An Economic Analysis of Bird Damage in Vineyards of the Marlborough Region

By

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Foreword

As the area of vineyards in New Zealand keeps on expanding the costs of bird damage will also increase in importance. While currently the loss of production due to bird damage from a national point of view may be insignificant compared to losses due to other factors such as weather and market fluctuations, the cost of bird damage may be the difference between profit and loss to individual growers.

The Marlborough region was chosen as a case study to analyse the impact of bird damage. This region is the largest viticultural region within New Zealand in terms of area and quantity of grapes. A postal survey was conducted to determine the potential loss due to bird damage, the loss avoided through control and the cost of that control. In addition different control measures were evaluated in terms of cost and effectiveness.

Control measures are costly and it is important that the most cost-effective measures are used. This discussion paper provided factual information on control costs, effectiveness, regional impacts and economic impacts and should be of interest to those involved in the wine industry as well as those involved in research in new technologies for bird control. The discussion paper also raises the issue of the wider social costs associated with some of the control measures.

The discussion paper is the result of research conducted by Ms Laurie Boyce for a Bachelor of Applied Economics (Honours) degree, supervised by Professor Anton D Meister from the Department of Applied and International Economics, Massey University and Dr A (Sandy) Lang from HortResearch. Special thanks go to the Marlborough Grape Growers Association, HortResearch, the Marlborough District Council, the Marlborough Research Centre Trust and Montana Wines (Marlborough) for financial and other support.

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Chapter 1

Introduction

1.1 The Problem and the Objectives

> "*The actual loss of yield to bird and mammal pests in volume and dollars has not been assessed for many crops in New Zealand as it is difficult and expensive to do so*"
>
> Porter, Rudge and McLennan, 1994, p8

This research project aims to quantify the costs and benefits associated with bird damage and bird control measures. As identified in the quote above, the actual loss due to bird damage is difficult and expensive to assess, this is because it is time consuming, and particularly for grapes, difficult to identify. It is estimated to be about 20% of grapes within a vineyard (Porter *et al*, 1994). Trim's 1982 paper reported 10% damage in the Marlborough/Nelson Westcoast region, over all crops.

In the 1987 season, Dick Porter, then a DSIR ecologist, estimated that Hawkes Bay grape growers lost around $1 million in production from grapes damaged by birds. This estimate included money spent on bird damage prevention. He surveyed 6 vineyards and found some spent as much as $742 per hectare on bird damage prevention, and suggested that much of it was to no avail (Hawkes Bay Notes, 1987). Porter believes that bird damage is the biggest problem the industry needs to address and that there is plenty of room for research into the problem.

> *"While there is some basic research data on understanding the problem, what is needed now is research to find out how the damage can be reduced on grapes at a cost which is worthwhile... It is no good spending a thousand dollars just to reduce a hundred dollars worth of damage in a vineyard, and this has happened on some properties where people are spending far more than the level of damage*."
>
> Hawkes Bay Notes, 1987, p283

Marlborough was chosen as a case study because of its rapidly expanding importance as a grape growing area.

The objectives of this research are:

1. To determine the relative effectiveness of different bird control methods.
2. To calculate the financial and economic benefit of bird control in vineyards of the Marlborough region.
3. To describe the social issues associated with bird control.
4. To draw conclusions and make recommendations regarding the current state of bird control in Marlborough.

1.2 Background

Bird damage in New Zealand is on a relatively low scale compared to some parts of the world because New Zealand's birds are resident. The population of our birds only varies as they die in winter and breed in summer, although some New Zealand birds have 'seasonal excursions' between foothills and plains. Where bird species are migratory, as they are overseas, damage can be catastrophic due to millions of flocking birds that can destroy whole crops (Porter *et al*, 1994).

The effects of bird damage can still be devastating in New Zealand, depending on weather conditions, fungal rots and diseases which all vary from year to year. There also appears to be a rather obvious dynamic relationship between bird species prevalent in an area, the crops and the damage done (Trim, 1982). Some birds remove the whole grape while others 'peck' at the fruit leaving it open to fungal infection. The seeping juice attracts wasps, but Porter *et al* (1994) suggest that this can be beneficial as they limit the dripping of juice that would otherwise spoil the rest of the fruit and causes fungal rot. In certain weather conditions and if fungal diseases are rife, this 'secondary' damage is potentially devastating. Secondary damage decreases the quality of the must[1]; hence it depreciates the quality of wine produced.

Birds are particularly difficult to manage as 'pests' because, unlike rodents and possums, many people regard birds "...as a delight to the eye and ear" (Porter *et al*, p7). Birds of the countryside and gardens do not appear as pests, so there is an obligation to manage them in an environmentally friendly and humane way. The damage is often highly seasonal and localised, which also makes management difficult.

In the Canterbury region rooks are considered pests of local importance (Canterbury Regional Council, 1991). In 1991 rook control was undertaken by the Council and funded by rates. Although rooks do not damage grapes (see Table 2), flocks of 100 plus have been known to ruin emergent crops in a single day. Rooks mainly eat and destroy newly sown cereals, ripening lentils, walnuts, acorns, and pumpkin seeds (Canterbury Regional Council, 1991, p61). In the past, farmers undertook their own control measures, but it was evident that the main impact was to shift birds to other properties in the area, or cause the birds to shift and create new rookeries. The Manawatu-Wanganui Regional Council poisons thousands of rooks each year. The rooks cause about $120,000 worth of damage to crops in this region each year (Sargent, 1998). These are examples of where regional councils have seen obvious benefits from controlling birds.

The loss of production due to bird damage could be insignificant compared to losses from other factors like the weather, market variation and poor land management. Unfortunately for birds, they are more visible than bad management and therefore more readily blamed. Bird damage may be the difference between profit and loss to the

[1] Winepress

individual grower, but to any particular industry, region or country as a whole, it may be relatively unimportant.

Marlborough is the largest viticultural region within New Zealand, in terms of area and quantity of grapes. According to the results of the Lincoln University Economic Impact study[2] for each $1 increase in the demand for Marlborough wine grapes, $2.07 worth of economic activity is generated. There has been a continual expansion since the late 1980s, 93%, or 1324 ha since 1990, with respect to grape growing area[3]. It is expected to continue to be New Zealand's dominant wine grape region, with 37.3% (2747 ha) of the national producing area in 1998. The forecasted producing area for 2001 is 3323 ha[4]. Hence, the bird damage problem is not expected to show any sign of decline.

Nationally, there has been a significant move by many growers to higher valued varieties of grapes. Marlborough has followed this trend. This implies that crop losses due to bird damage will increase in value. The figures in Table 1 below reflect this trend. The planted area of Muller Thurgau has declined rapidly in New Zealand, from 1306 hectares in 1990 to 537 hectares in 1998, and is predicted to continue doing so. The projected plantings of Muller Thurgau in 2001 is only 353 hectares. Conversely, the planted areas of Sauvignon Blanc and Chardonnay have dramatically increased.

The new varieties are worth significantly more than Muller Thurgau as can be seen in Table 1 below. They also demand a higher level of quality. High quality is also increasingly demanded from standard varieties as buyers of wine grapes aim to increase the quality of their wine. Clauses stating maximum levels of damage to grapes are now common in contracts between growers and buyers. Although some wine grapes are exported out of the region, a vast majority is used in Marlborough wines. The cost of bird damage to individual growers, the region, and the country will probably increase in the future. Likewise, additional economic activity will be generated by the overall increase in production and value.

[2] A Summary of the Results of the 1997 Marlborough Wine Industry Economic Impact Study
[3] The Bank of New Zealand Wine & Grape Industry Statistical Annual, 1998, p5
[4] The Bank of New Zealand Wine & Grape Industry Statistical Annual, 1998, p19

Table 1 Comparison of Planted Area and Price between selected Grape Varieties

Variety	Planted Hectares in NZ			Average Price per Tonne 1998		Planted Hectares in Marlborough	
	1990	1998	2001*	NZ	Marlborough	1998	2001*
Muller Thurgau	1306	537	353	444	477	105	61
Sauvignon Blanc	427	1678	1923	1286	1368	1150	1382
Chardonnay	689	2006	2800			678	818
Still				1428	1481		
Sparkling				1397	1416		

*forecasted

Adapted from The Bank of New Zealand Wine & Grape Industry Statistical Annual 1998

Accurate scientific assessment of the losses requires careful measurements and proper statistical analyses. This is especially difficult for crops that ripen in sequence, such as different varieties of grapes. Damaged fruit could be counted, but this would require detailed inspection as often the whole fruit is removed without leaving evidence unless the stalks are carefully checked. For a grower this type of assessment is out of the question, and the situation is often confused by natural loss and wind damage. Estimation of the secondary damage would also be difficult. The growers can make an educated 'guess' at the overall level of damage. However, as Porter *et al* (1994) note, the actual measurement is often less than this subjective judgement.

Bull (1983) highlights some of the difficulties in assessment. A nation-wide survey of orchard and berry gardens during the 1966-67 growing season[5] revealed important defects in data collection by questionnaire. Only 14% of grower's responded and subsequent interviews with a sample of the non-respondents showed that they had suffered less bird damage than respondents had. Therefore, the questionnaire tended to exaggerate the overall extent of the damage. He also noted that few growers had time to watch birds closely to observe whether they are feeding on unblemished fruit or windfall fruit that is already damaged. The DSIR admitted these limitations and found that the most damaging bird species were blackbird, song thrush, myna, starling, white-eye and the house sparrow. They also found the fruits most chiefly affected were strawberries, grapes, cherries, pears and apples.

Bird control measures are varied in method and effectiveness. Bird control has become an increasing problem since the withdrawal of a chemical, Methiocarb. It was a highly effective method, leaving only 1% damage (Hawkes Bay Notes, 1987). It was removed because of overseas complaints due to unacceptable levels of chemical residue in some

[5]By the Ecology Division of DSIR (New Zealand Journal of Agricultural Research, May 1970)

New Zealand wine. This highlights the growing awareness of environmental and health concerns within society.

A satisfactory bird control measure must be legal and should avoid offending neighbours through excessive noise and loud explosions (Brough, 1962-65). This poses a problem for growers because many effective control measures are noisy. The Acclimatisation Society suggest that bird scarers that imitate gunshot noises are the best deterrent (Trim, 1982).

Increasing urban encroachment onto rural areas creates a conflict of interest that is increasingly hard to deal with. The question arises as to whether the Council needs to include provisions to limit noise from bird control methods. Mr Gregan, the Chief Executive Officer of the Wine Institute, has stressed the importance of the issue from an industry point of view. He said that it is "...imperative appropriate provision for the industry is made by local regulatory authorities, notably under the Resource Management Act, so expansion of the industry is not curtailed in the years ahead".[6]

Noise emission from bird scaring devices is currently a contentious issue in the Marlborough Region (Munden, 1998), particularly as the Marlborough District Council is in the process of preparing an Annual Plan. Recently, it became a political issue during the local body elections, and decisions on its inclusion in the Annual Plan were put on hold.

When considering methods of bird control growers need to consider the species of bird causing the damage. Table 2 contains a list of the problem birds and control measures available. While the table covers the most common methods, there are other methods. The effectiveness of some deterrents depends on the biology of the bird. "Mixed flocks of starlings and house sparrows in urban areas will respond quite differently to deterrent sounds" (Porter *et al*, 1994, p10). For example, Multi-Frequency Generators (MFG's) are only effective on waxeyes while starlings are deterred by AV-Alarms. Starlings remove more grapes in a short time than other species because they flock, whereas thrushes and blackbirds take just as much, but inconspicuously. Thrushes and blackbirds are more susceptible to trapping, but do not respond to alarm calls.

A combination of shotgun patrols and scatterguns is effective in deterring birds. Airhorns mounted on four wheel motorbikes and foot patrols can also be effective. Movement in and around the vineyard is important, or the birds become accustomed to the noise very quickly. An American study of bird behaviour (Verrengia, 1998) has shown that birds have episodic, or event based memory. Hence, they may be able to recall where, and when the noise had occurred and become accustomed to it. It seems that growers will employ a variety of bird control measures to achieve the best result.

[6] A Summary of the Results of the 1997 Marlborough Wine Industry Economic Impact Study

Timing of control measures is also critical. Ripened grapes are highly attractive to birds, so control must begin at this time. "Populations of any animal or bird are in dynamic balance with a variety of factors, all of which have to be taken into account for control to be effective" (Trim, 1982, p5).

Table 2 Identification of Problem Birds and Common Control Measures

Birds Identified as a Problem for Grapes (in alphabetical order)	Blackbird
	Greyfinch
	House Sparrow
	Myna
	Rosella
	Song Thrush
	Starling
	Waxeye (Silvereye)
Bird Control Measures Commonly Used (in alphabetical order)	AV-Alarm
	Barriers
	Big-eyed Balls
	Enclosures
	Pop-up Scarecrows
	Protective Measures (netting)
	Scareguns
	Shooting
	Starling Distress And Alarm Calls
	Trapping

Adapted from Porter *et al* (1994)

Shelterbelts provide a roosting site for birds, so damage will probably be worse along tree lines. Grapes need little shelter so growers tend to remove or thin non-essential shelterbelts on their properties. The edges are also generally the worst affected as birds prefer to have easy access to food. Surrounding buildings, poultry farms, orchards and other features will also influence the areas damaged. Growers may place netting over the rows along tree lines and edges of their vineyards. Netting is considered to be an effective and humane damage prevention measure, but to cover large vineyards the cost can be prohibitive. Growers are concerned too that the quality of grape may be affected

due to increased humidity and shading. Research has shown that netting can exacerbate botrytus problems if it is particularly humid[7].

Certainly, the costs of each of these control methods, and the level of bird damage they can prevent, needs to be quantified so that growers can make more informed choices about which methods to use. Each grower must be willing to spend at least as much on bird control as the value of the damage it is preventing, but certainly not more. In marginal terms, any more would be uneconomic, as would any less. The optimal level of bird control for each individual vineyard is where the marginal cost equals the marginal benefit of that control. That is, where the cost of an additional unit of control yields an equal additional unit of benefit from damage prevention.

Growers who participated in the survey (to be discussed later) were asked to give information on the costs of bird control and the level of bird damage that still occurs. They were also asked to estimate the damage caused by birds if they employed no bird control methods. By gathering information on the costs of bird control, and growers' perception of their damage prevented, it is possible to quantify the costs and benefits. Hence, this research involves the use of grower's estimates of damage rather than the use of accurate scientific assessment, which is inherently difficult, as discussed earlier. Information on the perceived effectiveness of each bird control method was also collected.

[7] Trought, personal communication

Chapter 2

Economic Theory

While a financial analysis may be concerned with financial profit or loss from an individual or industry point of view, a benefit cost analysis may consider resource allocation from a national point of view. This leads to differences in the results of each.

