitoring and Insect Growth Regulators (IGR) instead of organophosphates for the management of *Lepidoptera spp.* pests. However, to minimise the risk of actionable or passenger pests being found at USDA inspection, growers have to apply an organophosphate late November (timed for the crawler stage of mealy bug) and another prior to harvest to remove any passenger pests. Growers are paid the \$1.00 per carton as an incentive for meeting the US-COP standard plus the \$0.25 IFP incentive. In 1997/98, ninety nine growers were involved in the IFP-USA programme, while in 1998/99 this number has risen to 315 growers.

### **1.5 A General Overview of Technology Transfer Methods Used by New Zealand Pipfruit Growers**

Currently, the key agents for the transfer of new technologies in the New Zealand pipfruit industry are ENZA, growers, scientists (predominantly from HortResearch), consultants and industry representatives (agricultural merchants).

Stewart (1997) surveyed growers in 1992 and found 68% of Hawke's Bay growers cited agricultural merchants as their most important source of pest and disease management information, 14% cited consultants, and 6% other growers. The survey also found that growers thought grower publications were useful sources of information. The key grower publications are the 'Orchardist of New Zealand', the ENZA 'Pipmark' technical bulletin, Horticultural News, and 'The Good Fruit Grower' (an American publication).

HortResearch holds annual field-days to present the outcomes from their industry funded research. In addition to those field days, HortResearch scientists present

information at industry funded extension meetings, provide advice to consultants and agrichemical representatives, and produce extension articles (Stewart 1997). HortResearch also monitor pest and disease levels (eg, summer egg hatch of European Red Mite) and publish timely guidelines and recommendations for growers in local newspapers. Approximately 6% of HortResearch's research funding comes from ENZA and a component of this funding is tagged for extension of the outcomes of that research.

The agrichemical and consultancy companies also host field days and seminars to promote new products. Some of the larger packhouses have their own field staff or contract consultants to provide their suppliers with technical support.

Since 1997, Hawke's Bay, Nelson, and Otago each have a regional Focus Orchard which aims to implement sustainable production technologies on a commercial orchard and present the findings to the wider community. The focus of these orchards is grower, industry, and community sustainability. Two field days are held each year to present the outcomes of technologies implemented on the Focus Orchards.

Consultants offer a range of private services to growers. Stewart (1997) found that some provided day-to-day pest and disease management advice, while other consultants left the day to day pest management decisions to the grower and spray representative. These consultants provided more long term guidance and management advice, such as financial management and strategic planning.

Until 1996 ENZA employed field staff to liase and provide an extension service to growers. Currently ENZA produces technical manuals, technical bulletins, and holds seminars to introduce and promote technologies such as spray application, TRV, or managing new varieties.

### **1.5.1 Technology transfer and communication of the ENZA-IFP programme**

The ENZA-IFP programme was introduced to growers and the industry via ENZA technical bulletins (ENZA Express) and grower meetings in 1996 (Batchelor, 1997). HortResearch has played an important role in producing the ENZA-IFP standards and a related specifications manual. The manual targets growers, consultants, and industry representatives.

During the first season (1996/97) growers, consultants and industry representatives intending to participate in the pilot IFP programme were involved in three ENZA training courses: an introduction to ENZA-IFP; a session on pest monitoring and management; and one on disease monitoring and management. The NZ-IFP committee developed a model for the transfer of technical information to the growers involved in the pilot programme. This model involved regular discussion group meetings of 10-12 growers with a facilitator (predominantly consultants) and a research adviser. Problems that were not solved in the meetings were faxed to HortResearch scientists who then faxed answers and information to all the group facilitators.

This model worked well for the 1996/97 season. However only 88 out of 1650 growers nationally were involved. There was concern that the current specialist resources available (HortResearch scientists and consultants) would not be sufficient to cater for 1650 growers if this model was extended in the future. ENZA acknowledged that it would be important for the industry to identify other technology transfer methods to assist with the industry adoption of ENZA-IFP (Batchelor, 1997).

To participate in the ENZA-IFP programme for the 1997/98 season, growers were required to be registered with a discussion group. These groups were run by accredited ENZA-IFP facilitators who were predominantly consultants and spray representatives. To be an ENZA-IFP facilitator participants had to complete a one

day training course on the technical aspects of ENZA-IFP and group facilitation. HortResearch also held a follow-up technical session in late Spring.

## **1.6 Problem Statement**

The New Zealand Apple and Pear Marketing Board has indicated that it aims to have all export pipfruit produced under the ENZA-IFP guidelines by the year 2001. However, little is known about New Zealand growers' attitudes towards the ENZA-IFP programme, or the factors that may influence the programme's adoption. Understanding those factors could identify the most appropriate technology transfer methods and/or tools required to meet the NZAPMB's objective.

The IFP system in the initial years has been quite fluid, due to the relatively small number of growers involved (Batchelor, 1997). However, it will be essential that effective technology transfer processes are established to meet industry needs and to achieve ENZA's goal of 100% production under ENZA-IFP. IFP is complex, and uptake has been documented to be slow unless education programmes are designed to encourage adoption of new practices (Wildbolz, 1992). The underlying complexity also contributes to the low rate of adoption (Herbert 1994; McNamara 1991). As a consequence of the above points, it is important that researchers and ENZA understand the social, economic, and bio-physical determinants of adoption by producers, in order to develop a programme that will be taken up successfully and at the rate sought by ENZA.

## **1.7 Objectives of the Study**

The objectives of the study were to:

- Identify key differences between IFP and non-IFP growers and their attitudes towards IFP.
- Identify key factors that influence grower adoption and implementation of the ENZA-IFP standards.
- Review the technology transfer processes used to enhance the adoption of sustainable technologies, such as IFP.

- Identify methods of technology transfer that may encourage grower adoption of the ENZA-IFP programme.

## **1.8 Study Outline**

The next chapter is a review of the relevant literature which was used to develop the protocols for the field work, and is broken into the following sections:

1. Adoption theory;
2. Methods of technology transfer;
3. Review of IFP and IPM programmes in developed countries, New Zealand and internationally;
4. Review of international literature on the adoption of such programmes and influencing factors;
5. Survey results from international research projects identifying factors that influence grower adoption of sustainable technologies;
6. Review of contemporary literature to isolate international best practice in methods that facilitate grower learning and technology adoption.

From the review, a conceptual framework of the factors that influence the adoption of sustainable technologies has been prepared for use in the later stages of this research.

Chapter Three outlines the method used for this study. It discusses qualitative methods for social research and the reasons why a case study approach was taken. Data collection and data analysis methods are also described.

The results from the case study analysis for the IFP and non-IFP growers are presented in Chapter Four. The results were compared and contrasted within case and between case, then compared with the conceptual framework derived from the literature.

In Chapter Five the results are discussed with reference to the study objectives, conclusions are made, and areas for further research are identified.

## **CHAPTER TWO: A REVIEW OF FACTORS THAT INFLUENCE ADOPTION OF SUSTAINABLE TECHNOLOGIES**

### **2.1 Introduction**

The objectives of this literature review are to identify and discuss theories of adoption of technologies related to sustainable management practices, such as Integrated Fruit Production (IFP), and to identify the key factors that have been shown to influence adoption of such technologies in developed countries.

The literature review is divided into the following sections:

- theory on the adoption of technologies in agriculture and horticulture, in terms of why growers adopt such technologies and what change processes are used.
- a review of factors that influence adoption of sustainable technologies as identified in international research;
- examples of IFP and IPM programmes, both international and in New Zealand, and the technology transfer processes used in them; and
- strategies that may enhance adoption as identified in the literature

Factors that influence adoption of sustainable technologies in developed countries, in particular IFP or IPM systems, have been often documented in the literature. However, most of this literature is produced from the European Union or the United States of America where the IFP or IPM systems, extension services, and/or the growers' are predominantly subsidised (Thompson, 1996). Furthermore, for the New Zealand pipfruit industry the factors that influence growers decisions to implement IFP are not well described. Two particular frameworks that could be used to describe adoption of agricultural technologies (and sustainable technologies) are Rogers' (1995) 'Diffusion of Innovations' model and Roling's (1994) 'Knowledge and Information Systems' model. These two models take opposing views on the way in which agriculture technologies are adopted and have been discussed by many authors in attempting to summarise the factors that influence adoption.

This section discusses the attributes and limitations of the two adoption models with respect to grower adoption of agriculture/horticulture technologies.

## **2.2 Diffusion of Innovations**

'Diffusion of Innovations' was first introduced during the early 1960's (Rogers 1995). Rogers (1962) categorised farmers on their rate of adoption of a new technology from when it was first introduced. Farmers who adopted the technology early were characterised as innovators, and those that were slow to adopt, the laggards.

Several authors made reference to and used this theory to describe the of adoption and implementation of Integrated Pest Management (IPM) (Fernandez-Cornejo *et al* 1996; Lambur *et al* 1985). The authors also suggested that a number of factors influenced the success or failure of the adoption of IPM/IFP programmes, and suggested that putting diffusion theory into action could facilitate adoption. Guerin and Guerin (1994) found that Rogers' Diffusion of Innovations model was applicable for the adoption of technologies for Australian beef farmers. One review said that this model has been the predominant model for agriculture research and extension (Reid 1996).

Rogers (1995) suggests that adoption or rejection of technologies follows a innovation-decision process. The first stage of this process is becoming aware of the technology and gaining some knowledge of what it involves, then forming an opinion regarding the technology. A decision to adopt or reject the technology follows. If the technology is adopted the next stage involves implementing and putting it to use. Confirmation of the decision to adopt is the final stage of the innovation-decision process. Lambur *et al* (1985) found that for growers to make an adoption decision three stages of information are required: (1) stimulation of an issue; (2) contact with new technologies; (3) and collaboration with growers in the transition phase. This confers with Rogers' theory.

The Diffusion of Innovations model has been described as a linear model where research comes up with the innovation which is then passed on to extension agents, who then transfer the innovation to the farmers or growers (Reid *et al*, 1996).

Rogers describes diffusion of an innovation as a percentage of adoption over time, producing an 'S' shaped curve. Rogers (1983) established a framework to try and describe the rate of adoption of innovations. This framework is made up of five 'perceived attributes of an innovation', namely: relative advantage; compatibility; complexity; trialability; and observability.

Relative advantage is defined as the degree the innovation is perceived to be better than the current idea or practice, for example economic profitability, initial cost, perceived risk, degree of discomfort, savings in time and effort, and immediacy of reward. Wearing (1988); Zalom (1993); Glass (1992); and Cross *et al* (1996) all agree that economic profitability, or the technology's relative advantage is a key motivating factor in the adoption of sustainable technologies.

Compatibility is defined as the degree to which the innovation is perceived to be consistent with the existing values or technology, and needs of the individual. Kennedy (1990); McNamara *et al* (1991); and Wearing (1988) all found that the more compatible an innovation was with the farmer's/grower's current situation the more readily it would be adopted. Technologies need to be compatible with a farmer's/grower's current situation, easily understood and easily implemented (Wearing 1988; Herbert *et al* 1994; Kennedy 1990; McNamara *et al* 1991; Lambur *et al* 1985).

Rogers (1995) described complexity as the degree to which an innovation is perceived as relatively difficult to understand and use. Many authors have recognised complexity of innovations as a barrier to adoption as discussed in section 3.3.2.

Trialability is described by Rogers (1995) as the extent to which a grower can try out or test the technology. Other authors talked about this, but used terms such as the success of the technology and hence the confidence growers had in the innovation or technology (Wearing 1988; Glass 1992).

Rogers (1983) described observability as how much the outcomes from adopting an innovation are visible to others. Wearing (1988) also reported that if peers had adopted an innovation, and it was seen to be successful, it positively influenced the rate of adoption. If the results from research are simple, easily observed, and simple to communicate they are more likely to be adopted (Guerin and Guerin 1994).

Many technologists think that advantageous innovations will sell themselves, that the obvious benefits of a new idea will be widely realised by potential adopters, and that the innovation will therefore diffuse rapidly. Unfortunately this is seldom the case. Most innovations diffuse at a surprisingly slow rate (Rogers 1983).

### **2.2.1 Categories of Adoption - The innovativeness of an individual**

*“Innovativeness indicates overt behavioural change, the ultimate change” (Rogers 1995, pg 252).*

Over the last forty years diffusion theory researchers have developed a number of systems and names for characterising different groups of people or industries and their rate of adoption. The method developed by Rogers (1995) groups adopters on their degree on innovativeness using five adopter categories. The author noted that these categories are ‘ideals’ and exceptions can be found. The categories are:

#### **1. Innovators (2.5% of population)**

This group are characterised by their interest in new ideas and wanting to lead the way. They generally have financial resources to cover for possible unprofitable

innovations, the ability to understand and implement complex technological innovations, and the ability to deal with uncertainty regarding the success or not of an innovation.

2. Early Adopters (13.5% of population)

Early adopters serve as role models for potential adopters as they are not far ahead of the average adopter. Potential adopters seek out advice and information from early adopters. Characteristics of an early adopter include peer respect, they are an integral part of the local social system, and they reduce uncertainty about new ideas by their subjective interpersonal communication regarding the innovation.

3. Early Majority (34% of population)

This group adopts new ideas just before the average member of a social system. Characteristics include considering the idea for a long time before adopting and are willing to adopt innovations but not to lead.

4. Late Majority (34% of population)

This group adopts new ideas just after the average member of a social system. Characteristics include: the reason for adoption is generally out of economic necessity and increasing pressure from peers; for this group the pressure of peers is necessary to motivate adoption; innovations are approached sceptically and cautiously; and most of the uncertainty regarding a new idea needs to be removed before they feel it is safe to adopt.

5. Laggards (16% of population)

This group is the last to adopt. This group generally makes decisions on what has been done or has been experienced in the past. Laggards are generally suspicious of new ideas and change agents, and have a poor economic position which makes them cautious of adopting new ideas.

## 2.2.2 Characteristics of adopter categories

Rogers' (1995) diffusion research has identified a number of generalisations regarding characteristics of adopter categories. These are divided into socio-economic characteristics, personality variables, and communication behaviour:

### Socio-economic Characteristics

- *Earlier adopters are not different from later adopters in age*
- *Earlier adopters have more years of formal education than later adopters*
- *Earlier adopters are more likely to be literate than are later adopters*
- *Earlier adopters have higher social status than later adopters*
- *Earlier adopters have a higher degree of upward social mobility than later adopters*
- *Earlier adopters have larger units(farms, schools, companies) than later adopters*

### Personality Variables

- *Earlier adopters may be less dogmatic than later adopters*
- *Earlier adopters have a greater ability to deal with abstractions than do later adopters*
- *Earlier adopters have greater rationality than later adopters*
- *Earlier adopters have greater intelligence than later adopters*
- *Earlier adopters have a more favourable attitude to change than later adopters*
- *Earlier adopters are better to cope with uncertainty and risk than later adopters*
- *Earlier adopters have a more favourable attitude to science than later adopters*
- *Earlier adopters are less fatalistic than later adopters*
- *Earlier adopters have higher aspirations (for education/occupation etc.) than later adopters*

### Communication Behaviour

- *Earlier adopters have more social participation than later adopters*
- *Earlier adopters are more highly interconnected through interpersonal networks in their social system than later adopters*
- *Earlier adopters more cosmopolite than later adopters*
- *Earlier adopters have more years of formal education than later adopters*
- *Earlier adopters have more change agent contact than later adopters*
- *Earlier adopters have greater exposure to mass media communication channels than later adopters*
- *Earlier adopters seek information about innovations more actively than later adopters*
- *Earlier adopters have greater knowledge of innovations than later adopters*
- *Earlier adopters have a higher degree of opinion leadership than later adopters. (Rogers 1995, p. 269)*

Rogers (1995) identified a paradox when looking at innovativeness and adopter characteristics. Those that most need the benefit from a new idea (less wealthy, less educated) are generally the last to adopt it, whereas, the leaders and people doing well in a social system are most likely to adopt early and benefit from an innovation. This only then widens the socio-economic gap.

### **2.2.3 Extension model used - Transfer of Technology (ToT)**

The Diffusion of Innovations model uses the traditional ToT model for the transfer of information. This is a simple two way linear model between the growers or farmers and the scientists (figure 1). It assumes that the scientists are the creators of a technology and the receivers are farmers. Linking the two are extension agents. This model has worked well when considering homogeneous production environments for market driven innovations (1994).

**Figure 2.1** Transfer of Technology Extension Paradigm (Parminter 1994)



#### **2.2.4 The limitations of the ‘Diffusion of Innovations’ model**

Not all authors agree with the ‘Diffusion of Innovations’ model and the theory has received much criticism since its proposal in 1962 (Roling 1994; Ridgley and Brush 1992; Guerin and Guerin 1994; Foster *et al* 1995). Criticisms include that diffusion of innovations has shown only to occur within homogeneous groups with access to key resources, production objectives and opportunities (Parminter and Parminter 1994) and that desirable innovations would be adopted by a homogeneous group regardless of intervention from scientists or extension agents.

Several authors have stated that this model is not applicable to explain the adoption of sustainable agriculture technologies, because selective adoption is not explained. Ridgley and Brush (1992) state that the adoption or non-adoption of sustainable production technologies is not a black and white ‘issue’, and that a grey area exists where selective adoption forms an important part of the adoption process.

Roling (1994) said that sustainable agriculture can not be described as an ‘innovation’ that farmers ‘adopt’, but that it is more a evolution in agriculture. The author states that this shift involves a learning path leading to new perspectives on risk avoidance, new professionalism, a greater reliance on one own expertise and observation, the use of new indicators and usually a greater dependence on collective decision making.

Roling (1994), like Rogers (1983), argues that extension and research play an important role in agricultural innovation, but the roles are different. Rather than a transfer of knowledge to farmers as implicit in Roger's model, an exchange of knowledge with farmers is the key, according to Roling. Extension science for a number of years has been based on the extension worker introducing 'innovations' to users (farmers) and then expecting the innovation to spread through the community by 'diffusion' as discussed by Rogers. According to Roling this theory has been the dominant sociological concept for some time. The theory suggests that once new ideas are introduced to innovative and better educated growers, they will then diffuse to others in the community.

During the 1970's the Diffusion of Innovations theory was used in developing countries and it became apparent that this trickle-down approach didn't work, that adoption was not a linear model with technologies adopted first by the innovators and eventually picked up by the laggards (Roling 1994; Guerin and Guerin 1994). The reasons for this included: the observation that a particular technology may not necessarily be applicable to all farmers; innovations are often developed on experimental farms with little regard to the conditions the farmer may face in reality; and little account is taken for local conditions or social factors. Innovations have often proved fruitless if the end users were not involved in the development or implementation of the technology (Roling 1994; Wearing 1988).

Other limitations noted by Ridgley and Brush (1992) were that the classical model assumed that awareness and knowledge of an innovation will always filter to all sections of the farming community, and that it assumes that awareness of new and relevant technology is sufficient reason for farmers to adopt. Partial adoption of the technology or innovation is not accounted for in this model (Roling 1994). Also adoption does not always follow the stages suggested by Rogers (1983) of awareness through to knowledge, trial, and adoption, as it is not always possible to trial a new technology.

However, even though it has been documented that the linear model has

limitations, in reality it is still the predominant model used (Roling 1994; Guerin and Guerin 1994). One reason for this is that researchers are still judged on the number of innovations or new technologies developed rather than how successfully the innovations are adopted (Roling 1994).

### **2.3 Knowledge and Information Systems - The “Participatory Action Research’ (PAR) Model**

The ineffectiveness of the diffusion of innovation research and extension theory in developing countries has led to the development of new adoption theory systems (Roling 1994; Foster *et al* 1995). Participatory Action Research (PAR) has been suggested as an improved model for the adoption of technologies. Several authors have discussed the way in which PAR complements the traditional adoption-diffusion model and that both are valuable when looking at the transfer of multifactoral innovations in agriculture (Guerin and Guerin 1994; Roling 1994).

PAR involves farmers in the research process from the development of the project, through implementation, analysis of the results, through to recommendations. A participatory approach aims to encourage the farmer to stimulate the research. The participatory approach has been described as interaction between farmers/growers, extension agents, and scientists, using extension methods such as workshops, appraisal, or focus groups (Foster *et al* 1995). A study of Waikato livestock farmers found that for resolving issues of sustainable agriculture a participatory approach was important (Parminter 1996). To date, the ENZA-IFP programme has been using a participatory approach by combining the knowledge of research, extension, leading growers, environmentalists, agri-chemical groups and the community (Batchelor, 1997).

An adaptation of PAR that helps to describe the adoption of sustainable technologies is Farming Systems Research (FSR). FSR incorporates local farmer knowledge in the development of new or adapted technologies. It still places the initiation of the technology onto researchers, but incorporates farmers’ local

knowledge into the technology development using a participatory approach.

As agriculture and horticulture face increasingly complex issues, adoption of sustainable technologies being one of them, the FRS model is expected to add value to the traditional model for agriculture research and extension (Reid 1998; Parminter 1994; Paine 1997). Authors discussing FSR identified that for the successful adoption of sustainable technologies there needs to be a collaboration of all parties involved including research, extension agents, farmers, growers, managers, and the community (Roling 1994; Foote-Whyte 1991), there needs to be a co-ordinated approach (Wearing 1988; Cross 1996), and there needs to be an exchange of knowledge instead of a transfer of knowledge.

However, the review by Guerin and Guerin (1994) also highlighted some perceived limitations to PAR, including that PAR distracts scientists from their primary role of research, with working in groups the information may be retained by the group and not shared with the wider community, and that PAR has yet to be validated.

### **2.3.1 Extension science - facilitating learning**

The word extension has a number of meanings and covers a number of activities (Roling 1988). In the UK, Germany, and Scandanavia extension implies 'advisory work', whereas in the United States they use the term extension education to describe an 'educational activity which seeks to teach people to solve problems by extending information'. In France extension implies a simplification of information and a top down information flow process. Roling (1988, page 39) describes five common elements of extension.

- (1) Extension is an intervention
- (2) Extension uses communication as its instrument to induce change
- (3) Extension can be effective only through voluntary change
- (4) Extension focuses on a number of different target processes and outcomes which distinguish it from other communication interventions

(5) Extension is deployed by an institution.

Extension involves the transfer of information. To effect change generally requires more than one intervention, and for agricultural technologies a combination of technical intervention and communication intervention (technology transfer) is required. Extension should be a two way process, both bottom up and top down (Roling, 1988). Rogers (1983) stated that communication is a two way process, rather than one way, where participants both create and share information.

