Evaluation and measurement of consumer preferences for outdoor ornamental plants

A thesis presented in partial fulfilment of the requirements for the degree of Doctor of Philosophy in Marketing at Massey University, Palmerston North, New Zealand

Wilmien Brascamp

July, 1996

ABSTRACT

For the New Zealand nursery industry to survive in an increasingly competitive environment, it is vital to cater effectively for its customers. One of the major factors complicating the required shift towards a consumer oriented industry, is a lack of information on consumer attitudes towards, and perceptions of nursery products. The current study was aimed at contributing to the future of the industry by enhancing knowledge and understanding of the consumer market for nursery products.

Data on perceptions of outdoor ornamental plants were obtained through personal interviews with garden centre customers in three major areas within New Zealand. Compared to the New Zealand population in general, the sample of garden centre customers interviewed, included higher percentages of females, home owners, of families living without dependent children at home, and of people between the ages of 45 and 65 years of age.

Interviews were structured according to a fractional factorial design that allowed for uncorrelated estimation of eight plant factors and selected interactions.

Of the plant characteristics included in the study, health was the main consideration to respondents when selecting a plant for purchase. The suitability of a plant for the growing conditions in the respondent's garden ranked second in importance, and was followed by plant shape and bushiness. Price and final height were the fifth and sixth most important factors respectively in determining the attractiveness of plants to respondents. Leaf and flower colours had a statistically significant effect on consumer evaluations, but contributed little to the ability to predict the responses from treatment variables.

The effects of price on the perceived attractiveness of a plant depended upon its health status, suitability for the respondent's garden, and on its final height and shape. The effect of the interaction between shape and bushiness was also found to be of statistically significance.

Healthy, cheap plants were preferred over highly or averagely priced plants with an average or poor health status. The nature of the interaction between price and health indicated that respondents were more likely to pay the difference between a medium and a high price level for healthy plants than they were for a plant with an average or poor health status.

Where cheap plants were concerned, respondents paid more attention to the suitability of such plants for the growing conditions in their garden than they did for more expensive plants. For averagely priced plants, garden centre customers interviewed expressed a preference for plants reaching a final height of 1-2m. At lower or higher price levels they preferred plants growing up to 1m. Plants with an expected height of over 2m were the least attractive to respondents. A well-balanced shape was particularly important for cheap and expensive plants and for bushy plants.

Based on the findings, recommendations were formulated to facilitate an alignment between the quality of plants offered for sale at garden centres and desires of the customers.

Plant evaluations depended upon several respondent characteristics. Judgements of different health levels varied with the age of the respondent's house, and his or her marital status. Attractiveness ratings for plants differing in their suitability for intended growing conditions depended on the respondent's income level. Emphasis placed on the mature height and the shape of plants varied with the size of the respondent's section. Keen gardeners attached greater importance to a symmetrical shape than did others.

Regional differences were observed between respondent opinions about price, health, suitability, and shape. Whilst garden centre customers interviewed in Wellington appeared to be mainly concerned with the two most important factors, namely 'plant health', and 'suitability', respondents in Palmerston North and Auckland paid relatively more attention to the remaining factors.

Interactions between respondent characteristics and plant factors not only had implications for current production and retail practices, but also gave an insight into potential effects on plant perceptions of a change in consumer market composition.

From the synthesis of results and observations, several methodology related issues emerged. Limitations and caveats were addressed for the benefit of future research into consumer perceptions of horticultural products and/or services.

ACKNOWLEDGEMENTS

I wish to express my sincere thanks to my chief supervisor, Professor N.E. Marr, for his guidance and advice. Particularly his confidence in my abilities and the positive way in which he provided me with feedback on progress have been of great encouragement.

Funding for this project was gratefully received from the Massey University Agricultural Research Foundation and the Massey University Research Fund.

My thanks also go to:

Professor E.W. Hewett for his constructive criticism of the draft thesis,

Professor D.J. Chalmers who encouraged me to undertake this project,

Mr. G.C. Arnold for his help with the statistical part of my study,

the garden centre managers for their cooperation,

the majority of respondents who made the field work for my study very interesting and enjoyable, and

my family, friends, and colleagues, without whom I would have felt even more isolated.

I am most grateful to two special people. Time spent with my daughter Hermaleigh was the most wonderful distraction I could have wished for. Mummy has finally completed her 'very difficult puzzle'. My mother, who gave up so much to support me when I needed it most, spent the last six months making sure I would continue, and being a 'real' mama and oma.

Voor mijn vader, door wiens liefde voor de natuur en tuinbouw
ik werd aangemoedigd tot de eerste stap in deze richting

CONTENTS

Page

Abstract ii

Acknowledgements iv

Contents vi

List of Figures x

List of Tables xii

1. Introduction 1

1.1 Introduction 1
1.2 The New Zealand nursery industry 2
1.3 Objectives 9
1.4 Development of the chapters 10

2. The consumer market for nursery products and services - A review of extant literature 12

2.1 Introduction 12
2.2 Landscaper and retailer perceptions of nursery products and services 13
2.3 Target markets for, and consumer perceptions of, nursery products and services 18
2.4 Consumer perceptions of specific groups of woody ornamentals 20
2.5 Summary of consumer evaluation studies relating to nursery products and services 26

Page

3. Quantifying evaluative criteria reviewed within the context of consumer behaviour - A review of extant literature 28

3.1 Introduction 28
3.2 An overview of consumer behaviour theories 29
3.3 Evaluation of alternatives 40
3.4 Conjoint measurement 46
3.4.1 Introduction 46
3.4.2 Determination of attributes and specification of levels 48
3.4.3 Selection of the model 51
3.4.4 Data collection methods 55
3.4.5 Reliability and validity of conjoint measurement 59
3.5 Summary 66

4. Elicitation of relevant attributes 68

4.1 Introduction 68
4.2 Objective of the elicitation procedure 68
4.3 Method of eliciting relevant attributes 69
4.4 Results of elicitation interviews with garden centre customers 73
4.5 Results of elicitation interviews with producers and retailers 78
4.6 Comparison of customers' opinions with those of producers and retailers 82
4.7 Specification of relevant attributes and their levels 83
4.8 Concluding remarks about the elicitation phase 85

5. Questionnaire design and interviewing method 88

5.1 Introduction 88
5.2 Conjoint questionnaire design 88
5.2.1 Introduction to fractional factorial designs with confounding 89
5.2.2 Factorial experiments 93
5.2.3 Fractional replication of asymmetrical factorial experiments 99
5.2.4 Confounding within fractions of factorial experiments 110
5.2.5 Specification of the design and method of interviewing 116
5.2.6 Stimulus representation 118
5.3 The self-explicated part of the questionnaire 125
5.4 The socioeconomic part of the questionnaire 127

Page

6. Evaluation of ornamental plants as affected by plant factors	128
6.1 Introduction	128
6.2 Introduction to the analysis of variance of conjoint data	128
6.3 Analysis of variance for profile ratings	135
6.3.1 Introduction	135
6.3.2 Analysis of variance	138
6.4 Estimated effects of plant factors having specified levels	142
6.4.1 Introduction	142
6.4.2 Calculation of estimated effects and treatment yields	143
6.4.3 Discussion of effects of plant factors and interactions	148
6.5 Self-explicated phase: rankings of factor levels	156
6.6 Relative importances of significant effects and interactions	158
7. Evaluation of ornamental plants as affected by interactions between plant factors and respondent characteristics	167
7.1 Introduction	167
7.2 Characteristics of garden centre customers	170
7.3 Analysis of variance incorporating characteristics of respondents	175
7.4 Interactions between respondent characteristics and plant factors	182
7.5 Summary: interactions between respondent characteristics and plant factors	195
7.6 Analysis of variance for profile ratings in each of three areas	202
8. Conclusions and implications	210
8.1 Introduction	210
8.2 Elicitation of attributes relevant to garden centre customers	211
8.3 Questionnaire design and interviewing method	214
8.4 Evaluation of ornamental plants as affected by plant factors	216
8.5 Interactions between plant and respondent factors	222
8.6 Evaluation of methodologies	225
8.7 Concluding remarks	232

Page

References 233

Appendices 250

Page

LIST OF FIGURES

Figure 1.1	Total average weekly household income and expenditure	1
Figure 1.2	Yearly household expenditure on garden products, green goods, trees, shrubs and bushes	6
Figure 2.1	Distribution channel map for the nursery consumer market	12
Figure 3.1	Black box model of consumer behaviour	30
Figure 3.2	The Nicosia model of consumer behaviour	32
Figure 3.3	Simplified version of the Howard-Sheth model of consumer behaviour	33
Figure 3.4	Output stages of the Howard-Sheth model of consumer behaviour	34
Figure 3.5	Stages in the consumer decision process suggested by Dewey	36
Figure 3.6	Alternative evaluation in the Engel, Blackwell and Miniard model	37
Figure 3.7	Flow chart for a conjoint measurement study	48
Figure 5.1	Profile card for treatment combination $a_1b_2c_2d_1e_0f_0g_1h_0$	124
Figure 6.1	Estimated effects on ratings, of health at different price levels	150
Figure 6.2	Estimated effects on ratings, of suitability at different price levels	151
Figure 6.3	Estimated effects on ratings, of final height at different price levels	152
Figure 6.4	Estimated effects on ratings, of shape at different price levels	153
Figure 6.5	Estimated effects on ratings, of bushiness at different shape levels	154
Figure 7.1	Estimated effects of the interaction between health and marital status	183
Figure 7.2	Estimated effects of the interaction between price and respondent's age	184
Figure 7.3	Estimated effects of the interaction between health and age of house	185
Figure 7.4	Estimated effects of the interactions between final height and section size	186
Figure 7.5	Estimated effects of the interaction between shape and section size	187

Page

Figure 7.6	Estimated effects of the interaction between suitability and income	188
Figure 7.7	Estimated effects of the interaction between shape and time spent on gardening	189
Figure 7.8	Estimated effects of the interaction between price and area	190
Figure 7.9	Estimated effects of the interaction between health and area	191
Figure 7.10	Estimated effects of the interaction between suitability and area	192
Figure 7.11	Estimated effects of the interaction between final height and area	193
Figure 7.12	Estimated effects of the interaction between shape and area	194
Figure 7.13	Palmerston North respondents: estimated effects on ratings, of health at different price levels	204
Figure 7.14	Wellington respondents: estimated effects on ratings, of shape at different price levels	205

LIST OF TABLES

Table 4.1	Elicitation survey: answers of a hypothetical respondent	72
Table 4.2	Factors elicited in Palmerston North (PN) and Auckland (AKL)	74
Table 4.3	% of respondents ranking factors as most, second most, or third most important	75
Table 4.4	Factors elicited from retailers and producers	79
Table 4.5	% of retailers and producers ranking factors as most, second most, or third most important	80
Table 4.6	Factors and levels selected for further study	84
Table 5.1	Degrees of freedom (Df) for a 3^4x2^4 experiment	92
Table 5.2	Treatment combinations of a 3^3 experiment with factors *a*, *b*, and *c*	93
Table 5.3	Linear effects of factor *a* for a 3^3 experiment with factors *a*, *b*, and *c*	95
Table 5.4	Effects involving factor *a* for a 3^3 experiment with factors *a*, *b*, and *c*	95
Table 5.5	Degrees of freedom for effects and interactions of a 3^3 experiment	96
Table 5.6	Representation of effects and interactions of a 3^3 design	97
Table 5.7	Fraction of a 3^4 experiment based on $x_1 = 0$ (modulo 3)	101
Table 5.8	Effects and interactions of a 3^3 experiment	103
Table 5.9	Development of a 1/3 fraction for a 3^4 factorial experiment	104
Table 5.10	Treatment combinations for a 1/3 fraction of a 3^5 experiment	105
Table 5.11	Treatment combinations for a 1/3 fraction of a 3^5 experiment	107
Table 5.12	2^3 experiment with two replicates, in four blocks of two	111
Table 5.13	Relative information given by a 2^3 system in blocks of two	112
Table 5.14	Replicate I: treatment combinations $a_ib_jc_k$ in nine blocks	114
Table 5.15	Relative information given by a 3^3 system in blocks of three	115
Table 5.16	Treatment combinations for factors *a*,*b*,*c*,*d*,*e'*, and *e* in nine blocks	115
Table 5.17	Treatment combinations $a_jb_jc_kd_le_mf_ng_oh_p$ in eight blocks (replicates I, II)	116
Table 5.18	Factors and levels selected for the conjoint questionnaire	118

		Page
Table 6.1	Hypothetical ratings for profiles defined on factors *s* and *t* with levels i and j respectively	129
Table 6.2	Description of factors selected for the conjoint questionnaire	132
Table 6.3	Effects and interactions significant at $p<0.05$	139
Table 6.4	Effects and interactions as deviations from the overall mean $\mu=3.343$	144
Table 6.5	Profiles with estimated ratings of 6.5 or higher	147
Table 6.6	Effects and interactions as deviations from the overall mean $\mu=3.343$	149
Table 6.7	Self-explicated phase: most preferred and least preferred levels of plant factors	157
Table 6.8	Estimated Hays' omega squared for effects and interactions	161
Table 6.9	% of respondents ranking factors as 1 or 2 in the self-explicated part	164
Table 7.1	Demographic and socioeconomic factors and their respective levels	170
Table 7.2	Demographic and socioeconomic factors: frequency distribution (%)	172
Table 7.3	Significance of effects and interactions at $p<0.01$	178
Table 7.4	Significant interactions between respondent characteristics and plant factors ($p<0.01$)	182
Table 7.5	Relevant interactions between respondent characteristics and plant factors	195
Table 7.6	Summary of analysis of variance results for each of three areas	203
Table 7.7	Relative importance of effects and interactions in each of three areas	207

1. INTRODUCTION

1.1 Introduction

Since the late eighties, New Zealand garden centres have been facing increasing competition from mass merchandisers entering the garden market (Anon., 1994a). At the same time, the New Zealand nursery industry as a whole was confronted more than ever with the fact that purchasing plants and services for gardening is not the only way in which consumers spend their discretionary income.

As illustrated in Figure 1.1, the average weekly incomes of New Zealand households have more or less stagnated during the early nineties (Anon., 1995a).

Figure 1.1 Total average weekly household income and expenditure (Anon., 1995a)

As a result, average weekly household expenditures no longer followed an upward trend from year to year. Skeggs (1993) stated that the garden industry tends to be affected later in a recessionary cycle than many others, such as the travel, white goods, and motor vehicle industries, and that warning signs were already apparent.

The key to outperforming competition lies in doing a better job of meeting and satisfying customer needs (Kotler, 1994). In shortage economies, there is no need for sellers to spend extra effort to please customers. In buyer markets however, retailers must deliver quality products or they will lose customers to competitors. Meeting customers' demands is only possible when their desires are known. Knowledge about customers and their behaviour is therefore an essential attribute of successful industries (Engel et al., 1978). Francese and Piirto (1990) stated that the nineteen nineties are characterised by the fact that customer knowledge is market place power, and that if a business doesn't know its customers, the competitors probably will. Today's consumers can choose from a large array of products and services, and are much more educated and demanding than they used to be (Kotler, 1994).

Thus, the most crucial issue facing the New Zealand nursery industry today, is making the shift towards a truly customer-focused industry. A prerequisite for becoming consumer-oriented, is acknowledging the importance of knowledge about the target market. Conference speakers invited by the New Zealand Nurserymen's Association, such as Kepner (1990a and b) and Saunders (1992), have helped to create a climate favourable for receptiveness of nursery industry members to consumer behavioural studies. Currently, limited information is available on consumers of, and their behaviour towards, nursery products and services. Lack of this type of information, coupled with a long-standing underestimation by growers and retailers of its relevance to business success, is at least partly, if not mainly, responsible for the relatively slow growth of the nursery industry (Anon., 1995c) during the last decade.

1.2 The New Zealand nursery industry

In New Zealand, the nursery plant commodity group includes woody perennials, herbaceous perennials, biennials, and annuals, for outdoor or indoor use.

Woody perennials may have a single trunk, in which case they are commonly referred to as trees. Shrubs can be defined as woody perennials without a single trunk. Herbaceous perennials are non-woody plants that have the potential to live longer than two years. Common usage of the term 'herbaceous perennial' is often associated with plants of which the above ground parts die down in autumn and reappear in spring, but in relatively mild climates such as that of New Zealand, many herbaceous perennials fully persist during winter. Annuals complete their life cycle in one year, whereas biennials require two years to complete their life cycle.

Nursery products include bedding plants, i.e. plants which are intended for 'bedding' out for a limited time of the year. These are generally sold as seedlings of vegetable or ornamental plants. An ornamental plant is defined as any plant that is grown primarily for beautification purposes as opposed to one grown mainly for production of edible fruit or other plant parts. Thus, the distinction between ornamental and other plants lies in the relative importances of their intended purposes.

Prior to the nineteen sixties, nursery plants were sold mainly by mail order and transported by rail (Anon., 1994a). The first garden centres were established during the late fifties and the early sixties (Cameron, 1996). Since then, garden centres have gradually become major retail outlets for nursery plants. In recent years, garden centres have lost part of their market share to large retailers, such as supermarkets, and department stores.

Ninety eight percent of respondents in a mail survey conducted by Bourke and West in 1976 and repeated by West in 1980, bought their trees and shrubs from garden centres and/or nurseries (Bourke and West, 1976; West, 1980). Hardware stores, supermarkets, department stores, mail order companies, and wholesalers, each served as the major outlet for trees and shrubs for only 1% or less of the respondents. Also for green goods other than trees and shrubs, such as house plants, vegetable and flower plants, bulbs and seeds, garden centres and/or nurseries were the major sources of supply for most respondents.

'Quality of merchandise' and 'the selection available' belonged to the two main factors of importance to 29% and 24% of respondents respectively, when selecting a retail outlet for plants and garden requirements. Seventeen percent of respondents considered the service offered by a retailer as one of the two most important factors, whereas 14% mentioned price. Only 26% of respondents bought garden tools and hardware from garden centres rather than from other outlets. Approximately 60% of people surveyed usually went to hardware stores to purchase tools and garden ornaments. Ten percent of respondents relied on department stores for their requirements for garden tools and ornaments (Bourke and West, 1976; West, 1980).

In 1989, garden centres had a share of about 65% of the total garden market (Anon., 1994a). During the early nineties, Mitre 10 and supermarket sales accounted for 21% of the total business, while the garden centre share was down to less than 50%. Since 1990, the garden market share of supermarkets, hardware and department stores has continued to grow, while the garden centres' share has shrunk even further (Anon., 1994a; Edwards, 1994). A large proportion of the shift in the type of retail outlet may be due to an increase in the use of suppliers other than garden centres for 'dry' gardening goods. However, this shift is likely to exert an influence on the frequency with which these other retail outlets are used as a sources for green goods. The more players entering a market, the higher the competition amongst them. The increasing competition has placed new demands on both retailers and growers of nursery crops.

The ability of chainstores and supermarkets to offer green goods at low prices is generally perceived as the main instrument in their quest for a larger slice of the action (Edwards, 1994). Traditional grocery markups of 15% to 25% are far below those the garden centre trade has enjoyed. Suggested retail markups of 130% to 150% in 1993 were disputed by the chief executive of Palmers' garden centres, New Zealand's leading garden centre chain (Anon., 1993). According to him, 20% of green goods offered by Palmers' garden centres, was sold at 70% to 75% markup, with the majority of their stock being retailed at 50% to 55% markup. Only 25% to 30% was sold at 90-100% markup. These figures are lower than those suggested for the overall garden centre trade by Edwards, who stated in 1994 that dry goods were sold at 60% plus markups, and that until recently markups for green goods were 100% or more (Edwards, 1994). Thus, although it seems unclear what the exact markups in the garden centre trade are, there is no doubt about the fact that they are higher than grocery markups.

Does the key to survival for garden centres, and for the nursery industry at large, in this increasingly competitive environment really lie in lowering the prices of goods offered for sale?

According to Saunders (1992), the effect of price on perceived quality of nursery products is overestimated. He stated that most consumers are interested in value rather than price, and suggested that this is the issue with which the nursery industry has to come to terms. Edwards (1994) also believed that pricing is overemphasised. He related the commonly heard comment that garden centres are expensive, to the fact that customers impulse-buy, purchase more than they intended, and thus spend more than they planned.

Rather than focusing on the strength of large retail outlets in the form of low markups, Edwards (1994) stressed the importance of their weaknesses in maintaining quality of green goods. Most large suppliers, such as Foodtown and Woolworths, have artificially lit, air-conditioned, plant-unfriendly conditions. In many cases, plant-ageing is further accelerated by the plant department's proximity to ethylene-emitting produce, such as ripening fruit. Ethylene is generally recognised as a hormone that is produced by plant materials, especially by fleshy fruits, and that stimulates a series of processes which collectively come under the heading of plant maturation, senescence, and/or stress (Leshem et al., 1986; Moore, 1989; Mattoo and Suttle, 1994). Of the large supermarkets only stores with an excellent stock keeper or a garden-oriented manager score good sales figures. It took years before the presence of Foodtown was felt by the garden market.

Garden centres are generally better equipped to maintain quality than are supermarkets. Edwards (1994) believed that for their survival, garden centres should focus on quality maintenance. This would place them in a better position, not only to compete with supermarkets and chainstores, but also to benefit from spin-offs resulting from the promotion by large retailers of plants and gardening to the masses. The latter could lead to an increase in the relatively low level of expenditure by the public on gardening goods. Hicks (1994) commented on the potential benefits of mass merchandising on the American nursery industry. Like Edwards (1994), he also believed that retail giants with their large advertising budgets can reach more potential gardeners than ever before. Once interested in plants and gardening, people will demand a wider selection of merchandise than that generally offered by large retailers. This demand will lead new customers to garden centres, and increase average household expenditure on garden products.

Bourke and West (1976) and West (1980) used estimated costs of previous years' purchases by respondents to calculate the average expenditure per household on items belonging to one of six categories, four of which were comprised of green goods, i.e. plants. Results suggested a large increase in 1979 in annual expenditure per household compared to 1975 in most product categories. The average amount spent by respondents on house plants had increased by 65%. In 1979, 31% more was spent on bulbs and seeds than four years earlier. Expenditures on trees and shrubs, and on vegetable and/or flower plants had increased by 40% and 64% respectively, since the first survey conducted by Bourke and West (1976). Average amounts spent by households in 1979 on dry goods, such as chemicals, garden tools and furniture, were 65% higher than they were in 1975.

Despite these increases in amounts spent on garden products, overall average expenditure per household remained low. From 1976 to 1980 the consumer price index increased by 65.4%. Thus, for most garden product categories, consumer expenditure barely kept pace with inflation.

Regularity of purchase also remained low. Vegetable plants were bought on the most regular basis, followed by flower plants. Of respondents to the 1980 survey, 50% often purchased vegetable plants for their garden, and 36% frequently bought flower plants (West, 1980). Only 23% of respondents in 1976, and 21% in 1976 often purchased trees and shrubs (Bourke and West, 1976; West, 1980). Percentages of respondents making frequent purchases of products in the remaining green goods categories were less than 20% for both surveys (Bourke and West, 1976; West, 1980).

West (1980) concluded that the lack of change since 1976 in most aspects investigated in the study suggests that the New Zealand Nurserymen's Association should undertake development planning to stimulate expenditure, or move the industry in a particular direction.

Since 1980 the nursery industry has expanded, but according to Wynyard, development officer of the New Zealand Nursery and Garden Industry Association, growth has been much less than for others which have multiplied fivefold in the time gardening turnover has doubled (Anon., 1995c).

As illustrated in Figure 1.2, household expenditure on gardening at retail level increased from $128 million in 1987 to $225 million in 1995 (Anon., 1995b).

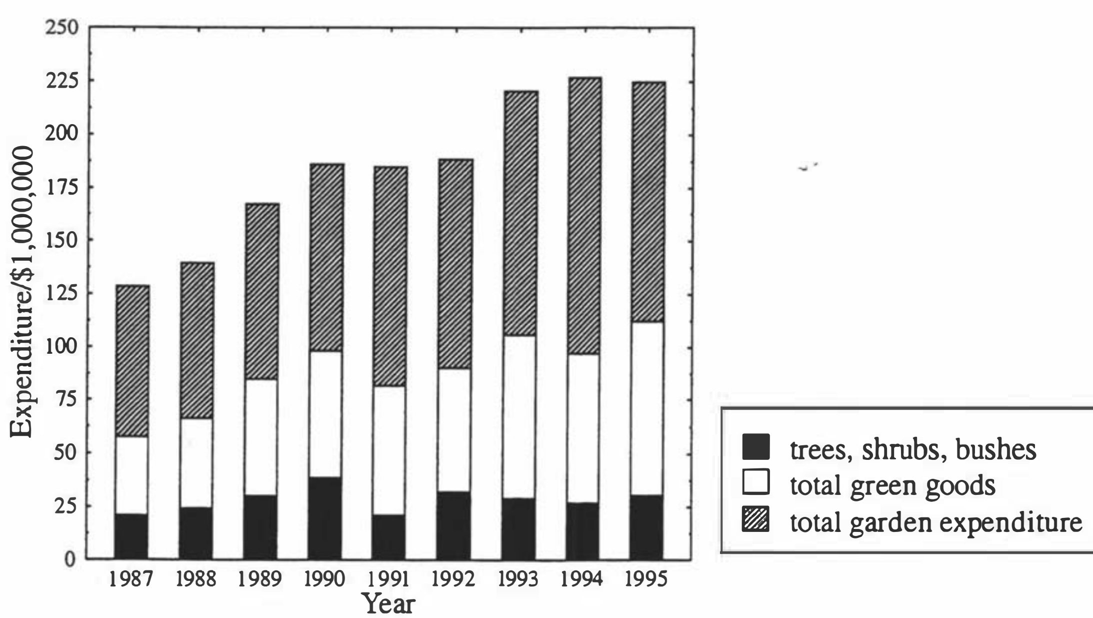

Figure 1.2 Yearly household expenditure on garden products, green goods, and trees, shrubs and bushes (Anon., 1995b)

Comparison of Figures 1.1 and 1.2 indicates that from 1987 to 1993, yearly household expenditure on garden products increased from approximately 0.5% to 0.7% of the total yearly household expenditure. In 1994 and 1995, costs of garden product purchases per household remained at a level of 0.7% of total household expenses.

Amounts spent on green goods as a percentage of total garden expenditure, have increased from 45% in 1987, to 50% in 1995. Purchase expenses of trees, shrubs, and bushes has decreased from 36% of total green goods expenditure in 1987 to 27% in 1995. Pot and indoor plant consumption in 1995 was lower than in 1987, while since 1990, purchase expenses of outdoor plants other than trees, shrubs, and bushes, has increased to 65% of total expenditure on green goods in 1995. Thus, during the last five years, consumption of outdoor plants, such as herbaceous perennials and bedding plants, has risen at the expense of indoor plants, and outdoor trees, shrubs, and bushes.

Wynyard believed that the relatively low growth figures for the nursery industry are largely due to the fact that many members of the industry regard marketing as no more than an equivalent of selling through promotion (Anon., 1995c). These industry members tend to follow the selling concept, which Kotler (1994) described as an approach aimed at selling what is produced, rather than at producing what the market wants.

From the late eighties, marketing and planning have been emphasised by many conference speakers invited by the New Zealand Nurserymen's Association, but according to Wynyard the industry has not acted on their advice (Anon., 1995c). During the nineties a growing awareness of the need for marketing research emerged within the New Zealand Nurserymen's Association. As Toombs and Bailey (1995) pointed out, the importance of knowledge about consumers and thus about consumer behavioural studies, first needs to be acknowledged. Subsequently, in order to succeed in an increasingly competitive environment, consumer oriented research needs to be followed up by application of its findings. The importance of a more consumer oriented attitude of nurserymen was stressed again during the New Zealand Nursery and Garden Industry Association mid-year meetings in 1995, which were themed 'Meeting the consumer's demand'.

'Meeting the consumer's demand' may be understood as equivalent to 'providing the consumer with the quality of service and products s/he desires'. Drucker (1974) stated that the aim of marketing is to make selling superfluous, and to know and understand the customer so well that the product or service fits him or her and sells itself. This statement is an expression of the marketing concept, which has challenged the selling concept since the mid-1950s. The distinction between both approaches, is that the marketing concept focuses on the needs and wants of the buyer, whereas the selling concept emphasises the needs and desires of the seller (Kotler, 1994). Kotler also argued that companies can confront their competition better if they move to the marketing concept approach, and as such become consumer-oriented.

A first priority of customer-oriented companies, is to retain existing customers. Whereas classic marketing theory and practice have emphasised the attraction of new customers, today more companies recognise the importance of retaining current customers. The costs of persuading current customers to make an additional purchase are much lower than those required to solicit new customers (Kotler, 1994). According to Reichheld and Sasser (1990), companies can improve profits anywhere from 25% to 85% by reducing customer defections by 5%.

Improvement of what is offered to current customers of garden centres may be regarded as the first step in a process that should eventually lead to the attraction of a larger number of customers. For the latter part of this process, individual plants are irrelevant. To promote gardening and therefore increase the number of people making up the gardening public, the nursery industry must start to sell the atmospherics of specific garden themes, such native or scented gardens (Stanley, 1990). His ideas are similar to those expressed by Behe (1993), who believed that consumer education programs based on an understanding of current and potential consumers' wants and needs in terms of overall garden experience, are essential to create a larger market for gardening products. To maintain satisfied customers and to increase purchase frequencies by existing customers, the nursery industry must focus on the perceived quality of its offerings.

The increasing competition, both internally within the nursery industry, as well as externally with other industries, has forced growers and retailers into a more professional approach (Anon., 1993; Anon., 1994a). Prior to 1985, wholesalers grew what they liked, in sizes they liked, and at a time they liked (Anon., 1994a). Since then growers have become confronted with the necessity to pay attention to quality issues. Quality maintenance in retail outlets is only possible when products are of high standard to start of with.

One of the major problems faced by growers and retailers in their endeavours to improve and maintain quality, is that definitions of quality are not substantiated by factual evidence. Whatever growers and retailers regard as part of quality, it must be in line with what the users of their products, i.e. customers, perceive as quality.
Also, the consumer market for nursery goods does not necessarily remain static, but its composition and the quality perceptions of its members may change over time. Chisholm (1995) reported that in 1995, people of 50 years and over no longer represented the largest group within the consumer market for gardening products. She

believed that when opportunities for investment were restricted by the sharemarket crash of the late eighties, 30 to 40 year old homeowners became increasingly interested in gardening because they realised that gardening was not only a healthy hobby, but could also increase street appeal and market value of their property. These people between 30 and 40 years of age were responsible for changing the face of garden centres to convenience-based retail outlets, rather than suppliers of goods required by customers who regard gardening as a task. According to the chief executive of New Zealand's leading garden centre chain, who was quoted by Chisholm, retailers and producers must change to meet changing demands of the consumer market.

1.3 Objectives

The goal of the current study was to provide growers and retailers with information that facilitates quality improvement of products they deliver to garden centre customers. For plant breeders and researchers, especially those involved in the development of new outdoor ornamentals, the study was aimed at providing guidelines for prioritising research topics in terms of desires of the end user.

Based on literature about peoples' perceptions of nursery products and services, and about consumer purchasing behaviour which is reviewed in Chapters 2 and 3 respectively, several hypotheses and assumptions were specified prior to the formulation of objectives for the current study.

Firstly, it was hypothesised that perceived quality of nursery plants is a function of consumers' attitudes towards selected plant attributes, such as health status and/or price. Consumers were presumed to be able to verbalise which product features they consider when purchasing nursery plants, and to give an overall evaluation of the attractiveness of plants offered for sale. However, it was not assumed that consumers can indicate how their attitudes towards separate product features combine into such an overall judgement. Rather, relative effects of product attributes in determining appreciation for nursery plants were believed to be quantifiable indirectly from consumers' overall evaluations of plants differing from each other in the extent to which they possess the attributes concerned.

It was also postulated that attitudes towards plant attributes vary with personal characteristics of consumers, such as income and/or age.

To achieve the goals specified, the following objectives were formulated:

1. to identify plant attributes that influence garden centre customers' appreciation for a pre-specified group of ornamental woody plants,

2. to quantify relative importances to garden centre customers of plant attributes thus identified, and

3. to investigate possible interactions between selected socioeconomic and demographic characteristics of garden centre customers and their perceptions of plant attributes identified.

Motivated by the possibility that the plant group consisting of woody ornamentals was too diverse to use for eliciting any other than very general responses about desired plant attributes, homogeneity within the product category under study was further increased by focusing on evergreen, flowering, ornamental shrubs for outdoor use only. An evergreen plant does not lose its leaves at the end of the growing season, but remains 'green'. The term 'flowering' in the product definition implied that flowers contributed to the attraction of the plants. This excluded evergreen shrubs which were mainly grown for their foliage or ornamental fruit. Flowering shrubs were selected instead of non-flowering plants, because the presence of flowers on plants was found to be the most important consideration to New Zealanders when purchasing evergreen shrubs (Vink, 1989).

Unless stated otherwise, the term 'garden centre customer' or 'garden centre consumer' is used throughout this thesis to describe a person who has been to a garden centre at least once, regardless of whether or not the visit resulted in a purchase.

1.4 Development of the chapters

To prioritise research topics, it was essential to first make an inventory of information currently available. A review of extant literature on the consumer market for nursery products and services is presented in Chapter 2.

Gaps were apparent particularly in the area concerned with evaluation of alternatives by garden centre customers, which is one of the stages in the process termed 'buying behaviour'. In Chapter 3, an overview is given of theories proposed to explain consumer buying behaviour, followed by a discussion of models suggested to depict the evaluation stage. Measurement of evaluative criteria is described with special reference to the technique selected to quantify the relative importances of attributes of the product group under study.

Data for the current study were collected through personal interviews with garden centre customers. Elicitation interviews were required to determine which attributes to include in further study. In Chapter 4, the method used to elicit the relevant attributes, and results of the elicitation interviews are described.

A subsequent survey was conducted to quantify relative importances of the relevant attributes and to investigate relationships between socioeconomic characteristics of garden centre customers and perceived importance of plant attributes. Most of Chapter 5 is devoted to the development of the design for this survey. In the remaining sections of Chapter 5, the structures of the self-explicated and the socioeconomic parts of the questionnaire are described.

In Chapter 6, results of the major survey are analysed and discussed without reference to relationships between perceptions of ornamental plants and personal characteristics of respondents. The latter are incorporated in the presentation and discussion of results in Chapter 7.

Conclusions and implications of results are documented in Chapter 8, which also includes recommendations for further research suggested by outcomes of the present study.

2. THE CONSUMER MARKET FOR NURSERY PRODUCTS AND SERVICES - A REVIEW OF EXTANT LITERATURE

2.1 Introduction

Retail customers represent the majority of end-users, i.e. the consumers, of nursery products and services. The reseller market consists of retail outlets, such as garden centres and mass merchandisers. Horticultural professionalists and businesses, landscapers, as well as city councils are part of the industrial market. A simplified channel map for nursery products and services is presented in Figure 2.1. The channel

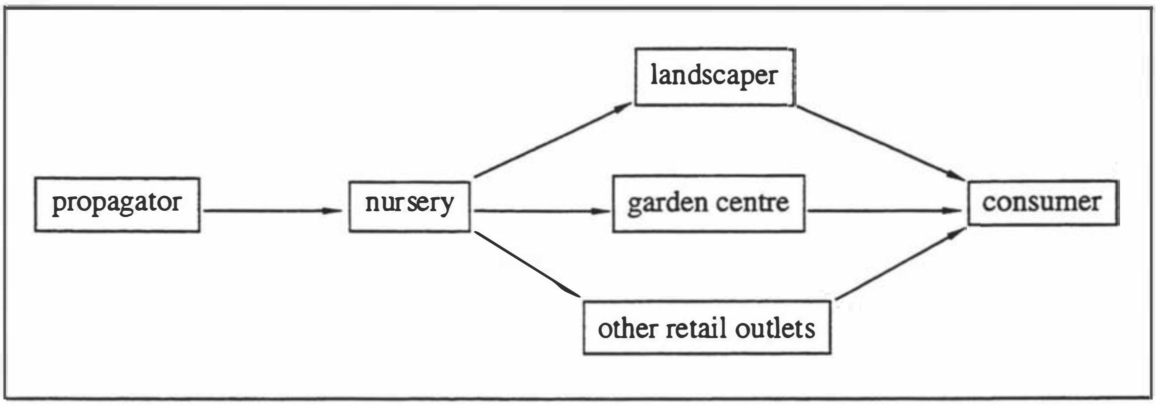

Figure 2.1 Distribution channel map for the nursery consumer market

map is simplified in that only the most important routes are indicated, and the relative importance of each channel is not specified. For example, many nurseries in New Zealand propagate their own plant material, and may purchase only relatively small quantities of growing-on plants or none at all from companies specialised in propagation.

It was postulated that landscapers, garden centres, and other retail outlets differ in their requirements for, and perceptions of, what is made available by nurseries. Preferably these needs and opinions should line up with the desires of their respective customers.

In the following sections, an overview is presented of information published to date on consumers of, and their attitudes towards, nursery products and services. On an international scale, research on consumer appreciation and perception of horticultural products and services has been conducted predominantly in the United States of America. Here, the greenhouse and nursery crops commodity group includes turf grass, bedding plants, cut flowers and greens, foliage and flowering plants, flower and vegetable seeds, bulbs, greenhouse vegetables, and other nursery and greenhouse products. In spite of the growing importance of this commodity group, even in the United States of America, little empirical work has been done to assess product and service attributes important to the consumer market. In the final section, commonalities between retailer, landscaper, and customer perceptions are summarised.

2.2 Landscaper and retailer perceptions of nursery products and services

Landscapers not only have direct impact on sales at retail outlets by buying products for their clients, or by advising their clients what to purchase, but they may also indirectly influence demand for nursery products and services. This would occur when consumers observe plants in highly visible commercial projects and subsequently request the same plants from their local garden centre or other outlet.

In 1980, only 2% of respondents surveyed in New Zealand by West (1980), indicated that they obtained information about what to buy from a professional landscaper. Advice at the place of sales was the most important source of information to 40% respondents, whereas 29% of respondents used books or newspaper articles. While direct influences of landscapers on customer sales in New Zealand have been limited in the past, this is not necessarily the case nowadays. Future monitoring of both direct and indirect impacts of landscapers on consumer demands for nursery plants may be needed for growers to develop appropriate marketing strategies.

In Georgia, landscape architects play an important indirect role in determining demand

for plants, and are also directly involved through specifying plant choices for commercial, government, and private landscape projects (Garber and Bondari, 1992a). The total value of plant material purchased or specified by landscape architects in 1990, was estimated to be equal to approximately 43% of the wholesale value of landscape plants produced in Georgia. Relatively few firms, namely 21% of landscape architectural businesses responding to the survey conducted by Garber and Bondari (1992a), accounted for 67% of plant material specified by respondents.
The need for growers in Georgia to treat landscapers as important customers became even more apparent when Garber and Bondari (1992b) demonstrated that landscapers also exert a significant influence on the choice of production nursery. Approximately 61% of responding landscape architectural firms, indicated that they determine, or at least recommend the source for plants specified in their landscape projects.
Plant quality was the most important consideration in selecting a production nursery, followed by the availability of plants in desired sizes. Availability of required varieties was the third most important consideration. Importance of these factors varied with size of the landscape architectural firm. Plant quality was significantly more important in the decision making process of large firms than it was for small firms. Medium sized firms rated the importance of availability of plants in desired sizes significantly higher than did large or small firms. The importance of price increased with size of the firm.

Most studies aimed at providing information to growers about their primary customers, were focused on product and service perceptions of retailers and/or landscapers, rather than on quantifying their respective importances as customers.

Gineo (1989) studied effects of several plant and service related factors on Connecticut landscapers' and retailers' perceptions of Rhododendrons. Results suggested that plant quality was the most important consideration to buyers. The range of products offered by the seller ranked second in importance. Buyers preferred firms offering a wide variety of plants over those offering little choice. Landscapers' and retailers' perceptions of Rhododendrons were also significantly influenced by the region in Connecticut where the plants were grown. Gineo (1989) showed that effects of price and size on Rhododendron evaluations were only moderately significant. The finding that buyers appeared to prefer paying cash rather than obtaining credit, may be due to an implicit assumption of respondents that discounts would be offered for cash payments. Flower colour, length of delivery time, and container size did not influence perceived overall attractiveness of Rhododendrons.

Makus et al. (1992) analysed survey data from managers of 311 garden centres, landscaping businesses, and combined garden centre/landscaping firms in selected western United States trade centres. Respondents were asked to indicate the importance to them of 35 attributes when purchasing nursery stock. Additional questions were asked to identify the importance of price in respondent purchasing decisions. Almost all product attributes were considered to be important, with a mean response between moderately and very important. 'Plants free of insects and diseases', 'properly dug and handled container or balled and burlapped stock', 'properly dug and handled bare root stock', and 'plants available when needed' were the highest-ranking product characteristics.

Most supplier services under study were also identified as important, but overall they ranked lower in importance than did product attributes (Makus et al., 1992). 'Supplier knowledgeable about plant materials' was perceived as the most important service feature. Price appeared to be a secondary criterion in purchasing decisions. Sixty one percent of respondents would try a new supplier if plants of the same quality were available for a lower price, but 78% were prepared to try a new supplier if higher quality plants were available for the same price. Almost two-thirds of all respondents indicated that previous years' prices paid for nursery stock were about average. Periodic availability of sale-price plants was not very important in purchasing decisions. Approximately 81% of respondents expected only a slight or moderate increase in sales if plant prices were slightly lower.

Makus et al. (1992) examined the possibility that within the sample of responding landscapers and garden centre managers specific segments were present with distinct perceptions of desired attributes for products and services offered by nursery stock sellers. They had hoped to be able to describe such segments in terms of three characteristics, namely size, type, and geographic location of responding businesses. This would assist growers of nursery plants with designing marketing strategies aimed at specific target markets. However, because respondents had similar perceptions about the importance of most product and service attributes associated with purchase of nursery stock, no segments could be specified using all three criteria. Nevertheless, some significant differences were found between attribute importance ratings of respondents from firms differing in one of the three business characteristics.

Attributes such as 'plants free of weeds', 'availability of plants in several sizes', and 'labels explaining plant characteristics', were more important to garden centre managers than they were to landscapers. These differences were attributed to the fact that landscapers select plants for use at a job site, whereas garden centre operators have more direct dealings with the customer.

Because of the greater convenience of individual plant containers for retail customers, and since they generally purchase smaller plants better suited to containers than do customers of landscaping firms, it was not surprising to find that garden centre operators preferred containerised plants over burlapped or balled plants.

Garden centre operators regarded 'shipping costs' as a more important factor than did landscapers and respondents from combined firms. According to Makus et al. (1992) garden centres, in contrast to landscaping firms, are more product-based than service-based. Therefore, garden centre operators are probably more competitive as far as plant prices are concerned than are landscapers. To maintain price competitiveness, costs, such as those incurred by transport of stock to garden centres, need to be controlled.

Makus et al. (1992) believed that landscaping firms, due to their service-based nature, require less advertising and use advertising with a more general focus as opposed to the more specific consumer-focused advertising of garden centres. This could explain why opportunities to share advertising with nursery stock suppliers were rated higher in terms of importance by garden centre operators than they were by respondents from other business types.

'Shipments in time for peak sales' was a more important attribute to landscapers and respondents from combined operations than it was to garden centre managers. Landscapers have to meet deadlines and order plants as needed. In garden centres, large amounts of stock need to be maintained on a continuous basis.

Not only the type of business but also its size influenced importance ratings for some of the attributes selected. Respondents from larger firms placed more emphasis on properly pruned or sheared plants than did respondents representing smaller firms. Expertise to judge the quality of pruning and shearing is more likely to be present within large rather than small firms. Moreover, large business generally hold larger quantities of similar plant materials than do small businesses. Therefore, their operators are in a better position to evaluate pruning and shearing practices than are managers of small businesses.

Plant care instructions were of less importance to respondents from large firms, whereas they placed more importance on availability of a fax number than did respondents from small firms. The finding that willingness to ship small quantities was more important to managers of small firms than it was to other respondents, was related to the limited storage possibilities of small businesses.

Few significant differences were found between respondents from firms belonging to different size or type categories in their answers to the questions asked to identify the importance of price in purchasing decisions. Respondents from combined landscape-garden centre firms were more likely to try a new supplier if higher quality plants were available at the same price. Those from smaller firms expected a large increase in sales if plant prices were slightly lower.

Brett (1995) conducted a survey in New Zealand to examine attitudes of retailers towards services offered by 43 growers of trees and shrubs, perennials, bedding plants, roses, or house plants. Respondents were asked to rate the importance of 16 service aspects, and to rank growers' performance in each of these aspects.

Ninety eight percent of respondents considered the delivery of quality plants to be a very important service. Of all producer groups specified in the survey, house plant growers were perceived as the best performers as far as delivery of quality products was concerned. Forty two percent of respondents believed that producers of indoor plants were very good at offering only products of high standards. Tree and shrub growers received the lowest scores. Only 18% of respondents thought that woody plant producers other than rose growers, only offered plants of good quality.

Timely delivery of promotion stock was perceived as being very important by 98% of respondents. House plant suppliers scored well, and were rated by 52% of respondents as very good in offering promotion stock on time. Perceived performance of other growers was disappointing. Only 34% of respondents believed that tree and shrub growers were very good at delivering promotion stock in time.

The attributes 'quality of products', and 'timely delivery of promotion stock', were followed in importance by 'prompt same-week delivery', 'prompt response to queries', and 'hassle-free prompt credits', which were considered to be very important by 75%, 69%, and 67% of responding retailers respectively. According to 63% of respondents large pictorial labels were very important, but only 50% believed that all plants should be delivered with labels attached. Sixty percent of respondents indicated that availability of product information was essential, and that a Monday to Thursday delivery was highly desirable.

House plant growers were perceived as the best overall performers. Average overall performance of each of the remaining five grower groups specified in the survey, was regarded as very good by less than 30% of responding retailers, suggesting there is much scope for improvement.

During the 1993 conference of the New Zealand Nurserymen's Association, a forum consisting of retailers and growers discussed several issues (Anon., 1993) that were later raised in the survey conducted by Brett (1995). Growers believed that the quality of their products was improving, but they expressed disappointment in quality maintenance of plants in garden centres.

In response to a question relating to problems of untimely deliveries of promotion plants, producers argued that retailers need to appreciate the weather dependency of plant production. However, growers agreed that weather influences on crop timing could be reduced by investing more in covered growing areas and heated houses. Other solutions proposed to minimise the risk of missing delivery deadlines, included improvement of communication between growers and retailers, and a warning to producers not to grow crops on contract without sufficient prior production experience.

2.3 Target markets for, and consumer perceptions of, nursery products and services

Customers of different types of landscape plant sellers may be typified by certain socioeconomic characteristics (Turner and Dorfman, 1990, Turner et al., 1990). Makus et al. (1992) held similar beliefs when they attempted to identify specific target markets for growers within their customer pool of landscapers and retailers, and to describe such segments in terms of characteristics of landscaping and retailing firms.
A telephone survey was conducted to investigate target markets for retail outlets of landscape plants in Georgia (Turner and Dorfman, 1990; Turner et al., 1990). For large retail stores and mass merchandisers (e.g. K-mart), the target market could be characterised by age, race, income, and the market value of homes. As the age of the customer increased, the percentage of expenditure at large retail stores increased at a decreasing rate until age 45. After the age of 45, increases in age were associated with decreases in percentages expected to be spent at large retail stores. Non-whites, low income level buyers, as well as respondents with low home market values, were more likely to patronise a mass outlet than were whites, high income earners and respondents with high home market values respectively. Turner et al. (1990) suggested that mass merchandisers should use marketing strategies such as offering landscape plants for low prices, promotions targeted to the young, lower- to middle class families, and location of firms in areas that contain a large population of the target market.

Marital status, income, and home market value were significant descriptors of the consumer market for large lawn and garden centres. Singles, respondents with high incomes, and owners of high value homes, purchased larger percentages of their plants from large garden centres than did married people, low income earners, and owners of houses with low market values. Strategies recommended for large lawn and garden centres include location in affluent housing areas, and promotions that appeal to singles' households (Turner et al., 1990).

Marital status, race, and gender significantly characterised the small, local garden centre's clientele. Being married, white, and female appeared to identify the segment of the sample most likely to purchase higher percentages of plants from local garden centres. Results suggested that small garden centres should concentrate on strategies involving child participation and family activities (Turner et al., 1990).

The authors also estimated the impact of changes in socioeconomic characteristics of new and existing customers on expenditures at different types of retail outlets (Turner and Dorfman, 1990; Turner et al., 1990). Results indicated that 60% of the total change in expenditure at large retail stores resulting from a change in an explanatory factor, would be generated by non-customers becoming customers. For small local and large garden centres on the other hand, approximately 60% of the total change in expenditure would be due to existing customers. For example, a change in the factor 'marital status' from single to married would increase the percentage spent at small local garden centres by 35%. Of this increase, 60% is expected to come from existing customers, while the remainder is attributable to new customers. Thus, results lent support and empirical evidence to the premise that different outlet types have different target markets and that effects on expenditure of changes in socioeconomic characteristics of new and existing customers depend on the type of outlet.

Identification of specific segments within the consumer market is important for retailers since it facilitates a more efficient allocation of marketing and advertising resources. Especially when membership information about target markets can be linked with preferences for specific product and/or service attributes, design and application of marketing strategies can be aimed at relatively small groups that are not only more homogenous in certain personal characteristics of its members, but also in their needs and desires, than is the total consumer market. Another way to reveal meaningful segments within the consumer market consists of first examining consumers' evaluations of the products concerned, followed by an attempt to relate these preferences to particular socioeconomic or demographic characteristics of consumers. This approach to segmentation was followed by Makus et al. (1992), whose findings were discussed in the previous section.

The study reported on by Carlson (1991) may be regarded as a first step in an attempt to reveal such 'preference-segments' within the consumer market for outdoor annual flowering plants and container plants. Of the consumer market, a sample consisting of

479 people in different locations in Michigan was surveyed about the importance of selected factors when buying annual flowering plants and container plants. Respondents were also asked what information they would like to have at the point of sale to help with buying and/or planting.

To 72.5% of respondents, the health status of a plant was an important consideration. Colour, height, and variety were taken into account by 64.9% of people surveyed. Low prices were attractive to 34.2% of respondents, while 18.8% were concerned with the compactness of plants. Good value was indicated by 13.6% of those surveyed as being an important consideration. Except for the factors 'an indication of the colour of the plant', and 'the presence of flowers on the plant', which were mentioned by 7.9% and 6.9% respectively, the remaining top fifteen considerations in buying flowering annuals and containers included retail outlet-related attributes, such as 'selection available', and 'convenience of the store'.

Information customers would like to have provided at the point of sale included environmental requirements, instructions for planting and for pest and disease management, and the cost of plants. Customers would appreciate an indication of the appearance of the plant at maturity and the duration of the flowering period. They also wanted to know whether plants were annuals or perennials. Much of this information lends itself to be incorporated in plant labels. Apart from these product-related information needs and demands, several service attributes were elicited. Customers stressed the importance of the presence of knowledgeable persons at retail outlets to answer questions or to assist with design issues. 'Variety selection' was another factor mentioned by customers in response to the question about desired information.

Results described by Carlson (1991) could lead to the formation of useful segments for growers of annuals and container plants, when combined with information about characteristics of respondents.

2.4 Consumer perceptions of specific groups of woody ornamentals

Due to the diversity within the category consisting of nursery plants, it was felt that the product for the current study needed to be restricted to a limited and well-defined group of plants. The selection of ornamental woody plants was based on personal interest and on an examination of this industry sector which suggested much scope for improvement. Expenditure on these plants by New Zealand households remained constant over time, accounting for only a small proportion of total garden expenditure, namely 16% in 1987, and 14% in 1995 (Anon., 1995b), while overall performance of their producers was not perceived as satisfactory by retailers (Brett, 1995).

A limited number of studies on consumer preferences for narrowly defined groups of outdoor woody plants has been reported.

DeBossu (1988) studied consumer evaluations of narrow-leaved evergreens. Based on elicitation interviews with nursery customers, six plant attributes were selected for further study. Of the attributes 'size at purchase', 'growth rate', 'resistance to insects and diseases', 'colour or shade', 'price', and 'mature height', the factor 'resistance to insects and diseases' was found to be the most important consideration to customers. The specification of this attribute is somewhat unfortunate, since its importance could be a measure of concern customers had with the health status of a plant, but it could also signify their disfavour regarding the use of pesticides.
Plant purchase size ranked second in importance, with medium sized plants being the most preferred. Tall and short plants were the least favoured as far as the desired mature size was concerned.

Price had the least effect of the six characteristics on preference ratings. Customers preferred moderately priced plants compared to low-priced plants by a small margin. Respondents were negatively disposed towards fast growing plants, which could be attributed to the associated pruning requirements. Dark green foliage was slightly preferred over light green and bluish grey leaves. Both growth rate and leaf colour had relatively little effect on the ratings.

Survey data were re-analysed incorporating personal characteristics, such as gender, age and income of respondents, the size of their property, the amount spent on trees and shrubs during the previous year, and expected expenditure on trees and shrubs in the next year.

Respondents less than 50 years of age, low income earners, and large property owners, were more adamant about the importance of plant health than were other respondents. Those in their 20s showed a stronger aversion than did other respondents to plants with low levels of pest and disease resistance, which would require frequent pesticide applications. Nursery customers over 50 years of age were more concerned than others with the short term visual effect, and preferred plants of medium height at purchase. They were prepared to buy small plants that would eventually reach a medium height.

Respondents in their 20s were more negatively disposed than were other respondents towards plants with a fast growth rate, which would require more frequent pruning. Large property owners showed a strong preference for plants that were either tall or small at purchase, whereas plants that would become tall at maturity were slightly preferred. Small spenders considered mature size more important than pest and disease resistance or purchase size, preferring plants reaching medium sizes. Respondents belonging to the low income group favoured moderately priced plants over low-priced plants.

The majority of respondents made their purchasing decisions jointly as couples. Of the remaining respondents, women as opposed to men were the sole decision makers in twice as many cases. Male respondents, making purchasing decisions themselves, accounted for 11% of the sample. This group differed significantly from female or joint decision makers in their preferences for some of the attributes under study. Men who were sole decision makers had a strong aversion to bluish grey foliage, did not appear to be concerned about pest resistance, and preferred small plants as opposed to plants of medium purchase size. In contrast, female decision makers were less prepared to buy small plants or plants that would grow tall after purchase. They were more concerned about pest resistance than were males, the latter attribute being the prime consideration for couples.

Vink (1989) used a similar method as DeBossu (1988) to elicit and analyse responses from 94 New Zealand residents concerning their evaluations of seven features of evergreen shrubs. Respondents belonged to one of three sample populations, namely a neighbourhood group, a paid response panel, or a local Horticultural Society. They were required to rate eighteen profiles, each representing a plant described in terms of the attributes 'size at time of purchase', 'growth rate', 'mature height', 'colour or shade of the foliage', 'flowers', 'pest and disease resistance', and 'price'. Of these plant attributes, 'the presence of flowers' was the most important consideration to respondents, with the level 'flowers as a major feature' being attributed the highest value, and the level 'no flowers present' being the least preferred. The factor 'pest and disease resistance' ranked second in importance, followed by the price of the plant.

Height at maturity, growth rate, size at purchase and foliage colour or shade were of minor relative importance, each accounting for less than 10% of the portion of variation explained by the independent variables. As far as height at maturity was concerned, respondents had a slight preference for plants reaching a height of 1-2 m as opposed to taller or shorter plants. Tall plants were the least preferred.

As in Debossu's study (DeBossu, 1988), the most preferred levels and the relative importances of plant features varied with characteristics of respondents.

People over 60 years of age placed more emphasis on the presence of flowers as a significant feature than did respondents belonging to other age categories. They also perceived price as a more important factor than did other respondents, possibly due to a lower disposable income. Respondents older than 60 years preferred plants reaching heights of less than 1 m as opposed to taller plants.
Price was a considerably more important selection criterion for male respondents than it was for female respondents, with relative importances of 19% versus 7% respectively. Both groups expressed a preference for flowering plants over non-flowering plants, but for females this feature had a relative importance of 39% compared to 30% for male respondents.

Seventy seven percent of respondents had purchased a shrub in the last twelve months. Non-purchasers assigned a higher relative value to the flowering characteristics of a plant (42%) than did those who had made a purchase (34%). Respondents who had not made a purchase, also placed more emphasis on foliage colour (6% versus 3%), but were less concerned with the growth rate of the plant and its pest and disease resistance (1% and 26% respectively, versus 8% and 31%).

Purchase behaviour of keen gardeners was more influenced by pest and disease resistance and less by price than was that of moderately keen gardeners. Only 7% of the sample classified themselves as 'not keen gardeners'. Their responses were atypical, possibly due to the small sample size. Presence of flowers was also the most important plant feature (44%) for this group, with height at maturity ranking second in importance (19%). 'Not keen gardeners' were virtually equally concerned with attributes 'price' (11%), 'pest and disease resistance' (11%), and 'size' (10%).

Results presented by Vink (1989), indicated a favourable tendency towards 'instant gardens'. Respondents were more likely to purchase fast growing plants as opposed to plants with an average or slow growth rate, and most were more attracted to plants with a height of over 0.4m at purchase than to smaller plants. Chisholm (1995) recognised a similar trend in New Zealand six years later, among what she termed 'the nouveau gardeners'.

In the studies conducted by DeBossu (1988) and Vink (1989), perceived attribute values were inferred from respondents' overall evaluations of plants, while Florkowski et al. (1992) asked respondents to rate plant attributes directly, i.e. to 'self-explicate' attribute importances. In Chapter 3, the 'conjoint measurement' method employed by DeBossu (1988) and Vink (1989) is described in detail and contrasted with the 'self-explicated' approach.

Florkowski et al. (1992) studied the importance of natural Christmas tree characteristics as related to socioeconomic variables and opinions of choose-and-cut farms' customers. More than half of the 148 surveyed customers 'strongly agreed' that each of the selected tree attributes, namely 'shape', 'colour', 'price', 'density' and 'height', was important. Almost 85% 'strongly agreed' that shape was an important attribute. Density was important to 63% of respondents, followed by height which was considered and important attribute by 59%. The smallest percentage of respondents (52%) believed that colour or price was an important characteristic.

Tree shape was more important to female respondents, high income earners, and to customers who had brought their family to the choose-and-cut farm, than it was to other customers surveyed. College educated respondents were less concerned with the shape of a tree than were those with lower levels of education.

Tree density was less important to highly educated respondents, and to customers who agreed with the statement that a tree makes the Holiday season special, than it was to other respondents.

Perceived importance of tree height was also related to respondents' education and to their opinion about the statement that a Christmas tree contributes to a special Holiday atmosphere. College educated customers were less concerned with tree height than were respondents with other levels of education. Respondents who believed that a tree makes the Holiday season special, and those who expected a visit from relatives during the Holidays, placed less emphasis on tree height than did other respondents.

Tree colour had less influence on the opinion of respondents who perceived artificial trees as expensive, and of those who expected relatives to visit them during the holidays than it had on perceptions of the remaining respondents.

Importance attached to the price of a tree depended upon respondents' gender, income, and level of education. Female customers' purchase selections were more affected by price than were those of male customers. Price was of less importance to college educated respondents than it was to customers with other levels of education. Respondents belonging to the highest income category paid more attention to price than did low income earners.