2.1 Financial Analysis

The financial analysis is from the point of view of individual vineyards. The financial analysis forms the basis for the economic analysis. In this study, information on the primary costs and benefits of bird control was gathered using the postal survey. This included:

Primary Costs

- Capital costs of bird control equipment
- Maintenance and annual operating expenses of bird control equipment
- Hours of labour dedicated to bird control
- Hours of motorbike, tractor and other vehicles used for bird control

Primary Benefits

- The value of crop damage avoided

Data collected in the questionnaire were used to evaluate, for each vineyard, the total amount spent on each bird control method used for the 1998 season. These were then compared to the effectiveness ratings given. The costs for each vineyard can then be summed and total regional expenditure on bird control can be calculated. The total cost figures reflect the actual amount spent on bird control by vineyards in the region in terms of:

- Total expenditure and per hectare expenditure on individual methods
- Expenditure on labour
- The total cost of the bird damage problem to each vineyard

From an individual vineyard's perspective, the total cost of bird damage includes the cost of bird control and the loss of crop value due to remaining bird damage. This relationship will also be examined.

A secondary benefit of bird control is termed the 'multiplier effect'. The extra output created (because less damaged by birds) and inputs bought all generate flow-on economic activity within the region. The magnitude of this effect is not examined in this analysis, however it is significant from a regional perspective.

2.2 Benefit Cost Analysis

A benefit cost analysis involves the concept of economic profitability rather than financial profit. That is, it deals with the real worth of a project to a country.

The basic benefit cost analysis rule is that "...an expenditure is judged to be potentially worthwhile if its benefits exceed its costs, where benefits and costs are defined to include any welfare gain and loss which occurs because of the expenditure on the project" (Pearce, 1983, p25). Here, the 'project' is bird control implemented by individual vineyards in the Marlborough region and the analysis is from the point of view of New Zealand.

To evaluate the costs and benefits of the bird control, values from the financial analysis are modified to meet the benefit cost analysis criteria and assumptions.

In a Benefit Cost analysis, 'transfer payments' must be removed to reflect the real economic costs and benefits. Transfer payments do not represent flows of actual goods and services within an economy, i.e. they do not constitute a using-up of real resources (such as labour hours) but are merely a redistribution of money. Such a transfer does not add or subtract from the social welfare of a country because it merely transfers money from one person to another. For example, income tax (a loss) is paid to the government and is redistributed to members of society via income support payments (a gain). Other examples of transfer payments include subsidies, debt servicing and interest. These must be removed so prices reflect the true cost to society.

This analysis is from a national point of view so payments of Goods and Services Tax, Income tax and Accident Compensation Levies are removed from regional expenditure because they are 'transfer payments'. Hence, the 'cost' of bird control is the level of regional expenditure minus the GST, Income tax and ACC levy components.

The 'benefit' of a project is the value of any costs that have been avoided because of the project. In other words, it is the difference between the 'with' and the 'without' situations. For this analysis, it is the value of grape damage that has been avoided due to the implementation of bird control measures.

Further to this, there is an external cost; the social cost of bird control that is created by the use of noisy bird control methods. There is no market price for "peace and quiet",

so the value of this cost cannot be easily estimated and has not been included in this analysis. This does not take away the fact that external costs are real costs to society (i.e. cause a decrease in social welfare) and should therefore be included in a Benefit-Cost analysis. There are techniques available to place dollar values on costs of this nature, this however, was not done in this study.

Sometimes individuals are required to internalise the external costs they produce. For example, under the Resource Management Act 1991, regional and local councils can require the mitigation or avoidance of such effect (e.g. noise pollution or water pollution). The internalisation process imposes a cost on the firm required to do the mitigation and hence in a benefit-cost analysis of a bird control project (with noise mitigation requirements) the external cost is no longer external but internal to the firm and is included in the analysis.

There are a variety of ways in which regional and local authorities attempt to deal with the problem of external costs (e.g. negative environmental effects). Policy options are moral suasion, education, outright bans, standards or economic incentives and disincentives. Currently the issue of noise and appropriate policies is being debated in the Marlborough region and this will be discussed further later on in this report.

It should also be recognised that a cost benefit analysis ignores the distribution of costs and benefits. The analysis is based on utilitarianism and its underlying ethic. More specifically, the analysis gives an equal weighting to each individual in society, thereby assuming that each person values money in the same way. This has implications for policy decisions based on cost benefit analysis.

Chapter 3

Methodology

3.1 Data Collection

In order to obtain the necessary information, both personal interviews and a postal survey were conducted. An interview with the Marlborough District Council was also conducted. The personal interviews were used to gather preliminary information on which the postal survey was based. A discussion of the results of the personal interviews is presented below.

3.1.1 Personal Interviews

Selection of Participants

The participants in the personal interviews were chosen on the basis of willingness to participate and availability during the week I was in Blenheim. The 12 vineyards covered a range of vineyard areas and locations; however, they were all in the Marlborough Region.

Development of the Personal Interview Questionnaire

A questionnaire was developed to both guide the personal interview and collect preliminary information for the development of the postal survey (see Appendix I). The interviews also provided some good background information, as participants were encouraged to give advice and opinions on the issues involved.

General information about the vineyard and its proximity to shelter belts and buildings etc was gathered to identify common factors and problem areas on each vineyard. The participants were asked which bird control methods were used so that a comprehensive list of methods used could be made. The costs of each method and the estimated level of bird damage with and without bird control were essential questions for this analysis. It was recognised that the costs and benefits of bird control would need to be expressed in comparative monetary values, so it was necessary to ask participants for a crop value and/or turnover for the vineyard.

The personal interviews helped to identify how the postal survey should be structured, which questions should be asked, and how they should be asked. For instance, it was

realised that questions on the cost of bird control methods would need to be very specific so that the data could be aggregated and compared easily.

Information on the frequency and magnitude of bird damage was gathered to determine if the 1998 season would be comparable to other years. Participants were also asked of they thought the problem was becoming worse, and why. This was to identify any wider issues that could be important.

Opinions on the secondary effects of bird damage were needed to determine if the postal questionnaire should differentiate between direct loss of fruit and indirect loss through secondary damage. Opinions on the effect of bird damage on the market price for grapes were used to identify whether bird damage has a price effect.

The information on the effectiveness of each bird control technique was necessary for comparing perceived effectiveness and the amount spent on the method. The participants were asked to give an effectiveness rating and a rating of how often the method is used. These ratings were to be given on a scale of 1 to 5, 1 being 'poor' or 'never', 5 being 'excellent' or 'all the time'.

The interview with the Marlborough District Council was an informal discussion of the social issues involved with bird scaring. The issues identified are included in the discussion below.

3.1.2 Discussion of Personal Interview Results

Methods

The majority of the 12 growers interviewed used a combination of netting, gas guns and persons shooting around the vineyard (either on motorbike or walking) to reduce bird damage. Other methods included bird alarms, airhorns and sirens mounted on motorbikes, scarecrows, kites and balloons. See Table 3 below.

Table 3 Methods of Bird Control Identified in Personal Interviews

Method	Description
1	Motorbike and Shotgun
2	Motorbike with Mounted Siren
3	Motorbike with Mounted Airhorn
4	Gas Gun
5	AV – Alarm
6	Multi-Frequency Generator
7	Netting
8	Traps
9	Balloons
10	Tape (i.e. strung along rows)
11	Scarecrows
12	Kites
13	Walking Patrols
14	Walking Patrols with Shotgun

Bird Damage

Bird damage appeared to be the biggest problem facing growers in the 1998 season. The dry weather has been good for grape growers and levels of fungal diseases have been low. Some believed that there has been a higher population of birds in 1998, possibly due to the dry 1997 winter, although others believed the bird population has been lower because of the drought. The main birds mentioned as a problem were waxeyes and starlings. Waxeyes are self-introduced birds that are protected.

The problem occurs from approximately Waitangi day each year, when veraison[8] occurs, until the end of April. Bird damage is a seasonal problem with grapes, but when considering other crops such as apples and cherries, the problem can be all year round.

When asked to estimate the level of bird damage that still occurred, answers ranged from less than 1% to 20%, although they were mainly less than 5%. The growers were also asked to estimate damage if they did **not** employ any bird control measures. These answers ranged from 10% to 100%. The majority of the answers were less than 50%.

[8]Veraison is when the sugar level in the grape begins to rise.

Birds tend to pick early maturing fruit, and will continue to eat that variety. The birds also prefer red grape varieties. Growers mentioned they had moved away from bulk variety grapes such as Muller Thurgau, to varietal grapes such as Chardonnay, which contain more sugar. Birds are more attracted to higher sugar levels so the level of damage is greater. Because these varietal types of grapes have a higher value, the cost of the damage is also greater. Hence, the secondary effects of bird damage are more significant.

Netting

One grower used only netting on the vineyard but the vineyard still suffered considerable damage from birds. However, others growers did not use netting due to its high initial outlay. These growers would only consider netting as a 'last resort'. Some growers mentioned that they would probably use more netting in the future, although a few thought that more research was needed into the negative aspects of netting. These include shading and the fact that netting interferes with spraying. It was also suggested that netting delays ripening by up to 10%, especially with red varieties. Grapes need high sunlight levels on their leaves to increase quality. Humidity can also be a problem. If the season has a high humidity level, or sunlight levels are low, the quality of grape can be reduced. Netting can intensify these effects.

Shelter Belts and Trees

Areas of the vineyard with shelter belts and trees are the worst affected. Many shelterbelts and trees had been removed where possible. Shelterbelts are considered unnecessary, although they help ripen the fruit quicker, less bird damage seems to be preferred. One grower mentioned that they had left a shelterbelt to protect young vines from the wind.

Price Effect

Some respondents identified that there is the potential for bird damage to have a price effect. In an acute situation, where damage is severe, grape buyers will either pay less, or not purchase the fruit from individual vineyards. From an industry perspective, the decreased supply due to damage could increase the price of undamaged fruit. Possibly, it is only when the majority of vineyards suffer severe damage that there will be a price effect across the industry. However, severe damage mainly occurs when there is a 'bad season', and fungal diseases are rife. 1998 was considered a 'good' year, so a price effect was not considered.

Alternative Methods

In terms of alternative methods, some were mentioned that were **not** currently used by those interviewed. These included: Savannah, a natural bird deterrent that is a mixture of garlic and chilli etc, alphachloralase and Measurol. Measurol is now banned.

There were two alternative methods mentioned that the growers actually used. Hawks are considered by several growers to be an effective deterrent to birds. One grower had built perches and left food to encourage them to the area. Another planted Riesling,

which birds apparently dislike, around the edges of the vineyard, particularly where shelter belts and trees are serious problems. Others mentioned that human presence on the vineyard is an effective deterrent.

Some growers advocated an industry wide post harvesting strategy. Mechanical harvesting means that there are bunches of grapes left on the vines. This provides extra food for birds. Some thought that these bunches should be picked and dumped to reduce the food supply. An industry wide strategy would involve other crops such as sweetcorn, cherries, apples and olives. Such a strategy may help reduce the bird population. But even if the local population is reduced, some believe that birds will just come from further away.

Social Issues

Bird control becomes a social issue because of the 'noise' pollution caused by some bird scaring devices such as gas guns and shotguns. Noise is a sensitive issue that is difficult and expensive to deal with. Growers have a right to protect their crops and neighbours have a right to 'peace'. Isolated vineyards cause no problems, only those situated near urban habitation.

Most of the growers used gas guns and shotguns, although, as mentioned above, one used only netting. One respondent suggested that more shooting would be employed if gas guns were disallowed and another found shooting an inefficient use of time. It is a common story for birds to be seen perched on gas guns, which leads some to question their effectiveness. It has also been suggested that they cost more than they save growers in terms of crop damage. This is difficult to assess because growers commonly use a combination of methods, which is more effective. It seems that the majority of growers choose to use gas guns, this suggests that the method is cost effective. Further study into bird behaviour could be helpful when considering the direct effectiveness of gas guns.

Gas guns can be a significant problem, particularly if they are not operated properly and left on all night, for example. The Marlborough Grape Growers Association's suggested limit on gas guns was quoted as 12 shots per hour by one of the interviewees. These voluntary guidelines have worked well in the past, but as the noise issue is of increasing magnitude, there is now a move towards having 'rules'. Another believed that the Council had a time restriction on when gas guns could be used, i.e. between 6am and 6pm and on weekdays only. There were rules similar to this set out in the Proposed Wairua/Awatere District Plan. Tape can also be a noise 'nuisance' as it whistles when blowing in the wind. Under the Resource Management Act, landowners are obligated to take the best practical action to ensure noise levels are not unreasonable. If they don't, they can be served with noise abatement notices. The difficulty is defining what 'unreasonable' is.

During the preparation of their Annual Plan, the Marlborough District Council received about 30 submissions on the issue of noise, ranging from one extreme to the other, all of which must be reviewed. At the time of these interviews the Council was in the

process of finalising their Annual Plan. The Council cannot ban outright bird scaring devices in rural areas, but can aim to have a workable rule that can be implemented and enforced. The difficulty in finding a workable rule is the measurement of noise (there are about 127 different methods) and understanding the problem of bird damage which is essential to achieving an effective management regime.

In order to understand the problem, the economics of bird control need to be considered. The question that needs to be addressed is "are the quantifiable benefits of 'noisy' bird control measures greater than the loss without them?" However, evaluation of policy measures must also address the issue of distribution of these costs and benefits. These equity consequences are not dealt with in economic analysis, which only concerns itself with the question of efficiency.

3.1.3 The Postal Survey

Selection of Sample

The sample population for the survey consisted of a combined list of members of the Marlborough Grape Growers Association and the Wine Institute of New Zealand. The sample size was 249, but it was later found that there were approximately 200 vineyards on the region. Basically, the sample covered the whole population of growers in the Marlborough Region. The difference in the numbers is probably due to 'double ups' through combining the two lists.

Development of the Questionnaire

The survey needed to specify that the information given should relate to a defined vineyard area (given by the respondent) and the 1998 season. It was decided that in terms of general information, only vineyard size, crop value and crop weight were necessary in the postal survey.

The bird control methods identified in Table 3 were selected for the postal survey and included as a table for simplicity. The postal survey also included a further option of 'other' for any extra methods employed by the vineyard. See Appendix 1 for a copy of the actual survey. The participant was asked to tick each method used and also give an 'effectiveness rating' for that individual method. The rating system used in the personal interviews appeared to work effectively, so it was used again in the postal survey. However, the rating for frequency of use and overall ranking were removed because it was decided they would have been difficult to quantify into meaningful results.

The participants were then asked for information regarding the cost of each method employed. The questions were very specific in order to gather easily quantifiable and comparable information (as discussed above).

Finally, the questionnaire asked for an estimate of bird damage that occurs when the vineyard employs bird control and an estimate of bird damage **if** the vineyard had **no**

bird control. This was to determine the level of remaining damage and the perceived amount of damage avoided by bird control. Although it was identified that each vineyard has problem areas where bird damage is worse, it was felt that only one overall vineyard estimate of bird damage was necessary for each of these questions.

It was considered unnecessary to ask about the frequency and magnitude of bird damage across years in the postal survey because most of the answers from the personal interviews were the same. That is, bird damage occurs every year for a period of approximately 2 ½ months and varies in magnitude from year to year.