Roling (1988) suggests that research and extension science should not be looked at in isolation but be part of an integrated information process. This process should involve collecting information and ideas from people to help shape the information and ideas that are disseminated to growers, and vice versa.

Roling (1988) defined extension science 'as a body of knowledge that accumulates experience and research findings with respect to extension'. Extension is important for the further development of agriculture as today advancements in agriculture are technology driven, and the combination of research, extension, and education are important for this advancement. Extension is also used to change farmer behaviour where developments in agriculture have lead to undesirable macro situations such as over-production and environmental pollution.

### **2.3.2 Extension models used**

Compared to the linear model of ToT, the extension model used for 'Knowledge and Information Systems' is multi-interactive. A number of extension methods may be used including discussion groups, workshops and focus groups, where information, discussion, and research between farmers, extension agents, and scientists can be stimulated. In this instance farmers are encouraged to partake in the research development through to implementation.

### **2.3.3 Selective adoption**

Steffey (1995) and Ridgley and Brush (1992) indicated that for IFP/IPM programmes to be successful full adoption of the programme may not be necessary and that selective adoption can be a step in the adoption process of sustainable production systems. Selective adoption may be a better model for the changes brought by IPM than simple diffusion models based on innovations, such as Rogers' (Glynn 1995).

Most innovation diffusion research categorised farmers as adopters or non-adopters of a particular technology with no grey area between (Roling 1994) and many evaluations of technology adoption equate selective adoption as non-adoption (Ridgley and Brush 1992). However the adoption of most technology is limited and often partial, even when the benefits of the new technologies have been proven through research. More researchers now accept the proposition that an understanding of local knowledge and informal experimentation is an essential element in the development of agricultural technologies (Gladwin 1989).

In the US, only a low number of farms or farmers are meeting all the defined goals and practices of IPM, but a large number have adopted some techniques (Glynn 1995). The majority of growers see IPM as a pest management strategy because of the emphasis on pest scouting education and the use of economic damage thresholds for pesticide application. However, IPM guidelines also promote soil and water conservation practices and biological control if suitable. This not only requires different behaviour, but a new way of looking at problems and solving them.

Technology adoption usually focuses on the technical aspects and establishing technical aids to assist the adoption. This is not suitable for IPM, which involves complex behavioural change and new perceptions (Ridgley and Brush 1992).

Rogers (1983) found that people are more likely to adopt innovations that are compatible with their current situation. Previous research on the process of selective adoption found that people adopt aspects of a technology that are readily compatible, then gradually incorporate more tactics as long as profit and confidence are maintained. They adopt practices that they are confident with, that have been tested and proved by research and peers, and practices that are significant for the management of their farm or orchard.

A European example is the significant economic pest, Codling Moth. Codling Moth monitoring and economic thresholds which aim at efficient use of pesticides are more readily adopted than alternative or biological control of other pests. Reasons are that growers are used to and comfortable with using pesticides, and a reliance on beneficials for controlling pests is more complex, unknown, unreliable, and time-consuming (Ridgley and Brush 1992). As Codling Moth can be a significant pest if not controlled properly, hence much work has been done to improve monitoring procedures and economic thresholds. Long-term experience of Codling Moth monitoring has reduced any uncertainty of the practice, and growers have learned that IPM crop monitoring ensures high fruit quality. Other pests such as Pear Psylla are not a major problem every year, hence the monitoring procedures have not been streamlined and are time consuming and complex. Additionally, the thresholds and procedures have not been as well tested by the growers and there is uncertainty regarding the procedures. This has resulted in lower adoption of this technology.

Pest managers will often selectively adopt and implement portions of the IPM technology cluster that best suit their resources and needs. Farmers are selective and adaptive in their adoption of IPM despite it being promoted as a package to a relatively homogeneous population. Farmers will adopt those components that are best suited to their circumstances and reject others.

Ridgley and Brush (1992) stated that the primary goal of IPM is to reduce pesticide load. They posed the following questions: (1) is the adoption of all

components of the technology necessary in order to achieve reductions in pesticide use?; (2) which components have the greatest impact on reduction in pesticide use?; and (3) is it possible that the adoption of some components without others can actually increase pesticide use?

The authors concluded that their study indicated that modification and selective adoption are not merely characteristics of the diffusion process among poor farmers in developing countries, but adaptation occurs even under the best circumstances and should be considered a natural part of the adoption process. Recognising the validity of selective adoption, rather than simply trying to overcome it, is important in technology adoption (Steffey 1995). This research confirms that social research can make important contributions to the design and implementation of IPM programmes. The findings also question the common assumption that if farmers are involved in the research process, have adequate education and information, and are supplied with the adequate inputs and economic resource, they will adopt a proven beneficial technology.

Ridgley and Brush (1992) recommended that in order to reduce the perceived complexity of IPM programmes, they can be presented as a series of individual tactics and tools, with each component promoted separately. For example, growers could first be encouraged to use selective pesticides, then to monitor and use action thresholds, look at predator/prey ratios, and finally to initiate biological control.

#### **2.4 Diffusion of Innovations, Participatory Action Research, and Selective Adoption**

When comparing the two models, the traditional diffusion-adoption model and the PAR model, and its adaptations, the role of the extension agent in each is different. As discussed in the linear model, the extension agent's role is to transfer knowledge from research to the user. In sustainable agriculture the farmer can be classified as the expert and manager of their own complex, region specific farm

system, hence the extension agent needs to focus on supporting the farmer learning process and facilitating group education (Roling 1994).

IFP and IPM production systems have been well documented as being complex technologies in comparison to conventional production systems (Zalom 1993; Lambur *et al* 1985; Herbert 1995; Guerin and Guerin 1994). Implementation of complex technologies requires examination of a number of factors including social, financial, technical, risk, education and empowerment of the user. Whereas the Diffusion of Innovations model categorises farmers as adopters and non adopters (Rogers 1983), research into the adoption of IPM indicates partial adoption is an important stage of the adoption process, where growers do not adopt IPM as a whole system but adopt or select the parts of the programme that fit their needs (Ridgley and Brush 1992). Diffusion theory is useful as a basis for understanding factors that influence grower adoption of IFP, however selective or partial adoption of IFP is an important part of the adoption process.

It is also acknowledged that an understanding of local situations, grower knowledge and local experimentation are important aspects in the development of new technologies (Gladwin 1989). These points indicate that for adoption of sustainable technologies the diffusion of innovations model may be too simplistic and that a participatory approach or selective adoption may be a better model for the changes brought by IPM or IFP (Glynn 1995).

Roling (1994) suggested that as adoption of more sustainable practices is not so much a question of adopting an innovation, but of a paradigm shift requiring a learning process, then a greater understanding of the learning path is required. The changing perception of risk and insecurity along that path needs to be understood, and the way progress is made along the path needs to be made visible.

## **2.5 The Key Factors that Influence Grower Adoption of Sustainable Technologies - A Discussion of International Research**

The factors influencing adoption of sustainable technologies have been described as multifactorial (Guerin and Guerin 1994) with a number of key factors identified. These factors include financial, risk, confidence, complexity, technical, and educational factors. Researchers also found that despite evidence for producer and environmental benefits from IPM/IFP, adoption has never occurred at the levels hoped for (McNamara 1991; Herbert 1994; Lenz 1990; Guerin and Guerin 1994). Following these observations a number of researchers have focused on trying to identify the key factors that influence adoption and what practices or systems can be put in place to enhance adoption of sustainable technologies in agriculture.

Research and extension specialists in Europe, USA, and Australia/New Zealand were surveyed by Wearing (1988) to identify the obstacles or factors that had contributed to the adoption of IPM programmes. Wearing (1988) is referenced by many authors. Important factors influencing adoption have been classified as technical, educational, institutional, financial, and social issues (Wearing 1988; Zalom 1993). Wearing (1988) found that social and marketing obstacles rated above all others for their impact on IPM adoption.

Many other authors concurred with these findings (Herbert 1994; McNamara 1991; Kennedy 1990) and added factors such as; grower trust in an IPM programme, complexity, incentives and benefits, information and communication, uncertainty associated with new approaches, compatibility with current practices, the availability of resources, and information on environmental consequences of various activities.

Wearing (1988) discussed further barriers to IPM implementation. These included:

- 1) a lack of incentives for growers to change from existing pest controls they perceive to be satisfactory;

- 2) a lack of grower confidence in new systems until they have been proved in operation;
- 3) a need for new systems to compare favourably with the relative simplicity and low cost of standard chemical controls (IPM systems requiring extensive data collection and input are unlikely to be well received);
- 4) a lack of the data required to develop control thresholds that relate pest and disease levels to reductions in final income.

Many of these barriers to the implementation of IPM systems can be attributed to problems with information collection and manipulation, or the attitudes of the decision maker to the system.

Regional workshops held in five states in the US during 1993 to identify grower constraints to the adoption of IPM and the solutions to overcoming these constraints found the top constraints were:

- (1) lack of incentives;
- (2) differing agendas and conflicting messages from government agencies;
- (3) loss of funding for applied research;
- (4) lack of adequate funding for IPM education and research (Steffey 1995).

Lack of extension funds and funding for IFP research and education was also reported as an obstacle by Herbert (1994), and that traditionally funding has been for development of IPM programmes and not implementation, adoption and continued maintenance.

A survey of IFP growers in Central Europe indicated that in regions where IFP had been adopted without direct financial benefit it was proving difficult to sustain grower interest and that growers need financial compensation to keep motivating them to remain in the programme. Financial reward was found to be the strongest motivating factor, and it needs to be sufficient to cover additional costs or difficulties involved with IPM production. It was found that even a small increase in fruit price (<1%) is sufficient to motivate growers to adopt. Additionally,

growers reported that IPM offered no short-term advantage in profit compared to conventional practices and IPM was more difficult to manage, partly due to cost of labour, cost of IPM services offered by consultants, costs of complex monitoring, and staff supervision (Cross *et al* 1996). Few farms and only small areas are involved in the IFP programme in West Germany (Lenz 1990). It was found that, in this region, the main motivating factors to change to IFP was improved marketing, to be better informed, and to consider public pressure.

In the United States, IPM in soybean production has not been widely adopted by growers. An evaluation indicated that insecticide use resulted in superior economic outcomes when compared with a strategy based on co-operative extension economic threshold guidelines. Economic threshold was defined as the lowest pest density that will cause economic damage. The results indicated that the threshold guidelines should be re-evaluated and more finely tuned to ensure a reduction in risk (Szmedra 1990).

One review suggested that farmers who adopt new technologies are more willing, or able, to take financial risks (Guerin and Guerin 1994). The same review indicated that a farmer's attitude to change is an important factor in the adoption of innovations, and for innovations to be adopted farmers adverse attitudes to innovation need to change. Bangura (1983) reported that when an innovation is perceived to be profitable, simple and easy to understand, be able to fit the needs and resources of the farmer, have an acceptable level of risk, and be compatible with the farmers goals the rate of adoption will be enhanced.

Many authors talked about the comparison between conventional pest and disease management with pesticides and the integrated approach of IPM which aims to use pest and disease monitoring information and 'soft selected' pesticides integrated with biological control. The advantages of conventional pesticides over IPM are; conventional production is easier and more cost effective to manage pests, most pesticides are proven to be effective, and there is a high ratio of chemical supply personnel, distributors, and advisors in comparison to IPM

advisors (Glass 1992). There is also a perception that alternatives are less effective or more expensive than synthetic chemical pesticides (Zalom 1995) and Wearing (1988) reported that sustainable integrated production systems can not be 'packaged' for sale to growers but need to be tailored for local conditions.

Agrichemical industries have been cited as a significant constraint to IPM implementation (Vorley 1990). There is an established infrastructure (policy, legislation, distribution, information etc.) for pesticide supply and use, and many of the social, environmental, and resistance costs and risks of chemical use are hidden. Additionally, growers have experience, confidence, and satisfaction with chemicals, have the equipment to use them, and chemicals fit the needs of a grower.

Additional obstacles identified were a lack of communication and promotional channels for biologically orientated IPM compared to these of pesticides, a shortage of trained IPM personnel to develop and transfer IPM technology to local level, a pro-pesticide attitude by some consultants, and a lack of extension demonstrations and education programmes.

A consistent pattern in the key factors that influenced adoption of sustainable technologies was reported in the literature. Financial factors and grower perceptions of risk were consistently noted as the key factors or obstacles to grower adoption. Social factors such as grower confidence in the programme, grower characteristics and education/technology transfer factors were rated as more significant to successful adoption than technical or environmental factors.

For this study a conceptual framework was developed of the key factors that influence adoption of sustainable technologies such as IFP. These key factors are based on the review of the international research. The key themes identified in the review are categorised under financial, social, marketing, technology transfer, technical, organisational, and environmental factors.

### 2.5.1 Financial factors

Financial factors are described by many authors in the literature as one of the key factors influencing adoption of IFP or IPM. Financial factors include lack of financial benefit (Cross *et al* 1996; Wearing 1988) and risk of, or perceived risk of, financial loss (Herbert 1994; Zalom 1993). Perceived risk, lack of trust, and resulting perceived financial consequences are probably the greatest financial obstacles (Wearing 1988; Herbert 1994; Glass 1992; Lambur *et al* 1985; Guerin and Guerin 1994). The perceived risk is in the form of the expected increase in pests in the crop as a result of reducing pesticide use, thereby increasing the risk of financial loss.

Herbert (1994) declared that the risk is often perceived rather than real. This study indicated that growers using IPM were more profitable and operated businesses less prone to risk than non-growers do. The author suggested that this was achieved because these growers (a) suffered minimal crop loss because they sprayed when thresholds were reached and (b) if thresholds were not met they did not spray, hence savings were achieved. Steffey (1995) reported that some growers choose not to adopt IPM because they lack access to and/or trust in the information they are provided and that risk reduction may be a way of enhancing adoption. By showing growers that through monitoring they can minimise risks could encourage adoption (Zalom 1993).

Many authors commented on the importance of not increasing the risk or the farmer's perception of it. If growers are to voluntarily adopt biological strategies they need to trust the IPM programme and be convinced that the returns are greater than the risks and effort they put into the programme. Kennedy (1990) suggested that this requires adequate cost-effective resources, and these resources must be convincingly demonstrated so growers know how and when to use them. Consultants and other advisors are recognised as being important in this role of reducing grower risk, by providing independent advice, giving growers peace of mind and promoting the benefits of IPM to the general public (Wardlow 1991; Wearing 1988).

However, the benefits of IPM take longer to realise than conventional production and the concept of economic threshold is risky for many growers. It was indicated that too many programmes lacked the economic targets that match the farmer's perception of financial advantage (Wearing 1988).

A review by Manktelow (1987) found growers' motivations, such as maximising profit, maximising yield or minimising risk of loss, form the basis of grower decision making, and when making pest management decisions growers perceive worst possible loss and risks of financial failure. The decision maker's perceptions are formed on a number of factors including past experience with pest management, association with agrichemical representatives and advertising, and advisory programmes. The author identified two key problems facing decision makers, lack of information and a lack of skills on how to interpret and use the information for pest and disease management. The factors that may influence the growers utilisation of information include their training, experience, and use of technical advisors.

### **2.5.2 Social factors: Complexity, Compatibility, and Confidence**

Wearing (1988) found that social and marketing obstacles had a major impact on adoption. Social factors included a growers personal characteristics, a growers confidence in the programme, the compatibility of the programme to a growers current situation, and the complexity of a programme. Social obstacles discussed included: grower satisfaction with existing chemical control; lack of grower confidence in IPM, and a general resistance of growers to change in attitude.

Confidence is an important factor. In one survey lack of grower confidence in IPM ranked alongside satisfaction with chemicals as a primary obstacle to adoption of IPM. Two authors recommended that grower confidence in the program must be nurtured and maintained as a primary objective (McNamara 1994; Wearing 1988). To build grower confidence the IFP/IPM technology needs to be credible and backed up by science with proven alternative methods of control (Wearing 1988).

Having experience with IPM helps to build confidence. To build grower trust and confidence in IPM the new technology needs to be compatible with the existing system. Guerin and Guerin (1994) reported that for farmers to adopt a new technology they need to have an understanding and a belief in the technology. Zalom (1993) suggested that the concept of economic threshold may be too risky for many growers but that experience with IPM can change this perception and build grower confidence.

One reason for the slow development and adoption of IPM is the complexity of agroecosystems and the almost unlimited number of possible interactions in such a programme (Lambur *et al* 1985, Guerin and Guerin 1994). IPM systems are a complex set of behaviours, decision-making procedures, methods, technologies, and values organised to provide efficient alternative methods. Implementation of complex innovation requires intensive education of users. Lack of education of IPM developers about the perceptions and needs of growers is discussed by many as a major obstacle to adoption.

### **2.5.3 Grower Characteristics**

Many authors discussed the importance of understanding grower characteristics that are associated with adoption when considering the implementation of IPM/IFP programmes. The reviewed literature indicated that the characteristics that are likely to influence uptake are social aspects such as grower goals, skills, knowledge, attitudes, beliefs, motivation, and attitude towards risk, (Herbert 1994). Also indicated as being important were age, level of education, level of farm experience, farm size, and total income. Growers that have contact with extension, attend field days, and read farm literature have a higher rate of adoption than those who do not (McNamara *et al* 1991; Ridgley and Brush 1992; Rogers 1983). Lambur *et al* (1985) described the characteristics of growers who adopt and implement IPM most quickly as likely to have larger operations, be better educated, use more information sources, and be industry leaders. Rogers (1995) also describe these characteristics as attributes of early adopters of innovations.

The authors suggested that when planning to introduce IPM/IFP the focus should be on the group of farmers with the above characteristics in order to enhance adoption. Bangura (1983) suggested that farmer's characteristics and economic limitations need to be considered when planning to implement new technologies. Enhancing IPM adoption may be possible by developing an IPM education programme targeting grower characteristics that favour adoption. Once this group has adopted the technology, additional programmes may be designed for other groups, including part-time growers.

#### **2.5.4 Marketing factors**

Marketing factors have been identified as a key motivating factor for growers adopting IFP (Cross 1996; Wearing 1988). Marketing factors include market access issues and the marketing of conventional chemical control compared to IPM marketing.

There is increasing pressure on primary producers to comply with food safety legislation which requires all parts of the food industry to show 'due diligence' that food is safe (Manktelow 1987). Kennedy (1990) suggested that market access and consumer demands for food safety are likely to encourage the adoption of biological controls if the demand is translated to marketing opportunities.

The competitive advantages of chemical control over IPM were reviewed by Wearing (1988). The survey found that the more important advantages were: the chemical industry established infrastructure (policy, legislation, distribution, information etc.) for pesticide supply and use; a high ratio of chemical supply personnel, distributors, and advisors compared to IPM advisors; much of the social, environmental, and pest resistance costs and risks of chemical use are hidden; and the cost of advice on chemical use is included in the price of the product. Growers also have experience, confidence, and satisfaction with chemicals, they find chemicals simple, easy to use, they have the equipment to use them, and chemicals meet their pest and disease management requirements

(Manktelow 1987). Few alternatives to pesticide use offer the management flexibility, range of control and guarantees of success that pesticides have given.

Zalom (1993) noted lack of marketing expertise by IPM specialists, and a lack of education of IPM developers about the perceptions and needs of growers as a potential obstacle. A lack of understanding of such complexities can lead to development of inappropriate technology which will never be adopted (Wearing 1988; Lambur *et al* 1985).

### **2.5.5 Technology transfer**

Technology transfer is a significant factor authors noted as important during the development and implementation stages of IPM/IFP adoption (Huus-Brunn 1991; Wearing 1988; McNamara 1991; Herbert 1994; Guerin and Guerin 1994; Zalom 1993).

Research carried out by Glass (1992) identified that biologically orientated IPM programmes lack trained IPM specialists, training programmes, scientists specialising in IPM, and training in IPM monitoring and decision making. Additionally, Wearing (1988) identified such adoption constraints as lack of simple communication, lack of educational programmes, and a lack of published information. A review of an IFP programme in Switzerland found that pest and disease control measures change regularly, hence growers need more technical support (Wildbolz 1992).

Lack of extension funds was found to be an obstacle to adoption (Wearing 1988). To attract consultants, IPM programmes must be able to offer competitive payment, which can be difficult for small farmers to sustain. This obstacle seems to have been identified and addressed in the EU where IFP programmes are being implemented with the support of a range of tools such as guidelines, grower training courses, on-orchard monitoring, record books and subsidised technicians. Funding sources identified include regional government, co-operative marketing

associations, grower organisations, and grower levies (Thompson 1996; Cross 1996; Wildbolz 1992; Wardlow 1991).

### **2.5.6 Education factors**

A poor educational standard of growers was seen only as a minor obstacle to adoption (Wearing 1988). However Ridgley and Brush (1992) found that higher levels of education generally lead to higher levels of adoption (Rogers 1983), and growers that have contact with extension workers and information have a higher rate of adoption.

### **2.5.7 Technical factors**

Most authors ranked technical factors as the least likely to inhibit adoption of IPM and IFP. However, in one review it was suggested that until technical problems with the innovation have been addressed there is little benefit in trying to change the attitudes of non-adopters (Guerin and Guerin 1994). The technical factors that have been identified as important include: lack of simple monitoring methods and economic thresholds; lack of IPM control measures to control key and secondary pests; lack of selective chemicals and the complexity of selecting IPM compatible chemicals; and the cosmetic quality standards for produce (Wearing 1988; Glass 1992; Zalom 1993).

Glass (1992) found that IPM and IFP programmes still tend to focus on technical aspects and lack clear economic data on the benefits. McNamara *et al* (1991) suggested that IPM programmes need to focus on providing growers with production systems that fit the needs of the local grower in all respects (social, economical, cultural, technical, organisational, political) and can be integrated into their current management systems.

### **2.5.8 Organisational factors**

Organisational obstacles include: a lack of distinct financing and planning for implementation; a lack of social science skills in IPM teams, which leads to a lack of understanding of the implementation process and its organisation; a lack of pest scout services, trained extension workers and extension entomologists; and the dangers of premature release of IPM methods. One study suggested acceleration of the process of IPM adoption requires a policy to increase funding for public and private sectors to invest in research and education (Wearing 1988).

Manktelow (1987) discussed that growers have to be profit motivated to remain in business, but profit driven goals may be in conflict with long term production sustainability. If growers perceive IPM systems to be less cost effective than their current system they may not be willing to change. Hence in these situations the author recommended that sustainable programmes such as IPM need to be “directed or dictated” by the wider industry. This includes the New Zealand Apple and Pear Marketing Board, government research institutions, and possibly pesticide manufactures and distributors.