Customers with a higher level of education, and those who agreed with the statement that a tree makes a Holiday season special, were less concerned with tree attributes than were other respondents. These findings suggest that attributes other than those selected for study were more important to these customers. The perceived importance of shape and density stresses the need for careful and judicious shearing of pine species. Price was perceived as less important than the overall tree quality, but consumers' willingness to pay was not assessed.

One of the major problems associated with interpreting results from self-explicated approaches, is that respondents are not forced to make choices among product attributes. Therefore, stated attribute values may not adequately reflect relative importances of attributes. In real life situations, customers are seldom presented with products that have all the desired features at the right levels. Generally, consumers have to choose from a range of products, none of which completely meet the consumers' ideal. Producers may not even be able to offer this ideal product, for example when the making of it is not yet possible within the constraints of the current state of technology. Rather than attempting to satisfy all consumers' needs and desires, it would be more useful for producers and retailers to concentrate on meeting the most important wants of their clients.

Unlike DeBossu (1988), Vink (1989) and Florkowski et al. (1992), Kravanja (1995) did not specify the plant attributes beforehand, but attempted to infer choice determining plant features from respondents' overall evaluations of photographed plant species. Broadleaved woody ornamentals appeared to be preferred over conifers and herbaceous plants. Shrubs with solitary flowers received better ranks than did woody ornamentals with flowers united into inflorescences.
Further research would be required to determine the extent to which the attributes 'type of plant' and 'type of flower' really influenced preference judgements. For example, the broadleaved woody species included in the study may have had other characteristics in common that could be responsible for their perceived attractiveness rather than just the type of plant. The arbitrary nature and the complexity of trying to determine underlying reasons for plant preferences in the study of Kravanja (1995) illustrated the disadvantages of not defining plant attributes beforehand.
The high levels of heterogeneity in responses, which further complicated interpretation of results, may have been partly due to the use of a variety of existing plant species. Respondents' evaluations may have been influenced by past experiences with these species. Differences in past experiences between respondents may have added an extra source of variation.

In general, research methodologies that require respondents to evaluate profiles of plants illustrated and/or described in terms of pre-specified attributes seem to be preferable to self-explicated approaches and methods where plant characteristics are not specified beforehand.

2.5 Summary of consumer evaluation studies relating to nursery products and services

Buyers of nursery products generally placed more emphasis on product attributes than on service related factors (Bourke and West, 1976; West, 1980; Gineo, 1989; Carlson, 1991; Garber and Bondari, 1992b; Makus et al.,1992).

Of the product attributes, 'plant quality' was of major importance (Bourke and West, 1976; West, 1980; Garber and Bondari, 1992b; Brett, 1995). The usefulness of this information is limited since the issue of what constitutes a quality plant was not addressed. It is likely that the health of a plant was perceived as a major component of its quality.

In studies where quality was not specified as an option, plant health was found to be one of the dominant characteristics of buyer preference (DeBossu, 1988; Vink, 1989; Carlson, 1991; Makus et al.,1992). It is assumed here that the value customers attached to the attributes 'freedom of insects and diseases' and 'pest and disease resistance' was a reflection of their concern with plant health, rather than a disfavour of the need for pesticides.

Price was a secondary consideration in purchasing decisions. The relative importance of price varied to some extent with the socioeconomic characteristics of the customers, but no conclusive correlations were evident.

Results of the studies reviewed in the previous sections are difficult to compare other than in general terms, since they were dependent upon several factors, such as the research methods, the sample size, and the evaluated product, which were different in each case. Findings described by DeBossu (1988) and Vink (1989) may also have been affected by the attributes included in the study, the number of levels for each attribute, and the type of profiles presented to respondents.

None of the research projects discussed allowed for the possibility of interactions between product characteristics. For example, the importance of price may vary with the health status of a plant. In the case of healthy plants, price may only play a minor role in buying decisions, whereas with unhealthy plants customers may be much more concerned with price.

The majority of published research on consumer perceptions for nursery products and services did not involve trading off amongst different product or service attributes. As a consequence, reported importances of the attributes concerned were not relative to one another.

Thus, although some information was available about consumers of, and their attitudes towards, woody ornamentals, its value for the New Zealand industry was limited. Hence, any study aimed at further increasing knowledge about the consumer market was entirely justified.

3 QUANTIFYING EVALUATIVE CRITERIA REVIEWED WITHIN THE CONTEXT OF CONSUMER BEHAVIOUR - A REVIEW OF EXTANT LITERATURE

3.1 Introduction

The motivation for the current study originated from the lack of information on variables of consumer decision processes involved in nursery product purchases. Knowledge about consumers and their buying behaviour is generally accepted as an essential attribute of successful industries (Engel et al., 1978).

All business success ultimately rests on sales, which, according to Peters and Waterman (1982) may be regarded as temporary marriages between company and customer. In their study of highly successful corporations, Peters and Waterman (1982) concluded that one of the major factors that distinguishes companies with a high standard of excellence from others, is their close relationship with customers. Effects on performance of acknowledging the importance of such a relationship combined with an effort to achieve it, were further elaborated upon by Peters and Austin (1985).

Francese and Piirto (1990) also emphasised the relationship between businesses and their customers as the key to success. They describe how information about consumers can be used to reduce the complexity of communicating effectively with consumers and to increase the probability of making a sale.

Knowledge about the customer and his or her behaviour form the basis for five areas of commonalities between outstanding organisations (Albrecht, 1992), namely those of 'market and customer research', 'strategy formulation', 'education, training and communication', 'process improvement', and of 'assessment, measurement, and feedback'. Successful organisations understand the needs, desires, and buying motivations of their customers, as well as the structure and the dynamics of the market place. Outstanding businesses develop and use strategies that attract and maintain customers. Top performing organisations use intensive programs of educating their employees about customers. They continuously seek ways to assess and improve their performance on behalf of the employees and customers. Workers receive feedback on how well they are doing in meeting customers' wants and needs. Albrecht (1992) described how transformations can be achieved to adhere to the standards prescribed by these five key areas, leading to the formation of truly customer-centred companies.

Toombs and Bailey (1995) stressed the importance of the application of consumer behavioural research for performance improvement of organisations in terms of profitability and customer satisfaction. They described three examples of companies that used measurements of customer perceived value to successfully redesign their organisations, to develop new products and services, and to improve existing offerings. According to Toombs and Bailey (1995), attempts to become customer-driven are likely to fail if the full extent of the importance of knowledge about customer purchase behaviour is underestimated, or when insufficient use is made of expertise on internal organisational structures and how they can work together to help the company satisfy its customers.

Consumer behaviour was defined by Engel et al. (1978, p.3) as "the acts of individuals directly involved in obtaining and using economic goods and services, including the decision processes that precede and determine these acts." A more comprehensive definition was given by Bennett (1988, p.40) who described consumer behaviour as "the dynamic interaction of cognition, behaviour, and environmental events by which human beings conduct the exchange aspects of their lives". This definition emphasises that consumer behaviour is dynamic, and that it involves interactions between consumers' thoughts, feelings, and environmental factors.

A wide variety of theories have been offered to explain consumer behaviour. To provide a general reference for the focus of the current study on a specific stage in the consumer behavioural process, namely that of product evaluation, an overview of these theories and associated models is given in the following section.

3.2 An overview of consumer behaviour theories

Interest in the development of theories to describe consumer behaviour emerged after World War II, and was stimulated by dramatic changes in supply and demand that resulted from the war effort (Sternthal and Craig, 1982).

Theories are generally formulated in the form of models, which are defined as simplified representations of real phenomena.

Early attempts to explain consumers' behaviour relied on concepts from a single discipline, such as economics or psychology, and led to the formulation of so-called monadic models (Sternthal and Craig, 1982), such as black box models and personal variable models.

Black box models are those concerned with external environmental influences on behaviour, such as advertising, and in-store factors (Nicosia, 1966; Sheth, 1974; Engel et al., 1978; Williams, 1981; Rice, 1993). The relationship between stimuli, intervening variables and response variables is illustrated in Figure 3.1. Intervening variables are the individual and his or her mental processes involved in decision making, which are regarded as an impenetrable black box. Thus it is assumed, that judgements about what takes place within this black box can only be made by inference.

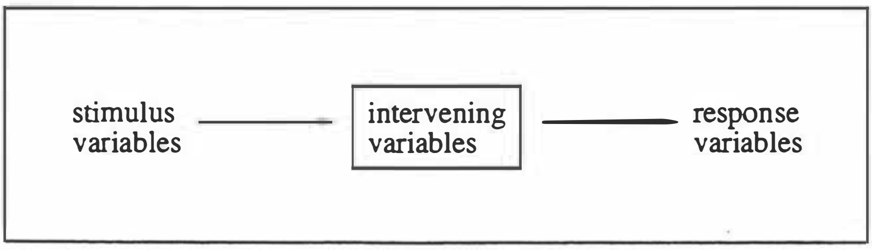

Figure 3.1 Black box model of consumer behaviour

An example of a black box approach is the microeconomic model of consumer choice, which is founded on the concept of utility, which is the ability of an object or idea to satisfy human wants, and on the law of diminishing marginal utility (Mansfield, 1991). The latter states that as a person consumes more and more of a given commodity, the marginal utility of the commodity, i.e. the additional satisfaction derived from an additional unit, will tend to decline. The microeconomic theory assumes that consumers attempt to maximise the utility of their purchases subject to some budget constraint. Thus, in selecting his or her most preferred consumption bundle, the consumer is faced with an utility maximisation problem and an expenditure minimisation problem (Mas-Colell and Whinston, 1995). Finally, it is assumed that consumers act in a consistent manner. The assumptions of maximisation and consistency are particularly important, since they imply complete rationality on the part of the consumer, i.e. the existence of an 'economic man'.

The black box approach is useful to the marketer since it concentrates on effects of external factors on behaviour on which marketing strategy can exert an influence. Evaluation of relative importances of external variables places the marketing strategist in a strong position to determine how consumer behaviour can be influenced in a desired direction.

In Kotler's buying process model (Kotler, 1965), the buyer's mental processes are also regarded as being contained within a black box. Its distinction from the microeconomic model lies in the fact that buying influences and channels through which these are communicated to consumers, include not only economic, but also social factors. Hence, the theory underlying Kotler's model, is positioned in between those forming the foundations for the development of black box and personal variable models.

Personal variable models are primarily concerned with psychological variables and exclude external and environmental variables that may affect behaviour. Personal variable models take account of such variables as beliefs, attitudes and intentions. Generally, they are relatively simple models, involving only a few variables. Nowadays, they are often used as submodels of the more complex, comprehensive models. Examples of personal variable models, such as those developed by Rosenberg (1956) and Fishbein (1967 and 1975), are discussed in Section 3.3.

Neither the black box models nor the personal variable models alone, can sufficiently explain and predict consumer behaviour. Edwards (1954) published a major review for psychologists of research on behaviour done by economists, statisticians, and philosophers. He argued that research on decision models conducted by economists and others should be important to psychologists concerned with judgement and choice. According to Simon (1955), research of economists interested in understanding actual decision behaviour, should focus on the psychological factors that cause behaviour to deviate from that predicted by the 'economic man' model.

The realisation that adequate theories of consumers' purchase and consumption activities could not be achieved by a single concept, resulted in progressively more complex representations of consumer behaviour developed by marketing theorists. Thus, the monadic models proposed during the 1950s and 1960s were superseded by multiple variable models, also called comprehensive models.

Since the late 1960s, comprehensive models that take both personal and environmental variables into account, have dominated theories about consumer behaviour. To provide a general framework for the basic theories underlying the current study, concepts of several examples of multiple variable models are discussed in this section. Foxall (1983) summarised sequences of a selection of comprehensive models developed between 1923 and 1978.

The most complex models, also called 'grand' models, such as those developed by Nicosia (1966), Howard and Sheth (1969), and Engel et al. (1990), are frequently quoted and discussed within consumer behavioural contexts.

A summary flow chart of the model developed by Nicosia (1966) is presented in Figure 3.2. The model is divided into four fields. Field One consists of two sub-fields, namely the firm's attributes and consumer attributes. Communication between the two sub-fields involves all processes associated with message exposure, such as perception and retention of advertisements or promotions, and takes account of environmental and social influences at the time of interaction. Such communication may lead to a positive attitude on the part of the consumer towards a particular need.

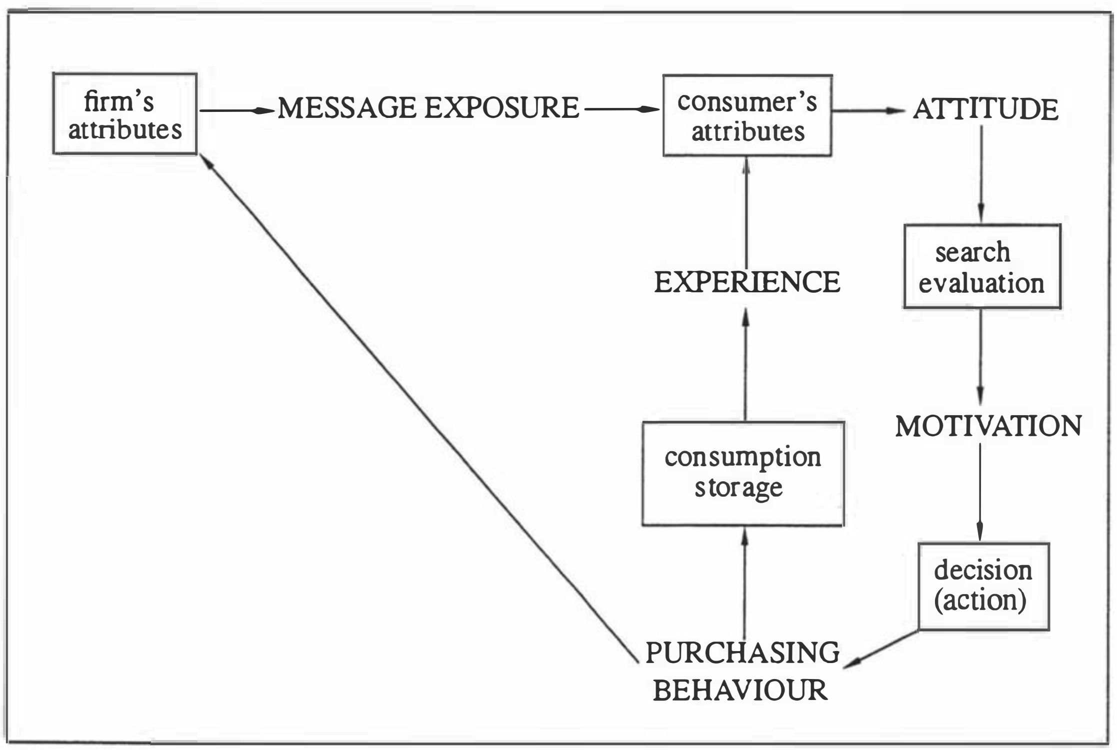

Figure 3.2 The Nicosia model of consumer behaviour

In Field Two, this positive attitude encourages the consumer to engage in a search for, and an evaluation of, products or services that may fulfil this need. Field Three represents the act of purchase, which is assumed to be the outcome of a decision made by the consumer on the basis of the search and evaluation phase. Field Four is concerned with effects of the consumer's action on attributes of the firm and the consumer. Purchase followed by consumption will add to the consumer's experience, which in turn becomes part of his or her attributes in the form of predispositions. Non-purchase reduces profitability of the firm, and may convince the firm's management to alter messages to the consumer.

The four fields described, are the central components of the Nicosia model, and each is further elaborated to give a complex and sophisticated model. The strength of the Nicosia model lies in the fact that consumer behaviour is regarded as an overall process, not limited to the consumer alone. The explicit inclusion of the selling firm distinguishes the Nicosia model from most other models of consumer behaviour. According to Engel et al. (1978) the model made a strong impact when first published, but it never received the needed elaboration to provide an adequate explanation of behaviour. The Nicosia model is regarded as outdated since it has never been revised to incorporate new insights gained in the discipline of consumer behaviour.

The Howard-Sheth model of consumer behaviour (Howard and Sheth, 1969) is based on a model originally developed by Howard, and subsequently revised and refined with the assistance of Sheth. A simplified version of the model is presented in Figure 3.3.

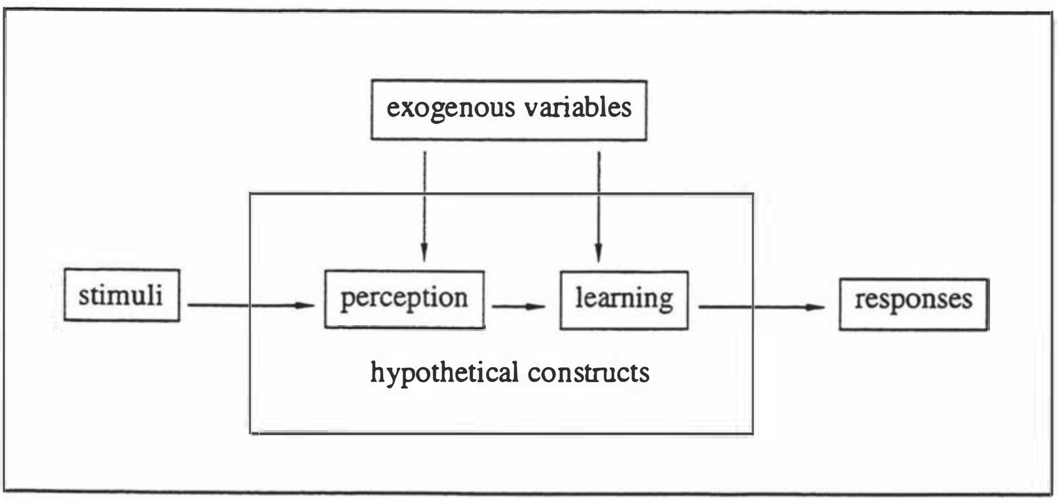

Figure 3.3 Simplified version of the Howard-Sheth model of consumer behaviour

Input stimuli, which initiate the purchase process, consist of information from the social environment, such as the consumer's family, and from the commercial environment, such as those communicated to consumers through advertising and other promotional activities. Perception is associated with processing of incoming information by the consumer. Products of the information processing stage are represented by the model component 'learning'.

Perception and learning are influenced by exogenous variables such as demographic and socioeconomic characteristics of the consumer, and subsequently lead to responses. The output stages of the Howard-Sheth model are illustrated in Figure 3.4. Attention,

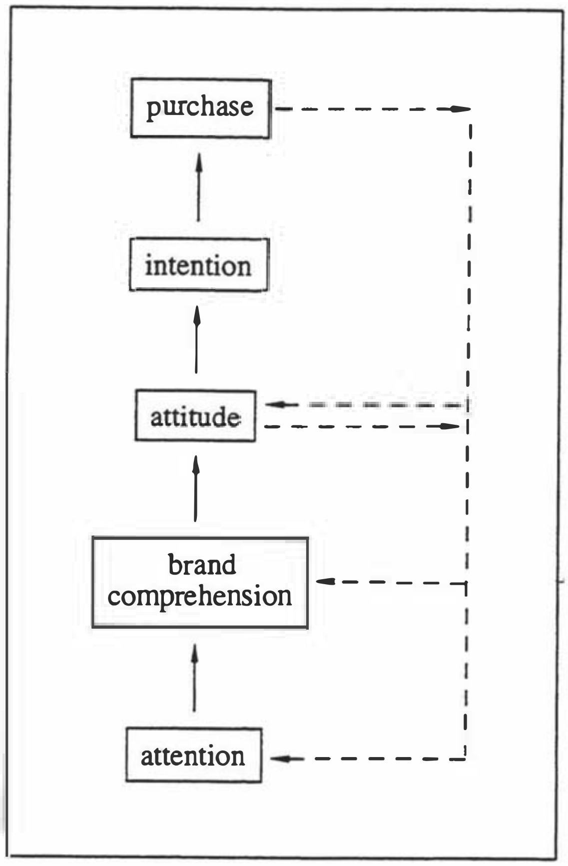

Figure 3.4 Output stages of the Howard-Sheth model of consumer behaviour

attitude, brand comprehension, and intention are also included in the 'hypothetical constructs'. Here, they represent unobservable concepts inferred from intervening variables rather than from measurements of buying behaviour. For example, it is not possible to see an attitude, or intention. However, within limits, it is possible to measure an attitude and an intention. Different types of measurement scales have been developed to provide structured ways of obtaining these measurements through questionnaires (Bagozzi, 1994). Among the outputs, the model components concerned represent constructs based on such measurement of some aspect of purchasing by the consumer. Thus, the measurable components of attention, brand comprehension, attitude, and intention, constitute the output of the Howard-Sheth model, whereas the more abstract, real phenomena are included in the hypothetical constructs.

Social stimuli, such as influences of the buyer's family, and/or commercial stimuli, such as advertisements, lead to search for, and processing of, information. The consumer considers a set of brands that meet the criteria necessary to be deemed satisfactory alternatives. Subsequently an attitude is formed towards a brand, which forms the basis for the formulation of a buying intention that may lead to actual purchase. Once a brand is purchased, experience will influence the consumer's subsequent attitude towards the product or brand purchased. Experience may lead to a revision of the consumer's comprehension of different brands.

The Howard-Sheth model is similar to that developed by Engel et al. (1978 and 1990). They both concentrate on learning processes, but they differ in the way they treat processing of information and the role of post-choice experience.

The Engel, Blackwell, and Kollat model of consumer behaviour (Engel et al., 1978), and its revised version, the Engel, Kollat, and Miniard model (Engel et al., 1990), are based on five phases of consumer decision making behaviour suggested by Dewey (1910). These stages are presented in Figure 3.5.

Consumers feel that they need to solve a particular problem, or can benefit from features of products or services, when they perceive a difference between an ideal state of affairs and the actual state at any given moment. For example, for a person who has discovered that the climber s/he planted in the garden to cover an unsightly fence, has died, a covered fence is the desired state. An uncovered fence will be the actual state in the near future; thus a problem is perceived. Many of the problems that consumers perceive, result from depletion of the product being used to solve a problem. If a person who is in the process of fertilising a garden discovers that s/he will not have sufficient fertiliser to cover the intended area, then having enough fertiliser is the desired state, and being out of fertiliser will eventually be the actual state. Fertiliser is the product being used to solve a problem this person perceives. In a situation of depletion, this problem will remain unresolved without further action.

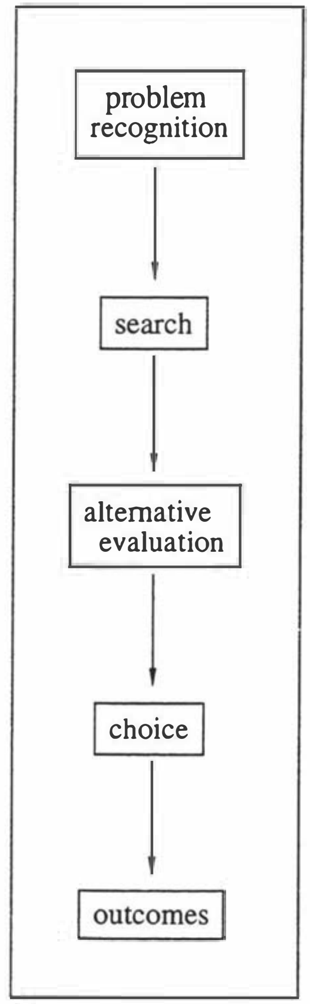

Figure 3.5 Stages in the consumer decision process suggested by Dewey

As illustrated in Figure 3.6, Engel et al. (1990) proposed that need recognition is determined by environmental influences, such as culture and social class, by individual differences, such as consumer resources, and by information stored in the memory. Problem recognition initiates search to learn about, and to identify what is available in the market. Information search may be limited to internal memory search to establish whether or not the individual has enough information about available options to make a decision, or it may involve an external search. External information search can take place in a passive manner, e.g. exposure to marketing messages, or be acquired in an active manner, such as trial or inspection of products, or self-initiated exposure to marketing messages. The extent to which external search takes place is determined by the perceived balance between expected benefits and costs. Information received can exert an effect on evaluative criteria.

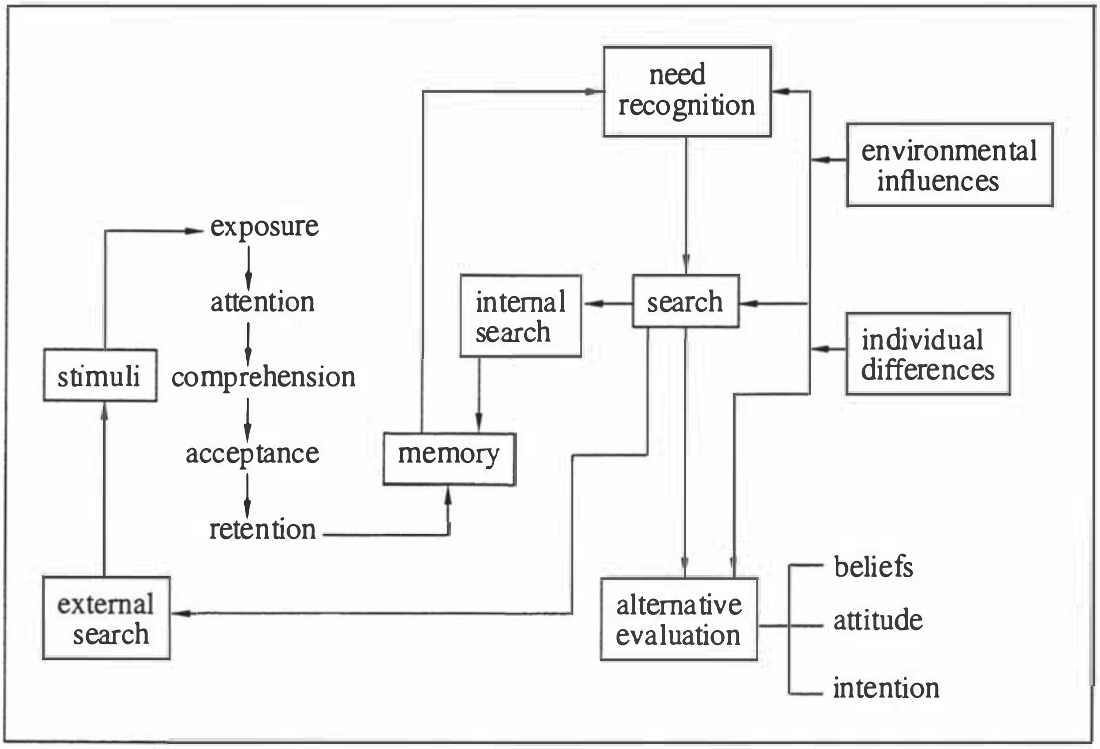

Figure 3.6 Alternative evaluation in the Engel, Blackwell and Miniard model

Evaluative criteria are standards and specifications used by consumers to evaluate alternative products and services. Thus, they are defined on the desired outcomes of a decision process.

Beliefs represent information that links a given product or service to evaluative criteria, and can be readily influenced by marketers. For example, a consumer may decide that low prices of plants offered for sale represent the most important desired attribute of garden centres. Through exposure to promotional appeals, this consumer may then arrive at the belief that a particular garden centre is cheaper than other garden centres. Once beliefs are formed or changed, attitudes will be affected.

An attitude can be defined as the evaluation of consequences of using a particular brand or service. Attitudes lead to intentions, which represent the subjective probability that a specified action, such as the choice of a particular product, will be undertaken. If none of the products or brands evaluated meet the evaluative criteria, a new information search phase may be initiated. For instance, if a consumer evaluates different climbers and comes to the conclusion that none of the climbers offered are desirable in terms of particular criteria, s/he may decide to go to other garden centres, or opt for another solution to the problem of the unsightly fence, such as renovation of the existing fence.

Choice generally will follow the formation of purchase intention. The most important outcome of choice is related to satisfaction. A customer is satisfied when s/he evaluates the chosen alternative as being consistent with prior beliefs and attitudes. Growth of dissatisfaction has been a major incentive for the rise of the consumerism movement, which is defined by Kotler (1972, p.49) as "a social movement seeking to augment the rights and power of buyers in relation to sellers". Another outcome of choice is post-decision dissonance, which is a state of doubt about the alternative selected, caused by the belief that unchosen alternatives also have desirable attributes.

The cause of most reservations against the Howard-Sheth model and the Engel, Blackwell and Miniard model, is the fact that in both models the roles of a number of variables and relationships between variables are merely noted and not well-defined, which makes them difficult to use for practical purposes.

Comprehensive models that involve the use of decision nets or trees (Bettman, 1979), are easier to apply to practical situations than are the remaining comprehensive models discussed here. Decision nets generally take the form of a tree of tests that sort and classify information until a final decision is reached. Each test relates to an attribute of the input variable, and classifies the attribute into one of two or more categories. Tests may consist of simple questions, such as 'Am I buying this plant for my own garden?', or of more complex issues, such as 'Is there something special about this plant?'. Decision nets are constructed by asking subjects to verbalise processes involved in their purchasing decision, and may subsequently be used to simulate consumer behaviour. Whilst decision net models, which were defined as information processing models by Williams (1981), have more practical merit than do the 'grand' models, the latter have received more attention in literature about consumer behaviour, possibly due to their greater heuristic value. Binary decision nets cannot represent the potential range of heuristics used in consumer choice processes. This applies in particular to heuristics for which comparisons across alternatives are needed rather than comparisons to a standard assumed in decision nets. Von Winterfeldt and Edwards (1986) described decision nets within the context of decision analysis, and attributed their infrequent use to a tendency for excessively complex modelling which adversely affects the user-friendliness of resulting nets.

Variations on, and deviations from the views underlying the classes of behavioural models described here, are summarised by Foxall (1990). This classification of the various consumer behavioural theories is based on dimensions proposed by Hillner (1984) in his overview of behaviourism, namely the nature of mind-body relationships, the relevance of mind and consciousness, the presumed location of the primary determinants of behaviour, the primary location of the internal mediators, and the reducibility of central mediators to behavioural terms.

Whereas methodological behaviourists subscribe to the black box theory, believing that mental events exist, but that they are outside the scope of scientific analysis, metaphysical behaviourists deny the existence of mind, while descriptive behaviourists acknowledge the existence of mental events, but do not treat them as causal factors for behaviour.

Beliefs of radical behaviourists are positioned in between beliefs of those advocating the black box and the personal variable models, and argue that mental processes, although not causative, are important variables that should be investigated. In this view, mental processes are influenced by external, environmental factors, which themselves are regarded as primary determinants of behaviour (Skinner, 1953).

Logical behaviourists, on the other hand, regard internal mediators as primary determinants, and as such, believe that personal variable models adequately explain and predict consumer behaviour. Some logical behaviourists regard 'central mechanisms', or cognitive processing as the vehicle for primary determinants of behaviour (Tolman, 1932), whereas others believe that internal mediators are confined to 'peripheral mechanisms', such as muscles and glands (Hull, 1951; Guthrie, 1952).

Cognitive behaviourists in contrast to analytical behaviourists, claim that mental processes cannot be reduced, that they are not the result of external effects, and that they are causative in their own right (Hillner, 1984). This view is fundamental to the information processing models which have had a profound influence on psychology, marketing, management science, and economics (Foxall, 1990). Unlike Williams (1981), Foxall (1983 and 1990) classified the 'grand' models discussed in this section as information processing models. That cognitive psychologists predominantly use the information processing approach is reflected by the fact that cognitive psychology is often described as the experimental study of human information processing (Reed, 1992; Haberlandt, 1994).

A satisfactory model should be easy to understand, consistent with known facts, logically consistent, original, explanatory, predictive, have heuristic power, and be verifiable (Williams, 1983; Rice, 1993). None of the models described previously, fully meet these criteria.

Despite the seeming diversity of ways in which theorists have attempted to model consumer behaviour, there are important commonalities. In multiple variable models, purchase behaviour is viewed as a process rather than a discrete act. They are concerned not only with the resulting decision, but also with the way in which a decision is reached. Outcomes of multiple variable models described in this section, which represent the major comprehensive theories of consumer behaviour, are determined principally by information processing on the part of the buyer. These most widely accepted and influential models assume that the consumer is able to process information in an intellectual and rational manner. This assumption is based on theories developed in the area of cognitive psychology, which has also become the dominant paradigm for psychological research in general (Kassarjian, 1982; Gardner, 1985; Foxall, 1990; Haberlandt, 1994).

Olshavsky and Granbois (1979) criticised the theory of prepurchase processes and suggested that for many purchases a decision process never occurs. They referred to some examples of purchases that according to them, do not involve decision making, such as those made exclusively on recommendations from personal or non-personal sources. However, their view failed to account for the fact that the way in which purchasing occurs according to them may actually be regarded as part of the decision process. Personal and non-personal sources may create a need (problem recognition) and provide the source of information used in the search phase of the decision process. Moreover, the consumer behavioural models discussed do not exclude the possibility that some stages are involved only to a limited extent in the prepurchase process.

Information processing components of the major models of consumer purchase behaviour, all include, or are followed by, evaluation of alternatives. This process consists of comparisons of various alternatives for purchase or consumption against criteria which the consumer regards as important in decision making. Evaluative criteria may be objective, and relate to specific physical features of the product, or subjective, i.e. associated with symbolic values or benefits of a product. Regardless of their nature, evaluative criteria are always expressed in terms of desired product attributes. The benefit, attractiveness or otherwise desirability of a particular product is then determined by evaluating the alternatives against these evaluative criteria.

3.3 Evaluation of alternatives

A myriad of theories exists on the mechanics of the process that takes place when consumers evaluate alternatives. In the current section, an overview of the major theories is presented, including those which provided the foundation for the development of the method selected in the present study for identifying and quantifying evaluative criteria for outdoor ornamental plants.

Evaluative criteria can be identified with direct or indirect questioning, or by means of observation or experimentation. Each of these methods is briefly discussed in Chapter 4 as part of a description of the elicitation of relevant ornamental plant attributes.

Formation of evaluative criteria results in separate bits of information which combine in some way to lead to a decision. Consumers develop evaluation rules relative to which they can compare products in an holistic manner.

Personal variable models depicting different ways in which this aggregation can be achieved, may be broadly classified as compensatory and noncompensatory models. Compensatory models, which assume that a weakness of an alternative on one attribute may be compensated for by strengths on other attributes, fall into two main categories, namely expectancy models and attribute adequacy models.

According to the expectancy theory, individuals make rational decisions based on the importance to them of the outcome, and on their perceived probability that this outcome will result from an action (Vroom, 1964). Normally a number of different outcomes will be associated with a particular action. It is hypothesised that individuals will behave in the way they believe will give the most desired outcomes overall. A general expectancy model can be represented as:

$$F = \sum (E \times V) \tag{3.1}$$

where:

F = motivation to behave

E = expectation that the behaviour will be followed by a particular outcome, and

V = desirability of the outcome.

Models developed by Rosenberg (1956) and Fishbein (1967 and 1975) show marked similarities to expectancy theories and models. In the initial publication of Rosenberg's model (Rosenberg, 1956), it took the following form:

$$A_o = \sum_{i=1}^{n} (VI)_i \, (PI)_i \qquad (3.2)$$

where:

A_o = overall evaluation of the attractiveness of alternative o,
VI_i = importance of the i^{th} value,
PI_i = perceived instrumentality of alternative o with respect to value i, which equals the estimated degree to which following an action will either enhance or inhibit attainment of a value, and
n = number of pertinent or salient values.

Value importance is assessed using 21 categories ranging from 10, 'gives me maximum satisfaction', to -10, 'gives me maximum dissatisfaction'. Perceived instrumentality is measured on a scale from 5, 'the condition is completely attained through a given action, to -5, 'the condition is completely blocked through a given action'.

Similarly, the Fishbein model states that an attitude towards an object is equal to the sum of the products of the belief about each attribute of the object, weighted by the evaluation of the importance of each attribute (Fishbein, 1967). This statement can be expressed as follows:

$$A_o = \sum_{i=1}^{n} B_i \, a_i \qquad (3.3)$$

where:

A_o = attitude towards object o,
B_i = belief i about o,
a_i = evaluation aspects of B_i, i.e. its goodness or badness, and
n = number of beliefs.

Thus, the Fishbein model indicates which attributes are of importance to the consumer in determining an attitude towards an object, and the degree to which the consumer evaluates the object in terms of these different attributes.

The Extended Fishbein model (Fishbein, 1975) was developed to account for the fact that a positive attitude towards a product is not necessarily followed by purchase. For example, an individual may have highly favourable attitudes towards several ornamental plant attributes, but financial constraints may prevent him or her from acting. The Extended Fishbein model attempts to predict an individual's attitude towards the act of purchase, and is stated as:

$$\text{A-act} = \sum_{i=1}^{n} b_i \, e_i \qquad (3.4)$$

where:

A-act = attitude towards performing a specific act,
b_i = perceived belief that performing the act will result in outcome i,
e_i = evaluation of consequence i, and
n = number of perceived beliefs involved.

In most cases researchers have not explicitly followed the Fishbein, or the Rosenberg model, but have applied modifications, of which the attribute adequacy model is an example. Evaluation is modeled in a similar way as in the Fishbein and Rosenberg models, with the exception that the attribute adequacy model includes an assessment of the difference between ideal and actual state on each attribute. Preference is postulated to be inversely related to the distance of an object to the ideal point. This approach was used by Lehmann (1971) to predict television show preference with the model:

$$A_s = \sum_{i=1}^{n} W_i \, | P_{ni} - I_i |^{k} \qquad (3.5)$$

where:

A_s = distance from television show s to the ideal point,
W_i = importance weight attached to show attribute i,
P_{ni} = show's belief score on attribute i
I_i = ideal position on attribute i,
n = number of attributes, and
k = an integer defining the distance measure.

Thus, compensatory models are typically expressed as additive functions or variants thereof, that do not exclude the possibility that products with one or more undesirable characteristics are still perceived as attractive, and may even be regarded as more attractive than products of which all attributes have desirable, but not ideal levels.

In contrast to expectancy value and attribute adequacy models, noncompensatory models state that a weakness of an alternative on a given attribute cannot be compensated for by strengths in other attributes. Bettman (1979) and Peter and Olson (1990) recognise four categories of noncompensatory processes, namely those described by conjunctive, disjunctive, and lexicographic models, and elimination by aspects.

The conjunctive model states that the consumer determines a minimum acceptable level for each product attribute. An alternative is only accepted when each attribute equals or exceeds this minimum.

Application of disjunctive models assumes that the consumer recognises one or more attributes as dominant, and accepts an alternative when each key attribute is equal to, or exceeds a specified minimum.

According to the lexicographic model, consumers rank attributes, or evaluative criteria in order of importance. The best alternative is selected on the most important criterion. Should the selection procedure result in two equally attractive alternatives, then the second most important criterion is taken into consideration, and so on.

Eliminations by aspects involves the establishment by the consumer of minimum cutoffs for each evaluative criterion. The consumer selects one criterion and eliminates all alternatives that do not exceed the cutoff level. The procedure is repeated until one alternative is left.

Both compensatory and noncompensatory approaches involve application of aggregated models, where measurement of separate model components results in a single computed value, which is associated with the overall evaluation of, or the attitude towards, an object. The central paradigm of aggregate models is that the consumer is able and willing to evaluate each attribute separately. The models then imply application of a particular rule to compose an overall evaluation.

The great degree of mental activity required to combine bits of information using the compensatory model, led to the view that consumers probably use less demanding strategies, especially in complex decision making situations. Noncompensatory models are examples of proposed simplifying strategies.

Day (1972) in his review of attitude structure models, suggested that one of the most crucial issues concerning additive models is their presumed ability to accurately capture the complexities of choice behaviour. For example, no consideration is given to possible interactions between attributes, i.e. failures of the weights of particular attributes to be the same for each value or level of the remaining attributes in the model. Due to their simplicity relative to additive models, a similar concern overshadows application of noncompensatory models.

Compensatory and noncompensatory models are both based on the widely accepted view that a product is a collection of attributes, and that a product in itself is not the object of utility, but that utility is derived from the properties or characteristics of that product (Lancaster, 1966).

From the outline of compensatory and noncompensatory models presented here, it is clear that many theories have been developed in an attempt to answer the question pertaining to the way in which separate utilities combine to an overall product utility. Another more basic question is whether or not joint effects of attribute utilities on overall product utility are in fact measurable. Several authors addressed this issue, and advocated the use of decompositional approaches, such as multidimensional scaling and conjoint analysis, which, unlike compositional approaches, are not based on the assumption that consumers are able and willing to combine measurable evaluations of attributes to arrive at an overall evaluation. In contrast to compositional approaches where overall judgements are composed from stated attribute utilities, decompositional approaches involve inference of attribute utilities from overall product evaluations.

Multidimensional scaling (Green and Rao, 1972; Green, 1975; Tull and Hawkins, 1987; Green et al., 1988; Cox and Cox, 1994) is such an indirect approach, the motivation for which lies in the fact that many consumers find great difficulty in explaining underlying reasons for their purchasing behaviour. Multidimensional scaling (MDS) methods are designed to represent objects as points or vectors in a multidimensional space, where the dimensions are assumed to represent evaluative criteria.

Several data collection procedures are available for MDS research. A common approach is the collection of 'similarities data'. Respondents are presented with all possible pairs of the objects under study, e.g. brands or products, and are required to rank order the pairs from most similar to least similar, or to rate similarities between pairs of alternatives, usually on a 10-12 point scale. A number of computerised MDS analysis techniques exist. The objective of the analysis is to produce coordinates of each object in a multidimensional space or map. Coordinates are selected in such a way that the pair of objects perceived as most similar to the respondent has the smallest distance between them in the multidimensional space. The respondent may also be asked to rank order each of the objects in terms of his or her preference. A joint-space map may then be developed. Computer programs are available that allow for simultaneous consideration of preference and similarities judgements, and which provide ordinates or scores for the respondent's 'ideal' object on each selected dimension. Subsequently the analyst must infer the nature of evaluative criteria and label the axes.

MDS is used particularly to position products, i.e. to measure consumers' perceptions of a particular product relative to other products. The methodology may also be applied for the purpose of market segmentation or to identify new product opportunities.

MDS is no panacea, however, in revealing evaluative criteria used by consumers. The labelling of dimensions is often subjective and can be erroneous. Another disadvantage, and one reason for its relative infrequent use, is that evaluative criteria cannot be determined until after alternatives are rated, thus representing a rather elaborate process to arrive at limited output.

The main distinction between multidimensional scaling and conjoint analysis is that in the latter, objects are designed according to some type of factorial structure, where object attributes may be referred to as factors, and an object is a treatment combination of factorial levels. Thus, since in conjoint analysis, the 'dimensions', i.e. attributes, are specified beforehand, problems associated with interpretation of dimensions, which are inherent to MDS techniques, are avoided.

3.4 Conjoint measurement

3.4.1 Introduction

Luce and Tuckey (1964) provided the methodological framework for conjoint measurement, which originated from the fact that many quantities that one would like to measure, do not lend themselves for conventional measurement based on concatenation. This was illustrated by Luce and Tuckey with the following example. Individuals appear to be able to order pure tones according to their loudness. Evidence shows that loudness, so determined, depends upon the attributes intensity and frequency of the tone. It is not clear how to measure the joint effects of frequency and intensity on the loudness of a pure tone directly. According to axioms proposed by Luce and Tuckey (1964), measures can be assigned to intensity and frequency in such a way that the response, i.e. the loudness of a pure tone, is determined by the sum of an intensity contribution and a frequency contribution. Thus, it is possible to measure both the attributes and responses at a single stroke.

Axioms published by Luce and Tuckey (1964) were soon adopted by mathematical psychologists who further developed and extended the conjoint measurement technique. The first detailed description of the approach was published by Green and Rao (1971), who stated that conjoint measurement is concerned with the joint effect of two or more independent variables on the ordering of a dependent variable, such as preference.

Subsequently, the method has received considerable academic and industry attention. Commercial use of conjoint analysis in the United States was documented by Cattin and Wittink (1982). In their update, Wittink and Cattin (1989) concluded that annual commercial use in the period from 1981 to 1985 appears to have exceeded annual use during the 1970s. Wittink et al. (1994) reported on applications of the technique by market research agencies offering quantitative analysis to clients in Europe. Survey results indicated that in both the Unites States for the period 1981 to 1985, and in Europe during 1986 to 1991, the number of firms applying the technique has increased, with an average of slightly over three conjoint analysis projects per respondent per year being carried out. Most commercial applications documented in Europe and the United States involved consumer goods.

The structure of the current study is essentially the same as for a typical conjoint measurement study illustrated in Figure 3.7.

For determination of attributes and specification of attribute levels, for selection of the model and of the data collection method for the current study on consumer evaluation of outdoor ornamental plants, extensive use was made of literature on techniques applied in conjoint measurement studies. The relevant flow chart components are discussed in Sections 3.4.2 to 3.4.4, followed by a synthesis of findings relating to the reliability and validity of conjoint measurement in Section 3.4.5.

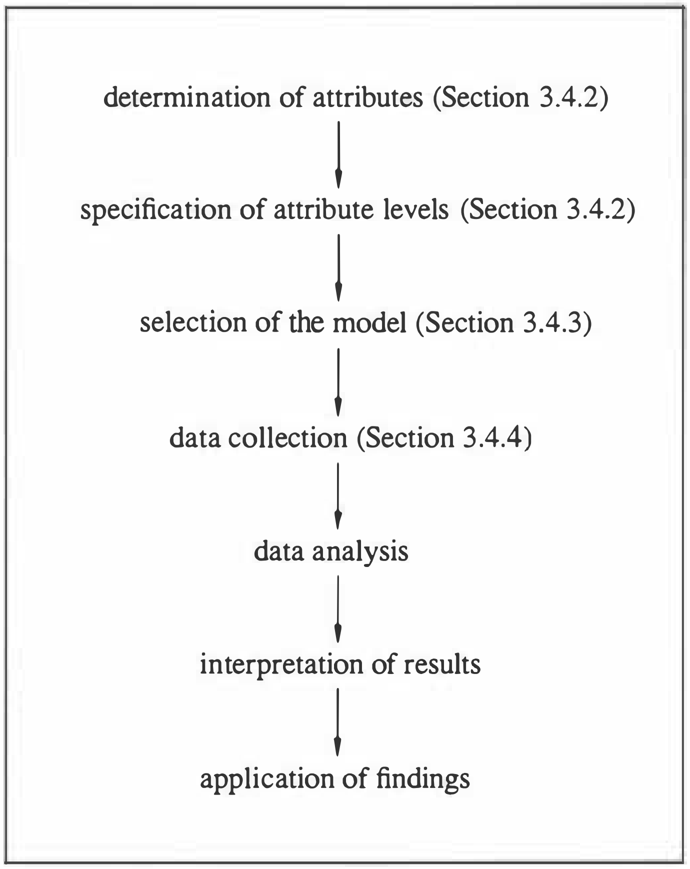

Figure 3.7 Flow chart for a conjoint measurement study

Further elaborations on issues associated with the methodology are integrated with descriptions of the specific conjoint measurement application in the current study. For example, in Section 3.4.2 only a brief overview is presented of selected aspects involved with the determination of attributes and attribute levels. A more detailed discussion of methods to identify attributes that warrant further study, follows in Chapter 4, entitled 'Elicitation of relevant attributes'.

3.4.2 Determination of attributes and specification of levels

A close relationship exists between conjoint measurement and an analysis of variance, where variation in the response variable is decomposed to obtain significance measures of proportions of this variation accounted for by contributions of separate factors. Conjoint measurement may thus be regarded as factorial measurement.

As with factorial measurement, the number of factors that can be taken into account is limited by practical considerations. It is usually not desirable, and often impossible, to include all attributes of a product in a conjoint measurement study. Generally, the total number of attributes needs to be reduced to a more manageable set consisting of the most important attributes. Determination of this set of attributes and specification of levels for each attribute, are essential preliminaries to the data collection phase because of the significant influence both have on reliability of the results.

The attribute set selected for further study, should include those that are most relevant to potential customers, and those which satisfy managerial constraint. Thus, input from the target market as well as from management should be used (Cattin and Wittink, 1982). Only in cases where it is known with certainty which attributes are most important to consumers, may management be justified in exclusively deciding upon the set of relevant attributes.

In their conjoint measurement study on telephone service quality, Lynch et al. (1994) made a conscious decision not to involve consumers directly in the elicitation phase nor in the subsequent conjoint data collection. Attributes of telephone service quality were elicited from expert regulators within the Florida Public Service Commission rather than from everyday customers. Expert regulators make assessments of quality offered by local telephone companies, and their preferences are assumed to be highly correlated with the preferences of the customers. Because expert regulators are continuously faced with assessing customer complaints in the light of services offered by a given company and of those offered by other telephone companies operating within the state, they can be expected to have preconceived stable trade-offs among regulated features. Most customers on the other hand, have never had to make choices among competing services. Non expert customers lack the knowledge about engineering interdependencies among features.

One could argue that the regulators are in fact the main 'customers' for the 'product' in the form of the weighted quality index developed by Lynch et al. (1994) to facilitate quality assessments of telephone companies. Nevertheless, since the index should eventually lead to improvement of services offered to the everyday customer, it may have been better to rely partly on direct input from the average client. Indirect feedback through the regulators may not be representative of the needs and desires of the average customer.

Earlier researchers, Myers and Alpert (1968), and Alpert (1971) suggested several alternate methods of qualitative research to facilitate identification of attributes that are considered by consumers when forming their preferences. These methods may be broadly classified as:

1) direct questioning,

2) indirect questioning, and

3) observation and experiment

Each of the approaches are discussed in Chapter 4, Section 4.3.

In determining the range of variation of attribute levels, two conflicting issues need to be considered (Green and Srinivasan, 1978). Use of stimulus descriptors similar to those that exist in reality, will increase believability and hence validity of preference judgements. This strategy has the disadvantage that variation in profile evaluations due to differences in attribute levels, may not be sufficient to detect attribute effects. For example, in a conjoint measurement study involving attribute 'price' with three levels, namely \$2, \$4, and \$6, an effect of price on profile ratings may not be classed as significant, unless respondents are extremely consistent in their ratings. Had price been defined on levels \$2, \$6, and \$10, then detection of an effect of price on profile evaluations would have been more likely.

Using ranges for attribute values that are much larger than reality may decrease validity of the respondent's preference judgements, but attributes are then more likely to exhibit sufficient variation for detection of attribute effects. Requiring subjects to evaluate products defined on unrealistic attribute levels is likely to trigger scepticism on the part of the subjects towards the evaluation task which in turn, may negatively affect the willingness of subjects to provide realistic answers. Moreover, respondents may experience considerable difficulty in interpreting potential benefits or the attractiveness of products with unfamiliar attribute levels.

For these reasons, Green and Srinivasan (1978) suggested that ranges be made larger than reality, but not so large as to be unbelievable. Understandably, Green and Srinivasan (1978) refrained from giving absolute recommendations. Thus, it is up to the researcher to conjecture an acceptable balance between expected effects of the level range on believability of preference judgements and on the ability to detect significant attribute effects on profile ratings.

Once attributes and their levels are decided upon, a model needs to be specified for the way in which overall product evaluations can be decomposed into separate attribute judgements.

3.4.3 Selection of the model

The basis for models proposed for application in conjoint measurement studies, is referred to as the part-worth model (Green and Srinivasan, 1978), which can be expressed as follows:

$$y_j = \sum_{p=1}^{t} f_p(x_{jp}) \qquad (3.6)$$

where:

y_j = individual's preference for the jth alternative,
x_{jp} = level of the pth attribute for the jth alternative, and
f_p = a function denoting 'part worths' of levels x_{jp} for the pth attribute.

The outcome of model 3.6 is a set of part worths, or utilities, i.e. numerical expressions of the value the consumer places on each attribute level.

Analogue to models (3.2 to 3.5), which relate attitude towards, or preference for, an alternative, to separate attributes, model 3.6 posits that an individual's preference for an alternative is a function of values attached to attributes possessed by that alternative. Additional assumptions about the nature of this function have led to the development of vector and ideal-point models of preference.

The vector model depicts preference as an additive linear function of separate attribute judgements, and as such is identical in mathematical form to the Rosenberg (1956) and Fishbein (1967 and 1975) models. The vector model, also referred to as the composite criterion model (Srinivasan and Shocker, 1973; Parker and Srinivasan, 1976) is represented by the following equation:

$$y_j = \sum_{p=1}^{t} b_p x_{jp} \qquad (3.7)$$

where:

y_j = individual's preference for the *j*th alternative,
b_p = individual's weights for the *t* attributes, and
x_{jp} = level of the *p*th attribute for the *j*th stimulus.

The vector model restricts the outcome to one utility for each level of an attribute, whereas the part worth model allows for different utilities for each attribute level. When the weight placed on the most important attribute is considerably larger than the second most important attribute weight, and when the latter in turn is much larger than the importance attached to the third most attribute, and so on, the evaluation rule approximates that represented by the previously defined lexicographic model.

The ideal-point model is in essence an attribute adequacy model, and can be written as follows:

$$d_j^2 = \sum_{p=1}^{t} b_p (x_{jp} - i_p)^2 \qquad (3.8)$$

where:

d_j^2 = measure of preference for the jth alternative
b_p = individual's weights for the *t* attributes
x_{jp} = level of the *p*th attribute for the *j*th stimulus, and
i_p = individual's ideal point.

Thus, in the ideal-point model, preference y_j is presumed to be negatively related to the squared distance of the location x_{jp} of the jth alternative from the individual's ideal point i_p.

The relationship between the part-worth model and the ideal-point model is represented by equation 3.9;

$$f_p(x_{jp}) \quad = \quad -b_p(x_{jp}{}^2 - 2x_{jp}i_p + i_p{}^2) \tag{3.9}$$

or by equation 3.10;

$$f_p(x_{jp}) \quad = \quad a_p + c_p x_{jp} + d_p x_{jp}{}^2 \tag{3.10}$$

where:

$a_p \quad = \quad -b_p i_p{}^2$,
$c_p \quad = \quad 2b_p i_p$, and
$d_p \quad = \quad -b_p$.

Thus, the essence of the ideal-point model can be captured in the vector model by introducing component $x_{jp}{}^2$ (Carroll, 1972).

Green and Srinivasan (1978) pointed out that problems associated with selection of an appropriate model, are not as serious as they may seem when predictive validity is considered. The ability of a model to give good predictions of behaviour is generally the main concern of researchers. Daws and Corrigan (1974) showed that linear models are often good approximations in many decision making situations.

In comparison with the vector and ideal-point models, the part-worth model is generally regarded as the most attractive because of its greater flexibility of the shape of the preference function. No prespecified assumptions are necessary about the nature of the function. Application of the part worth model allows for estimation of different utilities for the various levels of each attribute, but it does not exclude the possibility that the actual composition rule used, could be described by the ideal-point or the vector model (Green and Srinivasan, 1978). For example, if the difference in attractiveness of a cheap and an averagely priced plant is perceived as equal to the difference between a plant with an average price and an expensive plant, then both the vector model and the part-worth model would have the same outcome, namely one utility for each price level. A utility for an average price level which is higher than that for a low and a high price level, the latter being at least approximately equal, suggests that the actual composition rule used by the consumer is probably similar to the one described by the ideal-point model. Even noncompensatory evaluation rules, such as the one expressed by the lexicographic model, can be approximated by the part-worth model.

For these reasons it is not surprising that of the three models discussed in this section, the part-worth model, in particular one involving summation of main effects of attributes, was found to be the most commonly used model in commercial applications of conjoint measurement (Cattin and Wittink, 1982; Wittink and Cattin, 1989).

A disadvantage of a model including only components for main effects, i.e. simple effects of attributes on overall preference, is that interactions between attributes cannot be detected. Significant interactions may not exist, in which case a main-effects model would suffice, but this cannot be established with statistical evidence without incorporating model components for effects of interactions in the first place. Moreover, variation in utility of an attribute level with the level of another attribute, may cause significant distortions in attribute utilities inferred from models that do not take attribute interactions into account.

Meyer and Johnson (1995) in their quest for empirical generalisations in modelling of consumer choice, postulated that the rule which best describes how valuations are composed into an overall valuation is a multiplicative-multilinear function. This generalisation supports the use of models that recognise the possibility of interactions among product attributes.

The part-worth model can readily be extended to account for effects of interactions between attributes. Implications of such an extension for the experimental design are explained in Chapter 5. The part-worth model used in the current study, which allowed for uncorrelated measurement of main effects and selected interactions, is specified in Chapter 6.

3.4.4 Data collection methods

Most commercial applications of conjoint analysis involve personal interviewing. Less frequently used methods of collecting evaluative judgements from respondents include computer-interactive procedures, mail questionnaires, and telephone interviews (Wittink and Cattin, 1989). In telephone-mail-telephone procedures, respondents are recruited by telephone screening, the main interview materials are sent by mail, and subsequently data are collected by telephone (Levy et al., 1983).

Conjoint interviews are structured according to one of two basic procedures:

1) the two factor-at-a-time approach, or

2) the full-profile approach

The two-factor-at-a-time procedure, also referred to as the trade-off procedure (Johnson, 1974; Westwood et al., 1974), requires respondents to rank combinations of levels of two factors at a time. Advantages of this approach include ease of application, reduction of information overload on the part of the respondent, and the fact that it lends itself to mail questionnaire form.

A major disadvantage of the trade-off procedure is loss of realism caused by decomposing a full set of factors to two-at-a-time combinations. Respondents may not be clear as to what should be assumed about the remaining factors when evaluating combinations of levels of only two factors. Moreover, the method lends itself better to verbal descriptions of factor combinations, rather than to more realistic representations, such as illustrations or actual products. Even though the approach involves relatively easy judgements to be made by respondents, the number of evaluations required is generally large, even when partially incomplete block designs (Green, 1974) or related procedures are used. Further reduction of the number of two-way tables is only possible at the cost of excluding one or more factors from the study. Johnson (1976) pointed out that respondents may also adopt certain patterns of responses.

The model of preference formation underlying the two-factor-at-a-time method assumes that attributes studied are independent. As stated before, an unsubstantiated assumption of no interactions among attributes may lead to erroneous conclusions about relative utilities of attributes.

The full-profile approach, also referred to as the concept evaluation task, requires respondents to rate or rank combinations in which each of the factors are specified in terms of the appropriate level. The full-profile procedure was the most commonly used data collection method in commercial applications of conjoint analysis in the United States (Cattin and Wittink, 1982; Wittink and Cattin, 1989).

The procedure does not have the same limitations as the trade-off method, its major advantage being an increased degree of realism. Product profiles may consist of factor descriptions, illustrations, or combinations thereof. Even actual products may be used as profiles. An additional advantage is that the method allows the researcher to measure overall preference judgements directly using behaviourally oriented constructs, such as intentions to buy, or likelihood of trial of, the product represented by a particular profile (Green and Srinivasan, 1990).

A disadvantage of the approach is the possibility of information overload, which may tempt respondents to simplify the evaluation task by ignoring variations in less important factors, or by simplifying the factor levels themselves. Several authors reported on effects of information overload (Jacoby et al., 1974; Payne, 1976; Lussier and Olshavsky, 1979; Payne et al., 1992). Results of the study conducted by Jacoby et al. (1974) indicated that, possibly due to adoption of a simplifying strategy, increasing information load lowers the probability of correctly selecting one's 'best' brand, i.e. the brand which most closely approximates one's ideal brand, the latter being determined from importance scores the subject assigns to each product attribute.

Payne (1976) found that respondents used a noncompensatory strategy when presented with six or twelve alternatives, whereas in simpler choice situations compensatory strategies were used.

Results published by Lussier and Olshavsky (1979) also provided support for the theory that task complexity influences choice strategies used by consumers. When faced with three alternatives, subjects evaluated alternative brands using a compensatory strategy. When the number of brands was increased to six or twelve, subjects tended to use a noncompensatory strategy to eliminate unacceptable alternatives, followed by a compensatory strategy to evaluate the remaining alternatives.