Unfortunately, respondents were not asked if their answers included Good and Services Tax (GST) or not. Due to this oversight, we have to assume that they did, unless otherwise stated. This will slightly understate costs in cases where they did not. The crop values are assumed to be GST exclusive[9].

A summary of the research results was offered as a 'reward' to those who participated, so respondents were asked if they would like a copy of the results. This was the final question.

Survey Response Rate

Response to the postal survey was quite high. In total, 249 postal surveys were mailed out, however many of the addresses were to the same vineyard, while some vineyards have had no crop over the 1998 season. Table 4 below categorises the responses that were received.

Table 4 Breakdown of Respondents

Completed Surveys Returned	125
Returned to Sender	4
Sold, leased or no vineyard	6
No harvest in 1998	8
Same as another return	15
Other	4
Total No of Respondents	**162**

[9] Using figures from the BNZ Wine and Grape Industry Statistical Annual 1998, the average crop value per vineyard in the Marlborough region (assuming there are 200 vineyards) is $160,540 excl GST. In this analysis the average crop value per vineyard was $161,440. As these values are very close, it is assumed that the crop values given in the survey did not include GST.

The 1998 Vineyard Survey[10], which is estimated to cover 95% of the national vineyard[11], found a total of 189 vineyards in the Marlborough region. The 125 completed returns account for 66% of these vineyards, although, it should be considered that there are probably just over 200 vineyards in the region. Therefore the response rate is approximately 62%.

In terms of area coverage, the total (producing) vineyard area in Marlborough is estimated to be 2747 Ha[12], while the total area covered by the responses is 2201 Ha. This accounts of approximately 80% of the area. The 1998 Vineyard Survey found an average vineyard size of 14.5 Ha[13], while this survey found an average of 17.6 Ha. The medians were 7.8 Ha and 10.1 Ha respectively. This suggests that many of the non-respondents to this postal survey have smaller vineyards. Hence, their absence produces a higher average. This has some implications for the results that will be discussed in the section on Limitations.

3.2 Evaluation of Costs

The following assumptions were made in order to complete this analysis.

3.2.1 Methods of Evaluation

Costs were evaluated based on the figures given by the respondents. That is, for each method of bird control, the capital cost, maintenance, labour and vehicle costs etc were added to attain the total cost. Where respondents entered a question mark, an average of the other respondents' values was used. However, this was not done for the estimates of damage. Where a range was given, the values were averaged.

If a shotgun was used for both Method 1 (motorbike patrols) and Method 14 (walking patrols), the cost of the shotgun was divided evenly between the two methods.

The current Goods and Services tax (GST) rate of 12.5% was also assumed. This has been the GST rate since 1988. As the average years of purchase for capital equipment were all later than this date, this was the most appropriate rate to use.

3.2.2 Estimates of Hourly Running Costs and Labour

Labour

The hourly rate is based on the typical wage rate of Orchard Workers in Canterbury. These estimates, given in Table 5 below, were considered to be comparable to wages on a Vineyard in Marlborough. The Grape Growing ACC premium of $0.217 ($2.26 per $100) was added to the average of $9.59.

[10] Conducted by Hort+Research 1998
[11] The Bank of New Zealand Wine & Grape Industry Statistical Annual 1998, p3
[12] *ibid.*, p9
[13] *ibid.*, p10

Table 5 Wages and Salaries for Horticultural Employees

Orchard Workers in Canterbury	Hourly Rate
Permanent Staff	
Permanent Leading Hand	$10.38 to $10.71
Permanent Leading Hand II	$9.64 to $10.01
Casual Staff	
Casual	$7.54 to $8.52
Casual Supervisor	$10.00
Average of Above	$9.59
	These figures exclude Holiday Pay

Adapted from the Financial Budget Manual 1998

Hence, an hourly rate of $9.85 was used to estimate the cost of labour. This rate was used for all of the labour hours, including hours worked by the vineyard manager and staff on salaries. The actual wage will vary depending on training, experience and alternative opportunities (Efferson, p70), however, it is assumed that workers receive $9.85 per hour, and that the manager and those on salaries would at least expect the same amount as if he/she worked for a neighbouring vineyard.

Where a contractor had provided the shotguns for Method 1 and 14, a contractor rate of $12.05 per hour was used. This figure is based on the hourly labour rate of $9.85, plus a shotgun allowance of $2.20 per hour.

An income tax rate of 21.5% was used, as this was the general tax rate for income between $0 and $34,200 per annum for the period of the analysis.

Tractor

The hourly running cost of a tractor was based on figures given in the Financial Budget Manual 1998. An average of the estimates given in Table 6 was used.

Table 6 Total Tractor Running Costs

Tractor Type	Total fixed cost per hour (580 hours/year)	Total variable costs per hour excluding labour	Total cost per hour
75kW (100HP) 2WD Tractor	$18.46	$17.03	$35.49
75kW (100HP) 4WD Tractor	$21.53	$18.68	$40.21
Average			$42.58

Motorbike

The estimate of a motorbike running cost was based on a number of figures in the Financial Budget Manual. However, unlike the tractor estimate, they were not as explicit. The cost was estimated at $10 per hour.

UtilityVehicle

The cost of a Ute per hour was based on the assumption that the vehicle travelled at 25 km/hour, and travelled between 1601 and 2000 kilometres per year. The cost per kilometre is estimated at 77.9 cents (Financial Budget Manual, 1998, pB-112). Hence, the cost per hour is $19.47.

3.2.3 Evaluation of Capital Equipment

To evaluate the cost of capital equipment for one year of use, an equivalent annual annuity was used. This was based on the assumption that the vineyard took out a table mortgage to pay for the equipment, the equivalent annuity being the value of one year's payment.

The interest rates used for each year were an average of the 12 months in that year. For 1998, the interest rate was an average of the first 9 months of the year.

Chapter 4

Analysis of Results

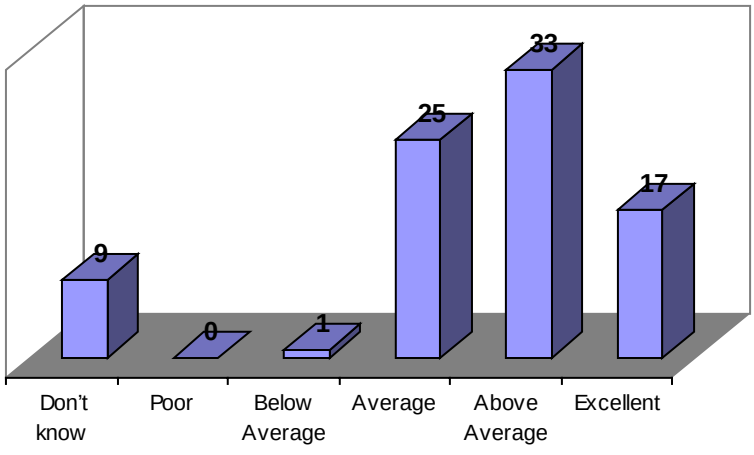
4.1 Methods of Bird Control Used and their Effectiveness Ratings

The methods of bird control used by the respondents and the effectiveness ratings given are discussed below. Note that the respondents were asked to rate each method individually, which may have been difficult in situations where many methods are used and combined. However, the ratings give an idea of the perceived effectiveness of each.

Method 1: Motorbike and Shotgun

This method was used by 68% (85) of the respondents. The effectiveness ratings given by each are shown in Figure 1 below. Of these 85 users, 24 combine this method with Method 2 and/or Method 3; a motorbike with mounted siren or airhorn respectively. Figure 1 below shows how the respondents rated Method 1 in terms of effectiveness. The distribution of ratings is significantly skewed to the right, which indicates that this method is rated quite highly.

Figure 1 Frequency of Effectiveness Ratings for Method 1



Method 2: Motorbike with Mounted Siren

This method was only used by 5% (6) of the respondents. Due to this, and the similarity to Method 3, the two were combined. The results are discussed below.

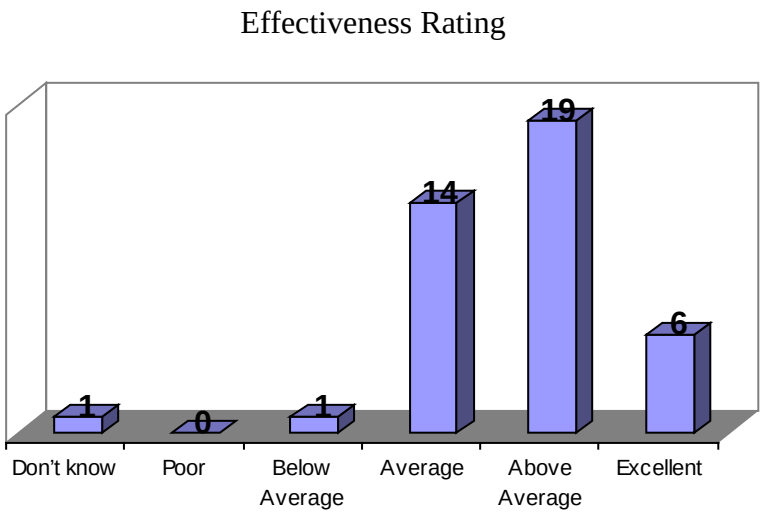
Method 3: Motorbike with Mounted Airhorn

This method was more popular than Method 2, with 28% (35) of the respondents employing this method. The combined results of Methods 2 and 3 are below.

Method 2 & 3: Motorbike with Mounted Siren or Airhorn

There were a total of 40 respondents using either one of these methods. One of the respondents used both methods, so there are 41 observations (33%) on the following histogram (Figure 2) showing the associated effectiveness ratings. This distribution is also skewed to the right, so this method is also rated quite highly.

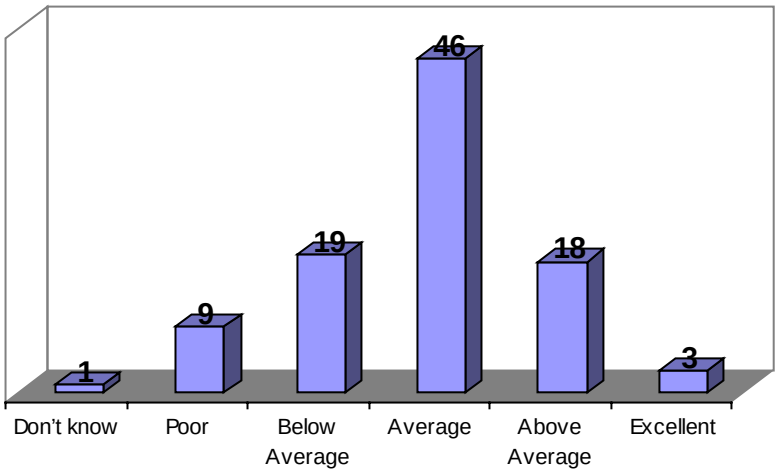
Figure 2 Frequency of Effectiveness Ratings for Method 2 & 3



Method 4: Gas Gun

This method had the highest level of use with 77% (96) of the respondents using the method. Figure 3 below shows that the distribution of ratings is fairly evenly spread, although it is very slightly skewed to the left. This indicates that the method is perceived as being generally average in effectiveness.

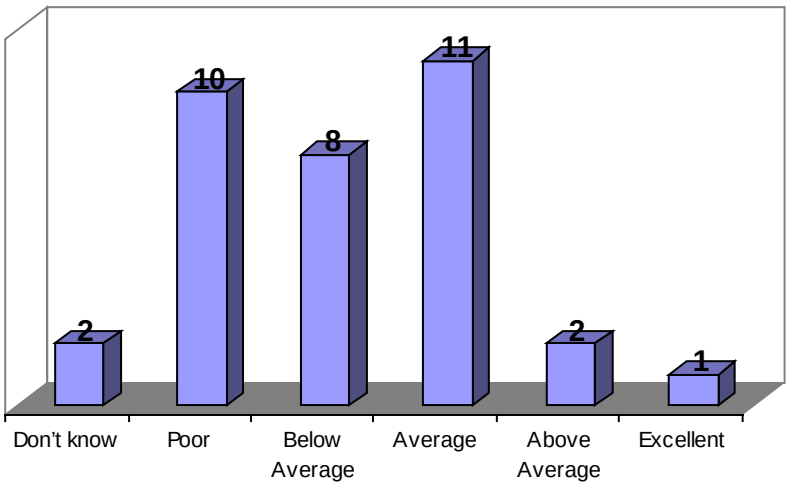
Figure 3 Frequency of Effectiveness Ratings for Method 4



Method 5: AV-Alarm

Of the 125 respondents, 34 (27%) of respondents used this method. It can be seen in Figure 4 that opinions on the effectiveness of AV-Alarms vary widely, and in general, the method did not rate highly.

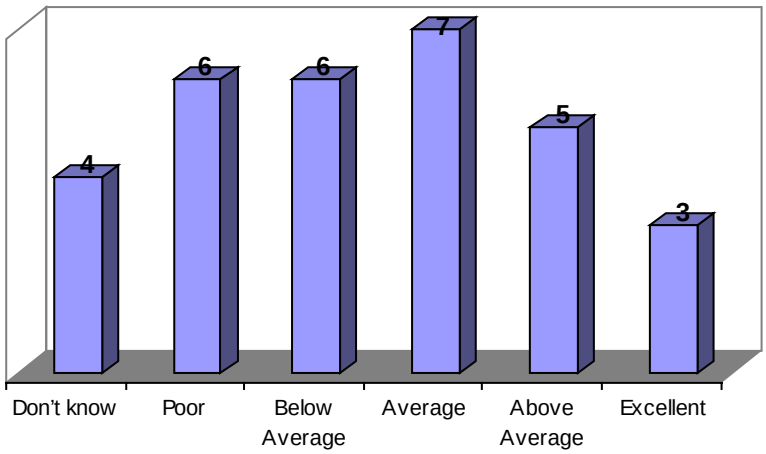
Figure 4 Frequency of Effectiveness Ratings for Method 5



Method 6: Multi-Frequency Generator

The results for this method were quite similar to that of the AV-Alarm. There were 31 users (25%) and the effectiveness ratings ranged considerably. However, the distribution was more evenly spread across all ratings indicating that there is a wider variation in the perceived effectiveness of Multi-Frequency Generators. This can be seen in Figure 5 below. Note that only about ¼ of the users rated it higher than average.

Figure 5 Frequency of Effectiveness Ratings for Method 6

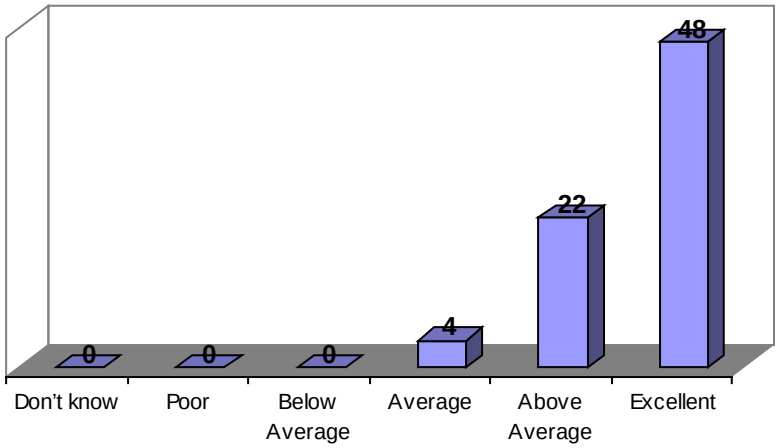


Effectiveness Rating

Method 7: Netting

Netting was used by 59% (74) of the respondents. Figure 6 below shows that those who use it rate netting very highly. The distribution of the ratings is highly skewed to the right. Users of this method are willing to spend considerably more on it than other methods as will be seen in the next section.