### **2.5.9 Environmental factors**

Environmental factors influencing adoption included the need for more sustainable technologies for farming (e.g., minimal tillage), reducing pesticide load on the ‘environment’, preserving habitats for predators and enhancing biological control, and public interest in environmental issues (Feather and Gregory 1994; Fernandex-Cornejo and Kackmeister 1996; McNamara *et al* 1991; Wardlow 1991; and Wearing 1988).

In general, environmental issues and grower hazard from insecticide use were found to have a minor impact on grower decision about pest control. (Wearing 1988; McNamara *et al* 1991). However, of the environmental issues raised, grower concern for conservation of the specific natural enemies of pests were

most important. One survey indicated growers have negative attitudes towards the use of pesticides for environmental and health reasons, but positive attitudes from a financial point of view. Hence, information about the environmental impact of IPM may not influence adoption. One piece of research found that increased public interest in environmental matters has encouraged greater use of IPM (Wardlow 1991).

### **2.5.10 Summary**

The major constraints to adoption identified are little or no financial benefit and associated financial factors, the complexity of the technology coupled with little back up support, the lack of observability of the benefits from adoption, perceptions regarding the technology, and the farmer's attitude towards risk and change. Innovations will not be adopted if the farmer perceives them to be too risky financially, too complex, and to not fit with the farmer's situation or available resources. Rapid development of IFP may not occur unless these factors are addressed. Science and education may not address these issues alone. They may require intervention in the form of new legislation, policies and institutional restructuring.

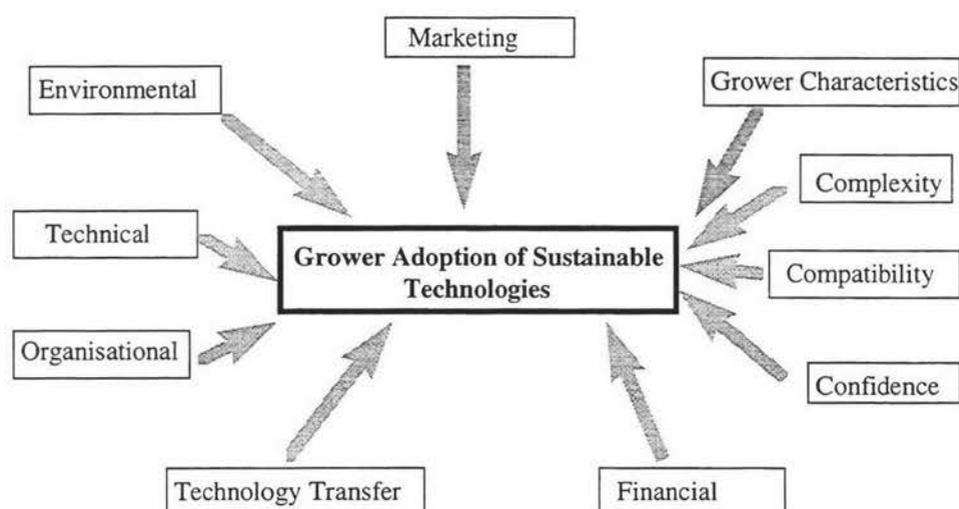
## **2.6 Conceptual Framework Developed from the Reviewed Literature of the Key Factors that Influence the Adoption of Sustainable Technologies**

Many factors have been identified that influence the adoption of sustainable technologies in primary industries. These factors have also been reported to influence the adoption of IPM and IFP technologies.

A conceptual framework of the factors that influence the adoption of sustainable technologies was developed by reviewing the literature and clustering together the common themes. These factors do not act in isolation but are interrelated. An example is financial factors are closely related to perceived risk, confidence in a

programme, and marketing factors. Additionally, different factors may be of greater importance than others to an individual grower or to an industry. Each factor noted in Figure 2.2 encapsulates a number of sub-factors and issues that have been clustered together under one factor title, as discussed in the preceding section.

**Figure 2.2** Conceptual framework of the factors that influence the adoption and implementation of sustainable technologies.



## 2.7 The Role of Technology Transfer and Education in the Adoption of Sustainable Technologies

A number of authors focused on the importance of technology transfer and education in the implementation process of IFP and IPM with greater education leading to quicker adoption (Fernandez-Cornejo *et al* 1996; Wearing 1988; Guerin and Guerin 1994, Manktelow 1987).

Technology transfer and education are important in minimising growers' perceived risk about a technology, building confidence, ensuring compatibility between the new technology and current practice, and to ensure that the

programme fits the perceptions, resources, and constraints of the end user (Wearing 1988; McNamara 1991; Stewart 1993).

It was also suggested that to enhance adoption of sustainable technologies it is important to enlarge the extension service and provide specific training to extension agents (Lenz 1990; Herbert 1994, Wearing 1988). Extension specialists have a role in building trust and confidence in growers (Stewart 1993), and as well as facilitating farmer training and providing backup support. However, for extension programmes to be successful extension personnel need to identify and address the constraints perceived by the grower (Guerin and Guerin 1994). These authors suggested that further implementation of 'Participatory Action Research' may assist in overcoming some of the constraints that lead to non-adoption.

A study of the implementation and extension process of pipfruit IFP programmes in Switzerland by Wildbolz (1992) found that growers need additional support to implement IFP and additional emphasis on extension is required. The reasons cited included the complexity of the programmes and additional grower skills and knowledge required of IFP compared to conventional production systems. The study found that introducing integrated methods requires more research and extension to assist the growers with the more demanding tasks. In West Germany, all fruit growing areas believed IFP requires special training and learning processes and therefore specialists in extension (Lenz 1990). Wardlow (1991) identified that problems for extension workers included lack of basic biological information on what the actual number of pests or predators on the crop means in terms of success or failure of IPM, hence the need to train extension workers.

Stewart (1993) conducted a interview survey of Hawke's Bay apple growers to determine their pest and disease problems, their use of IPM, and their decision-support requirements. The author found 68% of growers got their spray advice from horticultural merchant field representatives and 14% from private consultants.

The author concluded that the reasons growers sought outside advice for pest and

disease management were: many did not have a long association with the crop; few had tertiary horticultural training; they lacked time; growing apples to export standard is complex and requires a good technical knowledge of pest and disease management; leaving part of the decision-making to a trustworthy specialist relieves the burden; and due to the close proximity of orchards to advice providers in Hawke's Bay person to person contact can be frequent. The author concluded that as the advice givers play a major role in pest and disease management and IPM decisions, their role needs to be considered in any IPM development strategy. Their influence could facilitate (or hamper) the adoption of any new techniques.

In another survey, Kennedy (1990) looked at what information growers needed to successfully implement IPM technologies. The author found that growers want practical information that includes easy, reliable monitoring techniques and information on thresholds of pests and appropriate control mechanisms. They want sufficient information to give them the same level of confidence that they have with conventional technologies, which is their reference point. The survey also found that smaller growers find obtaining training and information a greater barrier than large farms or co-operatives, which often have greater financial resources and their own technical experts. Education extension programmes that informed producers of the incentives and how to incorporate IPM into their current management practices increased adoption (McNamara 1991).

### **2.7.1 Co-ordination of technology transfer**

A number of surveys discussed the need for a high level of co-ordination between growers, consultants, chemical company representatives, researchers and marketers during the implementation stage of IPM/IFP (Wearing 1988; Cross 1996; Herbert 1994).

Huus-Brunn (1991) looked at successful IFP programmes and identified that close contact between research institutes, growers and extension personnel were essential to the success of the development and implementation of the programme.

Collaboration between the parties means there is a greater chance that the needs of the end users will be identified. The author concluded that it is important resources are allocated not only to develop new techniques but also to implement them. Malavolta (1992) identified lack of direct contact between growers and technicians as an obstacle to increasing the number of IFP growers.

Guerin and Guerin (1994) suggested that research funding organisations should ensure that the issue of extension is addressed for each research proposal, and to enhance adoption researchers and those developing the technology need to collaborate with the end users regarding their needs.

### **2.7.2 Technology transfer methods and tools suitable for sustainable technologies**

Several authors examined extension methodologies and identified which are most suitable for IPM/IFP technologies. One on one consultation between extension workers and growers was rated higher than any other method surveyed. Courses and field days were rated second, followed by grower-scientist contact, and grower groups. Articles, bulletins, and newsletters were described as useful with the use of computers as a decision support tool increasing (Wearing 1988). These survey results are backed up by research undertaken by Lambur *et al* (1985) and Steffey (1995).

Wardlow (1991) looked at the role of the Agriculture Development and Advisory Service (ADAS) in IPM programmes in the UK and found that the horticulture industry no longer needs general publicity about IPM but constant updating is important. The advisors also play a key role in promoting the benefits of IPM to the general public and this, combined with public interest in environmental matters, has encouraged greater use of IPM. This information is transferred using regular grower meetings, newspaper bulletins, television networks, computer networks and telephone recordings.

Many other tools are used to aid the transfer of technology and information flow regarding IFP and IPM. Extension tools that are being identified in the literature include: direct mail, newsletters, data sheets, booklets, databases, computer based decision aids, e-mail, Internet, media, television, radio, video, videotex, teleconferencing, fax link, demonstration farms, open days, workshops, seminars, training days, focus groups, and discussion groups. Grower training days, guidelines, demonstration orchards, focus groups and extension agents are all used in IFP programmes.

Several authors talked about the need to identify the purpose of the extension before deciding on what tool to use (Garforth 1993). Mass media channels are more effective for introducing innovations and increase the observability of an innovation. Demonstrations to increase observability can include field days, on-farm demonstrations, and visits to farms that have adopted the technology (Guerin and Guerin 1994). Interpersonal channels are more effective in forming and changing attitudes towards a new idea, and thus in influencing the decision to adopt or reject a new idea (Wearing 1988). Most individuals evaluate an innovation not on the basis of scientific research by experts, but through the subjective evaluations of near peers, whose innovation behaviour tends to be imitated by others in their system (Rogers 1995).

Many authors discussed technology transfer models, and which ones were the most appropriate to assist with the adoption of IPM. There is a trend towards a participatory approach to technology transfer. Participation of grower groups will ensure meeting growers' needs remains a top priority (Vorley 1990). Steffey (1995) found that for extension work to be successful, educators need to understand grower expectations of IPM, which varies between growers.

## **2. 8 Integrated Fruit Production (IFP) - A Review of International and New Zealand Programmes**

The concept of IFP is not new. Growers in Switzerland, Italy and Germany have been practicing IFP for many years, and in Switzerland from the early 1960s. Adoption is now widespread, 35% across Europe, with 70% in Tyrol (Italy). IFP was initially introduced in the European Union and the United States due to organophosphate resistance and because of consumer demands for growers to be more environmentally accountable. Additionally supermarkets and food processors like IFP programmes because they pass on the costs and responsibility to the grower and the market receives a 'safe' product for sale to consumers.

Generally, in Western Europe regional grower organisations are responsible for the running of the IFP programmes, with regional grower organisations developing their guidelines based on the International Organisation for Biological and Integrated Control of Noxious Animals and Plants/ West Palearctic Regional Section (IOBC/ISHS) European guidelines. The majority of programmes in the EU and the USA are subsidised (Thompson 1996).

In a study of IFP programmes in Switzerland, Wildbolz (1992) reported that there was regular contact between growers and advisors. IFP study groups were formed and growers met two to three times per year in orchards to discuss recent developments and initiate new projects. Growers attended training courses organised by advisors and local grower associations. The study found that introducing integrated methods requires more research and extension to assist the growers with the more demanding tasks.

In South Tyrol, Italy, growers are assisted by technicians who are subsidised by producer associations, regional bodies or governments by 40-90% (Thompson 1996). Technicians are responsible for assisting implementation of the guidelines, providing training activities for growers and providing technical information. A computer network is used to collect and collate the data collected from the farms

and to supply meteorological data to the technicians. Due to the difficulty of providing all growers with a one on one extension service a computer information system for decision making is being trialed for the major pests and diseases. This is based on information gathered from pilot areas. For the remaining pests and diseases, where specific orchard monitoring is required, monitoring is the responsibility of the growers and growers are required to record justification of applications applied (Malavolta 1992).

Many European and United States cooperatives have introduced IFP labels (Thompson 1996). In Switzerland, Wildbolz (1992) found that the IFP label created by the national IFP organisation in 1990 helped to motivate consumers and growers to adopt the concept. However, labelling food products as 'natural', 'no detectable residues' and 'pesticide free' has proven problematic due to difficulties in defining and regulating such claims (Kennedy 1990).

In the EU, non-compliance to IFP standards and the wide extent to which IFP guidelines are not adhered to has undermined the integrity of IFP in Europe to some degree (Cross 1996). It was found that the control procedures to ensure the standards are upheld varied substantially, as did the proportion of growers excluded from IFP for non-compliance.

In the early 1990s IFP was implemented in Chile, South Africa, and Argentina, New Zealand's southern hemisphere pipfruit competitors. The IFP infrastructure that has been set up in South Africa is perceived to be very good (Thompson 1996). The programme was initiated in 1992/93 due to widespread organophosphate resistance and now has 80-90% grower support. Nationally South Africa has 35 national Integrated Production (IP) advisers, all certified, who update the manual and standards annually; evaluate seasonal difficulties and formulate control strategies; and facilitate fortnightly meetings during the season. The next tier are pest control advisors, certified to interpret monitoring results and give recommendations based on the action thresholds. The pest control advisors are usually co-operative technicians or private consultants. Pest and disease

monitoring is done by orchard monitors who are certified in identifying pests, diseases and beneficial insects. In South Africa it is the packhouses that are managing the implementation of IFP. The packhouse provides packing, coolstorage, local market options and technical support on all aspects of production. South Africa has the advantage of having fewer packers, each with large grower base, which achieves rapid transfer of information.

The UK introduced IFP guidelines in 1991. In this instance, growers seem to have been relatively slow to adopt it. One reason may be that they were not involved in the development of the programme. In Europe, IFP growers are audited to varying degrees by subsidised advisers or regional coordinators (Cross 1996), however in the UK growers must pay levies which subsidise inspections by ADAS (the UK government extension service) advisers to ensure compliance with the standards. Thus, in this case, the costs of implementing the programme are greater to the individual growers than is the case in some of the other European cases identified. Education programmes are available to growers and industry. The British Agrochemical Association, supported by Sainsburys and LEAF (Linking Environment And Farming), sponsors the programmes. Demonstration farms are used as a technology transfer tool (Thompson 1996).

ADAS has played a major role in the expansion of IPM in England and Wales. Growers have been trained by specialist courses on the technical aspects of IPM and kept up to date by the media, group meetings, conferences, and visits by ADAS advisers. ADAS consultants offer varying services to meet the needs of the client, from crop walking to full scale monitoring and interpretation of results. Problems that have been identified include lack of simple monitoring procedures, complexity, relatively few suitable pesticides, and the cost of IPM. Growers must pay for these monitoring and information services which in comparison are usually offered free by chemical merchants (although the cost is recouped in price of pesticide). There is also a general trend for growers to seek training for their staff who play an important role in IPM decisions (Wardlow 1991).

In New Zealand in 1995, J. Wattie Foods Ltd (now Heinz Wattie Australasia) initiated an IPM programme for their process peach growers. The development of the programme was funded by the Foundation for Research, Science, and Technology, the Summerfruit council, and J.Wattie Foods Ltd, and initially involved five Hawke's Bay growers. The objective was to get the research findings adopted by the growers and reduce unnecessary agrichemical use. In the first year scientists were involved in monitoring the orchards and providing the growers with recommendations. The extension process was one to one between the scientists and growers. At the end of the season field days were held for all growers to discuss the project and its success. In the second year the project involved thirteen growers, and still used a one to one technology transfer approach. By the third year 20 growers were involved, they now did their own monitoring, but the advice continued on a one-one basis. Now 100 % of Heinz Wattie peach growers are involved in the programme. The programme has successfully reduced organophosphate applications from an average of 4 to 0.5 per year. Problems encountered include growers not adhering to the recommendations and spraying regardless, and not all turning up to the field days.

The New Zealand Kiwigreen IPM programme for Kiwifruit is defined as an environmentally responsible production system that ensures safe fruit for the consumer (Steven 1997). Research began on developing a IPM programme for Kiwifruit in the mid 1980s. In 1991, market access was threatened by increasing market and legislative concerns about chemical residues. Due to the need to maintain market access the industry developed the Kiwigreen programme. The pilot scheme in 1992 involved 23 growers, by 1994 12% of the crop was Kiwigreen, and by 1997 100% of the crop was. During the transitional phases of Kiwigreen, growers were paid a financial incentive and the New Zealand Kiwifruit Marketing Board (NZKMB) set up the initial monitoring services.

The key features of the Kiwigreen programme are:-

- (1) sprays can only be applied in response to a demonstrated need;
- (2) product choice is limited with emphasis on safer, more selective sprays;

- (3) conventional sprays are further restricted by long export with holding periods;
- (4) the whole system can be audited, as required by supermarket chains;
- (5) spray operators must be trained;
- (6) spray diaries have to be submitted before a crop is exported.

Steven (1997) reported that the Kiwigreen programme is successful. The transition period from the first adopters to full industry adoption was only five years. Reasons for the success include that the programme is simple, growers were given clear direction by the NZKMB, and an incentive was paid over the transition period. Packhouses are the focal point for implementation and they employ semi-skilled scouts to monitor the orchards. IPM consultants are not required due to the simple monitoring methods. Additional benefits to growers identified include an improved living and working environment and retained market access.

## **2.9 Conclusion**

Literature regarding adoption theory, diffusion, participatory action research, and factors that influence grower adoption of sustainable agricultural technologies in developed countries was discussed in this chapter. The key factors identified in this literature review were financial, social, risk, confidentiality, complexity, technical, and technology transfer factors were discussed. Those factors provide a base to develop the conceptual model from which the results from the interviews will be compared.

An initial literature search produced large quantities of international technical information relating to IFP production, predominantly from the European Union and the United States. However, in comparison, there seems to be a lack of publications or work in the area of grower attitudes to IFP, factors that influence grower adoption, and technology transfer systems that accelerate grower adoption of innovations such as IFP. The importance of understanding such factors, such as grower motivation, was stated by many authors (Cross 1996).

There was very little New Zealand literature. The literature that does explain the extension process is often not relevant to New Zealand. For example, many programmes were subsidised financially in some way, IFP programmes in Europe and the United States have government, state, or university funded/subsidised extension officers who provide technical information, facilitate discussion groups, and in some cases audit production. This is not a viable option under user pays in New Zealand agriculture and horticulture.

## **CHAPTER THREE: METHODOLOGY**

### **3.1 Introduction**

This chapter describes the research method used for this study, and discusses the rationale for selecting the case study approach. Semi-structured interviews were employed for data collection; the protocols and the reasons why this research approach was chosen are also discussed. The process of selecting the case studies, testing, and implementing the data collection protocols is described. Following this the process for analysis of the case studies is described, and the reasons why and how the software programme 'NUD-IST'™ and conceptual frameworks were used. Following this, the process of comparing and contrasting the data within case, between case, and finally with the reviewed literature, is described.

### **3.2 Determining Appropriate Research Methods**

There are a number of methods for data collection and analysis including experiments, surveys, and the use of case studies. Yin (1994) discusses the importance of selecting the most appropriate method for the research problem. To determine the most appropriate research strategy Yin suggests three areas that need to be considered:

- (1) the type of research question being asked;
- (2) the extent of control the researcher has over actual behavioural events;
- (3) how contemporary information is sought as opposed to historical information.

The following table shows how these three conditions relate to the research strategies:

**Table 3.1** Relevant Situations for Different Research Strategies (Yin, 1994).

<b>Strategy</b>	<b>Form of research question</b>	<b>Requires control over behavioural events?</b>	<b>Focuses on contemporary events?</b>
Experimental	how, why	Yes	Yes
Survey	who, what, where, how many, how much	No	Yes
Archival analysis	who, what, where, how many, how much	No	Yes/No
History	how, why	No	No
Case study	how, why	No	Yes

The information generated from this research project will assist with the development of a technology transfer strategy to achieve adoption of the ENZA-IFP programme. It is important for ENZA and the NZ-IFP committee to understand what factors influence grower adoption of IFP, and what technology transfer methods or tools will accelerate the adoption, in order to develop that strategy. The research findings will be useful for further research to identify the educational needs and the technology transfer requirements of different grower groups.

The information required to answer the objectives of this research includes answers to the questions of why, or why haven't, growers adopted the ENZA-IFP programme, and what technology transfer methods have assisted or hindered with the implementation of ENZA-IFP. For this exploratory study, Yin's (1994) case study research procedure, using qualitative research methods, was chosen as the most appropriate methodology. The reasons for this are that the 'how' and 'why' questions form the focus of the study. For this study the most appropriate method

of data collection is the use of case studies to collect qualitative data. The reasons for this pertain to the characteristics and uses of qualitative data. Patton (1990) describes qualitative data as detailed, thick, inquiry in depth, and descriptive. Direct quotations capture people's personal perspectives and experiences. Tolich and Davidson (1999) describe the characteristics of qualitative research approach as: inductive; having complex variables that are difficult to measure; ending with a hypothesis and grounded theory; naturalistic; using the researcher as an instrument; having minor use of numbers; and having a descriptive write-up.

The uses of qualitative research are diverse. Lofland and Lofland (1995) are cited in Tolich and Davidson (1999) discussing nine different research areas where qualitative research is appropriate. One of those areas is the examination of certain behaviours and practices, such as is required for this study.

The role of the researcher is important in the qualitative research process, and the results of the data analysis are the researcher's interpretation of the interview (Scott *et al* 1991). Tolich and Davidson (1999) describe the researcher as the instrument and observe that the researcher's own background can influence the research process and analysis of the data. However, Scott *et al* (1991), point out that researchers need to identify their own assumptions and be careful not to prejudice the data collection.

### **3.3 Case Study Selection - Selection of participants**

Case study research can investigate a single study or many cases. In order to study a number of different grower scenarios, that is IFP and non-IFP growers in the two key pipfruit regions of New Zealand (Hawke's Bay and Nelson), multi-case studies were used.