In real life situations consumers usually consider a limited set of brands or alternatives, i.e. the evoked set. The crucial question is how people select their evoked sets.

Lussier and Olshavsky (1979) suggested that at least for unfamiliar products, alternatives are evaluated in a noncompensatory fashion to arrive at a limited set of alternatives for further consideration. However, further research on strategies people use for selectively attending to information would be valuable (Payne et al., 1992). Because of uncertainties that still exist about the way in which consumers resolve information overload problems in reality, especially when determining the evoked set for familiar products, it is important to minimise the risk of information overload in research situations. This is one of the reasons why full-profile procedures are generally confined to five or six factors.

Fractional factorial or related designs may be implemented to further reduce the number of judgements to be made by the respondent (Green, 1974). In fractional factorial designs, measurement of some or all interaction effects is traded off to obtain a design with a smaller number of treatment combinations. Development of fractional factorial designs is described in Chapter 5.

Traditionally, conjoint data are collected on a non-metric scale. Green and Srinivasan (1978) expected rank order data to provide greater reliability than rating scale data. They suggested that it is easier for respondents to rank objects in terms of preference than to express the magnitude of his or her preference. Nevertheless, survey results showed that the rating scale was the dominant measurement approach in commercial applications (Wittink and Cattin, 1989; Wittink et al., 1994). Reasons for their popularity may include the belief that rating scales provide interval-scaled data, and as such are suitable for analysis of variance approaches. However, this belief does not fully justify a preference for rating scales since the consequences of failure to meet the assumption of interval-scaled responses underlying the use of an analysis of variance, are not serious (Hinkle et al., 1979).

With rank order data, the maximum difference in parameter estimates for the best and worst levels of an attribute depends on the number of intermediate levels. Consequently, derived importances may not be comparable across attributes with different numbers of levels (Wittink et al., 1982).

In 1989, Wittink et al. obtained approximately the same size of the number-of-levels effect for ratings as for rank order data. They then suggested that the similarity in this effect could be due to a lack of metric quality in preference ratings. Steenkamp and Wittink (1994) showed that most respondents in their study provided metric judgements when using rating scales, and that for them the number-of-levels effect was much smaller than it was for respondents who did not satisfy the criteria for metric quality.

Until such time that causes of individual differences in metric quality of responses have been identified, the choice between the use of rating or ranking scales may therefore be guided by convenience or other subjective considerations.

Motivated by reported differences in psychological demands of judgements and choices and therefore the questionability of using responses to judgement tasks to predict choices, Louviere and Woodworth (1983) proposed that one could design conjoint choice studies in which individuals have to make purchase decisions like they do in real markets. In such studies, attribute bundles or products plus one or more non-choice options compete for consumers' choices. Thus, instead of asking respondents to rank or rate products in terms of preference, they are now asked to make the choice between 'would buy' and 'would not buy'. The choice approach to conjoint measurement has received considerable attention and has been extended in a variety of ways (Batsell and Louviere, 1991; Louviere, 1992; Louviere, 1994).

The fact that choice based conjoint studies provide an obvious parallel to real market behaviour could be regarded as an advantage over rating based conjoint studies. However, although ratings cannot readily be linked to real behavioural data since they cannot be observed directly, they can be used as input for choice simulators. Thus, assuming that there is a strong relation between ratings and probabilities of choice, rating based analyses can provide similar information as choice based analyses.

Whereas ratings can be analysed with any software package that allows for ordinary least squares regression, choice based conjoint analyses require the use of, for example, probit or logit regression models estimated by maximum likelihood procedures. Available software packages may not be able to perform such an analysis in the case where a large data set is combined with an ill-conditioned design matrix.

The most important disadvantage of choice based conjoint analysis, that is inherent to its use regardless of software availability and data set sizes, is the increased likelihood of information loss. Since respondents are forced to make a choice, information about gradations of choice is lost. For example, the choice of a most preferred product profile by an individual who expresses no problems with arriving at his/her choice is treated the same as the response of another individual who reluctantly selects the same product profile as his/her most preferred alternative. Also, the question whether or not one would buy a product, potentially leads to a large number of negative responses and only a small number of positive ones, which again equates to information loss.

3.4.5 Reliability and validity of conjoint measurement

The generalisability theory recognizes that there are several factors which could contribute to unreliability of conjoint results. This is in contrast to the assumption that the various procedures were measuring a single underlying construct called 'reliability'. According to the generalisability theory, conjoint reliability includes stability over time, attribute set, stimulus set, and over data collection procedures. Peter (1979) discussed this theory in the context of marketing.

In their review on conjoint reliability, Bateson et al. (1987) concluded that it was difficult to make generalisations from literature on reliability of conjoint analysis studies because of the large number of different procedures and approaches used. They advocated adoption of the generalisability theory to overcome confusion caused by the lack of clarity over what reliability means.

Reliability over time, also referred to as temporal stability, depends on the ability of respondents to reproduce their judgements after a certain amount of time (Bateson et al., 1987).

Using a test interval of two months, Parker and Srinivasan (1976) examined the test/retest stability for estimated attribute weights in their conjoint measurement study on consumers' preferences for rural health care facilities. Results indicated considerable temporal stability. The appropriateness of generalising findings published by Parker and Srinivasan (1976) is debatable, since their study involved only eight respondents.

However, other studies involving a larger number of respondents, also indicated that conjoint measurement is highly reliable over time (Acito, 1977; McCullough and Best, 1979; Segal, 1982; Teas, 1985).

The increase in temporal stability over six consecutive days reported by Acito (1977) may have been caused by a learning effect (McCullough and Best, 1979).

Indications of some unreliable responses in the study conducted by McCullough and Best (1979) were attributed to extreme unreliability of a few subjects. Of the seventeen differences between attribute level utilities, estimated two days apart, only one was significant.

Reliability over time may depend on the data collection procedure used. Segal (1982) compared the estimated utilities from data collected seven and ten days apart, using the two basic conjoint data collection approaches, and demonstrated that both methods provided highly reliable results, with the full-profile method being more reliable over time than the two-factor evaluation method.

Findings by Teas (1985), based on results from 148 subjects and a test/retest interval of one week, furnished further evidence of high temporal stability of the conjoint methodology.

Although results of the studies reviewed indicated that conjoint measurement is highly reliable over time, conclusions about the temporal stability of the approach should not be relied upon too heavily. A major issue when attempting to measure this component of reliability is the length of time necessary between administration of the main questionnaire and the retest. If the selected time interval is too short, respondents may use their memory to appear consistent, which means that replicates are not independent. If the time period is too long, there is a risk of changes in underlying part worths.

The most desirable lag time is difficult, if not impossible, to determine. If two identical conjoint measurement studies, carried out at different times, result in differences between estimates of one or more parameters, one cannot conclude that the technique is unreliable since the differences may be attributable to a change in underlying part worths. Moreover, it would be unrealistic to assume that subjects' evaluations of product or service attributes remain stable over an extended period of time. The existence of one particular ideal test/retest interval for conjoint reliability studies in general is highly unlikely. Factors such as the actual products under study, type of customer, and the nature of product attributes may all have an impact. Thus, studies examining temporal stability of conjoint measurement over time, must rely on establishment of a subjective balance between memory effects and influences of changed preferences for the goods or services concerned. As such, their outcomes can merely lead to conjectures, rather than well-founded conclusions about reliability over time.

The extent to which estimated parameters for a given attribute depend on other attributes or levels in the stimuli is defined as reliability over attribute sets. This form of structural reliability may be estimated by comparing results of two conjoint measurement studies with the same number of attributes and levels, but differing in one of the attributes.

McCullough and Best (1979) evaluated the structural reliability by comparing subjects' ratings for profiles describing three attributes, with a second set of ratings for profiles in which one of the attributes had been replaced by a new attribute. For one of the two products under study, no significant differences were apparent between both estimated utilities for each of the unchanged attributes. Differences between the two estimations of utilities for attribute levels of the second product were either not or only slightly significant.

Findings of McCullough and Best (1979) may be attributable to the importance of attributes included in the profiles. Reibstein et al. (1988) provided evidence for a high reliability over attribute sets that include the key attributes. They concluded that as long as the most important attributes are part of the profiles, which of the remaining attributes are included, will have minimal bearing on reliability of conjoint measurement studies. Based on their findings, Reibstein et al. (1988) suggested that in designing a conjoint study, one does not have to be overly concerned with having all attributes included in the design.

Another way of examining reliability over attribute set involves varying the number of parameters to be estimated by adding attributes, sometimes referred to as embedding. Scott and Wright (1976) demonstrated that conjoint measurement results were highly reliable over the number of five-level attributes, although reliability decreased when using six-attribute profiles rather than stimuli including two or three attributes.

To examine interactions between the number-of-attributes effect and inferred importances of product attributes, Malhotra (1982) required respondents to rank order profiles of houses with varying numbers of attributes. He demonstrated that for four of the five factors under study, the number of factors had no significant effect on their importance weights. However, the relative weight of one of the factors, namely 'presence of a separate dining room', which was regarded by respondents as the most important one, decreased significantly when the original five factors were embedded with five other factors.

A number of researchers studied reliability over attribute set by increasing the number of levels of one or more attributes. Currim et al. (1981), using a variation of the trade-off approach involving rank order data, observed that attributes defined on three levels tended to be more important on average than attributes with two levels.

Similarly, Wittink et al. (1982) documented a number-of-levels effects for rank order data obtained through the full-profile and the trade-off method.

Results published by Currim et al. (1981) and Wittink et al. (1982) were contradicted by Reibstein et al. (1988) who examined effects of the number of attribute levels by varying this number for one common attribute across five products from three to five. Irrespective of the data collection method, results did not support the theory that having fewer levels, and thus a smaller number of parameters to estimate, makes the process any more reliable. Nevertheless, research is needed to further examine interactions between reliability over attribute set and relative importances of attributes included in the set.

The impact of the number-of-levels on reliability of conjoint measurement was approximately the same for rank order data and ratings (Wittink et al., 1989). According to Steenkamp and Wittink (1994), the effect of the number of attribute levels on relative attribute importances derived from ratings, was due to a lack of metric quality of responses given by some subjects.

Findings by Steenkamp and Wittink (1994) did not exclude the possibility that in many cases, such as in the study conducted by Reibstein et al. (1988), conjoint measurement results are reliable over different numbers of attribute levels. However, it is not yet clear what the characteristics of these cases are. Steenkamp and Wittink (1994) suggested that future research should focus on reasons why some people do not provide metric responses, and on identifying differences in characteristics between 'metric' and 'other' subjects. Such information would place conjoint analysts in a better position to judge beforehand whether or not an effect of the number of attribute levels is likely to occur.

Measurement of reliability over stimulus set in its purest form involves a complete repetition of the data collection phase. Collection of responses to a holdout sample, consisting of a subset of the total number of profiles is often preferred since it is less demanding on the part of the respondent.

Using two different sets of 25 stimuli, each with five attributes, Parker and Srinivasan (1976) showed that conjoint analysis has substantial reliability over different stimuli sets. However, the measure they used was not purely one of reliability over stimulus set, since the check was performed two months later.

Although Cattin and Weinberger (1980) also confounded reliability over stimulus set with reliability over time, the high level of reliability they reported is likely to be more closely related to reliability over stimulus set since they administered the second survey only one day after the first.

With the design of the stimulus set to be presented to respondents in conjoint analyses, two conflicting issues need to be considered. Ideally, the researcher would like to include as many attributes, and hence as many stimuli, as possible. This is particularly the case when little is known beforehand about relative importances of product attributes. However, information overload on the part of the respondent quickly becomes a problem if too many stimuli are required for the conjoint study. Green (1974) suggested the use of fractional factorial designs to reduce the danger of respondent fatigue. Stimulus sets are generally designed according to some type of factorial structure. In some cases it may be possible to use only part of a full factorial design, i.e. a fraction of the total number of profiles, to measure all effects and interactions of interest. Malhotra (1982) reported that the probability of information overload increased significantly when respondents had to evaluate 25 profiles, regardless of whether five factors or ten factors were included. When using five factors, an increase in the number of stimulus profiles from 15 to 20 did not significantly affect the standard error of the parameters of the part worth function. When using ten factors, an increase in the number of profiles from 15 to 20, significantly reduced reliability.

While the use of fractional instead of full factorial designs may decrease unreliability attributable to information overload, reliability is not necessarily increased since other causes for unreliable responses may be introduced simultaneously. Darmon and Rouziès (1991 and 1994) studied reliability of conjoint analysis, using indices which capture different aspects of quality of a utility function recovery. They provided evidence in support of the hypothesis that utility functions are recovered better under a full rather than a fractional design, irrespective of the noise level in the data. These findings led Darmon and Rouziès (1994) to the conclusion that researchers should guard against the use of too few degrees of freedom in fractional designs.

Even though results were encouraging, there are still several gaps apparent in the research stream concerned with this type of reliability. While holdout samples are most commonly used to measure reliability over stimulus set, measures of reliability derived from full replication and other methods warrant further investigation. With respect to the use of a holdout sample, Hagerty (1993) advocated a research focus on the impact of the actual stimuli in the sample. Research is also needed to assess the influence of the size of holdout samples on reliability scores.
The fact that use of a fractional design may influence recovery of utility functions (Darmon and Rouziès, 1991 and 1994) stresses the importance of further investigations on effects on reliability, of different degrees of fractionation, and of the nature of stimuli making up the fraction.

Estimations of parameters in conjoint analysis studies may vary with the method used to obtain conjoint data. This component of reliability is regarded by some as convergent validity. Campbell and Fiske (1959) defined convergent validity as the agreement between two attempts to measure the same trait through maximally different methods. Their definition of reliability is based on the agreement between two attempts to measure the same trait through maximally similar methods. To clarify the distinction between maximally different and maximally similar methods, Bateson et al. (1987) considered a reliability study one where the two parts of the study, the main task and the reliability check task, both took an additive decompositional approach based on active evaluations. By this definition, studies comparing conjoint analysis results with actual behaviour or with self-explicated importances, are classified as validity studies. Reliability over data collection procedure applies only to studies comparing results obtained from multiple-factor evaluations with results from two-factor evaluations.
Several authors reported a high correlation between part worths estimated from full-profile evaluations and those from trade-off matrix procedures (Oppendijk van Veen and Beazley, 1977; Jain et al., 1979). Segal (1982) also showed that reliability measures for both multiple-factor and two-factor evaluations are good, with an overall preference for the multiple-factor evaluation procedure.

Results published by Wittink et al. (1982), who concluded that the data collection method has no significant effect on the resulting importance weights, were contradicted by Reibstein et al. (1988). Whilst Reibstein et al. (1988) found the full-profile approach to be less reliable than the trade-off procedure, Safizadeh (1989) provided evidence for a higher level of reliability of results obtained with the full-profile method as opposed to trade-off results.

Thus, even though the type of data collection procedure may have a significant impact on the reliability score, the conjoint method appears to be reliable under a variety of data collection procedures and across a number of product categories.

Akaah and Korgaonkar (1983) found significant differences between part worths obtained using traditional conjoint methods and hybrid conjoint methods. Since the latter are based on combinations of self-explicated and conjoint models, the study cannot be clearly classified as one concerned with reliability. Reported differences between attribute importance weights resulting from self-explicated methods and conjoint approaches were more directly related to differences in validity of the methods.

Bateson et al. (1987) chose to view only two types of convergent validity. Internal validity, or cross-validity, may be measured by comparing self-explicated utilities with those obtained from full-profile evaluations. External validity, also referred to as predictive validity, is associated with comparisons between conjoint measurement predictions and actual behaviour.

High correlations between results of the two data collection methods were reported by Wind et al. (1968), Green and Wind (1973), and Scott and Wright (1976). However, correlations between derived coefficients and self-reported attribute importances appear to depend upon the number of attributes included (Scott and Wright, 1976).

Results of studies examining the ability of both data collection approaches to predict full-profile responses or self-explicated attribute ratings were in favour of conjoint measurement (Dorsch and Teas, 1992; Van der Lans and Heiser, 1992). Van der Lans and Heiser (1992) demonstrated relatively high internal validity between self-explicated utilities and those derived from full-profile evaluations, but showed that conjoint measurement results are better able to predict full-profile evaluations in a calibration sample than are self-explicated results. Findings of Dorsch and Teas (1992) suggested that self-explicated methods do not possess a high degree of convergent validity when compared to full profile conjoint methods for either part-worth estimates or attribute importance ratings. Results indicated that convergent validity of the self-explicated importance ratings is much lower than that of the part-worth measures. Dorsch and Teas (1992) used self-explicated measures for each individual subject to forecast whether full-profile stimuli should be acceptable or unacceptable to that individual. Subjects were asked to indicate acceptable and unacceptable attribute levels. Subsequently respondents were required to evaluate a set of full profiles. The self-explicated approach proved to be inconsistent in the identification of acceptable and unacceptable stimuli.

The potential benefit of using self-explicated approaches as 'warmup exercises' was demonstrated by Huber et al. (1993). The purpose is then to familiarise respondents with attributes and their levels, rather than to collect preference data. Huber et al. (1993) showed that the full-profile method combined with self-explicated tasks, outperforms either the full-profile or the self-explicated method alone, in predicting choice.

Several researchers reported on the external validity of conjoint measurement (Louviere, 1974; Robinson, 1980; Montgomery and Wittink, 1980; Louviere and Meyer, 1981). Using actual behaviour as criterion variable, Louviere (1974), Robinson (1980) and Louviere and Meyer (1981) reported high levels of external validity of conjoint analysis at the aggregate level. In their study on effects of different aggregation schemes on prediction of actual job choices by MBA students, Montgomery and Wittink (1980) showed that predictions based on conjoint models were consistently better than those based on a random choice model. Predictive validity decreased with increasing levels of aggregation.

Comparisons between predictive validity of self-explicated and conjoint approaches led to inconclusive results. According to Wright and Kriewall (1980) self-explicated utilities yield good predictions of actual behaviour and outperform the conjoint approach in predictive validity under certain conditions. They expected however that, if aspects of the ranking task that induce simplifying strategies atypical in the real-world decision context can be eliminated, the derived and reported utilities would match more closely, and be equally good predictors.
Leigh et al. (1984) used the subject's choice of a calculator in a raffle as a criterion variable for assessing predictive validity of various conjoint approaches and self-explicated procedures. They found no significant differences between the external validity of conjoint analysis and self-explicated methods. Leigh et al. (1984) speculated that the self-explicated weights approach might be sufficient, perhaps even better than conjoint analysis in certain situations, e.g. when attributes are dichotomous like they were in their study, and when attribute values are uncorrelated.

In developing their review of conjoint analysis reliability and validity Bateson et al. (1987) had hoped to be able to give readers insights into the best conjoint analysis procedure and the most appropriate methodology to use for assessing reliability and validity. However, lack of conclusive results limited them to presenting conjectures rather than conclusions. They postulated that reliability and validity will be reduced when the number of factors and/or levels within factors are increased. They expected reliability and validity to be relatively unaffected by the degree of fractionation, and that the particular fractional factorial used does not influence reliability of conjoint measurement. They suggested that reliability scores based on part worths are more appropriate than those obtained with holdout samples, since little is known about the impact of size or choice of the sample on the reliability score.

Even though there is still much scope for further research into several aspects of reliability and especially of validity of conjoint analysis, most studies indicated that it tends to be a reliable technique, and that it appears to be valid. Sufficient evidence is available to validate the application of conjoint measurement in this particular study which attempted to identify determinant attributes and to provide reliable predictions of attribute importances.

3.5 Summary

The key to successful businesses lies in knowledge and understanding of consumer behaviour. Theories of consumer behaviour have evolved towards the currently dominant paradigm of the 'cognitive consumer'. Purchasing behaviour is generally regarded as a process that may be affected by personal and environmental variables. The most widely accepted representations of this view are the comprehensive models. These multiple variable models each incorporate a stage where alternatives are evaluated by the consumer. Various theories exist about the mechanics of this evaluation process, but all recognise the likelihood that consumers apply certain evaluative criteria defined in terms of desired alternative characteristics.

Compositional approaches are more explicitly based on cognitive theories than are decompositional approaches, and invest consumers not only with the skills to make rational, comprehensive decisions, but also with the ability to explain their purchasing behaviour and to quantify their evaluative criteria.

Development of decompositional methods, namely multidimensional scaling and conjoint analysis, arose from doubts about the ability and willingness on the part of consumers to disclose measurable evaluations of separate alternative attributes. Since in conjoint measurement use is made of prespecified attributes, the problem of dimension interpretation inherent to multidimensional scaling techniques, is avoided.

Conjoint measurement is a method used to quantify evaluative criteria of consumers through estimation from their overall judgements. To avoid inclusion of attributes irrelevant to consumers, preliminary data collection is needed to elicit attributes that are relevant to consumers and satisfy managerial constraint.

An additive part-worth model is the most common representation of the way in which overall product evaluations are to be separated into attribute utilities. The part-worth model can account for compensatory or noncompensatory choice strategies. Conjoint data are usually collected through personal interviews during which respondents are required to rate full profiles of alternatives. Generally, these ratings serve as input for an analysis of variance type of approach to estimate part worths for attributes specified on the profiles. Resulting estimates are measures of the importance consumers attach to each attribute level.

Results of studies examining reliability and validity of conjoint measurement were inconclusive. Nevertheless, considerable evidence exists for a high temporal stability and structural reliability of estimated attribute weights in conjoint measurement studies. Conjoint data collection procedures appear to have only a minor impact on reliability of results.

Findings of researchers comparing conjoint measurement with compositional methods are in favour of the decompositional conjoint approach. Predictive power of conjoint measurement may be improved with preliminary warm-up exercises in the form of self-explicated tasks prior to the conjoint rating tasks.

Although uncertainties are still apparent with respect to several aspects of conjoint measurement, the technique has sufficiently matured for researchers in areas other than marketing, such as horticulture, to have full confidence in the appropriateness of its application in studies examining consumer evaluations of products or services.

4. ELICITATION OF RELEVANT ATTRIBUTES

4.1 Introduction

For each product or service, at least two levels of evaluation by consumers are relevant. Firstly, consumers have an overall attitude toward the item in terms of its desirability. Secondly, they may have attitudes toward each of the item's attributes, or factors.

It is generally accepted that a correlation exists between a consumer's overall attitude and his or her attitudes towards certain attributes of the product. Riter (1966) introduced the term "determinant" for attributes which are either amongst the most frequently stated reasons for purchase, or have the highest average importance rating in a set of rated attributes. While this correlation cannot establish a causal link between attributes and plant choices, one may expect high preference for determinant attributes to lead to the choice of the plant perceived as having them.

Non-determinance does not necessarily equate to 'not important', but may relate to attributes that do not differentiate one product from another. Consumers may take these for granted, but would be highly concerned if the attributes were missing, in which case they would be classed as determinant. Thus, determinance is a dynamic concept, dependent upon perceived differences between products or services.

To date, there is no consensus as to the best approach to determinant attribute identification, but it is generally accepted that preliminary research usually helps in deciding which attributes to include in conjoint measurement studies (Green and Srinivasan, 1978; Louviere, 1988a; Van Gaasbeek and Bouwman, 1991).

4.2 Objective of the elicitation procedure

The main objective of the elicitation survey was to elicit attributes projected by the product's image that affect the level of consumers' appreciation for the product, which in the current study was defined as a flowering, evergreen, outdoor ornamental shrub. Furthermore, the survey was designed to give a measure of the relative importance of each of the elicited plant characteristics to facilitate the selection of attributes to be included in the conjoint questionnaire.

Thus, the elicitation survey was used as an instrument to avoid researcher bias and to exclude irrelevant attributes from further study, i.e. attributes which did not influence customers' buying behaviour.

4.3 Method of eliciting relevant attributes

Several alternate methods exist to facilitate the identification of determinant attributes. They may be broadly classified as direct questioning, indirect questioning, and observation and experimentation (Myers and Alpert, 1968; Alpert, 1971).

In direct approaches the respondent is asked directly why he/she bought a product or which attributes influenced his/her choice. Using Riter's (1966) definition (refer to Section 4.1), attributes are then classed as determinant or non-determinant. Kelly's repertory grid technique (Kelly, 1955) is a more elaborate variant on such a direct questioning approach, and is often suggested as a useful method of eliciting determinant attributes (Green and Srinivasan, 1978; Marr, 1983; Louviere, 1988a; Rice, 1993). Kelly's approach involves asking individuals to compare three profiles of products or services, indicating which one is different, or which two are similar, and why. Thus, a personal construct is elicited about the products or services concerned. Subsequently, all products and services with the same attribute that differentiates the profile selected from the remaining two in the first set, are eliminated from the full set. Then, the individual is required to evaluate another set of three profiles chosen at random from the remaining profiles. In this way a grid can be developed to examine ways in which constructs relate or overlap, or of similarities and differences in perceptions between the products or services under study.
Uncertainties exist about the validity and utility of the repertory test proposed by Kelly (1955) as a measure of personal constructs (Aiken, 1993). Research findings indicating that in reality the formulation of constructs often follows behaviour rather than vice versa (Aiken, 1993), cast further doubt over the appropriateness of Kelly's technique

for eliciting determinant product attributes.

Direct questioning techniques assume that respondents are capable of decomposing their overall judgements into attribute evaluations. Another assumption implied when using this method is the willingness on the part of the respondent to give honest answers.

The dual direct questioning approach, which has gained considerable popularity, consists of asking respondents to describe the characteristics of the 'ideal' brand or company in the product or service category under study. Subsequently, respondents are asked to provide ratings of a particular brand or service in terms of these characteristics. Results are then used to give an indication of the position of the brand or company in relation to the optimal brand or company image. This approach shares the same problems as the traditional direct questioning approach. Respondents may have difficulties in conceptualising the 'ideal' brand or company. They may also be unwilling to admit to some of the attributes which influence them in reality.

Alpert (1971) concluded that dual questioning appears to be superior to simple questioning methods in identifying determinant attributes. Since his findings were merely suggestive, he recommended that the decision of whether to use simple or dual questioning be dependent upon cost differences in data collection and the value of a slightly improved accuracy given by dual questioning.

Indirect questioning is defined as any interviewing approach which does not directly ask respondents to indicate why they bought a product or service, or which features or attributes are most important in determining choice.
An example is the "third person" projective questioning, where the respondent is asked to state the importance of various attributes in determining the choices of most people for a particular product.
Covariate methods may be classed as indirect, since they infer determinant attributes from respondents' ratings of product characteristics, as related to some criterion, such as product purchase, brand preference, or an overall evaluation of the product.

According to Alpert (1971), direct questioning procedures produce a more effective predictive model of overall preference than do indirect questioning approaches other than covariate methods. The latter involve questions of a format which makes comparisons with direct questioning difficult.

Observation of consumers in purchasing situations is one of the oldest techniques used for identifying consumer buying motives. As Pieters (1993) pointed out, similar actions, e.g. purchases of the same product by different customers, do not necessarily reflect identical desires. Thus, observation of consumers' buying behaviour may not be effective in identifying determinant attributes.

The experimental approach can be regarded as an extension of the observational method. An attempt is made to isolate the role of one or more specific features by holding all others constant, varying the factor in question, and then measuring the impact upon some operationally defined performance criterion, such as buying choice. Whereas the previously described methods are limited to the identification of possible relationships between respondent's answers and their behaviour, the experimental approach has the major advantage of uncovering causality.

The most appropriate method for eliciting attributes to include in further study, depends on several factors, such as the type of product, the customer groups, and the purchase environment.

To identify determinant attributes of ornamental plants, the observational and experimental approaches had little practical value. Indirect questioning was regarded as unnecessary, since the product concerned was not socially sensitive nor was it expected to involve subjective buying motives.

For these reasons, the direct questioning approach was used to elicit the required preliminary information from garden centre customers. Since the study was not aimed at investigating the positioning in the minds of garden centre customers of a particular plant species vis-á-vis alternate species, the simple questioning method was considered to be more appropriate than dual questioning. Apart from the avoidance of researcher bias, and of the inclusion of irrelevant attributes, the elicitation survey, especially when using the direct questioning method, also enabled the researcher to describe the elicited attributes in terms commonly used and therefore easily understood by customers.

Owners and managers of six and seven randomly selected garden centres in the Palmerston North and Auckland area respectively, were asked for their permission to survey their customers as they were leaving the garden centre. In Palmerston North the sample consisted of 47 respondents. In Auckland 50 garden centre customers were interviewed.

Respondents were asked to describe factors they take into consideration when deciding which outdoor, evergreen, flowering, ornamental shrub to buy. The factors 'price' and 'the number of flower buds' were given as examples.

Subsequently, respondents were asked to select from all factors mentioned during the interview, the six attributes that were the most important to him or her. They were then required to rank these six factors on a scale ranging from one, being the most important, to six being the least important.
An example answer is given in Table 4.1. The hypothetical respondent in this example

Table 4.1 Elicitation survey: answers[1] of a hypothetical respondent

factor	**most important**	**rank[2]**
number of flower buds	[*v*]	[*6*]
price	[*v*]	[*3*]
healthy...................	[*v*]	[*1*]
bright flower colour....	[*v*]	[*2*]
New Zealand native....	[ ]	[ ]
fast growing............	[*v*]	[*4*]
scented flowers..........	[ ]	[ ]
easy to look after.......	[*v*]	[*5*]
....	[ ]	[ ]

[1]: Factors taken into consideration by the respondent when selecting an outdoor, evergreen, flowering, ornamental plant to buy, are described in the first column. The respondents' selection of the six most important factors of those listed and mentioned by the respondent is indicated in the second column. Ranks assigned to these six most important factors are presented in the third column.
[2]: 1 = most important, 6 = least important.

mentioned six factors s/he takes into account when buying an ornamental plant, in addition to 'the number of flower buds' and 'price'. Of all these attributes, the factors 'native plant' and 'scented flowers' had the least impact on his or her choice, the latter being mainly influenced by the health status of the plant.

4.4 Results of elicitation interviews with garden centre customers

The assumption that customers are able to decompose their considerations into separate components is supported by the fact that respondents appeared to have no difficulties in expressing the importance to them of at least six factors.

Results of the elicitation interviews are summarised in Tables 4.2 and 4.3. For each area, only the ten most important attributes, i.e. those with the lowest average ranks are listed. A complete list of elicited factors is given in Appendix A, Tables A1 and A2. In Table 4.2 the average ranks for each of the ten factors are presented, together with the percentage of respondents who mentioned those factors as being of importance to them. Table 4.3 lists for each of these factors the percentages of respondents who ranked the factor as first in importance and/or included the factor among the three most important considerations.

It was felt that when a factor was indicated as an important consideration, without being assigned a rank, it should be given a higher degree of priority than a factor which the respondent did not consider as one of the choice affecting attributes.
Factors which had not been mentioned at all by a respondent, but had been mentioned by other respondents, were therefore given rank 9 for the respondent concerned.
Attributes which had been mentioned by a respondent, but were not included in the ranking of the six most important ones, were given rank 7.
For each of the two locations, the average rank of each attribute was calculated by dividing the sum of the ranks for the attribute concerned by the number of garden centre customers interviewed.

To garden centre customers in both Palmerston North and Auckland the health status of a plant was the most important consideration when deciding which ornamental plant to purchase. The higher standard deviation for the average rank assigned to plant health

Table 4.2 Factors elicited in Palmerston North (PN) and Auckland (AKL)

	% respondents who mentioned this factor		average rank[4]	
factor	PN	AKL	PN	AKL
health	70	90	4.2 (3.4)[5]	3.5 (2.7)
suitability[1]	70	78	5.0 (3.1)	5.1 (2.7)
price	68	70	5.5 (2.9)	5.3 (3.0)
height	72	54	5.7 (2.8)	6.6 (2.7)
flower colour	64	54	6.0 (2.8)	6.4 (2.9)
label/information	60	68	6.1 (2.8)	5.9 (2.7)
shape	45	34	6.8 (2.8)	7.3 (2.7)
flower/picture[2]	57	34	7.3 (1.9)	8.0 (1.6)
#[3] flower buds	40	24	7.4 (2.1)	7.8 (2.3)
scent	21		8.1 (2.0)	
foliage colour		26		8.1 (1.8)

[1]: for the respondent's garden, [2]: presence of at least one flower or a picture thereof, [3]: # = number of, [4]: ranks increase with decreasing importance, [5]: standard deviation

by garden centre customers in Palmerston North, indicated that they were more divided in their opinions concerning the importance of health than were respondents in Auckland.

Table 4.3 **% of respondents ranking factors as most, second most, or third most important**

	% respondents			
	1 (most important)		1, 2 or 3[3)]	
factor	**PN**	**AKL**	**PN**	**AKL**
health	28	24	60	64
suitability[1)]	15	12	45	32
price	17	16	30	32
height	13	6	21	20
flower colour	4	8	26	24
label/information	4	6	28	20
shape	4	8	19	12
flower/picture present	2	0	4	2
#[2)] flower buds	0	0	6	12
scent	2		4	
foliage colour		0		6

[1)]: for the respondent's garden, [2)]: # = number of, [3)]: 2 = second most important, and 3 = third most important

One of the major differences between both groups of respondents lay in the percentages of respondents who did not mention the factor 'health' at all. In Palmerston North, 30% of respondents did not consider plant health when selecting ornamental plants. Only 10% of garden centre customers surveyed in Auckland did not regard plant health as a determinant attribute. According to respondents who did take the health status of a plant into account, criteria for good health included the presence of green leaves with no signs of pest or diseases, strong growth from the base, and a reasonable number of young shoots.

Of next concern to garden centre customers was the suitability of the plant for the growing conditions in their garden. Seventy four percent of all customers surveyed took this factor into consideration when selecting ornamental plants for their garden. Frost tenderness, the ability to withstand certain soil types, and wind tolerance were some of the aspects determining this suitability according to respondents.

Factor 'price' received the third best average rank in both areas. Slightly higher percentages of respondents ranked this factor instead of suitability as the most important. In Auckland, equal percentages of respondents ranked both factors as their first, second, or third choice, whereas in Palmerston North more respondents selected 'suitability' as the most, second, or third most important factor.

The ranking procedure applied to factors not mentioned by one or more respondents and to those that were mentioned but not ranked, may not be entirely appropriate for the factor 'price', since it was given as an example on the questionnaire form. If a respondent did not explicitly indicate the importance of this factor to him or her, it was assigned rank 9 for this respondent. This would result in a rank higher than appropriate, if there were respondents who did not feel the need to mention the factor because it was already on the form. On the other hand, respondents may have felt more or less obliged to include the factor 'price' in their ranking of the six most important factors, in which case the attribute would have received a lower than appropriate average rank and consequently a higher importance.

For garden centre customers in Palmerston North, price was followed in importance by the attribute 'height', with most respondents being mainly concerned about the expected or final size of the plant as opposed to the height at purchase. Compared to the factor 'price', the attribute 'height' was mentioned by a higher proportion of respondents in Palmerston North, but on average factor 'price' received better ranks.

The buying behaviour of respondents in Auckland was likely to be more influenced by the presence of and the information on the label than it was by the expected final height of the plant. Sixty eight percent of garden centre customers in Auckland expressed their concern with labelling. However, only 6% believed that it was the most important consideration to them.

Flower colour was also of concern to garden centre customers in both areas, with 25% of all respondents including it in the three most important factors. Most respondents did not have a preference for a particular flower colour, but rather for a group of colours, such as bright versus soft.

Factor 'shape' was perceived as a feature consisting of several components other than just the degree of balance, such as bushiness and size. Compared to results in Auckland, a higher proportion of respondents in Palmerston North was concerned with the shape of the plant.

Of garden centre customers interviewed, 57% in Palmerston North and 34% in Auckland stated the importance of the presence of an open flower on the plant at the time of purchase, or else a picture of the flower on the label. Only 3% of all respondents included this factor in the three most important attributes.

The number of flower buds present on the plant was taken into consideration by 40% of the respondents in Palmerston North, and by 24% in Auckland, but to none of the respondents did it represent the most important consideration. The interpretation of results for this factor may have suffered from the same problems as those described for factor 'price' since the number of flower buds was also given as an example on the questionnaire form.

The tenth attribute was 'scent' according to garden centre customers in Palmerston North, a factor which ranked lower in importance than did foliage colour for respondents in Auckland.

Even though results are described in terms of relative importance, it must be borne in mind that the data were to be used only to decide which factors to include in the conjoint questionnaire. The sample was too small to draw realistic inferences about the significances of importances of elicited factors relative to one another.

It was initially intended to survey customers of garden centres on a national basis. Based on the type of factors elicited and the similarities between the results in both areas, with the nine most important factors being the same, it was decided that the potential benefit did not justify the cost of a large scale survey.

4.5 Results of elicitation interviews with producers and retailers

The ultimate objective of the present study was to link consumer preferences with products in the market place. This objective originated from the fact that this linkage was not optimal and from the hypothesis that discrepancies existed between the perceptions of producers and retailers of determinant product attributes and the customers' actual preferences. Both retailers and growers would also have their own set of desired attributes of plants to grow and sell. It would be a matter of trading off some factors to more efficiently cater for their customers' needs.

During the Annual Conference of the New Zealand Nurserymen's Association in 1990, elicitation interviews similar to those held later with garden centre customers, were conducted with twenty three growers of outdoor ornamental plants, and eighteen garden centre operators or employees. The attributes 'price', 'health', and 'number of flower buds' were given as examples.

A large proportion of the respondents tended to fill in their answers independently, without interaction with the interviewer, or responded via mail. Disadvantages of this type of data collection became apparent when tabulating the responses. Firstly, in a number of cases, it was not clear what the respondent meant with a particular attribute. For example, the attribute 'presentation' appeared to have different connotations for different respondents, such as the presentation of plants as part of a display, or the presentation of plants in terms of cleanliness of the containers. Secondly, respondents tended to mention not only product-related attributes but also desired characteristics of garden centres. Good displays, professional advice, the available selection and service offered by garden centres were elicited amongst the ten most important factors. For these reasons, the interviews with garden centre customers were conducted according to a much more interviewer-structured process, ensuring that answers were relevant and understood by the interviewer.

Results of the interviews with producers and retailers are summarised in Tables 4.4 and 4.5. Fourteen attributes that were considered to be the most important to the consumer according to retailers and producers are listed. Of these attributes, ten were explicitly product-related. Data for the remaining four attributes are presented in italics.

According to 44% of the producers and 39% of the retailers, the health status of a plant was the most important consideration for garden centre customers.

Table 4.4 **Factors elicited from retailers and producers**

factor	% respondents who mentioned this factor: growers	% respondents who mentioned this factor: retailers	average rank [3)]: growers	average rank [3)]: retailers
health	100	94	2.0 (1.3)[4)]	2.5 (2.0)
price	96	100	3.6 (2.2)	4.1 (1.8)
height	57	56	6.1 (3.0)	5.8 (3.3)
label/information	48	56	6.5 (2.8)	5.9 (2.7)
#[1)] flower buds	57	61	6.3 (2.7)	6.7 (2.2)
suitability[2)]	48	61	7.3 (2.1)	6.4 (2.5)
colour	39	33	7.1 (2.9)	6.9 (3.2)
presentation/display	*44*	*28*	*7.0 (2.8)*	*7.7 (2.5)*
professional advise	*30*	*28*	*7.7 (2.1)*	*7.5 (2.7)*
selection	*13*	*22*	*8.4 (1.5)*	*7.9 (2.2)*
service	*4*	*22*	*8.7 (1.5)*	*7.9 (2.4)*
shape	35	17	7.6 (2.2)	8.4 (1.5)
new varieties	44		8.0 (1.2)	
easy care	22	17	8.3 (1.5)	8.7 (0.8)
known plants		17		8.7 (0.8)

[1)]: # = number of, [2)]: for the respondent's garden; [3)]: ranks increase with decreasing importance; [3)]: standard deviation

Table 4.5 % of retailers and producers ranking factors as most, second most, or third most important

	% respondents			
	1 (most important)		1, 2, or 3[3)]	
factor	growers	retailers	growers	retailers
health	44	39	87	83
price	22	6	57	39
height	4	11	30	39
label/information	0	0	13	22
#[1)] flower buds	4	0	17	6
suitability[2)]	0	0	13	22
colour	9	11	17	22
presentation/display	*4*	*6*	*17*	*11*
professional advise	*0*	*6*	*4*	*11*
selection	*0*	*0*	*0*	*11*
service	*0*	*0*	*4*	*11*
shape	0	0	9	0
new varieties	0		0	
easy care	0	0	0	0
known plants		0		0

[1)]: number of, [2)]: for the respondent's garden, [3)]: 2 = second most important, and 3 = third most important

Price and health were both mentioned by nearly 100% of respondents, but ranks for health were better than were those for price. Of the retailers and producers surveyed, 85% ranked health amongst the most important three considerations. Fifty seven percent of the growers and 39% of the retailers believed price to be one of the three most important factors to consumers.

The third most frequently mentioned factor was height or size. Approximately 57% of respondents thought that the expected height or size of a plant was a determinant factor for garden centre customers. Size at purchase was treated as a separate factor and as such did not appear amongst the ten most important product attributes.

Of retailers and producers interviewed, 52% regarded presence of a label and/or the information on a label as a determinant attribute for garden centre customers, but none of them believed that it was the most important factor.

The number of flower buds was mentioned by 59% of retailers and producers surveyed, but only a small percentage included this factor amongst the most important three.
Suitability for the growing conditions in the respondent's garden was thought to be of importance to customers by 48% of producers and 61% of retailers.
Factor 'colour' in Tables 4.4 and 4.5 includes colour, flower colour, and foliage colour. Thirty six percent of retailers and producers believed that purchase decisions of garden centre customers were influenced by the colour of the plant.
Thirty five percent of producers surveyed, which was more than twice as high as that of the retailers, regarded the shape of the plant as one of the determinant attributes.
Easy care was mentioned by 22% of producers and 17% of the retailers, but none of them believed that it was one of the three most important factors to garden centre customers.

Whereas new varieties did not appear amongst the ten most important product attributes for retailers, 44% of producers thought that customers took this factor into consideration. Retailers thought that consumers were attracted to plants they knew from friend's gardens or books, rather than to new varieties or unusual plants.

Product attributes 'easy care', 'new varieties', and 'plants known from friend's places or books' did not feature on the list of attributes important to garden centre customers (Tables 4.2 and 4.3).

Several other differences between opinions of garden centre customers and those of retailers and growers were apparent from a comparison of results presented.

4.6 Comparison of customers' opinions with those of producers and retailers

The majority of factors that were taken into account by garden centre customers at purchase according to producers and retailers, also appeared in Tables 4.2 and 4.3. However, with the exception of health, the order of the factors in terms of their importance differed greatly between consumer and producer/retailer groups.

Consumers placed more emphasis on the suitability of the plant for their garden conditions than producers and retailers anticipated. Flower colour was mentioned by 59% of garden centre customers surveyed, whereas only 36% of retailers and producers thought that colour was important to consumers. For both groups of respondents the factor 'number of flower buds' was given as an example. According to 59% of producers and retailers, the number of flower buds on a plant was a determinant factor for garden centre customers, whereas in fact only 32% of consumers considered this factor when deciding which plant to buy.

Results of interviews conducted with nursery growers and garden centre operators or employees tended to be more 'skewed' than were those of customer interviews, in the sense that close to 100% of the respondents indicated the importance of factors 'health' and 'price', but the third most frequently stated reason for purchase, namely 'height', was mentioned by only just over 56% of retailers and growers.

Differences in the rank order of attribute importances supported the expectation that discrepancies would occur when trading off certain attributes against others.

During the elicitation interviews with both retailers and producers it also became apparent that their perceptions of certain attributes were dissimilar to those of their clients. For instance, whereas to garden centre customers the factor 'health' consisted of several different components, retailers and producers understood health as being mainly determined by the presence or absence of pests and disease symptoms.
This stressed the importance of investigating the meaning to respondents of elicited factors.

Because of the differences between results of interviews held with buyers and sellers, and since the consumer represented the central focus of the current study, attributes and their levels for the conjoint questionnaire were selected primarily on the basis of opinions expressed by garden centre customers.

4.7 Specification of relevant attributes and their levels

Eight attributes were selected from the elicitation phase with garden centre customers (Tables 4.2 and 4.3) for inclusion in the conjoint questionnaire, namely health, suitability for the respondent's garden, price, final height, shape, bushiness, flower colour, and leaf colour.

Since both the health status of the plant as well as its shape appeared to be correlated with the degree of bushiness of the plant, the latter was selected as a separate attribute. The importance of the presence of a label and of the information on the label were considered to be represented by that of other factors, such as the suitability for the respondent's garden, flower colour, leaf colour, and final height. Labelling was therefore excluded from the conjoint questionnaire. Since it was hypothesised that perception of the intensity of the flower colour may be influenced by the value of foliage colour, the latter was selected as a relevant attribute.

Directions for appropriate specifications of attribute levels were suggested during the elicitation interviews. The selected attributes and their levels are presented in Table 4.6. Complete descriptions and illustrations are given in Appendix B.

Based on the average cost of outdoor ornamental plants at the time of interviewing, three price levels were chosen from $6.95 to $18.95, a range slightly wider than the one existing in reality, but not so wide as to appear unrealistic.
As explained previously, the original factor 'health' was reduced to one being purely related to the absence or presence of pests and diseases, the remaining components being absorbed by other factors. Three levels were selected for the attribute 'health', namely poor, average, and good. Illustrations associated with these levels differed in the number of brown or dead leaves, a plant in poor health having twice as many brown leaves as a plant in average health condition, and a healthy plant having no brown leaves at all.

Table 4.6 Factors and levels selected for further study

factor	description	level 0	level 1	level 2
a	**price**	$6.95	$12.95	$18.95
b	**health**	poor	average	good
c	**suitability**[1)]	poor	average	good
d	**final height**	< 1m	1-2m	> 2m
e	**shape**	balanced	unbalanced	
f	**flower colour**	bright	soft	
g	**bushiness**	not bushy	bushy	
h	**leaf colour**	dark green	light green	

[1)]: suitability for the growing conditions in the respondent's garden

The suitability for the respondent's garden was described in terms of the ability of the plant to withstand a number of aspects, namely the soil type, temperature, moisture, light situation, wind, and coastal conditions. A plant with a poor suitability was described as one that was only suitable for the respondent's garden as far as two of those factors were concerned. For a plant with an average suitability four aspects were favourable, and a good suitability indicated that all six factors were suitable for growth of the plant in question.

Three final height levels were selected, ranging from up to 1m to an expected height of over 2m.

The remainder of the factors were each described in terms of two levels. The shape of the plant referred to symmetry rather than form, and as such was assigned the levels 'balanced' and 'unbalanced'.

Flower colour was classified as bright or soft, and leaf colour as dark green or light green.

To illustrate the levels of the factor 'bushiness', respondents were presented with a drawing of a bushy plant and a sparsely branched plant.

4.8 Concluding remarks about the elicitation phase

Observations during the elicitation phase of the current study led to a number of conclusions about issues not immediately associated with its primary objective, i.e. identification of attributes to be included in the conjoint phase.

It became apparent that identical attribute definitions could have different meanings to respondents, and vice versa so, that asking respondents to give their definition for an attribute associated with a specific meaning, could lead to various attribute definitions. For example, plant health, according to some respondents, was primarily associated with freedom of pests and diseases, whereas others regarded health as a composite factor including bushiness and shape in addition to freedom of pests and diseases. While most garden centre customers surveyed defined plant height at maturity as 'height', some respondents used 'size' as a definition for final height.

These observations illustrated one of the advantages of the method used to determine attributes for further study. Eliciting attributes through personal interviews with garden centre customers proved to be preferable to, for example, using mail questionnaires for the elicitation phase, because it provided an opportunity to verify and enhance understanding of plant characteristics elicited.

An advantage of mail surveys is that monetary costs involved are generally lower than are those of personal interviewing, the latter being more labour intensive. However, cost differences between both methods depend on the desired size of the respondent sample. Results of the study conducted by Griffin and Hauser (1993) suggested that personal interviews with 20 to 30 customers identify 90% or more of the customer needs in a relatively homogenous respondent sample. Thus, elicitation of relevant attributes requires a relatively small number of respondents. Of garden centre customers asked to cooperate in the elicitation phase of the current study, only a very small percentage refused, while few customers indicated their wish to complete the survey at home and to return the form by mail.

When mail surveys are selected exclusively as a means for identifying product characteristics important to customers, then more customers need to be approached than for personal interviews, since the response rate is usually low because there is no obligation for the client to complete and return the questionnaire (Brook, 1991). In general, the lower the response rate, the higher is the probability of non-response error (Tull and Hawkins, 1987). Non-response error can be a serious problem when differences between respondents and non-respondents leads the researcher to incorrect conclusions or decisions.

Personal interviews or mail surveys do not represent the only elicitation-survey instruments. Relevant attributes could also be elicited through telephone surveys or computer interviews. The latter two survey types share the potential disadvantage of mail surveys related to the effect of interview environments on respondents' frame of mind, which in turn may influence responses. Personal interviews conducted at retail outlets provide a convenient method of controlling the respondent sample if existing retail customers are targeted. Although not based on evidential facts, it is conceivable that people who have just been shopping at a particular outlet, are in a more appropriate frame of mind for answering questions about products offered than are customers who less recently were in contact with the product studied.

Respondents did not appear to experience difficulties in explaining which plant attributes they considered when purchasing outdoor ornamental shrubs. Results of the subsequent ranking task indicated that attributes mentioned before others did not necessarily represent more important plant characteristics than did those elicited later during the interview. Thus, it was justified to base conclusions about relevant attributes not on the order in which these plant factors were elicited, and not only on the number of respondents mentioning them, but also on attribute importance rankings. Griffin and Hauser (1993) provided evidence in support of the use of importance rankings in addition to frequency of mention as indicators of attribute values. Their results suggested that important needs are no more likely to be mentioned by a customer than are needs in general.

The apparent lack of correlation for some customers surveyed, between the length of time from mentioning the first attribute and the value of plant factors elicited, strengthened the prior belief that ideally time should not be felt by respondents as a restrictive element. The decision to interview only customers who were on their way out from a garden centre, was therefore not only appropriate in view of the fear expressed by some retailers of interfering with sales, but also because customers who had completed their shopping were likely to feel less constraint by time than were those who still needed time to make purchase decisions. It was also expected to be easier for these garden centre customers to refuse cooperation on the grounds of other time commitments than it was for those who were still intending to spend time shopping for garden products. Customers who were intending to shop around may have cooperated with the survey despite time constraints if they would feel uncomfortable being seen taking considerable time purchasing products. Thus, customers leaving garden centres were not only expected to feel less constraint by time than did others, but it was also anticipated that they would be more forward in indicating when this was not the case.

5. QUESTIONNAIRE DESIGN AND INTERVIEWING METHOD

5.1 Introduction

The main survey consisted of three separate parts. The part which was designed to assess the relative importance in purchase decisions of plant attributes, will be referred to as the conjoint questionnaire, and is discussed in Section 5.2.
In the conjoint questionnaire, using the full-profile approach, respondents were required to evaluate a set of plant profiles. Subsequently, attribute evaluations were inferred from the profile judgements. These deductions were analogue to those performed in an analysis of variance of data obtained through factorial experimentation. The plant attributes selected from the elicitation interviews may be referred to as the factors. The plant profiles were treatment combinations designed according to a factorial structure.

To familiarise respondents with the plant attributes presented on the plant profiles in the conjoint questionnaire, a self-explicated phase was designed in which respondents were asked to indicate the importance to them of each of the factors and to rank the attribute levels in order of preference. The self-explicated phase is described in Section 5.3.

In the last section, the third part of the questionnaire is described which was designed to investigate possible interactions between selected socioeconomic and demographic characteristics of respondents and their perceptions of plant attributes.

5.2 Conjoint questionnaire design

In designing an experiment with eight factors, four of which have two levels, and four have three levels, one would have to consider 1296 ($=3^4 x 2^4$) combinations. Since individual level analysis requires each respondent to evaluate the full set of treatment combinations, it is obvious that the size of the experimental design needs to be reduced since it is impossible for an individual to evaluate 1296 combinations. Thus, individual level analysis is ruled out, unless one is prepared to give up the possibility of obtaining information on the effects on plant profile evaluations of each of these eight factors and of selected interactions. Instead of concentrating on all eight factors which arose from the elicitation phase, one would have been forced to include a smaller number of factors in the conjoint phase. Such a trade-off between the number of profile evaluations per respondent and obtainable information is avoided when using an aggregate level

approach. Aggregate level analysis can be performed if a design is developed that reduces the number of profiles to be evaluated by each individual without reducing the total number of treatment combinations that needs to be evaluated to obtain information on effects of all selected factors and interactions.
If the fractionating process results in a number of treatment combinations that is still too large for one individual to evaluate, as it was in the current study, then blocking procedures can be used to arrive at a more manageable set size per respondent. Each respondent thus evaluates a different set of plant profiles, where the sets are designed to allow for aggregate level effect estimates of all selected factors and interactions.

In opting for an aggregate level approach possibilities of *ex post* market segmentation are reduced. Whereas individual level analysis allows for exploration of segmentation on the basis of individual utility functions, with aggregate level analyses potential segmentation criteria need to be incorporated as extra factors in the design matrix. For example, if it is likely that plant profile evaluations of respondents differ between interview locations, then the latter must be treated as an extra factor with each location as one of its levels, in addition to the selected plant factors.

In view of the exploratory nature of the present study, where an aggregated market response was all that was required, priority was given to the objective of examining the effects a large number of plant factors and selected interactions.

5.2.1 Introduction to fractional factorial designs with confounding

Factorial experimentation in which each of the possible combinations of the levels of several factors are allocated to one or more experimental units is a technique that was introduced by Fisher (1926).

The advantages of factorial experimentation over single-factor experimentation depend upon the purpose of the experiment (Cochran and Cox, 1992). Imagine the purpose is to investigate the effects of each factor over some preassigned range that is covered by the levels of that factor which are used in the experiment. An alternative to studying all factors simultaneously by means of a factorial experiment, is to conduct a series of separate experiments, each of which is dealing with only one of the factors. If factors are independent, then factorial experimentation will be more cost-efficient than such a single-factor approach. In case of independence between factors, the simple effects of a factor are equal to its main effect, so that main effects are the only quantities needed to fully describe the consequences of variations in the factor. Also, in a factorial experiment, each main effect is estimated with the same precision as if the whole experiment had been devoted to that factor alone. Thus, for quantifying the effects of two independent factors for example, one factorial experiment would be as precise and informative as two single-factor experiments, the latter requiring twice the number of experimental units.

When factors are not independent, the simple effects of a factor vary according to the particular combination of the other factors with which these are produced. In this case the single-factor approach is likely to provide only a number of disconnected pieces of information that cannot easily be integrated. The experiment reveals the effects of a factor only for a particular combination of the levels of the other factors used in the experiment.

With a factorial approach, on the other hand, the effects of a factor are examined for every combination of the other factors included in the experiment. Thus, a great deal of information is gained both about the effects of the factors and their interactions.

Practical considerations may overshadow these advantages. The experimenter frequently lacks the resources to conduct a large experiment with many treatments. Furthermore, the standard error per unit increases as the number of treatment combinations in an experiment is enlarged. The standard error is therefore likely to be higher for a large factorial experiment than for a comparable single-factor experiment (Cochran and Cox, 1992).

The size of a factorial experiment with numerous factors and consequently a large number of treatment combinations, can be limited to only a single replication. When even a single replication of a factorial experiment is beyond the resources of the investigator, or when it gives more precision in the estimates of the effects than is needed, an experiment which consists of only a fraction of a complete replication is worth carrying out.

The present experiment could be regarded as a $3^4 x 2^4$ factorial experiment, that is, an experiment involving four factors with three levels and four factors with two levels. The total number of treatment combinations required for one replication of the full factorial experiment was 1296 ($=3^4 x 2^4$). An experimental design involving factors with different numbers of levels is generally referred to as 'asymmetrical'. Symmetrical factorial designs are those where each factor has the same number of levels.

Of the factors to be included in the conjoint questionnaire, the effect of the factor 'price' was expected to interact with the effects of each of the other factors, i.e. the effect of price on preference might depend on the levels of the other factors. It seemed plausible to assume that a consumer's preference for a particular leaf colour depended on the brightness of a plant's flowers. Effects of the factors 'shape' and 'bushiness' were also likely to interact. It was considered reasonable to assume that effects of the remaining interactions were negligible. For example, few would argue that consumers' appreciation for a particular final height of a plant might depend upon the brightness of its' colours. Louviere (1988a) provided general guidelines for such prior judgements about interaction effects. He described four generalisations which are known to hold in almost all cases involving real data. Main effects explain most of the variance in responses, often 80% or more. Two-way or first-order interactions, i.e. interactions between two factors, account for the next largest proportion of variance. Proportions of variance in responses accounted for by interactions between three factors seldom exceed 2% to 3%. Finally, higher-order terms explain minuscule proportions of the variation. According to Louviere (1988a) these generalisations, coupled with the problem of how to interpret two- or higher-order interactions, justify decisions to concentrate on main effects and two-way interactions.

The subdivision of the 1296 degrees of freedom for an experiment with four factors a, b, c and d, each with three levels, and four factors, e, f, g and h, each with two levels, is given in Table 5.1. In this table, only the main effects and the interactions of interest are listed. Degrees of freedom for interactions that were assumed to be negligible, are included in the error degrees of freedom.

Information on main effects and selected interactions was obtained from the testing of only a fraction of the full factorial experiment. The general process by which this was accomplished is known as fractional replication, and is described in Section 5.2.3.

The number of treatment combinations, i.e. profiles, to be presented to each respondent for evaluation, should ideally be divisible by 2 and 3, since two- and three-level factors were involved. To avoid increasing the complexity of an already difficult task for the respondents, it was preferable to give each person the smallest possible number, namely six profiles, to evaluate.

The blocking procedure which necessitated the confounding of some effects with block effects is described in Section 5.2.4. Confounding usually reduces the increase in standard errors per unit that results when the number of treatment combinations in an experiment is enlarged.

The aim was to develop a fraction of a 2^4 experiment with treatment combinations arranged in blocks of two plots and a fraction of a 3^4 experiment with treatment

Table 5.1 Degrees of freedom (Df) for a 3^4x2^4 experiment

Effect/Interaction	Df
A	2
B	2
C	2
D	2
E	1
F	1
G	1
H	1
AB	4
AC	4
AD	4
AE	2
AF	2
AG	2
AH	2
EF	1
GH	1
AEF	2
AGH	2
error	1257
Total	1295

combinations arranged in blocks of three plots. Both fractions were then to be combined into one 2^4x3^4 experiment with six treatment combinations per block.

The construction and properties of such a factorial experiment with fractional replication and confounding are described in the following sections, initially with a simple 3^3 experiment as an example.

5.2.2 Factorial experiments

In a factorial experiment the effects of a number of different factors are investigated simultaneously. This allows for estimation of the effects of each of the factors as well as for estimation of the extent to which the effect of one or more factors varies over the levels of other factors.

Treatment combinations consist of all possible combinations of the levels of the different factors. For an experiment with three factors each of which has three levels, the twenty seven treatment combinations may be represented as in Table 5.2.