Figure 6 Frequency of Effectiveness Ratings for Method 7



Effectiveness Rating

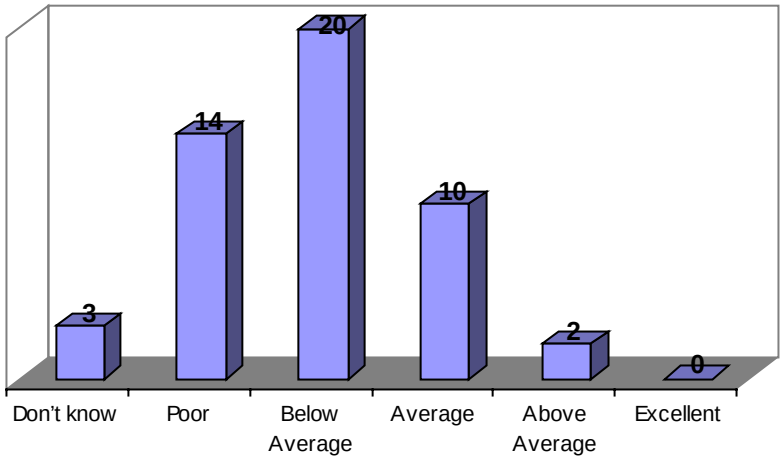
Method 8: Traps

There was only one user of traps, so the method cannot be analysed.

Method 9: Balloons

Balloons were quite popular, with 39% (49) of respondents using them. The rating distribution shown in Figure 7 was fairly skewed to the left indicating that the method is not highly effective, however, as will be seen later, this is one of the least expensive (and quiet) methods.

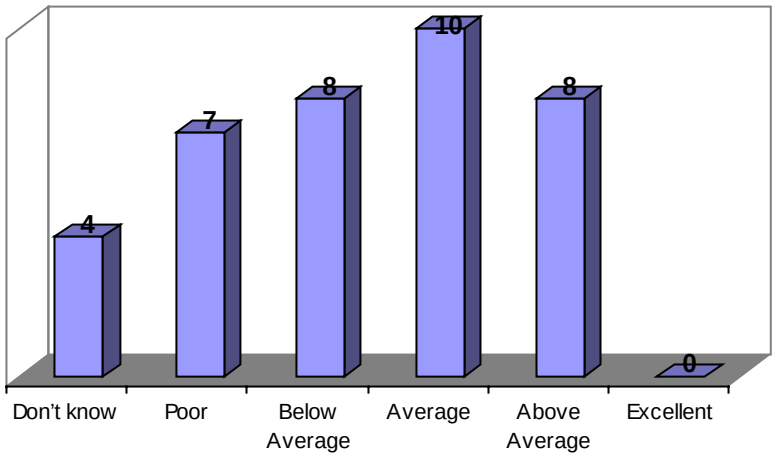
Figure 7 Frequency of Effectiveness Ratings for Method 9



Method 10: Tape

This method was used by 37 (39%) of the respondents. The effectiveness ratings were quite varied, although no user rated the method as excellent. Figure 8 shows the distribution. This method is also cheap, although, as mentioned earlier it can create a noise nuisance.

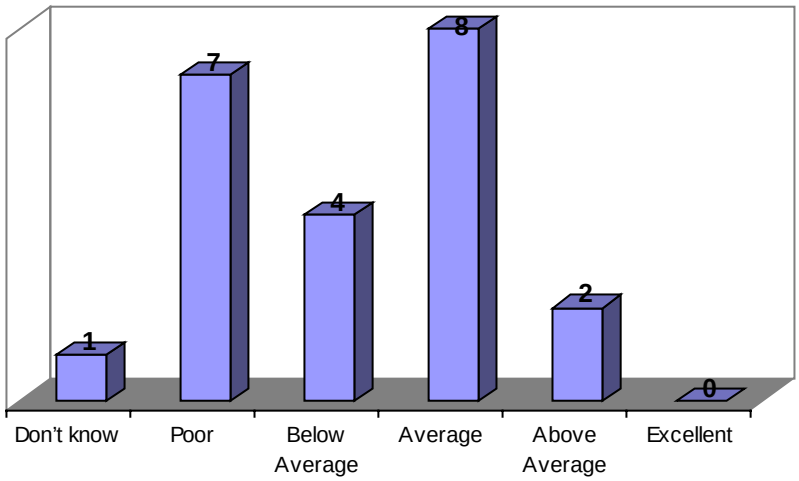
Figure 8 Frequency of Effectiveness Ratings for Method 10



Method 11: Scarecrows

This is another cheap and quiet method. 22 respondents (18%) used this method. The effectiveness ratings varied, but it generally rated poorly. Figure 9 illustrates this.

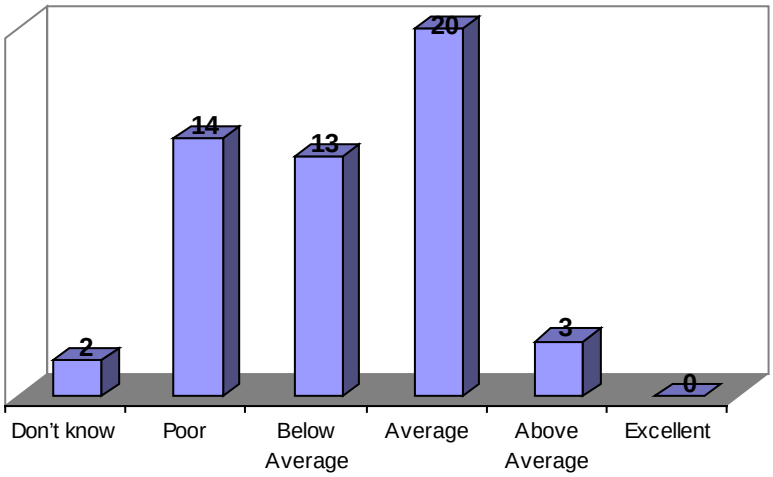
Figure 9 Frequency of Effectiveness Ratings for Method 11



Method 12: Kites

This method was used by quite a large number of respondents, 52 or 42%. As can be seen in Figure 10, the ratings varied. The users mainly rated the method between poor and average, and no user rated the method as 'excellent'. Again, this method is quiet and less expensive.

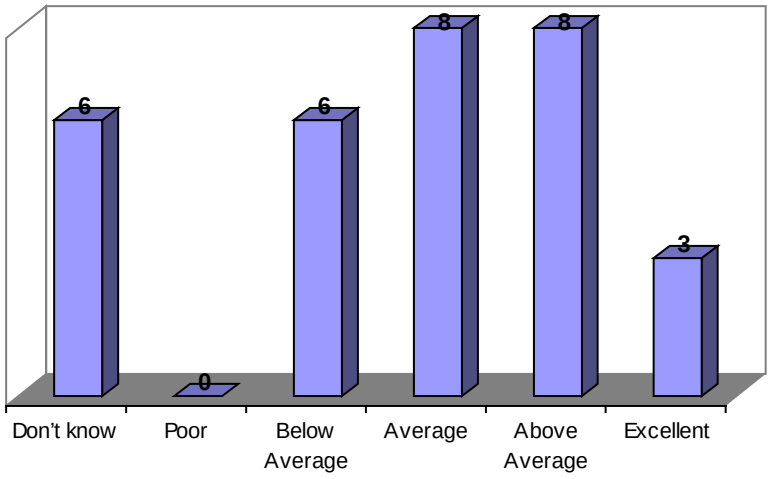
Figure 10 Frequency of Effectiveness Ratings for Method 12



Method 13: Walking Patrols

Walking patrols were used by 25% of the respondents. This method of bird control is often a secondary activity done while employees and/or the vineyard manager are attending to other matters on the vineyard, so it is difficult to assess the cost and the effectiveness of such a method. Hence, there were a relatively high number of 'don't know' responses. Figure 11 below shows the distribution of the ratings given which is quite spread.

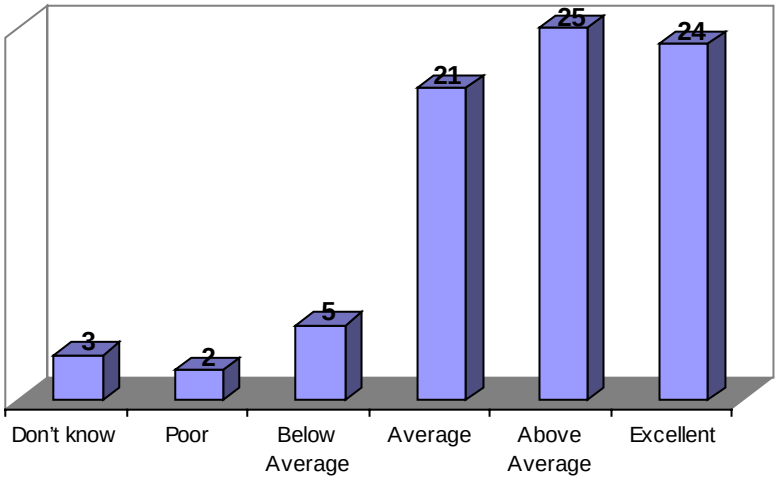
Figure 11 Frequency of Effectiveness Ratings for Method 13



Method 14: Walking Patrols and Shotgun

A total of 80 (64%) respondents used this method. Figure 12 below shows how the distribution of ratings is skewed to the right indicating that the method is generally considered to be effective. In fact, over half the users rate it above average.

Figure 12 Frequency of Effectiveness Ratings for Method 14



Other Methods

Table 5 below illustrates the additional methods of bird control given. Similar activities have been grouped; the number of users, their effectiveness ratings and amount spent per hectare are also given. Some of these methods are also similar to the 14 methods given in the questionnaire, but for simplicity, they have been analysed separately.

Table 7 Other Bird Control Methods, their Effectiveness Ratings and Amount spent per hectare

Description	No. of users	Effectiveness Rating	$ per Ha in 1998
Shotgun only	1	Average	?
Motorbike only	5	Don't Know	327
		Average	5
		Above Average	60
		Above Average	?
		Excellent	?
Motorbike with no muffler	2	Average	?
		Excellent	?
Motorbike with flag	1	Above Average	364
Hawk kite towed behind motorbike	1	Excellent	20
Tractor only	1	Above Average	15
Tractor and shotgun	1	Excellent	807
Light Tractor and shotgun	1	Above Average	?
Ute with mounted airhorn	1	Excellent	?
Ute with mounted kite & airhorn	1	Excellent	79
4wd and horn	1	Above Average	330
Flat deck truck and horn	1	Above Average	?
Car and horn	1	Average	15
Many varied activities	1	Don't Know	?
Car Radio	2	Below Average	?
		Above Average	7
Radio with Scarecrow	1	Average	?
Bird Guard – electronic scarer	1	Average	28
Air rifle	1	Above Average	129
303 blanks	1	Average	?
Tractor with mounted siren	1	Above Average	?

Tape and plastic carrier bags	1	Excellent	?
Peaceful Pyramid	3	Average	15
		Average	21
		Above Average	?
Rotating glass	1	Average	21
Mirror pyramid	1	Below Average	4
Mirror tiled ball	1	Above Average	0.29
Christmas decorations	1	Average	?
Old CD's	1	Average	0
Encouraging/attracting hawks	2	Above Average	?
		Average - Above Average	15
Cat faces	1	Above Average	4
Scary eyes	1	Below Average	?
Other stationary gimmicks	1	Poor	4
Pegging Nets	1	Don't Know	18

Amounts spent on these 'other' methods vary widely, while some could not be evaluated. The list highlights that some growers will employ a variety of methods, some unconventional, in order to reduce bird damage.

Overall, it is obvious that some methods are perceived to be more effective than others are. Next we will consider expenditure on the main methods analysed.

4.2 Expenditure on Individual Bird Control Methods

As many vineyard managers combine some bird control methods for practical reasons, we will now consider the methods, or groups of methods given in Table 6 with respect to expenditure on each. The table also shows the percentage of users and the average amount spent on each method per hectare. They are ranked in order of highest to lowest usage.

Table 8 Expenditure, Usage, and Average Amount Spent on Bird Control Methods

Method	Description	Users %	Average $ Spent in 1998	Average $ spent per Ha in 1998
M4	Gas Gun	77	1205**	83**
M7	Netting	59	3837	452
M1	Motorbike and Shotgun	48	3968**	241**
M14	Walking Patrols with Shotgun	48	921	80
M12	Kites	42	93	12
M9	Balloons	39	92	5
M15	Other	32	537	115
M10	Tape	30	113	10
M5	AV-Alarm	27	285	31
M6	Multi-Frequency Generator	25	299**	31**
M1, M2&3	Motorbike and Shotgun with Airhorn or Siren	20	5620	384
M11	Scarecrows	18	13	3
M13&14	Walking Patrols - with and Without Shotgun	16	1011*	296*
M2&3	Motorbike with Mounted Siren and/or Airhorn	13	1741	172
M13	Walking Patrols	8	668	58

* Has had 1 observation removed because of potential bias.
** Has had 2 observations removed because of potential bias.

Gas Guns are the most widely used method of bird control. They are also relatively cheap compared to netting, and patrols. Netting ranks as the second most used method. Per hectare, this is the most expensive method at $452. As noted, some of the figures in Table 6 have had observations removed. This is for reasons discussed in the following section.

The average year of purchase for capital equipment is also of some interest. Although they were all within the 1990s, netting and siren/airhorns were the most recent at 1996. Shotguns and gas guns had the earliest average year of purchase; both were calculated at 1992. The average years of purchase for Multi-Frequency Generators and AV-

Alarms were 1995 and 1993 respectively. Individual average years of purchase were not calculated for Balloons, Kites, Tape and Scarecrows. However, their combined average year of purchase was 1995.

4.3 Expenditure and Effectiveness Ratings

The graphs below require some explanation. The bar represents the number of users of a particular method who rate the method as shown on the x - axis. The diamond represents the average amount spent per hectare by users who gave the method that particular rating. The bar relates to the left-hand y-axis, while the diamond relates to the right-hand y-axis. For example, in Figure 13, there are 13 users of Method One who rated the method as 'excellent'; the bar represents this. The average amount spent per hectare by these 12 users is $213, as represented by the diamond above this bar.

Generally, we would expect higher expenditure per hectare from those that rated a method highly, although this is not a strict rule. These figures should give the reader a direct comparison between a vineyard managers' perception of the effectiveness of bird control methods, and their associated willingness to pay for them.