Andrew and Hildebrand (1982) discuss the advantages of a random sampling procedure in order for each person in the sample population to have an equal

chance of being selected. The sample populations for this survey were:

- (1) Export pipfruit growers in Hawke's Bay or Nelson that had adopted IFP. The IFP grower population pool was eighty eight. However twenty were removed as the researcher acted as a group facilitator to these Hawke's Bay IFP growers, and to remove any bias that may have been caused by the researcher's knowledge about these people. Therefore, the population pool that the IFP growers were selected from was sixty six.
- (2) Export pipfruit growers in Hawke's Bay or Nelson that continued to follow conventional production systems, that is they produced fruit for the USA or conventional EU supply programmes. These growers from here on are called non-IFP growers. Approximately 1000 growers fall into this non-IFP category.

For this project the case studies were selected by the following process. Nineteen ENZA-IFP and sixteen non-IFP growers were randomly selected by ENZA staff from their list of Hawke's Bay and Nelson growers. In order to preserve confidentiality, ENZA initially wrote to the selected growers to request their permission to be involved in the survey and to outline the purpose of the survey. Of the sixteen non-IFP growers contacted by ENZA staff, only eight replied that they were available to participate in the research. All of the IFP growers responded that they were willing to be involved.

Once permission was obtained, the growers were contacted by phone to set up an interview time. Originally the plan was to interview ten IFP and ten non-IFP growers, however as only eight of the non-IFP growers were prepared to participate, twelve IFP and eight non-IFP growers were selected. To maintain the random nature of the selection, the IFP growers that had agreed to be contacted were listed alphabetically, and were then contacted in order until a total of twenty interviews had been set up. This process of obtaining consent from the orchardists to participate voluntarily in the interviews is recommended by Tolich and Davidson (1999). It was made clear verbally to the interviewees that the information would be confidential and growers details would not be revealed in the report. The interviews were conducted during August and September 1997, a quiet season for pipfruit growers.

A total of twenty one orchardists were interviewed from Hawke's Bay and Nelson, 13 IFP and 8 non-IFP growers. The extra interview arose as one participant nominated by ENZA as a non-IFP grower was found to be in both the IFP and US programmes during the interview. The grower intended converting the remainder of his orchard to IFP for the 1997/98 season and was keen to be interviewed from an IFP perspective. Following this ENZA staff provided the name of another non-IFP grower that was prepared to be interviewed. Of the 21 orchardists, 18 were interviewed alone, and three as husband and wife partnerships. A summary of the demographic characteristics of the orchardists interviewed are presented is discussed in the results and discussion chapter.

### **3.4 Determining Qualitative Data Collection Methods**

To determine data collection options or strategies a number of questions first need to be answered (Patton 1990), including:

- (1) Who is the information for?
- (2) Who will use the findings?
- (3) How will the information be used?
- (4) When is the information required?
- (5) What resources are available?
- (6) What methods are appropriate to the research?

Patton concluded that answers to these questions will determine the kinds of data that will be most useful in a particular evaluation. Although many researchers discuss the importance of selecting the most appropriate methodology for qualitative research, selecting the method is more difficult. Patton (1990) stated that the method cannot be completely specified in advance of field work. The reasons for this are the naturalistic and inductive nature of qualitative research which makes it both impossible and inappropriate to specify sampling methods and operational variables. The author concluded that the design of the method is partially emergent as the study occurs.

Collation of data using case studies may involve interviews, field observations, focus groups, and the collation of relevant documents (Yin 1993). For this exploratory study semi-structured interviews using open ended questions and discussion points were used to explore the topic. Scott *et al* (1991) described a semi-structured questionnaire as a guideline and to be used to check that all the issues have been discussed, rather than as a rigid plan.

### **3.4.1 Development of data collection protocol**

Following the development of a conceptual framework derived from the literature, cases were selected for the research and the data collection protocol designed. The case studies were designed to gather information to be used to:

- Evaluate the factors that influence grower adoption of the ENZA-IFP production technology,
- Evaluate differences between IFP and non-IFP growers
- Test the validity of the outcomes generated from the reviewed literature.

### **3.4.2 Framework for the semi-structured interview questions**

Tolich and Davidson (1999) recommend that interview questions are divided into three parts:

- (1) Introductory questions to get the interview started and the participants talking freely and feeling relaxed about the interview and topic. It is recommended that introductory questions be general, easy for the interviewee to answer, and open ended. Questions that are of interest to, and are based on, the interviewee's experience are likely to put the interviewee at ease. For this project questions such as; "Tell me about your orchard business?", "How long have you been orcharding here?", "What varieties do you have?", are likely to be useful for this purpose. Introductory questions are also suggested by Scott *et al* (1991) for the same reasons.
- (2) A list of themes and questions that cover the information the researcher would

like to find out on the research topic. They may include 8-10 topics that need to be discussed during the interview. They can be written up as open-ended questions but, unlike a questionnaire, the interviewer is not required to methodically work through the list of questions. The list of themes or questions can just be a check list for the interviewer to make sure all areas have been covered during the course of the interview.

- (3) some generic prompts, such as why?, how?, that's interesting, I would like to know more, I don't understand that, what do you mean by....? These are questions or prompts to signal to the interviewee that the researcher would like more information or clarification of a topic.

Scott *et al* (1991) commented that the questions asked need to be clear, use terminology that fits with the topic, avoid ambiguous meaning, and be simple. Tolich and Davidson (1999: p 166) quote that 'the function of any researcher is to create a good interview guide that taps into the informant's knowledge with good questions, themes, and prompts'.

The aim of the interviews with IFP growers was to establish what factors had influenced their decision to adopt the ENZA-IFP programme, either positively or negatively, and what technology transfer methods they perceived would accelerate the rate of adoption. For the interviews with non-IFP growers the purpose was to establish their perceptions of the ENZA-IFP programme, what they believed would influence grower participation in the ENZA-IFP programme, and what technology transfer methods they perceived would accelerate wider adoption of IFP methods.

The semi-structured interview questions were drafted based on guidelines suggested by Tolich and Davidson (1999) and Scott *et al* (1991) and the objectives of the research proposal. Andrew and Hildebrand (1982) and Scott *et al* (1991) highlight the importance of linking the survey questions to the research problem and objectives. Separate sets of questions were prepared for the IFP and non-IFP grower interviews (Appendix 1 and Appendix 2). The question sheets were similar

but some questions were phrased differently to take account of the fact that the non-IFP growers did not have experience with ENZA-IFP. Instead of questions about what IFP involved and how they implemented it, non-IFP growers were asked what they perceived IFP to involve and how they had implemented other innovations or technologies. In addition, a grower data sheet was drawn up to collect relevant quantitative grower and orchard information (Appendix 3).

In order to test the validity of the conceptual framework developed from the reviewed literature, the qualitative information required included:

- Personal details, including family situation, education, age, and what technologies the grower had previously adopted.
- An appreciation of the grower's philosophy towards pipfruit production.
- An understanding of how the grower gets the knowledge and technical information to make decisions.
- An appreciation of how the grower perceives the ENZA-IFP programme.
- An appreciation of the growers perceived benefits or risks of adopting the ENZA-IFP production system compared to remaining in a conventional production system.

### **3.4.3 Pre-testing interviews**

Pre-testing is important when commencing the interviews in a field situation (Andrew and Hildebrand 1982; Tolich and Davidson 1999). Pre-testing of the interviews was conducted in July 1997 with a Hawke's Bay IFP grower, using a draft of the semi-structured interview questions. Following the pre-test interview, the interviewee was asked to comment on the structure, flow and clarity of the open ended questions; and appropriate changes were made. The questions were redrafted and ambiguous words removed.

During the course of interviewing the 21 growers, further fine-tuning was required and the questionnaire evolved further. The purpose of the fine tuning was to take

into account a greater appreciation of the issues that was gained by the researcher during the interviewing process.

#### **3.4.4 Conducting interviews**

Scott *et al* (1991) recommend that effort needs to be put into preparing the interviewee by ensuring interviewees know the time and location of the interview and know the purpose of the interview. The selected orchardists were contacted by phone to make an appointment for the interview, and again the night before to confirm that the time was suitable. This process worked well as none of the interviewees forgot about the meeting. Prior to the interview, permission was sought from all the growers to tape the interviews.

At the start of the interview the purpose of the research, the number of people being interviewed in each region, and how the information would be used was discussed with the interviewee. This process is recommended by Tolich and Davidson (1999).

The practice interview was conducted outside, however the background noise made it difficult to transcribe the tape and some data was lost. Following this, interviews were conducted inside. Scott *et al* (1991) recommend that interviews are conducted in enclosed rooms to avoid distracting noises.

The interview length ranged from 40 minutes to over 2 hours. The interviews were tape recorded and later transcribed. During the interview issues which arose were noted down, and information sought about these as appropriate. Demographic and orchard details were recorded on a data collection sheet (Appendix 3).

Scott *et al* (1991) commented that the success of the interview depends on the success of the interaction between the researcher and the interviewee. The interviewer needs to keep the interviewee interested and motivated and be sensitive to individual styles. These authors also recommended that it is very

important for the interviewer to pay attention to the answer, rather than thinking about the next question. By using a range of listening techniques the interviewer can respond to the answer before moving to the next question. For example, by asking follow up questions, confirming the understanding of the answer, resolving contradictions, or asking for clarification.

## **3.5 Analysis**

### **3.5.1 Initial analysis of the case study data**

Tolich and Davidson (1999) discuss three stages of qualitative data analysis: (1) data reduction, (2) data organisation, and (3) data interpretation. Data reduction of interviews involves coding the data into subgroups to be used in a conceptual framework. Categorising the information is referred to as data organisation, and this may involve rich pictures, flow diagrams, conceptual frameworks or graphs. Data interpretation is where conclusions are drawn. This process for qualitative data analysis is also recommended by Dey (1993).

The interviews were transcribed verbatim, read, and then the data was coded into conceptual themes. Data from the IFP and non-IFP growers was coded and analysed separately and collated into summary reports to identify the key factors and themes. This initial process of categorisation of key information is described by Dey (1993) as an important first step. Tolich and Davidson (1999) describe coding as the process of reading through the transcripts and categorising and sorting data into the conceptual themes. The computer software NUD-IST™ was used to assist with the process of sorting, categorising, and organising the data for analysis. NUD-IST™ was a useful tool for this research project due to the ability to set up a conceptual framework and then sort, organise, shift, and code data into a framework. Using this process conceptual frameworks were developed for the IFP and non-IFP case studies.

The grower information collected, such as age, number of years orcharding, and use of technologies such as IPM, was collated and analysed quantitatively to determine any relationship between grower characteristics and adoption of the ENZA-IFP programme.

### **3.5.2 Further analysis of the data**

Conceptual frameworks were developed from both the reviewed literature and the case study analysis by following the process described by Dey (1993). Conceptual frameworks were developed from both the IFP and non-IFP case study results. These results were analysed both for differences and similarities between the growers in the each group. Regional differences or similarities were also explored within each case. Cross-case analysis was the next step taken in the analysis to look for similarities and differences between IFP and non-IFP cases. Subsequently, a singular conceptual framework for factors that influence the adoption of ENZA-IFP was derived. The results from the cross-case study analysis were then compared and contrasted with the conceptual framework developed from the literature review. This was to identify how well the outcomes from the research compared with the literature. Finally, conclusions were drawn about the factors that influence grower adoption of sustainable technologies.

### **3.6 Summary**

Using Yin's (1993) classification system, case study analysis was the method chosen to research the problem posed in this study. Multi-case study analysis was used in order to get replication of results and to target two different groups, IFP and non-IFP growers. Cases were selected randomly, and the data was collected using semi-structured interviews. The data was coded into conceptual themes and analysed by comparing and contrasting between cases to identify differences and similarities in factors that influenced grower adoption. The results from the case study analysis were then compared and contrasted with the conceptual framework developed from the literature and background information. Following this conclusions were drawn about the factors that influence growers adoption of sustainable technologies.

## **CHAPTER FOUR: CASE STUDY RESULTS AND DISCUSSION**

### **4.1 Introduction**

The results from the 21 grower interviews are detailed in this chapter. The first part of this chapter presents the results from the IFP and the non-IFP grower interviews. A conceptual model is presented for each. The results from these two cases are then compared and contrasted and a cross-case conceptual model is derived. The case study results are then discussed and compared with the literature review.

### **4.2 Factors that Influenced Adoption and Implementation of the ENZA-IFP Programme: IFP Growers**

This section presents the results from the thirteen growers who had adopted the ENZA-IFP programme in its pilot year (1996/97). In particular, the reasons that growers had adopted the programme and the factors that assisted them with its implementation are described.

#### **4.2.1 Philosophical**

One definition for philosophy in the Oxford reference dictionary (pg 628, 1986) is ‘the use of reason and argument in the search for truth and the knowledge of reality, especially of the causes and nature of things, and of the principles governing existence, perception, human behavior, and the material universe.’

Eleven of the thirteen interviewees noted their ‘philosophy’ towards apple growing, and in particular pest and disease management, as the key reason for adopting the ENZA-IFP programme. ‘Philosophy’ meant a range of things to different growers. Growers associated their philosophy predominantly with three

issues: (1) their concerns for the environment, especially their own living and working environment; (2) their philosophy towards spraying, especially wanting to reduce unnecessary spraying and to minimise the use of organophosphates; and (3) their philosophy towards the USA supply programme.

Of the two growers that did not mention their philosophy towards apple growing as a reason for adoption, one said that his key reason for adoption was for environmental factors and the other noted as important a better environment from reduced organophosphate use.

Many growers linked philosophy and environmental factors together. Ten out of the eleven noted both philosophy and living and working environment concerns as the predominant reasons for adoption. These growers considered their adoption reasons philosophical but also mentioned their environmental concerns, especially the impact of organophosphates on their living and working environment. Environmental issues also meant a range of things to the different growers. This is discussed in section 4.2.2.

All thirteen growers agreed with the IFP philosophy towards pest and disease management, of justified action based on pest and disease monitoring results. Five growers stated clearly that they did not agree with unnecessary spray use. Two had already been trying to reduce organophosphate use prior to the introduction of the ENZA-IFP programme and three discussed how they did not like spraying personally hence wanted to reduce agrichemical usage. Seven of the growers said that they were philosophically against the USA supply programme and did not agree with the calendar spray programme of organophosphates, regardless of any financial premium paid for that programme. Four of these growers, who had young families, noted that they wanted to reduce organophosphate use because of family concerns. The majority believed that by adopting IFP they were providing a healthier environment for themselves, family and workers. The following quotes provide examples:

*'...I've got a horticultural degree from Lincoln. Coming from our background we knew there were opportunities there to reduce the chemical input, so philosophically we wanted to try and have a lot less sprays.'*

*'Basically I was philosophically against the USA programme.'*

*'I think the main reason was for health reasons, for our family as well. We've got kids who play out in the orchard. We felt uncomfortable after we had sprayed an organophosphate to have them running through the trees. There's always that concern. We feel a lot more relaxed about living on the place.'*

#### **4.2.2 Environmental**

Feather and Gregory (1994), Fernandex-Cornejo and Kackmeister (1996), McNamara *et al* (1991), Wardlow (1991), and Wearing (1988) made reference to environmental factors in the context of: adoption of more sustainable technologies for farming (e.g., minimal tillage); reducing pesticide load on the 'environment'; an association of pesticides and negative effect on the environment; preserving habitats for predators; and public interest in environmental issues.

Twelve out of the thirteen growers discussed environmental reasons as an important factor influencing their decision to adopt the IFP programme. Four of the growers said environmental concerns were their key reason. They believed the IFP programme to be a more sustainable method of production than current conventional production. The environmental reasons the growers gave as important included:

- minimising unnecessary use of sprays, especially organophosphates;
- wanting to preserve predators by using softer sprays instead of organophosphates;
- concern for their living and working environment. This was discussed by eight growers;
- pressure from the community and the regional councils to minimise their environmental impact, in particular reduce spray drift. Two growers discussed this;

- improving their environment for the health of themselves, families and workers. One grower reported a dramatic improvement in his health from reducing organophosphate use.

*'[The reason for adoption] ...was primarily environmental with a secondary aspect - because I do most of the spraying - of handling OPs. I've always felt like a bit of a criminal when I've sprayed an OP, right from when I first started spraying. I used to hate it.'*

When the growers were discussing environmental reasons they were referring to their bio-physical environment which they live and work in, and which they want to be safe. Seven growers reported a more friendly environment for their family and workers to live and work in as a benefit from adopting IFP. The perceived improved environment was from reduced agrichemical use. Nine of the thirteen growers thought that reduced spray use, notably reduced organophosphates, was a major benefit of adopting the ENZA-IFP programme.

*'... not using OP sprays. It's quite funny because I was a grower that used to think there's nothing to worry about it until I stopped using these sprays and noticed changes in my health.'*

*'I love not having OPs around - it really bugs me. Especially as I've got a young family. We won't go out for a walk on a Sunday afternoon on the orchard if we put an OP through on Friday. The kids love running around the orchard, so not having OPs on the orchard is great.'*

Several of the growers were also keen to move away from their current practice and explore other areas including biological control of pests, and alternative methods for soil, and understorey management. Several of the growers had stopped using residual herbicides and one was trialing herb lays instead of herbicides. It is assumed that these growers perceived such practices were better for the environment than relying solely on chemicals.

*'And I really enjoyed seeing the parasites wipe out woolly aphids. To me, seeing the biological activities is really important., '*

*' alongside this decision to go IFP I then cut out residual weed spraying... It's a bit of an unknown question what roundup's doing with so much of it being used but it seems more passive that some of the residual things. ... , and i quite like to idea of letting the grass get a bit longer, managing that as more of a mulching type scenario...'*

The one grower that did not specifically discuss environmental factors as a reason for adoption was philosophically against the USA programme and agreed with the IFP concept.

None of the growers commented about water quality or soil health when discussing environmental concerns. The key environmental concern was air quality in their orchard and the community in general.

### **4.2.3 Marketing**

Market access and increasing demands for food safety (Cross 1996, Manktelow 1987, Kennedy 1990) were discussed as part of marketing factors in the literature review, section 2.5.4.

The interviews identified that growers understood that ENZA was under pressure from overseas supermarkets to supply fruit produced to IFP specifications. All growers responded that marketing factors attributed to their decision to adopt IFP and that continued market access was a key benefit of adopting the programme. They understood they must implement IFP in the near future anyway, in order to continue exporting their fruit to Europe.

*'You'll get shut out or you'll lose market opportunities because they will take IFP fruit from other country before they will take New Zealand. What it does is keeps out foot in the door.'*

*'We have to accept that this is the way to go and that this is what is going to be demanded by our customers...the inevitability of it being forced on us. We have to move in that direction, like it or not.'*

Eight growers also commented that the risks of not adopting IFP were greater than the risks in adopting it. The risk of non-adoption was the future loss of market access. These growers felt IFP was inevitable if they wanted to continue exporting apples in the future.

Most of the interviewees were confused about how the ENZA-IFP and USA programmes could work simultaneously. ENZA was promoting both as important for the success of the pipfruit industry,

*'They're diametrically opposed.'*

#### **4.2.4 Financial**

Financial factors as described in the literature include lack of financial benefit or incentive (Cross *et al* 1996; Wearing 1988) and risk of, or perceived risk of, financial loss (Herbert 1994; Zalom 1993). Rogers (1995) discusses financial factors and perceived risk in the context of relative advantage. He further defines relative advantage as the degree the innovation is perceived to be better than the current idea or practice.

None of the IFP growers cited financial gains as their key motivating factor for adopting the IFP programme. One grower went into the programme with the expectation that they would save money on sprays; five found as a consequence of IFP that they saved money in spray application.

*'But at least with IFP any cost, hopefully, is offset by the savings on the other side, so we end up with a better result, hopefully, for the same amount of money.'*

*'I definitely saved costs in the chemicals. There's probably a few other savings like tractor costs.'*

However, six out of the thirteen growers noted no savings associated with adopting the IFP programme as any savings in sprays were balanced by increased

monitoring costs. ENZA told growers at the introduction of the programme that there was no premium, and there would not be, for IFP produced fruit in export markets. One Hawke's Bay orchardist expected IFP to cost more than conventional production in the future.

*'Half way through the season I could see that I was going to make a saving on the spray bill...once you add in the monitoring costs, take off the reduced spray cost everything will balance out.'*

*'We certainly didn't save any money going IFP. It cost us money'.*

Growers were paid \$0.25 per carton for all fruit produced under the ENZA-IFP programme. Half of the growers interviewed thought that ENZA needed to offer growers a financial incentive over the transitional phase to encourage growers to adopt the programme. They acknowledged that they had adopted the programme for philosophical reasons not financial, but they thought the majority of non-IFP growers would require a tangible financial incentive for encouragement. One grower thought that once 100% of the industry was involved a grower incentive would not be needed, but one was required initially to motivate change. Another grower recommended that a financial disincentive should be in place for growers that do not meet the ENZA-IFP standards. The same grower commented that at present there is a disincentive for US supply growers to convert to the ENZA-IFP programme.

*'If you had a disincentive there [for growers not meeting IFP standards] I think it would work wonders... the argument which I'm going to get from other growers is that they can't afford to give away the US premium. For as a grower, It's a financial disincentive to do IFP.'*

The majority of growers thought the USA market incentive of \$1.00 per carton was the key reason why growers have not adopted the IFP programme. Two of the IFP growers interviewed were trialing a small area of IFP. Their decision to convert the remainder of their orchard to IFP will be based on the incentives ENZA offers for the different programmes for the coming season.

*'Yes at the end of the day the dollar in the bank is the one that keeps me in business. Especially the USA premium. I wouldn't expect IFP premiums to be*

*anywhere near USA. As long as there's an incentive for me to have my whole orchard on IFP I'll be quite happy'.*

#### **4.2.5 Perceived risk**

Two growers felt there were risks associated with the programme and five thought any additional risks were minimal if the programme was followed correctly. The risks perceived were not monitoring correctly, increased pest and disease damage and resulting lower production and profit per hectare.

*'There'll always be a risk that someone has a pest problem and suffers a financial loss.'*

The growers found that the best way to minimise any risk of pest and disease problems was to do the monitoring correctly, follow the IFP thresholds and recommendations, and to have the necessary skills and knowledge to be able to implement the programme confidently.

*'I think we have to make sure that the information is there, it's user friendly, there's contact with growers...'*

*'you've got to be knowledgeable and have the skills to identify the problems.'*

From their one season's experience with the IFP programme, many of the growers identified technical issues that need to be addressed to minimise risks of pest and disease failures. These include the management of secondary pests, economically effective alternatives to organophosphates for pest control, and effective biological control methods.