Table 5.2 Treatment combinations of a 3^3 experiment with factors *a*, *b*, and *c*

		treatment combinations					
		complete form			abbreviated form		
level of		level of *a*			level of *a*		
c	*b*	a_0	a_1	a_2	a_0	a_1	a_2
c_0	b_0	$a_0b_0c_0$	$a_1b_0c_0$	$a_2b_0c_0$	000	100	200
c_0	b_1	$a_0b_1c_0$	$a_1b_1c_0$	$a_2b_1c_0$	010	110	210
c_0	b_2	$a_0b_2c_0$	$a_1b_2c_0$	$a_2b_2c_0$	020	120	220
c_1	b_0	$a_0b_0c_1$	$a_1b_0c_1$	$a_2b_0c_1$	001	101	201
c_1	b_1	$a_0b_1c_1$	$a_1b_1c_1$	$a_2b_1c_1$	011	111	211
c_1	b_2	$a_0b_2c_1$	$a_1b_2c_1$	$a_2b_2c_1$	021	121	221
c_2	b_0	$a_0b_0c_2$	$a_1b_0c_2$	$a_2b_0c_2$	002	102	202
c_2	b_1	$a_0b_1c_2$	$a_1b_1c_2$	$a_2b_1c_2$	012	112	212
c_2	b_2	$a_0b_2c_2$	$a_1b_2c_2$	$a_2b_2c_2$	022	122	222

Effects of each three-level factor can be expressed in two ways (Kempthorne, 1962). Firstly, effects can be estimated at each of the three factor levels as a deviation from the mean yield at the three levels. The sum of the three estimates per three-level factor will then be equal to zero.

Secondly, a linear and quadratic effect can be calculated for each factor as follows. When the level of factor *a* is increased from a_0 to a_2, there are two responses to a unit amount of the factor, (a_1-a_0) and (a_2-a_1). The average effect of *a* is the sum of these two responses, i.e. $(a_2-a_1) + (a_1-a_0)$, which equals (a_2-a_0). The difference between the responses, i.e. $(a_2-a_1) - (a_1-a_0)$, is a measure of the extent to which the response changes as the level increases, and equals $(a_2-2a_1+a_0)$. The linear effect of factor *a* can therefore be defined by;

$$A = (a_2-a_0)$$

and the quadratic effect by:

$$A^2 = (1/2)(a_2-2a_1+a_0)$$

The effect of increasing the level of factor *a* from a_0 to a_2 may depend on the levels of factors *b* and *c*. In Table 5.3 the linear effect of factor *a* is defined for all possible combinations of the levels of factors *b* and *c*.

The average linear effect of factor *a* is obtained by taking the mean of the nine differences, which equals:

$$A = (1/9)(a_2-a_0)(b_0+b_1+b_2)(c_0+c_1+c_2)$$

Other effects involving the linear or quadratic component of factor *a* can be determined from the equations listed in Table 5.4. Kempthorne (1962) stressed that the procedure is an approximation of the facts. For instance, the linear effect of factor *a* is approximated by the average linear effects of *a* at each level of factors *b* and *c*. Factors are assumed to be largely linear rather than quadratic in their effects.

Table 5.3 Linear effects of factor *a* for a 3^3 experiment with factors *a*, *b*, and *c*

level of *c*	level of *b*	linear effect of *a*
c_0	b_0	$a_2b_0c_0-a_0b_0c_0$
c_0	b_1	$a_2b_1c_0-a_0b_1c_0$
c_0	b_2	$a_2b_2c_0-a_0b_2c_0$
c_1	b_0	$a_2b_0c_1-a_0b_0c_1$
c_1	b_1	$a_2b_1c_1-a_0b_1c_1$
c_1	b_2	$a_2b_2c_1-a_0b_2c_1$
c_2	b_0	$a_2b_0c_2-a_0b_0c_2$
c_2	b_1	$a_2b_1c_2-a_0b_1c_2$
c_2	b_2	$a_2b_2c_2-a_0b_2c_2$
mean linear effect of *a*:		(1/9)(sum of the above)

Table 5.4 Effects involving factor *a* for a 3^3 experiment with factors *a*, *b*, and *c*

Effect	Equation
A	$= (1/9)(a_2-a_0)(b_0+b_1+b_2)(c_0+c_1+c_2)$
A^2	$= (1/18)(a_0-2a_1+a_2)(b_0+b_1+b_2)(c_0+c_1+c_2)$
AB	$= (1/6)(a_2-a_0)(b_2-b_0)(c_0+c_1+c_2)$
AB^2	$= (1/12)(a_2-a_0)(b_0-2b_1+b_2)(c_0+c_1+c_2)$
A^2B^2	$= (1/24)(a_0-2a_1+a_2)(b_0-2b_1+b_2)(c_0+c_1+c_2)$
ABC	$= (1/4)(a_2-a_0)(b_2-b_0)(c_2-c_0)$
ABC^2	$= (1/8)(a_2-a_0)(b_2-b_0)(c_0-2c_1+c_2)$
AB^2C^2	$= (1/16)(a_2-a_0)(b_0-2b_1+b_2)(c_0-2c_1+c_2)$
$A^2B^2C^2$	$= (1/32)(a_0-2a_1+a_2)(b_0-2b_1+b_2)(c_0-2c_1+c_2)$

The division of the twenty six degrees of freedom for the 3^3 experiment is given in Table 5.5.

Table 5.5 Degrees of freedom for effects and interactions of a 3^3 experiment

Source	Degrees of freedom
a	2 (1 df for each of the 2 components of *a*)
b	2 (,, ,, ,, ,, ,, ,, ,, ,, *b*)
c	2 (,, ,, ,, ,, ,, ,, ,, ,, *c*)
ab	4 (,, ,, ,, ,, ,, 4 ,, ,, *ab*)
ac	4 (,, ,, ,, ,, ,, ,, ,, ,, *ac*)
bc	4 (,, ,, ,, ,, ,, ,, ,, ,, *bc*)
abc	8 (,, ,, ,, ,, ,, 8 ,, ,, *abc*)

Each of the twenty seven treatment combinations of a 3^3 experiment may be represented by a point in three-dimensional space with axes x_1, x_2 and x_3, the first coordinate referring to the level of *a*, the second to the level of *b*, and the third coordinate referring to the level of *c* (Kempthorne, 1962). The main effect of *a* for example, is determined by comparisons among three means; those for which $x_1=0$, for which $x_1=1$, and for which $x_1=2$. Likewise, the main effect of *b* will be represented by the comparison among three means, for which $x_2=0$, $x_2=1$ and $x_2=2$. Kempthorne (1962) described how similar representations can be derived for the remaining effects and interactions for a 3^3 design. These are summarised in Table 5.6.

Two of the four degrees of freedom of the interaction between factors *a* and *b* are given by comparisons between three sets of treatment combinations, namely:

(0,0), (2,1), and (1,2),

versus (1,0), (0,1), and (2,2),

versus (2,0), (0,2), and (1,1).

Table 5.6 Representation of effects and interactions of a 3^3 design

Effect/interaction	Representation	
A	x_1	= 0, = 1, = 2
B	x_2	= 0, = 1, = 2
AB	x_1+x_2	= 0, = 1, = 2 (modulo 3)
AB^2	x_1+2x_2	= 0, = 1, = 2 (modulo 3)
C	x_3	= 0, = 1, = 2 (modulo 3)
AC	x_1+x_3	= 0, = 1, = 2 (modulo 3)
AC^2	x_1+2x_3	= 0, = 1, = 2 (modulo 3)
BC	x_2+x_3	= 0, = 1, = 2 (modulo 3)
BC^2	x_2+2x_3	= 0, = 1, = 2 (modulo 3)
ABC	$x_1+x_2+x_3$	= 0, = 1, = 2 (modulo 3)
ABC^2	$x_1+x_2+2x_3$	= 0, = 1, = 2 (modulo 3)
AB^2C	$x_1+2x_2+x_3$	= 0, = 1, = 2 (modulo 3)
AB^2C^2	$x_1+2x_2+2x_3$	= 0, = 1, = 2 (modulo 3)

For convenience, factor *c* is not specified in these treatment combinations. Inclusion of a level for factor *c* in the first set would lead to nine treatment combinations denoted by (0,0,0), (0,0,1), (0,0,2), (2,1,0), (2,1,1), (2,1,2), (1,2,0), (1,2,1), and (1,2,2). For the first set of treatment combinations, x_1+x_2 equals 0 or 3, which can be represented as 0 (modulo 3), indicating that any number can be replaced by the remainder when it is reduced by three or a multiple of three. For the second set, x_1+x_2 takes on the value 1 or 4, i.e. 1 (modulo 3), and for the third set, x_1+x_2 equals 2. Thus, the respective comparisons corresponding to the pair of degrees of freedom for the interaction between *a* and *b* denoted by the symbol AB, are between sets of treatment combinations for which x_1+x_2 = 0, 1, or 2 (modulo 3).
The remaining two degrees of freedom of the interaction between *a* and *b*, denoted by AB^2, represent comparisons between the following sets of treatment combinations:

(0,0), (1,1), and (2,2),

versus (1,0), (2,1), and (0,2),

versus (2,0), (0,1), and (1,2).

The first set is described by $x_1+2x_2 = 0,3$, or 6, i.e. 0 (modulo 3). For the second set $x_1+2x_2 = 1$ (modulo 3), and for the third set x_1+2x_2 equals 2 (modulo 3).

Kempthorne (1962) showed that the interaction degrees of freedom for factors *a* and *b* may also be represented by AB and A^2B. The interaction degrees of freedom corresponding to A^2B are given by the contrasts among the three sets of treatment combinations specified by the following equations:

$$2x_1+x_2 = 0 \quad \text{(modulo 3)}$$

$$2x_1+x_2 = 1 \quad \text{(modulo 3)}$$

$$2x_1+x_2 = 2 \quad \text{(modulo 3)}$$

Solutions of the equation $2x_1+x_2 = 0$ (modulo 3) are the same as those for the equation $2(2x_1+x_2) = 0$ (modulo 3), which equals $4x_1+2x_2 = 0$ (modulo 3). Equation $4x_1+2x_2 = 0$ (modulo 3) may be reduced to $x_1+2x_2 = 0$ (modulo 3). Similarly, the solutions of the equation $2x_1+x_2 = 1$ (modulo 3) are the same as for the equation $x_1+2x_2 = 1$ (modulo 3). Therefore, the groups given by the symbols AB^2 and A^2B are the same. For convenience, the rule that the order of the letters is to be chosen first and that the power of the first letter must be unity has been adopted.

The above procedure, where each of the twenty seven treatment combinations is regarded as a point in a three-dimensional space with axes x_1, x_2 and x_3, will be used in the following section to describe the formation of appropriate fractions for the 3^4x2^4 factorial experiment.

5.2.3 Fractional replication of asymmetrical factorial experiments

Since main effects and selected rather than all interactions were of interest, the testing of only a fraction of all treatment combinations for the 3^4x2^4 factorial experiment would result in a more efficient estimation of the effects and interactions concerned than would a full factorial experiment.

Fractional factorial experiments were introduced by Finney in 1945. Plackett and Burman (1946) described designs for fractions of experiments involving factors with two levels. They also provided a limited number of solutions for reducing the size of experiments based on factors with more than two levels. Since then, a great variety of fractional plans have been developed for both symmetrical and asymmetrical experiments. Most of the techniques for designing fractional replicate plans that were known at the time, were reviewed by Addelman in 1963, who updated his review in 1972. For the construction of an appropriate fractional factorial design for the experiment under study, extensive use was made of Kempthorne's (1962) comprehensive description of ways in which such plans can be developed.

Several authors have discussed application of fractional factorial designs in marketing research (Holland and Cravens, 1973; Green et al., 1978; Kuhfeld et al., 1994). Holland and Cravens (1973) outlined the essential aspects of fractional factorial designs and identified different types of marketing research situations where such designs are potentially useful. They illustrated the application of a fractional factorial design in a screening experiment aimed at determining which of seven factors were important to the sales of a new candy bar.

Green et al. (1978) described fractional factorial designs for marketing experiments, other than the more or less traditional types, which are technically called Resolution V designs. The latter permit estimation of all main effects and two-factor interactions, which, depending on the number of factors involved, still may require undesirably high numbers of treatment combinations. For marketing research projects where orthogonal designs, i.e. designs that allow for uncorrelated parameter estimation, are not available, Kuhfeld et al. (1994) suggested ways in which nonorthogonal fractional factorial designs can be developed that are efficient in the sense that variances and covariances of parameter estimates are minimised.

In the following discussion, the experiment is for convenience regarded as a combination of two factorial experiments, a 3^4 factorial for which each of the treatment combinations was repeated for each of the treatment combinations of the second experiment, a 2^4 factorial.

Starting with the 3^4 experiment, with factors *a*,*b*,*c* and *d*, there are forty ways in which fractions of twenty seven treatment combinations can be developed. Analogous to the 3^3 factorial experiment described in Section 5.2.2, each of the treatment combinations for the 3^4 factorial experiment may be represented as a point in a four-dimensional space (x_1, x_2, x_3, x_4), where x_1, x_2, x_3 and x_4 can take on the values 0, 1, or 2 (modulo 3):

1) $x_1 = 0, 1, 2 \pmod 3$

2) $x_2 = 0, 1, 2 \pmod 3$

.

.

.

.

.

40) $x_1+2x_2+2x_3+2x_4 = 0, 1, 2 \pmod 3$

Considering the first possibility, there will be one fraction which consists of those twenty seven treatment combinations for which $x_1 = 0$ (modulo 3). Another consists of those for which $x_1 = 1$ (modulo 3) and the third is made up of the treatment combinations for which $x_1 = 2$ (modulo 3).

The fraction for which $x_1 = 0$ (modulo 3) is given in Table 5.7 in abbreviated form. The design presented here is in fact a 3^3 factorial experiment with factors *b*,*c* and *d* and does not allow for estimation of the main effect of factor *a*, because it is 'confounded' with the fraction. Since one is generally interested in estimating as many main effects as possible, this design has little practical value as compared to designs in which none of the main effects are confounded.

Table 5.7 Fraction of a 3^4 experiment based on $x_1 = 0$ (modulo 3)

treatment combinations for which $x_1=0$		
0000	0100	0200
0001	0101	0201
0002	0102	0202
0010	0110	0210
0011	0111	0211
0012	0112	0212
0020	0120	0220
0021	0121	0221
0022	0122	0222

If it is reasonable to assume that higher order interactions are negligible, then one could develop fractions with which only these higher order interactions are confounded. For instance, for the 3^4 factorial experiment one of the forty possible fractions of twenty seven treatment combinations could be based on the equation $x_1+x_2+x_3+x_4 = 0$ (modulo 3). This design is given by the following identity relationship:

$$I = ABCD,$$

The four confounding relations involving the main effects of factors *a*, *b*, *c*, and *d* are obtained from the identity relationship by regarding the relationship as an algebraic identity and I as unity. For example, I = ABCD, when multiplied by A gives $A = A^2BCD$, where the equality sign is used to denote "completely confounded with". In Section 5.2.2 it was shown that the symbols AB^2 and A^2B have the same meaning.

Similarly, A^2BCD equals $AB^2C^2D^2$. Thus, if the rule is adopted that the power of the first letter must be unity, then $A = AB^2C^2D^2$. The result of multiplication of the identity relationship with A^2 is A^3BCD which equals BCD, since A^3 is unity. The confounding relations for the main effects of factors *a*, *b*, *c*, and *d* may now be written in the form:

$$A = AB^2C^2D^2 = BCD$$

$$B = AB^2CD = ACD$$

$$C = ABC^2D = ABD$$

$$D = ABCD^2 = ABC$$

The above procedure is described in detail by Kempthorne (1962).

Another method to develop fractions of an s^n factorial experiment with n factors with s levels, is based on the full $s^{(n-p)}$ factorial, where p is an integer and smaller than n, and $s^{(n-p)}$ equals the desired number of treatment combinations in the fraction. The interactions of the $s^{(n-p)}$ factorial can be considered as factors to construct orthogonal main-effect plans for a symmetrical factorial experiment involving up to $(s^{(n-p)}-1)/(s-1)$ factors, each with s levels (Addelman, 1962a).

For the 3^4 experiment with twenty seven treatment combinations, (n-p) equalled three. Effects and interactions for the 3^3 experiment are listed in Table 5.8.

The fourth factor *d* could now be introduced, so that its effect was confounded with one of the effects or interactions that were assumed to be negligible.
If D was confounded with ABC, the resulting fraction would be identical to the one for which the derivation was described previously.

For a 1/3 fraction of a 3^4 experiment which allowed for the estimation of all main effects and interactions of one of the factors with each of the others, it was relatively easy to find the possible confounding relationships. Firstly, the effects for the full 3^3 experiment were listed in a single column in Table 5.9 in the same order as in Table 5.8. Subsequently, effects which were not likely to be negligible were repeated to the right of this column.

Table 5.8 Effects and interactions of a 3^3 experiment

effect	2 factor interaction	3 factor interaction
A		
B		
	AB	
	AB^2	
C		
	AC	
	AC^2	
	BC	
	BC^2	
		ABC
		ABC^2
		AB^2C
		AB^2C^2

In Table 5.9, factor *a* is regarded as factor 'price' of the experiment to be designed. As stated previously, the effect of price was expected to interact with effects of the remaining three factors.

There were six possible effects, which were assumed negligible and with which D could be confounded.

In addition, another three-level factor, *e'*, could be introduced, still allowing for orthogonal estimation of effects and interactions concerned. E, AE and AE^2 would then take up the remaining three spaces in one of the columns 1-6 in Table 5.9.

Table 5.9 Development of a 1/3 fraction for a 3^4 factorial experiment

3^3 factorial	effects/interactions assumed to be **not** negligible	**possible introductions for D, AD, AD^2** (columns 1-6)					
		1	2	3	4	5	6
A	A						
B	B						
AB	AB						
AB^2	AB^2						
C	C						
AC	AC						
AC^2	AC^2						
BC		D		AD^2			AD^2
BC^2			D		AD^2	AD^2	
ABC		AD		D			AD
ABC^2			AD		D	AD	
AB^2C			AD^2		AD	D	
AB^2C^2		AD^2		AD			D

The three-level factor *e'* could be collapsed to a two-level factor *e*. The collapsing procedure has been described by Addelman (1962 a and b), and will be explained later in this section.

Treatment combinations for a 1/3 fraction of a 3^5 factorial experiment with factors *a*, *b*, *c*, *d*, and *e'* are presented in abbreviated form in Table 5.10.

It can easily be verified that the following confounding relationships held:

D = ABC (Table 5.9, column 3), and

$E' = ABC^2$

and therefore:

$$I = ABCD^2 = ABC^2E'^2 = ABDE',$$

where E' denotes the effect of factor *e'*.

Table 5.10 Treatment combinations for a 1/3 fraction of a 3^5 experiment

treatment combinations		
abcde'	*abcde'*	*abcde'*
00000	10011	20022
00112	10120	20101
00221	10202	20210
01011	11022	21000
01120	11101	21112
01202	11210	21221
02022	12000	22011
02101	12112	22120
02210	12221	22202

The identity relationship could be used to derive the remaining confounded effects and interactions. For example, for effect A of factor *a* the following confounding relationships held:

$$A = BCD^2 = AB^2C^2D = BC^2E'^2 = AB^2CE' = BDE' = AB^2D^2E'^2 = ACDE'^2 = AC^2D^2E'$$

Factor *e'* could be collapsed to a two-level factor *e*, using the following correspondence scheme:

Three-level factor		Two-level factor
0	→	0
1	→	1
2	→	0

The resulting twenty seven treatment combinations may be abbreviated as in Table 5.11.

The levels of factor *e* did not occur equally frequently with each of the levels of any other factor. However, the condition of equal frequencies is not a necessary one for uncorrelated estimation of all effects and interactions. It was shown by Plackett (1946) that a sufficient condition for estimates of the main effects of any two factors to be uncorrelated is that the levels of one factor occur with each of the levels of the other factor with proportional frequencies. Consider two factors, *a* and *b*, occurring at r and s levels respectively. Let:

N = number of treatment combinations in the plan, and

$n_{i.}$ = number of times the ith level of factor *a* occurs in the plan,

$n_{.j}$ = number of times the jth level of factor *b* occurs in the plan, and

n_{ij} = number of times the ith level of factor *a* occurs with the jth level of factor *b*.

Table 5.11 Treatment combinations for a 1/3 fraction of a 3^5 experiment

treatment combinations		
abcde	*abcde*	*abcde*
00000	10011	20020
00110	10120	20101
00221	10200	20210
01011	11020	21000
01120	11101	21110
01200	11210	21221
02020	12000	22011
02101	12110	22120
02210	12221	22200

Hence:

$$\sum_j n_{ij} = n_{i.},$$

$$\sum_i n_{ij} = n_{.j}, \text{ and}$$

$$\sum_{i,j} n_{ij} = N$$

A necessary and sufficient condition that estimates of the components of two factors *a* and *b* be orthogonal to each other and to the mean in a factorial arrangement, is that

$$n_{ij} = n_{i.}n_{.j}/N$$

The condition of proportional frequencies can be generalized so that plans can be constructed which permit uncorrelated estimates of two-factor interactions as well as main effects.

Consider three factors, *a*, *b*, and *c*. In order for the interaction AB to be orthogonal to C, each combination of the levels of *a* and *b* must occur with the levels of *c* with proportional frequencies, that is

$$n_{ijk} = n_{ij.}n_{..k}/N \qquad (5.1)$$

For A and B to be orthogonal, the following condition must be satisfied:

$$n_{ij.} = n_{i..}n_{.j.}/N \qquad (5.2)$$

Equation 5.3 can be obtained by substituting equation 5.2 in equation 5.1:

$$n_{ijk} = n_{i..}n_{.j.}n_{..k}/N^2 \quad (5.3)$$

This condition of orthogonality of C and AB also implies that AC is orthogonal to B and BC is orthogonal to A.

Equation 5.3 was first formulated by Plackett (1946), and can easily be extended for designs with more than three factors. With four factors *a*, *b*, *c*, and *d*, the following extended version of equation 5.3 implies that the interaction AB is orthogonal to CD, that AC is orthogonal to BD, and AD is orthogonal to BC:

$$n_{ijkm} = n_{i...}n_{.j..}n_{..k.}n_{...m}/N^3$$

It is easily verified that the plan for the 3^4x2 fractional factorial, constructed by collapsing the three levels of factor *e'* to two levels of factor *e*, satisfied the proportional frequency conditions.

Efficiencies of main effect and interaction estimates obtained using proportional frequencies vary with the correspondence scheme used, and differ from those of estimates which would result from using equal frequencies of the levels of each factor. If there are two or more different correspondence schemes possible, then the relative efficiencies, i.e. efficiencies of estimates relative to those resulting from equal frequencies, may be used as criteria for determining the "best" scheme. A procedure that can be used to calculate relative estimate efficiencies is explained in Appendix C.

The orthogonal contrasts which define effects and interactions can be readily determined from a table of orthogonal polynomials (Fisher and Yates, 1938). The regression theory provides a convenient method to check the desired features of a particular design as far as orthogonality is concerned. By convention, the vector of effects and interactions is represented by β in the regression model:

$$Y = \mathbf{X}\beta + \epsilon,$$

where the vector Y is the observation vector, and **X** is the design matrix.

Estimates of the effects and interactions are given by $\beta = (\mathbf{X'X})^{-1}\mathbf{X'}Y$, where $(\mathbf{X'X})^{-1}$ is the variance-covariance matrix. The property of uncorrelated estimates is reflected in the fact that the variance-covariance matrix is a diagonal matrix. The inverse of the **X'X** cross-products matrix can be readily obtained using a computer package such as SAS, where the 'I-option' of the regression procedure prints the variance-covariance matrix (Anon., 1989a).

The 1/3 fraction of the 3^4x2 factorial design was to be combined preferably with a fraction of the 2^3 design. Ideally, the combining should be accomplished so that effects and interactions involving factors belonging to a different set (either 3^4x2 or 2^3) were orthogonally estimable. Following the conventions outlined in Section 5.2.1, the effects and interactions for a full 2^2 factorial plan with factors f and g, may be written as:

F
G
FG

It is obvious that no third factor h could be introduced, in such way that the main effects of all three factors and at least one interaction effect involving two factors, were orthogonally estimable. The only possibility that did not result in the confounding of two main effects with each other, was to confound H with FG. The confounding relationships for this example were:

F = GH
G = FH
FG = H
I = FGH

As can be seen from these confounding relationships, all main effects were confounded with two-factor interactions. None of the interactions involving two factors were unconfounded.

The remaining option was that of a combination of the 1/3 fraction of the 3^4x2 plan with the full 2^3 plan. The arrangement of the eight treatment combinations for the 2^3 experiment in four blocks of two plots, and of the twenty seven treatment combinations of the 3^4x2 experiment in nine blocks of three plots is described in the following section.

5.2.4 Confounding within fractions of factorial experiments

As explained in Section 5.2.1, it was desirable to give each person the smallest possible number of profiles, divisible by both two and three, for evaluation. This was accomplished by combining four blocks of two plots for the 2^3 experiment with nine blocks of three plots for the 3^4x2 experiment, resulting in an arrangement of 216 treatment combinations in 36 blocks of six plots.

To arrange the treatment combinations of the 2^3 experiment with factors *f*, *g*, and *h*, in four blocks of two plots, it was necessary to confound either FG, FH and GH or F, GH and FGH with block effects. Neither of these possibilities allowed for uncorrelated estimation of all relevant effects. The use of two replicates, each with a different confounding system, overcame this problem. Effects and interactions could then be estimated from the replicate in which they were unconfounded with blocks. The basic pattern of the design with partial confounding is given in Table 5.12.

Table 5.12 2^3 experiment with two replicates, in four blocks of two

Replicate I treatment combinations $f_i g_j h_k$

confounded with block effects: **FG, FH, and GH**

block 1	block 2	block 3	block 4
000	001	010	011
111	110	101	100

Replicate II treatment combinations $f_i g_j h_k$

confounded with block effects: **F, GH, and FGH**

block 1	block 2	block 3	block 4
000	001	100	101
011	010	111	110

The relative information on each effect and interaction for the system presented in Table 5.12, is given in Table 5.13.

Table 5.13 Relative information given by a 2^3 system in blocks of two.

Effect/Interaction	Relative information
F	½
G	1
H	1
FG	½
FH	½
GH	0
FGH	½

No information could be obtained on the interaction GH. Since the interaction effects of factors 'flower colour' or 'foliage colour' with factors 'bushiness' or 'shape' were assumed to be negligible, there were still four possibilities for assigning these factors to letters, so that the design allowed for estimation of effects and interactions concerned.

For the arrangement of the 3^4x2 plan in blocks of three plots, the 3^4x2 experiment was regarded as a 3^3 experiment with factors *a*, *b*, and *c*.
In finding a suitable confounding system, the highest priority was given to the main effects A, B, and C, as well as to the three-factor interactions ABC and ABC^2, which were to be replaced by D and E respectively, in the 3^4x2 experiment.

There are thirteen different systems of confounding in blocks of three for a 3^3 experiment. Since no single system of confounding was entirely satisfactory, the only way to obtain the required information was again to use the device known as partial confounding, which was also described above for the 2^3 system in blocks of two. A suitable plan was formed by the basic pattern of four replicates with the following confounding:

I AB, AC, BC^2, AB^2C^2

II AB^2, AC, BC, ABC^2

III AB, AC^2, BC, AB^2C

IV AB^2, AC^2, BC^2, ABC

The composition of the blocks was easily obtained from the definition of effects and interactions. For instance, the nine blocks for replicate I were given by the solutions of the equations,

$$x_1+x_2= i \text{ (modulo 3)}$$

$$x_1+x_3= j \text{ (modulo 3)}$$

where i, and j each take on the values 0, 1, and 2. Thus, there were nine pairs of equations, each pair giving one block.

The block containing the treatment combination 000, was that for which the equations,

$$x_1+x_2= 0 \text{ (modulo 3), and}$$

$$x_1+x_3= 0 \text{ (modulo 3)}$$

were satisfied. Solutions for the equations $x_2+2x_3 = 0$ (modulo 3) and $x_1+2x_2+2x_3 = 0$ (modulo 3) led to the same treatment combinations.

Another block was given by the equations,

$x_1+x_2= 0$ (modulo 3), and

$x_1+x_3= 1$ (modulo 3)

The nine blocks of replicate I with treatment combinations for factors *a*, *b*, and *c*, represented by the subscripts only, are given in Table 5.14.

Table 5.14 Replicate I: treatment combinations $a_ib_jc_k$ in nine blocks

treatment combinations $a_ib_jc_k$ in abbreviated form in block number:								
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
000	001	002	010	011	012	020	021	022
122	120	121	102	100	101	112	110	111
211	212	210	221	222	220	201	202	200

The relative information on each effect and interaction for the above system is given in Table 5.15. Subscripts for factors *d* and *e'* in a particular treatment combination were equal to $x_1+x_2+x_3$ (modulo 3) and $x_1+x_2+2x_3$ (modulo 3) respectively. The arrangements of treatment combinations in replicate I for factors *a*, *b*, *c*, *d*, and *e'* of the 3^5 experiment and for factors *a*, *b*, *c*, *d*, and *e* of the 3^4x2 experiment are given in Table 5.16.

Table 5.15 Relative information given by a 3^3 system in blocks of three

Effect/Interaction	Relative information
main effects	1
two-factor interactions	½
three-factor interactions	¾

Table 5.16 Treatment combinations for factors *a*,*b*,*c*,*d*,*e*', and *e* in nine blocks

Replicate I: treatment combinations $a_ib_jc_kd_le'_m$ in block number:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
00000	00112	00221	01011	01120	01202	02022	02101	02210
12221	12000	12112	10202	10011	10120	11210	11022	11101
21112	21221	21000	22120	22202	22011	20101	20210	20022

Replicate I: treatment combinations $a_ib_jc_kd_le_m$ in block number:

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
00000	00110	00221	01011	01120	01200	02020	02101	02210
12221	12000	12110	10200	10011	10120	11210	11020	11101
21110	21221	21000	22120	22200	22011	20101	20210	20020

5.2.5 Specification of the design and method of interviewing

The design for the desired fraction of the asymmetrical 3^4x2^4 experiment was completed by combining the four blocks of replicate I and those of replicate II of the 2^3 experiment (Table 5.12) with the nine blocks of each of the four replicates of the 3^4x2 experiment (Table 5.16). The design consisted of eight replicates, each with 36 blocks. Treatment combinations in eight of the 36 blocks of replicate I and II of the 3^4x2^4 experiment are given in Table 5.17.

Table 5.17 Treatment combinations $a_ib_jc_kd_le_mf_ng_oh_p$ in eight blocks (replicates I, II)

Replicate I: treatment combinations $a_ib_jc_kd_le_mf_ng_oh_p$ in block number:

(1)	(2)	(3)	(4)
00000000	00000001	00000010	00000011
12221000	12221001	12221010	12221011
21110000	21110001	21110010	21110011
00000111	00000110	00000101	00000100
12221111	12221110	12221101	12221100
21110111	21110110	21110101	21110100

(5)	(6)	(7)	(8)
00110000	00110001	00110010	00110011
12000000	12000001	12000010	12000011
21221000	21221001	21221010	21221011
00110111	00110110	00110101	00110100
12000111	12000110	12000101	12000100
21221111	21221110	21221101	21221100

Table 5.17 continued

Replicate II: treatment combinations $a_ib_jc_kd_le_mf_ng_oh_p$ in block number:

(1)	(2)	(3)	(4)
00000000	00000001	00000100	00000101
12221000	12221001	12221100	12221101
21110000	21110001	21110100	21110101
00000011	00000010	00000111	00000110
12221011	12221010	12221111	12221110
21110011	21110010	21110111	21110110
(5)	**(6)**	**(7)**	**(8)**
00110000	00110001	00110100	00110101
12000000	12000001	12000100	12000101
21221000	21221001	21221100	21221101
00110011	00110010	00110111	00110110
12000011	12000010	12000111	12000110
21221011	21221010	21221111	21221110

Each block consisted of six treatment combinations or profiles. For each respondent one block was randomly selected for evaluation. The set of profiles to be evaluated was presented to the respondent together with a card describing the rating scale. Subsequently the respondent was asked to rate each profile using the following scale:

1 = very unattractive
2 = somewhat unattractive
3 = unattractive
4 = neither attractive nor unattractive
5 = somewhat attractive
6 = attractive
7 = very attractive

In Palmerston North 288 customers of four garden centres were interviewed. This constituted one repetition of the experiment (36 blocks x 8 replicates = 288). In Wellington the experiment was 'repeated' twice (576 respondents at seven garden centres). The sample in Auckland consisted of 864 customers of 14 garden centres, with each profile set being presented to three different respondents for evaluation. The whole experiment was thus 'repeated' six times in that treatment combinations of each block were evaluated by six different people. The total number of replicates was 48.

5.2.6 Stimulus representation

To facilitate the reading of this section, the levels of each of the selected factors are presented in Table 5.18.

Table 5.18 Factors and levels selected for the conjoint questionnaire

factor	description	level 0	level 1	level 2
a	price	\$6.95	\$12.95	\$18.95
b	health	poor	average	good
c	suitability	poor	average	good
d	final height	< 1m	1-2m	> 2m
e	shape	balanced	unbalanced	
f	flower colour	bright	soft	
g	bushiness	not bushy	bushy	
h	leaf colour	dark green	light green	

Representation of factors and their levels for the full-profile method may involve variations and combinations of four basic approaches, namely verbal description, paragraph description, the use of actual products, and pictorial representation.

Advantages of the verbal description approach where respondents are presented with stimulus cards on which the levels of each of the factors are defined in words, are its simplicity and the efficiency with which the data can be collected.

The paragraph description approach (Hauser and Urban, 1977) is similar to the verbal description method, but provides a more realistic and complete description of the stimulus. To reduce information overload, the total number of descriptions is limited to a small number, which may reduce the accuracy of the parameter estimates.

Visual stimuli, i.e. actual products or pictures, are superior to verbal profiles for several important reasons. A consumer's judgement of hypothetical products is likely to be more valid the more it resembles the evaluation in the market-place environment, where the consumer is generally presented with partially described, but primarily visual products. This hypothesis is supported by the fact that the processing system involved in visual perception differs from that associated with verbal information (Paivio, 1971). The functional elements of the visual system are spatially parallel, capable of receiving, transmitting and processing information simultaneously. The verbal symbolic system on the other hand, is characterised as a sequential processing system. The grammar of a language involves a serial ordering of its elements. Furthermore, the verbal symbolic system is linked to the auditory perception, which is also based on processing serially, rather than spatially organised stimulus patterns. Using pictorial stimuli, Loosschilder and Ortt (1994) provided empirical evidence in support of the theory that an increase in realism of stimuli has a positive effect on the validity of respondents' judgements. Results suggested that a high degree of realism is particularly important for products with which respondents are not familiar. Loosschilder and Ortt (1994) proposed that for commonly known products, consumers base their evaluations of functional aspects on sources of information other than the representation, such as previous experience. With respect to unfamiliar products on the other hand, a close inspection of the representation may form the primary basis for alternative evaluation.

The processing systems associated with verbal and visual stimuli also influence the quantity of information which can be evaluated by a respondent within a certain time frame, without resorting to simplifying the evaluation task. With visual stimuli, the likelihood of information overload is reduced since the respondent is not required to read and subsequently visualise information (Green and Srinivasan, 1978). Because the evaluation task is less fatiguing and more interesting when visual rather than verbal stimuli are used, higher task involvement and motivation on the part of the respondent may be expected.

The visualising process involved with the interpretation of verbal information, will not always lead to the same perception for all respondents. If the levels of for instance the factor 'plant health' are illustrated, perceptions of the attribute 'health' will be more homogeneous across respondents than when terms such as 'poor', 'average' and 'good' are used to describe the health levels.

The use of visual stimuli is strongly recommended when the design of a product is expected to be an important feature, and especially for products of which the styling is difficult to describe (Holbrook and Moore, 1981; Page and Rosenbaum, 1992; Loosschilder et al., 1995). Yamamoto and Lambert (1994) demonstrated that even evaluations of industrial products, which unlike consumer products, are conventionally regarded as having no significant aesthetic value, are influenced by product appearance. Using photographs of selected industrial products, they showed that in some cases the influence of product appearance exceeded the effect of certain product performance or price attributes.

Where evaluative judgements are influenced by subjective phenomena, such as styling, product evaluations may depend on interactions between design features. Holbrook and Moore (1981) confirmed their hypothesis that for objects with visual appeal, such interactions are easier to detect in pictorial displays than they are in verbal presentations. Their findings also supported the hypothesised tendency of pictorial representations to elicit a larger number of main effects compared to verbal descriptions. According to Holbrook and Moore (1981) this is consistent with the view that processing systems involved in visual perception tend to be more holistic and integrative.

In some cases the use of visual information may escalate research costs. However, as Louviere et al. (1987) pointed out, the time and effort involved in developing verbal profiles of a suitable quality, i.e. verbal descriptions that correspond with actual products, may considerably outweigh the costs of preparing and administering visual materials.

Apart from the greater degree of realism of the judgement task, the use of actual products or pictorial stimuli has the added advantage that attribute-order effects on profile evaluations are avoided. Several authors suggested that the order in which attributes are presented on written profiles may influence relative attribute importances to respondents (Acito, 1977; Huber et al., 1993; Chrzan, 1994). The position of an attribute on the stimulus card may be interpreted by a respondent as an indication of its relative importance. Respondents may adopt a simplifying strategy in evaluating profiles, such as always considering the attributes at the top of a stimulus card first, and ignoring or paying less attention to the remainder. Although no predictable pattern of attribute-order effects on utilities was revealed, Chrzan (1994) advised researchers to rotate the attribute sequence on profiles across respondents to offset the order bias. When existing products can be used instead of written profiles, such manipulations are not necessary. Effects of presentation factors, such as dominance of certain features over others due to their location on the product or their prominent colour, will then be identical to those occurring in reality.

Ultimately, the choice of profile-production method depends mainly on the product concerned, its relevant attributes, and the nature of the study. These factors also determine the appropriateness and practicalities of using actual products, which clearly represents the most preferred method in terms of realism. Oprel (1990) reported no practical difficulties in presenting respondents with real specimens of Saintpaulia and Dieffenbachia. Subjects were required to give an overall impression of each plant and to specify which characteristics influenced their judgements. Because of their controlled production environment, indoor plants lend themselves better for certain manipulations than do outdoor plants. For example, with indoor crops it is easier to achieve uniform groups each with specific degrees of bushiness than it is with outdoor plants. Also, the exploratory nature of the study asked for variety, rather than structured differences among plant specimens. The objective was to identify criteria for evaluating existing plant species, rather than to quantify the relative importance of each evaluative criterion. Thus both the product concerned and the nature of the study conducted by Oprel (1990), made the use of actual products as stimuli possible.

For the current study the use of actual products was considered. To avoid biases due to the fact that respondents may prefer one particular plant species over another species, all plants within the stimulus set had to belong to the same species. This created a major problem. It was impossible to find one plant species with for instance three different final heights, unless cultivars of the same species were used with each reaching one of the required sizes. However, cultivars were inappropriate since their appearance generally differs from each other and from the species they stem from. They may be dissimilar in attributes such as shape, leaf colour and preferred growing conditions. Therefore, the use of several cultivars belonging to the same plant species could lead to problems relating to the levels of characteristics other than those for which they were selected.

When using one plant species without resorting to cultivars, a description could be added to each of the plants to be presented to the respondent, indicating a fictitious final height. However, the willingness to respond, as well as evaluation judgements of respondents who are aware of the actual final height of the plant species concerned, may then be influenced by the knowledge of being presented with semi-realistic stimuli.

Familiarity of customers with plant species to be evaluated may cause biases in responses due not only to an awareness of discrepancies between real and actual attribute levels, but also to other factors. Recognition of a plant species may be associated with a judgement in the context of his or her experience with the species concerned. Thus, stimuli may be 'prejudged' to some extent. If, because of a prejudgement, only part of the rating scale is used by the respondent, then differences between importances attached to various plant factors are likely to be smaller than appropriate.

Practical difficulties of the use of actual plants, such as transportation, storage, and maintenance for the duration of the conjoint interviewing phase, could be partly overcome by photographic means. However, the disadvantages of using live plants described previously also apply to photographs of plants. An added complication with the use of photographs is that of reproducing colours of leaves and flowers with consistent hues and intensities. Problems associated with the photographed products may be avoided by using other techniques for the creation of visual stimuli. Loosschilder et al. (1995) reviewed alternative methods for the preparation of pictorial representations other than photographs. Traditional approaches include two-dimensional drawing and three-dimensional model making. Nowadays, computer-aided design and computer graphics are available for two- and three-dimensional visualisation of products. Loosschilder et al. (1995) suggested that in view of the importance of realism, coupled with the need for efficiency, computer-aided creation of conjoint stimuli is more promising than are hand-crafted techniques.

In the current study, profiles had to be realistic only to a certain degree. To avoid species- or cultivar-specific judgements and to prevent presentation of unrealistic specimens to respondents, plants presented on the stimuli were not to resemble particular existing plants. For example, Lavenders, such as those belonging to the species *Lavandula dentata*, are generally offered as bushy plants. Thus profile illustrations resembling spindly Lavender plants may seem unbelievable to respondents, and as such, could influence subjects' ability and willingness to give meaningful answers. *Lavandula dentata* plants usually have pale purple flowers. Profiles showing specimens with brightly coloured flowers may cause the attribute 'flower colour intensity' to account for a larger proportion of the variation in responses than an identical difference in flower colour intensity would cause for evaluation of other plants which are commonly available both with bright or soft coloured flowers, such as hybrids of *Fuchsia fulgens* and *Fuchsia magellanica*.

Since realism was not of primary importance in the current study, advantages of using computer-aided designing profiles did not outweigh the costs of purchasing the required software and of acquiring the skills to use it.

Taking into account the considerations mentioned previously, and because of the nature of the product, it was decided that a mixture of verbal and hand-crafted pictorial presentation would be used. The reason for not using illustrations only, was that some of the plant attributes, such as the final height and the suitability for the respondent's garden, did not lend themselves for this approach. The selected method was by far the more popular stimulus presentation approach used in commercial applications at the time (Green and Srinivasan, 1990).

To avoid problems associated with familiarity of the respondent with the plants to be evaluated, a hand drawing of a hypothetical plant, bearing no obvious similarities to existing plant species was created. On the profile cards, levels of factors 'health', 'shape', 'bushiness', 'flower colour', and 'leaf colour' were illustrated as characteristics of this hypothetical plant. The respective levels of price, suitability for the respondent's garden, and final height were described underneath the illustration. Figure 5.1 shows the profile card representing the treatment combination $a_1b_2c_2d_1e_0f_0g_1h_0$, i.e. a healthy, balanced, bushy plant, priced at \$12.95, with a good suitability for the garden, a final height of 1-2m, brightly coloured flowers, and dark green leaves.
An illustration or description for each of the factor levels is provided in Appendix B.

There were 48 ($=3\text{x}2^4$) treatment combinations when considering only the five plant attributes that were to be illustrated rather than described. To reduce the costs and impracticalities associated with the use of 1296 different profile cards, the required 48 illustrations were prepared and attached to the top half of laminated cards.
The descriptions of the 27 ($=3^3$) treatment combinations involving the remaining factors were prepared separately.
Subsequently, full profiles were made up by attaching the laminated description cards to the bottom half of the profile cards. The use of photo corners for the attachment of the description cards provided a convenient method for changing the treatment combinations on the profile cards.
Magnetic strips were glued to the back of the profile cards, so that the latter could be attached to a magnetic white board for presentation to respondents during interviews.

FINAL HEIGHT:

1-2 m

SUITABILITY FOR YOUR GARDEN:

GOOD

PRICE:

$ 12.95

Figure 5.1 Profile card for treatment combination $a_1b_2c_2d_1e_0f_0g_1h_0$[1])

[1]): $a_1b_2c_2d_1e_0f_0g_1h_0$ = a healthy, balanced, bushy plant, priced at $12.95, with a good suitability for the garden, a final height of 1-2m, brightly coloured flowers, and dark green leaves

5.3 The self-explicated part of the questionnaire

During the interview, respondents were asked to complete a self-explicated task prior to rating the plant profiles and before answering questions about themselves.
The self-explicated part was included in the questionnaire for two reasons, the most important one being the familiarisation of the respondent with the attributes and levels included in the conjoint part of the survey. Huber et al. (1993) showed that a combination of self-explicated and full-profile approaches was more effective in predicting choice shares than was either method alone. Results indicated that the full-profile approach is likely to be more effective when preceded rather than followed by a self-explicated task in which respondents can familiarise themselves with attributes and levels included in the study. The motivation for Huber et al. (1993) to study combinations of alternative preference elicitation procedures was related to the distinction between judgement and choice. Most market research studies, in which choice prediction is the major objective, elicit respondents' judgements. Although it is possible that choice equates to a particular degree of preference, over a period of fifteen years several authors emphasised the differences between choice and judgements in psychological demands on respondents (Payne, 1976; Bettman and Park, 1980; Payne, 1982; Louviere, 1988b; Huber and Klein, 1991). Huber et al. (1993) selected three elicitation procedures, each of which had been reported or postulated to evoke different processing strategies in respondents. Results provided evidence in support of the hypothesis that a combination of such approaches would approximate choice better than would any one single elicitation process. However, the increased effectiveness of combined approaches is not necessarily due to the presumed ability of each elicitation approach to tap into different aspects of choice. The value of using a preliminary elicitation phase may well be rooted simply in preparing respondents for the subsequent data collection phase. One could argue that a similar familiarisation process takes place in reality in the form of information gathering and processing prior to evaluation of alternatives.

Without prior exposure to the nature of plant attributes involved in the conjoint questionnaire, it would be difficult to interpret the illustrations on the profile cards. The fact that on each profile card a plant was illustrated in terms of five different plant attributes might not be immediately obvious. To facilitate the rating task and to minimise the risk of overlooking differences between profile cards, it was felt of importance that respondents were aware of this fact.

Self-explicated importances of the selected plant characteristics and rankings of their levels also provided a basis for assessing the validity of expectations about the amount of agreement among respondents. The latter was important for deciding upon an appropriate aggregation level for analyses of variance of data obtained in the conjoint phase of the study. The simplest approach to analysing conjoint data is to perform an analysis of variance of aggregated data, that is one analysis of all data, as opposed to several analyses of smaller groups of data. In an analysis of variance, the effect of a factor will only be detected as significant if there is substantial agreement among respondents about its importance. If, for example, half of the respondent sample prefers one level of a two-level attribute, and the other half prefers the other level, then the effect of the factor on overall responses will not be statistically significant. Thus, for an attribute to have a significant importance at the aggregate level of a respondent sample, then two conditions must be met (Moore, 1980). Firstly, a large number of people must regard it as an important attribute. Secondly, there must be substantial agreement on its most preferred level.

The product group selected for the current study was expected to generate relatively homogenous answers in comparison to a more specific product category, e.g. specimens of a particular species, such as *Lavandula dentata*, or of a specific genus like *Rosa*. Outdoor, evergreen, flowering ornamental shrubs were defined on attributes applicable to any specimen belonging to this diverse group. The attribute levels selected, with the exception of those for foliage and flower colour, lent themselves for prior conjectures about attribute level preferences. For example, common sense led to the expectation that most people would prefer healthy over unhealthy plants, and plants well suited to intended growing conditions over plants with a poor suitability. Respondent evaluations of attributes with a less general nature, such as foliage colour and flower colour, were expected to be more heterogenous. Incorporation of the self-explicated phase prior to the conjoint data collection provided a means of verifying such expectations.

Respondents were presented with 'explanation cards' (Appendix B), on which all factors and their levels were described, as well as illustrated where appropriate.
They were required to rank the levels of each factor in the order of preference, from 1, being the least attractive to 2 or 3, being the most preferred where a two- or a three-level factor respectively was concerned. Subsequently respondents were asked to assume that they were intending to buy an evergreen ornamental plant for their garden. They were then required to indicate the importance of each of these factors in determining their choice for a particular plant on a five-point scale ranging from very unimportant to very important.

Instructions for the self-explicated phase are given in Appendix D as part of the complete questionnaire. These written instructions only served as reminders for the interviewer, since in almost all cases respondents were instructed verbally.

5.4 The socioeconomic part of the questionnaire

Personal characteristics of respondents were likely to affect responses in the self-explicated and the conjoint part of the design. To test this hypothesis, and to obtain demographic statistics on the nature of the sample, respondents were asked to answer a set of questions about themselves. The issue of confidentiality was stressed to them as well as the right to ignore questions they did not wish to answer.

The socioeconomic part of the questionnaire had been pretested during the elicitation interviews. The questions were adjusted and are listed in Appendix D as part of the complete questionnaire.

General questions relating to the type of household, gender, age, occupation and gross household income of the respondent were included, as well as questions pertaining to characteristics relating specifically to the nature of the present study, such as expenditure on plants, time spent on gardening, the size of the respondent's section, the age of his or her house, and whether or not the latter was owned or rented by the respondent.

A relatively high number of categories was selected for each of these factors with the view of reducing it later where appropriate, to avoid categories with very small percentages of respondents.

Garden centre customers were interviewed about their personal characteristics after the self-explicated and prior to the conjoint part of the questionnaire. Since the profile rating task might appear daunting to some respondents, it was thought that this sequence would be the least threatening and would therefore be more likely to ensure completion of all parts by each respondent.

6 EVALUATION OF ORNAMENTAL PLANTS AS AFFECTED BY PLANT FACTORS

6.1 Introduction

The main objective of the current study was to determine which of the selected plant characteristics had a significant impact on garden centre customers' opinions about outdoor, evergreen, flowering ornamental shrubs. Furthermore, the relative importance of each of the plant factors in determining consumers' preferences was to be quantified. The first null hypothesis to be tested stated that there were no treatment effects, i.e. that consumers' opinions about the plant attributes included in the study did not influence their overall judgements of outdoor ornamentals. Should this null hypothesis be rejected, then similar null hypotheses would be tested for each of the selected plant characteristics. Information required for the testing of such null hypotheses for experiments with a factorial design is generally obtained through an analysis of variance.
In the following sections, results of the analysis of variance performed on data from the conjoint interviews is described. The discussion includes a presentation of estimated effects of plant factors at specified levels and of the relative importance of each significant effect and interaction.

6.2 Introduction to the analysis of variance of conjoint data

The foundation of conjoint analysis rests on the generally accepted theory that a consumer's evaluation of a product can be separated into judgements about the product's attributes (Lancaster, 1966).

For reasons explained in Section 3.4.3, the overall evaluation of an outdoor evergreen flowering plant was assumed to be an additive function of judgements about plant attributes and interactions. This assumption implied that plant profile ratings could be modeled by adding the effects of attributes and interactions. If, for example, variations in evaluations of plant profiles were completely accounted for by effects and interactions of factors *s* and *t*, each with two levels, then, based on the previous assumption, a customer's judgement of a plant profile was described by the following model:

$$\text{rating}_{ij} = \mu + S_i + T_j + (ST)_{ij} \tag{6.1}$$

where:

rating_{ij} = rating for profile ij, with i and j taking on the values 0, or 1,
μ = mean of profile ratings,
S_i = effect of factor *s* occurring at level i in profile ij,
T_j = effect of the jth level of factor *t*, and
$(ST)_{ij}$ = interaction between *s* and *t*.

The following numerical example is included to recapitulate how effects on profile ratings of factors *s* and *t* in model 6.1 could be estimated using procedures described in Chapter 5. The four treatment combinations of factors *s* and *t*, can be written in terms of the values of their respective levels i and j, as 00, 01, 10, and 11. In treatment combination 00, both factors occur at level 0, i.e. i and j are both equal to 0. Level 0 of factor *s* is combined with level 1 of factor *t* in treatment combination 01. Hypothetical ratings for profiles representing these four combinations are listed in Table 6.1.

Table 6.1 Hypothetical ratings for profiles defined on factors *s* and *t* with levels i and j respectively

i j	rating
0 0	1
0 1	4
1 0	2
1 1	7

The estimated effect of factor *s* when level i = 0, is equal to the difference between the mean yield of treatment combinations containing level i = 0 of factor *s* and the mean yield of all treatment combinations, i.e.:

$$S_0 = ((1+4)/2) - (1+4+2+7)/4 = -1$$

Similarly, factor *s* can be shown to have an estimated effect of 1 when i=1. Estimates for effects of factor *t*, denoted by T_0 and T_1 , are equal to -2 and 2 respectively.

The interaction $(ST)_{ij}$ between *s* and *t* has two components defined by $(ST)_{(i+j) \bmod 2}$. The estimated effect of component $(ST)_0$ is equal to the difference between the mean yield of treatment combinations for which i + j = 0 (modulo 2) and the overall mean μ, i.e.:

$$(ST)_0 = ((\text{rating}_{00} + \text{rating}_{11})/2) - \mu =$$

$$= ((1+7)/2) - (1+4+2+7)/4 = 0.5$$

The estimated effect of $(ST)_1$ is obtained by subtracting the overall mean from the mean yield of treatment combinations i=0 with j=1, and i=1 with j=0, and is equal to -0.5.

A definition of the interaction $(ST)_{ij}$ that easily lends itself for generalisation is given by the following formula:

$$(ST)_{ij} = \text{rating}_{ij} - (\mu + S_i + T_j)$$

$$= \text{rating}_{ij} - (\text{prediction based on single factors})$$

Thus, the two-factor interaction refines a prediction based on just main effects. Similarly, a three-factor interaction refines a prediction based on main effects and two-factor interactions.

Since in this example, ratings are assumed to be completely explained by model 6.1, each observation is exactly equal to the sum of estimated effects and interactions involved. For example:

$$\text{rating}_{00} = \mu + S_0 + T_0 + (ST)_{00}$$

$$= 3.5 - 1 - 2 + 0.5 = 1$$

Model 6.1 can readily be extended to incorporate effects of other factors and interactions. Ratings for plant profiles developed according to the design described in Chapter 5, could be expressed as:

$$\begin{aligned} \text{rating}_{ijklmnop} = \; & \mu + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p + \\ & A_iB_j + A_iC_k + A_iD_l + A_iE_m + A_iF_n + A_iG_o + A_iH_p + \\ & E_mG_o + F_nH_p + \\ & A_iE_mG_o + A_iF_nH_p \end{aligned} \quad (6.2)$$

where:

$\text{rating}_{ijklmnop}$	=	rating for profile ijklmnop,
$A_i, \ldots, H_p$	=	estimated effects of factors *a, b, c,...,* and *h*, listed in Table 6.2, where i,j,k, and l each represented one of three levels with the values 0, 1, or 2, and subscripts m, n, o, and p could take on the values to 0 or 1, and
$A_iB_j, \ldots\ldots, A_iH_p$	=	first-order interactions between factor 'price' and each of the remaining factors, and
$A_iE_mG_o$, $A_iF_nH_p$	=	second-order interactions.

Table 6.2 Description of factors selected for the conjoint questionnaire

Factor	Description
a	price
b	health
c	suitability for the respondent's garden
d	final height
e	shape
f	flower colour
g	bushiness
h	leaf colour

Model 6.2 specified that a respondent's rating for a particular profile was equal to the sum of the mean rating and effects of factors 'price', 'health', 'suitability', 'final height', 'shape', 'bushiness', 'flower colour' and 'leaf colour', and of selected interactions.

Generally, models are simplified descriptions of phenomena. Since they are expected to approximate rather than equate to reality, an error term should be included to account for variation in responses not explained by the model.
If one assumed that only one two-level factor had an effect on responses, then the mathematical description of plant profile ratings, including an error component, was given by:

$$Y_i = \mu + X_i + \epsilon_i \qquad (6.3)$$

where:

Y_i = response variable,
μ = mean of the two profile ratings,
X_i = effect of factor x occurring at level i, and
ϵ_i = error in observation Y_i.

The ϵ_i's were assumed to be from a population of ϵ's with mean zero. A requirement for valid inferences about a population is that errors be uncorrelated (Steel and Torrie, 1987). In the present study, this was assured by drawing the sample in a random manner.

In conventional regression terms, model 6.3 could be written as:

$$Y_i = \beta_0 + \beta_1 \mathbf{X}_i + \epsilon_i \qquad (6.4)$$

where:

Y_i = response variable,
β_0 = population Y intercept, i.e. the mean of the observations,
β_1 = slope of the line through the means of the Y populations, and
$\mathbf{X}_i$ = coefficient associated with the effect X_i of factor x occurring at level i. (Steel and Torrie, 1987).

Tables of coefficients for orthogonal contrasts which define effects and interactions, are readily available (Fisher and Yates, 1938). For a two-level factor x, the coefficients are -1 for level 0, and 1 for level 1, i.e. $\mathbf{X}_0=-1$ and $\mathbf{X}_1=1$. From equations 6.3 and 6.4, it follows that X_i equals $\beta_1\mathbf{X}_i$. Thus, $X_0=-\beta_1$, and $X_1=\beta_1$.

The response variable Y is also termed the dependent variable since any Y value depends on the population sampled. The **X** variable is called the independent, explanatory or predictor variable. It should be noted here that the term 'independent' does not imply that the explanatory variables are independent amongst themselves.

Components of the equations describing responses of a hypothetical experiment involving two observations, may be written in vector and matrix notation as follows:

$$Y = \begin{bmatrix} Y_0 \\ Y_1 \end{bmatrix} \quad \mathbf{X} = \begin{bmatrix} 1\ \mathbf{X}_0 \\ 1\ \mathbf{X}_1 \end{bmatrix} \quad \beta = \begin{bmatrix} \beta_0 \\ \beta_1 \end{bmatrix} \quad \epsilon = \begin{bmatrix} \epsilon_0 \\ \epsilon_1 \end{bmatrix}$$

The set of two observations may now be written as:

$$\begin{bmatrix} Y_0 \\ Y_1 \end{bmatrix} = \begin{bmatrix} 1\ \mathbf{X}_0 \\ 1\ \mathbf{X}_1 \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \end{bmatrix} + \begin{bmatrix} \epsilon_0 \\ \epsilon_1 \end{bmatrix} \tag{6.5}$$

or, more compactly, as matrix equation 6.6:

$$Y = \mathbf{X}\beta + \epsilon \tag{6.6}$$

where:

Y = (2 x 1) vector of profile ratings,
$\mathbf{X}$ = (2 x 2) design matrix,
β = (2 x 1) vector of parameters to be estimated, and
ϵ = (2 x 1) vector of unknown components, associated with the proportion of the variance in observations that can not be explained by the model.

In the case of n observations, where each is assumed to be a function of the effect of more than one factor, Y represents a (n x 1) vector of ratings, $\mathbf{X}$ is a (n x p) design matrix, β represents the (p x 1) vector of unknown parameters, and ϵ is a vector of error terms.

For the previous example with factors *s* and *t*, each with two levels, $S_0=-\beta_1$ and $S_1=\beta_1$, and $T_0=-\beta_2$ and $T_1=\beta_2$.

In the current study, n was equal to 10368, since each of 1728 respondents evaluated six profiles. In the design matrix, p represented 39 vectors of coefficients, including one for the mean, and 38 vectors for the coefficients of contrasts for effects and interactions specified in Section 5.2.6. Coefficients defining contrasts for effects of a three-level factor were represented by two vectors, one with the values -1, 0, and 1, and the other containing the values -1, 2, and -1. For two-level factors other than 'shape', the coefficients were given by one vector consisting of -1s and 1s. The coefficients for the factor 'shape' were represented by a vector consisting of 2s and -1s. The vector representing the mean, was a column of 1s.

Model 6.6 could readily be extended to include 'respondent' effects, i.e. effects due to variation in socioeconomic or demographic characteristics of respondents. To account for the possibility that evaluations of particular plant factors depended upon characteristics of respondents, interactions between respondent factors and plant factors were included as components of an extended version of model 6.6. Such an extension increased the size of design matrix **X** to (10368 x q), where q was larger than p, and represented the vectors of coefficients including those of contrasts defining effects of interactions between plant factors and respondent factors. The vector of effects and interactions in the extended model was a (q x 1) vector.