Method 1: Motorbike and Shotgun

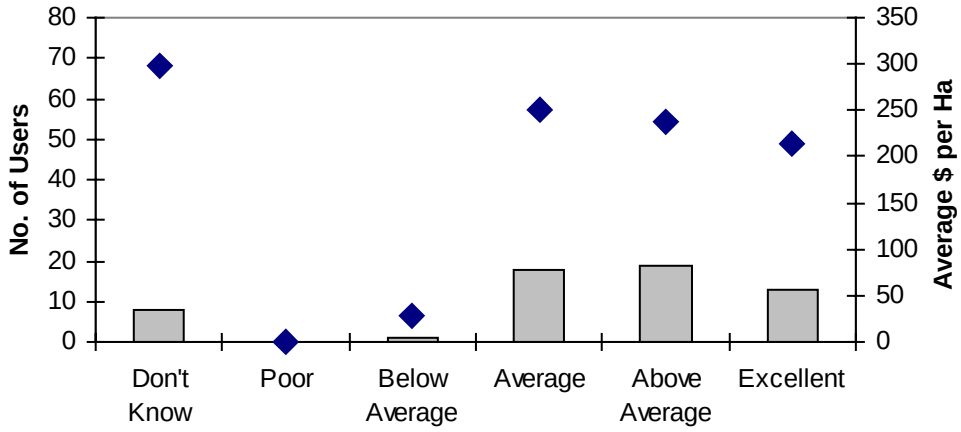
The respondents that used both Method 1 (motorbike and shotgun) and Method 2&3 (motorbike with mounted airhorn and/or siren) have been excluded from these figures because the costs are combined.

One observation has been removed from the 'don't know' rating because the vineyard spent $4681 per hectare[14] on this method. When this figure is included, the average is increased to $786, instead of $299. Another observation has been removed from these results because the respondents estimate of labour for this method included labour for all bird control and this may have biased the results. Hence, there are only 59 observations.

Interestingly, those who didn't know how effective they thought the method was spent the highest average amount per hectare, $299.

[14] This figure may seem excessively high but is due to a relatively high number of hours (378) this method was undertaken in 1998 on a relatively small vineyard (<2Ha).

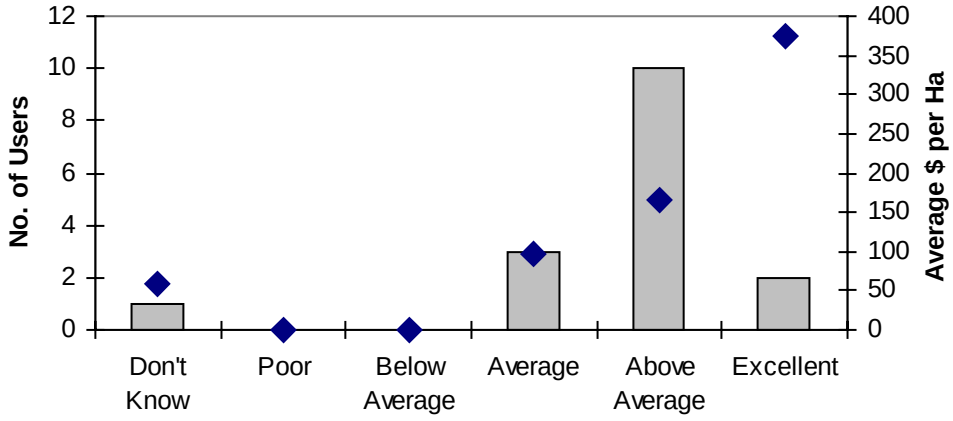
Figure 13 Effectiveness Rating and Average Amount Spent per Ha for Method 1



Method 2&3: Motorbike with Mounted Airhorn/Siren

This graph follows the pattern we would expect. That is, the higher the effectiveness rating, the more is spent per hectare. As stated above, those who combine Method 1 with Method 2&3 have been removed so there are only 16 observations in this result.

Figure 14 Effectiveness Rating and Average Amount Spent per Ha for Method 2&3

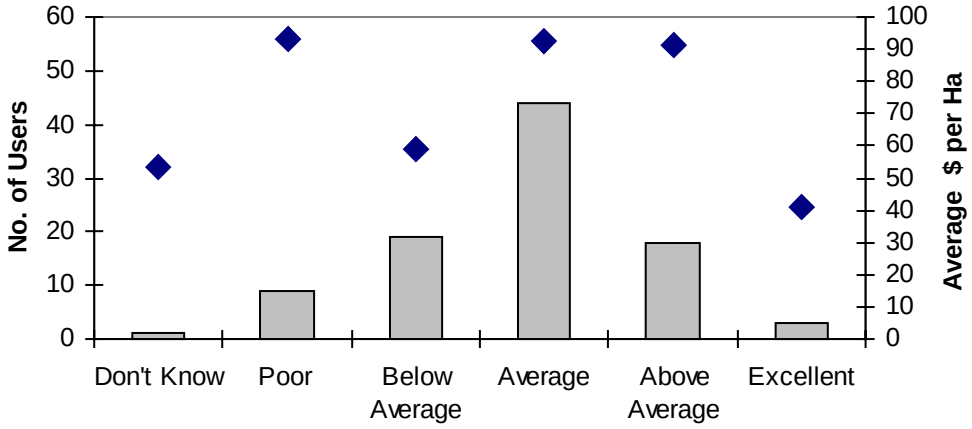


Method 4: Gas Gun

This figure shows that there is not much difference in the amount spent on gas guns between the effectiveness ratings, and in fact, those who rate them as excellent spend the least. This figure has had two observations removed, as they would have biased the

results. One was removed for reasons previously mentioned, the other had excessively high estimates of labour hours for this method, which may have been incorrect.

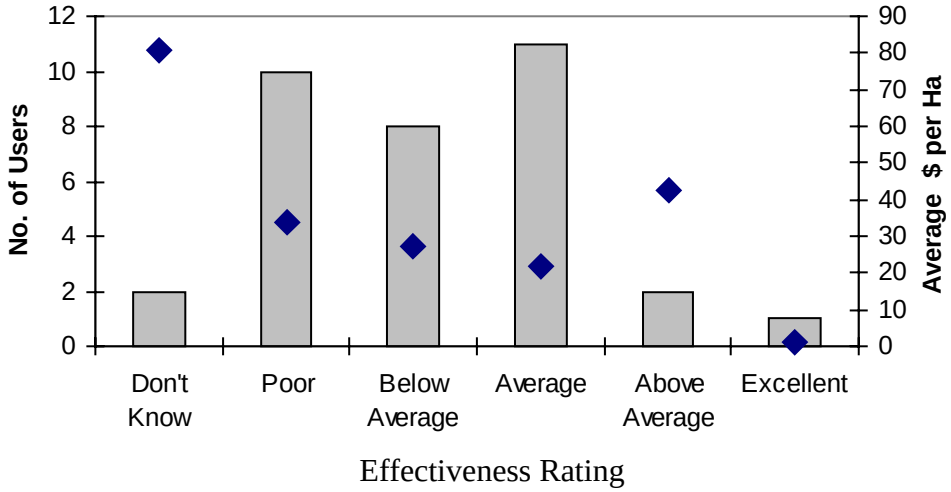
Figure 15 Effectiveness Rating and Average Amount Spent per Ha for Method 4



Method 5: AV-Alarm

This figure shows the opposite result to what we would expect. Apart from the increase in the amount spent for the 'above average' rating, there is an inverse relationship between the rating and average amount spent.

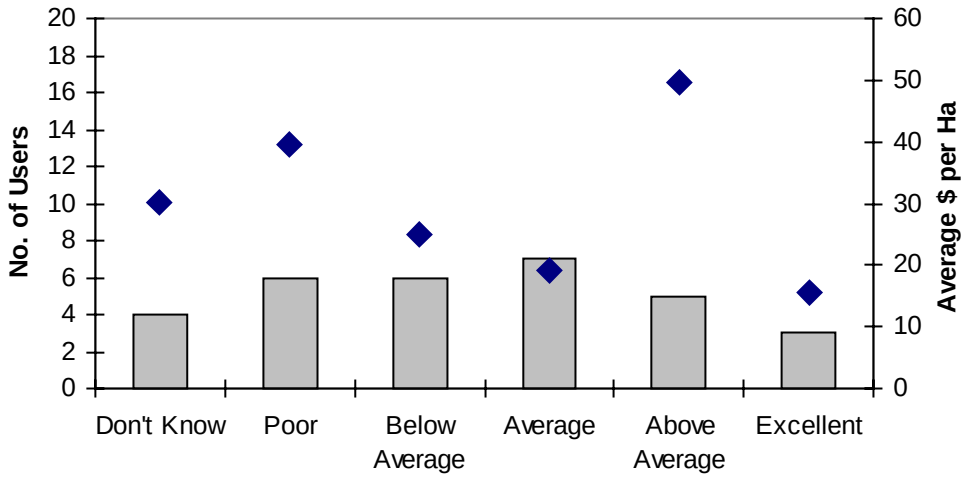
Figure 16 Effectiveness Rating and Average Amount Spent per Ha for Method 5



Method 6: Multi-Frequency Generator

The results for the MFG are somewhat similar to that of the AV-Alarm. This figure has had the two observations mentioned removed also.

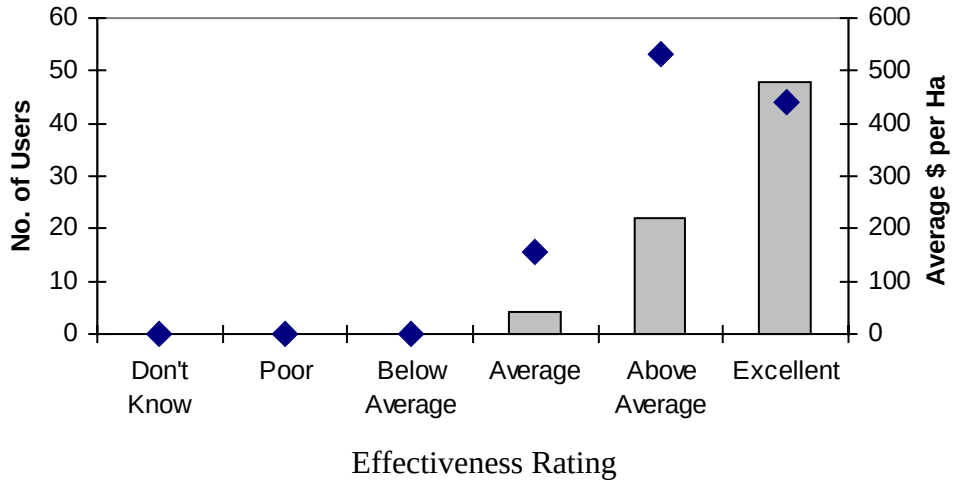
Figure 17 Effectiveness Rating and Average Amount Spent per Ha for Method 6



Method 7: Netting

Again, this figure reflects the how highly netting is rated. The average expenditure per hectare for each rating is relatively high. As stated in the table earlier, the average expenditure per hectare on this method is $452, however, the average amount spent per 'netted' hectare is $702. This analysis also shows that the average initial capital cost of netting is approximately $3300.

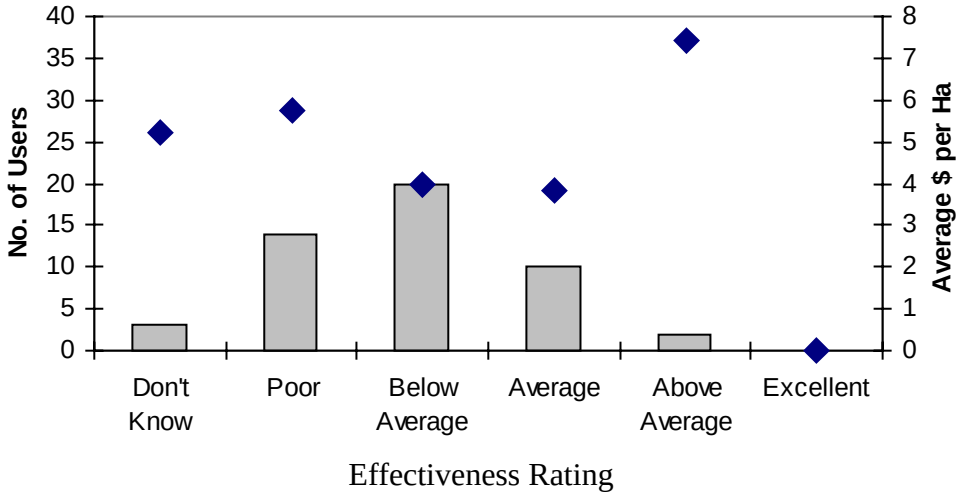
Figure 18 Effectiveness Rating and Average Amount Spent per Ha for Method 7



Method 9: Balloons

This was a rather mixed result. The average amount per hectare is between $4 and $8, so there is not much variation.

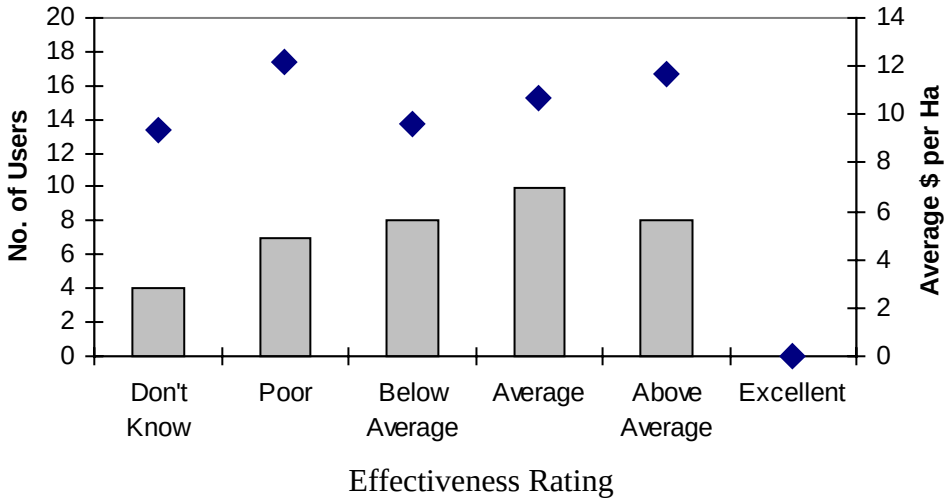
Figure 19 Effectiveness Rating and Average Amount Spent per Ha for Method 9



Method 10: Tape

The average expenditure on Tape is fairly constant. This is probably because this method is comparatively cheap and on any given vineyard, there is a limited amount that can be used per hectare.