#### **4.2.6 Organisational - Information from ENZA**

Wearing (1988) included financing of and planning for implementation, social science skills in IPM teams, understanding of the implementation process and its organisation, and communication as organisational factors.

At the time of this research only one grower thought the information he was receiving about the programme was good and accurate. However, all said they had received information from ENZA regarding the importance of growers adopting the IFP programme and ENZA's target for 100% of New Zealand export pipfruit to be IFP by the season 2001.

Twelve of the thirteen interviewees felt that some of the information growers received was poor, confusing, and incorrect. Nine of these growers reported that poor timing of information hindered their decision making. Examples of this include waiting until Spring (when growers start pest and disease management) before ENZA released information about the programmes, including financial incentives (IFP and USA). Growers reported that technical aspects of the programme were not sent to growers until after the first sprays were applied.

*'No, that communication flow hasn't been good because a lot of the regional staff haven't known until the last minute exactly what was going to happen.'*

*'the information arrived quite often three days after when we needed it.... we dropped the Lorsban out of the oil spray then literally I think four or five days after we did that we got a note from HortResearch saying "definitely don't drop your Lorsban out of the oil spray" and we'd already done that. You know, it should have been five days before we'd done that not five days after.'*

Many believed ENZA was giving the growers mixed messages about the ENZA-IFP and the USA supply programmes - both were promoted as vital to the industry's success, regardless of the very different growing philosophies. This viewpoint was held more strongly by the Nelson growers. Traditionally, due to a favorable climate, Nelson has a good record of success in meeting the USA phytosanitary requirements. Two of the Nelson growers only had their Cox's Orange Pippin variety in the ENZA-IFP programme as Cox's are not sold in the USA. They were not keen to change their other varieties in the orchard to the ENZA-IFP programme unless it was eligible for a premium equivalent to that paid for the USA programme.

*'They've said they want the whole industry to be on some IFP plan by the year 2000. IFP and the US markets seem to me to be too unachievable..... I guess there's IFP as we know it this year and there's IFP as the Board is trying to redefine it for the American market. They're somewhat different.'*

Several growers also felt that the mixed messages regarding the programme were due to ENZA not being fully committed to the programme. This included ENZA management and regional staff working with growers. One grower felt this lack of commitment reduced grower confidence in the programme and did not give growers the necessary message about the importance to change. Two Nelson growers commented that the local ENZA staff were not well informed about the IFP programme or were unable to answer practical questions on how the fruit should be segregated. None of the Hawke's Bay growers commented on this issue.

*'Well you're getting mixed messages. We're getting hey yes, we've got to run with this,... we'll give it a go, but the local ENZA staff didn't know what was going on. We'd say hey look, we've got to segregate stuff, what's the deal. They'd have to ring Hastings to find out what was going on.'*

*'I feel like ENZA aren't really 100% behind IFP. I think there's a few people in ENZA that are but it isn't really being driven at the moment'.*

The growers felt that ENZA needed to give growers very clear guidelines about the implementation of the IFP programme. Growers needed to know: over what period it would be implemented; how it would be implemented; what resources would be available; what IFP actually involved and what standards would the grower need to meet; how it would fit with the USA programme; and what incentives would there be over the transitional period. Five growers said that ENZA needs to give growers an ultimatum that 'only IFP fruit will be accepted by ENZA by 2001'. Additionally, ENZA needs to continue educating growers why IFP is important to the New Zealand industry.

*'I believe that we have to have guidelines fully explained to us, parameters fully put into place and said this is what we want to fruit to look like to meet these standards to get into a box.'*

*'This might sound awfully brutal but in the end, if you've got a cut-off date and people aren't producing under IFP conditions'[they can't export their fruit through ENZA].*

Two Nelson growers said that for the programme to be successful it needs to be grower driven, rather than ENZA driven, and involve leading growers from each region. These growers identified this as important to increase the level of adoption, especially in Nelson.

*'The most acceptable way to have IFP ...is to have peer pressure. In other words, those people doing it now do it successfully, it's financially viable, and they are recognized growers of good standing amongst the orchard industry. If you don't have that the IFP is going to be very, very hard to pick up by the bulk of the growers.'*

#### **4.2.7 Technology transfer**

In Chapter Two, the discussion of technology transfer encompasses technology transfer models (Rogers 1995; Roling 1994), the role of IPM specialists in IPM adoption, extension funding, training in IPM of specialists and growers, educational programmes and level of education, tools required to assist growers with the implementation of IPM technologies, the role of technicians and technical support. (Guerin and Guerin 1994; Herbert 1994; Huus-Brunn 1991; Lambur *et al* 1985; McNamara 1991; Wearing 1988; Zalom 1993).

All thirteen interviewees thought that the triangle discussion group meetings were a good method for technology transfer. Eight out of the nine Hawke's Bay growers described their discussion groups as good to excellent. The remaining Hawke's Bay grower said the concept was good but their facilitator required more skills in facilitation. Of the four Nelson growers, one commented that they were very good, two noted while quite good, at times their group meetings focused too much on the political aspects, such as "*Most people argued about the loss of the USA premium*", rather than the technical aspects that these two growers were more interested in. One Nelson grower was also a group facilitator and believed discussion groups in the orchard involving hands-on activities were the most

appropriate method for assisting growers to learn the skills necessary to implement IFP.

*'Hands-on is certainly a better or more interesting way of learning.'*

All the respondents noted that the discussion group meetings were their prime source of information. Secondary sources included the IFP manual, IFP technical fax-outs, their consultant, and the ENZA and HortResearch IFP training days.

The key advantages the growers found with discussion groups were: meeting other growers; sharing IFP results, problems, and successes; helping to build confidence in the programme; walking and looking around other people's orchards; and having the specialist scientists involved.

*'[The discussion groups were] Very, extremely [useful], I don't think we could have done it without it. Just gave you confidence I think when you're talking to other people you know who have got the same problems.'*

*'The best way to learn is to walk around somebody's orchard. That's where IFP discussion groups are great...talking about IFP, but at the same time you pull his orchard to bits and put it back together again'.*

The opinions on the effectiveness of the HortResearch training days during Spring varied in both regions. Four growers did not think it was very useful to discuss pest and disease life-cycles in a laboratory environment. They also commented that the seminars were made more complicated than necessary. Other growers ranked the training days from OK to very good, especially in conjunction with the ENZA-IFP manual, and the grower discussion groups. Over half of the growers reported that IFP manual was a useful reference document. Only two growers commented that they had not used it, and one thought it was not very user friendly.

One grower commented that the location for technology transfer was important in order for growers to gain the necessary skills and feel confident in the IFP technology. ENZA ran the training courses in a laboratory, which this

grower/facilitator did not think was suitable. Pest and disease identification needs to be taught in the field.

*'...they're putting all this data and technical stuff out, but what does that mean on the ground? What does it mean if I go out in my orchard, because the barrier we found was actually knowledge in the triangle groups and it's actually getting people out there confident that they're looking at the right part of the tree'*

Several growers made the comment that an effective technology transfer programme gave growers the necessary skills and knowledge to implement IFP and helped to minimize any risks. Growers noted a technical knowledge of pest, predator and disease life-cycles, identification, and monitoring protocols as the necessary skills and knowledge required. At this stage the ENZA-IFP programme is focusing on pest and disease management, however more than half the growers noted the need to also have a knowledge of beneficial host plant species, weed and understorey management.

*'I think we've got to make sure the information is there, it's user friendly, people are available so that growers,...but I think communication's probably the key to it.'*

The growers were asked what sort of technology transfer programme and methods are required to implement the IFP programme throughout the pipfruit industry and how the current technology transfer could be improved. The growers concluded that a successful technology transfer programme would identify the information and skills growers need to successfully implement the IFP programme, and provide a conducive environment for growers to learn. There is a need to keep it simple. All agreed that the current system based around discussion groups was the most effective for new growers. Reasons included that discussion groups are held on growers' orchards and involved a hands-on approach in the orchard. Eleven interviewees noted that the best way for growers to learn and gain confidence is by hands-on experience. Four growers also discussed the importance of having trained facilitators for the IFP discussion groups and the need for industry people

(consultants, spray merchants, monitors) with the necessary IFP skills and knowledge.

Additional resources growers thought important for the future included an improved manual, with better pest, predator, and disease life-cycle and identification information, and colour wall charts of the IFP programme. Field days held by the specialists were also thought to be useful. Seven growers also noted the need for rapid access to information to answer specific pest and disease questions in a timely manner, either by fax, e-mail, or via an Internet site.

Several noted the importance of involving the spray merchants as they are the people that most often see the grower and have traditionally been involved in pest and disease decision making.

*'We'd have to have the researchers available. We'd have to put the expertise in the merchants people because they would focus on that and say hey, let's show all the next lot of growers that it can be done on a commercial basis.'*

Seven of the IFP growers reported a greater knowledge about what was happening on their orchards and improved skills in pest and disease management as a benefit from adopting the ENZA-IFP programme. Sharing knowledge and experiences with other growers in the discussion groups was also noted as a benefit.

#### **4.2.8 Compatibility**

In Chapter Two compatibility is defined as the degree to which the innovation is perceived to be consistent with the existing values or technology, and needs of the individual (Rogers 1995).

All growers found the IFP programme compatible with their current production system. They had all previously adopted Integrated Mite Control (IMC) technology and had been involved in other forms of orchard monitoring. Most commented that they used weather-based spraying for disease management.

*'Really the only thing I've done different is do more monitoring for your leaf roller and your leaf curling midge. I've always monitored myself for mites. Black spot, I've always monitored Mills Periods myself.'*

However, two Nelson growers said the IFP programme did not fit with their philosophy of maximizing profit per hectare. They embraced the IFP philosophy, and it fitted with their overall orchard management, but could not understand why they could not submit their fruit for the USA market and earn the USA premium.

*'So when the IFP part came up, that was excellent. Here's a chance to do it (minimise OP's), and we were not told until much later on that we would not be eligible for the US fruit premium and that's what our whole philosophy on this orchard is - to maximize our grower return.'*

#### **4.2.9 Confidence in the programme**

In the reviewed literature the factor 'confidence' is discussed by Wearing (1988) and McNamara (1994) in terms of a grower's confidence with the IPM technology, in many cases in comparison with confidence in an existing technology.

Eleven of the growers said they were confident in the IFP technology. They developed this confidence by following the monitoring programme and thresholds correctly (either monitoring themselves or employing trained people to do the monitoring) and by experiencing the success of the programme (clean fruit at harvest).

*'My confidence has definitely improved through the harvest season'.*

*'I was never really worried about using the IFP regime because I knew we'd do accurate monitoring.'*

One grower had a unexpected leafroller problem in their first year of IFP. He was not confident in the IFP technology or the monitoring programme and thought more research was required. Two other growers said a lot more research on technical aspects of the programme was required for them to feel confident in the

programme, specifically secondary pest management, weed and understorey management, and validation of thresholds.

*'I'm not confident without solving the leaf roller problems...I'm not confident without some feedback from HortResearch.'*

Growers noted that it is important to have confidence in the IFP technology as many growers are changing the way they have been managing their orchard, in particular pest management and spraying. When asked how they gained confidence in the programme, the majority commented that their confidence came with experience, success with the programme, and by having an effective technology transfer programme. Aspects of this are discussed in section 4.2.7.

*'I was very nervous last year. I think that's probably why I did a lot more monitoring by myself [in addition to the pest scout], but after being in it for a year I don't think the thresholds are too bad.'*

#### **4.2.10 Complexity**

Rogers (1995) described complexity as the degree to which an innovation is perceived as relatively difficult to understand and use. Many authors have recognised complexity of innovations as a barrier to adoption.

In general the growers did not find ENZA-IFP complex, and had a good understanding of what IFP involved for them. They found that it involved spending more time in the orchard monitoring for pests and diseases, recording information, and justifying any subsequent spray applications. Three growers commented that it was more time consuming than anticipated. Two growers commented that IFP was perceived by non-IFP growers as complex and that ENZA was trying to make IFP more complex than was required.

*'[IFP involved] a lot more time on the orchard actually'.*

*'I think it could be made a lot simpler. I'm dead scared they're going to raise the bar so high that we can't achieve, or set ourselves standards that, sure, they could be achieved, but at what cost'.*

Seven of the growers expected the IFP programme to expand in the future to encompass soil, water, air, weed and understorey management. Two growers did not think it would require anything more than they were doing now and three thought the amount of time required monitoring would reduce as they learned more about their orchard and build up a history of pest and disease incidence.

*'I think eventually IFP will be, to coin a phrase, total management of the whole orchard and pest and disease control is just one aspect of it.'*

Growers suggested the complexity of the ENZA-IFP programme could be minimised by; keeping the pest and disease monitoring and thresholds simple, not making the 'goal posts' so high so that the programme is not achievable, and by selective adoption. By selective adoption the growers mean the introduction of IFP to growers in small steps<sup>6</sup>, rather than forcing new entrants to tackle all aspects and changes in one season. Selective adoption is further discussed in section 4.2.12.

*'You'd make it less complex by introducing a smaller amount of chapters at one time which is why when they said by the year 2000 everyone's going to be IFP, this is the first step. Everyone in the country this year does this. We're now under an IFP programme. The progression then is information dissemination which takes 5 years.'*

#### **4.2.11 Technical**

Technical factors include: lack of simple monitoring methods and economic thresholds; lack of IPM control measures to control key and secondary pests; lack of selective chemicals and the complexity of selecting IPM compatible chemicals; and the cosmetic quality standards for produce (Wearing 1988; Glass 1992; Zalom 1993).

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<sup>6</sup> At this stage the growers had implemented three parts of the ENZA-IFP programme. The total programme involves sixteen aspects of orchard management.

The growers identified a number of technical issues that need to be addressed for growers to have confidence in the ENZA-IFP programme and for it to progress. These include alternative economically viable methods for weed and soil management, alternatives to organophosphates for pest control, control methods of secondary pests such as Fullers Rose Weevil and Lemon Tree Borer, and information on the use of beneficial organisms for biological control. In the past, most growers have had success with organophosphates as a broad spectrum product to manage pests, giving complete control. This product is their benchmark. Many of the soft or selective products are not as effective as the organophosphates.

*'What we're missing is some suitable predator insects really. Or else some appropriate soft chemicals - one or the other.'*

Four growers also talked about the positive feelings they had when biological control for pests such as Woolly Apple Aphid and European Red Mite were successful. This technical aspect of IFP had a positive influence on the implementation of the programme.

*'And I really enjoyed seeing the parasites wipe out woolly aphids. To me, seeing the biological activities is really important, but also as a step to whatever comes next.'*

Two Hawke's Bay growers already had pest resistance to organophosphates and hence could not supply the USA market. They also talked about the increasing problem of pest resistance to organophosphates and the need to look for alternative pest and disease management. For this reason IFP was a good alternative to conventional production in order to improve pest and disease management. Six of the growers stressed the importance of keeping the programme technically simple in terms of monitoring and thresholds.

One Nelson grower commented that too much emphasis was being placed on the technical aspects of the programme and not enough on the strategy of getting IFP implemented throughout the industry.

*'There's more emphasis on the technical, we've all got to do it right now instead of the more structured, very slow approach.'*

#### **4.2.12 Selective adoption**

Guerin and Guerin (1994) refer to the process of selective adoption as adoption of aspects of a technology that are compatible with a growers current situation, then gradual incorporation of further aspects as profit and confidence are maintained.

Two growers suggested that to achieve widespread grower adoption of IFP, ENZA should introduce small changes and progressively add more to the programme as grower education, experience, and confidence grows. They commented that at this stage the programme involved changes to pest and disease management, two chapters out of the proposed sixteen, and that a further three were planned to be introduced to growers for the coming season. They suggested that, rather than in three years from now growers having to implement changes to all their management practices in one season, each concept be introduced over a period of time.

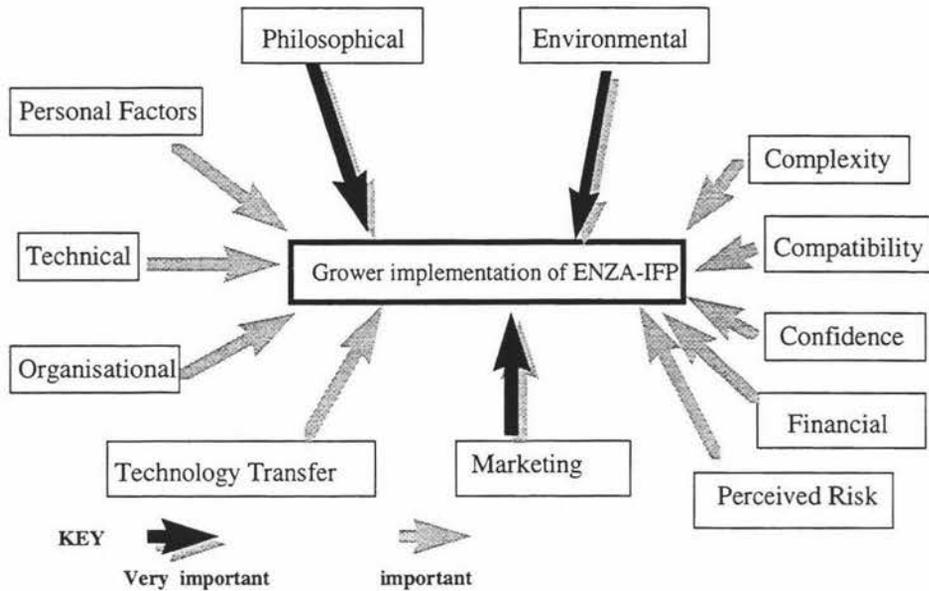
*'It is complex and from the grower's point of view it's going to be seen as more complex. As soon as we get into the 16 parts of the manual and we've only got two or three with a whole lot more coming in this year - if you start hitting them with that level, there will be a huge information overload.'*

#### **4.2.13 IFP conceptual framework developed from the case study research**

The conceptual framework in Figure 4.1 shows diagrammatically the key factors that influenced adoption and implementation of the ENZA-IFP programme. The framework shows that many factors influenced the growers' decisions to adopt. However, different factors were of greater or lesser significance. For example, the results indicate that for this group philosophy was a very strong factor and

complexity only minor. The relative weighting of these factors is denoted by the shading of the arrows.

**Figure 4.1** Factors That Influenced Adoption Of The ENZA-IFP Programme For IFP Growers



#### 4.3 Factors that May Influence Adoption and Implementation of the ENZA-IFP Programme: Non-IFP Growers

This section presents the results from the eight growers who had not adopted the ENZA-IFP programme but continued to produce fruit using conventional technologies. Seven out of the eight supplied fruit to the USA market. The remaining grower had been orcharding conventionally for over thirty years and was now retired onto his own block. He was not interested in the USA programme, but did not know how to get involved with the IFP programme. Currently he managed his orchard using a mix of conventional and IFP practices. The interviews focused on the reasons why growers had not adopted the

programme and what factors they perceived would assist them with the implementation of the programme.

#### **4.3.1 Financial**

Seven out of the eight non-IFP growers interviewed said that the reason they had not adopted the ENZA-IFP programme was the lack of any financial incentive. Currently they supplied the USA market because of the USA premium of approximately \$1.00 per carton. As IFP fruit was not eligible for the USA market, and hence the incentive, the growers were not prepared to convert to IFP. The growers noted that \$0.25 per carton incentive being offered by ENZA for IFP produced fruit was insufficient to attract them to the programme. To adopt the IFP programme they would require an incentive similar or equal to the USA premium.

*'Until they can get IFP eligible for the US market, we'll stay with what we're doing.'*

*'Basically we're getting one side - the Europeans - want us to go a bit greener, and we've got the Americans who don't want any insects so you're caught in the middle - what way do you go? Do you commit your orchard one way or the other and if you commit yourself to the greener side you're actually losing money.'*

The majority of growers talked about the importance of profitability, that they made the decision to follow the USA programme for financial reasons. Due to the current lack of profitability in the pipfruit industry, they had to look at what options would return them the most dollars per hectare. Several growers commented that they did not agree with the pest management approach (a calendar programme of organophosphates) required to meet the USA supply criteria. However, until IFP became compulsory or the incentive structure changed these growers had made a conscious decision to remain USA suppliers. Half of the growers responded that if they could supply fruit produced to ENZA-IFP standards to the USA market, and still earn the incentive, they would be interested in changing to this programme.

*'it comes back to the dollars and cents - as long as they can prove to me if I go this way [IFP] I'm going to make as much money or more money. Then I'm interested. But the way it is now, I'm not... it all comes down to profitability.'*

*'it's stupid to put an insecticide on just so you qualify for US if you don't actually need to put it on. If you monitor and find you don't need it, why put it on?'*

Two growers perceived that they would save money on sprays if they adopted the IFP programme. However, one grower thought any savings in chemical costs would be taken up by additional time required in the orchard.

#### **4.3.2 Perceived risk**

Perceived risk was identified as a factor influencing the decisions of many of the growers to not adopt the IFP programme. Six of the growers perceived IFP to have associated risks. The main perceived risk was increased pest and disease damage at harvest, especially black spot, resulting in financial loss for the grower. The perception that IFP increased the risk of black spot identified misconceptions some growers had about the programme. Two growers did not perceive any additional risk as long as the monitoring was done properly.

*'Well our main problem and our main concern is black spot. I wouldn't be prepared to take the risk of growing a crop under this scheme without using the sprays to stop black spot, like DMI's and stuff like that.'*

*'The way I see an IFP programme, you'll run your sprays as long as you can without reapplying. I could be quite wrong. As I said, there's a lot I don't know about.'*

Even though the majority perceived some risks associated with the programme, five out of the eight acknowledged that there were risks to their business and to the industry if they remained conventional. These growers acknowledged that in the future they needed to meet the overseas market demands for fruit produced to IFP standards. The key risks identified were loss of market access, trade barriers, increasing pressure from the local community and local bodies over issues such as spray drift, and increasing pest control failures due to pesticide resistance. One

grower commented that growers have no choice and will have to change in the future.

*'For the image that it gives the people. Your overseas customers aren't going to tolerate it much longer, and the insecticides are just not performing like they should anyway.'*

*'... we're getting pushed by bylaws, council laws, and that's going to be a thing - we have to change.'*

### **4.3.3 Marketing**

Seven of the eight growers responded that continued market access to Europe and the UK is the prime reason why IFP is important to the New Zealand pipfruit industry and why the industry must adopt this technology in the future. Others commented that for marketing reasons New Zealand needed to maintain its 'clean green' image and meet the world trend for 'healthier, fresher foods' .