The impact on plant profile evaluations, of plant attributes and selected interactions, and of interactions between plant factors and characteristics of respondents, was assessed using model 6.6 in an analysis of variance approach. In the following sections, further explanations of the methodology are presented in conjunction with a discussion of results.

6.3 Analysis of variance for profile ratings

6.3.1 Introduction

The GLM (General Linear Models) procedure of the SAS computer package (Anon., 1989a) was used to perform an analysis of variance on ratings given to plant profiles by respondents from Palmerston North, Wellington, and Auckland. Dependent and independent variables are specified in model 6.7.

$$Y_{ijklmnopq} = \mu + \text{respondent}_q + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p$$
$$+ A_iB_j + A_iC_k + A_iD_l + A_iE_m + A_iF_n + A_iG_o + A_iH_p +$$
$$E_mG_o + F_nH_p +$$
$$A_iE_mG_o + A_iF_nH_p +$$
$$\epsilon_{ijklmnopq} \qquad (6.7)$$

where:

$Y_{ijklmnopq}$	=	response variable,
μ	=	mean of profile ratings, and
'respondent$_q$'	=	proportion of the variation in Y explained by variation in characteristics of respondents, where subscript q could take on the values 1,2..,1727, since there were 1728 respondents,
$A_i,\ldots,H_p$	=	estimated effects of factors *a, b, c,...,* and *h*, where i,j,k, and l could take on the values 0, 1, or 2, and m, n, o, and p were equal to 0 or 1, and
$A_iB_j,..,F_nH_p$	=	first-order interactions,
$A_iE_mG_o$, $A_iF_nH_p$	=	second-order interactions, and
$\epsilon_{ijklmnopq}$	=	variation in the response variable not accounted for by the model.

As explained in Section 6.2, model 6.7 could be written in matrix and vector notation as follows:

$$Y = \mathbf{X}\beta + \epsilon \qquad (6.8)$$

where:

Y = (10368 x 1) vector of observations,
$\mathbf{X}$ = the (10368 x (1727+39)) design matrix,
β = ((1727+39) x 1) vector of unknown parameters, and
ϵ = ((1727+39) x 1) vector of error terms.

Apart from the size of the design matrix, and the lengths of vectors Y, β, and ϵ, equation 6.8 was exactly the same as equation 6.6.

The GLM procedure of the SAS package routinely solves the normal equation $\mathbf{X'X}b=\mathbf{X'}Y$, producing a generalised inverse $(\mathbf{X'X})^{-1}$ and a solution b for β, which equals $(\mathbf{X'X})^{-1}\mathbf{X'}Y$.

$(\mathbf{X'X})^{-1}$ is the variance-covariance matrix introduced in Chapter 5 as a tool for checking orthogonality of factorial designs. The solution $(\mathbf{X'X})^{-1}\mathbf{X'}Y$ is the conventional estimate for β, also called the least squares estimate, and is determined by minimising the error sum of squares. For $\mathbf{X}_i$, e_i is the deviation of the observation from the regression line, or a residual. The sum of squares of all residuals is a measure of the overall failure of the model to fit the data, and in vector notation is equal to e'e, where e is the vector of estimates for the values of vector ϵ in model 6.8.

Several packages other than SAS were considered for use in performing an analysis of variance on the profile ratings. Due to the large number of degrees of freedom, representing the 1727 contrasts between the levels of factor 'respondent', the size of the design matrix was too large for processing with the SPSS-X system (Anon., 1988). With Genstat (Anon., 1989b), data obtained in Palmerston North, Wellington, and Auckland could be analysed separately, but before an analysis of all ratings could be performed, Massey University's license for this package was discontinued.

SAS offers the option of 'absorption' for handling large experimental designs. Absorption is a computational technique that allows effects to be adjusted out prior to the construction and solution of the rest of the model. Without absorption of the factor 'respondent', the limits of available computer capacity were exceeded, and the necessary calculations for the GLM procedure of SAS could not be completed.

The output was the same as it would be for a model that included the factor 'respondent' with the exception that for the absorbed factor, only sequential sums of squares were computed. An understanding of hypotheses tested when using different types of sums was necessary when performing an analysis of variance based on a model including demographic and socioeconomic variables. An explanation of sequential and partial sums of squares is given in Section 7.3.

When using absorption, the size of the **X'X** matrix is a function only of effects in the model statement. Absorbed effects do not contribute to the size of the **X'X** matrix, thereby reducing the number of megabytes of memory required for computation of the **X'X** matrix.

6.3.2 Analysis of variance

Results of the analysis of variance are presented in Table 6.3 and in Appendix E. To determine the level of significance for each effect and interaction included in model 6.7, the F-values obtained by dividing the treatment mean square by the error mean square were compared with the appropriate tabulated F-values.

The F-test for the model was a joint test of the hypothesis that all parameters except the intercept were zero. The significance of the effect of the model indicated that some linear function of the parameters was significantly different from zero.

A probability level $p<0.05$ implied that, if the null hypothesis of no effect was rejected, there was a chance of less than 5 in 100 that a result more extreme than that obtained could occur by chance. In other words, if a factor had no effect at a probability level of $p<0.05$, then a difference greater than that observed could result with a probability of less than 0.05.

Factors and interactions listed in Table 6.3, were selected for inclusion in the conjoint part of the current study on the basis of their postulated effects on attractiveness judgements of ornamental plants. Analysis of variance results provided statistical evidence that effects of all plant characteristics concerned were significant. Thus, evaluations of ornamental plants in terms of attractiveness were significantly affected by price, health status, suitability for the garden, final height, shape, bushiness, flower colour and leaf colour. Results indicating that the effects of plant factors included were not statistically significant, would have casted serious doubt over the effectiveness of

Table 6.3 Effects and interactions significant at $p < 0.05$[1)]

Source	DF[2)]	significant at $p < 0.05$
Model	1765	*
Error	8602	
Total	10367	
Respondent	1727	*
A (price)	2	*
B (health)	2	*
C (suitability)	2	*
D (final height)	2	*
E (shape)	1	*
F (flower colour)	1	*
G (bushiness)	1	*
H (leaf colour)	1	*
AB	4	*
AC	4	*
AD	4	*
AE	2	*
AF	2	-
AG	2	-
AH	2	-
EG	1	*
FH	1	-
AEG	2	-
AFH	2	-

[1)]: * = significance, - = non-significance; [2)]: DF = degrees of freedom.

the elicitation phase.

Apart from the main effects, several interactions were also significant at a probability level of $p < 0.05$. Preference for a particular price level depended on the health status, the final height, the suitability for the respondent's garden, and the shape of the plant. A significant interaction also existed between the shape and the degree of bushiness of a plant. The first-order interactions of the factor 'price' with 'flower colour', 'bushiness', and 'leaf colour', and the second-order interactions were not significant.

The analysis of variance results did not indicate which factor levels had a significant influence on profile ratings, or what the relative importance of each factor effect was, but rather for which factors the sum of the linear and quadratic effects were significant. Therefore, scope for discussion of results presented in the current section was limited to a comparison with other studies attempting to detect effects on nursery products of the factors listed in Table 6.3.

Effects of price on preferences for nursery products were described by several authors (DeBossu, 1988; Gineo, 1989; Vink, 1989; Carlson, 1991; Florkowski et al., 1992; Garber and Bondari, 1992a; Makus et al., 1992). Preferences of landscapers and retailers for nursery stock were influenced by price (Gineo, 1989; Garber and Bondari, 1992a; Makus et al., 1992). Price played a role in purchase selections of annual flowering plants (Carlson, 1991), and coniferous plants (DeBossu, 1988; Florkowski et al., 1992). Findings of the present study were in agreement with those reported by Vink (1989) who also concluded that people took price into consideration when evaluating evergreen shrubs.

Health defined as 'pest and disease resistance', was of importance to respondents interviewed by DeBossu (1988) and Vink (1989). Consumers of flowering annuals were primarily interested in the health status of plants according to Carlson (1991). Makus et al. (1992) reported that to plant retailers and landscapers, 'freedom of insects and diseases' was amongst the most desired product characteristics of nursery stock.

In Chapter 2, it was postulated that factor 'health' in the current study was equivalent to, or at least highly correlated with, the factor 'plant quality' in studies where plant health was not specified as an option. Should this have been the case, then the observed significance of the effect of plant health on respondents' evaluations of ornamental plants was in accordance with results published by Bourke and West (1976), West (1980), Gineo (1989), and Garber and Bondari (1992b). These authors reported that quality of nursery products was of major importance to respondents.

No published information was available on the extent to which buyer preferences were influenced by the suitability of plants for particular growing conditions. Chisholm (1995) reported that the most attractive plants to garden centre customers were those with the lowest maintenance. Respondents' obvious concern with the suitability of plants for their garden, could be an indication of the same trend. Plants which are well suited to the growing conditions in a particular garden will generally require less maintenance such as fertilising, staking, and soil improvement.

As in the present study, a significant effect of the expected plant height on customer evaluations of plants was also apparent in studies of DeBossu (1988), Vink (1989), and Florkowski et al. (1992).

Shape was not included in the conjoint phase of studies conducted by DeBossu (1988) and Vink (1989). Their decision to exclude shape from further study was based on results from elicitation interviews, and could therefore indicate that shape was less important to respondents than were the factors included in the conjoint phase. During the elicitation phase of the current study it became apparent that some garden centre customers perceived plant shape as a component of plant health. These respondents would not mention shape as one of the purchase determining factors after having mentioned plant health. Should this have occurred during the elicitation interviews conducted by DeBossu (1988) and Vink (1989), then the impact of shape on respondents' evaluations in their studies has been underestimated.

The finding in the current study that plant shape influenced respondents' opinions about the attractiveness of outdoor ornamental plants was comparable to some extent to observations by Florkowski et al. (1992) who concluded that shape had a major impact on Christmas tree selections.

As for shape, definitions of plant bushiness also varied amongst respondents. To some garden centre customers interviewed, it was equivalent to, or part of, plant health or shape. Thus, elicitation interviews during which respondents were not asked to clarify their responses, could have led to an underestimation of the effect of bushiness on perceptions of nursery products. Without a clear description of results of the elicitation interviews held by DeBossu (1988) and Vink (1989), it was impossible to judge whether or not the significant impact of bushiness on plant evaluations in the current study is contradicting findings by DeBossu (1988) and Vink (1989).
By most garden centre customers interviewed, the term bushiness was used during the elicitation phase of the present study to describe plant density. Results may therefore be compared to those presented by Florkowski et al. (1992) who reported that tree density was an important consideration to customers of choose-and-cut Christmas tree nurseries.

Compared to other plant factors, flower colour was of minor importance. Its effect was not significant at a probability level of $p<0.01$, whereas the remaining main effects were still significant at that level. Whilst Vink (1989) concluded that respondents were primarily attracted by the flowers of plants, her study was not designed to determine which flower-related features were responsible for the attraction. Higher ratings for flowering as opposed to non-flowering evergreen plants, may be explained by the presence of several factors, such as scent and colour. Results of the elicitation interviews conducted in the current study indicated that of plant attributes associated with the presence of flowers, respondents were primarily concerned with the colour of the flowers. Carlson (1991) also referred to the importance customers attached to flower colours when selecting plants.

Leaf colour influenced perceptions of narrow-leaved evergreen plants (DeBossu, 1988; Florkowski et al., 1992). Vink (1989) described a significant impact of leaf colour on customer preference for broad-leaved evergreen plants. For both categories of plants, leaf colour was likely to be relatively more important than it was for flowering evergreen ornamental plants, where the extra dimension of the presence of flowers was taken into account.

In summary, the finding that all plant factors included in the conjoint phase of the current study had a significant impact on evaluations of outdoor ornamentals, was in agreement with prior expectations based on results of the elicitation interviews. The nature of their impact and that of significant interactions, are addressed in the following section.

6.4 Estimated effects of plant factors having specified levels

6.4.1 Introduction

Results presented in the previous section (Table 6.3) merely indicated whether or not a factor had a statistically significant effect. They did not give any indication about the size of factor effects on profile evaluations. Estimated effects of factors and interactions were part of the output of an analysis of variance performed with the GLM procedure of the SAS computer package. The estimated effect on profile evaluations, of a factor having a specified level, would show whether or not opinions about plant profiles were adversely or positively affected. Most and least preferred factor levels could thus be identified for each plant characteristic. Estimated effects of factors and interactions could be used to estimate the yield of any treatment combination.

6.4.2 Calculation of estimated effects and treatment yields

In Table 6.4, effects are presented as deviations from the mean. For each estimate, a t-test was performed to test the null hypothesis that the estimate was equal to zero. Estimates for which the null hypothesis was rejected, are indicated with *. For the remainder, denoted by -, the difference between the estimate and zero was not large enough to be detected with the given sample size. An estimate greater than zero indicated a positive influence on plant profile ratings. Perceived attractiveness of plants presented on the profiles was adversely affected in the case of a significant negative estimate.

Whilst the estimates of effects presented in Table 6.4 were obtained as part of the computer output of the analysis of variance, it is worthwhile to understand how they were arrived at. The mean of treatment combinations in each of the following examples may be calculated from the sum of ratings for the appropriate replicates listed in Appendix F, divided by the corresponding number of observations in these replicates. The estimate for the effect A_0 of factor *a* at level 0 was calculated as follows:

$$A_0 = \text{(mean of treatment combinations containing } a_0\text{) - (overall mean)} =$$

$$= 12588/3456 - 3.343 = 3.642 - 3.343 = 0.299$$

Where an effect or interaction was confounded with blocks in some of the replicates, the estimate was calculated from the replicates where the effect or interaction was not confounded with blocks. For example, the average effect of factor *e* at level 0, which

Table 6.4 Effects and interactions as deviations from the overall mean $\mu=3.343$

Effect or Interaction		Estimate	A_0	A_1	A_2
A_0	$ 6.95	0.299*[1)]			
A_1	$12.95	0.016-			
A_2	$18.95	-0.315*			
B_0	poor health	-1.053*	-0.023-	0.045-	-0.022-
B_1	average health	0.109*	0.044-	0.057-	-0.101*
B_2	good health	0.944*	-0.021-	-0.102*	0.123*
C_0	poor suitability	-1.007*	-0.228*	0.154*	0.074-
C_1	average suitability	0.438*	-0.037-	-0.028-	0.065-
C_2	good suitability	0.569*	0.265*	-0.126*	-0.139*
D_0	<1 m	0.013-	0.283*	-0.461*	0.178*
D_1	1-2 m	0.242*	-0.191*	0.588*	-0.397*
D_2	>2 m	-0.255*	-0.092*	-0.127*	0.219*
E_0	balanced	0.616*	0.044-	-0.113*	0.069*
E_1	not balanced	-0.616*	-0.044-	0.113*	-0.069*
F_0	bright	0.050*	0.010-	0.018-	-0.028-
F_1	soft	-0.050*	-0.010-	-0.018-	0.028-
G_0	not bushy	-0.345*	-0.028-	-0.014-	0.042-
G_1	bushy	0.345*	0.028-	0.014-	-0.042-
H_0	dark green	0.095*	0.002-	0.015-	0.017-
H_1	light green	-0.095*	-0.002-	-0.015-	-0.017-
E_0G_0	balanced, not bushy	-0.095*	-0.048*	0.037*	0.011-
E_0G_1	balanced, bushy	0.095*	0.048*	-0.037*	-0.011-
E_1G_0	not balanced, not bushy	0.095*	0.048*	-0.037*	-0.011-
E_1G_1	not balanced, bushy	-0.095*	-0.048*	0.037*	0.011-
F_0H_0	bright, dark green	0.023-	-0.014-	0.011-	0.003-
F_0H_1	bright, light green	-0.023-	0.014-	-0.011-	-0.003-
F_1H_0	soft, dark green	-0.023-	0.014-	-0.011-	-0.003-
F_1H_1	soft, light green	0.023-	-0.014-	0.011-	0.003-

[1)]: significance and non-significance at $p<0.05$ is denoted by * and - respectively.

was unconfounded with blocks in replicates 1,2,5,6,7 and 8, was obtained as follows:

E_0 = ((mean of treatment combinations in replicates 1,2,5,6,7, and 8, containing e_0)

- (mean of all treatment combinations in replicates 1,2,5,6,7, and 8)) x 3/2 =

= ((19398/5184) - (25905/7776)) x 3/2 = (3.742 - 3.331) x 3/2 = 0.616

The multiplying factor of 3/2 accounted for the fact that level 0 of factor *e* occurred in twice as many treatment combinations as did level 1 of factor *e*. Without the multiplying factor, a value of 0.410 would have been obtained for E_0 and a value of -0.821 for E_1. The average effect of factor *e* was the average of both values, i.e. (0.410 + 0.821)/2, which equalled 0.616.

The coefficient A_0B_0 associated with the interaction between factors 'price' and 'health', consisted of two components, $(AB)_0$ and $(AB^2)_0$. $(AB)_0$ was the difference between the average yield of treatment combinations a_ib_j for which i+j= 0 (modulo 3), and the mean. Both the overall mean and the average yield of the treatment combinations a_ib_j for which i+j= 0 (modulo 3), were calculated from replicates 3,4,7, and 8, in which the interaction AB was unconfounded with blocks. $(AB^2)_0$ represented the difference between the average yield of a_ib_j for which i+2j= 0 (modulo 3) and the appropriate mean, calculated from replicates 1,2,5, and 6, in which the interaction AB^2 was not confounded with blocks. The coefficient A_0B_0 was the sum of both components:

$(AB)_0$ = 5692/1728 - 17468/5184 = -0.076

$(AB^2)_0$ = 5823/1728 - 17196/5184 = 0.053

A_0B_0 = -0.076 + 0.053 = -0.023

Similarly, the coefficient A_0D_0 associated with the interaction between factors 'price' and 'final height', was calculated as follows:

$(AD)_0 = 8466/2592 - 26021/7776 = -0.080$ (from replicates 3,4,5,6,7,and 8)

$(AD^2)_0 = 6412/1728 - 17354/5184 = 0.363$ (from replicates 1,2,7,and 8)

$A_0D_0 = -0.080 + 0.363 = 0.283$

Estimates presented in Table 6.4, could be used to construct the estimated yield of any treatment combination with the following formula:

$$
\begin{aligned}
a_ib_jc_kd_le_mf_ng_oh_p = {} & \mu + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p + \\
& A_iB_j + A_iC_k + A_iD_l + A_iE_m + A_iF_n + A_iG_o + A_iH_p + \\
& E_mG_o + F_nH_p + A_iE_mG_o + A_iF_nH_p \qquad (6.9)
\end{aligned}
$$

where:

$a_ib_jc_kd_le_mf_ng_oh_p$	=	yield to be estimated,
μ	=	overall mean, which was equal to 3.343,
A_i, B_j,., $A_iF_nH_p$	=	estimated effects or interactions of factors *a, b,....*, and *h*, with levels i,......,and p, where i, j, k, and l could take on the values 0, 1, or 2, and m, n, o, and p were equal to 0 or 1,

For example, an estimated rating for the plant profile in which all factors were presented at level 0, was calculated as follows:

$$
\begin{aligned}
a_0b_0c_0d_0e_0f_0g_0h_0 = {} & 3.343+0.299-1.053-1.007+0.013+0.616+0.050 \\
& -0.345+0.095-0.023-0.228+0.283+0.044+0.010 \\
& -0.028+0.002-0.095+0.023-0.048-0.014 = 1.9
\end{aligned}
$$

Thirty four profiles with an estimated yield of 6 or higher are listed in Appendix G. On the scale used to rate the profiles, a value of 6 was assigned to 'attractive'. Profiles rated as 'very attractive', were given a value of 7. Profiles with an estimated rating of 6.5 or higher, are listed in Table 6.5.

Table 6.5 Profiles with estimated ratings of 6.5[1] or higher

price	health	c[2]	height	shape	f[3]	bushy	leaf colour	rating
$6.95	good	average	< 1m	balanced	bright	yes	dark green	6.6
$6.95	good	average	< 1m	balanced	soft	yes	dark green	6.5
$6.95	good	good	< 1m	balanced	bright	yes	dark green	7.0
$6.95	good	good	< 1m	balanced	bright	yes	light green	6.8
$6.95	good	good	< 1m	balanced	soft	yes	dark green	6.9
$6.95	good	good	< 1m	balanced	soft	yes	light green	6.7
$6.95	good	good	1-2m	balanced	bright	yes	dark green	6.8
$6.95	good	good	1-2m	balanced	bright	yes	light green	6.6
$6.95	good	good	1-2m	balanced	soft	yes	dark green	6.5
$12.95	good	average	1-2m	balanced	bright	yes	dark green	6.6
$12.95	good	good	1-2m	balanced	bright	yes	dark green	6.6

[1]: scale used for profile ratings: 1 = very unattractive, 2 = unattractive, 3 = somewhat unattractive, 4 = neither attractive nor unattractive, 5 = somewhat attractive, 6 = attractive, 7 = very attractive; [2]: suitability for the growing conditions in the respondent's garden; [3]: flower colour

All treatment combinations listed in Table 6.5 represented healthy, bushy, and balanced plants. Two profiles of plants priced at \$12.95 had an estimated rating over 6.5. In the remaining treatment combinations in Table 6.5, the level of factor 'price' was \$6.95.

The plant profile for which the estimated rating (7.0) was the highest of all 1296 possible plant profiles, was the one representing treatment combination $a_0b_2c_2d_0e_0f_0g_1h_0$. This was the profile of a cheap, healthy, balanced, bushy plant with a bright flower colour, dark green leaves, a good suitability for the respondent's garden, and an expected height of less than 1m.

If interactions had not been taken into account, inspection of the resulting main effects would have led to the conclusion that the most popular plant profile was given by treatment combination $a_0b_2c_2d_1e_0f_0g_1h_0$, representing a cheap, healthy, balanced, bushy plant with a bright flower colour, dark green leaves, a good suitability for the respondent's garden, and an expected height of 1 to 2m.
This illustrated the importance of considering the possibility that not all factors were independent of one another, and of incorporating the option of detecting significant interactions in the design of an experiment.

6.4.3 Discussion of effects of plant factors and interactions

The following discussion is mainly based on results presented in Table 6.4, which for convenience of the reader are repeated in Table 6.6. Because the simple effects of several factors depended on the levels of other factors, the main effects and interactions are considered simultaneously.

In accordance with the findings of Vink (1989), and with prior expectations, the lowest price level was the most preferred of those included. Debossu (1988) found that customers preferred moderately priced coniferous plants rather than low-priced conifers by a small margin. Extrapolation showed that this was only true up to a relatively low price level, approximately equal to the sum of the lowest price and one third of the difference between the lowest and the average price level. As price approached the highest level included in her study, it had an increasingly negative impact on preference. A similar trend could exist in the current study for price at particular levels of plant factors the effects of which significantly depended upon price. The nature of

Table 6.6 Effects and interactions as deviations from the overall mean μ=3.343

Effect or Interaction		Estimate	A_0	A_1	A_2
A_0	$ 6.95	0.299*[1)]			
A_1	$12.95	0.016-			
A_2	$18.95	-0.315*			
B_0	poor health	-1.053*	-0.023-	0.045-	-0.022-
B_1	average health	0.109*	0.044-	0.057-	-0.101*
B_2	good health	0.944*	-0.021-	-0.102*	0.123*
C_0	poor suitability	-1.007*	-0.228*	0.154*	0.074-
C_1	average suitability	0.438*	-0.037-	-0.028-	0.065-
C_2	good suitability	0.569*	0.265*	-0.126*	-0.139*
D_0	<1 m	0.013-	0.283*	-0.461*	0.178*
D_1	1-2 m	0.242*	-0.191*	0.588*	-0.397*
D_2	>2 m	-0.255*	-0.092*	-0.127*	0.219*
E_0	balanced	0.616*	0.044-	-0.113*	0.069*
E_1	not balanced	-0.616*	-0.044-	0.113*	-0.069*
F_0	bright	0.050*	0.010-	0.018-	-0.028-
F_1	soft	-0.050*	-0.010-	-0.018-	0.028-
G_0	not bushy	-0.345*	-0.028-	-0.014-	0.042-
G_1	bushy	0.345*	0.028-	0.014-	-0.042-
H_0	dark green	0.095*	0.002-	0.015-	0.017-
H_1	light green	-0.095*	-0.002-	-0.015-	-0.017-
E_0G_0	balanced, not bushy	-0.095*	-0.048*	0.037*	0.011-
E_0G_1	balanced, bushy	0.095*	0.048*	-0.037*	-0.011-
E_1G_0	not balanced, not bushy	0.095*	0.048*	-0.037*	-0.011-
E_1G_1	not balanced, bushy	-0.095*	-0.048*	0.037*	0.011-
F_0H_0	bright, dark green	0.023-	-0.014-	0.011-	0.003-
F_0H_1	bright, light green	-0.023-	0.014-	-0.011-	-0.003-
F_1H_0	soft, dark green	-0.023-	0.014-	-0.011-	-0.003-
F_1H_1	soft, light green	0.023-	-0.014-	0.011-	0.003-

[1)]: significance and non-significance at $p<0.05$ is denoted by * and - respectively.

the interactions between price and other plant factors, did not provide supporting evidence for this theory.

Even though the interaction of price and health was not significant at a probability level of $p<0.01$, its significance at $p<0.05$ warranted further investigation of the nature of this interaction. The significance of the interaction of price and health at $p<0.05$ indicated the failure of the price effect to be the same for each level of health, or, conversely, the failure of the response to health to be the same for each level of the factor 'price'. This interaction is illustrated in Figure 6.1.

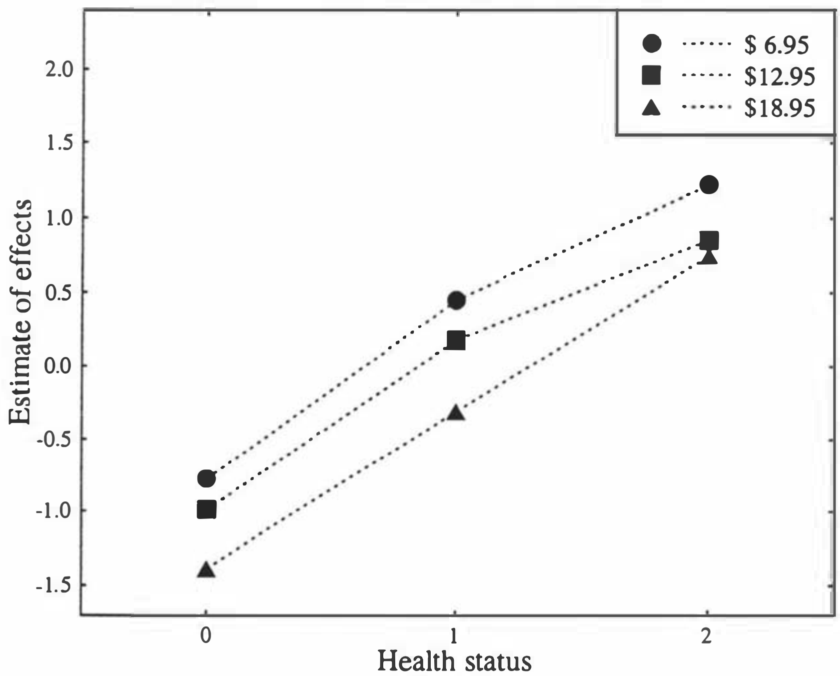

Figure 6.1 Estimated effects on ratings, of health at different price levels

As expected, a healthy plant was preferred over a plant which was less healthy. The cheapest plants were preferred at all health levels. However, the perceived difference between the price levels, which was assumed to reflect willingness to pay, depended on the health status of the plant. For plants in poor or average health, the response to health was unaffected by price. The slopes of the lines for this part of the graph were virtually identical. For healthy plants, the difference between mean attractiveness ratings for plants of $12.95 and $18.95 was smaller than it was for plants with a poor or average health status. In other words, where a plant in good health was concerned, little difference was perceived between price levels of $12.95 and $18.95. Within the price bracket of $12.95 to $18.95, garden centre customers interviewed were less likely to spend more money on an unhealthy plant or a plant of average health, than they were on a healthy plant. Customers were more likely to pay the difference between $12.95 and $18.95 for a healthy plant than they were for a plant with an average or poor health status.

Ratings for plants which were well suited to the growing conditions in the respondent's garden were higher than were those for poorly suited plants.
As illustrated in Figure 6.2, the perceived difference between plants with an average suitability level and a good suitability level was smaller at average and high price levels than it was at a low price level. For cheap plants, respondents appeared to be more concerned with the suitability of the plant for the growing conditions in their garden than they were for plants priced at $12.95 or $18.95. For expensive plants, and those with an average price level, garden centre customers were prepared to trade in on the

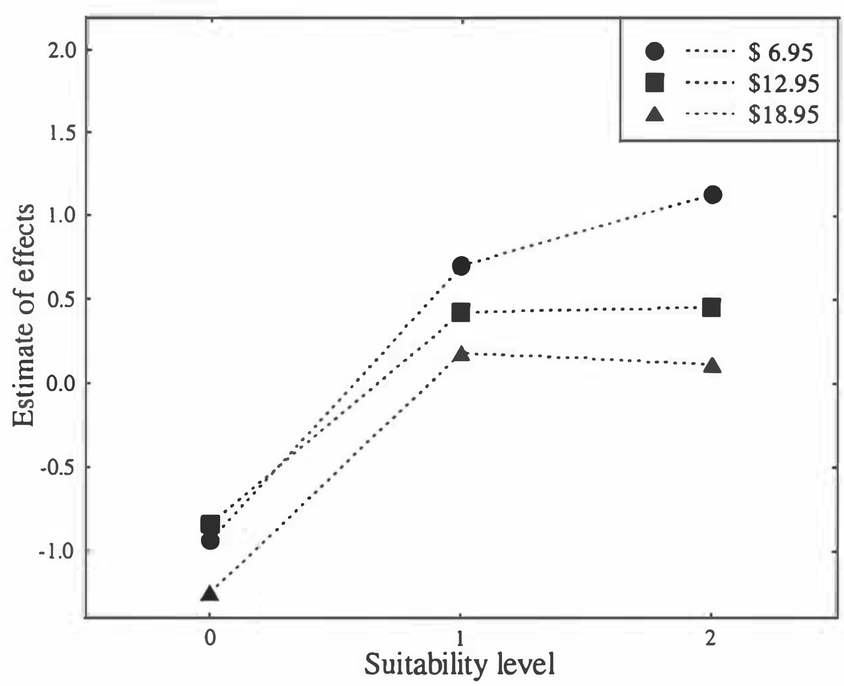

Figure 6.2 Estimated effects on ratings, of suitability at different price levels

suitability level. This could be due to the possibility that, as long as plants were not poorly suited to the conditions in the respondent's garden, high and average price levels were associated with a better overall quality and treated with less suspicion than were cheap plants. Plants with a poor suitability for the respondent's garden received the lowest rating. At this suitability level, differences in appreciation for the three price levels were the smallest, indicating that at no matter what price, plants must at least be reasonably suitable for the conditions in the customer's garden. To reiterate the descriptions for suitability levels included in the questionnaire, a plant with a reasonable suitability was defined as one for which four of the factors 'soil type', 'temperature', 'moisture', 'light', 'wind', and 'location with respect to the coast' were suitable.

Effects of the factor 'final height' at three price levels are illustrated in Figure 6.3.

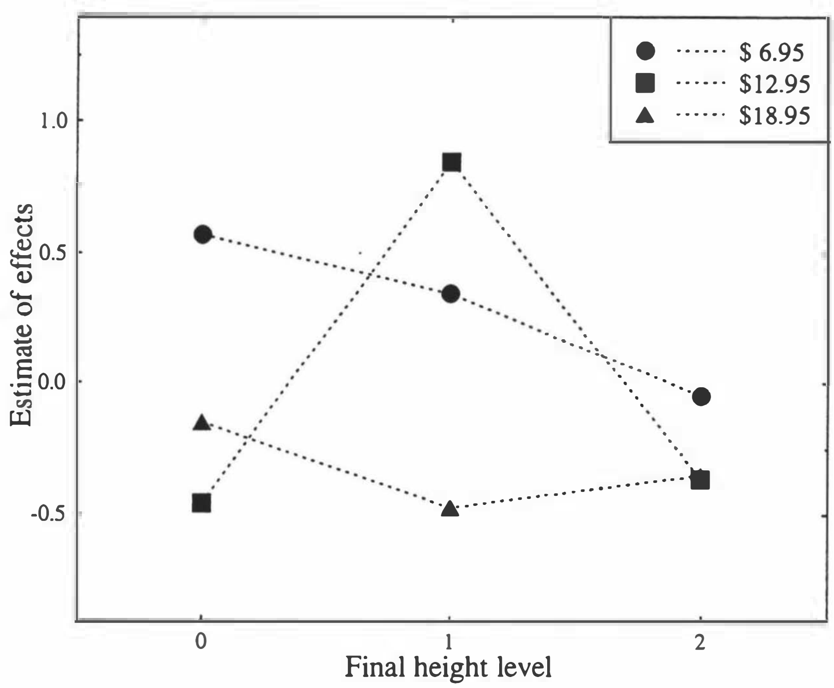

Figure 6.3 Estimated of effects on ratings, of final height at different price levels

For plants priced at $12.95, an average final height of 1-2m was preferred by garden centre customers interviewed. At price levels of $6.95 and $18.95, respondents preferred plants with a final height of up to 1m. Low growing plants may naturally be associated with low costs. One would assume that a higher price was coupled with the expectation of a taller growing plant, and that the correlation between the price of a plant and the expected final height was stronger at a price of $18.95 than it was at lower price levels. However, results indicated that respondents were less concerned about the final height of expensive plants than they were about heights reached by low or averagely priced plants.

As stated previously, this was a good example illustrating the importance of considering interactions where possible, when analysing results. DeBossu (1988) and Vink (1989) concluded that plants of medium height were the most popular. A similar conclusion would have been reached for the present study if, like in the studies of Vink (1989) and DeBossu (1988), no interactions had been taken into account.

In Figure 6.4, the interaction between factors 'price' and 'shape' is illustrated. As expected, respondents preferred balanced rather than unbalanced plants. The difference between attractiveness ratings for balanced and unbalanced plants, was smaller at an average price level than it was at either a high or a low price level. This meant that at an average price level, the reduction in attractiveness due to an unbalanced shape was

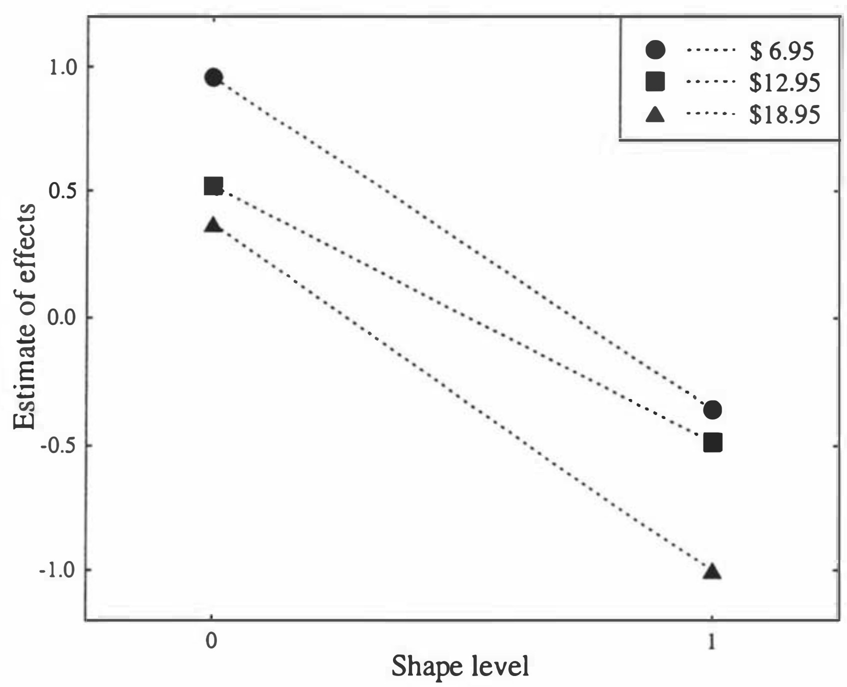

Figure 6.4 Estimated effects on ratings, of shape at different price levels

smaller than it was at price levels of $6.95 and $18.95. It is therefore important that a well-balanced shape is maintained in garden centres, especially where cheap or expensive plants are concerned. Florkowski et al. (1992), concluded that shape was an important Christmas tree attribute to customers of choose-and-cut farms. However, the survey conducted by Florkowski et al. (1992), was not designed to discover how customers perceived the dimensions of shape. Thus, it is unclear as to what extent the factor 'shape' in the current study equated to the attribute 'shape' of Christmas trees.

Respondents were more attracted to bushy plants than they were to spindly plants. As already explained in the case of the plant factor 'shape', the survey conducted by Florkowski et al. (1992), was not designed to reveal preferences for particular levels of plant attributes. The importance customers attached to density, which may be regarded as a synonym for 'bushiness', was not separated into judgements about degrees of density. As illustrated in Figure 6.5, garden centre customers interviewed during the present study, were more concerned with the shape of bushy plants than they were with the shape of spindly plants. This may be due to the possibility that shape had a larger impact on the appearance of plants that were more densely foliaged. A bushy plant with an asymmetrical shape may have appeared more unbalanced than a spindly plant with a shape that was asymmetrical to the same degree.

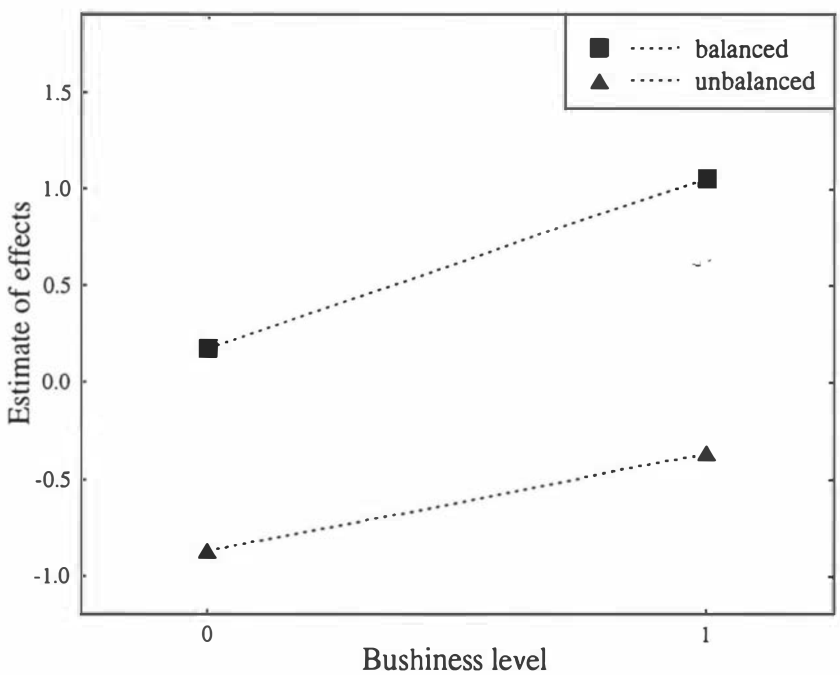

Figure 6.5 Estimated effects on ratings, of bushiness at different shape levels

Ratings for dark green leaf colours were higher than were those for light green leaf colours. Similar preferences were reported by DeBossu (1988), who had included the levels 'light green', 'dark green', and 'bluish grey'. Vink (1989) concluded that bronze or purple foliage was preferred over green or yellow.

Even when respondents were presented with profiles that were balanced for factors 'health' and 'leaf colour', they may still have associated light green leaf colours with low health levels. This association may have been strengthened by the fact that the health-level determining factor was the percentage of brown or dead leaves. Although the interaction between 'health' and 'leaf colour', was not significant, the fact that brown or dead leaves stood out more if the remaining leaves were light rather than dark green, may have had an effect. Vink (1989), who found no significant differences between the preferences for green and yellow foliage, used profile cards with descriptions rather than illustrations of factors. The postulated association between light green foliage and poor health, was specifically connected with the visual perception process, and as such, was less likely to be made by people responding to profiles consisting of descriptions than by those evaluating visual stimuli.

In view of the results of the elicitation interviews, which indicated that 59% of respondents took the colour of the flowers into consideration when selecting plants for purchase, it was surprising that the effect of 'flower colour' was only significant at a probability level of $p<0.05$ and not at $p<0.01$.

Since during the elicitation interviews, respondents were not required to make trade-offs amongst plant factors, results were likely to overestimate perceived importances of elicited factors. Even if 59% of garden centre customers indeed considered flower colour, then their selection process was apparently affected to a greater extent by plant characteristics other than flower colour. It was also possible, that respondents perceived flower colour at least as important as some of the other plant characteristics, in which case the relatively low level of statistical significance of its effect was the result of a lack of consensus amongst respondents with respect to preferred flower colours.
Results of the self-explicated part of the conjoint questionnaire could provide a plausible explanation.

6.5 Self-explicated phase: rankings of factor levels

The self-explicated phase of the conjoint questionnaire consisted of two parts. Results of the first part of the self-explicated phase, where respondents were required to rank the levels of each factor from least to most preferred, gave an indication of the degree of homogeneity in responses concerning the factor levels. Factor importance ratings obtained in the second part of the self-explicated phase, are presented in Section 6.6 as part of a discussion on the conjoint data pertaining to the relative importance of each of the significant factors and interactions.

Percentages of respondents selecting a particular factor level as the most preferred level of the factor concerned, are listed in Table 6.7, together with the least preferred level of each three-level factor, and corresponding proportions of the respondent sample. Only the levels that were most or least preferred by the highest percentages of respondents are given in Table 6.7. Numbers of respondents selecting other factor levels as their first choice or their least preferred option, are presented in Appendix H. Percentages of respondents indicating no preference for particular factor levels are also listed in Appendix H.

Even though ties were permitted, respondents generally tended to differentiate between factor levels. The apparent homogeneity of responses relating to the factors 'price', 'health', 'suitability', 'shape', and 'bushiness' was therefore not the result of artificial induction.

The order of the self-explicated rankings of factor levels was identical to the order of magnitude of estimated factor effects inferred from the conjoint evaluations listed in Table 6.4. Levels selected as most preferred in the self-explicated part of the questionnaire were the same as those for which the estimated factor effects were the highest.

The occurrence of ties was responsible for the relatively low percentage of respondents selecting an average final height level as the most preferred level. A final size of up to 1m was the first choice of 22% of customers interviewed. If respondents had been asked to rank combinations of height and price levels, then results may have been more in line with findings in the conjoint phase of the study. Since evaluations of the final height levels proved to be dependent upon price levels, respondents were not given a realistic task in the self-explicated part of the questionnaire as far as rankings for final height levels were concerned.

Table 6.7 Self-explicated phase: most preferred and least preferred levels of plant factors

factor	most preferred	respondents (%)	least preferred	respondents (%)
price	$6.95	98	$18.95	99
health	good	99	poor	100
suitability[1]	good	99	poor	100
height[2]	1-2m	29	>2m	49
shape	balanced	85		
fl colour[3]	bright	46		
bushiness	bushy	74		
lf colour[4]	dark green	29		

[1]: suitability for the respondent's garden; [2]: final height; [3]: flower colour; [4]: leaf colour

A similar explanation may be appropriate in the case of factors 'shape' and 'bushiness'. Of garden centre customers interviewed, 21% indicated no preference for a particular level of the factor 'bushiness'. Eleven percent did not perceive a difference in attractiveness between a balanced and an asymmetrical shape.

Fifty seven percent and 28% of respondents respectively, did not have a preference for either light green or dark green foliage, nor for bright or soft flower colours. Twenty nine percent of garden centre customers interviewed preferred dark green foliage, while 46% selected bright as the most preferred level of the factor 'flower colour'.

Concluding from the estimated effects listed in Table 6.4, neither of these two factors had a large impact on attractiveness ratings for outdoor plants compared to the remaining factors. Self-explicated importance ratings, discussed in detail in Section 6.6, revealed that 71% and 84% of respondents respectively, did not regard the colour of flowers and foliage as very important when selecting ornamental plants for purchase.

Low self-explicated importance ratings for a product feature, and a low level of statistical significance of the effect of such a feature on the decision making process of consumers do not necessarily mean that, if that were possible, the attribute may be left out in the making of the product. Rather, such findings imply that no differences were perceived between the potential benefits of the levels of the attribute concerned. Clearly, the less important a factor was to a garden centre customer, the more likely it was that s/he regarded each of the factor levels as equally attractive.

High self-explicated importance ratings for a product characteristic, and a low level of statistical significance of the effect of such a characteristic on the overall product evaluation, would suggest a high level of disagreement amongst respondents with respect to the most preferred level of the product feature concerned. Particularly in these situations are self-explicated tasks, that include ranking of factor levels, invaluable since they provide a means of examining heterogeneity suggested by subsequent findings.

6.6 Relative importances of significant effects and interactions

Effects associated with any treatment combination could be estimated as explained previously. While these estimated effects provided useful information in terms of perceived attractiveness of plants presented on the profiles, a measure of the relative importance of each of the factors an interactions in determining such effects on plant profile evaluations was still required.

The relative importance of a factor can be expressed as the amount of variation in the response variable that is explained by this factor, and may be assessed by an estimate of the omega squared proposed by Hays (1963). The application of omega squared to marketing research was discussed by Green et al. (1988). The omega squared, which measures the strength of association between the response variable and independent variables represented by significant treatment and interaction effects, is defined as follows:

$$\omega^2 = (\sigma_y^2 - \sigma^2_{y|x})/\sigma_y^2 \qquad (6.10)$$

where:

ω^2 = proportion of variance of the response variable Y accounted for by the independent variable X,
σ_y^2 = variance of the marginal distribution of Y, and
$\sigma^2_{y|x}$ = variance of the conditional distribution of Y given the variable X.

If the probability of an observation involving the X variable is assumed to be proportional to the representation of cases in the sample, then an estimate $\hat{\omega}^2$ may be calculated as follows:

$$\hat{\omega}^2 = (SS_{among} - (df_{among} * MS_{error}))/(SS_{total} + MS_{error}) \qquad (6.11)$$

where:

$\hat{\omega}^2$ = estimate for ω^2,
SS_{among} = sums of squares among treatments,
df_{among} = degrees of freedom among treatments,
MS_{error} = the error mean square, and
SS_{total} = total sums of squares.

The index represents the relative reduction in variance of response variable Y afforded by the information that an observation belongs in an independent variable category X. If the variance in a response variable is for 100% attributable to X, then MS_{error} equals zero, and $\hat{\omega}^2$ is equal to 1.
Substituting the appropriate quantities for factor *a* in Appendix E in equation 6.11 gave:

$$\hat{\omega}^2 = (652.788 - (2*2.163))/(43675.623 + 2.163) = 0.015$$

Factor *a* was therefore estimated to account for about 1.5% of the variance in the preference ratings.

Estimates of the omega squared values for significant effects and interactions are presented in the first column of results in Table 6.8. In the second column, the omega squared values are presented as proportions of the total variation accounted for by the significant effects and interactions listed, and as such, add up to 100%.

Of the effects of factors and interactions included in model 6.7, only those that were found to be statistically significant are listed in Table 6.8.

$$
\begin{aligned}
Y_{ijklmnopq} = \; & \mu + \text{respondent}_q + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p \\
& + A_iB_j + A_iC_k + A_iD_l + A_iE_m + A_iF_n + A_iG_o + A_iH_p + \\
& E_mG_o + F_nH_p + \\
& A_iE_mG_o + A_iF_nH_p + \\
& \epsilon_{ijklmnopq} \qquad (6.7)
\end{aligned}
$$

where:

$Y_{ijklmnopq}$ = response variable,
μ = mean of profile ratings, and
'respondent$_q$' = proportion of the variation in Y explained by variation in characteristics of respondents, where subscript q could take on the values 1,2..,1727,
$A_i,\ldots,H_p$ = estimated effects of factors *a, b, c,...,* and *h*, where i,j,k, and l could take on the values 0, 1, or 2, and m, n, o, and p were equal to 0 or 1,
$A_iB_j,.., F_nH_p$ = first-order interactions,
$A_iE_mG_o$, $A_iF_nH_p$ = second-order interactions, and
$\epsilon_{ijklmnopq}$ = variation in the response variable not accounted for by the model.

Table 6.8 Estimated Hays' omega squared[1] for effects and interactions

effect/interaction	$\hat{\omega}^2$	$(\hat{\omega}^2$ / 0.411[2]) x 100
A price	0.015	3.6
B health	0.159	38.7
C suitability	0.121	29.4
D final height	0.007	1.7
E shape	0.060	14.6
F flower colour	0.000	0.0
G bushiness	0.028	6.8
H leaf colour	0.002	0.5
AB	0.000	0.0
AC	0.002	0.5
AD	0.014	3.4
AE	0.001	0.2
EG	0.002	0.5

1): $\hat{\omega}^2 = (SS_{among} - (df_{among} * MS_{error}))/(SS_{total} + MS_{error})$, where SS_{among} and df_{among} denote the sums of squares and degrees of freedom respectively among treatments, MS_{error} denotes the error mean square, and SS_{total} represents the total sums of squares.

2): 0.411 = the sum of omega squared of effects and interactions listed

Model 6.7 accounted for 57% of the variation in the response variable. This measure was analogous to the coefficient of determination, R^2, which was equal to the sums of squares for the model, divided by the total sums of squares.

The relative importance of the factor 'health' was the greatest in the sense that this factor contributed the most to the variation in the response variable, namely 38.7% of all variation explained by significant effects and interactions.

In a study using conjoint analysis to examine preference structures for narrow-leaved evergreen plants, resistance to pests and diseases was found to be by far the most important consideration to consumers (DeBossu, 1988). In a number of other studies, plant health was reported to be one of the dominant characteristics of buyer preference (Vink, 1989; Carlson, 1991; Makus et al., 1992). Results of surveys conducted by DeBossu (1988) and Vink (1989) may be regarded as comparable to a certain degree with results of the present study, if one assumes that a preference for 'resistance to pests and diseases' signified a preference for 'health' rather than a dislike for the use of pesticides. Makus et al. (1992) defined plant health as 'freedom from pests and diseases', which was similar to the definition of the plant attribute 'health' included in the current study, where the number of dead or brown leaves was used as a measure for the severity of pests and or diseases present on a plant.

Factor 'health' was followed in importance by the factors 'suitability for the respondent's garden', 'shape of the plant', 'bushiness of the plant', 'price', the interaction between 'price' and 'final height', and finally the attribute 'final height'. The two factors with the largest impact on profile ratings, together accounted for 68.1% of all variation explained by factors and interactions significant at $p<0.05$.

Contributions to the variation in attractiveness ratings, of factors 'flower colour', 'leaf colour', and the remaining interactions, were near zero. Even though these were found to have a significant effect on the evaluation judgements, they actually contributed very little to the ability to predict the response variable from treatment variables.

Of six characteristics, factor 'price' had the least effect on preference ratings for conifers in the study of DeBossu (1988). In other studies, factor 'price' was also found to be of secondary importance in purchasing decisions (Vink, 1989; Carlson, 1991; Florkowski et al., 1992; Makus et al., 1992). One could argue that respondents may have experienced difficulties in differentiating between plant profiles with different prices since they did not actually have to pay for the plants presented on the profiles. However, even if this was the case, then the fact that price ranked only fifth in importance, still clearly indicated that garden centre customers were not only driven by economic considerations when evaluating outdoor ornamental plants.

Results of the study published by DeBossu (1988), indicated that the size of the plant purchased ranked second in importance, and was followed in importance by the mature size of a plant. Thus, assuming that attributes selected by DeBossu for further study were the most relevant, garden centre customers appeared to be relatively more concerned with the final height of coniferous plants than they were with the mature size of evergreen, broadleaved shrubs. The fact that the selection of conifer attributes was based on preliminary interviews with garden centre customers, gave reason to believe that the attributes selected were the most relevant. Had prior research not formed the basis for selection of the attributes, the plant profiles used by DeBossu (1988) may not have been appropriate to represent narrow-leaved plants for the purpose of evaluation by garden centre customers. This would cast doubt on the validity of comparisons between the order of relative importances of factors inferred from conjoint ratings of the study conducted by DeBossu (1988) and of the present study.

Vink (1989) concluded that height at maturity was of minor importance to respondents evaluating evergreen shrubs. According to her report, the plant attribute 'mature height' accounted for 8.5% of the proportion of variation explained by the independent variables. If interactions had been taken into account, the impact of the final height on evergreen plant evaluations may have been even smaller and the variation explained by this factor may have been closer to the 1.7% found in the present study.

Comparisons with results published by other authors, such as DeBossu (1988) and Vink (1989), were further complicated by the fact that findings were dependent on the design of the experiment and the nature and number of plant characteristics and levels included. One would also expect for example, that determinant attributes for a narrow-leaved evergreen plant, the product evaluated in the study conducted by DeBossu (1988), differed from those for flowering evergreen ornamental plants. Evidence supporting this hypothesis was provided by the fact that different attributes were elicited in the preliminary survey with garden centre customers.

In Table 6.9, the self-explicated importance ratings for the plant attributes are summarised. The self-explicated order of importance for the two most important factors, namely 'health' and 'suitability', was the same as the one resulting from the conjoint part of the questionnaire.

Table 6.9 % of respondents rating factors as 1[1)] or 2[2)] in the self-explicated part

factor	% of respondents rating the factor as: (1)[1]	(1 or 2[2)])
a price	38.8	79.6
b health	89.2	98.4
c suitability	83.2	96.0
d final height	49.8	88.6
e shape	43.9	85.7
f flower colour	28.7	76.8
g bushiness	32.8	84.5
h leaf colour	16.0	60.4

1): (1) = very important;
2): (2) = somewhat important

When considering only the first column of values in Table 6.9, in which the percentages of respondents who rated factors as 'very important' are listed, then the attribute 'final height' ranked third in importance, followed by the factors 'shape', 'price', and 'bushiness'. Results of both the conjoint part and the self-explicated part of the survey, indicated that the factors 'leaf colour' and 'flower colour' were of minor importance to garden centre customers when selecting outdoor ornamental plants for purchase.
The existence of a significant interaction between the factors 'final height' and 'price' may have accounted for the fact that the self-explicated importance attributed to the

expected size of a plant was much higher than the estimated omega squared for this factor would suggest. This explanation is easily understood when considering a main-effects-only plan, where the estimates of each main effect do not necessarily represent the best estimates for the simple effects of each factor, but may include parts of interactions as well.

Although responses to the survey conducted by Florkowski et al. (1992) could be regarded as 'self-stated', the rating scale used complicated comparisons between their results and the self-explicated importances listed in Table 6.9. Respondents to the survey of Florkowski et al. (1992), could 'strongly agree', 'agree', 'somewhat agree', or 'disagree' with any of five statements about Christmas tree attributes.

Almost 85% of respondents 'strongly agreed' that shape was an 'important' Christmas tree attribute. Presumably these respondents would all 'agree' with the statement that shape was a 'very important' Christmas tree attribute. Assuming that relative importances of plant attributes may be inferred from self-stated importance ratings, and that attributes under study fully explain variation in overall evaluations of plants, then factor 'shape' had relatively more impact on evaluations of Christmas trees than it had on judgements about broadleaved, flowering shrubs. A plausible explanation for this finding is that Christmas trees are generally used as plants in their own right rather than as plants that are part of a garden setting.

Differences in usage of the purchased plant may also be responsible for the fact that customers of Christmas tree nurseries appeared to be more concerned with the density and colour of the tree than were garden centre customers with the bushiness and foliage colour of ornamental shrubs.

Both for broadleaved flowering shrubs and for Christmas trees, was shape perceived as a relatively more important attribute than was bushiness. This could indicate that the impact of the shape of a plant on its overall appearance was greater than was that of the bushiness of a plant. It is also possible, that shape was perceived as an attribute of which undesirable levels were more difficult to rectify after purchase than were those of the factor 'bushiness'.

Examination of the percentages of respondents rating a factor as 'very important' or 'somewhat important', listed in the second column of values in Table 6.9, provided supporting evidence for the belief that the factors selected for further study were in fact relevant. More than 76% of respondents attached at least some importance to each of the factors, with the exception of 'leaf colour'. The impact of the foliage colour on the appearance of a plant may have been difficult to visualise from the illustration of only a small part of a plant on the explanation card used in the self-explicated part of the questionnaire. This could account for the relatively low percentage of respondents rating the factor 'leaf colour' as 'very important' or 'somewhat important'.

The high percentages of respondents regarding factors at least as 'somewhat important', illustrated a problem associated with self-explicated data, namely that of an absence for the need to trade off certain factors against others. If no choices between factors are forced upon respondents, they are likely to use only a small part of the rating scale for each of the factors. Florkowski et al. (1992) reported that more than half of the total number of customers surveyed, 'strongly agreed' that each of the plant attributes included in the study was important. This phenomenon was also apparent in elicitation procedures, where people were asked which attributes they would like to have; most asked for everything on their wish list (Toombs and Bailey, 1995).

The main purpose of the self-explicated phase was not to gather information not otherwise obtainable, but to more or less force respondents to familiarise themselves with attributes involved in the subsequent part of the questionnaire. Asking respondents to rate factors and rank factor levels, required them to at least try to understand how these factors and levels were defined.

Since significant interactions were detected with the conjoint part of the questionnaire, self-explicated importances were of limited value. A method of incorporating the option of detecting interactions in the design of the self-explicated part of the questionnaire, consisted of asking respondents to rate the importance of combinations of factors. The rating task would thus be increased in magnitude and complexity, which in turn could have an adverse effect on the willingness of the respondent to complete the conjoint part of the questionnaire. As such, it would defeat the purpose of familiarisation of respondents with plant factors included in the conjoint part of the questionnaire.

7. EVALUATION OF ORNAMENTAL PLANTS AS AFFECTED BY INTERACTIONS BETWEEN PLANT FACTORS AND RESPONDENT CHARACTERISTICS

7.1 Introduction

In Chapter 6, evaluations of plant profiles were shown to be dependent upon the factor ‘respondent’, i.e. variations in demographic and socioeconomic characteristics of respondents, and on the factors ‘price’, ‘health’, ‘suitability for the respondent’s garden’, ‘final height’, ‘shape’, ‘bushiness’, ‘flower colour’, and ‘leaf colour’. Preference for a particular price level depended on the health status, the suitability for the respondent’s garden, the final height, and the shape of the plant. A significant interaction also existed between the shape and the degree of bushiness of a plant.

Brook (1994) suggested treating each of the socioeconomic and demographic characteristics as covariates in a model containing components associated with plant factors and interactions between plant factors. A covariance analysis would indicate whether or not respondents with particular characteristics differed in their overall opinions about plant profiles. For example, in the case of the respondent characteristic relating to employment with levels ‘employed’ and ‘unemployed’, it would test the hypothesis that profile ratings provided by garden centre customers who were part of the work force, were the same as those given by unemployed respondents. The outcome of a covariance analysis was of limited practical value to the issue to be addressed, namely that of potential variations in particular plant factor evaluations due to differences between respondent characteristics. The effects of interactions between respondent characteristics and plant factors, rather than the effects of respondent characteristics, on plant profile ratings were of specific interest. For example, it was feasible that price was a more important consideration to unemployed garden centre customers than it was to those who were in paid employment.