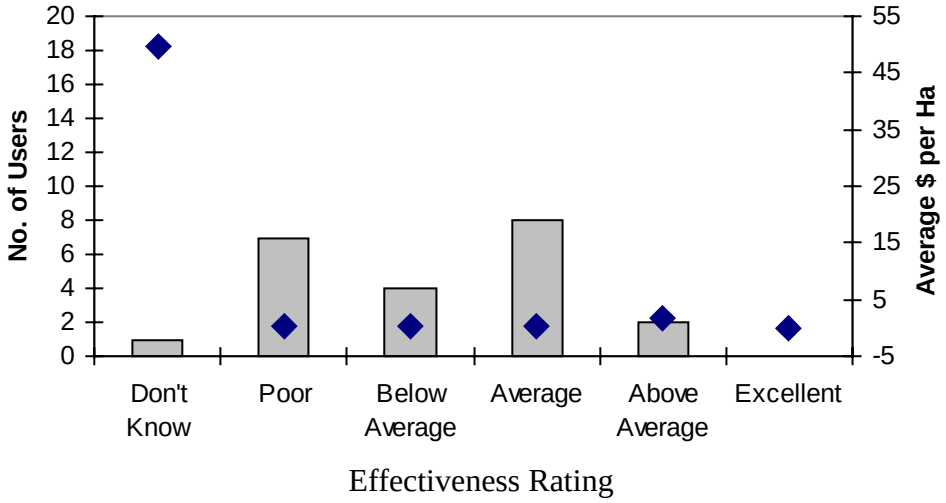
Figure 20 Effectiveness Rating and Average Amount Spent per Ha for Method 10



Method 11: Scarecrows

Again expenditure is constant, except for the 'don't know' rating. However, there was only 1 respondent with this rating. Scarecrows are also very cheap and many vineyards gave a zero cost for them.

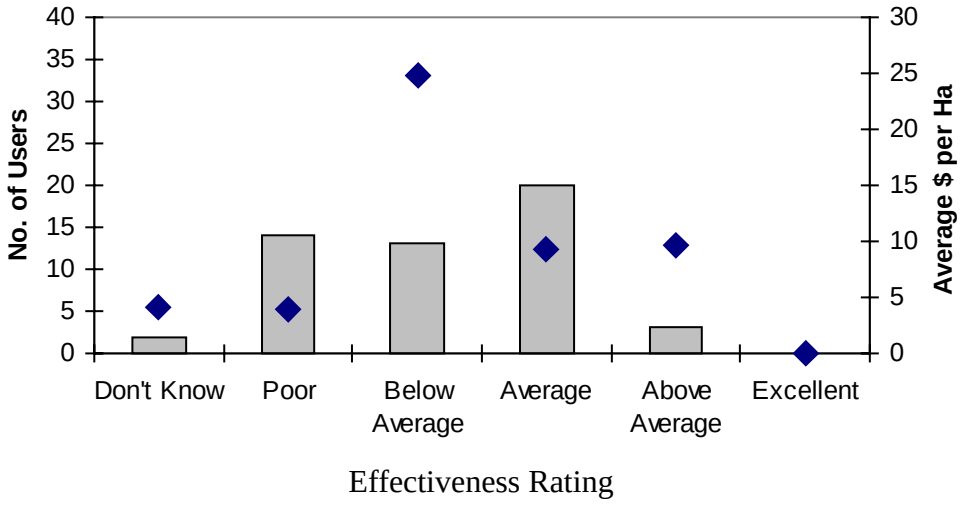
Figure 21 Effectiveness Rating and Average Amount Spent per Ha for Method 11



Method 12: Kites

This was another mixed result. The average amount spent does follow a general pattern when the 'below average' rating is removed. Again, expenditure is relatively low.

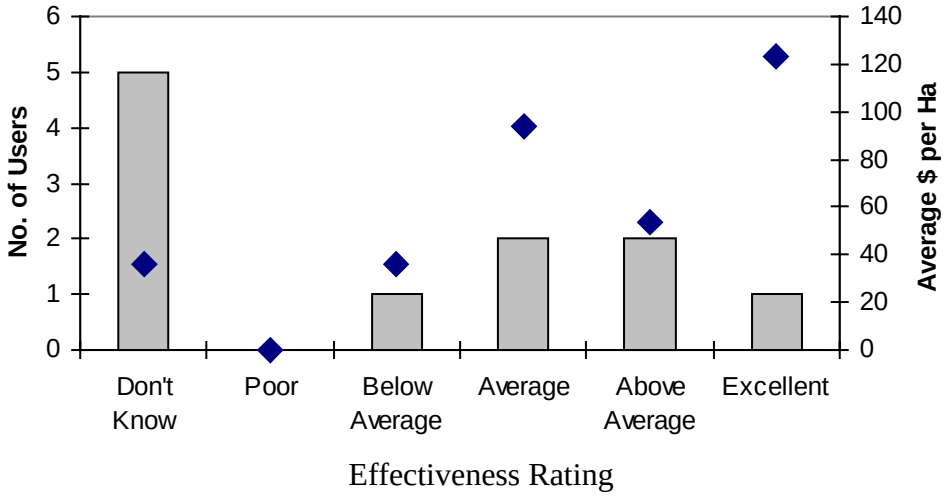
Figure 22 Effectiveness Rating and Average Amount Spent per Ha for Method 12



Method 13: Walking Patrols

For this figure respondents who used Walking Patrols with **and** without a shotgun have been removed. There is a positive relationship between the rating given and the average amount spent in this graph, except for the 'above average' rating. However, it should be considered that there are only a total of 11 observations.

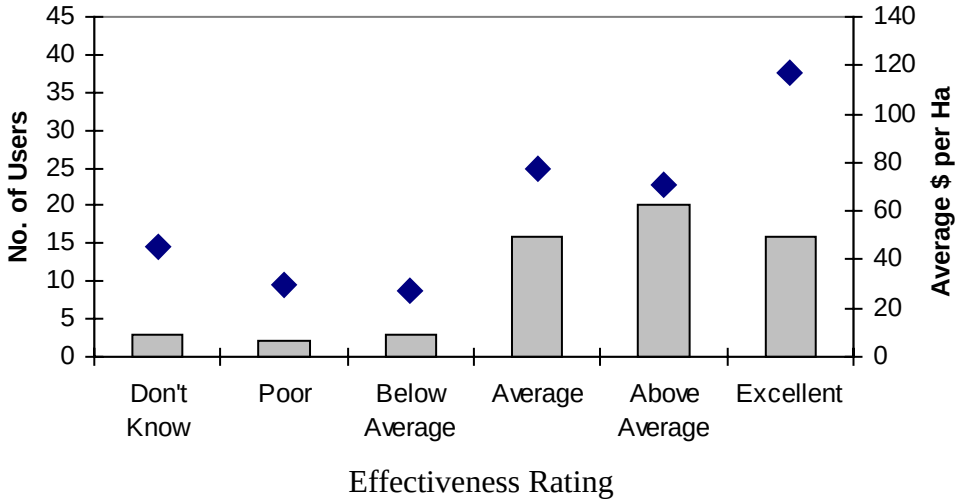
Figure 23 Effectiveness Rating and Average Amount Spent per Ha for Method 13



Method 14: Walking Patrols with Shotgun

There are 60 observations in this result because those who employ Methods 13 & 14 have been removed. The results for this method are generally what we would expect.

Figure 24 Effectiveness Rating and Average Amount Spent per Ha for Method 14



It is evident that in about half of the cases analysed, the amount spent is positively related to the effectiveness rating given. On comparison, these figures highlight the general trade-off between cost and effectiveness.

4.4 Financial Analysis

All dollar values in this section are rounded to the nearest dollar.

4.4.1 Expenditure on Bird control for the Region

The data collected shows that the 125 respondents spent a total of $968,009 on bird control over the 1998 season. This figure is based on 2201 hectares (the area the respondents covered) for the region. To estimate the level of expenditure for all vineyards within the region, the amount per hectare needs to be multiplied by the total number of hectares in the region. The closest estimate of this figure that is available is 2747 hectares given earlier. The amount spent on bird control per hectare from this analysis is $440, so for all vineyards within the region, expenditure is estimated to be $1,208,022.

The labour component (including contractors) of this expenditure is estimated to be $343,296 for the 125 respondents. Hence, for all vineyards in the region, it is estimated to be $428,414.

Although these are expenses for individual vineyards, from a regional perspective, they represent a secondary benefit of bird control. This is termed 'the multiplier effect'. For each dollar spent on inputs of production (bird control), more economic activity is generated, likewise for each dollar spent on labour. This effect is not quantified in this analysis because of additional data requirements.

4.4.2 Estimated Damage Avoided for the Region

Damage avoided is calculated as the difference between the 'with bird control' estimate of damage and the 'without bird control' estimate. This percentage of damage avoided was multiplied by the crop value of the vineyard. The level of damage avoided for the 106 respondents[15] is estimated to be $5,159,135. Scaling this figure up from 1879 to 2747 hectares, where the amount avoided per hectare is $2744, the estimated level of damage avoided for all vineyards within the region is $7,538,879.

The level of potential damage (without bird control) is estimated at $3125 per hectare. This result is calculated from 107[16] observations. Therefore, scaling up to 2747 hectares, potential damage for the region is estimated at $8,584,849.

The level of remaining damage can be calculated as the difference between potential damage and damage avoided. The total crop value of grapes in the Marlborough region is calculated at $32,287,625, assuming there are 200 vineyards and where the average crop value is $161,438.

[15] Only 106 respondents answered all the questions needed to estimate this amount. They covered a total of 1879 hectares within the region with average and median hectares equal to 17.7 and 10 respectively.

[16] These 107 respondents covered 1902 hectares and had an average and median hectares equal to 17.78 and 10 respectively.

Table 9 Results of Financial Analysis for Vineyards of the Region in 1998

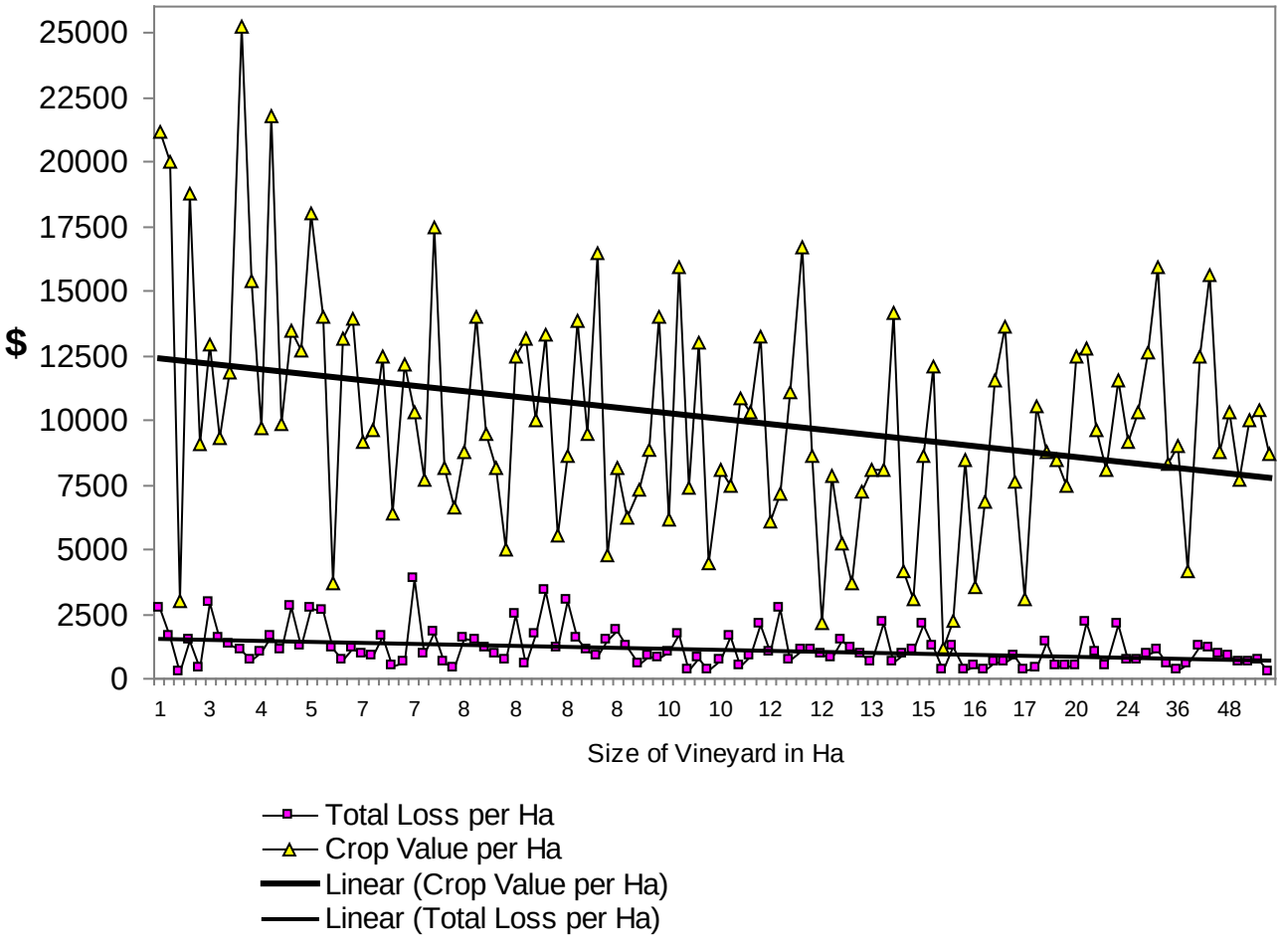
Damage avoided	$7,538,879
Potential damage (without control)	$8,584,849
Remaining damage (with bird control)	$1,045,970
Total Crop Value	$32,287,625

4.4.3 Total Financial Cost to Vineyards

The total financial cost to the vineyards can be calculated as the cost of bird damage control plus the value of remaining crop damage. There were 111[17] respondents that gave an estimate of the percentage of crop damage even with bird control measures in place. From these estimates, crop losses due to bird damage were estimated at $409 per hectare and $1,124,959 for the region. This figure differs from the above estimates because of the calculation method. The difference is $78,898, which is approximately 6% of the latter estimate.

A comparison of the total financial cost (i.e. the cost of bird control and the cost of remaining damage) and crop value per hectare is given in the figure below.