*'Hopefully we'll still be able to sell our crop. That's what it boils down to, doesn't it? I don't think there'll ever be any premiums in it, but if that's what the market wants, then we're going to have to do it. We don't actually like going out there and spraying, people seem to think we do. The less we can use the better.'*

*'I would think in the long term it would probably be important. We've got to keep that, or try and get that clean, green image.'*

### **4.3.4 Organisational - Information from ENZA**

During the interviews growers were asked what they knew about the IFP programme and what did they need to know about the programme. This identified that half of the growers interviewed had some incorrect information about the programme, the majority had received insufficient information from ENZA to make a decision regarding adoption of IFP, and half commented that they were receiving mixed messages about the IFP and the USA market programmes. One of the growers wanted to join the programme but did not know where to get

information from. Two of the growers were actively seeking information, but were finding it difficult to obtain.

*'If they don't educate me I can't go into it, that's the problem. I don't know what they want and nobody's telling me.'*

Within this group of eight growers there were three levels of non-IFP growers with respect to their knowledge of the IFP concept. Two growers had a very good understanding of the IFP concept of monitoring and justification of agrichemicals once thresholds were met. At this stage the growers did not consider the programme due to the USA premium. Four growers held some correct information about the programme but also held some misconception regarding the technology; two of these growers were considering trialing the programme the following season. Two of the growers had a very poor understanding of the IFP concept. This was indicated by their very limited knowledge of what IFP involved and their misconceptions regarding the technology. For example they were unsure if the current fungicide chemistry could still be used, and considered that IFP was virtually an organic production system.

Some of the incorrect beliefs and perceptions about what IFP involved included: three growers commenting that IFP was semi-organic or moving in that direction; three thinking that there was a tight restriction on the amount and type of sprays growers could use; that the current range of black spot fungicides may not be available; and one was not sure if IFP involved anything more than changes to pest management.

*'Have they got anything that can control black spot under this programme?'*

*'Yes, basically there's a limited number of sprays. It's either IFP or it's not, isn't it? Somewhere along the line you've got to take a risk, don't you? If you keep spraying and spraying and you're not prepared to take the risk somewhere along the line, you just go out of it, don't you?'*

*'That's a little hazy part of my mind about IFP. Does it include control of powdery mildew and black spot.'*

Several growers commented that they did not believe ENZA management were fully behind the programme. They commented that IFP was not often mentioned at ENZA growers meetings or referred to in the regular ENZA mail to growers.

*'They're not saying a lot about it at present. It gets a little mention now and again but they don't - maybe I don't read it all. I don't know whether people realise that the Board is serious about this.'*

Half of the growers commented that they were receiving mixed messages and were confused about the IFP programme and how it fitted with the USA supply programme. Growers understood that the USA market was very important for the success of the industry, but were now being told that all growers must adopt the IFP programme by the year 2001, even though IFP fruit would not be eligible for the USA market.

*'In fact, the IFP programme is great on one hand. On the other hand we're dictated to that we have to have x number of insecticides for the American market. Contradictory. We're told to do this for IFP, but on the other hand, you won't get into America or the Taiwan markets unless you spray x number of insecticides. It's a bit of a dilemma actually. I'm keen to not pour on chemicals, but at the same time I don't want to miss out on export possibilities.'*

*'It's been very confusing really. On one hand, they're trying to tell you to stop spraying as much as you can, and on the other hand they're penalising you if you don't get your insecticides on for the USA market.'*

All growers did have some correct information about what the ENZA-IFP programme involved for them as a grower, and that the industry needed to adopt the IFP programme to maintain market access into Europe and the United Kingdom.

*'Just by the year 2000 or 2001 I think we're all going to have to change over to that system.'*

### 4.3.5 Technology transfer

Of the eight non-IFP growers, two used a technical orchard consultant regularly and two used one occasionally. The remainder did not use consultants, preferring to get information from neighbours or their spray merchants. Other technology transfer methods the growers used to obtain technical information included 'The Orchardist' (four mentioned this), ENZA technical bulletins, their spray merchants, HortResearch field days and seminars, and talking to other orchardists.

*'It's keeping an ear to the ground about who's doing various things.'*

*'Just my rep. I don't use consultants.'*

The growers were asked what skills they perceived were needed, and what sort of technology transfer methods would be most appropriate to help implement the ENZA-IFP programme. Growers identified pest, predator, and disease identification and how to monitor and interpret the information as the key skills they required. The preferred methods for technology transfer included discussion groups, hands-on experience in the orchard, and links with the specialist scientists. Three growers did not believe gaining IFP qualifications was necessary to be able to implement IFP, that learning about IFP required hands-on experience in the orchard not a certificate<sup>7</sup>.

*'The basic thing is identification of insect pests and how you set out the traps and all the rest.'*

*'I think you'll find that the IFP discussion groups are excellent value. It keeps the industry together. That's especially with the structure of it where the discussion group has got direct avenues of communication with the specialists and the scientists. The information comes straight back, and is timely information.'* [Grower was ex-farmer that had been involved in farm discussion groups.]

*'You've got to see it. One picture's worth a thousand words. Take the bloke down the road and show him, and say this is what we're going to do.'*

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<sup>7</sup> For the USA supply programme growers had to have a GROW-SAFE certificate

#### **4.3.6 Confidence**

Only one grower commented that he was not confident in the IFP technology. The majority could see no problem in the transition to an IFP programme when it was required. They commented that to be confident the monitoring needed to be done properly and the technical support and backup available. However, this confidence does not match the finding that the majority of the growers did not have a full appreciation of what IFP involved. As an example, some of the growers were unsure if black spot could be managed successfully under IFP. The growers perceived that once they had all the information from ENZA, the necessary support, and the necessary skills, that they would be confident in the technology.

*'I think if the bulk of the growers could do it, I could do it.'*

#### **4.3.7 Compatibility**

Over half of the non-IFP growers perceived IFP to be compatible with their current orchard management practices. Three of these growers had been involved in leafroller monitoring using pheromone traps in the past, but found no value in continuing once they had to follow the strict USA Code of Practice. Two used a weather-based approach to disease management and six of the growers used IMC. In general, the growers felt they had some basic skills they could build on as they moved to the IFP programme in the future. However, the majority found the ENZA-IFP programme incompatible with the USA programme.

[The IFP and USA programmes are] *'Not compatible - you're one or the other'*.

#### **4.3.8 Complexity**

IFP was not perceived to be complex by the majority of the growers when asked. One grower commented that IFP was being made more complex than necessary by

all the paperwork required. However, the interviews revealed that only two of the growers had a good understanding of what IFP involved practically for an orchardist now, and none of the growers had a good understanding of what the ENZA-IFP programme would involve in the future once all sixteen chapters were introduced.

*' It's made complex just by the big razzmatazz it's being given. Look at growers. Some growers - I don't want to sound aloof or anything - but some are in awe of all this stuff. It's not awesome at all. As long as it's put in simple terms it's very easy, and that's the trick. You put things into simple terms. '*

#### **4.3.9 Technical**

Of the eight growers, three continued to use a calendar approach to spray application, two implemented a weather-based approach, and the remainder followed a standard USA programme. Three of the growers had previously used pheromone traps to monitor leafroller activity and were comfortable with this concept to assist with the management of *Lepidoptera spp.* pests. Six had successfully implemented IMC. The two growers who had not implemented IMC were also the growers that followed a calendar approach to spraying (however one of these had used pheromone traps in the past).

*' But even if I went out there - which I do - and don't see any pests I'd still spray just to make sure I don't get anything. But as I said, the year before last I lost one block because of leafroller but they only found two or three apples. So that is the problem with it. '*

*' I still tend to spray by the calendar or by the day. We put it on this Monday and at this time of the year on seven days thou shalt go out and apply it again. That's the big difference, and that's the bit that makes me nervous. '*

*' we've done mites [monitoring] ever since the IMC came out. We don't actually use agencies any more, we just do it ourselves. I've got blocks where we haven't had miticide for 15 years. '*

One grower who had previously used pheromone traps to monitor leafroller activity and time spray applications now found no use for this technology, or the

information he gained, because under the USA programme he was not allowed to implement this knowledge.

*'I got involved 5 or 6 years ago when Jim Walker was setting up a group of orchardists where we had pheromone traps and integrated mite control.... I thought it was going somewhere, but the fact was that when we asked if we could drop sprays out from the programmes, the answer was no. So there were no cost savings and therefore I discontinued it because I had no benefit.'*

#### **4.3.10 Environmental factors**

Two of the growers perceived they would have a better living environment if they adopted the IFP programme due to a reduction in agrichemical use. Four also commented that growers are under increasing pressure from councils and communities to reduce their impact on the environment, in particular reduce spray drift. They felt growers will be forced to adopt practices such as IFP in the future. The one grower who didn't follow the USA programme associated biological control of mites as a positive environmental effect rather than using chemicals.

*'we're getting pushed by bylaws, council laws, and that's going to be a thing - but we have to change.'*

*'I have been trying to minimise OP sprays here and watching the result. I don't know if you've ever seen a 62 year-old man get excited over seeing bugs, .... showing people because I'm so proud because I can see what I've done in the past.'*

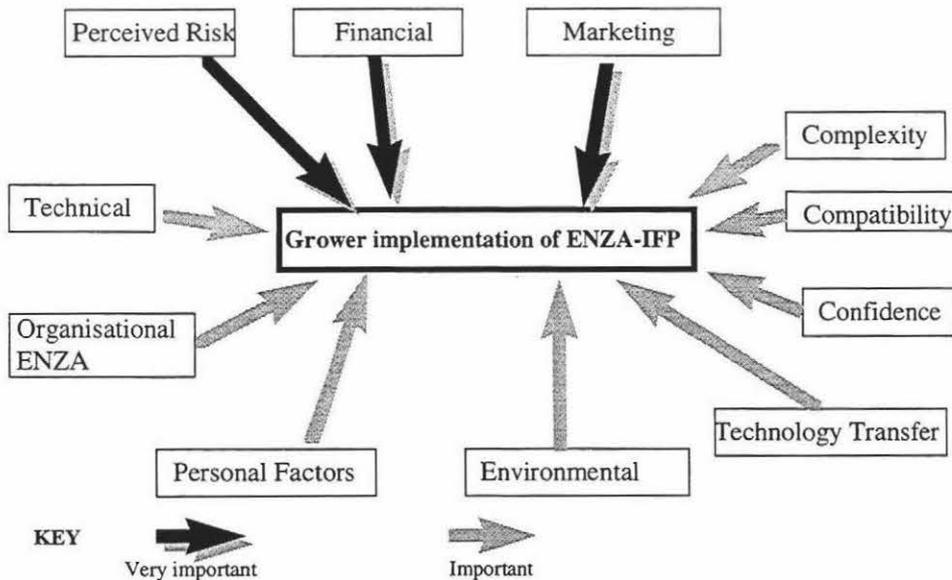
#### **4.3.11 Selective adoption**

Two growers thought the most appropriate way to adopt the IFP technology was in stages, by trialing the programme on a small area and increasing the area or number of aspects of IFP as they gained confidence and experience. They perceived this method would minimise any risks of crop failure.

#### 4.3.12 Non-IFP conceptual framework developed from the case study research

The conceptual framework in Figure 4.2 shows diagrammatically the key factors that may influence adoption and implementation of the ENZA-IFP programme. The framework shows that many factors may influence the growers' decisions to adopt. However, as with the IFP growers, different factors were of greater or lesser significance. For example, the results indicate that for this group financial factors were very important while environmental factors were only minor. The relative weighting of these factors is denoted by the shading of the arrows.

**Figure 4.2** Factors That May Influence Adoption Of The ENZA-IFP Programme For Non-IFP Growers



#### 4.4 Cross Case Comparison Between IFP and Non-IFP Growers

This section compares and contrasts the results from the IFP and the non-IFP case studies. The comparison of the demographic characteristics is discussed first,

followed by a review of the differences and similarities between the factors that influence adoption of the ENZA-IFP programme. The two conceptual frameworks are then compared, and from this one conceptual framework is derived for factors that influence the adoption of ENZA-IFP for all growers. This is then compared with the conceptual framework for adoption of IFP technologies developed from the reviewed literature.

#### **4.4.1 IFP and non-IFP grower characteristics**

The growers were selected randomly from the population of IFP and non-IFP growers. During the interviews other information was collected including their age, number of years orcharding, education etc. Of the 21 grower interviews<sup>8</sup>, 13 were Hawke's Bay growers and eight were from the Nelson region. Thirteen of the growers had adopted the ENZA-IFP programme (nine from Hawke's Bay and four from Nelson) and eight remained conventional (non-IFP) producers (four from each region). Twenty of interviewees were owner-operators and one was an orchard manager.

Table 4.1 shows the age range of the respondents. Nine out of the thirteen IFP growers were under 40 compared to seven of the eight non-IFP growers who were over 40. It should be noted that the thirteen IFP growers were randomly selected from a sample size of 88, while the eight non-IFP growers were randomly selected from the Hawke's Bay and Nelson non-IFP grower population of approximately 1000. While the non-IFP sample is an indication of the entire population it is not statistically representative. The older age range of the non-IFP growers may be a consequence of a small sample size of growers selected for non-IFP and is not necessarily to be the average age of non-IFP growers at the time.

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<sup>8</sup> In total 24 growers were interviewed on 21 orchards, as three of the IFP orchards were husband/wife partnerships that participated in the interviews. However for the purpose of this discussion each orchard interview will be described as one grower interview.

**Table 4.1** Age of Respondents

	20-30 years	30-40 years	40-50 years	50+ years
<b>Total</b>	1	9	5	6
<b>IFP</b>	1	8	3	1
<b>Non-IFP</b>	0	1	2	5

Of the thirteen IFP growers and eight non-IFP growers interviewed:

- IFP growers were younger. 70% of the IFP growers were under 40 years of age; 12.5% of the non-IFP were under 40.
- IFP growers were more highly qualified. Eighty eight percent of the IFP growers had some form of tertiary education compared to 25% of non-IFP growers. This may be related to the younger age of the IFP growers compared to the non-IFP growers.
- Younger growers were more qualified than older growers. 80% of growers under forty had tertiary qualifications compared to 27% of the growers over forty.
- 77% of the IFP growers used consultants and attended field days compared to 25% and 50% respectively of non-IFP growers. Age may be important here also. Of the combined under 40 year old growers, eight out of the ten used a consultant and attended field days regularly compared to four out of the eleven growers over forty.
- Orchards or orchard blocks that were not suitable for supply to the USA market were more likely to be IFP.
- Orchard size was not related to the use of IFP.

In summary, the growers interviewed that voluntarily registered for the IFP programme in the pilot year were younger growers, most had tertiary qualifications, used a consultant, and attended field days regularly. Additionally,

the younger growers were more likely to be tertiary educated, use consultants, and attend field days, and the older growers were more likely to have only secondary qualifications. For contrast, the following quotes from (1) an IFP grower under forty and (2) a non-IFP grower over 40 with no tertiary education are provided to exemplify the differences.

*(1) 'I've got a horticultural degree from Lincoln. Coming from our background we knew there were opportunities to reduce the chemical input, so philosophically we wanted to try and have a lot less sprays.'*

*(2) 'Hopefully at my age I could get someone else to do it and perhaps pay for the monitoring, plus it would keep you free with your other jobs as well. You wouldn't want to be tied up with the programme, having to walk around the orchard every so often and other things getting neglected...Like with my computers we've become computer conscious with our grading and that type of thing, but I'm afraid I'm not that well up with it so I've just employed people to do it. Sometimes a little bit of knowledge is a dangerous thing, isn't it?'*

All of the nine Hawke's Bay IFP growers implemented the IFP programme on all varieties on their trial block. Four of the Hawke's Bay growers mentioned they had problems with mealy bug, or mealy bug resistance to Lorsban, hence their blocks were not suitable for the USA supply programme anyway. Another two growers said that as a result of the IFP programme they had found mealy bug for the first time in their orchards at harvest. In Nelson, due to climatic conditions mealy bug is not a key pest and Lorsban resistance had not been recorded to date. One of the Nelson IFP growers only implemented the IFP programme on their Cox's Orange Pippin blocks; the remainder of his varieties remained in the USA supply programme. Cox's are not exported to the USA and hence are not eligible for the USA premium. Three Nelson growers said that many Nelson growers were keen to trial the IFP programme, but only on their Cox's blocks until fruit produced to IFP standards was eligible for the USA market.

*'Underlying that was we had the resistant mealy bug anyhow, so I couldn't get into USA, why waste all that money' (Hawke's Bay grower)*

*'In Nelson mealy bug does not have Lorsban resistance and it's a different species.'* (Nelson grower)

*'I think in the Nelson region, which is important - we've got to talk about Nelson - is we've got a variety, we've got Cox's Orange. There's Cox's - which is an IFP variety.'* (Nelson grower)

#### **4.4.2 Similarities between case study results from the IFP and non-IFP growers**

The IFP growers thought other growers had not adopted the programme due to the premium paid for fruit supplied to the USA pool. This was confirmed in the interviews with the non-IFP growers, who said the key reason they had not adopted the programme was due to the lack of financial incentives compared to the USA supply programme. Both IFP and non-IFP growers thought ENZA needed to pay growers an incentive over the transitional phase to encourage adoption of ENZA-IFP.

The majority of the non-IFP growers perceived risks associated with moving to an IFP programme in terms of increased pest and disease damage. Two IFP growers also perceived the same risks and would feel more comfortable when more research was undertaken on specific technical aspects. However, the majority of IFP growers did not perceive additional risks with IFP.

Other risks mentioned by both groups included loss of market access into key export markets, increasing pest resistance to organophosphates, and increasing pressure from local government and the community to reduce spraying and spray drift.

Maintaining market access was a contributing adoption factor for the IFP growers. They understood clearly, via information from ENZA, that growers had to adopt IFP production systems in order to maintain market access into key export markets of Europe and the UK. The majority of non-IFP growers interviewed understood that ENZA planned to have 100% of growers involved in ENZA-IFP programme by the year 2001 and that market access was the prime reason why the industry had to adopt this technology. While they understood this, they were not forced to

adopt IFP immediately and the USA programme offered a greater financial reward.

The majority of both groups understood why ENZA was introducing ENZA-IFP. Both groups concluded that much of the information they received from ENZA was confusing and/or poorly timed, and that they received mixed messages. There was consensus between the groups regarding the ENZA-IFP programme and the USA programme. Growers could not see how these could work simultaneously and felt they were receiving mixed messages from ENZA regarding the importance of the programmes. Both groups also commented on a seeming lack of commitment throughout ENZA (from management to field staff) towards ENZA-IFP.

Both groups identified that the key skills growers require to implement ENZA-IFP are pest and disease identification, a knowledge of how to monitor, and how to interpret the information. The technology transfer methods identified by both groups as most suitable were 'hands-on' experience in the orchard and the use of discussion groups as a way for growers to share ideas and experience.

The majority of growers from both groups found IFP, or perceived it to be, compatible with their current production system. All the IFP and the majority of non-IFP growers used IMC successfully to manage European Red Mite, which involves monitoring and action thresholds (Table 4.2). Three of the non-IFP growers had previously been involved in leafroller monitoring using pheromone traps and were therefore used to the IFP concepts. As these growers had already been involved in some forms of orchard monitoring they expected that they could comfortably move to an IFP programme.

**Table 4.2** Use of Integrated Mite Control (IMC) for European Red Mite control by IFP and non-IFP growers

<b>USE IMC</b>	<b>Yes</b>	<b>No</b>
<b>IFP Growers</b>	13	0
<b>Non-IFP Growers</b>	6	2

Both groups agreed that IFP and the USA supply programmes were not compatible. IFP focused on justification of spray application and the USA Code of Practice demanded a calendar programme of organophosphates regardless of pest incidence.

The majority of the IFP growers felt confident with the programme, this confidence came with their experience with the programme. Most of the non-IFP growers were also confident that when the time came they would be able to implement the ENZA-IFP programme. Both groups thought there was no need for it to be complex.

#### **4.4.3 Differences between IFP and non-IFP growers and the factors that influence adoption of ENZA-IFP**

The majority of the IFP growers adopted IFP due to their personal philosophy towards pipfruit growing and their concerns for the environment. The main philosophical reasons were regarding the USA supply programme and spraying. These growers did not want to follow the USA calendar-based insecticide programme and they wanted to minimise the use of organophosphates. However, many in this group of growers acknowledged that this viewpoint was different from the views of the majority of growers. This group placed their philosophical values and concerns for their environment above financial issues.

More than half of the IFP growers perceived that they would improve the living and working environment for their families and workers by adopting the IFP programme. Having adopted the programme they confirmed this was the case, many quoting they were happier for their children now to run around the orchard. For the majority of non-IFP growers this was not a key consideration. Financial sustainability was more important to this group than environmental or health issues. However, two non-IFP growers did believe they would improve their living

and working environment if they adopted the IFP programme, but this was outweighed by financial issues.

The majority of non-IFP growers perceived that a benefit of the IFP programme would be financial savings in chemical costs. However, half of the IFP growers found no cost savings associated with the programme due to additional costs in pest and disease monitoring offsetting any reduction in spray costs.

The majority of the IFP growers felt that any risks associated with the IFP programme were minimal if the technical aspects of the programme were followed correctly. However, the majority of non-IFP growers perceived increased risks of pest and disease damage at harvest and resulting financial implications.

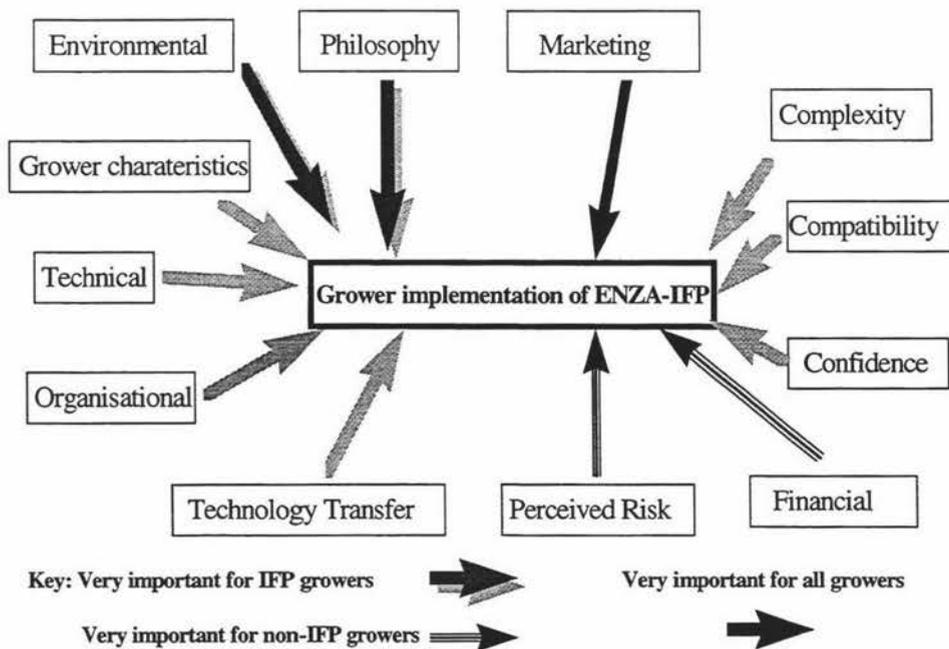
IFP growers had an accurate knowledge of what ENZA-IFP involved and what it was likely to involve in the future. The research found that the majority of the non-IFP growers did not have a clear understanding of what IFP involved now or in the future, and many had misconceptions of what it involved.