To investigate the possibility that variation in the response variable was partly explained by interactions between plant factors and respondent factors, the latter were incorporated in model 6.7. A simplified version of model 6.7 is given by:

$$Y = \mu + \text{respondent} + \text{(effects of plant factors)} + \text{(interactions between plant factors)} + \text{error} \quad (7.1)$$

where:

Y = response variable

μ = mean of the plant profile ratings,

respondent = the proportion of variation in Y explained by variation in characteristics of respondents,

(effects of plant factors) = sums of terms A_i,...,and H_p in model 6.7,

(interactions between plant factors) = sum of terms A_iB_j,........, $A_iF_nH_p$ of model 6.7, and

error = variation in the response variable not accounted for by the model.

Components representing interactions between plant factors and respondent factors were included in model 7.1 as follows:

$$Y = \mu + \text{respondent} + \text{(effects of plant factors)} + \text{(interactions between plant factors)} + \text{(interactions between plant factors and respondent characteristics)} + \text{error} \quad (7.2)$$

where:

(interactions between plant factors and respondent characteristics) = variation in Y accounted for by the effects of interactions between each plant factor and each selected respondent characteristic.

Similarly, Hoffman et al. (1968) in their study on the assessment of criteria used by radiologists to decide whether or not a gastric ulcer was benign or malignant, performed an analysis of variance using a model incorporating interactions between radiologists and ulcer symptoms to determine possible dependencies of importance ratings for ulcer symptoms on radiologists.

An analysis of variance, using model 7.2 would not only test the hypothesis that part of the variation in Y was accounted for by interactions between plant factors and respondent characteristics, but would also indicate the significance level of each interaction between plant and respondent factors (Arnold, 1995).

Whereas effects of plant factors and their interactions specified in model 7.1 could be estimated uncorrelated, the experimental design did not allow this for all components of model 7.2. For example, if it was desirable to obtain an uncorrelated estimate for the effect of plant factor 'price' on plant evaluations by respondents belonging to specified income levels, the design of the experiment needed to be extended with a factor 'income' in such a way, that balance was maintained for all relevant factors and interactions. A simple solution consisted of a complete repetition of the original design for each specified income category. From a practical point of view, such a design would create major problems, since each respondent was now required to evaluate a set of plant profiles that was partly determined by his or her income. If more than one respondent characteristic was included, the number of profiles would soon have increased to an unacceptable level. Moreover, the interviewer would have needed to classify each respondent on the basis of more than one characteristic, and subsequently select the appropriate set of profiles. The implications for data analysis of an experiment with an unbalanced design are further discussed in Section 7.3.

The numbers of respondents in each of the three areas were selected so that one repetition could be completed in Palmerston North, two in Wellington, and three in Auckland. Thus, the demographic variable representing the area of interviewing, was the only respondent characteristic for which uncorrelated estimates for the effects of plant factors and their interactions could be obtained for each level. Separate analyses of data from garden centre customers interviewed in Palmerston North, Wellington, and Auckland, would be of special interest if an overall analysis revealed significant interactions between plant factors and the respondent factor 'area'. If evaluations of plant factors did not depend upon the location of interviewing, then one analysis of aggregated data would provide the same information as, but with more precision than, would separate analyses of data from each area.

7.2 Characteristics of garden centre customers

The twelve demographic and socioeconomic variables, selected on the basis of their postulated influence on plant preference, are listed in Table 7.1. Factor names are abbreviated where appropriate. In some cases these abbreviations suggest levels other than those intended. For example, the levels selected for the factor 'married' were 'single' and 'couple', the latter referring to respondents who lived together with a partner irrespective of their marital status. Retired respondents and students were included in the category of unemployed respondents.

Table 7.1 Demographic and socioeconomic factors and their respective levels

factor	explanation level	0	1	2	3	4
married	marital status	single	couple			
child	children < 16 yrs at home	no	yes			
gender		male	female			
age	age group (years)	<35	35-44	45-54	55-64	65+
employ	employed?	no	yes			
own	own house?	no	yes			
agehouse	age of house in years	<5	5-9	10-14	15+	
section	size of section in m^2	<500	500-749	750-999	1000+	
income	gross income/$1,000	<30	30-60	60+		
expend	expenditure on plants in $/yr	<120	120-300	300+		
time	time spent gardening in hrs/wk	<3	3-6	6+		
area	location of interview	PN	WN	AKL		

After tabulating the frequencies for each factor level, the original number of levels per factor was reduced by joining categories with very small percentages of respondents with subsequent levels, except for the factors 'married', 'gender', and 'area'. For instance, respondents younger than 25 years were not regarded as belonging to a separate age group, but were included in the larger category of respondents under 35 years of age. The original levels selected for respondent characteristics are described in the conjoint questionnaire (Appendix D).

The frequency distribution for each of the demographic and socioeconomic variables is presented in Table 7.2.

Interviews were conducted during the latter part of 1991, 1992, and the beginning of 1993. A comparison with the 1991 Census of population and dwellings (Anon., 1994b) provided some general indications about the type of customer that frequented garden centres. Within the context of the present study, it was assumed that the respondents represented a random sample drawn from the larger population of New Zealand garden centre customers.

It appeared that customers of garden centres were more likely to be female than male. This casts some doubt over the results of surveys relating to garden centres conducted by Bourke and West (1976) and West (1980), which were referred to in Chapters 1 and 2. In both studies, the person doing the most gardening was male, who in the majority of cases completed the questionnaire. Unless the division of gardening duties between males and females have changed in the years after the surveys, the person mainly responsible for the garden, was not the same person making the purchasing decisions at the individual plant level. DeBossu (1988) also concluded that, although most respondents cooperating with her study made their decisions jointly as couples, women rather than men, were more often the sole decision makers. Garden centre customers interviewed during the current study may be compared to those of 'local garden centres' responding to the survey conducted by Turner and Dorfman (1990), who were most likely to be married, white, and female.

According to the 1991 Census of population and dwellings (Anon., 1994b), 65% of New Zealand families had children at home. For 80% of these families the children were classed as 'dependent', which referred to children under 16 years of age and to children between the age of 16 and 18 years who were still at school. Thus, 52.5% of all New Zealand families included one or more children of a dependent age. Even though the factor 'child' in Table 7.2 excluded children between 16 and 18 who were still attending school, the differences between the 1991 Census results and those of the present study were such that one may conclude that garden centre customers were less likely to have younger children at home than were New Zealanders in general. This

Table 7.2 Demographic and socioeconomic factors: frequency distribution (%)

factor	level 0	1	2	3	4
married	23.1	76.9			
child	80.3	19.7			
gender	31.1	68.9			
age	21.5	20.4	24.2	19.2	14.7
employ	30.3	69.7			
own	11.2	88.8			
agehouse	10.4	8.0	10.1	71.4	
section	12.8	29.9	18.0	39.3	
income	32.5	36.3	31.2		
expend	30.1	33.7	36.2		
time	42.1	26.0	31.9		
area	16.7	33.3	50.0		

may be due to the possibility that people without dependent children have more leisure time for hobby's, such as gardening, which are difficult to combine with children's needs and desires.

Of all garden centre customers interviewed, most (57.9%) spent at least three hours a week on gardening. A substantial proportion of the respondent sample, namely 42.1%, claimed that their gardening jobs took up less than three hours per week. If the amount of time spent on gardening was positively correlated with enthusiasm, than 31.9% of respondents could be described as 'keen gardeners', spending six hours or more per week on gardening. A comparison of the amounts of time spent on gardening by respondents with or without younger children at home, presented in Appendix I, Table I1, supported the theory that people without dependent children have more time for hobby's such as gardening than do those with young children. Of garden centre customers without dependent children, 40% spent less than three hours per week on gardening. Thirty four percent could be classed as 'keen gardeners', spending more than six hours per week on gardening jobs. Of respondents who had younger children at home, only 24% worked in their garden for more than six hours per week, with 49% spending less than three hours per week on gardening.

The relatively small percentage of young families amongst garden centre customers, appeared to represent New Zealanders who, within the constraints of bringing up a young family, could still find some time to work in their garden. As such, the group of garden centre customers with younger children at home, was likely to include a higher percentage gardening enthusiasts than did the New Zealand population of families with dependent children.

In the 1991 Census, the age distribution of the New Zealand population was presented using the age categories 0-14, 15-29, 30-44, 45-64, and 65 years of age or older. If the respective proportions of the population were calculated as percentages of the population that was older than 14 years of age, then 31.2% would have been included in the category of 15-29, 28.6% was between 30 and 44 years, 26% belonged to the age category of 45-64, and 14.3% was 65 or older.
In the present study, 43.4% of respondents were between 45 and 65 years of age, which was considerably higher than the comparable Census percentage. This may be partly explained by the fact that, as shown in Table I2, Appendix I, ninety two percent of these respondents had no younger children living at home, which was a much higher proportion than it was for respondents belonging to other age categories, with the exception of those aged 65 or over. The proportion of respondents aged 65 or over, was nearly equal to the percentage of the New Zealand population belonging to the corresponding age group. Compared to respondents of younger ages, those in the highest age category could be typified as customers who spent less money per year on plants, generally belonged to the 'unemployed' category, and had a lower income.

Without reference to the source of information, Chisholm (1995) stated that "30-40 year olds make up 40% of garden centre customers, ahead of the 30% of the traditional market, the 50s-up." In the present study, different age categories were specified, but the proportion of respondents between 30 and 40 years of age was certainly not larger than 36% and was not likely to exceed the percentage of garden centre customers over the age of 50. Discrepancies possibly indicated a recent change in garden centre population.

Of New Zealanders aged 15 years and over, 60.4% were classed in 1991 as part of the labour force, consisting of people who worked for one or more hours per week, either in paid employment or unpaid in a family business, and of unemployed New Zealanders actively looking for employment. If the proportion of people who were unemployed but were actively looking for work was subtracted from the total work force, the resulting 54.1% could be classed as employed. Of garden centre customers interviewed, only 30.3% were unemployed, retired, or students, and 69.7% were in employment. Since plants tend to be regarded as luxury items rather than necessities, it was not surprising that garden centres attracted employed people, who were more likely to have disposable income than were the unemployed.

In 1991, almost three-quarters of New Zealanders owned their home outright or with a mortgage. Of the garden centre customers interviewed, 88.8% owned their home with or without a mortgage. The higher percentage of home owners amongst garden centre customers could be accounted for by the higher proportion of 45 to 65 year olds, who were the least likely to be living in rented accommodation according to the 1991 Census. People living in rented accommodation might be less prepared to spend money on a garden that was not their own.

The majority of respondents (71.4%) lived in houses that were fifteen years or older. Of the consumers surveyed, 10.4% owned or rented recently built accommodation. Since their gardens were likely to be in the development stage, the preferences for outdoor ornamental plant attributes of these customers were expected to differ from those of respondents living in older accommodation.

As may be expected of people who visit garden centres, a relatively high proportion of respondents estimated their section to be larger than 1000 m^2. Only 12.8% of the garden centre customers interviewed, occupied accommodation with a small section of less than 500 m^2.

Both for the age of the accommodation and for the section size, no comparable categories were present in the 1991 Census.

Whereas 77.8% of New Zealanders received an income of less than $30,000 in 1991, only 32.5% of respondents belonged to this income category. Of the garden centre customers interviewed, 36.3% earned between $30,000 and $60,000, which may be compared to 15.2% of New Zealanders receiving an income of in between $30,000 and $70,000. Garden centre customers clearly represented a more affluent group of people than New Zealanders in general. As stated previously, since plants tend to have the status of a luxury commodity, garden centres are more likely to be frequented by customers with a higher disposable income than they are by people with less financial means.

The total number of respondents was approximately evenly distributed over the three selected expenditure levels, with 36.2% of garden centre customers spending more than $300 on plants per year.

The number of respondents interviewed in each area was partly determined by the design of the experiment, allowing for at least one repetition with eight replicates in the area with the smallest population. Palmerston North customers were slightly over-represented, with 0.4% of Palmerston North residents being part of the sample, compared to 0.1% and 0.2% of the Auckland and Wellington population respectively.

In summary, the garden centre customer population included higher percentages of females, homeowners, of families living without younger children at home, and of people between the ages of 45 and 65 years, than did the New Zealand population in general. Percentages of garden centre customers who were unemployed, or belonged to the category of people earning an income less than $30,000, were smaller than comparable percentages of the New Zealand population.

7.3 Analysis of variance incorporating characteristics of respondents

To test the hypothesis that part of the variation in plant profile ratings was accounted for by interactions between plant factors and respondent characteristics, and to investigate the nature of these interactions, an analysis of variance based on model 7.2 was performed. The component (interactions between plant factors and respondent characteristics) in model 7.2 was a simplified representation of expression 7.3:

$$A_i married_r + A_i child_s + A_i gender_t + A_i age_u + A_i employ_v + A_i own_w +$$

$$A_i agehouse_x + A_i section_y + A_i income_z + A_i expend_a + A_i time_b + A_i area_c +$$

$$B_j married_r + \ldots\ldots + B_j area_c + C_k married_r + \ldots\ldots + C_k area_c +$$

$$D_l married_r + \ldots\ldots + D_l area_c + E_m married_r + \ldots\ldots + E_m area_c +$$

$$F_n married_r + \ldots\ldots + F_n area_c + G_o married_r + \ldots\ldots + G_o area_c +$$

$$H_p married_r + \ldots\ldots + H_p area_c \qquad (7.3)$$

where:

$A_i married_r, .., $and $H_p area_c$	=	first-order interactions between respondent and plant factors,
a,b,c,i,..,l, and z	=	0, 1, or 2,
m,...,t,v, and w	=	0 or 1,
x, y	=	0, 1, 2, or 3, and
u	=	0, 1, 2, 3, or 4.

Model 7.2 could be written in vector and matrix notation, and as such took on the form of equation 7.4 which, apart from the lengths of the vectors and the size of the design matrix, was similar to equation 6.8 given in Section 6.3:

$$Y = \mathbf{X}\beta + \epsilon \qquad (7.4)$$

where:

Y	=	(10368 x 1) vector of observations,
β	=	((1727+39+276) x 1) vector of parameters to be estimated, including the mean, with 276 being equal to the sum of the degrees of freedom for each of the interactions specified in equation 7.3,
$\mathbf{X}$	=	(10368 x (1727+39+276)) design matrix, and
ϵ	=	((1727+39+276) x 1) vector of error terms.

The factor 'respondent' was 'absorbed' to reduce computer time and storage requirements. Implications of absorption were described in Section 6.3. Differences in demographic and socioeconomic characteristics were believed to account for at least part of the variation in evaluation judgements of the respondents. Factors representing these characteristics were thus assumed to be absorbed as part of the factor 'respondent'.

An analysis of variance using model 7.4 revealed that interactions between plant factors and respondent characteristics were indeed responsible for part of the variation in plant profile ratings. Interactions of plant factors with demographic or socioeconomic variables listed in Table 7.3, are those that were significant at $p < 0.01$ using the 'full' model 7.4 and either the type I or type III sums of squares, or those that were significant at $p < 0.01$ using a 'reduced' version of model 7.2 with the class variables limited to those present in the model. The reduced version 7.5 of model 7.4 is specified later in this section.

In view of the fact that respondent characteristics were not necessarily independent of one another, and thus caution was needed when drawing conclusions, a probability level $p < 0.01$ was selected for comparisons between the calculated F-values and the respective tabular F-values.

Type I sums of squares, also called sequential sums of squares, are the incremental improvements in error sums of squares as each effect is added to the model (Anon., 1989a). Type I sums of squares for all effects add up to the model sums of squares. Since effects are adjusted for the preceding effects in the model, hypotheses to be tested depend on the order in which the effects are specified in the model.

Type III sums of squares are also referred to as partial sums of squares. The hypothesis for an effect does not involve parameters of other effects, except for containing effects, and is not dependent upon the ordering of effects in the model (Anon., 1989a).

Especially where characteristics of respondents were involved, inferences could be drawn from comparisons of significances resulting from both types of sums of squares. For instance, since the highest age category was comprised of a large percentage of unemployed respondents, it was possible, that the effect on attractiveness ratings of 'being employed' or 'unemployed' was measured as part of an 'age' effect. If the factor 'age' preceded 'employment' in the model statement, and, using the sequential sums of squares, the age of the respondent was found to have a significant effect on the dependent variable, then the analysis could lead to the conclusion that the factor 'employment' had no significant effect. If 'employment' preceded 'age' in the model,

Table 7.3 Significance of effects and interactions at $p < 0.01$[1)]

Effect/Interaction	MODEL:	FULL		REDUCED		REDUCED	
	Class variables:	all	all	limited	limited	all	all
	Type SS:	I	III	I	III	I	III
price		*	*				
health		*	*				
suitability		*	*				
final height		*	*				
shape		*	*				
bushiness		*	*				
leaf colour		*	*				
price * suitability		*	*				
price * final height		*	*				
price * shape		*	*				
shape * bushiness		*	*				
married * health		*	*	*	*	*	*
age * price		*	*	*	*	*	*
employ * final height		-	*	-	-	*	*
agehouse * health		-	-	*	*	-	-
section * final height		*	*	*	*	*	*
section * shape		*	*	*	*	*	*
income * suitability		*	*	*	*	*	*
time * suitability		*	*	-	-	-	-
time * shape		*	*	*	*	*	*
area * price		*	*	*	*	*	*
area * health		*	*	*	*	*	*
area * suitability		*	*	*	*	*	*
area * final height		*	*	*	*	*	*
area * shape		*	*	*	*	*	*

[1)]: significance and non-significance are denoted by * and - respectively.

then results of the analysis may have indicated that the factor 'age' had no significant effect, and that the factor 'employment' significantly affected preference judgements of respondents.
If a significant effect of age was really caused by an employment effect, then both factors would be found to have a significant effect based on the partial sums of squares, irrespective of the ordering. It was thus important to simultaneously consider results based on partial sums of squares and on sequential sums of squares.

The full model 7.2 was specified in vector and matrix notation in equation 7.4. The following was referred to as the reduced model:

$$
\begin{aligned}
Y_{ijklmnopqd} \quad = \quad & \mu + \text{respondent}_q + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p \\
& + A_iB_j + A_iCk + A_iD_l + A_iF_n + A_iG_o + A_iH_p + E_mG_o + F_nH_p \\
& + A_iE_mG_o + A_iF_nH_p + A_i(\text{sociodemo}_d) + B_j(\text{sociodemo}_d) + \\
& C_k(\text{sociodemo}_d) + D_l(\text{sociodemo}_d) + E_m(\text{sociodemo}_d) + \\
& F_n(\text{sociodemo}_d) + G_o(\text{sociodemo}_d) + H_p(\text{sociodemo}_d) + \epsilon_{ijklmnopqd}
\end{aligned}
\tag{7.5}
$$

where:
sociodem_d = one of the twelve socioeconomic or demographic variables,
d = level of the respondent variable concerned, and took on the values 0 or 1 for factors 'married', 'child', 'gender', 'employ', and 'own', the values 0, 1, or 2 for factors 'income', 'expendit', 'time' and 'area', the values 0, 1, 2, 3, or 4 for the respondent factor 'age', the values 0, 1, 2, or 3 for the remainder of the twelve respondent variables, and
$A_i(\text{sociodemo}_d)$,.........., and $H_p(\text{sociodemo}_d)$ = interactions between plant factors and respondent factors.

The difference between model 7.2 and model 7.5 lies in the fact that only one of the twelve respondent characteristics was incorporated in the reduced model (7.5). In the full model 7.2, the components $A_i(\text{sociodemo}_d)$,.........., and $H_p(\text{sociodemo}_d)$ were repeated for each respondent characteristic to give (interactions between plant factors and respondent characteristics).

Model 7.5 written in vector and matrix notation took on the form of equation 7.6:

$$Y = \mathbf{X}\beta + \epsilon \qquad (7.6)$$

where:

Y = (10368 x 1) vector of observations,

β = ((1727+39+x) x 1) vector of parameters to be estimated, with the value of x depending upon the socioeconomic or demographic variable concerned. For example, for the five-level factor 'age', $x = 48$, whereas x was equal to 12 in the case of a two-level respondent characteristic.

$\mathbf{X}$ = (10368 x (1727+39+x)) design matrix, and

ϵ = ((1727+39+x) x 1) vector of error terms.

Apart from the lengths of the vectors and the size of the design matrix, equation 7.6 was equal to equations 6.8 in Section 6.3 and 7.4 in the current section.

For an analysis involving one dependent variable, the GLM procedure of SAS uses an observation only if values are present for that dependent variable and all variables that are specified as 'class variables', i.e. classification variables to be used in the analysis. This meant that for an analysis of the reduced model, the number of observations included in the calculations was likely to be larger when only class variables of the reduced model were involved than it was when all demographics and socioeconomic characteristics were entered as class variables. For example, if the income category of the respondent was denoted as a class variable, all observations of respondents who did not wish to indicate their income level, would be excluded from the analysis, even when the characteristic 'income' was not specified as a model component. It was therefore worthwhile to perform an analysis of the reduced model with only model components as class variables.

Since differences between results based on the sequential sums of squares and those based on the partial sums of squares were mainly due to correlations between respondent characteristics, such discrepancies were less likely to occur in the case of the reduced model than they were using the full model.

The effect of the interaction between the respondent characteristic 'employ' and the plant factor 'final height' was significant when considering the type III sums of squares. An analysis of variance using type I sums of squares did not indicate a significant interaction between these factors. Potential effects of 'being unemployed' versus 'employed' may have been more or less contained in effects of other demographic variables, such as age. The highest age category was comprised mainly of unemployed or retired respondents. If there was a significant interaction between 'employ' and 'final height', but it was not detected using the type I sums of squares for the reasons explained, an analysis based on the reduced model 7.5 would give a significant result. This was indeed the case if the observations included in the calculations were the same as those used to obtain the first column of results in Table 7.3.

If only reduced model components were entered as class variables, then the evaluations of the three levels of 'final height' did not significantly depend upon the respondents being employed or not. Because this was the result of an analysis including all observations, since there were no respondents who did not want to answer the question about their employment, it was regarded as the most valid result. The interaction of 'employment' and 'final height' is therefore not discussed in Section 7.4.

An analysis of the reduced model including all observations with no missing values for the respondent factor 'age of house', suggested that attractiveness ratings for plants in poor, average or good health, significantly depended upon the age of the respondent's house. Because only five respondents did not answer the question about the age of their house, it was considered worthwhile to include a discussion on this interaction in the following section.

Discrepancies between significance levels resulting from the application of different models, and/or the inclusion of different numbers of observations, also occurred for the respondent characteristic 'time' and the plant factor 'suitability'. An analysis based on the full model resulted in a significant interaction when using either sequential or partial sums of squares, but an analysis of results based on the reduced model did not support the hypothesis that inferred attractiveness ratings for 'suitability' depended on the amount of time spent on gardening by the respondent. When an analysis of the full model was performed with interactions between plant factors and the characteristic 'time' entered in the model before interactions with other respondent factors, the result based on the type III sums of squares remained unaffected, but when taking the sequential sums of squares into account, the addition of the interaction term to the model did not lead to a significant improvement in the error sums of squares. It appeared that a different interaction, introduced in the original model before 'time', is partly contained within the interaction between 'time' and 'suitability'. Once the contained interaction was measured and therefore not taken into account again when it came to the interaction 'time x suitability', the latter had changed to such an extent that it had become significant based on sequential sums of squares and partial sums of squares. For these reasons, the interaction between time and suitability was treated as not significant.

7.4 Interactions between respondent characteristics and plant factors

Interactions between plant factors and respondent variables which, based on the previously described considerations, warranted further investigation, are listed in Table 7.4. Estimated effects of interactions listed in Table 7.4 are illustrated in Figures 7.1

Table 7.4 Significant interactions between respondent characteristics and plant factors ($p < 0.01$)

Interaction		
Respondent factor		**Plant factor**
married	*	health
age	*	price
agehouse	*	health
section	*	final height
section	*	shape
income	*	suitability
time	*	shape
area	*	price
area	*	health
area	*	suitability
area	*	final height
area	*	shape

to 7.12. Effects were estimated as deviations from the average of the mean ratings for each of the profiles representing the relevant treatment combinations. For example, the effects of the interaction between factors 'health' and 'marital status' on the mean attractiveness ratings for outdoor ornamental plants, were estimated as deviations from the average of the mean ratings for each of six treatment combinations of factor 'health' with three levels and factor 'married' with two levels.

As illustrated in Figure 7.1, the difference between the mean rating of an unhealthy plant and a healthy plant was smaller for single respondents than it was for those who lived together with a partner. This indicated that single respondents were less concerned with the health of a plant than were respondents living with a partner.

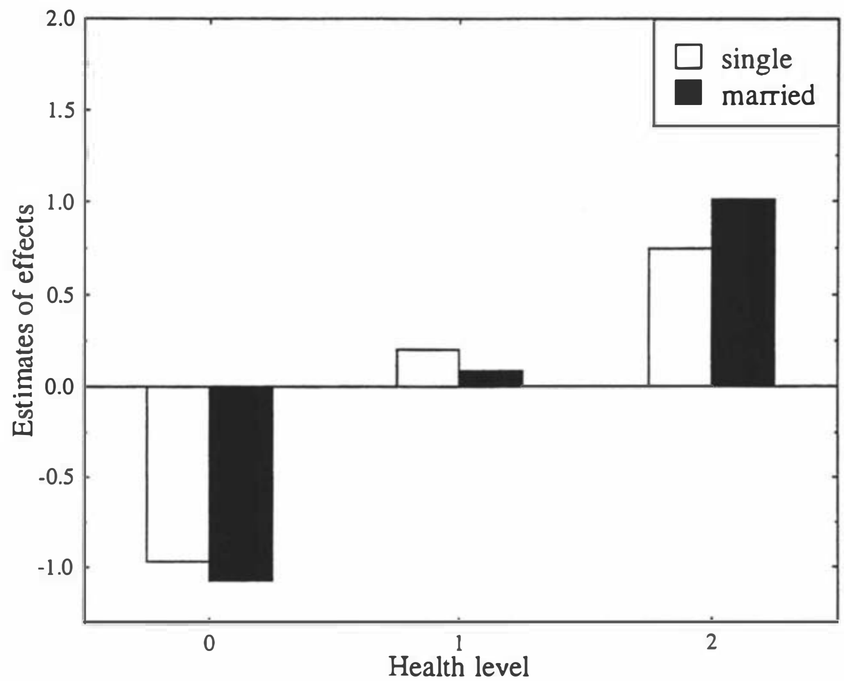

Figure 7.1 Estimated effects of the interaction between health and marital status

It is possible that single people compared to those who were part of a couple, had more time available, and could afford the extra time required to care for unhealthy plants. However, the length of time spent on gardening was similar for both groups (Appendix I, Table I3). An analysis of the reduced model did not reveal significant interactions between health and time, nor between health and any other demographic variable that could be correlated with the factor 'married'. This result alone should not be relied upon when drawing conclusions. Output of the analysis of variance performed, included overall significance levels of interactions, but did not provide information about the separate components of interactions. Therefore, even whilst the interaction between time and health was found to be insignificant, it was still worthwhile to examine the ratings given by people spending various amounts of time in the garden to plants in poor, average, and good health, should single and married respondents have been found to differ in the amounts of time spent on gardening. Assume for example, that respondents spending more than six hours per week on gardening were not concerned with the health status of plants in garden centres. If respondents spending less time working in their garden did pay attention to plant health in the same way as the majority of all garden centre customers interviewed, then averaged over all 'time' categories, ratings for plants in poor, average, or good health might not significantly depend upon the time spent on gardening.

For both, respondents under 35 years of age and respondents over 65 years, differences between the mean ratings for plants priced at three different levels were greater than they were for respondents belonging to other age categories, as illustrated in Figure 7.2. Respondents in between 55 and 65 years of age were the least price-conscientious, which indicated that for them, factors other than price were more important.

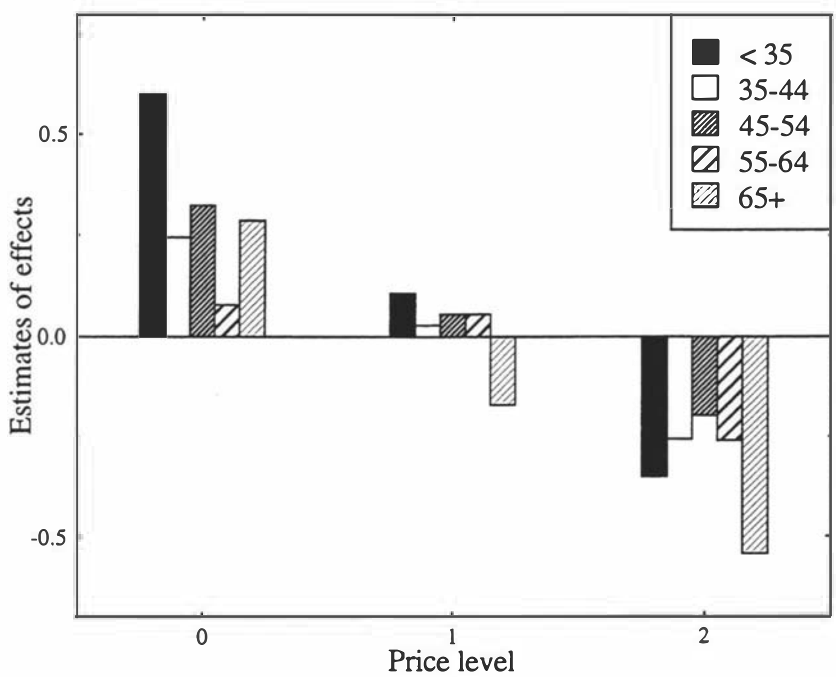

Figure 7.2 Estimated effects of the interaction between price and respondent's age

Results were in accordance with findings of Vink (1989), which indicated that people older than 60 and those younger than 41 years were more concerned with the price of evergreen shrubs than were respondents of other ages. For the older age group this may be partly explained by the fact that 70% of respondents belonging to this category were low income earners (Appendix I, Table I4). Even though no significant interaction between 'income' and 'price' was found, percentages presented in Appendix J show that respondents with low incomes appeared to attach more importance to the factor 'price', than did others. According to Florkowski et al. (1992) price was more important to Christmas tree purchasers with low incomes than it was to high income earners.

Results of the present study were partly in contrast with those published by DeBossu (1988), which did not reveal a significant interaction between the price of conifers and respondent factor 'age'. DeBossu (1988) concluded that low income earners favoured moderately priced narrow-leaved plants over low-priced conifers, but she did not comment on any differences between low and high income earners in the relative importances they attached to the factor 'price'.

As shown in Figure 7.3, differences between the mean attractiveness ratings for plants in poor, average, or good health were the largest for respondents who lived in houses belonging to the age category of over 15 years. This indicated that the factor 'health'

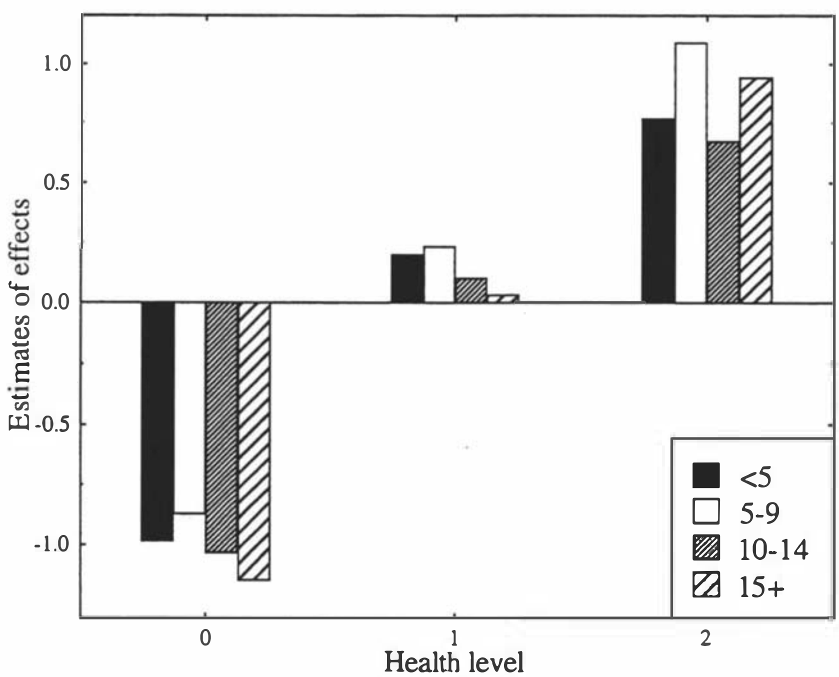

Figure 7.3 Estimated effects of the interaction between health and age of house

was more important to those who lived in houses older than 15 years than it was to those occupying younger houses. Respondents living in older houses would generally have lived there for longer periods, and would be more aware of the implications of health problems in their gardens than would occupiers of younger houses. This would also explain why people in new houses tended to rate plants in poor or average health higher than did people living in old houses. Relative importances attached to plant health, inferred from ratings supplied by respondents occupying houses of an intermediate age, were difficult to explain. Respondents with accommodation between 5 and 10 years regarded plant health nearly as important as did respondents living in houses over 15 years of age. Garden centre customers with houses in between 10 and 15 years of age shared the relatively low concern with the factor 'health' expressed by residents of new houses.

The interaction between 'final height' and 'section size' is graphically presented in Figure 7.4. Of all respondents, those with sections of $1000m^2$ or larger appeared to be the least concerned with the mature height of plants, whereas to those with small sections of less than $500m^2$ the final height was of greatest importance.

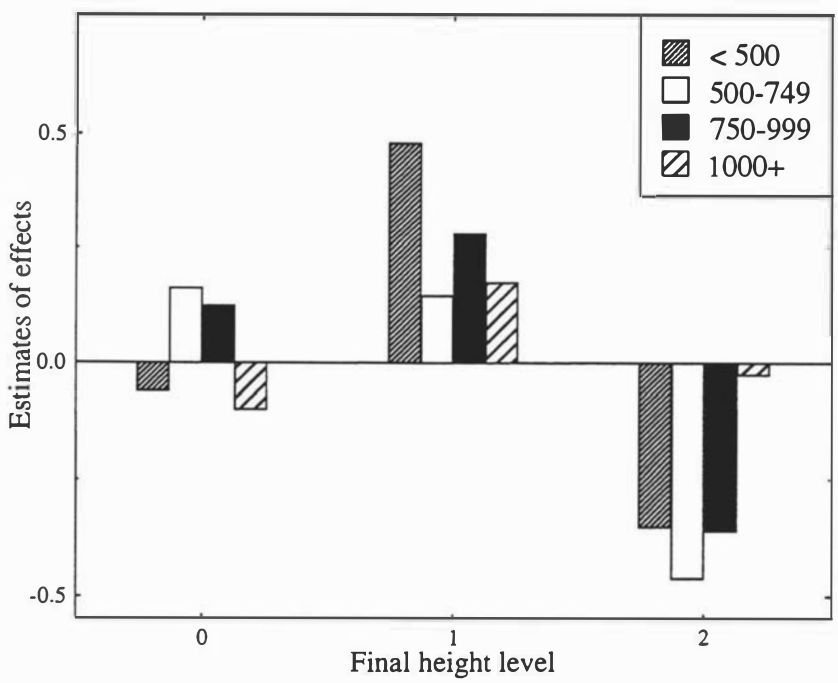

Figure 7.4 Estimated effects of the interaction between final height and section size

As may be expected, people with gardens larger than $1000m^2$ were less negatively disposed towards tall growing plants than were respondents with smaller gardens. This was in accordance with results published by DeBossu (1988). In her study on garden centre customers' preferences for narrow-leaved evergreens she found that contrary to the generally preferred medium-sized mature plants, respondents with large properties had a slight preference for tall plants. Respondents with section sizes other than 500 to $749m^2$ preferred plants of an average height as opposed to low growing plants, the difference between the mean ratings for plants belonging to these two height categories being the largest for respondents having a small section of less than $500m^2$. As explained in Section 6.4.3, an expected plant height of 1-2m was actually only preferred by customers selecting plants priced at $12.95. For cheap or expensive plants, final heights of up to 1m were preferred.

Results of evaluations of balanced and unbalanced plants by respondents with different section sizes, are illustrated in Figure 7.5. Respondents preferred balanced plants, regardless of the size of their section. Garden centre customers with a section of 500 to $749m^2$ and those with a large section of over $1000m^2$ rated unbalanced plants on average higher than did respondents with other section sizes. The difference between the mean ratings for balanced and unbalanced plants was the smallest for people with a section in between 500 and $750m^2$, and the largest for respondents with sections

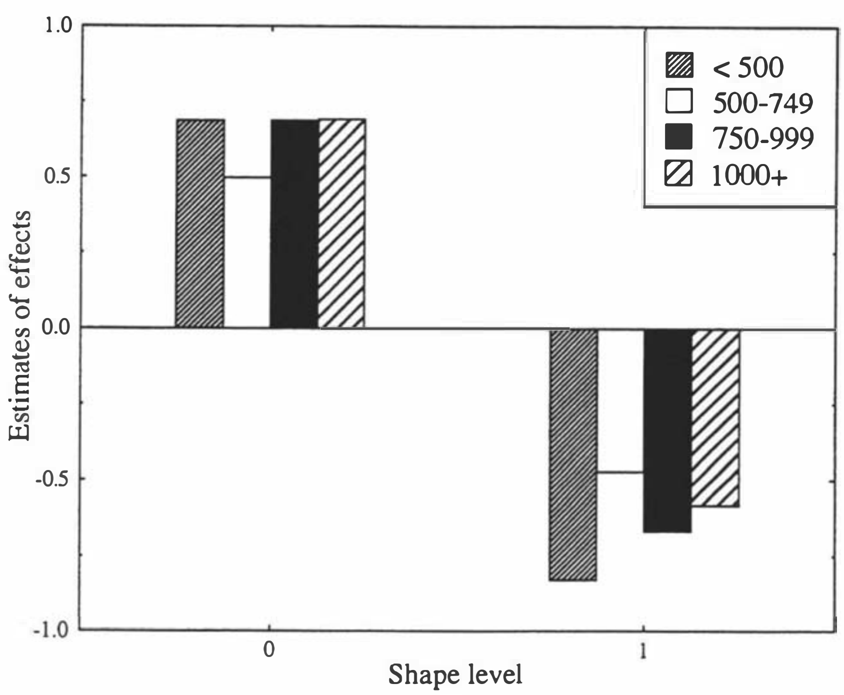

Figure 7.5 Estimated effects of the interaction between shape and section size

smaller than $500m^2$. On small sections, individual plants may be more important in their own right, whereas on larger sections, viewers' perception may tend to be more focused on the garden as a whole. However, if this theory is correct, then another, more important factor was involved in the evaluation of 'shape' by respondents with a section size in between 500 and $750m^2$.

As shown in Figure 7.6, respondents belonging to low, average, and high income categories differed substantially in their opinions about attractiveness of the suitability of plants for the growing conditions in their gardens.

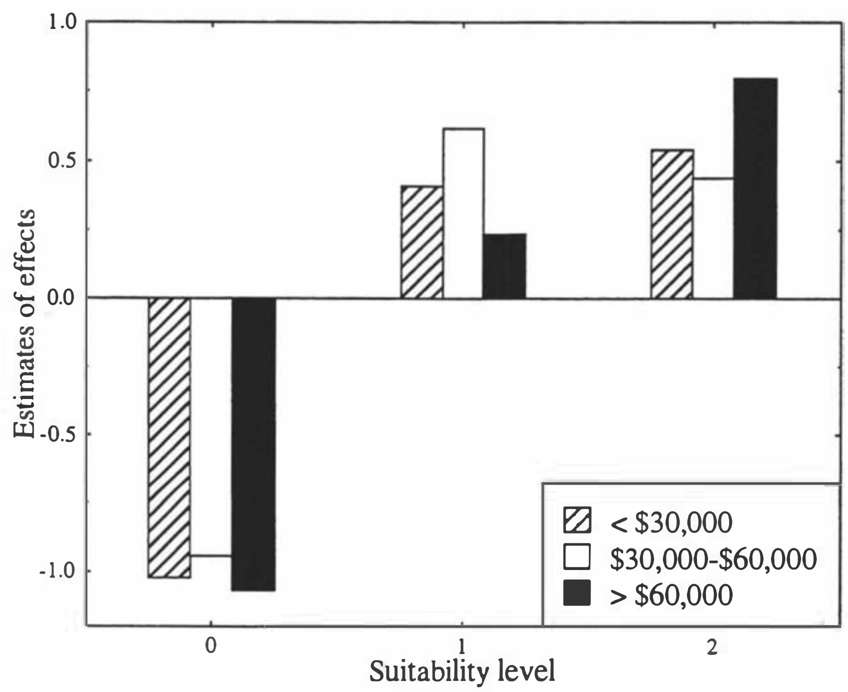

Figure 7.6 Estimated effects of the interaction between suitability and income

High income earners attached more importance to this factor than did respondents with low and middle incomes. As shown in Appendix I, Table I5, of respondents with high incomes, 59% spent more than $300 per year on plants, compared to 35% of middle income earners, and 18% of respondents with low incomes. High income earners may spend more money on individual plants, and therefore attach more value to their suitability for the growing conditions in the garden. Respondents with high incomes may also buy a larger number of plants, and may be more aware of problems associated with plants that are not suitable for the environmental conditions in their garden. Little or no difference existed between the mean ratings of respondents earning $60,000 or less, for plants with an average suitability and plants which were well suited to the growing conditions. Middle income earners appeared to have a preference for plants with an average suitability for their garden rather than for plants that were well suited to their gardens.

The interaction between plant shape and the amount of time spent on gardening is illustrated in Figure 7.7. Shape was more important to keen gardeners than it was to

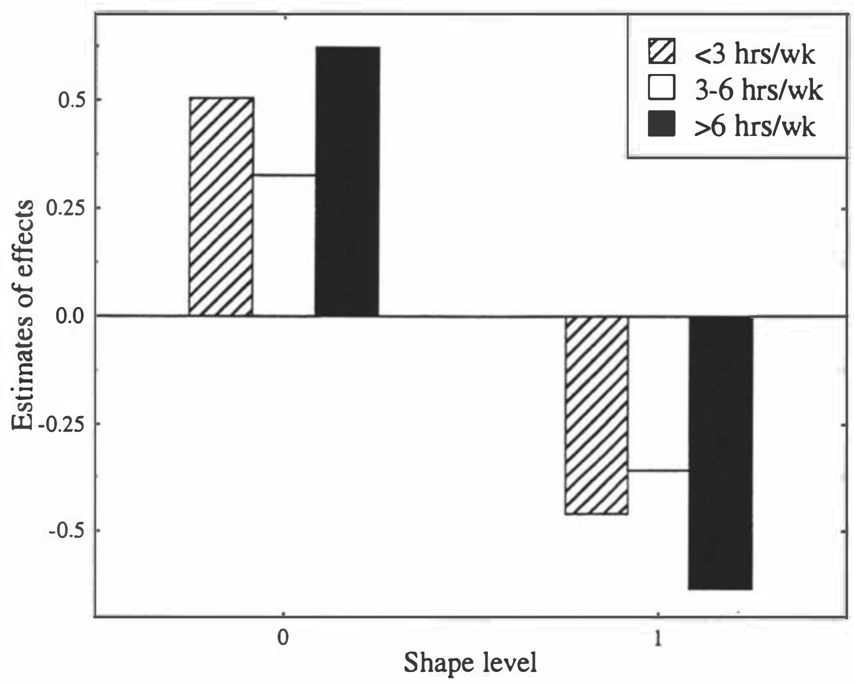

Figure 7.7 Estimated effects of the interaction between shape and time spent on gardening

those who spent less than six hours per week on gardening. Garden enthousiasts may have more experience than others with disadvantages of unbalanced plants, and/or may give a higher priority to gardening jobs other than reshaping plants. Respondents who spent little time in their garden were more concerned with plant shape at purchase than were those who worked three to six hours in their garden. This indicated that those who had limited time available for gardening, were not keen to spend this on improving the shape of plants purchased.

Effects on plant profile ratings, of the area in which the interviews were held significantly depended upon the levels of factors ‘price’, ‘health’, ‘suitability’, ‘final height’, and ‘shape’. The samples in each of the three areas may have differed in characteristics of respondents, which in turn could provide possible explanations for significant effects of interactions between area and plant factors.

As shown in Figure 7.8, customers interviewed at garden centres in Auckland, were more concerned with price than were those from Wellington, who in turn paid more attention to plant prices than did respondents in Palmerston North.

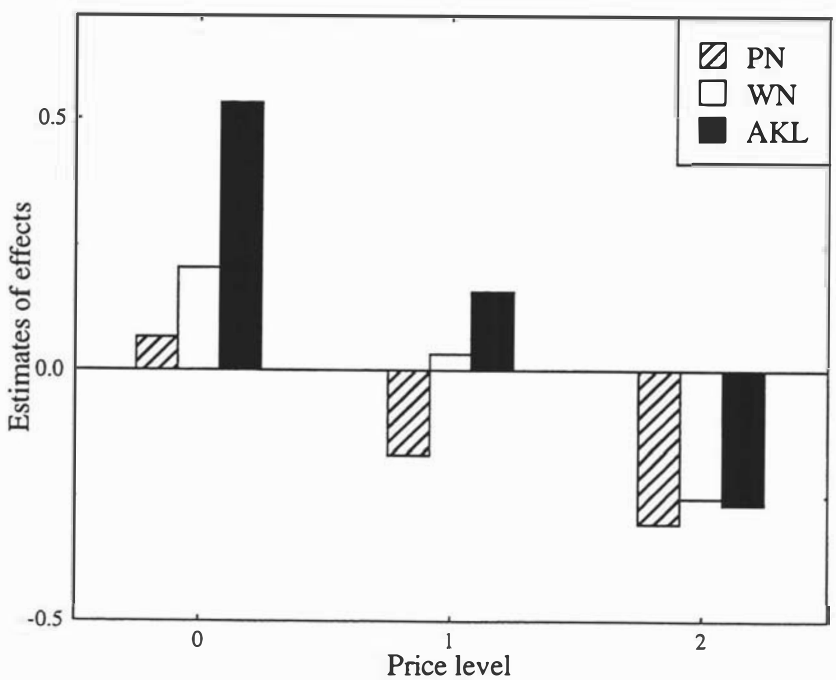

Figure 7.8 Estimated effects of the interaction between price and area

If the previously proposed theory that the importance attached to the factor ‘price’ depended on the income level of the respondent, was correct, than one would have expected that garden centre customers in Palmerston North were more concerned with plant prices than were those in Wellington and Auckland. Cross tabulations of income levels and location of interviewing are presented in Table K9 in Appendix K. Of respondents in Palmerston North, 41% belonged to the category of low income earners, whereas only 25% and 35% respectively of respondents in Wellington and Auckland earned less than $30,000. The failure of the responses to the factor 'price' to be the same for each of the three areas was therefore due to causes other than those associated with differences in income levels of respondents.

The interaction between the plant factor 'health' and respondent factor 'area' is illustrated in Figure 7.9. The health status of a plant was less important to Aucklanders

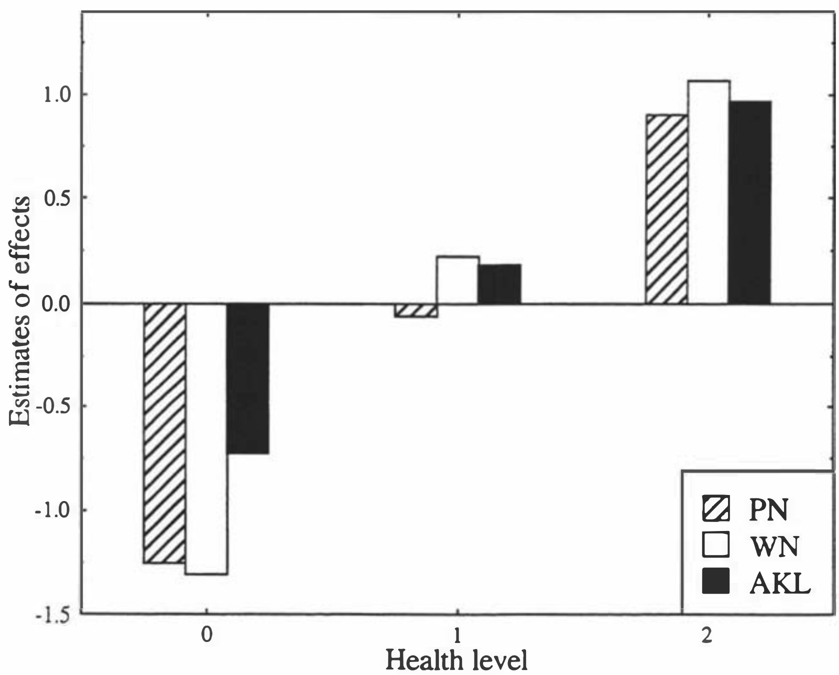

Figure 7.9 Estimated effects of the interaction between health and area

than it was to respondents in both Wellington and Palmerston North. With the climate in Auckland being more favourable to plant growth, respondents in Auckland may have been less often confronted with plant health problems, and may therefore have paid less attention to this factor when purchasing plants, than have customers of garden centres in the other two areas. Differences in the amounts of time spent on gardening by respondents in Auckland and those in Palmerston North and Wellington may also have contributed to variations in the opinion about the importance of factor 'health'. The amounts of time allocated to working in the garden by customers interviewed in each area are listed in Table K11, Appendix K. Gardening enthusiasts are more likely to derive pleasure from improving the growing conditions in their garden and from nursing unhealthy plants than are others. The sample of garden centre customers interviewed in Auckland included the highest percentage of keen gardeners when compared to respondent samples in Wellington and Palmerston North.

Evaluations of plants with a poor, average, and a good suitability for the respondent's garden, are graphically presented in Figure 7.10 for respondents from each area.

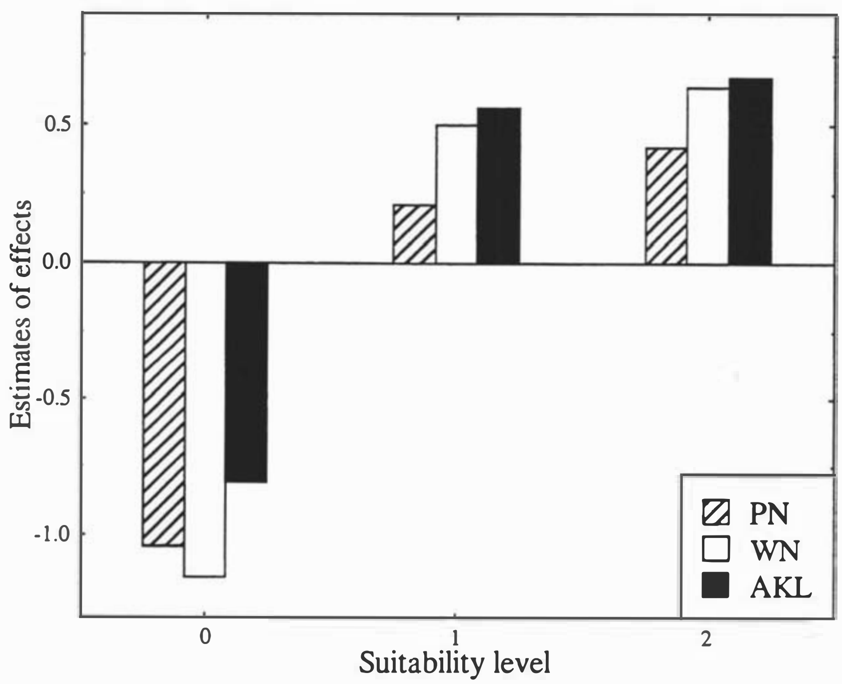

Figure 7.10 Estimated effects of the interaction between suitability and area

The fact that Aucklanders were less discouraged by plants that were not suitable for their garden than were respondents in Palmerston North, and especially those in Wellington, may be due to the same factors that were believed to be responsible for their attitude towards the health status of plants. Garden centre customers interviewed in the Wellington area, were more concerned with the degree in which plants were suited to the conditions in their garden than were respondents in Auckland and Palmerston North. The definition of the factor 'suitability for the respondent's garden' was based on a plant's ability to withstand a specific number of aspects, namely the soil type, temperature, moisture, light situation, wind, and coastal conditions. As such, it did not allow for other than general conclusions. Had suitability for the respondent's garden been defined on just one aspect for example, then it would have been possible to assess the likelihood that differences in opinions between respondents from Auckland, Wellington, and Palmerston North were caused by regional variations in this aspect.

As illustrated in Figure 7.11, respondents in Auckland perceived a larger difference between the attractiveness of plants with an average final height and tall plants than did respondents in Wellington and Palmerston North. Plants reaching heights of over 2m

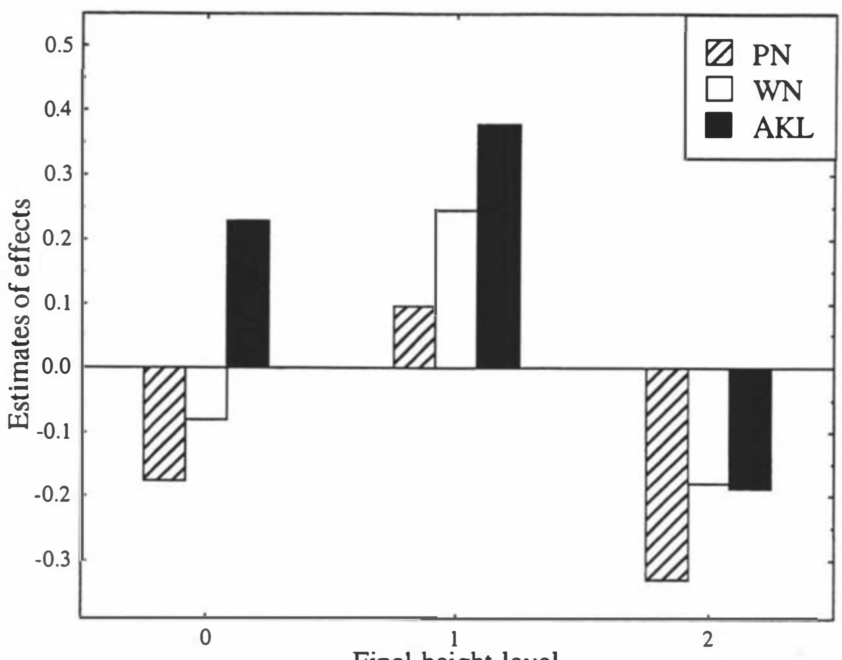

Figure 7.11 Estimated effects of the interaction between final height and area

generally require more space in the garden than do plants growing to heights of under 2m. Respondents may therefore have based evaluations of different heights on the appropriateness for their section. However, this hypothesis was not supported by results presented in Table K8, Appendix K, which show that 46% of respondents in Auckland estimated that the size of their section was over $1000m^2$, compared to 30% and 39% respectively, of garden centre customers interviewed in Wellington and Palmerston North. Up to a mature height level of 1 to 2m, Aucklanders were less concerned with the plant factor 'final height' than were garden centre customers in Palmerston North and Wellington.

As shown in Figure 7.12, the difference between mean ratings for balanced and unbalanced plants was smaller for respondents in Wellington than it was for people interviewed in Palmerston North and Auckland. It appeared that garden centre customers in Wellington were more readily prepared to prune plants for improvement of shape than were those in Palmerston North and Auckland. As with most interactions it was only possible to suggest reasons rather than to give explanations for the observed effects of this interaction.

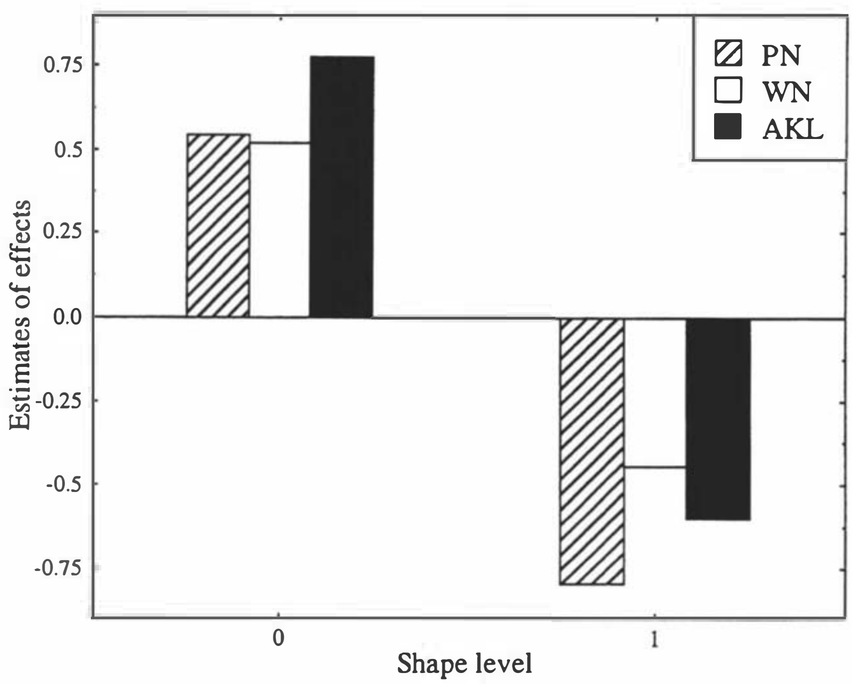

Figure 7.12 Estimated effects of the interaction between shape and area

7.5 Summary: interactions between respondent characteristics and plant factors

In this section, results of the analyses involving interactions between characteristics of respondents and plant factors are summarised in the order of the interactions specified in Table 7.5. This table differs from Table 7.4 only in the order in which the relevant

Table 7.5 Relevant interactions between respondent characteristics and plant factors

Plant factor	Interaction	Respondent factor
price	*	age
price	*	area
health	*	married
health	*	agehouse
health	*	area
suitability	*	income
suitability	*	area
final height	*	section
final height	*	area
shape	*	section
shape	*	area
shape	*	time

interactions are listed. Discrepancies and similarities with other studies as far as significant interactions are concerned, were discussed in Section 7.4. Comparisons of non-significant interactions with findings of others, are included in the current section.

PRICE

Differences between mean preference ratings for the three price levels varied significantly with age of the respondent, and with the interview location. Garden centre customers younger than 35 or older than 65 years of age, placed greater emphasis on price when rating plants on an attractiveness scale than did respondents of other age categories. Customers interviewed at garden centres in Auckland attached more importance to price than did respondents in Wellington and Palmerston North.

Interactions between price and the respondent factors 'married', 'child', 'employ', 'own', 'agehouse', 'section', 'income', 'expend', and 'time' were not significant.

Findings in the present study that effects of price on plant evaluations did not depend on gender, were in accordance with results published by DeBossu (1988). She observed that respondents in general favoured an increase in price up to a moderate price level, and that male and female respondents did not differ significantly in their perceptions of price. Vink (1989) on the other hand, found that price was considerably more important to male respondents than it was to female respondents. Whilst low prices were most preferred by both genders, females rated expensive plants as more attractive than medium priced plants. According to Florkowski et al. (1992), male customers were less concerned with the price of Christmas trees than were female customers. Thus, effects of plant price on plant evaluations by females and males, reported in other studies, were inconsistent. Such inconsistencies may be partly due to the complex nature of the factor 'price'.

In general, consumers are heterogenous in their perceptions of price (Erickson and Johansson, 1985; Dickson and Sawyer, 1990; Tellis and Gaeth, 1990; Lichtenstein et al., 1993). Some consumers perceive price strictly in a negative sense, where it represents the amount of money that must be given up. Others regard price as an indicator for quality. Lichtenstein et al. (1993) provided evidence for the occurrence of finer discriminations in consumer perceptions of both the positive and the negative roles of price. Results of the current study did not exclude the possibility that respondents differed in the way they perceived price. Segmentation on gender could still have led to the conclusion that there was a significant interaction between price and gender, if differences in price perceptions were unevenly distributed amongst female and male respondents. For example, if all female respondents regarded price as a sacrifice, and all men viewed price as an indicator of quality, then the appreciation for price levels would have been found to vary with gender. Results did not suggest such an uneven distribution.