Figure 25 Total Financial Cost per Ha and Crop Value per Ha



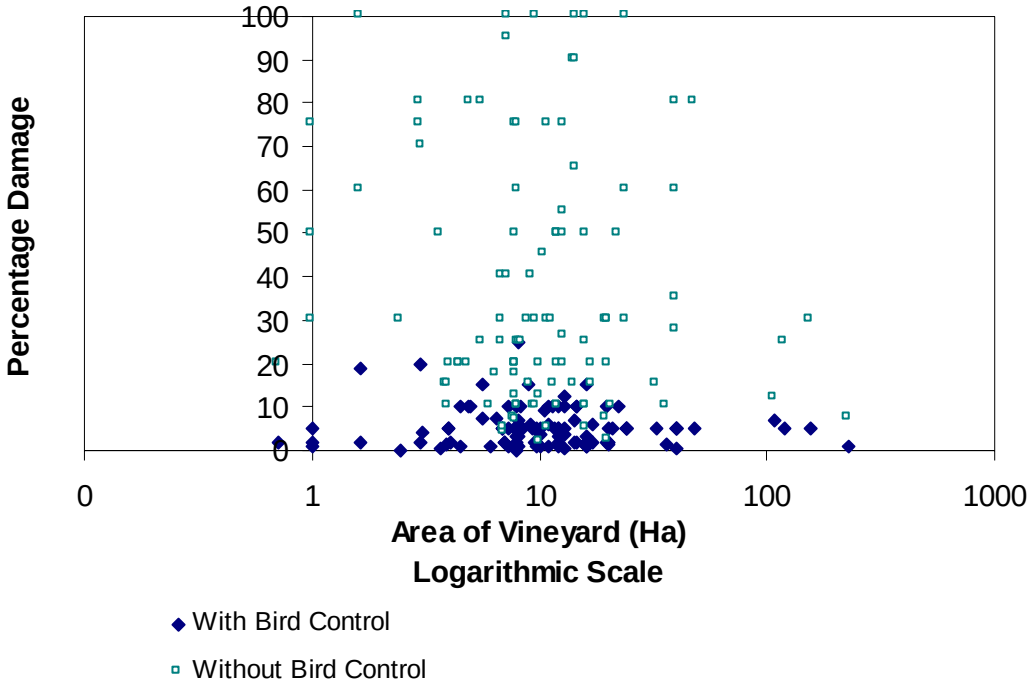
This figure has 110 observations. As previously noted, there were only 111 respondents that gave the necessary information to calculate the value of remaining crop damage. A further observation was removed because of the possibly incorrect number of labour hours given.

As can be seen in the graph above, there is a slight negative relationship between vineyard size and total loss. So, the larger the vineyard, the lower the total loss per hectare.

This is probably because as the trend-line shows, smaller vineyards tend to have a slightly higher crop value per hectare. Because the total loss per hectare is a function of crop value, it follows this trend.

Analysis of crop damage estimates shows no real relationship between crop damage and vineyard size, only that the very large vineyard have a lower estimate of potential (without bird control) bird damage. This is illustrated in Figure 26 below. This figure has 110 observations because only 110 respondents answered both necessary questions. One respondent gave an estimate of potential damage (without bird control) at 150%. This has been removed from figures throughout this analysis.

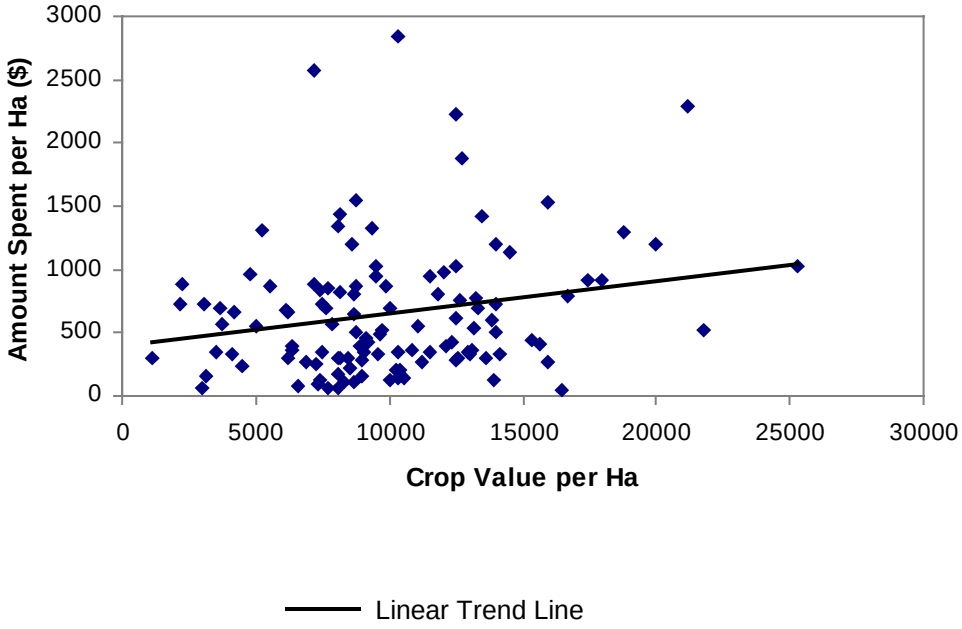
Figure 26 Crop Damage Estimates and Size of Vineyard in Ha



The relationship between the amount spent on bird control per hectare and crop value per hectare is shown in the figure below.

This figure suggests a positive relationship between the value of the crop and the amount spent on bird control. That is, more is spent on protecting crops where the crop is worth more. This is the result we would expect as growers try harder to protect more valuable grapes. However, when tested using regression analysis the relationship proved to be not significant.

Figure 27 Crop Value per Ha and Amount Spent on Bird Control per Ha

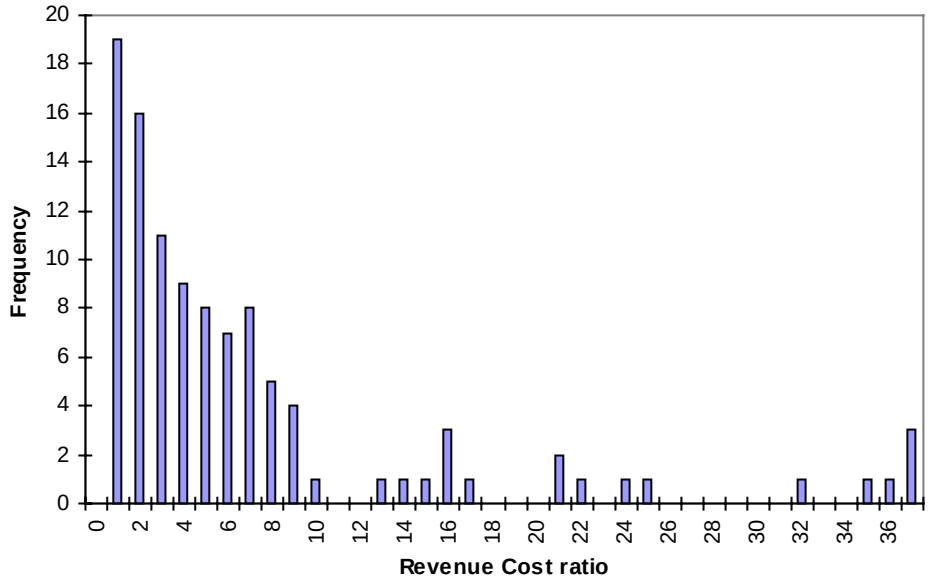


This figure has 116 observations. Of the 9 observations removed, 7 could not be included because the respondents did not give crop values. Another was removed because of the especially high labour estimates while an outlier (4170,7360) was removed for similar reasons.

4.4.4 Revenue Cost Ratios

Each individual vineyard has a level of expenditure on bird control and an estimate of bird damage avoided (revenue, in this context). Using these, a value can be calculated that represents the dollar value of damage avoided for every dollar spent on bird control. For example, if a revenue cost ratio is equal to 4, it is implied that for each dollar spent on bird control, $4 worth of bird damage is avoided. Ideally, the figure should be positive, and greater than 1. The figure below is a frequency plot of these values.

Figure 28 Revenue cost ratios for Individual Vineyards



This figure contains 106 observations as only 106 respondents had both a cost of bird control and estimate of damage avoided in this analysis. All of the observations were positive indicating that all vineyards had a positive level of expenditure on bird control and a positive benefit. As illustrated in the figure, 19 observations have a benefit cost ratio of less than 1. This implies that for each dollar the vineyard spends on bird control, they are saving less than $1 in bird damage. These 19 vineyards represent 18% of the 106 observations and 15% of the 125 respondents. The final column on the right indicates the number of observations that are greater then 36. The highest observation was in fact 326, followed by 69 and 43.

4.5 Benefit Cost Analysis

A Benefit Cost analysis looks at the real worth of a project to a country. Transfer payments need to be removed from the regional estimates in order to access the cost of bird control in Marlborough vineyards to New Zealand.

Income tax, GST and ACC premiums have been removed from the figures in the financial analysis above to estimate the costs of bird control to the region. Income tax for the region was calculated at $92,109. This is 21.5% of the total labour component of regional bird control expenditure. Total non-labour expenditure on bird control for the region is $779,608, hence, at 12.5%, the total value of GST the region was calculated at $97,451. Finally, the total ACC premium paid was calculated at $11,260.

Accounting for these transfer payments, the cost of bird control on Marlborough vineyards in 1998 to New Zealand is $1,007,201. There was no need to adjust the benefit because this figure did not include GST.

Table 10 The Benefit and Cost of Bird Control

Cost of Bird Control	$1,007,201
Benefit of Bird Control	$7,538,879

It is obvious from these results that the costs of bird control are far outweighed by the benefits to the region. These results represent a benefit cost ratio of 7.5. For each dollar spent on bird control, $7.50 worth of damage is avoided. This is a good result for the nation (and region) as a whole.

However, it should be remembered that the cost of bird control excludes the 'social cost' of the negative externality, noise pollution. As discussed, this is difficult to measure, but should still be considered. Also, the benefit doesn't include any multiplier effects which are not considered in a Benefit Cost Analysis.

Chapter 5

Social Issues

Historically, growers in the Marlborough region have had the right to use noisy bird control measures at their discretion. That is, the property rights of the land use by the grower allow for their use. Recently, this has become an issue of concern in the region for various reasons previously discussed. Although there have been voluntary guidelines provided by the Marlborough Grape Growers Association, these have been insufficient to deal with the problems occurring in some situations, for example, where a complainant may be surrounded by 4 or 5 vineyards (in some cases 10).

While the Hearing Committee has reviewed the submissions received with respect to this issue, the Council, at the time, did not accept their recommendations (Local body elections have been held since). Although, they did decide to go ahead with an application for enforcement orders to issue growers who exceed a 'reasonable' noise level. This would have come into effect in the 1999 season. However, the newly elected council has put this on hold, opting for a system where negotiations between parties are held first. Only in situations where an agreement cannot be reached, enforcement orders will be necessary.

The council is also addressing measurement issues. The Draft Annual Plan included provisions for the use of 'peak' measures, which are unweighted. It has now been decided that these will not be used and work is being done on a more suitable measure.

In terms of possible solutions to this social issue, consider the methods discussed in section 2.2.2. A policy combination of moral suasion, education and standards would probably be suitable.

The noise from gas guns (for example) only causes problems in some situations and areas. That is, not all noisy bird control methods create a negative externality. So, the standard need not apply in all cases. This creates a difficulty in deciding where they should apply. This suggests that in cases where there is a problem, a process of negotiation between parties involved would be a highly suitable solution. Enforcement orders should be used as a backstop to ensure compliance.

Chapter 6

Key Assumptions and Limitations

6.1 Limitations of the Survey

A good survey should have the following attributes:

- Comprehensiveness: to cover all aspects
- Coverage: the extraction of data by geographical region, or other criteria
- Accuracy and Reliability: precision and bias
- Consistency: in definition and units
- Cost and Time Minimisation[18]

As in all surveys, there must be trade-offs among the desirable attributes of the information and the limits set by time and budget. This survey was comprehensive, had good coverage and was consistent in definitions and units, although time constraints on the development of the questionnaire meant it was not perfect. Precision and bias will be discussed below.

6.1.1 The Questionnaire

As discussed the information for this project was gathered through the use of a questionnaire, both postal and a limited number of personal interviews. There are obvious limitations involved, and the result may over estimate the true measured loss. This places a special obligation on the surveyor to describe the survey and provide sufficient information to allow readers to assess the validity of the conclusions. It should be remembered that any measure would have variation and a margin of error, but that generally, it is better than no measure at all. By sampling almost the whole population set (vineyards in the Marlborough region), and focussing on a specific problem, the survey maximised precision while minimising bias.

[18] Adapted from Upton *et al* (1994), p27

6.1.2 Representation

Other Regions

Marlborough may not necessarily be representative of other grapegrowing areas of New Zealand. Each region has features specific to the area. Landscape, bird species, varieties of grape grown, and weather conditions are examples of some that may affect bird damage. In Trim's (1982) survey of 1500 farmers throughout New Zealand, the Marlborough/Nelson/Westcoast area rated 5th out of 11 in terms of the level of bird damage overall, which implies it is fairly average. The area has changed considerably in terms of increased grape production, so it may now be above average.

The region is the largest vineyard area in New Zealand, and is forecast to contribute significantly to the growth of total vineyard area over the next three years, along with Hawkes Bay and Gisborne[19]. Because of this the area may not be representative of smaller grape growing regions.

Bias

Bias can be avoided through a well-designed sampling scheme. This survey was sent to nearly all the vineyards in the Marlborough region. Non-Respondents were sent a follow up letter and given a date to respond by. It was not possible to personally contact the remaining non-respondents because of time constraints. It is possible that these non-respondents had suffered minimal bird damage and therefore did not respond. This would potentially bias the results, as it would tend to exaggerate the overall damage[20]. This potential bias was avoided as much as possible in this survey by having a large sample size and using several techniques to encourage growers to return the questionnaire. These included: hand signing of the cover letter, offering a summary of the results, and the use of a follow up letter (also hand signed).

As mentioned earlier, Porter *et al* (1994) note that a subjective measure of bird damage may be greater than a true measure. It is also possible that those who responded to the survey have greater problems with bird damage, and therefore may bias the results. Hence, the parameters that are estimated in this study might over estimate the actual measure.

On the other hand, it seems that many of the non-respondents may have smaller vineyards[21], which are typically viewed as having greater problems with bird damage due to the higher concentration of vulnerable area of vineyard, i.e., they have a higher ratio of edges to total area. This implies that the estimated parameters could underestimate the true measure. Analysis of damage estimates only suggest that the very large vineyards (greater than 50 hectares) estimated lower levels of existing and potential damage. In this analysis, there were only 5 vineyards with an area greater than 50 hectares.

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[19] The Bank of New Zealand Wine & Grape Industry Statistical Annual 1998.

[20] As was found in the 1966-67 nation-wide survey on bird damage in orchard and berry gardens (Bull, 1983).

[21] As discussed previously, the average (and median) area in hectares in this survey was greater than the average (and median) area in hectares found in the 1998 Vineyard Survey that covers approximately 95% of vineyards.

Social Issues

With respect to social issues, the Marlborough region may be significantly different. The region is considered to have a high level of urban settlement within the vineyard area, or conversely, a high level of vineyards around the urban settlements. Hence, noise pollution problems may be intensified. This could be an issue for further research.

Across Years

It should be considered that the figures attained might differ from other years. The analysis given in this report is based on figures for the 1998 season.

All but one of the participants in the personal interview stated that the magnitude of bird damage varied from year to year. Further to this, most stated that the main cause of the variation was the weather. Some reasoned that the drought had created a lack of alternative food sources, so more birds were eating grapes, while others noted that the humidity affects the level of damage.

6.2 Benefit Cost Analysis

The BCA framework has a design weakness in that it compares the project scenario with an alternative scenario based on what would have happened in the absence of the project. The margin of error for this specification is carried over the project analysis (Handbook of Cost -Benefit Analysis, 1991). In this analysis, the alternative scenario is the situation that would occur if no bird control measures were in place. As has been previous mentioned the estimates for these scenarios are highly subjective.