From the twenty one grower interviews that were conducted it became apparent that growers placed a different emphasis on the importance of the benefits. Much of this was due to the interactions between the benefits and financial situation (non-IFP growers), and perceived benefits and their production philosophy. The benefits the IFP growers found from being involved in ENZA-IFP were increased grower knowledge and skills, an improved family and working environment, a reduction in organophosphate use, and market access in the future. The key benefits non-IFP growers perceived were continued market access and possible cost savings in chemicals. However, a few of the non-IFP growers also reported enhanced grower skills and an improved working environment for family and workers as being benefits they would derive from being involved with IFP.

#### 4.4.4 Comparison of the conceptual frameworks

The cross-case comparison identified that the majority of the factors that influenced the decision to adopt ENZA-IFP were similar for both IFP and non-IFP growers. However, considerable differences in the weighting growers placed on the importance of these factors was identified. For example, financial factors and perceived risk of crop loss were identified by both groups as important. However, the non-IFP growers placed a greater emphasis of these factors than the IFP growers. The only factors that were substantially different between the two groups were philosophical and environmental factors. For the IFP growers these factors were the most significant reason why they had adopted the ENZA IFP programme. While some of the non-IFP growers acknowledged that a benefit of IFP would be an improved living and working environment, it was not a motivating factor. Figure 4.3 depicts the conceptual framework developed from the case study analysis.

**Figure 4.3** Factors that Influence Grower Adoption and Implementation of the ENZA-IFP programme .



## **4.5 Comparison With The Literature**

In this section the factors that were described in the literature as influencing adoption are compared and contrasted with the factors identified in the grower interviews. The demographic characteristics are discussed first, followed by a review of the differences and similarities between the factors that influence adoption of the sustainable technologies. Additional factors that were not described in the literature are also discussed. At the end of this section the conceptual framework derived from the case study research is compared and contrasted with the conceptual framework developed from the reviewed literature.

### **4.5.1 Grower characteristics from the case studies compared to the literature**

The case studies identified that:

- IFP growers were, on average, younger than the non-IFP growers - nearly all the IFP were less than 40 compared to nearly all the non-IFP being greater than 40;
- The majority of the IFP growers had been orcharding for less time than the non-IFP;
- There was no difference in the size of orchards between the two group;
- Education levels also differed between the groups - nearly all the IFP growers had tertiary education compared to a small proportion of the non-IFP;
- The majority of the IFP growers used consultants and attended field days more regularly than the non-IFP growers.

These characteristics compare favorably with traits Rogers (1995) identified in early adopters, including:

- Earlier adopters have more years of formal education than later adopters;
- Earlier adopters have more change agent contact than later adopters;

- Earlier adopters have greater exposure to mass media communication channels than later adopters;
- Earlier adopters have greater knowledge of innovations than later adopters;
- Earlier adopters seek information about innovations more actively than later adopters.

The grower characteristics of the IFP group compare with the findings of McNamara *et al* (1991), Ridgley and Brush (1992), and Lambur *et al* (1985). These authors described some of the characteristics of growers who have a higher rate of adoption as likely to have larger operations, be better educated, have contact with extension agents, attend field days, and read more farm literature.

#### **4.5.2 Comparison between factors identified in the literature with those identified in the case study research**

##### **Financial**

The case studies identified financial factors as the key factors influencing non-IFP growers' decisions to not implement the ENZA-IFP programme. This concurs strongly with the literature where a number of authors described financial factors as one of the key factors influencing adoption (McNamara 1991; Herbert 1994; Lenz 1990; Guerin and Guerin 1994; Wearing 1988; Zalom 1993; Kennedy 1990; Manktelow 1987).

Wearing (1988) and Steffey (1995) found that financial factors included a lack of financial incentives to change to IPM systems. The USA programme incentive of approximately \$1.00 per carton was the reason growers implemented that programme, and to achieve adoption of ENZA-IFP would require an incentive equal to the USA programme. The majority of growers concluded that ENZA needed to offer growers a financial incentive during the transitional phase to encourage growers to adopt the programme. This agrees with Cross *et al* (1996)

who found that even a small financial reward (less than 1%) was sufficient to encourage adoption.

None of the growers who had adopted IFP in the first season cited financial factors as a key reason for adoption. For the pilot programme in 1996, growers were asked to volunteer to register for the programme. Eighty eight growers did, which represents 5% of pipfruit growers. In this case, the philosophy of the growers towards production and environmental concerns were more important than financial factors for these early adopters.

Lack of funding for IFP research and education was identified in the literature as a factor affecting adoption (Steffey 1995; Herbert 1994). It is possible that the mixed messages growers were receiving about the ENZA-IFP programme, and the perceived lack of commitment from ENZA, were due to a lack of resources and education. Some growers commented that some ENZA staff were not knowledgeable about ENZA-IFP when they required information.

### **Environmental**

The majority of the non-IFP growers did not consider environmental or health factors as a reason to adopt the IFP programme. For these growers financial and marketing issues were of prime concern. This finding compares with the literature where environmental issues and hazards from insecticide use were found to have only a minor influence on adoption of IPM (Wearing 1988, McNamara 1991).

This does not agree with the findings from the IFP case study research. Four of the thirteen IFP growers adopted the ENZA-IFP programme primarily for environmental reasons, and twelve of the thirteen growers considered environmental factors very important in their decision to adopt ENZA-IFP. The majority reported a better environment for their family and workers as a consequence of adopting IFP. For many, the perceived benefits from not using a regular programme of organophosphates was a key reason why they adopted the

programme initially. These growers were concerned for their environment, and wanted to improve it by adopting the IFP programme. This is contrary to McNamara's (1991) statement that, even though producer and environmental benefits have been identified from the adoption of IPM systems, this has little impact on the adoption of such programmes.

The most important environmental issue identified by McNamara *et al* (1991) was the concern for preserving the habitat for natural predators. The success of biological control was identified by many of the IFP growers as a benefit of the IFP programme, but was not the most important environmental issue. For these growers, an improvement in their working and living environment from reduced organophosphate use was the most important.

### **Perceptions of Risk**

The majority of non-IFP growers perceived ENZA-IFP to be of greater risk than their current production system. The perceived risks were increased pest and disease damage resulting in financial loss, the same risks as those identified in the literature. Of the growers who had one year's experience with the programme, only two thought that IFP had added risk. The majority thought risk was minimised if the monitoring and the programme were followed correctly. This result compares favorably with the literature as financial factors and perceived risks associated with IFP programmes were consistently noted as key factors influencing adoption. Herbert (1994) identified that the risk is generally perceived rather than a real threat to a grower's livelihood. (Wearing 1988; Herbert 1994; Glass 1992; Lambur *et al* 1985; Guerin and Guerin 1994) found that perceived risk and lack of trust are probably the greatest financial obstacles. The perceived risk is in the form of increased crop loss from pest damage due to reducing agrichemical use and consequential financial loss. Wearing (1988) and Wardlow (1991) concluded that it was very important to reduce perceptions of risk in order to achieve adoption. They identified that consultants and other advisors played a role in reducing risk, as did providing education and support and promoting the

tangible benefits. In the ENZA-IFP example, the growers had the support of other growers, specialist IFP scientists, and facilitators in the first season which provided a good source of information, helped give the growers confidence, and probably helped reduce perceived risk.

## **Marketing**

The grower interviews identified continued market access as a key reason why non-IFP growers would adopt ENZA-IFP in the future. All the growers understood that ENZA was under pressure from overseas supermarkets to supply fruit produced to IFP specifications. The IFP growers noted that marketing factors contributed to their decision to adopt IFP and many perceived an advantage by adopting early to gain experience and knowledge with IFP before they were forced to adopt it. The majority of the IFP and some of the non-IFP growers identified that the risks of not adopting IFP were greater than adopting it, with the risk of non-adoption being loss of market access.

These results also match what was found in the literature where market access was identified as an important issue. Both Kennedy (1990) and Cross (1996) reported increasing pressure for producers to comply with food safety legislation and market access issues as factors that influence grower adoption of IFP programmes. Wearing (1988) found marketing and social issues were the key factors influencing adoption.

## **Confidence**

The majority of the IFP growers said they were confident in the IFP technology and believed having confidence in the programme was important to successfully move from a conventional to an IFP production system. For the IFP growers this confidence was built by their experience with IFP and their improved skills and knowledge in pest and disease identification and monitoring. This concurs with

Wearing's (1988) and Guerin and Guerin's (1994) findings, who identified confidence as a factor influencing adoption.

Seven of the eight non-IFP growers had experience, satisfaction and confidence with the USA programme. These growers found the USA programme successful in terms of pest and disease control. Some of the non-IFP growers did not believe that they could manage Black Spot if they adopted the IFP programme. This agrees with Wearing's (1988) finding that growers have experience, confidence, and satisfaction with chemicals, and lacked confidence in IPM.

However, some of the IFP growers were not completely satisfied and confident with conventional pesticides and methods of pest management. Four currently had problems with pest resistance to organophosphates and needed to consider alternatives to improve pest management.

The importance of building confidence in an IFP programme equal to a growers current confidence was highlighted by many authors. Wearing (1988) recommended that a grower's confidence in the programme must be nurtured and maintained as a primary objective. One IFP grower had a negative experience with IFP in the first season, which resulted in them losing confidence in the programme. They required more research, appropriate modifications to the programme, and support to feel confident in the technology. Wearing (1988) suggested that confidence could be built by having a credible and compatible IPM technology that is backed up with science and support, and that grower experience with IPM helps to build confidence. The growers reported that their confidence in the programme increased with experience.

### **Compatibility**

McNamara (1991) suggests that to be confident in the technology it needs to be compatible with the grower's existing system. The IFP growers found the programme compatible with their current production system. The non-IFP growers

perceived it to be compatible. All of the IFP and six out of eight of the non-IFP growers used Integrated Mite Control (IMC) technology and other forms of orchard monitoring in the past. Additionally, most used weather-based spraying for disease management. As these growers were used to the concept of monitoring they found IFP to be compatible with their orchard management.

Most of the non-IFP perceived the transition to ENZA-IFP would be manageable given their current orchard management. The growers that were not confident to move to IFP were also the growers that did not have a good understanding what it involved, had some misconceptions about the technology, and had not previously adopted technologies as IMC, weather-based spraying, or other monitoring methods. To these growers the concept of IFP was very different to their current orchard management, and not compatible.

### **Complexity**

The IFP growers interviewed did not find IFP complex. These growers had a good understanding of what IFP involved currently but acknowledged at the time of the interviews they had only had one years experience with the programme. At this time IFP only involved pest and disease aspects of the programme. Several growers commented that when the programme was complete it would be complex for a new grower to get involved, but at this stage it was relatively simple. However, several growers had identified some unexpected problems, such as secondary pests, that had not been problem in the past and now had to be managed. Conventionally, almost all pests were managed by a calendar programme of broad spectrum pesticides. Under IFP management, the use of selective soft pesticides meant that new secondary pest problems had to be managed separately. Therefore, even though the IFP grower said IFP was not complex, their descriptions of the system and what it involved had identified that IFP was more complex than conventional production and did require greater growers skills and knowledge. This agrees with the literature, where IFP was considered complex in comparison to conventional production systems by many

authors, including Lambur *et al* (1985) and Guerin and Guerin (1994). They described IFP systems as a complex set of behaviours, decision-making procedures, methods, technologies, and values organised to provide efficient alternative methods.

The majority of the non-IFP growers did not perceive IFP to be complex. However, most of these growers did not have a clear understanding of all the current grower requirements for the ENZA-IFP programme or what it would involve for growers in the future. This result indicates that the programme was not simple.

### **Education and technology transfer**

Lack of trained IFP specialists was not perceived as a constraint by the growers interviewed as was identified by Glass (1992). All were confident that their facilitator had the necessary skills and knowledge, or could gain them. However, lack of information and mis-information was highlighted as a key concern by growers. Some non-IFP growers felt they did not have enough information about the programme to make an adoption decision, and the majority of IFP growers felt that some of the information growers received was poor, confusing, and/or incorrect. This concurs with Wearing (1988), who reported that lack of simple communication was an adoption constraint. Additionally, lack of grower training programmes in IPM education and monitoring, lack of published information (Wearing 1988; Zalom 1993; Stewart 1993), and lack of education of IPM developers about the perceptions and needs of growers (Guerin and Guerin 1994) are discussed as obstacles to adoption. Hence the research findings match the literature.

This research project examined the information and skills growers perceived they required to adopt IFP successfully. The growers noted information on pests, predators and diseases, monitoring, and how to interpret the monitoring results as the necessary skills and knowledge to have. This concurs with Kennedy (1990),

who found that growers want practical information that includes easy, reliable monitoring techniques and information on thresholds of pests and appropriate control mechanisms. A number of authors concluded that due to the complexity and additional grower skills and knowledge required compared to conventional production, growers need additional education and support to implement IFP. This support helps to minimise growers perceived risk about a technology and build confidence. (Wearing 1988; McNamara 1991; Stewart 1993; Wildbolz (1992).

The research also looked at what technology transfer methods growers found or perceived to be the most appropriate to assist with the implementation of IFP. The prime source of information and support for the growers was the discussion groups, involving a facilitator, a specialist, and the grower group. The growers found this to be the most appropriate method for introducing the IFP technology. Reasons included that discussion groups are held on growers' orchards and involved a hands-on approach in the orchard - nearly all the growers noted that the best way for growers to learn and gain confidence is by 'hands-on' experience, by meeting and sharing information with other growers, and by having the specialist scientists involved. Non-IFP growers also perceived discussion groups involving hands-on experience as the most appropriate method for IFP technology transfer. This concurs with Wearing (1988), Steffey (1995), and Lambur *et al* (1985) who found that for grower adoption of technologies, such as IPM, verbal communication was the most effective. Verbal communication involved grower groups, courses, grower-scientist contact, and field days, which rated second after one-on-one consultation.

Second to the discussion groups, other technology transfer methods and tools the IFP growers found to be useful included the IFP manual, IFP technical fax-outs, their consultant, and the ENZA and HortResearch IFP seminars. Articles, bulletins, newsletters, and computers as decision support tools, were all reported in the literature to be useful, but less effective than verbal communication.

The non-IFP growers listed spray merchants, orchard peers, and to a lesser extent consultants as their main source of technical information. This suggests that verbal communication is the preferred medium. Other sources of information included technical bulletins, field-days, and seminars.

## **Technical**

The case studies identified technical issues as a factor influencing adoption of IFP. The IFP growers thought that for new growers to have confidence in the programme technical issues would need to be addressed. They also identified understorey, soil, and water management and 'new' problems with secondary pests as areas requiring research.

Increasing pest resistance to commonly used agrichemicals, such as organophosphates, was a reason why growers were keen to look at alternatives for pest management, such as IFP. This factor was not identified in the literature.

The identification that technical factors influence adoption agrees with the literature review where Wearing (1988), Zalom (1993), and Rogers (1995) discussed technical factors as a factor influencing adoption. These authors reported that technical factors were not key factors. Wearing (1988) reported that they were the least important factor influencing adoption. This agrees with the research where technical issues were discussed by the growers but were secondary to issues such as financial factors, risk, philosophy, or technology transfer.

The technical aspects that were noted in the literature to enhance adoption were:

- simple monitoring methods and thresholds;
- economic based thresholds;
- IPM technologies to manage secondary pests;
- selective chemical options that are compatible with IPM;
- a credible technology with clear advantages over current production;
- technical and scientific support;

- compatibly with the existing system;
- to be able to observe the technology.

Growers discussed the need for simple monitoring techniques, economic thresholds, technologies to manage secondary pests, the need to gain experience in the orchard (ie observe the technology), and to have technical support from specialists.

### **Organisational Factors**

Conflicting messages from ENZA regarding the importance of the IFP programme and a lack of timely information about the ENZA-IFP programme were two complaints growers had about the marketing board. This agrees with the finding from Steffey (1995) that differing agendas and conflicting messages from government agencies were obstacles to implementation of IPM.

Issues that growers felt hindered the implementation of the IFP programme included mixed messages from ENZA regarding the importance of IFP, and how the USA programme fitted with the IFP industry plan. Growers understood the USA programme to be important for the industry, and this view was supported by the \$1.00 premium paid per carton. At the same time, the growers have been told that the whole industry must be IFP by the year 2001, but that there will be no financial incentive for IFP produced fruit. Additional concerns were a general lack of information, poor timing of delivery of information, and a question mark over who was driving the programme.

Some growers deduced that this lack of information stemmed from the lack of commitment or lack of understanding of the program and grower needs by ENZA management. The need for clear guidelines on the direction of the programme and what it requires is important to growers

The growers' concerns agree with obstacles identified in the literature by Wearing (1988) which include lack of planning for implementation and a lack of understanding of the implementation process by IPM coordination teams.

### **Selective adoption**

The literature indicated that to be successful, full adoption of the programme may not be necessary, and that selective adoption can form an important part in the adoption of sustainable technologies (Steffey 1995; Ridgley and Brush 1992; Gladwin 1989). Gladwin (1989) found that adoption of agricultural technologies was often partial or limited and that they require adaptation, such as informal experimentation and local knowledge, to be implemented successfully.

The concept of selective adoption fits with the findings of the research. A weather-based approach to spray application and IMC are technologies which have been introduced to the New Zealand pipfruit growers over the past fifteen years. Both require tailoring to each orchard's location and knowledge of the orchard. Over half of the respondents had adopted weather-based spraying and all of the IFP growers and most of the non-IFP growers were currently using IMC successfully to manage European Red Mite.

Two Nelson IFP growers suggested a selective adoption approach would be effective for the ENZA-IFP programme. The reason given was that the ENZA-IFP programme involved sixteen aspects of orchard management and that to introduce one section at a time was more likely to be successful than to introduce the entire programme in one season. This concurs with the findings from Ridgley and Brush (1992), who recommended that in order to reduce the perceived complexity of IPM programmes, they could be presented as a series of individual tactics and tools, with each component promoted separately.

### **4.5.3 Factors identified in addition to the reviewed literature**

#### **Philosophy**

The majority of the IFP growers adopted IFP because of their 'philosophy' towards pipfruit growing. They had the belief that growing fruit using IFP methods, and minimising organophosphates, would result in an improvement in the living and working environment for their family and workers. Furthermore, they did not agree with the USA Code of Practice concept of calendar pesticide spraying. Many of these growers had supplied the USA programme in the past and were capable of meeting the current USA standards but decided to forgoe the \$1.00 incentive and adopt IFP for reasons other than financial.

This finding opposes the views of the majority of researchers reported in the literature review. It may be that this issue is peculiar to the New Zealand pipfruit industry, which is simultaneously running two production programmes with opposing standards and requirements. No examples were found where a grower's 'philosophical reasons' or attitudes and beliefs towards a technology were the key motivating factor. Rogers (1995) 'Diffusion of Innovations' model characterised growers who adopted a technology first as innovators and venturesome. The author suggested that the characteristics of innovators were their interest in new ideas and wanting to lead the way. They generally have financial resources to cover possible unprofitable innovations, the ability to understand and implement complex technological innovations, and the ability to deal with uncertainty regarding the success or not of an innovation.

### **4.6 Comparison of the Literature Review and Case Study Conceptual Frameworks**

This section compares the conceptual framework derived from the reviewed literature with the conceptual framework developed from the case study research. Figure 4.4 illustrates the conceptual framework derived from both the literature and the case study research. The key factors influencing the adoption of

sustainable technologies compare favorably between the research and the literature.

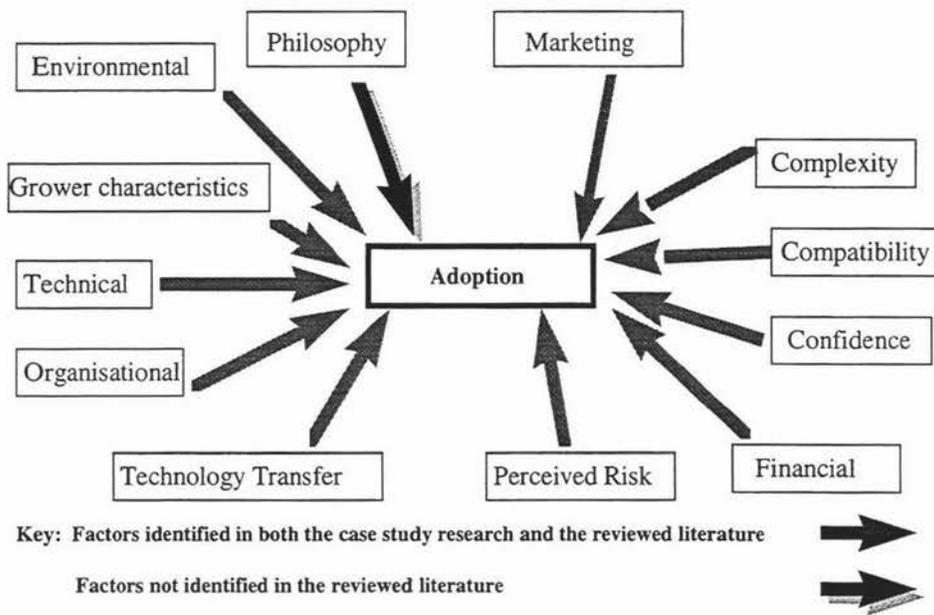
The only factor that is different from the literature derived conceptual framework is the factor 'philosophy'. Otherwise the factors influencing the adoption of sustainable technologies in primary industries are the same for both frameworks. However, the relative importance of the factors to adoption of sustainable technologies varies between the research and the literature frameworks. Financial and perceived risk factors were consistently rated the strongest factors in the literature and this is also shown in the research framework. However, 'marketing' factors were stronger in the research than identified in the literature. The reason for this may have been that ENZA had promoted widely that the industry needed to move to an IFP programme to maintain access to European supermarkets. Although this was not the key reason for the IFP growers to adopt the programme, they saw it as a key benefit from the programme. The non-IFP growers noted marketing as a key reason why they needed to adopt IFP in the future.