It is likely that different views of price were correlated with a number of respondent characteristics. Thus, female respondents in the survey conducted by Vink (1989) may have differed from male respondents in factors other than gender alone. Especially since only few respondent characteristics were taken into account by Vink (1989) and Florkowski et al. (1992), effects of interactions between price and gender in both studies may have been due to differences in such other factors.

HEALTH

The evaluation of different health levels depended on the marital status of the respondent, the age of his or her house, and on the location of the interview. Mean ratings for plants which differed in health status were more similar for single respondents than they were for those who lived with a partner. Health was less important to garden centre customers with houses built less than 15 years ago at the time of interviewing, and to respondents in Auckland, than it was to respondents belonging to other categories of the respective characteristics.

Opinions about the factor 'health' were not significantly dependent upon respondent factors 'child', 'age', 'employ', 'own', 'income', and 'time'.

DeBossu (1988) concluded that the level of pest and disease resistance of conifers was more important to men than it was to women. Effects of the interaction between plant health and gender appeared to be related to the type of plant under study, since female and male respondents in the present survey and in the one conducted by Vink (1989) did not significantly differ in their evaluations of broadleaved plants in poor, average, or good health.

A similar explanation may be appropriate for the interaction between section size and plant health. According to DeBossu (1988), the smaller their section size, the more concerned respondents were with the level of pest and disease resistance of conifers. For broadleaved evergreen shrubs such a trend was not apparent from the results of the current study.

People with a high expenditure per year on plants, had a greater distaste than any other group for low pest resistance of conifers (DeBossu, 1988). To understand the implications of such a finding, it would have been helpful to have some indication of the number of plants people purchased as well as their expenditure. In the study of DeBossu (1988), it was possible that respondents with a high expenditure bought the same number of plants each year as small spenders, but spent more money per plant. Results of the current study indicated that for expensive plants, good health was more important than it was for plants with an average or low price level. Thus, big spenders who bought a limited number of expensive plants per year were likely to place more emphasis on plant health than did small spenders. That garden centre customers' evaluations of broadleaved evergreens with a particular health status did not vary with the amounts of money spent per year on plants, suggested that respondents with high yearly expenditures did not buy more expensive plants than did others.
Vink (1989) only compared responses of people who had not purchased any plants during the year previous to the survey and of those who had. She showed that respondents who had not purchased a plant during the year previous to the survey, were less concerned with pest and disease resistance of broadleaved evergreens than were respondents who had made plant purchases. This may have been due to a difference in experience with plants between respondents. The more plants people have bought the more likely it is that they have been exposed to plant losses due to poor health.

If the number of hours per week spent on gardening can be regarded as a measure of enthusiasm, then the respondent factor 'time' was comparable to the factor 'keenness' incorporated in the study of Vink (1989). She concluded that purchase behaviour of keen gardeners was more influenced by the level of pest and disease resistance than was that of less enthusiastic gardeners. However, her conclusion was based on profile ratings supplied by 94 respondents, of whom only seven classed themselves as 'not keen' on gardening. In the present study, differences between profile ratings for plants in poor, average, or good health, were not large enough to suggest a significant interaction between the factors 'time' and 'health'.

SUITABILITY FOR THE RESPONDENT'S GARDEN

Attractiveness ratings for plants with different levels of suitability for the respondent's garden, were significantly affected by the income of the respondent and the location of interviewing. High income earners, paid more attention to this factor than did others. Respondents in Wellington were more concerned with the suitability of a plant for their garden than were those in Palmerston North and Auckland.

No significant interactions were apparent between the plant factor 'suitability for the respondent's garden', and the respondent characteristics 'married', 'child', 'gender', 'age', 'employ', 'own', 'agehouse', 'section', 'expend', and 'time'.

To date, no published information is available about effects on plant evaluations, of the degree in which plants are suited to the growing conditions in the customer's garden. Thus, no comparisons could be made with findings in other studies relating to possible effects on plant selections of interactions between the factor 'suitability for the respondent's garden' and characteristics of garden centre customers.

FINAL HEIGHT

Up to a mature size level of 1 to 2m, respondents in Auckland were less concerned with the plant factor 'final height' than were respondents in Wellington and Palmerston North. The perceived difference between the attractiveness of tall plants and that of plants reaching average final heights, was larger for garden centre customers interviewed in Auckland than it was for respondents in the other two areas. As may be expected, owners of large sections were less negatively disposed towards tall growing plants than were respondents with smaller sections. The mature size of plants was more important to people with sections less than $500m^2$ than it was to garden centre customers with larger gardens.

Single and married people, employed and unemployed respondents, and those with and without younger children at home, did not significantly differ in their opinions about preferred mature height levels or about the importance of the factor 'final height'. Likewise, none of the effects of interactions between mature plant size and the respondent factors 'own', 'agehouse', and 'time', were significant.

According to DeBossu (1988), women had a strong dislike for tall growing narrow-leaved evergreens. This could be related to a fear of dark, overgrown spaces, or to a dislike of pruning. In either case, one would expect that women were also less attracted to tall growing broadleaved shrubs than were men. However, results of the current study did not indicate such a correlation between gender and the evaluation of different final height levels of broadleaved ornamental shrubs.

DeBossu (1988) did not comment on relative importances attached to the factor 'final height' of conifers by women and men. Results of the survey conducted by Florkowski et al. (1992) revealed that male respondents were more concerned with the height of Christmas trees than were female respondents. Because of differences in usage of Christmas trees and outdoor ornamentals, it is debatable whether or not the Christmas tree attribute 'height' may be compared to the factor 'final height' of evergreen shrubs. In the current study, male and female garden centre customers did not appear to differ in the degree of importance they placed upon the final size of broadleaved evergreen ornamentals.

The mature size of conifers was relatively more important to garden centre customers with a low expenditure per year on plants than it was to those who spent large amounts of money per year on plants (DeBossu, 1988). Results of the current study did not indicate differences between small spenders and respondents with high expenditures per year as far as perceived importance of mature plant heights were concerned.

Results published by DeBossu (1988) did not suggest a significant effect of interactions between the age of respondent and the plant factor 'final height'. Vink (1989) on the other hand, concluded that people over 60 years of age preferred evergreen plants reaching heights of less than 1m, whereas younger people expressed a preference for plants with final heights in between 1-2m. She also showed that of all respondents, those older than 60 placed the most emphasis on the mature height of evergreen shrubs. Older people may be more concerned with security and therefore prefer gardens that allow for unobstructed views. However, results of the present study did not support this theory.

SHAPE

People with gardens smaller than 500 m^2 placed greater emphasis on the shape of plants than did garden centre customers with larger sections. Keen gardeners paid more attention to the shape of plants at purchase than did respondents who spent less than six hours per week on gardening jobs. Plant shape was less important to respondents in Wellington than it was to clients of garden centres in Palmerston North and Auckland.

Mean ratings for the plant factor 'shape' did not significantly depend upon the levels of respondent factors 'married', 'child', 'age', 'employ', 'own', 'agehouse', 'income', and 'expend'.

Shape of outdoor conifers was not elicited as one of the choice determining factors for garden centre customers responding to the survey conducted by DeBossu (1988). According to Florkowski et al. (1992) shape was an important attribute of Christmas trees, and female respondents were more concerned with the shape of the trees than were male respondents. While shape was one of the determinant attributes of broadleaved evergreen shrubs, the importance attached to this plant factor did not appear to be dependent upon the gender of respondents.

Comparisons with other studies, of interactions between plant and respondent factors, suffered from the same problems as mentioned in previous sections, such as those originating from differences in product groups, sample sizes and type of respondents. As was stressed in Section 7.3, interpretations of effects due to particular respondent characteristics were complicated by possible correlations between respondent factors. Analyses including as many characteristics of garden centre customers as possible, are more likely to help discover reasons underlying differences in plant evaluations between respondents, than are those based on models with only a few components representing effects of respondent factors. Assume for example, that only the income of respondents, their marital status, age, and gender were selected as the variables associated with characteristics of respondents. A significant influence of income level on plant evaluations could represent an effect of 'being employed' versus 'being unemployed or retired', and may be a reflection of the amount of gardening time available to respondents, rather than of the amount of disposable income.
Vink (1989) and Florkowski et al. (1992) attempted to relate plant attribute evaluations to four respondent characteristics, while DeBossu (1988) divided the sample of respondents into segments according to six demographic and purchasing behaviour variables.

To date, no reference was made in any other published research of the effect of region of residence of consumers on their evaluations of nursery crop attributes. In the present study, mean ratings for five of the eight plant factors were found to depend significantly upon the area of interviewing. Since the statistical design allowed for uncorrelated measurement of effects in each of the three areas, it was possible to further investigate interactions between plant factors and the respondent factor 'area of interviewing'. In the following section, results are presented of separate analyses of data obtained in each of the three areas Auckland, Palmerston North, and Wellington.

7.6 Analysis of variance for profile ratings in each of three areas

In previous sections, it was shown that respondents in Palmerston North, Wellington, and Auckland, differed in their opinions about the plant factors 'price', 'health', 'suitability', 'final height', and 'shape'. To investigate the relative importances attached to the plant factors under study in each of the three areas, a separate analysis of variance was performed on data gathered in Palmerston North, Wellington, and Auckland. The statistical design allowed for uncorrelated measurement of all effects and interactions specified in model 6.7, which is repeated here as model 7.6:

$$Y_{ijklmnopq} = \mu + \text{respondent}_q + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p$$
$$+ A_iB_j + A_iC_k + A_iD_l + A_iE_m + A_iF_n + A_iG_o + A_iH_p +$$
$$E_mG_o + F_nH_p + A_iE_mG_o + A_iF_nH_p +$$
$$\epsilon_{ijklmnopq} \qquad (7.6)$$

where:

$Y_{ijklmnopq}$ = response variable,
μ = mean of profile ratings, and
'respondent$_q$' = proportion of the variation in Y explained by variation in characteristics of respondents, where q could take on the values 1,2..,1727,
$A_i,\ldots,H_p$ = estimated effects of factors *a, b, c,...,* and *h*, where i,j,k, and l could take on the values 0, 1, or 2, and m, n, o, and p were equal to 0 or 1,
$A_iB_j,\ldots,F_nH_p$ = first-order interactions,
$A_iE_mG_o$, $A_iF_nH_p$ = second-order interactions, and
$\epsilon_{ijklmnopq}$ = variation in the response variable not accounted for by the model.

Profile ratings were analysed following the procedure described in Section 6.3. Results are presented in Tables L1, L2, and L3, in Appendix L. Comparison of results listed in Table 7.6, and those in Table 6.3, suggested that respondents in Auckland were

Table 7.6 Summary of analysis of variance results for each of three areas[1)]

	significant at $p < 0.05$[2)]		
Source	**PN**	**WN**	**AKL**
A (price)	*	*	*
B (health)	*	*	*
C (suitability)	*	*	*
D (final height)	*	*	*
E (shape)	*	*	*
F (flower colour)	-	-	*
G (bushiness)	*	*	*
H (leaf colour)	*	*	*
AB	*	-	-
AC	*	*	*
AD	*	*	*
AE	-	*	-
AF	-	-	-
AG	-	-	-
AH	-	-	-
EG	*	*	*
FH	-	-	-
AEG	*	-	-
AFH	-	-	-

[1)]: Palmerston North = PN; Wellington = WN; Auckland = AKL
[2)]: significance and non-significance at $p<0.05$ are denoted by * and - respectively.

responsible for the overall significant effect of flower colour on profile ratings. The effect of flower colour on the opinion of Auckland respondents was limited, and would not be classed as significant at a probability level of $p<0.01$. As far as first-order interactions were concerned, differences between the areas were apparent for the interactions between 'price' and 'health', and between 'price' and 'shape'.

Only for garden centre customers interviewed in Palmerston North did price ratings significantly depend upon the health status of plants. The graphical presentation in Figure 7.13 of the effects of price at each of the three health levels, estimated from ratings provided by Palmerston North respondents, shows that where an unhealthy plant was concerned, Palmerston North respondents perceived little difference between the three price levels.

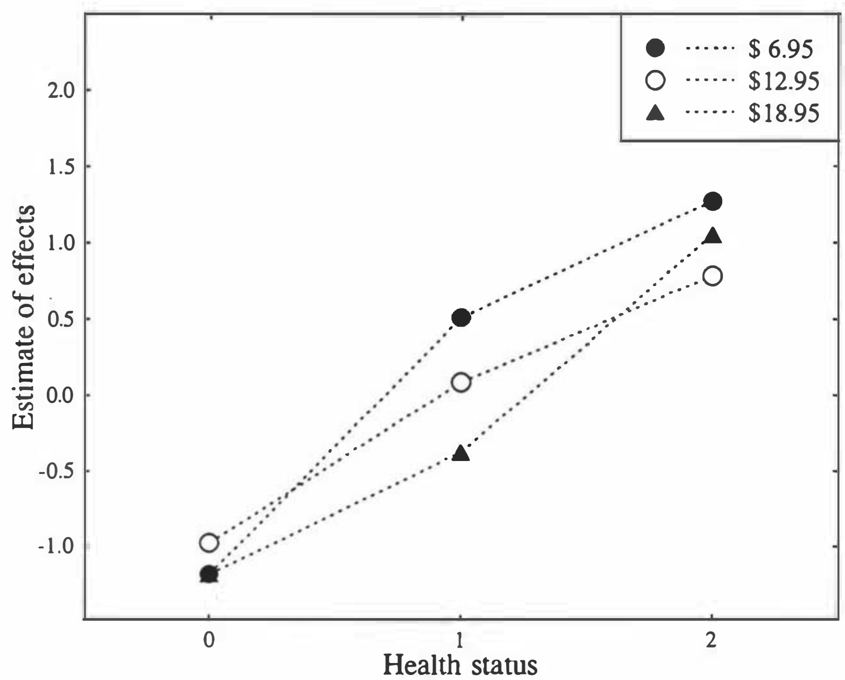

Figure 7.13 Palmerston North respondents: estimated effects on ratings, of health at different price levels

The extent to which price influenced preference ratings, was largest for plants with an average health status. Garden centre customers interviewed in Palmerston North appeared to associate 'high price' with 'good health'. Although $6.95 was still the preferred price level, respondents were more attracted to healthy plants priced at $18.95 than they were to averagely priced plants of similar health status.

As discussed in Section 6.4.3, results of an analysis of data obtained from all garden centre customers interviewed, led to the conclusion that customers were more likely to pay the difference between $12.95 and $18.95 for a healthy plant than they were for a plant with an average or poor health status. Results of separate analyses for each area suggested that no significant interactions existed between factor 'price' and 'health' for respondents in Wellington and Auckland, but that garden centre customers in Palmerston North would rather pay $18.95 for a healthy plant than $12.95.

That respondents from Wellington were equally prepared to pay $12.95 or $18.95 for balanced plants although they preferred the lower price of $6.95, is shown in Figure 7.14. Price was less important to garden centre customers in Wellington when they were presented with balanced plants than when they had to make a choice between plants with an asymmetrical shape. In the case of unbalanced plants, results indicated that plants with a low price and those with an average price were perceived as equally attractive. Expensive, asymmetrical plants rated very low.

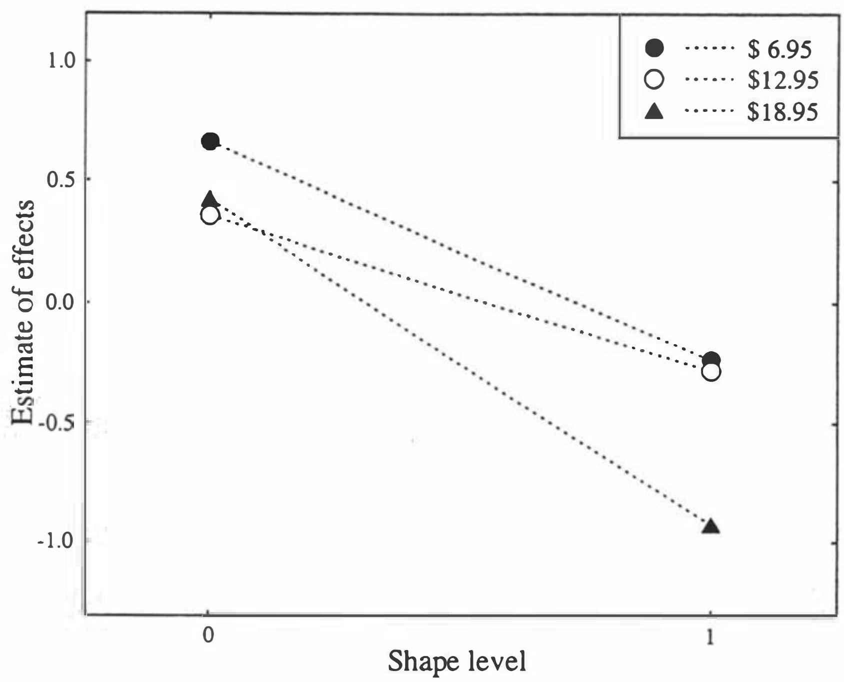

Figure 7.14 Wellington respondents: estimated effects on ratings, of shape at different price levels

A comparison with Figures 6.1 and 6.4, showed how the effects of interactions illustrated in Figures 7.13 and 7.14 respectively, influenced the relevant estimates calculated from the responses of all garden centre customers interviewed. The general trend remained the same, although less pronounced than in the areas where the interactions concerned were significant.

Responses from garden centre customers in Palmerston North indicated a significant second-order interaction between the factors 'price', 'shape' and 'bushiness'. Since this interaction would not be classed as significant at a probability level of $p<0.01$, and because its effect was not large enough to affect the results of the analysis involving all customers surveyed, it did not warrant further investigation.

Relative importances of effects and interactions, based on estimates of the omega squared proposed by Hays (1963) were calculated using equation 6.11, which is repeated here as equation 7.7:

$$\hat{\omega}^2 = (SS_{among} - (df_{among} * MS_{error}))/(SS_{total} + MS_{error}) \qquad (7.7)$$

where:

$\hat{\omega}^2$ = estimate for the proportion of variance in the response variable Y accounted for by the independent variable X,
SS_{among} = sums of squares among treatments,
df_{among} = degrees of freedom among treatments,
MS_{error} = the error mean square, and
SS_{total} = total sums of squares.

For a meaningful comparison of the omega squared estimates across the three areas, the resulting relative importances were transformed so that they added up to 100. Thus, each number in Table 7.7 represents a relative importance based on the assumption that the effects of factors and interactions listed in Table 6.8 accounted for 100% of the variance in plant profile evaluations. Only those responsible for more than 1% of the variation in ratings of each area, are listed in Table 7.7.

As far as the importances attached by respondents to each of the plant factors were concerned, results presented in Table 7.7 obviously should, and did lead to the same conclusions as those based on differences in slopes of lines connecting the bars for each area in Figures 7.8 to 7.12. For example, if each of the estimated effects in Figure 7.9

Table 7.7 Relative importances of effects and interactions in each of three areas[1]

effect/interaction	relative importance in %			
	ALL[2]	PN	WN	AKL
B (health)	38.7	43.2	47.0	30.0
C (suitability)	29.4	23.2	32.2	28.3
E (shape)	14.6	16.6	7.6	19.8
G (bushiness)	6.8	8.8	4.0	8.3
A (price)	3.6	1.3	1.7	6.7
D (final height)	1.7	1.3	1.2	2.7
AD	3.4	3.4	3.4	2.9

[1]: Palmerston North = PN; Wellington = WN; Auckland = AKL;
[2]: ALL : based on calculations including data from all three areas.

of plant health on ratings of respondents in Palmerston North were connected with a line, and the same was done for the bars representing estimated effects of the factor 'health' on ratings in Wellington and Auckland, the steepest line resulted in the case of the Wellington ratings, whereas the line drawn between the estimated effects on evaluations by respondents in Auckland was flatter than it was for the other two areas. Thus both, an inspection of results listed in Table 7.7, and an interpretation of the graphical presentation of the interaction between the factors 'area' and 'plant health' in Figure 7.9, suggested that Aucklanders were less concerned with plant health than were respondents in Wellington, the latter placing more emphasis on the health status of plants than did respondents in Palmerston North.

Relative importances to garden centre customers of plant factors and interactions, could also be inferred from Figures 7.8 to 7.12, but the listing of results in Table 7.7 provided a more convenient basis for comparisons between the three areas. The order of importance attached to the factors 'health', 'suitability', 'shape', and 'bushiness' was the same for each of the three areas. Even though profile evaluations by respondents in Auckland were most influenced by the health status of the plants, this attribute was closely followed by the plant factor 'suitability for the garden'. The perceived difference in relative importance of the top two considerations was largest for respondents in Palmerston North.

The factor 'shape' accounted for only 8% of the variation in responses of garden centre customers in Wellington, but had more than twice that effect on evaluations by respondents in Palmerston North and Auckland. The degree of bushiness also had less impact on profile ratings of customers surveyed in Wellington than it had on judgements of respondents in the other two areas. The impact of price on ratings of respondents in Auckland, was more than three times the effect of price on judgements of customers interviewed in Palmerston North and Wellington. Whereas 'price' and 'final height' were of approximately equal importance to respondents in the latter two areas, the evaluations of garden centre customers surveyed in Auckland were influenced more by the prices of plants on the profiles than they were by the final height levels.

In both Wellington and Palmerston North did the combination of the two factors 'price' and 'final height' account for more of the variation in the responses than did either 'price' or 'final height' individually.

In summary, results for respondents in Palmerston North and Auckland were less 'skewed' than were those for garden centre customers interviewed in Wellington. Whilst respondents in Wellington appeared to be mainly concerned with the two most important factors, namely 'plant health' and 'suitability', respondents in Palmerston North and Auckland paid relatively more attention to the remaining plant factors.

The decision to interview garden centre customers in three different areas was based on a desire to obtain a more representative sample of New Zealand garden centre customers than would be obtained if only customers in Palmerston North had been interviewed. The fact that results varied between areas suggests that a sample consisting of garden centre customers in one of the areas would indeed not be representative of New Zealand garden centre customers in general.

A myriad of factors may have contributed to the differences between profile evaluations in the three areas that were outlined in the current and the previous sections. Therefore, rather than focusing on possible explanations, it seemed more appropriate to concentrate on the implications of these differences for growers and retailers of ornamental plants. The latter are discussed in Chapter 8 as part of a general synthesis of consequences for the nursery industry, of findings presented in Chapters 6 and 7.

8. CONCLUSIONS AND IMPLICATIONS

8.1 Introduction

For garden centres to compete successfully with mass merchandisers and to optimise potential benefits from gardening and plant promotions by supermarkets and other large stores, and for the nursery industry to be able to compete with other industries for the same discretionary dollars, plant producers and garden centre operators must start to 'think like customers' (Kepner, 1990a and b).

Prerequisites for the shift towards a customer-oriented approach include acknowledgement that the customer holds the key to success. However, for growers and retailers to think like customers is not possible until they understand their customers' thought processes. To date, New Zealand nursery plant sellers could only rely on very limited information about garden centre customer behaviour towards nursery products.

A simple method plant producers and retailers could employ for increasing their knowledge about customers needs and desires consists of running a complaint and suggestion system. However, employing this method is likely to reveal only a small proportion of the necessary information. While customers are dissatisfied with one in four purchases, only 5% of dissatisfied customers will complain (Kotler, 1994).

Both lack of relevant information, and difficulties faced by industry members in attempts to elicit meaningful data from their clients, fully justify research projects positioned at the interface between the nursery industry and its major consumer market.

To contribute to an improved relationship between sellers and buyers through a more thorough understanding of consumer behaviour towards outdoor ornamental plants, results of the current study are translated in this chapter into information that can readily be applied in practical situations. Conclusions about findings in each phase of the current study are presented, followed by an outline of implications for the nursery industry.

This research provides practical information about ornamental plant buyers for plant growers, retailers, and horticultural professionalists engaged in the development of 'new' outdoor ornamentals, such as plant breeders. The thesis describes a method that could be employed by research funders to set client-driven research priorities based It also suggests the importance of several methodology-related issues, with implications for future research.

Further discussion of theories and methods used is included in this chapter to facilitate the assessment of their appropriateness for other research projects concerned with consumer perceptions of, and behaviour towards, horticultural products and services.

8.2 Elicitation of attributes relevant to garden centre customers

The main objective of the elicitation phase was to identify attributes which, based upon their importances stated by consumers, should be included in the conjoint phase of the current study. Observations also led to a number of conclusions about issues not immediately associated with the primary objective of the elicitation phase of the current study, such as the type of attributes elicited, and differences between consumers' opinions and those of plant producers and retailers.

Attributes to be included in the conjoint study

Attributes selected for further study included plant health, suitability of a plant for intended growing conditions, price, final height, shape, bushiness, flower colour and leaf colour.

Types of attributes elicited

Different types of attributes may vary in their relative importance with the nature of the judgement task (Lefkoff-Hagius and Mason, 1993). Elicitation procedures preceding conjoint measurement, should therefore not only focus on determining the actual attributes to be included in the conjoint phase of the study, but should also endeavour to examine the nature of these attributes.

Most attribute typologies make the distinction between three types of attributes, namely physical, beneficial, and symbolic attributes (Lefkoff-Hagius and Mason, 1993). Because physical properties are objectively measurable, they are meaningful to managers and product developers, and as such they are often referred to as 'actionable'. Attributes elicited in the current study, were primarily related to physical aspects of plants. Physical characteristics are often causally linked to beneficial attributes, i.e. benefits derived from the use or consumption of a product. For example, the foliage density of hedge plants, and their height at purchase, determine the privacy that would be obtained by using these plants for hedging purposes.

Apart from physical and beneficial attributes, products may have symbolic or image aspects. The latter reflect how consumers feel the use of a product associates them with a desired group, role, or self-image (Sirgy, 1982; Lefkoff-Hagius and Mason, 1993). People's intentions to buy a particular plant species may be influenced for example, by the frequency of its use in their neighbourhood. Some may be more inclined than before to purchase when their neighbours have planted a specimen of a specific plant species, whereas others may react negatively to underline their individuality.

That attributes elicited tended to be physical rather than beneficial or image-related, could be due to the nature of the product. Results could be viewed as supporting the theory that variation in evaluations of the product concerned was mainly caused by differences in physical properties rather than other factors. However, there was a possibility that the nature of attributes elicited was not completely correlated with the nature of those that influence consumer purchasing behaviour. Furthermore, the elicitation method used may have stimulated or directed respondents to think of physical properties rather than other product features. The factor 'health' appeared to be mainly regarded as a physical attribute since it was explained by most respondents in terms of plant damage. The link with the functional nature of this attribute is formed by the fact that healthy plants are more likely to survive transplanting than are unhealthy plants. Had respondents described the factor 'plant health' in terms of the likelihood of survival after transplanting, or in terms of their aversion against the use of chemicals for solving pest and disease problems, 'plant health' would have been more correctly classified as a beneficial attribute. If respondents had been asked to explain why plant health was important to them instead of asking them what plant health means to them, they may have been more inclined to search for reasons beyond those related to the physical appearance of healthy plants.

Image attributes are more likely to be of importance when consumers select a particular plant species from all plants offered for sale than they are when consumers need to decide which specimen to purchase from a range of different plant species. Respondents were asked for attributes important to them when purchasing plants rather than when deciding which species to select. Research projects involving products with more complex, ambiguous, and/or less general attributes than those elicited in the current study may benefit from an extended elicitation phase in which respondents are not only asked for the desired product attributes, but also for explanations as to why these attributes are desirable to them.

The importance of inviting respondents to elicit not just physical attributes was shown by Lefkoff-Hagius and Mason (1993). They demonstrated that different kinds of attributes were more or less important depending on the type of judgement task. Benefits were relatively more important in preference judgements than they were in similarity judgements, while physical characteristics and images were relatively less important in preference judgements than they were in similarity evaluations. Thus, accounting for the types of attributes involved in a study may provide insights into other otherwise unexplained variances in responses.

The type of attribute need not necessarily have an impact on relative importances of attributes in different judgement tasks, since this will depend upon the degree of correlation between attribute types. For example, if there is perfect correlation between a physical and a beneficial attribute, than similarity judgements and preference judgements may lead to identical results. Further research examining interactions between attribute-type correlations and the relative importance of the three types of attributes in different judgement conditions, would enhance understanding of the impact of different types of information on consumer's decision process.

Comparison of customers' opinions with those of producers and retailers

The elicitation interviews revealed discrepancies between sellers' thoughts about plant attributes relevant to customers, and actual perceptions of buyers themselves. For example, garden centre customers placed more emphasis on the suitability of plants for their garden than growers and retailers anticipated. This finding agreed with the prior assumption that retailers and growers might not be fully aware of the needs and desires of garden centre customers. That none of the respondents expressed any difficulties in answering the questionnaire, indicated that sellers and producers believed they were able to identify attributes of relevance to garden centre customers, and to rank these product characteristics in order of importance. Results suggested that further emphasis needs to be placed on increasing nursery industry members' awareness that an understanding of consumer behaviour can best be achieved by focusing directly on the consumer rather than relying on beliefs held by people other than consumers. Informal feedback from customers is valuable but difficult to place within the broader context of perceptions of the target market as a whole. Setting priorities for actions needed to resolve customers' problems with products offered for sale, is complicated without supporting evidence for their appropriateness based on formal investigations.

8.3 Questionnaire design and interviewing method

The most important issue that needed to be resolved in the questionnaire design phase of the study was related to the size of the experiment. Inclusion of eight factors, four of which had three levels and four had two levels, required 1296 treatment combinations for one replication of a full factorial experiment. Fractionation combined with blocking procedures were used to drastically reduce the number treatment combinations to be evaluated by each respondent without loss of information on effects of the selected factors and selected interactions. In Chapter 5 a synthesis of statistical literature is presented with the view to provide easily understood guidelines for researchers who are faced with a similar design problem.

Alternatives to manually developed designs for fractional factorial experiments

A computer program called Conjoint Designer has been available to facilitate the development of factorial designs specifically for use in conjoint measurement studies since 1985 (Carmone, 1986). A major disadvantage of this version of Conjoint Designer and of a conjoint package introduced later (Anon., 1990), was that only main-effects plans could be generated. A main-effects plan is a fractional factorial design that permits uncorrelated estimation of main effects only, and thus implies that all interactions are assumed negligible. In some cases this assumption may well be appropriate. However, in situations of doubt about possible effects on consumer evaluations of certain interactions, it is wise to incorporate the option for detecting interaction effects in the design since that is the only way in which such suspicions can be verified.

The general strategy of choosing a fractional design is to protect against sources of variation that are not estimated, are confounded with what is estimated, and are likely to produce the most bias in parameters to be estimated. This approach involves careful consideration of the expected interaction effect for each combination of two or more factors under study (Green, 1974). It may be relatively easy to come to a conclusion as to the expected interaction effect of certain factors. For example, few would argue that consumers' appreciation for a particular final height of a plant varies with the brightness of the colour of its flowers. It seems plausible to assume that a consumer's preference for a particular leaf colour depends on the brightness of a plant's flowers.

In 1991, CONSURV, a conjoint analysis computer software package, was introduced by Intelligent Marketing Systems Ltd. (Williams, 1991), which was subsequently reviewed by Green (1992). Unlike Conjoint Designer, the designer module of

CONSURV can produce orthogonal designs that contain one or more estimable two-way interactions. For future studies in which fractionation of factorial designs is desirable, it would be worthwhile to explore the possible advantages of using CONSURV to generate appropriate fractions.

Kuhfeld et al. (1994) in their publication on efficient experimental design, explained the benefits of using computer-generated designs in marketing research. Avoidance of the time-consuming process of finding and manually modifying an existing design was stressed as their major advantage. However, Kuhfeld et al. (1994) did not regard computerised searches for efficient designs as superior to traditional design-creation skills, but believed that they provided helpful tools that could be used in addition to intuition, understanding, and experience of the human designer. The description in Chapter 5, of methods which were primarily based on work published by Kempthorne (1962) and Addelman (1962a and b) may contribute to an understanding of the mechanics involved in designing fractional factorial designs.

A cautionary note on the use of fractional designs in conjoint measurement studies was given by Darmon and Rouzies (1994) when they warned against the use of designs with too few degrees of freedom. More research is required to establish a balance between respondent fatigue and information overload on the one hand, and recovery of utility functions as affected by various degrees of fractionation on the other.

Profile presentation

Treatment combinations for the current study were presented to the respondents in the form of profile cards which consisted of a hand drawing of a hypothetical plant illustrating the levels of five factors, and a description of the levels of the remaining three factors. In other conjoint measurement studies involving visual profiles, computer aided design techniques may be used to overcome some of the problems that are associated with manual profile preparation.

Preparation of the profiles in the current study was very labour intensive. Problems with consistency in reproducing colours and intensities by means of photocopying techniques, could have been overcome by the use of computer-aided design packages. Adding colours to computer-generated representations took only 3 to 6% of the total time required to complete the profiles (Loosschilder and Ort, 1994). In particular for studies involving products that are not yet available, and for which a high degree of realism is desired, a computer graphics program may be a worthwhile investment. It may even be cost efficient to hire an expert in computer-aided design techniques, since it was demonstrated that for such novel products more attention needed to be paid to details than for products with which respondents were already familiar (Loosschilder and Ort, 1994).

8.4 Evaluation of ornamental plants as affected by plant factors

One of the objectives of the current study was to determine the relative importance of plant attributes that influence garden centre customers' appreciation for outdoor ornamental plants. Results provide information about ornamental plant buyers that is vital for the survival of the New Zealand industry by enabling industry members to more successfully compete with other industries.
Several methodology-related issues emerged from the conjoint analysis phase of the current study. These are of particular importance where conjoint measurement is applied by research funders to obtain guidelines for setting research priorities and by researchers to analyse consumer perceptions of horticultural products other than outdoor ornamental plants.

Implications for the nursery industry

Of attributes included in the current study, plant health was the most important consideration to garden centre customers surveyed when deciding which outdoor ornamental shrub to buy. This finding stresses the importance of disease and pest management in production and retail settings. Costs of maintaining plants in a good health status, i.e. no foliage damage or discoloration, appear justified when considering the limited difference in perceived attractiveness of healthy plants priced at $12.95 and $18.95. At these prices, customers interviewed were more likely to pay six dollars extra for healthy plants than they were for plants with an average or poor health status.

Suitability of the plant for the respondent's garden was the second most important consideration when selecting an outdoor ornamental plant to purchase. This finding has two implications. Firstly, it emphasises the need for labelling of plants offered for sale. Labels provide a convenient way of conveying product information to customers without forcing them to seek and rely on communication with retail staff. Labels should indicate preferred growing conditions to give customers the opportunity to decide for themselves how well plants are suited to their garden. Secondly, because respondents preferred plants with a good suitability for the conditions in their garden over those less suited, retailers should endeavour to offer plants which can withstand the environmental conditions in the region of their target market. For example, tender outdoor plants should not be sold in areas with a high incidence of frosts, and plants unlikely to survive salt sprays must not be offered by retail outlets in coastal regions. In production- and development-oriented research higher priority should be given to projects involving crops which are anticipated to withstand a wide range of conditions rather than to plants that are expected to have very specific environmental needs that could only be met in a limited part of New Zealand.

Lack of labels as well as inaccurate or incomplete information given on labels have a direct impact on sales when they are the grounds for customers' decision not to purchase. Turnover may be influenced indirectly when purchase leads to dissatisfaction. Results of the current study suggested that such an indirect effect on sales of a lack of labels is less likely to occur than a direct impact, since 'suitability of the plant for intended growing conditions' was an important evaluative criterion. Customers for whom 'suitability for growing conditions' is not a consideration, are more likely to buy a plant without labels than are others. Negative experience may lead to a reassessment of evaluative criteria for future purchases, which may result in allocation of increased importance to the attribute 'suitability'. Inaccurate information potentially has a large impact on post-purchase behaviour of the majority of consumers who do take the attribute 'suitability' into account. For these customers, negative experiences are not likely to lead to a further increase in the attribute's importance, but may lead to reassessment of evaluative criteria of retail outlets, or alternatively, they may initiate a search for a new solution to the problem customers had hoped to solve with purchase and subsequent planting of an outdoor ornamental plant. Thus, labels with adequate and accurate information about plants offered for sale are necessary both to maintain current customers, but also to increase frequency of sales by existing customers.

Results suggested that for cheap plants in particular, information on labels must include preferred growing conditions. This could be an indication of garden centre customers' suspicions about the quality of plants offered for low prices, which could possibly be a reflection of previous disappointments with low priced plants, or cheap products in general. Bargain bins could fulfil a positive role in reducing this suspicion by giving the impression that cheap, low quality plants have been removed from the general stock.

Health and suitability were followed in importance by the attribute 'shape' of outdoor ornamental plants, suggesting that attention should be paid to the degree of balance of plants produced and offered for sale. Maintaining a good shape of plants in garden centres may involve more than pruning alone, and may extend to allocating sufficient space for individual plants. Different sides of plants at the edges of overcrowded areas will receive different amounts of light, which in turn may lead to uneven growth. If a mismatch between the numbers of ordered and sold plants has occurred, and the available retail area has become insufficient for the number of plants present, then priority should be given to either cheap or expensive plants when allocating space. Shape of averagely priced plants was less important to garden centre customers surveyed than was that of plants with either high or low prices.

The degree of bushiness of a plant was the fourth most important evaluation determining attribute, with bushy plants being preferred over spindly plants. Respondents were more concerned with the bushiness of unbalanced plants than they were with that of plants with a symmetrical shape. The significance of this interaction effect on overall evaluations of plants, provides further support for the recommendation that plants offered for sale in garden centres should have a well-balanced shape. Bushiness is more difficult to achieve and maintain for retailers than is a symmetrical shape of plants. It is a well-known fact that many plants can be forced to form side branches by removal of the growing point of the main stem. The shoot apex normally exerts a dominant influence that suppresses growth of lateral buds (Hopkins, 1995). By removal of the terminal bud, the lateral buds immediately below the cut start to develop. Soon after development, one of these will establish dominance over buds further down the stem (Hammett, 1992). Implications of the perceived value of the attribute 'bushiness' are particularly important for plant producers since they are in a better position than are retailers to stimulate the formation of side shoots on plants.

Price accounted for only 3.6% of the variation in responses explained by factors and interactions with statistically significant effects. This finding agreed with the statement by Saunders (1992) that most customers are interested in the perceived value rather than in the price of a product. Perceived value was earlier defined by Zeithaml (1988) as the consumer's overall assessment of the utility of a product based on perceptions of what is received and what is given. Thus, value of outdoor ornamentals represents a trade-off of the salient "give" components, such as price, and "get" components, such as plant health.

The impact of price on profile judgements by consumers, varied with levels of several other plant attributes, namely plant health, suitability of the plant for intended growing conditions, final height, and shape. Effects of these interactions caused differences in the magnitude of responses. Only for the factor 'final height' did the preferred level vary with price levels. At low and high price levels, plants growing up to 1 m were slightly preferred over taller plants, whereas 1-2m was the preferred final height level of plants priced at $12.95. Plants differing in mature height levels, but with otherwise identical properties, should be priced accordingly. Plants reaching an average final height should ideally be offered for an average price. Lowering or increasing the price of such plants has an equally negative effect on its attractiveness to garden centre customers. Thus, if perceived attractiveness is completely correlated with the likelihood of purchase, a price increase of six dollars will result in more revenue for the retailer than will a price decrease of six dollars, but neither is likely to be more profitable than is a price set at an average level. For tall growing plants, pricing issues are the least important since customers interviewed perceived little difference between values of such plants with different prices. Dwarf shrubs are more likely to be sold at lower prices than they are at high or average price levels.

The significant contribution of final height to response variations highlights the need for providing customers with information about the expected height of plants at maturity. This could be achieved by specifying expected final heights on plant labels. Thus, plant labels should include information on preferred growing conditions as well as height at maturity.

Labels must not be used as a means of conveying as much information to the customers as possible, but should provide only brief descriptions of features that are of significance to consumers, and that cannot be observed directly. Results of the study conducted by Jacoby et al. (1974) indicated that increasing package information tended to produce dysfunctional consequences in terms of the consumer's ability to select the brand which was best for him or her. Although with increased information subjects felt more certain that they had made the best decision, and less confused while making their decision, they actually made poorer decisions. Less than optimum purchase choices may, via experience and memory, have a negative impact on subsequent purchase frequencies. Although generalising from data published by Jacoby et al. (1974) cannot be justified since only one product category and one type of respondent were involved, results clearly suggested that more product information is not necessarily better.

Foliage colour value had only a limited effect on profile evaluations. Dark green leaves were slightly preferred over light green foliage. Values of colours other than green, or different colour hues may have a larger impact on overall attractiveness of plants, although this is not likely when considering results presented by Vink (1989). She studied the effect of foliage colour hues with levels of purple or bronze, green, and yellow on evaluations of evergreen ornamental shrubs. Purple or bronze foliage received the highest utility, while little difference was perceived by respondents between green and yellow foliage. Of the seven attributes included in her study, foliage colour hue had the smallest influence on profile evaluations, accounting for less than 2% of all variation explained by the independent variables selected.

Flower colour intensity of evergreen ornamental shrubs had a limited impact on garden centre customers' opinions about their attractiveness. It may be that the mere presence of flowers was more important to customers than were flower-colour characteristics. Since results of the elicitation interviews did not suggest an impact of flower colour properties other than intensity on the attractiveness of outdoor ornamental shrubs, promotion or development of such plants based on flower-colour characteristics is not likely to greatly increase purchase frequencies of existing customers.

Implications for future research

Results of the elicitation phase of the current study indicated that plant health was viewed by respondents as an attribute related to physical properties. Thus, assuming that the method used for eliciting relevant attributes and their levels was effective for different types of attributes, the implication of findings in the conjoint part of the study, as outlined in the previous paragraph is justified. The relative importance of plant health to garden centre customers may not necessarily change over time, but reasons for its importance, perceptions of what constitutes a healthy plant, and thus implications of a high level of concern with plant health, are likely to vary. In the current social climate, the growing concern for the environment may lead to an increased aversion to the use of chemical formulations for pest and disease management. If results of future studies suggest the occurrence of such a change in perceived benefit of plants free of pests and diseases, then the consequences are twofold. Firstly, plant health maintenance practices in garden centres may need to be altered so that they are acceptable to the customers. Biological pest control, where predator insects are introduced to control populations of other insects, may have potential as an alternative for pesticides. If extra costs are involved with environmentally friendly plant health maintenance, then examination of interactions between health and price are particularly important. Secondly, such results would emphasise the need for developing plants with genetically based pest and disease resistance. Potential changes over time in consumer perceptions of the meaning to them of plant health, or of any other attribute for that matter, underline the importance of including an effective elicitation phase in research projects prior to the collection of conjoint data, since it is during the elicitation phase that such changes can be determined.

Since the suitability of plants for intended growing conditions was of great importance to respondents, purchase experience may be affected positively by arranging products in garden centres according to their abilities to withstand certain environmental conditions. However, research is needed to examine links between consumer decision behaviour, desired product attributes and garden centre layout issues. For example, product group arrangements based on suitability for specific environmental conditions may be more convenient to customers, but do not necessarily stimulate purchasing. Customers who have the prior intention to buy only plants which are suited for a particular growing area, may actually be discouraged by such layouts to spend as much time browsing as they would otherwise do, and to reconsider their options. It is also possible on the other hand, that garden centre layouts based on desired product attributes do not have any influence on customer buying behaviour, and that such layouts are not perceived by customers as an important factor in deciding which retail outlet to use. When examining purchasing behaviour in relation to garden centre layouts based on plant attributes or other factors, the importance respondents attached to the suitability of plants for intended growing conditions presents an extra dimension that needs to be taken into account.

The fact that price of plants appeared to contribute little to plant value perceived by garden centre customers, may be related to the type of product. For other goods, especially those frequently bought as status symbols, such as cars, price is likely to determine a larger proportion of the overall value. Saunders (1992) suggested cars as an example of such product groups where part of the perceived value is accounted for by image-related factors, such as the value attached to the knowledge that other people cannot afford a particular expensive car. Now that gardening in New Zealand has shifted from vegetable plots and rows of roses to landscaping and the creation of an outdoor space (Chisholm, 1995), image aspects may become more important in the future to garden centre customers.

For other products where price is an important consideration for consumers, it may be worthwhile to investigate the effects of price competition on consumer behaviour towards new product concepts. Choi and DeSarbo (1994) described a conjoint-based product designing procedure incorporating reactions of price competitors. The methodology allows a firm designing a product to predict the short-term effects of price competition for each alternative product concept being tested. Thus, the firm can avoid any potential suboptimalities of a product that may result from failure to anticipate reactions of competitors to its introduction.

Results of the current study and those presented by Vink (1989) did not necessarily imply that leaf colour should not be given attention in other research projects on consumer perceptions of plants. Foliage colour characteristics are likely to be more important contributors to variation in evaluations of specific plant species than of outdoor ornamentals in general. However, results did indicate that in consumer evaluation studies of plants, leaf colour properties do not deserve priority over other plant attributes.

Like foliage colour, findings did not exclude the possibility that flower colour intensity is of importance in determining decisions to purchase specimens belonging to specific plant species, cultivars, or groups of nursery plants other than outdoor evergreen shrubs.

Effects of plant attributes and interactions between plant attributes described in this section, and effects of respondent characteristics were specified in model 6.7, reproduced here as model 8.1:

$$Y_{ijklmnopq} = \mu + \text{respondent}_q + A_i + B_j + C_k + D_l + E_m + F_n + G_o + H_p$$

$$+ A_iB_j + A_iC_k + A_iD_l + A_iE_m + A_iF_n + A_iG_o + A_iH_p +$$

$$E_mG_o + F_nH_p + A_iE_mG_o + A_iF_nH_p + \epsilon_{ijklmnopq} \qquad (8.1)$$

where:

$Y_{ijklmnopq}$	=	response variable,
μ	=	mean of profile ratings,
'respondent_q'	=	proportion of the variation in Y explained by variation in characteristics of respondents, where subscript q could take on the values 1,2,.., or 1727, since there were 1728 respondents,
$A_i,\ldots,H_p$	=	estimated effects of factors *a, b, c,...,* and *h*, where i,j,k, and l could take on the values 0, 1, or 2, and m, n, o, and p were equal to 0 or 1, and
$A_iB_j,\ldots,F_nH_p$	=	first-order interactions,
$A_iE_mG_o$, $A_iF_nH_p$	=	second-order interactions, and
$\epsilon_{ijklmnopq}$	=	variation in the response variable not accounted for by the model.

Fifty seven percent of the variation in the response variable, i.e. profile ratings, was attributable to effects included in model 8.1. To assess whether or not variation in responses could further be explained by effects of interactions between plant and respondent factors, model 8.1 was extended to include terms for such interactions.

8.5 Interactions between plant and respondent factors

The socioeconomic part of the conjoint interviews with respondents shed light on the composition of the garden centre customer market. A number of significant interactions between plant attributes and respondent factors were found. An understanding of the nature of these interactions contributes to the nursery industry, for example by increasing the effectiveness of advertising strategies by aiming at specific segments of the customer market. Results also gave an indication of the effects of a change in the customer market composition on perceived attribute importances.

Customers of garden centres appeared to represent a segment distinguishable from the rest of the New Zealand population because of its relatively higher percentages of females, home owners, of families living without younger children at home and of people between the ages of 45 and 65, and lower percentages of unemployed people or New Zealanders earning less than $30,000 per year.

The recent decrease in market share of garden centres coupled with the reported increase in gardening, in particular of 30-40 year olds (Chisholm, 1995), suggests that the sample of customers surveyed, is not necessarily representative of the New Zealand gardening public. As suggested in Chapter 1, mass merchandisers may contribute through their advertising to an increased interest in gardening by a wider range of the population. Edwards (1994) and Hicks (1994) believed that once people are interested in plants and gardening, they will demand a wider range of merchandise, which will lead new customers to garden centres. If this is the case, then the composition of the garden centre customer population is likely to change in the future, unless only customers similar to existing garden centre customers are attracted.

Assuming that effects of interactions between plant factors and customer characteristics are reasonably stable over time, examination of such interactions is not only of value in determining their implications for current production and retail practices, but also in giving an insight into potential effects of a change in customer market composition on perceived plant attribute importances. Results suggested that if the percentage of customers between 35 and 65 increases, then the relative importance of price for targeted customers is likely to decrease, since price was a more important consideration for respondents under 35 years or over 64 years of age than it was to respondents belonging to other age categories. Should the percentage of married garden centre customers or of those occupying houses older than 15 years increase, than more attention would need to be paid to plant health than before. Similarly, if the composition of the garden centre customer market changes to such an extent that it comprises a higher proportion of high income earners than it did in the current study, then it is likely that the level of concern for the suitability of plants for intended growing conditions increases. Mature height and shape of plants can be expected to gain in relative importance when proportionally more garden centre customers own sections less than $500m^2$ than was the case in the current study.

Some results of the analysis incorporating interactions between respondent and plant factors provided immediate opportunities for improving buyer-seller relationships. These were the results relating to interactions between respondent age and plant price, and those between area of residence and plant attributes.

The finding that customers younger than 35 or older than 64 years of age placed more emphasis on price than did other customers, could be used in advertising strategies by specifically targeting these age groups when promoting sale plants.

Regional differences in customer perceptions of outdoor ornamental plant attributes are particularly important for managers and employees of garden centre chains with outlets in various areas of the country. Respondents in Palmerston North, Wellington, and Auckland, differed in their opinions about plant factors 'price', 'health', 'suitability', 'final height', and 'shape'. In general, Auckland customers appeared to consider more plant attributes than did those in Wellington and Palmerston North.

Whereas customers in Palmerston North and Wellington were primarily concerned with plant health, to Aucklanders plant health and the suitability of the plants for their garden were of approximately equal importance. Thus, should a trade-off be unavoidable, plant health maintenance in garden centres in Palmerston North and Wellington should receive priority over labelling, whereas in Auckland both factors should receive an equal amount of attention, since a decrease in either has an identical detrimental effect on turnover.

Plant shape and bushiness were of greater importance to customers of garden centres interviewed in Palmerston North and Auckland than they were to respondents in Wellington. Therefore, managerial implications involving space allocation and pruning practices are of particular relevance to retailers in Palmerston North and Auckland.

When pricing plants, managers of garden centre chains with stores in different locations in New Zealand, should be aware that customers of the respective retail outlets may differ in their opinion about the importance of price. That respondents in Auckland placed relatively more emphasis on price when selecting plants for purchase than did other respondents, suggests that a lowering of prices is likely to have a more positive impact on sales in Auckland than on turnover of garden centres in Palmerston North and Wellington.

Aucklanders attached relatively more importance to final height than did garden centre customers in Palmerston North and Wellington. Thus the inclusion in plant labels of the expected height of a plant at maturity is especially important for retail outlets in Auckland.

For all three areas, effects of the interaction between price and suitability for intended growing conditions, price and final height, and between bushiness and shape were significant.

Only for respondents in Palmerston North did inferred ratings for different health levels depend on price. Retailers in Palmerston North could benefit from increasing the price of healthy plants from an average to a high price. In Auckland and Wellington, such an increase in price would have negative effects on sales, regardless of the health status of the plants.

Garden centre customers interviewed in Wellington, represented the only group of respondents for whom preferred price levels depended on the shape of plants. Results suggested that offering plants with a symmetrical shape to Wellingtonians at an average or high price would affect the number of sales. If low prices are not feasible, then selling highly priced, balanced ornamentals is likely to result in a higher turnover than would offering symmetrically shaped plants at average prices. Unbalanced plants should ideally be offered for average prices rather than low prices, since respondents in Wellington perceived no difference between the attractiveness of cheap and averagely priced asymmetrical plants.

Although incorporation of personal variables in the current study enhanced knowledge about consumers and their desires, it did not provide a complete picture of interactions between buyers' characteristics and product attribute perceptions, nor was it intended to do so. Many other consumer variables could have been taken into account, but the number was limited to a practically acceptable level, including variables that seemed most likely to interact with consumers' perceptions of outdoor ornamental plants. Inclusion of several cultural, social and psychological factors, such as nationality, racial groups, reference groups, and motivation, was not only considered to be beyond the scope of the current study, but was also presumed to contribute little in terms of practically applicable information.

8.6 Evaluation of methodologies

Although the conjoint measurement technique has sufficiently matured to have full confidence in the appropriateness of its application in studies examining consumer evaluations of products and services, a number of issues warrant further investigation. As stated in Chapter 3, results of studies examining reliability and validity of conjoint measurement are inconclusive. Comparisons between such studies are complicated by the uncertainties relating to the most appropriate way for measuring the different types of reliability and validity.
Another area of concern is the issue of heterogeneous responses and associated

problems in interpreting results from conjoint measurement studies. Inclusion of a self-stated phase in conjoint measurement studies gives some indication as to what degree of heterogeneity can be expected in the conjoint data collection phase. Further research however is required to determine the effect of different types of preliminary data collections on the subsequent data collections.

In the first part of the conjoint questionnaire, respondents were required to state the importance to them of attributes included in the study, and to rank attribute levels in order of preference. Prior beliefs about homogeneity among respondent perceptions of attributes selected were supported by results of this self-explicated phase.

For factors, such as 'final height', 'leaf colour' and 'flower colour', where less than 70% of respondents agreed upon the most preferred level in the self-explicated phase, a significant percentage of customers surveyed perceived no difference between the attractiveness of respective factor levels. None of the factors concerned were rated in the self-explicated phase as 'very important' by more than 50% of the respondent sample. Leaf colour and flower colour were attributes defined on levels that could have led to a division in perceptions among respondents. However, 57% and 28% of respondents did not have a preference for any of the levels selected for foliage colour, and flower colour respectively. Only 16% of customers surveyed indicated that leaf colour was very important to them, while 29% considered flower colour to be a very important attribute. Since in the self-explicated part of the questionnaire, respondents did not need to trade off certain factors against others, the latter percentages are likely to overestimate the importance of both flower colour and foliage colour.

Thus, self-stated attribute importances and preference order of attribute levels, gave no reasons for concern about heterogeneity within the respondent sample. Pooling profile preference ratings across respondents was therefore appropriate, and was further justified by the prior intention to incorporate measurement of interactions between plant factors and respondent characteristics. The latter led to a further increase in the level of homogeneity by dividing the sample into segments distinguishable from each other by personal characteristics of its members coupled with their inferred perceptions of outdoor ornamental plant attributes.

Should results of the self-explicated phase have indicated that the majority of respondents disagreed about attribute importances and level preferences, the appropriateness of an aggregated approach to the analysis of the conjoint data would have been questionable. Particularly in early applications of conjoint analysis, it was convention to estimate a separate attribute utilities for each individual (Green and Srinivasan, 1978). Moore (1980) stated that, although individual models have demonstrated good predictive power, the output in the form of a separate set of utility weights for each individual is difficult to translate into practical applications when the number of respondents is large. Individual level analysis also requires enough data to be collected from each individual to estimate attribute utilities for each respondent. Implications of these disadvantages need to be weighed up against the reported high levels of predictive power of individual analysis.

Several approaches have been suggested to deal with some of the disadvantages of individual level analysis.

Estimated individual attribute utilities may be used as input for a choice simulator which then predicts the utility for each product profile. If one assumes that each individual selects the product with the highest utility, such a choice simulator can be used to predict market shares for each product under study. Thus, a choice simulator provides results that can be readily interpreted in terms of what end-product the market wants. However, an overall product utility does not provide as much information as a set of utilities for each product attribute would do. Also, use of choice simulators does not overcome the problem associated with individual-level analysis of requiring enough data to be collected from each respondent to estimate individual utility functions.

Moore (1980) explored abilities of two types of segmented models in combining desirable properties of the two extreme levels of aggregation, and avoiding the problems of each. The two approaches studied included clustered segmentation where individuals are clustered on their individual part-worth utilities, and componential segmentation (Green, 1977; Green and DeSarbo, 1979) based on measurement of interactions between profile evaluations and respondent variables in a similar manner as in the current study. Both methods provided information in a much more user-friendly form than did a list of each individual's utility weights. Although clustered segmentation had a higher predictive power than componential segmentation, Moore (1980) did not suggest this would always be the case. Results led him to the hypothesis that componential segmentation will provide higher predictive power when respondent characteristics (or other background variables) are strongly related to utilities, and when there is a large number of attributes or a large number of levels for a small number of attributes.

Q-type factor analysis proposed by Hagerty (1985) is a method that represents respondents in a space without resort to non-overlapping clusters. According to Hagerty, respondents' preferences are uniformly distributed rather than clustered along perceived attribute importances. In his procedure, Hagerty allowed each consumer to belong to every segment, and optimum participation of each respondent in each of the segments was determined on the basis of maximising predictive accuracy of the conjoint results. A disadvantage of the Q-type factor analysis is that the procedure may lead to diffuse clusters that are not easily interpreted, let alone identified, which limits its application for practical purposes. Moreover, Hagerty (1985) cited only a limited number of sources in which the existence of non-overlapping clusters is questionable. It is likely that the occurrence of clusters that are distinguishable to a degree which allows for easy interpretation and application, depends upon several factors, such as the product under study and the variables upon which the clustering is based.

The disadvantage of factor analytical procedures, and the fact that in clustered segmentation estimated weights are used as observed characteristics of individuals being clustered, i.e. error incurred in their estimation is ignored, led Kamakura (1988) to the development of a least squares procedure for benefit segmentation. The objective of this method is to find a set of aggregate-level functions that maximises the ability to explain observed preferences of each consumer in the sample. The procedure forms clusters by simultaneous estimation of pooled regressions for each segment. In contrast to the factor analytical procedure described earlier by Hagerty (1985), the least squares benefit segmentation approach does not lead to overlapping clusters. Thus, the output is a set of clearly distinguished benefit segments, which can be used for the development of segment-specific marketing strategies. Kamakura formulated a predictive accuracy index which can be used to decide on an adequate aggregation level based on an estimate of the maximum predictive accuracy at a given aggregation level. This would enable managers to establish a balance between a meaningful and manageable set of segments and an acceptable predictive power. The proposed procedure was consistently better over different aggregation levels than was the clustered segmentation approach.

Although both Hagerty (1985) and Kamakura (1988) demonstrated superiority of segmented aggregation approaches over individual-level analyses, conclusions cannot be generalised since their results were contradicted by those of subsequent studies. Green and Helsen (1989) and Green et al. (1993) found no statistically significant empirical support for advantages in predictive power of Hagerty's approach relative to individual-level analyses. Hagerty (1993) stated that discrepancies between his earlier findings and those of Green and Helsen (1989) and Green et al. (1993), could indicate influences of uncontrolled variables on the validity of conjoint studies. Green et al. (1993) examined four such variables, namely the level of true correlations between individuals, the error in estimating true correlations, the levels of error within an individual's preference function, and the presence of non-monotonic attributes, and concluded that they did not affect validation results in conjoint studies. Hagerty (1993) suggested that the structure of holdout samples could be another variable that influences validation results. Should this indeed be the case, then accuracy of predictions for market shares of products under study is dependent upon the actual validation sets used. To gain some insight into this extra dimension of their validity, methods used in future studies should then be validated over several sets of holdout samples rather than one single validation set. The importance of Hagerty's suggestion (Hagerty, 1993) was substantiated by the fact that differences between the method proposed by Kamakura in earlier work and the clustered segmentation approach varied with the nature of the holdout stimuli (Kamakura, 1988). Thus, using the criterion of reported predictive power scores determined with a single set of holdout stimuli, may lead to biased decisions when selecting an appropriate methodology or approach.