The use of cost benefit analysis also raises equity concerns. There is an implicit assumption that each person values money in the same way, i.e. that the marginal utility of money is the same for each individual. In this analysis, this assumption is not of great concern because the primary costs and benefits affect a group of similar people, i.e. grape growers in the Marlborough region.

Chapter 7

Conclusions

It is estimated that in the Marlborough region approximately 3% ($1m) of total grape production was lost to or damaged by birds in 1998 despite growers bird control efforts. It is also estimated that without bird control, approximately 25% ($8m) of grape production would be lost to or damaged by birds. In an industry where the total crop value in Marlborough for 1998 is estimated to be $32 million, the potential loss is huge.

From a national point of view, the total cost of bird control for vineyards in the Marlborough region for 1998 was $1 million, while the benefit of this control was $7.5 million. This is clearly a net benefit to society and raises questions over whether more bird control should be employed. However, when considering the revenue cost ratios of individual vineyards, the answer to this question is not clear. The figures show that at least 15% of vineyards are not employing an optimal amount on bird control and may be spending too much on ineffective methods. Most had favourable revenue cost ratios, but this is still not a clear indication that they are employing least cost methods of bird control at an optimal level.

This analysis showed netting and sirens/airhorns to be the most recently purchased bird control equipment. The average year of purchase in this analysis was 1996 for both. This suggests they have gained popularity in recent years. Netting ranks as the second most used method, but per hectare it is also the most expensive. Netting rates very highly in terms of perceived effectiveness. In comparison, the average year of purchase for gas guns was 1992. Gas guns have the highest level of use and rate fairly well in terms of cost. The method is 7th out of 15 when ranked in order of highest to lowest cost per hectare. However, it is perceived to be only fairly average in effectiveness. The cheapest method of bird control in this analysis was the use of scarecrows. This, however, was also one of the most poorly rated in terms of effectiveness, but still had 18% usage (the 4th least used).

These results suggest that there is a trade off between cost and effectiveness. The cheaper the method, the less effective it is. There is a case for research and development into cheaper, more effective methods of bird control. There is also good

reason for the development of a cheap and effective method that does not create a noise nuisance. It seems that this has not been done yet and will obviously be difficult because of the trade off involved.

Of the $1.2m spent on bird control, approximately 50% involved vineyard patrols by staff. This includes walking and motorbike patrols, with and without shotguns and sirens/airhorns. In terms of perceived effectiveness, these methods generally rated as above average, although walking patrols on their own did not rate as highly. Even though netting is the most expensive method per hectare, only 30% of the total ($1.2m) was spent on netting. Expenditure on gas guns constituted just over 10% of the total, while the other methods discussed made up the remainder.

Last year (1998) was regarded as a 'good' year in terms of weather and disease for grape growers. In years where humid conditions are prevalent and diseases are rife, the potential for loss is increased as birds leave damaged fruit open to fungal infection. There is also concern over the effect of netting under these conditions, which may further reduce the supply and quality of grapes. Any significant change in supply will also affect demand. As stated earlier, results of the Lincoln University Economic Impact study[22] showed that for each $1 increase in the demand for Marlborough wine grapes, $2.07 worth of economic activity is generated. In years with high humidity and disease levels the overall effect would be more serious than this research shows.

In terms of social issues, progress is being made on ways to deal with the problem of noise nuisance. Measurement issues and the fact that not every instance of gas gun use, for example, creates a noise nuisance complicate this situation. It is important that all affected parties are consulted and considered in situations where problems exist. This may mean the process of finding a solution is long and ongoing, but a satisfactory result should eventually be reached.

[22] A Summary of the Results of the 1997 Marlborough Wine Industry Economic Impact Study

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Internet Sites:
http://www.ird.govt.nz
http://www.stats.govt.nz

Appendix I

Interviewers copy of Personal Interview Questionnaire

Questionnaire on Bird Damage in Vineyards of the Marlborough Region

Interviewer's copy

Interview No.
Date:
Name:
Company Name:

Contact Information:
Street Address:

Postal Address (if different from above):

Phone:
Fax:
E-mail:

General Information:

Size of Vineyard (ha):
Varieties of Grapes (ha):

Soil types:

Comment on Microclimate:

Age of Plantings:

Proximity to influencing factors:
i.e. trees, buildings, poultry farms, river beds, residential areas, rubbish dumps.
A sketch of the vineyard and the surrounding features would be useful.

Bird Damage:

Direct Costs

Does the vineyard employ bird control measures?
If not, why?

If yes -
Which methods of bird control are employed?
(See list of techniques for classification)

FOR EACH OF THE BELOW, WE NEED TO BE ABLE TO CONVERT TO A % OF CROP AND A % OF TURNOVER. SO NEED A DOLLAR VALUE, TIME PERIOD, CROP VALUE AND TURNOVER.

How much does each of these cost?

i.e. initial outlay, operating costs, maintenance, labour. In $ per year, week, etc.

How much bird damage still occurs?
(Even when using bird control measures)
In terms of direct fruit losses, and secondary loss through faecal fouling and increased attraction of wasps, for example.

How much bird damage would occur if you used no bird control measures?

Probability

How often does bird damage occur?
e.g. does it occur once a year, for a period of two weeks?

Is the bird damage always of the same magnitude?
i.e. does it vary from year to year? Are there major strikes every so often or is there a pattern of bird strikes that can vary in magnitude.

Why?

Is the bird damage problem becoming worse?

Do you know of any particular reasons why?

Indirect Costs

Do the secondary effects of bird damage downgrade the quality of grapes?
Secondary effects include; faecal fouling, increased attraction of wasps, for example.

Is it significant?
Can you evaluate this?

Do you think that the loss of crops through bird damage affects the market price for grapes?

Effectiveness of Bird Control Techniques:

For each method of bird control used -

How often is it used? (And for how long?)
5 = All the time
4 = Quite a lot
3 = Sometimes
2 = Hardly ever
1 = never

How effective is it?
5 = Excellent
4 = Above average
3 = Average
2 = Below average
1 = Poor

How do you rank them in terms of effectiveness? Best to worst.

Appendix II

Cover Letter

Hort+Research
Private Bag 11030
Palmerston North
New Zealand
Telephone +64-6-3568080
Facsimile +64-6-3546731

December 3, 1999

«FirstName» «LastName»
«Company_Name»
«Address_1»
«Address_2»
«City»

Dear «FirstName» «LastName»

You have been selected, as a vineyard owner/manager in the Marlborough region, to participate in a survey. The survey is part of an economic analysis of bird damage in vineyards of your region. The research project is well supported by Massey University, HortResearch, the Marlborough District Council, Marlborough Research Centre Trust, the Marlborough Grape Growers Association, and Montana Wines (Marlborough).

The survey will gather information on bird control methods. In particular, we are interested in the actual cost of these methods and the benefits resulting from their use in the vineyard. You may find some of the questions difficult, but we would appreciate your estimates.

We are offering a summary of results from the study to those who complete the questionnaire. These should be available around December 1998.

All information we receive will remain 'name' confidential; i.e. the results will be presented only in aggregate form. The number on the return envelope will only be used to record questionnaires that have been returned and if you wish to receive a summary of results.

If you have trouble understanding a question, or have questions relating to the survey, please do not hesitate to call me on 06 356 8636. You can leave a message during work hours, or call in the evening. If you leave your name and phone number, I can return your call.

Thank you for your time.

Sincerely,

Ms Laurie Boyce
Honours Student
Massey University

Dr Sandy Lang
Research Supervisor
HortResearch

Prof. Anton Meister
Research Supervisor
Massey University

Follow up Letter

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Palmerston North
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23 September 1998

«FirstName» «LastName»
«Company_Name»
«Address_1»
«Address_2»
«City»

Dear «FirstName» «LastName»,

You will recall that during August we sent you a questionnaire regarding bird control in your vineyard. This letter is to remind you that we have not yet received your reply, and that the completion and return of your questionnaire will still be very welcomed. Returns will be received only until the end of October.

Although we have had a good response rate (52%), the results will give a more accurate reflection of the industry situation with a higher number of returns.

If you use your own envelope for your reply, you should write your 'Reply No.' on it **if you wish to receive a summary report of the results**. Your Reply number is **«Reply_No»**. This number is strictly confidential.

If you have lost or misplaced your questionnaire, please call (06) 3568636 and leave your full name. We will be happy to send you a replacement questionnaire and return envelope.

We appreciate your time and effort taken to complete this survey.

Thank you.

Sincerely,

Ms Laurie Boyce
Honours Student
Massey University

Appendix III

Postal Survey

COST BENEFIT SURVEY - BIRD CONTROL IN MARLBOROUGH VINEYARDS

Please answer the following questions with respect to the 1998 season and to the vineyard area you specify in question 1.

Q1. Size of vineyard: _____ acres / hectares (Circle one)

Q2. What was the total value and weight of the 1998 crop? $_____

_____Tonne

Q3. What bird control methods did this vineyard employ? Please tick each in the appropriate box below.

Q4. Also, please give an 'effectiveness' rating for each method employed using the following scale:

5	4	3	2	1
Excellent	Above average	Average	Below average	Poor

Write this rating in the appropriate box below.

Method of Bird Control	Tick if Used	Rating
Motorbike and Shotgun		
Motorbike with Mounted Siren		
Motorbike with Mounted Airhorn		
Gas Gun		
AVA Bird Alarm		
Multi-Frequency Generator		
Netting		
Traps		
Balloons		
Tape (i.e. strung along rows)		
Scarecrows		
Kites		
Walking Patrols		
Walking Patrols with Shotgun		

Other (please specify)		

Please complete the information below concerning the bird control methods that you have ticked in the above table. I realise that this may be difficult for some of the questions, but I would appreciate it if you could "guestimate" the answers. Where a question is not applicable, please write N/A in the appropriate box.

MOTORBIKE AND SHOTGUN

Q5. How many shotguns were used for the purpose of bird control during the season?

Please circle the number below.

0 1 2 3 4 5+

If none, go to question 10.

Q6. For each shotgun, please give the price paid, year of purchase and an estimated lifetime. Place these in the table below.

Year	No. Purchased	Total Price Paid	Estimated Life

Q7. Please estimate the amount spent annually on maintenance for these guns. Place in the box below.

Gun maintenance	

Q8. How much was spent on ammunition for the purpose of bird control in the 1998 season? Place in the box below.

Ammunition	

Q9. Consider the following bird control method: Bird scaring using a motorbike **and** shotgun. Approximately how many hours were staff employed to do this during the season? Place the number in the box below.

No. of hours	

SIREN AND/OR AIRHORN MOUNTED ON A MOTORBIKE (if used)

Q10. For each siren and/or airhorn mounted on a motorbike, please give the price paid, year of purchase and estimated lifetime. Place in the table below.

Year	No. purchased	Total Price Paid	Estimated life time

Q11. Consider the following method of bird control: An employee patrolling the vineyard on a motorbike using a siren and or airhorn to scare birds. Approximately how many hours were staff employed to do this during the season? Place the answer in the table below.

Please note: If this method of bird control is combined with shooting while on a motorbike, the hours could already be included in question 14. If this is the case, there is no need to answer this question. Tick the appropriate box below if this applies.

Hours of labour	
Hours are already Included	

GAS GUNS

Q12. How many Gas Guns were used on the vineyard during the season?

0 1 2 3 4 5 6 7+

If none, go to question 18.

Q13. For each gas gun, please give the price paid, year of purchase and estimated lifetime of each in the table below.

Year	No. Purchased	Total Price Paid	Estimated lifetime

Q14. Please estimate the amount spent annually on the maintenance of these gas guns. Include batteries, if used, but **not** gas. Place the amount in the box below.

Maintenance of gas guns	

Q15. How many hours of labour were directly associated with the use of gas guns during the season? For example, time taken for employees move them to different areas of the vineyard. Place the number in the box below.

Hours of labour	

Q16. Please estimate of the hours that a motorbike was used in direct association with the gas guns. Place the number in the box below.

Motorbike hours	

Q17. How much was spent on gas for the gas guns during the season? Place the amount in the box below.

Gas used in gas guns	

AVA ALARM AND/OR MULTI-FREQUENCY GENERATOR, if used

Q18. Please give the number of each used during the season in the table below.

	No. used
Multi-Frequency Generator	
AVA Bird Alarm	

Q19. For each AVA Alarm (AVA) and Multi-Frequency Generator (MFG), please give the year of purchase, price paid, and an estimated lifetime and place in the table below.

AVA **or** MFG?	Year	Price Paid	Estimated Life time

Q20. Please estimate an annual maintenance cost on these devices and place in the table below.

AVA maintenance	
MFG maintenance	

Q21. How many hours of labour were directly associated with the use of an AVA Alarm and/or a Multi-Frequency Generator during the season?

AVA labour hours	
MFG labour hours	

Q22. If possible, please estimate the number of hours a motorbike was used in direct association with the use of an AVA Alarm and/or MFG. For example, travel to the device.

AVA motorbike hours	
MFG motorbike hours	

NETTING

Q23. How many acres / hectares (circle one) of the vineyard were netted during the season? _____

If none, go to question 29.

Q24. Please give the coverage area (please specify acres or hectares), price paid, year of purchase and estimated lifetime of netting used during the season. Place in the table below.

Year	Area in Acres **or** Ha	Price paid	Estimated Lifetime

Q25. Please estimate an annual maintenance cost on the netting. Place in the box below.

Netting maintenance	

Q26. How many hours of labour were used in direct association with the use of netting? For example, putting out and bringing in. Do not include time spent on maintenance if this has been included in the cost in Question 25. Place the number in the box below.

Hours of labour	

Q27. How many hours was a tractor used to aid with the netting, if at all? Place number in the box below.

Tractor hours	

Q28. A motorbike may have also been used in direct association with the use of netting. An estimation of the number of hours this occurred would be helpful. Place this in the box below.

Motorbike hours	

TRAPS, BALLOONS, TAPE, SCARECROWS, AND KITES

Q29. For each device used, please give the price paid, year of purchase and estimated lifetime. Include in the price any materials used (i.e. if you have constructed your own scarecrow), and labour.

	Price paid	Year	Estimated lifetime
Trap/s			
Balloon/s			
Tape			
Scarecrow/s			
Kite/s			

WALKING PATROLS, if used

Q30. Please estimate how many labour hours would have been used on walking patrols during the season.

Labour hours	

Note: If a shot gun was also used on these walking patrols, the expenses and ammunition should already be included in questions 10 to 13.

OTHER

Q31. For any other bird control methods used please give information about their costs. Include figures such as those mentioned during the questionnaire. For example, price paid, hours of labour involved, and maintenance costs. A table is provided on the next page, for you to record this information in. Additional paper may be used if necessary.

YOUR GUESSED ANSWERS TO THE FOLLOWING TWO QUESTIONS WOULD BE VALUABLE.

Q32. What percentage of the total crop is **still** eaten and damaged by birds, even though the vineyard employs bird control measures?

Q33. What percentage of the total crop would be eaten and damaged by birds if you **did not** employ bird control measures?

Q34. Would you like us to send you a summary of the results of this survey?

Please circle one: YES NO

THANK YOU VERY MUCH FOR TAKING THE TIME TO COMPLETE THIS SURVEY.