Although the research identified complexity, confidence, and compatibility as factors, the growers interviewed did not place as much importance on these factors as in the literature. This may have been because at the time of the research the ENZA-IFP programme had only been piloted for one season and did not involve all aspects of IFP, compared to European IFP programmes that have been implemented since the 1980's. In the reviewed literature, technology transfer, education, organisational issues, and personal factors were all found to be important in the adoption of sustainable technologies. This was also true for the conceptual model derived from the research.

Both the research and the literature identified that many factors influence a grower's decision to adopt sustainable technologies. Guerin and Guerin (1994) described adoption of sustainable technologies as multi-factoral. However, for different growers different factors are of a greater or lesser importance. For the early adopters of the ENZA-IFP programme, philosophy and environmental

reasons were of greater importance than financial considerations. The literature derived conceptual framework shows financial considerations are of greatest importance.

**Figure 4.4** Conceptual Framework Developed From The Reviewed Literature And The Case Study Research Of The Factors That Influence The Adoption And Implementation Of Sustainable Technologies And ENZA-IFP.



## **CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS**

The concluding chapter is divided into two parts. The first section discusses how well the research objectives discussed in Chapter One were met and summarises the key findings. The second section reflects on the process, recommends strategies that could enhance adoption of ENZA-IFP programme, and makes recommendations for further research required.

### **5.1 Key Findings**

IFP and non-IFP case studies were used to achieve the objectives of this research project. The case study research involved interviews of IFP and non-IFP growers in Hawke's Bay and Nelson to determine the factors that influence the adoption and implementation of the ENZA-IFP programme. The results of the case study research were compared between the groups, then compared and contrasted with the factors identified in the reviewed literature. Conclusions were then drawn regarding the factors that influence the adoption and implementation of ENZA-IFP. This enabled the research objectives of this thesis to be met, which were to:

- identify key differences between IFP and non-IFP growers and their attitudes towards IFP;
- identify key factors that influence grower adoption and implementation of the ENZA-IFP standards;
- review the technology transfer processes used to enhance the adoption of sustainable technologies, such as IFP;
- identify methods of technology transfer that may encourage grower adoption of the ENZA-IFP programme.

### 5.1.1 Differences Between IFP and Non-IFP Growers

The key differences noted between the two groups were philosophical and financial factors, perception of risk, knowledge and understanding of IFP, and grower characteristics.

A significant difference between IFP and non-IFP growers related to philosophical stance. IFP growers were motivated to change to ENZA-IFP for their philosophical and environmental concerns. These growers fully embraced the IFP philosophy. Four of the orchardists had already been looking at ways to minimise organophosphate usage. These growers had not been involved in the US programme prior to the introduction of ENZA-IFP. In addition, one had previously trialed organic production. These growers did not follow the US-COP because they did not agree with the pest control philosophy of this programme. Non-IFP growers, involved with the USA programme did not appear to be as concerned about environmental issues.

Family details were not collected, but during the interviews it was identified that at least seven of the IFP growers had young families, and four commented in particular that a benefit of adopting the IFP programme was providing a better environment for their children to live and play in. It is hypothesised that younger families are attracted to sustainable programmes such as IFP for environmental and health reasons.

The IFP growers were concerned with the impact of their orchard management practices on the living and working environment of themselves, their families, and their staff. They were also more concerned about the negative effects of organophosphates use on their health, the increasing risk of pesticide resistance, and the impact of conventional practices on the larger environment.

Financial factors were the most important consideration for the non-IFP growers. The financial consequence of adopting the ENZA-IFP programme, and thereby

losing the opportunity to earn the USA supply programme incentive, was their key financial concern. The two systems (ENZA-IFP and USA supply) were thus mutually exclusive as far as these growers were concerned.

Although it is not perceived that the IFP growers were in a better financial position than the typical grower, as several of the IFP growers commented about the current difficult times, they did not perceive IFP to be a financial threat to their business. The IFP growers were comfortable that any risk was minimised by following the ENZA-IFP procedures and by ensuring that they were fully informed through their involvement with the discussion groups.

The non-IFP growers were more concerned about the risks associated with adopting the ENZA-IFP than the IFP growers. The key risk perceived was increased crop failure from increased pest and disease damage.

The IFP growers had a much greater knowledge and understanding of IFP than the majority of the non-IFP growers. All the IFP growers had previously adopted integrated mite control (IMC) and weather-based spraying, compared to only some of the non-IFP growers. Growers with a knowledge of such technologies are better equipped to progress further to more complex technologies such as IFP.

### **Differences In Grower Adopter Categories**

It was found that the IFP growers were interested in new ideas, and their good understanding of what IFP involved suggests they had an ability to implement complex technologies. The IFP growers were younger on average, had more formal education, and were more likely to use a consultant and attend field-days regularly, than the non-IFP growers. This fits with Rogers' classification of innovators. It should be noted that the characteristics of each grower, or group of growers, do not exist in isolation. Many of the characteristics noted are linked, especially philosophy with age and education, and risk perception with financial situation and knowledge of the system.

The non-IFP growers fitted into three adoption as stages classified by Rogers (1995):

1. early adopters. Two of the growers interviewed currently used orchard monitoring methods and implemented IMC and weather-based spraying successfully. These growers wanted more information about ENZA-IFP;
2. early majority. Several of the growers fitted this category. They implemented IMC, weather-based spraying, and understood the concept of IFP. These growers were waiting for the right financial incentives from ENZA, or the ability to sell fruit produced to IFP standards to the USA market, before they would adopt the ENZA-IFP programme;
3. late majority - Two of the growers fitted this category. Either they did not use IMC or continued with a calendar spray programme. They did not have a good understanding of the concept of IFP. It is likely that these growers will adopt ENZA-IFP only when they are forced to by ENZA export requirements.

A precursor for IFP adoption appears to be grower involvement in activities such as IMC and weather-based spraying. At the other end of the spectrum; growers still involved in calendar spraying for pests and diseases appear to be far from being ready to adopt the IFP programme, as they do not have a grasp of any of the technologies that could be regarded as precursors to IFP.

### **5.1.2 Factors that Influenced the Adoption and Implementation of ENZA-IFP**

Many factors influenced growers' decisions to adopt the ENZA-IFP programme and these factors can not be examined in isolation. The key factors influencing adoption were philosophical, environmental, financial, risk, marketing, organisational, technical, grower characteristics, and social factors. Also important was grower knowledge and confidence in the IFP system, the complexity (or perceived complexity) of IFP, and how compatible the programme was with a

grower's current production system. All these factors, with the exceptions of philosophy and environmental factors, agree with the factors identified in the reviewed literature. Additionally, financial issues specific to the New Zealand pipfruit industry were identified.

### **Financial Factors**

Financial factors, especially the difference in the incentives paid for the different ENZA supply programmes, was identified as a key factor influencing adoption of ENZA-IFP. This factor is specific to the New Zealand pipfruit industry. An expected reduction in gross orchard income, due to the loss of the USA supply incentive, discouraged the adoption and implementation of ENZA-IFP. This factor was of such significance to the non-IFP growers that it completely negated any environmental concerns. If these growers do not perceive any financial benefit, or perceive a financial loss, they are unlikely to voluntarily adopt ENZA-IFP.

Both IFP and non-IFP suggested that a financial incentive was required over the transitional phase of IFP to encourage adoption.

### **Grower Philosophy Linked With Environmental Concerns**

The major positive influence, which encouraged the adoption and implementation of ENZA-IFP, was the 'green' philosophy of the IFP growers with regards to their living and working environment, and to the environment in general.

This finding is significantly different to the findings of the research reported in the reviewed literature. It is suggested that in this case, this difference is due to this grower group being made up of 'innovators' for technologies regarding environmental issues. While philosophical and environmental reasons may not be prominent in the reasons for the majority of the industry taking on ENZA-IFP, it was particularly important for the early adopters, and is likely to be important in the early adoption of any new sustainable technology.

### **5.1.3 Technology Transfer Processes used to Enhance the Adoption of Sustainable Technologies, such as IFP**

Knowledge and understanding of the ENZA-IFP system plays an important role in its adoption. Poor knowledge of the system results in low confidence in the likelihood of its success, expectations of it being complex and incompatible with current growing systems, and perceptions that there are high levels of risk associated with it. ENZA itself hindered the uptake of ENZA-IFP. Lack of information, mis-information, and a perceived lack of commitment by ENZA management over the period of this research resulted in many growers being unconvinced that adoption of the system was necessary.

Many of these issues could be addressed by putting in place a technology transfer programme that (1) provides growers with the correct information in a timely manner, and (2) empowers growers with the necessary skills and knowledge to implement IFP confidently.

For adoption of sustainable technologies, such as IFP, Roling's (1994) model of technology transfer, Knowledge and Information Systems, seems applicable. The reasons include that this technology transfer model allows for selective adoption, which forms an important part of the adoption of sustainable production technologies. Knowledge exchange is the key to extension for this model. The research results indicate that grower and industry participation and knowledge sharing in a discussion group forum has been successful, hence knowledge exchange is an appropriate method. Using this method growers gained the necessary knowledge and skills to successfully implement ENZA-IFP.

#### **5.1.4 Methods of Technology Transfer that may Encourage Grower Adoption of ENZA-IFP**

Technology transfer was identified as important for the successful adoption of ENZA-IFP. The technology transfer structure that had been put in place by the NZ-IFP committee provided the growers with the necessary skills and knowledge to implement IFP successfully.

To implement the IFP technology successfully two levels of technology transfer have been identified as important. The first is direct communication between the growers and IFP specialists. Discussion groups involving groups of growers, a facilitator, and an IFP specialist (scientist, consultant) in an orchard situation have been used successfully by growers involved in the ENZA-IFP programme. The key purpose of this direct technology transfer is for growers in the orchard to gain skills in the technical aspects of the IFP programme, and to discuss recommendations, results and experiences of the other growers. Additionally, this method provides direct feedback to the scientists to assist with the development of the IFP system. This method has accelerated the knowledge of the IFP technology and skill level of the growers. This method was recommended by the IFP growers as appropriate for wider industry use.

The second type of technology transfer which was identified as important was quick reference to technical information to answer specific queries. The technology transfer tools identified for this purpose were technical fax-outs, internet sites, computer-based decision support tools, pest and disease pocket identification booklets, and the ENZA-IFP manual.

#### **5.2 Recommendations: Strategies to Enhance the Adoption of the ENZA-IFP Programme**

IFP technologies that bring direct financial benefits to growers, have a participatory technology transfer system, have a low level of complexity and

perceived risk, and fit with a growers current production system and resources are likely to be adopted more readily. In summary the following could enhance the adoption of the ENZA-IFP programme.

### **Financial factors**

For growers to adopt the ENZA-IFP programme either the inequity between the incentives paid for the ENZA-IFP and the USA supply programme needs to be removed, or the technical aspects of the IFP programme need to be modified so growers can submit fruit grown to IFP standards to the USA supply programme if their fruit meets the phytosanitary requirements.

### **Minimise grower perceptions of risk.**

Perceived risk of crop loss and resulting financial loss is an important factor hindering adoption. This factor can be minimised by keeping the technical aspects of the programme simple, minimising complexity, ensuring the programme is compatible with the growers' current situation and resources, and building growers' confidence in the programme. Confidence is built by enabling growers to experience success and by giving growers the necessary support, skills, and knowledge to implement ENZA-IFP.

### **Clear communication and industry education programme**

Communication is one of the key areas to be addressed to enhance adoption. ENZA needs to communicate to growers its plans for the ENZA-IFP programme and clearly promote the reasons why the industry needs to adopt IFP. For instance continued market access, and this needs to be promoted clearly. It is very important that technical information and seasonal plans are timely and accurate.

The industry requires educational programmes catering to the varied needs of all participants to expediate adoption. This includes all growers (IFP and non-IFP),

ENZA management and staff, consultants, agrichemical merchants, and scientists. All industry participants need to know why the industry is adopting an IFP programme, what the benefits to the industry are, what the IFP programme involves, how it is going to be implemented, and over what time-frame.

### **Fit and collaboration between all parties.**

The ENZA-IFP programme needs to fit the needs and resources of the growers. It needs to be compatible with a growers' current production system. A high level of collaboration is required among all participants involved, especially within ENZA. Growers need to see ENZA's commitment to IFP.

### **Establish grower needs**

It is important to understand what the grower's existing knowledge of IFP is, and their current use of new technologies that may facilitate a smooth transition to ENZA-IFP, such as IMC and weather-based spraying. This information is necessary to identify the extension needs of the growers.

### **Technology transfer programme**

It is important that resources are spent not only on developing the technical aspects of the programme but also on implementation, adoption and continued maintenance, as discussed in 5.1.4.

### **Selective adoption**

It is important to understand that selective adoption forms an important part of the grower adoption process of ENZA-IFP. For growers that may be classified as late adopters and have not adopted precursor technologies to IFP, selective adoption would be important. Selective adoption would reduce the complexity of IFP and encourage changes in production methods that could be built on as grower experience and confidence grows.

### 5.3 Reflection on the Process

Due to the poor response of non-IFP growers to the request for interviews and a mistake in the selection of an IFP grower as a non-IFP grower, an uneven sample size resulted. Thirteen IFP growers were interviewed compared to eight non-IFP growers. This is likely to have impacted on the results, as more data was collected and considered in developing the conceptual framework for the IFP growers than the non-IFP growers. In hindsight, more effort should have been spent ensuring an even sample size at the time of the case study selection.

To enable further analysis more information about the growers and their business was required, particularly their financial status and their family situation. Some conclusions could then have been drawn regarding the interactions between the financial status of the grower and perceptions of the risks associated with IFP, and there was some indication that growers with young families were more likely to prefer an IFP system.

During the analysis it became obvious that a range of adopter types, as defined in Rogers' (1995) classification system of adopter categories, were present in the non-IFP case study group. More appropriate questions could have been designed to identify the attitudes of these growers to new technologies, what technologies they had previously adopted and why, and what technology transfer methods were used as they adopted those technologies. This information may have helped in confirming the adopter categories within the non-IFP group. Segregation of the non-IFP group into adopter categories would help in identifying methods to encourage them to adopt and implement ENZA-IFP.

It was difficult to correctly assign the non-IFP growers to the adoption categories for two reasons:

(1) The rate at which the early adopters and early majority would adopt the ENZA-IFP programme was influenced by the USA supply programme incentive. Even

though it appeared the some of the growers had the characteristics of early adopters they were not willing to move to ENZA-IFP until the financial incentives were correct.

(2) The case studies were selected on the basis of IFP and non-IFP growers. The growers in these groups were treated equally and the same information sought. It was not until the analysis stage that it was identified that many different groups of growers were evident in the non-IFP group and that the non-IFP growers can not be treated equally.

#### **5.4 Opportunities for Further Research**

This exploratory study identified the factors that influenced grower adoption and implementation of the ENZA-IFP programme and identified differences between IFP and non-IFP growers. To achieve the target of 100 percent grower adoption of ENZA-IFP by 2001, the additional research suggested below should be undertaken.

(1) Research could be undertaken to identify the different target groups with the non-IFP population and determine the most appropriate technology transfer method required for these target groups.

For example the early adopters and early majority may only need the correct financial incentives in conjunction with the current technology transfer programme to successfully implement ENZA-IFP. However for the late majority and the laggards it may be necessary to identify their current level of adoption of technologies, for example use of IMC and weather-based spraying, what their knowledge of IFP is, and use the concept of selective adoption to move this group towards the ENZA-IFP programme.

Additionally, it is not known how much a growers financial status impacts on adoption. The industry is suffering financially from three seasons of hail storms

and low export returns. This relationship between financial status and adoption needs to be further researched.

- (2) There is a need to identify the benefits of IFP perceived by the different grower groups and promote such benefits to the whole industry. For example, it is hypothesised that growers with young families are attracted to IFP because of the perceived improved living environment for their family.
- (3) This research was undertaken in Hawke's Bay and Nelson, the two major fruit growing regions in New Zealand. These factors may need validation for the other growing regions that face a number of issues that the key producing regions do not.
- (4) This exploratory study was undertaken with only a small number of growers. Broad factors that influenced adoption were identified. In order to validate the factors that influence adoption and obtain some quantitative analysis it is recommended a survey is undertaken focusing on the key issues identified.
- (5) The interviews were conducted during August 1997, two seasons ago. To confirm the conclusions drawn in this research, it would be useful to contact the growers again to see if the Nelson IFP growers that wanted to supply the USA market at that time, as well as implement IFP philosophies, have now adopted the IFP-USA programme. It would also be useful to survey the then non-IFP growers, in both Hawke's Bay and Nelson, to see which programmes they are now implementing. Based on the case study research results, it would be expected that one to two growers would now be involved in the ENZA-IFP programme, three to four would have implemented the IFP-USA programme, and two to three would have remained conventional USA suppliers.

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## **ADOPTION OF THE ENZA-IFP PROGRAMME**

### **Semi-structured Interview Question framework for ENZA-IFP Growers**

#### **Purpose**

To establish grower perceptions of:

- the factors that influenced their adoption of IFP technologies
- what influenced their participation in the ENZA-IFP Programme
- what technology transfer methods they perceive would accelerate wider adoption and continued use of IFP methods.

Suggested sequence of questions and discussion points

#### Background

1. Why did you get involved in the ENZA-IFP programme?
2. What are the key factors that motivated you to become involved?  
(financial (cost savings), market access, non US programme, environmental issues, social issues)
3. How important is the ENZA-IFP programme to the NZ export pipfruit industry? (How does it fit with other changes happening in the industry).
4. Describe in your own words your understanding of what orchard practices the ENZA-IFP covers now, and is likely to cover in the future?
5. What does being involved mean for you as a grower? ie. what is different about how you operate the orchard?
6. What are the implications of being involved in the ENZA-IFP programme for your business now, and in the future? (longer term, wider family and community issues).

#### The programme

7. What are your impressions of the ENZA-IFP programme?  
(Is it practical, workable? What are the key benefits? What are the key problems with the programme? What are the risks?)

*The following questions have to follow on from their responses to question 2. Also, for each, ensure to ask how this has affected their perceptions of the*

*programme, and how it has influenced their involvement, or might influence others.*

8. How well does the ENZA-IFP programme fit with your current production practice? (Why/why not? What aspects are compatible? What aspects are different?)
  
9. How confident are you :
  - in meeting market standards under a ENZA-IFP programme?, For what reasons?
  - in the ENZA-IFP technology (monitoring, thresholds, quality at harvest)
  
10. What risks do you see associated with:
  - continuing with conventional production
  - adopting the ENZA-IFP programme?
  - how could these risks be minimised?
  
11. Do you believe you/your staff/your consultant/rep have the necessary skills and knowledge to assist you implement the ENZA-IFP programme?

## **Technology transfer**

12. What would help you to implement ENZA-IFP on your orchard?  
(What has helped you with previous new technologies?)
  
13. How useful were the following with helping you implement the ENZA-IFP programme?:
  - discussions group meetings
  - the ENZA-IFP manual
  - the ENZA training workshops
  - your consultant/merchant

Thankyou very much, do you have any other comments about the ENZA-IFP programme?

## **Appendix 2      Semi structured question sheet for non-IFP growers**

### **ADOPTION OF THE NZ-IFP PROGRAMME**

#### **Semi-structured Interview Question framework for Non NZ-IFP Growers**

##### **Purpose**

To establish grower perceptions of:

- the ENZA-IFP programme
- what would influence grower participation in the ENZA-IFP Programme
- what technology transfer methods they perceive would accelerate wider adoption and continued use of IFP methods.

##### **Suggested sequence of questions and discussion points**

###### Background

1. Will you become involved in the ENZA-IFP programme this coming season?
  - If yes, what are the key factors that motivated you to become involved? (financial (cost savings), market access, non US programme, environmental issues, social issues)
  - If no, what are the key reasons why you do not want to be involved?
2. How important is the ENZA-IFP programme to the NZ export pipfruit industry?  
(How does it fit with other with other changes happening in the industry)
3. Describe in your own words your understanding of what orchard practices the ENZA-IFP covers now, and is likely to cover in the future?
4. What would being involved mean for you as a grower? ie. what would be different about how you operate the orchard?
5. What are the implications of being involved in the ENZA-IFP programme for your business now, and in the future? (longer term, wider family and community issues).

###### The programme

6. What are your impressions of the ENZA-IFP programme?  
(Is it practical, workable? What are the key benefits? What are the key problems with the programme? What are the risks?)

*The following questions have to follow on from their responses to question 2. Also, for each, ensure you ask how this has affected their perceptions of the programme, and how it has influenced their involvement/ might influence others.*

7. How well does the ENZA-IFP programme fit with your current production practice? (Why/why not? What aspects are compatible? What aspects are different?)
  
8. How confident are you :
  - in meeting market standards under a NZ-IFP programme?, For what reasons?
  - in the NZ-IFP technology (monitoring, thresholds, quality at harvest)
  
9. What risks do you see associated with:
  - continuing with conventional production
  - adopting the ENZA-IFP programme?
  - how could these risks be minimised?
  
10. Do you believe you/your staff/your consultant/rep have the necessary skills and knowledge to assist you implement the ENZA-IFP programme?

## **Technology transfer**

11. What would help you to implement ENZA-IFP on your orchard?  
(What has helped you with previous new technologies?)
  
12. How useful do you think the following would be to help you implement the ENZA-IFP programme?:
  - the discussions group meetings
  - the ENZA-IFP manual
  - the ENZA training workshops
  - your consultant/merchant

Thankyou very much, do you have any other comments about the ENZA-IFP programme?

ORCHARD DESCRIPTION	
Name:	.....
Location:	.....
Orchard area in pipfruit production:	.....
Export varieties planted:	.....
	.....
	.....
Percentage of crop exported:	.....
Ownership structure:	.....
Orchardist's Age:	.....
Number of years been orcharding:	.....
Education: Secondary or Tertiary:	.....
Use a consultant?:	.....
Regularly attend field days, industry meetings etc:	.....
Implemented a IMC programme:	.....