Hagerty (1993) also recommended development of measures of predictive accuracy that are more relevant to marketers, namely those relating to market share prediction rather than prediction of individuals' choices. Previously, Hagerty (1986) had shown that an increase in predictive accuracy of individuals' choices did not necessarily coincide with increased predictive accuracy of market share.

Segmentation presupposes heterogeneity in buyers' preferences for products and/or services. In the hypothetical and extreme case of no heterogeneity, the respondent sample itself would constitute the smallest possible segment. Because of uncertainties which still exist about appropriate aggregation levels, and about segmentation methods, there is scope for research answering more basic questions pertaining to conditions under which heterogeneity is likely to occur. When does segmentation lead to significantly increased predictive power compared to aggregated approaches? Is it likely that for certain product categories, responses are less variable than they are for others? In absence of empirical findings about conditions under which heterogeneity of responses may occur, self-stated attribute importances and attribute level preferences, provide a sound basis for assessing the validity of expectations about the amount of agreement among respondents in a subsequent conjoint phase. As such, incorporation of a self-explicated phase prior to conjoint data collection is particularly important for products where researchers cannot rely upon common sense for clear indications of preferred attribute levels. Thus, although a self-explicated phase such as the one designed for the current study may not be useful for quantifying relative importance of attributes, inclusion in future conjoint measurement studies provides important advantages.

Further research is needed to examine the impact of preliminary tasks on responses in data collections, and ultimately on actual behaviour. Wilson and Dunn (1986) reported that asking people to think about the reasons for their attitudes reduces attitude-behaviour consistency. Wilson et al. (1989a) believed that questions about reasons elicit incomplete and incorrect answers, and that people adopt attitudes implied by reasons expressed. Thus, respondents to the survey conducted by Huber et al. (1993), which was referred to on page 125, may have been trying to respond in a consistent manner to questions asked in both elicitation approaches.

When interacting with the attitude object, people's initial evaluation often returns and motivates their behaviour, leading to attitude-behaviour inconsistency (Wilson et al., 1989a). Findings of Huber et al. (1993) were based on simulated choices, i.e. selection of the most preferred alternative from a set of holdout stimuli. Thus, respondents were not faced with consequences of their choices as they would in the real market place. Measurement of predictive power based on actual behaviour towards real products after the survey, may not have indicated an improvement of external validity of the full-profile method combined with a self-explicated approach. Both methods alone as well as the combination may have caused a reduced attitude-behaviour consistency. If inaccuracy and incompleteness of elicited reasons for attitudes occurs because people have difficulty knowing why they feel the way they do, then it is likely that the degree of bias in responses depends on the type of attitudes.

Wilson et al. (1989b) hypothesised that attitudes based on relatively little knowledge about the object concerned, i.e. the attitude object, are more susceptible to disruptive effects of thinking about reasons than are other attitudes. Results of their study were in support of this hypothesis. Knowledge about an attitude object moderated the effects of explaining attitudes. Wilson et al. (1989b) offered two interpretations of the moderating effects of knowledge which were supported by their data. Firstly, due to difficulties unknowledgeable people have in understanding their attitudes, they are more likely than are others, to generate reasons that imply a different attitude than they previously held. Secondly, unknowledgeable respondents have cognitions about the attitude object that are more inconsistent than are those of knowledgeable respondents. Focusing on some subset of these cognitions is more likely to cause attitude change in these respondents than it is in knowledgeable people whose cognitions all tend to imply the same attitude.

Results published by Wilson et al. (1989b) underline the importance of issues related to the respondent sample and methodologies to be selected. In the current study, it seemed reasonable to assume that customers leaving garden centres had at least some experience with the product under study. Their knowledge about the product concerned was likely to be sufficient to moderate effects which the self-explicated phase may have exerted on results of the conjoint data collection, or that the combination of both phases may have had on subsequent purchase behaviour. However, a similar assumption may not be appropriate in studies on consumer perceptions of other products, in particular of those consisting of a smaller number of alternatives, such as a single species, and of products less common and/or more complex than outdoor ornamental plants. Attitude objects in the study conducted by Wilson et al. (1989b) consisted of presidential candidates, and relationships between dating partners of the opposite sex. Both categories are obviously much more complex from an attitudinal perspective than are outdoor ornamental plants, and as such may be more likely to generate a higher proportion of inconsistent or incomplete reasons for attitudes. If unexperienced people have difficulties in explaining their reasons for liking ornamental plants with certain attributes, then surveying people other than garden centre customers would have increased heterogeneity in product knowledge among respondents, and would have decreased the validity of the study.

In cases where respondents can *a priori* be expected to differ substantially in their knowledge about a product, respondents' experience may need to be measured beforehand so that different methodologies can be applied to elicit preference data from knowledgeable and unknowledgeable respondents. A combination of self-explicated phases of relatively short duration followed by full-profile methods does not appear to be appropriate for unknowledgeable respondents.

Preliminary phases other than those in which respondents are directed into thinking about reasons for their attitudes towards the product under study during a relatively limited time frame, may be preferable if their benefit lies mainly in increasing knowledge about the product concerned so that more consistent and complete reasons can be formulated. Wright and Kriewall (1980) studied the accuracy of methods using reported and derived utility functions of high school junior's family members in predicting actual college applications with forethought manipulations. Families in the forethought-prompted condition received a letter and other material several days before the interview. The letter urged each family member to start thinking seriously about features that determined the suitability of a college for 'their' student. The material contained information about student and college attributes other families said were important, while stressing the fact that families and family members may differ in their priorities. The same information was presented in an identical manner on the instruction sheet all subjects received just before the subsequent ranking task. Reported utility functions significantly outpredicted derived utility functions only when subjects had been told that the true application decisions would not be made for about nine months, and had been provided with descriptions of events that would unfold after the applications were mailed. Results indicated that the accuracy of both elicitation procedures in predicting actual choices of colleges was increased by forethought manipulations. These findings support the theory that the value of self-explicated phases as warm-up exercises lies in familiarisation of respondents with the product or object concerned.

The extent to which self-explicated phases are effective in increasing knowledge depends on the interaction between its duration and the complexity of adopting an attitude towards the object under study. It appears that for objects that are relatively simple or abstract, and/or commonly used by respondents, self-explicated phases such as the one designed for the current study, which immediately precede further data collection, are sufficient for the moderating effect of knowledge to occur. When studying people's perceptions of newly developed cultivars for example, other methods, such as the approach proposed by Wright and Kriewall (1980), may need to be employed to create a higher homogeneity of knowledge within the respondent sample.

Future research into the effects of self-stated preliminary phases on the results of subsequent data collections is certainly warranted within the framework of understanding of consumer behaviour.

8.7 Concluding remarks

Consumer markets and consumer buying behaviour have to be understood before effective and efficient marketing programs can be developed. In previous sections, ways in which results of the current study could contribute to an improved relationship between ornamental plant sellers and buyers were described. It was re-emphasised that acknowledgement by the growers and retailers of the importance of knowing and understanding their customers, is crucial for achieving this goal.

While focusing on garden centre customer perceptions of outdoor ornamental plants, the thesis illustrates how conjoint measurement could be used by funding bodies to obtain guidelines for setting research priorities, and by researchers to investigate people's attitudes to other horticultural products and services.

Throughout this thesis limitations of the current study have been stressed. Most of these limitations are related to constraints the current level of knowledge places on the understanding of consumer behavioural issues. Theories and results discussed add to the information that can be used for assessing the appropriateness for new research projects, of techniques employed in the present study. Suggestions for future research aimed at further completing the puzzle of consumer behaviour were presented.

The dynamic character of consumer behaviour presents researchers with the problem of finding the best solutions for an equation with potentially ever-changing variables. Embracing this difficulty as a challenge is the first step in the journey towards the ideal of "making selling superfluous". The value of ideals in general, does not lie in their achievement, but in their mental possession, which motivates and stimulates actions and efforts aimed at making improvements to the current *status quo*.

REFERENCES

Acito, F. (1977). An investigation of some data collection issues in conjoint measurement. In: Contemporary Marketing Thought, 1977 Educators' Proceedings, Chicago: American Marketing Association, 82-85.

Addelman, S. (1962a). Orthogonal main-effect plans for asymmetrical factorial experiments. Technometrics, 4 (1), 21-46.

Addelman, S. (1962b). Symmetrical and asymmetrical fractional factorial plans. Technometrics, 4 (1), 47-58.

Addelman, S. (1963). Techniques for constructing fractional replicate plans. Journal of the American Statistical Association, 58, 45-71.

Addelman, S. (1972). Recent developments in the design of factorial experiments. Journal of the American Statistical Association, 67, 103-111.

Aiken, L.R. (1993). Personality. Theories, research, and applications. Prentice Hall, Englewood Cliffs, New Jersey, USA.

Akaah, I.P. and P.K. Korgaonkar (1983). An empirical comparison of the predictive validity of self-explicated, huber-hybrid, traditional conjoint, and hybrid conjoint models. Journal of Marketing Research, 20, 187-97.

Albrecht, K. (1992). The only thing that matters. HarperCollins Publishers Inc., New York, USA.

Alpert, M.I. (1971). Identification of determinant attributes: A comparison of methods. Journal of Marketing Research, 8, 184-191.

Anonymous (1988). SPSS-X Introductory statistics guide for SPSS-X Release 3. SPSS Inc., Illinois, USA.

Anonymous (1989a). SAS/STAT User's guide. Version 6. Fourth Edition. Volume 2. SAS Institute Inc., North Carolina, USA.

Anonymous, (1989b). Genstat 5 reference manual. Oxford University Press, Oxford, UK.

Anonymous (1990). SPSS Categories. SPSS, Inc., Chicago, USA.

Anonymous, (1993). Nursery forum - retailers and growers square off. Commercial Horticulture, (July), 12-15.

Anonymous (1994a). Four feel trade's pulse. Industry experts examine the hot issues of the moment. Commercial Horticulture, (August), 7-9.

Anonymous (1994b). 1991 Census of population and dwellings. Statistics New Zealand.

Anonymous (1995a). Household Economic Survey. Year ended March 1995. Hot off the press, 31 August, Cat 09.505, Set 95/96-039, Statistics New Zealand.

Anonymous (1995b). Unpublished report on household expenditure on gardening from 1987 to 1995, prepared for the New Zealand Nursery and Garden Industry Association by Statistics New Zealand.

Anonymous (1995c). Garden trade told to pick up the pace. Commercial Horticulture, (August), 3.

Arnold, G.C. (1995). Personal communication. Department of Statistics, Massey University, Palmerston North, New Zealand.

Bagozzi, R.P. (1994). Principles of marketing research. Blackwell Publishers, Massachusetts, USA.

Bateson, J.E.G., D. Reibstein, and W. Boulding (1987). Conjoint analysis reliability and validity: A framework for future research. In: Review of Marketing, M.J. Houston, ed., American Marketing Association, Chicago, USA, 451-481.

Batsell, R.R. and J.J. Louviere (1991). Experimental analysis of choice. Marketing Letters, 2, 199-214.

Behe, B. (1993). Look at gardening through a consumer's eyes. Professional Plant Growers Association News, Michigan, USA, 24 (10), 2-6.

Bennett, P.D. (1988). Dictionary of marketing terms. American Marketing Association, Chicago, USA.

Bettman, J.R. (1979). An information processing theory of consumer choice. Addison Wesley Publishing Co., Inc. Reading, Massachusetts, USA.

Bettman, J.R. and C.W. Park (1980). Effects of prior knowledge and experience and phase of the choice process on consumer decision processes: a protocol analysis. Journal of Consumer Research, 7, 234-248.

Bourke, I.J. and S.J. West (1976). The consumer market for garden plants. Market Research Centre, Massey University, Palmerston North, New Zealand, Consumer Research Report No. 6.

Brett, B. (1995). Retailers identify top ten service factors. Commercial Horticulture (August), 60-63, 79.

Brook, R.J. (1991). Workshop: surveying clients (and potential clients). Department of Statistics, Massey University, Palmerston North, New Zealand, October 10.

Brook, R.J. (1994). Personal communication. Department of Statistics, Massey University, Palmerston North, New Zealand.

Cameron, E.A. (1996). Personal communication. Department of Agricultural and Horticultural Systems Management. Massey University, Palmerston North, New Zealand.

Campbell, D.R. and D.W. Fiske (1959). Convergent and discriminant validation by the multitrait-multimethod matrix. Psychological Bulletin, 56, 81-105.

Carlson, W. (1991). One to grow on: find out what your customers want. Greenhouse Grower, (March), 16-18.

Carmone, F. J. (1986). CONJOINT DESIGNER. Journal of Marketing Research, 23, 311-312.

Carroll, J.D. (1972). Individual differences and multidimensional scaling. In: Multidimensional scaling: Theory and applications in behavioural sciences, 1, R.N. Shepard et al., eds., Seminar Press, New York, USA, 105-155.

Cattin, P. and M.G. Weinberger (1980). Some validity and reliability issues in the measurement of attribute utilities. In: Advances in Consumer Research, 7, J.C. Olson, ed., Ann Arbor, MI: Association for Consumer Research, 780-783.

Cattin, P. and D.R. Wittink (1982). Commercial use of conjoint analysis: a survey. Journal of Marketing, 46 (3), 44-53.

Chisholm, D. (1995). Instant gardens....just add water. Sunday Star Times, 12 November, Section D.

Choi, S.C. and W.S. DeSarbo (1994). A conjoint-based product designing procedure incorporating price competition. Journal of Product Innovation Management, 11, 451-459.

Chrzan, K. (1994). Three kinds of order effects in choice-based conjoint analysis. Marketing Letters, 5 (2), 165-172.

Cochran, W.G. and G.M. Cox (1992). Experimental designs. Second edition. John Wiley & Sons Inc., New York, USA.

Cox, T.F. and M.A.A Cox (1994). Multidimensional scaling. Chapman & Hall, London, UK.

Currim, I.S., C.B. Weinberg, and D.R. Wittink (1981). Design of subscription programs for a performing arts series. Journal of Consumer Research, 8, 67-75.

Darmon, R.Y. and D. Rouziès (1991). Internal validity assessment of conjoint estimated attribute importance weights. Journal of the Academy of Marketing Science, 19 (4), 315-322.

Darmon, R.Y. and D. Rouziès (1994). Reliability and internal validity of conjoint estimated utility functions under error-free versus error-full conditions. International Journal of Research in Marketing, 11, 465-476.

Daws, R.M. and B. Corrigan (1974). Linear models in decision making. Psychological Bulletin, 81, 95-106.

Day, G.S. (1972). Evaluating models of attitude structure. Journal of Marketing Research, 9, 279-286.

DeBossu, A. (1988). What do people want to buy? American Nurseryman, 167 (9), 91-97.

Dewey, J. (1910). How we think. Heath, New York, USA.

Dickson, P.R. and A.G. Sawyer (1990). The price knowledge and search of supermarket shoppers. Journal of Marketing, 54 (3), 42-53.

Dorsch, M.J. and R.K. Teas (1992). A test of the convergent validity of self-explicated and decompositional conjoint measurement. Journal of the Academy of Marketing Science, 20 (1), 37-48.

Drucker, P.F. (1974). Management: tasks, responsibilities, practices. Harper and Row, New York, USA.

Edwards, W. (1954). The theory of decision making. Psychological Bulletin, 51, 380-417.

Edwards, B. (1994). Shopping on price - a phenomenon of the 90s. Commercial Horticulture, (June), 10-13, 15, 41-42.

Elrod, T.S., J.J. Louviere, and K.S. Davey (1992). An empirical comparison of ratings-based and choice-based conjoint models. Journal of Marketing Research, 29, 368-377.

Engel, J.F., R.D. Blackwell, and D.T. Kollat (1978). Consumer behaviour. Third edition, The Dryden Press, Hinsdale, Illinois, USA.

Engel, J.F., R.D. Blackwell, and P.W. Miniard (1990). Consumer behaviour. Sixth edition, The Dryden Press, Hinsdale, Illinois, USA.

Erickson, G.M. and J.K. Johansson (1985). The role of price in multi-attribute product evaluations. Journal of Consumer Research, 12, 195-199.

Finney, D.J. (1945). The fractional replication of factorial arrangements. Annals of Eugenics, 12, 291-301.

Fishbein, M. (1967). Attitude and prediction of behaviour. In: Readings in attitude theory and measurement, M. Fishbein, ed., Wiley, New York, USA.

Fishbein, M. (1975). Attitude, attitude change, and behaviour; a theoretical overview. In: Attitude research bridges the Atlantic, P. Levine, ed., American Marketing Association, Chicago, USA.

Fisher, R.A. (1926). The arrangement of field experiments. Journal of Ministry of Agriculture, 33, 503-513.

Fisher, R.A., and F. Yates (1938). Statistical tables for biological, agricultural and medical research. Oliver and Boyd, Edinburgh, UK.

Florkowski, W.J., O.M. Lindstrom, and M.A. Florkowska (1992). Importance of five natural Christmas tree characteristics as related to socioeconomic variables and opinions of choose-and-cut farms' customers. Journal of Environmental Horticulture, 10 (4), 199-202.

Foxall, G.R. (1983). Consumer choice. MacMillan Education Ltd., London, UK.

Foxall, G.R. (1990). Consumer psychology in behavioural perspective. Routledge, London, UK, and New York, USA.

Francese, P. and R. Piirto (1990). Capturing customers. American Demographics Books, New York, USA.

Garber, M.P. and K. Bondari (1992a). Landscape architects as related to the landscape/nursery industry: I. Impact on demand for plant material. Journal of Environmental Horticulture, 10 (2), 69-72.

Garber, M.P. and K. Bondari (1992b). Landscape architects as related to the landscape/nursery industry: II. Selection of the production nursery and plant availability. Journal of Environmental Horticulture, 10 (2), 73-77.

Gardner, H. (1985). The mind's new science: a history of the cognitive evolution. Harper and Row, New York, USA.

Gineo, W. (1989). The impact of product attributes on nursery stock purchases. University of Connecticut, Department of Agricultural Economics and Rural Sociology, AERS Staff Paper, 89-1.

Green, P.E. and V.R. Rao (1971). Conjoint measurement for quantifying judgemental data. Journal of Marketing Research, 8, 355-363.

Green, P.E. and V.R. Rao (1972). Applied multidimensional scaling. A comparison of approaches and algorithms. Holt, Rinehart and Winston, Inc., New York, USA.

Green, P.E. and Y. Wind (1973). Multiattribute decisions in marketing: A measurement approach. The Dryden Press, Hinsdale, Illinois, USA.

Green, P.E. (1974). On the design of choice experiments involving multifactor alternatives. Journal of Consumer Research, 1, 61-68.

Green, P.E. (1975). Marketing applications of MDS: Assessment and outlook. Journal of Marketing, 39 (1), 24-31.

Green, P.E. (1977). A new approach to market segmentation. Business Horizons, 20, 61-73.

Green, P.E., J.D. Carroll, and F.J. Carmone (1978). Some new types of fractional factorial designs for marketing experiments. Research in Marketing, 1, 99-122.

Green, P.E. and V. Srinivasan (1978). Conjoint analysis in consumer research: Issues and outlook. Journal of Consumer Research, 5, 103-123.

Green, P.E. and W.S. DeSarbo (1979). Componential segmentation in the analysis of consumer trade-offs. Journal of Marketing, 43 (4), 83-91.

Green, P.E., D. Tull, and G. Albaum (1988). Research for marketing decisions. Fifth edition. Prentice Hall, Englewood Cliffs, New Jersey, USA.

Green, P.E. and K. Helsen (1989). Cross-validation assessment of alternatives to individual-level conjoint analysis: a case study. Journal of Marketing Research, 26, 346-350.

Green, P.E. and V. Srinivasan (1990). Conjoint analysis in marketing: New developments with implications for research and practice. Journal of Marketing, 54 (4), 3-19.

Green, P.E. (1992). CONSURV: conjoint analysis software. Journal of Marketing Research, 29, 387-390.

Green, P.E., A.M. Krieger, and C.M. Schaffer (1993). An empirical test of optimal respondent weighting in conjoint analysis. Journal of the Academy of Marketing Science, 21, 345-351.

Griffin, A. and J. R. Hauser (1993). The voice of the customer. Marketing Science, 12 (1), 1-27.

Guthrie, E.R. (1952). The psychology of learning. Revised edition. Harper and Row, New York, USA.

Haberlandt, K. (1994). Cognitive psychology. Paramount Publishing, Massachusetts, USA.

Hagerty, M.R. (1985). Improving predictive power of conjoint analysis: the use of factor analysis and cluster analysis. Journal of Marketing Research, 22, 168-184.

Hagerty, M.R. (1986). The cost of simplifying preference models. Marketing Science, 5 (4), 298-319.

Hagerty, M.R. (1993). Can segmentation improve predictive accuracy in conjoint analysis? Journal of the Academy of Marketing Science, 21 (4), 353-355.

Hammett, K. (1992). Plant training and pruning. Revised edition. Octopus Publishing Group Ltd., Auckland, New Zealand.

Hauser, J.R. and G.L. Urban (1977). A normative methodology for modelling consumer response to innovation. Operations Research, 25, 579-619.

Hays, W.L. (1963). Statistics for psychologists. Holt, Rinehart and Winston, Inc., New York, USA

Hicks, F. (1994). On mass. American Nurseryman, (October), 45-48.

Hillner, K.P. (1984). History and systems of modern psychology: A conceptual approach. Gardner Press, New York, USA.

Hinkle, D.E., W. Wiersma, and S.G. Jurs (1979). Applied statistics for the behavioural sciences. Rand McNally College Publishing Company, Chicago, USA.

Hoffman, P.J., P. Slovic, and L.G. Rorer (1968). An analysis of variance model for the assessment of configural cue utilisation in clinical judgement. Psychological Bulletin, 69 (5), 338-349.

Holbrook, M.B. and W.L. Moore (1981). Feature interactions in consumer judgements of verbal versus pictorial presentations. Journal of Consumer Research, 8, 103-111.

Holland, C.W. and D.W. Cravens (1973). Fractional factorial experimental designs in marketing research. Journal of Marketing Research, 10, 270-276.

Hopkins, W.G. (1995). Introduction to plant physiology. J. Wiley, New York, USA.

Howard, J. and J.N. Sheth (1969). The theory of buyer behaviour. Wiley, New York, USA.

Huber, J. and N.M. Klein (1991). Adapting cutoffs in the choice environment: the effects of attribute correlation and reliability. Journal of Consumer Research, 18, 346-357.

Huber, J., D.R. Wittink, J.A. Fiedler, and R. Miller (1993). The effectiveness of alternative preference elicitation procedures in predicting choice. Journal of Marketing Research, 30, 105-114.

Hull, C.L. (1951). Essentials of behaviour. Yale University Press, Connecticut, USA.

Jacoby, J., D.E. Speller, and C.A. Kohn (1974). Brand choice behaviour as a function of information load. Journal of Marketing Research, 11, 63-69.

Jain, A.K., F. Acito, N.K. Malhotra, and V. Mahajan (1979). A comparison of internal validity of alternative parameter estimation methods in decompositional multiattribute preference models. Journal of Marketing Research, 16, 313-322.

Johnson, R.M. (1974). Trade-off analysis of consumer values. Journal of Marketing Research, 11, 121-127.

Johnson, R.M. (1976). Beyond conjoint measurement: A method of pairwise trade-off analysis. In: Advances in Consumer Research, 3, B.B. Anderson, ed., Proceedings of the Association for Consumer Research, Sixth Annual Conference, 353-358.

Kamakura, W.A. (1988). A least squares procedure for benefit segmentation with conjoint experiments. Journal of Marketing Research, 25, 157-167.

Kassarjian, H.H. (1982). Consumer psychology. Annual Review of Psychology, 33, 619-649.

Kelly, G.A. (1955). The psychology of personal constructs. W.W. Norton, New York, USA.

Kempthorne, O. (1962). The design and analysis of experiments. John Wiley & Sons Inc., New York, USA.

Kepner, K. (1990a). Think the way your customers think. Commercial Horticulture, (October), 8-12.

Kepner, K. (1990b). Think like your customers. Commercial Horticulture, (November), 13-16.

Kotler, P. (1965). Behavioural models for analysing buyers. Journal of Marketing, 29 (4), 37-45.

Kotler, P. (1972). What consumerism means for marketers. Harvard Business Review (May-June), 48-57.

Kotler, P. (1994). Marketing management. Analysis, planning, implementation, and control. Eighth edition. Prentice Hall, Englewood Cliffs, New Jersey, USA.

Kravanja, N. (1995). Appeal of outdoor ornamental plants. Acta Horticulturae, 391, 191-197.

Kuhfeld, W.F., R.D. Tobias, and M. Garratt (1994). Efficient experimental design with marketing research applications. Journal of Marketing Research, 31, 545-557.

Lancaster, K. (1966). A new approach to consumer theory. Journal of Political Economy, 74, 132-157.

Lefkoff-Hagius, R. and C.H. Mason (1993). Characteristic, beneficial, and image attributes in consumer judgements of similarity and preference. Journal of Consumer Research, 20, 100-110.

Lehmann, D.R. (1971). Television show preference: Application of a choice model. Journal of Marketing Research, 8, 47-55.

Leigh, T.W., D.B. MacKay, and J.O. Summers (1984). Reliability and validity of conjoint analysis and self-explicated weights: A comparison. Journal of Marketing Research, 21, 456-462.

Leshem, Y. Y., A.H. Halevy, and C. Frenkel (1986). Ethylene as a senescence factor. In: Process and control of plant senescence. Developments in crop science (8). Y.Y. Leshem, A.H. Halevy, and C. Frenkel, eds., Elsevier Science Publishing Company Inc., New York, USA, Chapter 2, 23-44.

Levy, M., J. Webster, and R.A. Kerin (1983). Formulating push marketing strategies: A method and application. Journal of Marketing, 47 (1), 25-34.

Lichtenstein, D.R., N.M. Ridgway, and R.G. Netemeyer (1993). Price perceptions and consumer shopping behaviour: a field study. Journal of Marketing Research, 30, 234-245.

Loosschilder, G.H. and J.R. Ortt (1994). The effect of realism of product representations on the validity of consumer evaluations. Proceedings of the ESOMAR Congress, 353-377.

Loosschilder, G.H., E. Rosbergen, M. Vriens, and D.R. Wittink (1995). Pictorial stimuli in conjoint analysis - to support product styling decisions. Journal of the Market Research Society, 37 (1), 17-34.

Louviere, J.J. (1974). Predicting the evaluation of real stimulus objects from abstract evaluation of their attributes: the case of trout streams. Journal of Applied Psychology, 59 (5), 572-577.

Louviere, J.J. and Meyer, R.J. (1981). A composite attitude-behaviour model of traveller decision making. Transportation Research, 15B, 411-420.

Louviere, J.J. and G.G. Woodworth (1983). Design and analysis of simulated consumer choice or allocation experiments: an approach based on aggregate data. Journal of Marketing Research, 20, 350-367.

Louviere, J.J., H. Schroeder, C.H. Louviere, and G.G. Woodworth (1987). Do the parameters of choice models depend on differences in stimulus presentation: visual versus verbal presentation? Advances in Consumer Research, 14, 79-82.

Louviere, J.J. (1988a). Analysing decision making. Metric conjoint analysis. Sage Publications, Inc., California, USA.

Louviere, J.J. (1988b). Conjoint analysis modelling of stated preferences. Journal of Transport Economics and Policy, 10, 93-119.

Louviere, J.J. (1992). Experimental choice analysis: introduction and overview. Journal of Business Research, 24, 89-95.

Louviere, J.J. (1994). Conjoint analysis. In: Advanced methods of marketing research. R.P. Bagozzi, ed., Blackwell Publishers, Massachusetts, USA.

Luce,R.D., and J.W. Tukey (1964). Simultaneous conjoint measurement: A new type of fundamental measurement. Journal of Mathematical Psychology, 1, 1-27.

Lussier, D.A. and R.W. Olshavsky (1979). Task complexity and contingent processing in brand choice. Journal of Consumer Research, 6, 154-165.

Lynch, J.G., T.E. Buzas, and S.V. Berg (1994). Regulatory measurement and evaluation of telephone service quality. Management Science, 40 (2), 169-194.

Makus, L.D., J.C. Foltz, J.F. Guenthner, and R.R. Tripepi (1992). Product and service attributes related to marketing nursery stock. HortTechnology, 2 (4), 483-488.

Malhotra, N.K. (1982). Structural reliability and stability of nonmetric conjoint analysis. Journal of Marketing Research, 19, 199-207.

Mansfield, E. (1991). Microeconomics: Theory, applications. Seventh edition. W.W Norton & Company, Inc., New York, USA.

Marr, N.E. (1983). The meaning and measurement of customer service in international marketing - an application of conjoint measurement. Unpublished PhD thesis, Cranfield Institute of Technology, School of Management, UK.

Mas-Colell, A. and M.D. Whinston (1995). Microeconomic theory. Oxford University Press, Inc., New York, USA.

Mattoo, A.K., and J.C. Suttle (1994). The plant hormone ethylene. A.K. Mattoo and J.C. Suttle, eds., Boca Raton, CRC Press, Florida, USA.

McCullough, J. and R. Best (1979). Conjoint measurement: Temporal stability and structural reliability. Journal of Marketing Research, 16, 26-31.

Meyer, R. and E.J. Johnson (1995). Empirical generalisations in the modelling of consumer choice. Marketing Science, 14 (3), 180-189.

Montgomery, D.B. and D.R. Wittink (1980). The predictive validity of conjoint analysis for alternative aggregation schemes. In: Market Measurement and Analysis: Proceedings of the 1979 ORSA/TIMS Conference in Marketing, D.B. Montgomery and D.R. Wittink, eds., Cambridge, MA: Marketing Science Institute, 298-309.

Moore, W.L. (1980). Levels of aggregation in conjoint analysis: an empirical comparison. Journal of Marketing Research, 17, 516-523.

Moore, T.C. (1989). Ethylene. In: Biochemistry and physiology of plant hormones. Second edition. T.C. Moore, ed., Springer-Verlag, New York, USA, Chapter 6, 228-254.

Myers, J.H. and M. I. Alpert (1968). Determinant buying attitudes: Meaning and measurement. Journal of Marketing, 32 (4), 13-20.

Nicosia, F.M. (1966). Consumer decision process. Prentice Hall, Englewood Cliffs, New Jersey, USA.

Olshavsky, R.W. and D.H. Granbois (1979). Consumer decision making - fact or fiction? Journal of Consumer Research, 6, 93-100.

Oppendijk van Veen, W.M. and D. Beazley (1977). An investigation of alternative methods for applying the trade-off model. Journal of the Market Research Society, 19, 2-11.

Oprel, L. (1990). Consumenten en telers hebben dezelfde smaak. Oogst, 19, 44-45.

Page, A.L. and H.F. Rosenbaum (1992). Developing an effective concept testing program for consumer durables. Journal of Product Innovation Management, 9, 267-277.

Paivio, A. (1971). Imagery and verbal processes. Holt, Rinehart and Winston, Inc., USA.

Parker, B.R. and V. Srinivasan (1976). A consumer preference approach to the planning of rural primary health-care facilities. Operations Research, 24 (5), 991-1025.

Payne, J.W. (1976). Task complexity and contingent processing in decision making: An information search and protocol analysis. Organisational Behaviour and Human Performance, 16, 366-387.

Payne, J.W. (1982). Contingent decision behaviour: a review and discussion of issues. Psychological Bulletin, 92, 383-402.

Payne, J.W., J. R. Bettman, and E.J. Johnson (1992). Behavioural decision research: a constructive processing perspective. Annual Review of Psychology, 43, 87-131.

Peter, J.P. (1979). Reliability: A review of psychometric basics and recent marketing practices. Journal of Marketing Research, 16, 6-17.

Peter, J.P. and J.C. Olson (1990). Consumer behaviour and marketing strategy. Second edition. Richard D. Irwin Inc., Illinois, USA.

Peters, T.J. and R.H. Waterman, Jr. (1982). In search for excellence. Lessons from America's best-run companies. Harper and Row Publishers, New York, USA.

Peters, T.J. and N.K. Austin (1985). A passion for excellence. Random House, Inc., New York, USA.

Pieters, R. (1993). A control view on the behaviour of consumers: turning the triangle. European Journal of Marketing, 27 (8), 17-27.

Plackett, R.L. and J.P. Burman (1946). The design of optimum multifactorial experiments. Biometrika, 33, 305-325.

Plackett, R.L. (1946). Some generalizations in the multifactorial design. Biometrika, 33, 328-332.

Reed, S.K. (1992). Cognition. Theory and applications. Wadsworth, Inc., California, USA.

Reibstein, D., J.E.G. Bateson, and W. Boulding (1988). Conjoint analysis reliability: Empirical findings. Marketing Science, 7 (3), 271-286.

Reichheld, F.W. and W.E. Sasser (1990). Zero defections: quality comes to services. Harvard Business Review, (September-October), 301-307.

Rice, C. (1993). Consumer behaviour: behavioural aspects of marketing. Butterworth Heinemann, Oxford, UK.

Riter, C.B. (1966). What influences purchases of colour television. Journal of Retailing, 42, 25-31, 63-64.

Robinson, P.J. (1980). Applications of conjoint analysis to pricing problems. In: Market measurement and analysis: Proceedings of the 1979 ORSA/TIMS Conference in Marketing, D.B. Montgomery and D.R. Wittink, eds. Cambridge, MA: Marketing Science Institute, 183-205.

Rosenberg, M.J. (1956). Cognitive structure and attitudinal affect. Journal of Abnormal and Social Psychology, 53, 367-372.

Safizadeh, M.H. (1989). The internal validity of the trade-off method of conjoint analysis. Decision Sciences, 20, 451-461.

Saunders, S. (1992). Customers - the weird people you need. Commercial Horticulture, (June), 19-21, 26-27.

Scott, J.E. and P. Wright (1976). Modelling an organizational buyer's product evaluation strategy: Validity and procedural considerations. Journal of Marketing Research, 13, 211-224.

Segal, M.N. (1982). Reliability of conjoint analysis: Contrasting data collection procedures. Journal of Marketing Research, 19, 139-143.

Sheth, J.N. (1974). Models of buyer behaviour: conceptual, quantitative, and empirical. Harper and Row Publishers, Inc., New York, USA.

Simon, H.A. (1955). A behavioural model of rational choice. Quarterly Journal of Economics, 69, 99-118.

Sirgy, M.J. (1982). Self-concept in consumer behaviour: a critical review. Journal of Consumer Research, 9, 287-300.

Skeggs, M. (1993). Trends all in the right direction for trade. Commercial Horticulture, (April), 16-19, 35.

Skinner, B.F. (1953). Science and human behaviour. The MacMillan Company, New York, USA.

Srinivasan, V. and A.D. Shocker (1973). Estimating the weights for multiple attributes in a composite criterion using pairwise judgements. Psychometrika, 38, 473-493.

Stanley, J. (1990). Knowing your customer is the key to successful marketing. Commercial Horticulture, (February), 32-33.

Steel, R.G.D and J.H. Torrie (1987). Principles and procedures of statistics. A biometrical approach. Second edition. McGraw-Hill International Book Company, Singapore.

Steenkamp, J.E.M. and D.R. Wittink (1994). The metric quality of full-profile judgements and the number-of-attribute-levels effect in conjoint analysis. International Journal of Research in Marketing, 11, 275-286.

Sternthal, B. and C.S. Craig (1982). Consumer behaviour. An information processing perspective. Prentice-Hall, Inc., Englewood Cliffs, New Jersey, USA.

Teas, R.K. (1985). An analysis of temporal stability and structural reliability of metric conjoint analysis. Journal of the Academy of Marketing Science, 13 (1), 122-142.

Tellis, G.J. and G.J. Gaeth (1990). Best value, price seeking, and price aversion: the impact of information and learning on consumer choices. Journal of Marketing, 54 (2), 34-45.

Tolman, E.C. (1932). Purposive behaviour in animals and men. Century Co., New York, USA.

Toombs, K. and G. Bailey (1995). How to redesign your organisation to match customer needs. Planning Review, (March/April), 20-24.

Tull, D.S. and D.I. Hawkins (1987). Marketing research. Measurement and method. MacMillan Publishing Company, New York, USA.

Turner, S.C. and J.H. Dorfman (1990). Retail target markets for landscape plants. Journal of Environmental Horticulture, 8 (3), 115-118.

Turner, S.C., J.H. Dorfman, and S.M. Fletcher (1990). Target markets for retail outlets of landscape plants. Southern Journal of Agricultural Economics, 22 (1), 177-183.

Van der Lans, I.A. and W.J. Heiser (1992). Constrained part-worth estimation in conjoint analysis using the self-explicated utility model. International Journal of Research in Marketing, 9, 325-344.

Van Gaasbeek, A.F. and V.C. Bouwman (1991). Conjoint analysis in market research for horticultural products. Acta Horticulturae, 295, 121-125.

Vink, I. (1989). Determining the relative importance of plant features as an aid to production decisions. Student dissertation in partial fulfilment of B.Hort.Sci(Hons) degree, Department of Plant Science, Massey University, Palmerston North, New Zealand.

Von Winterfeldt, D. and W. Edwards (1986). Decision analysis and behavioural research. Press Syndicate of the University of Cambridge, New York, USA.

Vroom, V. H. (1964). Work and motivation. Wiley, New York, USA.

West, S.J. (1980). The consumer market for garden plants. Repeat survey. Market Research Centre, Massey University, Palmerston North, New Zealand. Research Report, No. 27.

Westwood, D., T. Lunn, and D. Beazley (1974). The trade-off model and its extensions. Journal of the Market Research Society, 16 (3), 227-241.

Williams, K.C. (1981). Behavioural aspects of marketing. William Heinemann Ltd., London, UK.

Williams, M. (1991). CONSURV: Conjoint analysis software. Intelligent Marketing Systems, Inc., Edmonton, Canada.

Wilson, T.D. and D.S. Dunn (1986). Effects of introspection on attitude-behaviour consistency: analysing reasons versus focusing on feelings. Journal of Experimental Social Psychology, 22, 249-263.

Wilson, T.D., D.S. Dunn, D. Kraft, and D.J. Lisle (1989a). Introspection, attitude change, and attitude-behaviour consistency: the disruptive effects of explaining why we feel the way we do. In: Advances in experimental social psychology, L. Berkowitz, ed., Academic Press, Florida, USA, 22, 287-343.

Wilson, T.D., D. Kraft, and D.S. Dunn (1989b). The disruptive effects of explaining attitudes: the moderating effect of knowledge about the attitude object. Journal of Experimental Social Psychology, 25, 379-400.

Wind, Y., P.E. Green, and P.J. Robinson (1968). The determinants of vendor selection: The evaluation function approach. Journal of Purchasing, 4, 29-41.

Wittink, D.R., L. Krishnamurthi, and J.B. Nutter (1982). Comparing derived importance weights across attributes. Journal of Consumer Research, 8, 471-474.

Wittink, D.R. and P. Cattin (1989). Commercial use of conjoint analysis: a survey. Journal of Marketing, 53 (3), 91-96.

Wittink, D.R., L. Krishnamurthi, and D.J. Reibstein (1989). The effects of differences in the number of attribute levels on conjoint results. Marketing Letters, 1, 113-123.

Wittink, D.R., M. Vriens, and W. Burhenne (1994). Commercial use of conjoint analysis in Europe: Results and critical reflections. International Journal of Research in Marketing, 11, 41-52.

Wright, P. and M.A. Kriewall (1980). State-of-mind effects on the accuracy with which utility functions predict marketplace choice. Journal of Marketing Research, 17, 277-293.

Yamamoto, M. and D.R. Lambert (1994). The impact of product aesthetics on the evaluation of industrial products. Journal of Product Innovation Management, 11, 309-324.

Zeihaml, V.A. (1988). Consumer perceptions of price, quality, and value. Journal of Marketing, 52 (3), 2-22.

APPENDICES

LIST OF APPENDICES

			Page
A	Factors elicited in Palmerston North and Auckland		253
	Table A1	Factors elicited in Palmerston North	253
	Table A2	Factors elicited in Auckland	255
B	Factors and their levels selected for further study		258
C	Relative efficiencies of effect estimates		261
D	The conjoint questionnaire		262
E	Analysis of variance results for plant profile ratings		266
F	Sum of ratings for plant profiles		267
G	Profiles with estimated ratings of 6 or higher		269
H	Self-stated factor importance rankings		270
I	Two-way cross tabulations for respondent variables		271
	Table I1	Time spent on gardening by respondents living with or without children under 16 years of age	271
	Table I2	Respondents living with or without children under 16 years of age, and belonging to different age categories	271
	Table I3	Time spent on gardening by respondents who were part of a couple and by single respondents	272
	Table I4	Gross household income of respondents belonging to different age categories	272
	Table I5	Yearly expenditure on plants by respondents belonging to different gross income categories	273

Page

J Estimated effects of the interaction between price and income 274

K Characteristics of respondents in Palmerston North (PN), Wellington (WN), and Auckland (AKL) 275

Table K1 Marital status of respondents in PN, WN, and AKL 275
Table K2 Respondents in PN, WN, and AKL, living with or without children under 16 years 275
Table K3 Gender of respondents in PN, WN, and AKL 276
Table K4 Age of respondents in PN, WN, and AKL 276
Table K5 Employment status of respondents in PN, WN, and AKL 277
Table K6 House-ownership of respondents in PN, WN, and AKL 277
Table K7 Ages of houses occupied by respondents in PN, WN, and AKL 278
Table K8 Section sizes of respondents in PN, WN, and AKL 278
Table K9 Gross household income of respondents in PN, WN, and AKL 279
Table K10 Expenditure on plants by respondents in PN, WN, and AKL 279
Table K11 Time spent on gardening by respondents in PN, WN, and AKL 280

L Analyses of variance results for plant profile ratings of respondents in different areas 281

Table L1 ANOVA table for Palmerston North data 281
Table L2 ANOVA table for Wellington data 282
Table L3 ANOVA table for Auckland data 283

APPENDIX A Factors elicited in Palmerston North and Auckland

Table A1 **Factors elicited in Palmerston North**

factor	% of respondents who mentioned this factor
health	70
suitability site conditions	64
ability to withstand clay soil	2
ability to withstand wind	2
hardiness/ frost tenderness	2
price	68
expected height	51
space available in garden	2
size	19
flower colour	64
label with information	55
label + info on fertiliser	4
shape	45
label with picture of flower	34
1 flower open or picture	15
at least 1 flower open	9
no. of flower buds	40
scent	21
foliage colour	21
length flowering period	19
flowering time	17
suitability for cutting	13
colour	11
suitability for purpose	11
unusual flowers	11
age when buying	9
how well potted	4
hardy, easy care	4
easy to grow	4

Table A1 continued

initial height	4
shape for purpose	2
environment interaction,birds	2
attractive leaves all year	2
past performance/experience	2
unusually coloured shrubs	2
many flowers when in flower	2
low care	2
compatibility rest of garden	2
hardy	2
native	2
long lived plant	2
quick grower	2
balanced budding	2
pleasant to the eye	2
pest/disease resistance	2
when to prune?	2
not poisonous to stock	2
true to label	2
no need to trim too often	2
does it drop flowers/leaves on lawn	2
shape of flower	2
known plants	2
foliage quality	2
type of leaf	2
colour: flowers and foliage	2
foliage	2
rate of growth	2

Table A2 **Factors elicited in Auckland**

factor	% of respondents who mentioned this factor
health	90
suitable-growing conditions	74
frost-proof	2
climatic aspect	2
price	68
budget	2
expected height/size	42
will it fill the gap? (size)	2
space available	2
size	8
colour- flower	46
bright colours-flower	4
flower colour that ties in	2
plant in flower to see colour	2
label + info	64
info on fertiliser	2
label with expected height/size	2
shape- strong from base	28
balanced shape at purchase	2
not straggly	2
compact, not tall and straggly	2
flower open or picture	14
label + picture/flower	20
no of flower buds	22
well budded	2
colour - foliage	26
nice smell	22
length of flowering time	14
low maintenance	12
suitable for picking	10
how well is it bagged	2
nursery care	2
well looked after (weed free)	2
not root bound	4

Table A2 continued

new plants	2
unusualness	8
colour	8
compatibility rest of garden	8
reasonable size at time of buying	8
flowering season	8
old fashioned flowers	6
texture (leaf size, shape, shiny)	6
appearance	6
not too tall at purchase	4
flowers	4
no shedding (pool)	4
landscape atmosphere	4
shape relative to purpose in garden	4
disease-proof/resistant	4
native plant	4
impulse	4
colour and shape of flowers	4
amount of flowers	4
hardiness	4
fashion	2
looking good all year round	2
common plant/seen before	2
time to maturity	2
attractive to birds	2
display (eye-catching)	2
can you propagate it?	2
colour and shape of leaves	2
plant maturity	2
robust during life	2
height at purchase and expected	2
coming into flowering	2
speed of growth	2
foliage form	2
leaf colour change during year	2
flower colour change, fl. period	2
retailer knowledge-plant needs	2
poisonous/allergenic?	2
flower type: double/single?	2
ready to plant	2
leaf shape	2
foliage	2

Table A2 continued

recommended by magazine	2
recommended by garden centre	2
good size and shape	2
particular form	2
guarantee	2

APPENDIX B Factors and their levels selected for further study

HEALTH

POOR

AVERAGE

GOOD

FLOWER COLOUR

BRIGHT

SOFT

LEAF COLOUR

LIGHT

DARK

SUITABILITY FOR YOUR GARDEN

The suitability of a particular plant for your garden may depend on the following factors: 1) soiltype 2) temperature 3) moisture 4) light 5) wind 6) location with respect to the coast.

POOR: Your garden (or the position in your garden) is only suitable for the plant in question as far as two of the above factors are concerned.

AVERAGE: Your garden (or the position in your garden) is suitable for the plant in question as far as four of the above factors are concerned.

GOOD: Your garden (or the position in your garden) is suitable for the plant in question as far as all six of the above factors are concerned.

PRICE

$ 6.95

$ 12.95

$ 18.95

FINAL HEIGHT

TO 1 m

1 - 2 m

OVER 2 m

BUSHINESS

BUSHY

NOT BUSHY

SHAPE

BALANCED

UNBALANCED

APPENDIX C Relative efficiencies of effect estimates

In the current study, a 3^4 x 2 design was developed from a 3^5 factorial design by changing one of the five three-level factors into a two-level factor. That the resulting factor *e* occurred at level 0 twice as many times as it did at level 1, had an impact on the relative efficiency with which its main effect could be estimated. The variance of the main effect estimate for a two level factor in 2^n trials is equal to $(1/(2^{n-2}))\sigma^2$ with the information on a unit basis being $1/(4.\sigma^2)$ (Addelman, 1962a; Kempthorne, 1962). The variance of the main effect estimate for factor *e* was equal to (3/18) σ^2, and the information on a unit basis equalled $2/(9.\sigma^2)$. Thus, the relative efficiency of the main effect estimate for the two level factor *e* in the 3^4 x 2 experiment was equal to $2/(9.\sigma^2)$. $4\sigma^2 = 8/9$.

In situations where different correspondence schemes could be used to collapse levels of a factor to obtain another factor with a smaller number of levels, a comparison of relative efficiencies of effect estimates is necessary to determine the "best" correspondence scheme. If in the current study there were to be for instance 5^n trials instead of twenty seven trials, there would have been a choice between two different correspondence schemes. A correspondence scheme where (the number of times that level 0 occurs)/(the number of times that level 1 occurs) equalled 2/3, would result in a relative efficiency of the main effects estimates of 24/25 as compared to 16/25 for a correspondence scheme where level 1 occurred four times as often as did level 0.

APPENDIX D The conjoint questionnaire

CONSUMERS' PREFERENCES FOR EVERGREEN ORNAMENTAL PLANTS

PhD study conducted by:

Wilmien Brascamp

Supernumerary Lecturer
Department of Plant Science
Massey University
phone: (06) 3569099 ext 7874

Supervisors:

Prof N E Marr, Department of Marketing, and
Prof E W Hewett, Department of Plant Science

The first stage of this study consisted of the identification of all plant-related characteristics that may affect consumers' levels of appreciation for a particular plant. This was achieved by means of personal interviews with garden centre customers in Auckland and Palmerston North. An extensive list was obtained with factors garden centre customers regard as important when selecting ornamental plants. From this list, the eight factors that were mentioned most often by the interviewed garden centre customers and had received the best rankings, have been selected.

This questionnaire is designed to obtain more detailed information about these factors. The major aim of the study is to enable growers, researchers, breeders and retailers to more efficiently cater for their customers.

All answers will be treated with confidentiality and will be used exclusively for the purpose of this study.

Your cooperation is very important for the success of this research and is very much appreciated.

The factors that have been included are listed below. Each of these factors has been assigned either two or three levels. I would like you to rank these levels according to your preference. Give rank number 1 to the least preferred level. For a two-level factor, the level you prefer the most should be given rank number 2. For a three-level factor the most preferred level should receive rank number 3.

HEALTH	POOR	☐	AVERAGE	☐	GOOD	☐
BUSHINESS	BUSHY	☐	NOT BUSHY	☐		
SHAPE	BALANCED	☐	UNBALANCED	☐		
FLOWER COLOUR	BRIGHT	☐	SOFT	☐		
LEAF COLOUR	LIGHT	☐	DARK	☐		
SUITABILITY	POOR	☐	AVERAGE	☐	GOOD	☐
PRICE	$ 6.95	☐	$ 12.95	☐	$ 18.95	☐
FINAL HEIGHT	TO 1m	☐	1-2m	☐	OVER 2m	☐

Assume you are intending to buy an evergreen ornamental plant. I would like you to indicate how important each of the following factors are in determining your choice for a particular plant.

	——UNIMPORTANT			IMPORTANT——	
	very	somewhat	neutral	somewhat	very
HEALTH	☐	☐	☐	☐	☐
BUSHINESS	☐	☐	☐	☐	☐
SHAPE	☐	☐	☐	☐	☐
FLOWER COLOUR	☐	☐	☐	☐	☐
LEAF COLOUR	☐	☐	☐	☐	☐
SUITABILITY	☐	☐	☐	☐	☐
PRICE	☐	☐	☐	☐	☐
FINAL HEIGHT	☐	☐	☐	☐	☐

It is important that we have the opinions from people representative of the community. I would therefore be grateful if you could give me a little information about yourself.

1. **HOUSEHOLD**

Single ☐ Couple ☐

- living alone ☐
- sharing a flat or house ☐
- with children under 6 years ☐
- with children under 16 years ☐
- with children over 16 years ☐

2. **GENDER**

Female ☐ Male ☐

3. **AGE**

under 25	☐	35-44	☐	55-64	☐	>74	☐
25-34	☐	45-54	☐	65-74	☐		

4. **OCCUPATION MAIN INCOME EARNER**

- Horticultural ☐
- Agricultural ☐
- Retired/Unemployed/Social Welfare Beneficiary ☐
- Student ☐
- Other .... ☐

5. **OWNERSHIP OR RENT**

- own ☐
- rent, short term lease (less than 1 year) ☐
- rent, long term lease (longer than 1 year) ☐

6. AGE OF HOUSE OR FLAT

< 1 year ☐	5-9 years ☐	15 years + ☐
1-4 years ☐	10-14 years ☐	

7. SECTION SIZE (1/8 acre=506m^2)

smaller than 250m^2	☐
250 - 499m^2	☐
500 - 750m^2	☐
750 - 999m^2	☐
1000 - 1249m^2	☐
1250 - 1499m^2	☐
1500 - 1749m^2	☐
1750m^2 or more	☐

8. GROSS HOUSEHOLD INCOME

< $15,000	☐
$15,000-$30,000	☐
$30,000-$45,000	☐
$45,000-$60,000	☐
$60,000-$75,000	☐
$75,000-$90,000	☐
$90,000-$105,000	☐
$105,000 or over	☐

9. EXPENDITURE ON PLANTS

< $12 per year	(less than $1.00 per month)	☐
$12 -$59 per year	($ 1.00 - $ 4.99 per month)	☐
$60 -$119 per year	($ 5.00 - $ 9.99 per month)	☐
$120-$179 per year	($10.00 - $14.99 per month)	☐
$180-$239 per year	($15.00 - $19.99 per month)	☐
$240-$299 per year	($20.00 - $24.99 per month)	☐
$300-$359 per year	($25.00 - $29.99 per month)	☐
$360-$419 per year	($30.00 - $34.99 per month)	☐
$420 or more	($35.00 or more per month)	☐

10. TIME SPENT ON GARDENING

< 1 hr/wk ☐	3-4 hrs/wk ☐	6-7 hrs/wk ☐
1-2 hrs/wk ☐	4-5 hrs/wk ☐	7-8 hrs/wk ☐
2-3 hrs/wk ☐	5-6 hrs/wk ☐	8 hrs + ☐

APPENDIX E Analysis of variance results for plant profile ratings[1)]

source	df	ss	ms	F	Pr>F
model	1765	25069.939	14.204	6.57	0.0001
error	8602	18605.685	2.163		
total	10367	43675.623			

R-square = 0.57

source	df	ss	ms	F	Pr > F
respondent	1727	6996.957	4.051	1.87	0.0001
A (price)	2	652.788	326.394	150.90	0.0001
B (health)	2	6956.137	3478.068	1608.02	0.0001
C (suitable)	2	5291.237	2645.619	1223.15	0.0001
D (height)	2	319.154	159.577	73.78	0.0001
E (shape)	1	2617.310	2617.310	1210.07	0.0001
F (fl colour)	1	13.141	13.141	6.08	0.0137
G (bushiness)	1	1236.150	1236.150	571.51	0.0001
H (lf colour)	1	92.631	92.631	42.83	0.0001
A*B	4	25.772	6.443	2.98	0.0180
A*C	4	111.211	27.803	12.85	0.0001
A*D	4	606.080	151.520	70.05	0.0001
A*E	2	37.628	18.814	8.70	0.0002
A*F	2	4.266	2.133	0.99	0.3730
A*G	2	9.501	4.750	2.20	0.1113
A*H	2	1.774	0.887	0.41	0.6636
E*G	1	82.633	82.633	38.20	0.0001
F*H	1	2.732	2.732	1.26	0.2611
A*E*G	2	11.680	5.840	2.70	0.0673
A*F*H	2	1.158	0.579	0.27	0.7651

[1)]: df=degrees of freedom; ss=sums of squares; ms=mean square; Pr>F= probability of getting a larger value of F if the parameter is truly equal to zero. (A very small value leads to the conclusion that the independent variable contributes significantly to the variation in the response variable.)

APPENDIX F Sum of ratings for plant profiles

replicate	sum of ratings for profiles containing:					
	a_0	a_1	a_2	e_0	e_1	a_0b_0
1	1583	1431	1382	3355	1041	388
2	1548	1377	1322	3166	1081	346
3	1605	1489	1270	2951	1413	398
4	1571	1455	1367	3054	1339	356
5	1522	1455	1278	3174	1081	386
6	1526	1478	1294	3219	1079	332
7	1688	1403	1279	3244	1126	440
8	1545	1522	1274	3240	1101	322
	a_0b_1	a_0b_2	a_1b_0	a_1b_1	a_1b_2	a_2b_0
1	560	635	334	503	594	308
2	543	659	317	486	574	273
3	552	655	322	526	641	258
4	561	654	361	481	613	315
5	532	604	332	547	576	257
6	551	643	362	495	621	296
7	543	705	310	514	579	272
8	551	672	355	505	662	274
	a_2b_1	a_2b_2	a_0d_0	a_0d_1	a_0d_2	a_1d_0
1	459	615	561	570	452	406
2	461	588	557	520	471	427
3	430	582	561	546	498	465
4	444	608	579	524	468	471
5	436	585	493	541	488	418
6	446	552	518	510	498	461
7	427	580	636	519	533	394
8	380	620	524	525	496	407

replicate	sum of ratings for profiles containing:				
	a_1d_1	a_1d_2	a_2d_0	a_2d_1	a_2d_2
1	579	446	451	477	454
2	577	373	459	405	458
3	564	460	448	424	398
4	562	422	476	452	439
5	601	436	482	398	398
6	592	425	451	435	408
7	582	427	452	383	444
8	609	506	456	387	431

APPENDIX G Profiles with estimated ratings of 6[1] or higher

price	health	$c^{2)}$	height	shape	$f^{3)}$	bushy	leaf colour	rating
$6.95	good	good	<1m	balanced	bright	yes	dark green	7.0
$6.95	good	good	<1m	balanced	bright	yes	light green	6.8
$6.95	good	good	<1m	balanced	soft	yes	dark green	6.9
$6.95	good	good	<1m	balanced	soft	yes	light green	6.7
$6.95	good	good	<1m	balanced	bright	no	dark green	6.0
$6.95	good	good	1-2m	balanced	bright	yes	dark green	6.8
$6.95	good	good	1-2m	balanced	bright	yes	light green	6.6
$6.95	good	good	1-2m	balanced	soft	yes	dark green	6.5
$6.95	good	good	>2m	balanced	bright	yes	dark green	6.4
$6.95	good	good	>2m	balanced	bright	yes	light green	6.2
$6.95	good	good	>2m	balanced	soft	yes	dark green	6.3
$6.95	good	good	>2m	balanced	soft	yes	light green	6.1
$6.95	good	average	<1m	balanced	bright	yes	dark green	6.6
$6.95	good	average	<1m	balanced	bright	yes	light green	6.4
$6.95	good	average	<1m	balanced	soft	yes	dark green	6.5
$6.95	good	average	1-2m	balanced	bright	yes	dark green	6.4
$6.95	good	average	1-2m	balanced	bright	yes	light green	6.1
$6.95	good	average	1-2m	balanced	soft	yes	dark green	6.2
$6.95	good	average	1-2m	balanced	soft	yes	light green	6.1
$6.95	good	average	>2m	balanced	bright	yes	dark green	6.0
$6.95	average	good	<1m	balanced	bright	yes	light green	6.1
$6.95	average	good	<1m	balanced	bright	yes	dark green	6.3
$6.95	average	good	<1m	balanced	soft	yes	dark green	6.1
$6.95	average	good	<1m	balanced	soft	yes	light green	6.0
$6.95	average	good	1-2m	balanced	bright	yes	dark green	6.0
$12.95	good	good	1-2m	balanced	bright	yes	light green	6.3
$12.95	good	good	1-2m	balanced	soft	yes	dark green	6.4
$12.95	good	good	1-2m	balanced	soft	yes	light green	6.3
$12.95	good	good	1-2m	balanced	bright	yes	dark green	6.6
$12.95	good	average	1-2m	balanced	bright	yes	dark green	6.6
$12.95	good	average	1-2m	balanced	bright	yes	light green	6.3
$12.95	good	average	1-2m	balanced	soft	yes	dark green	6.4
$12.95	good	average	1-2m	balanced	soft	yes	light green	6.2
$18.95	good	average	<1m	balanced	bright	yes	dark green	6.0

[1]: scale used for profile ratings: 1 = very unattractive, 2 = unattractive, 3 = somewhat unattractive, 4 = neither attractive nor unattractive, 5 = somewhat attractive, 6 = attractive, 7 = very attractive; [2]: suitability for the growing conditions in the respondent's garden; [3]: flower colour

APPENDIX H Self-stated factor importance rankings[1)]

	1	2	3	no preference
price				0
$6.95	98	1	1	
$12.95	1	99	0	
$18.95	1	0	99	
health				0
poor	0	0	100	
average	1	99	0	
good	99	1	0	
suitability				0
poor	0	0	100	
average	0	99	1	
good	100	1	0	
final height				47
<1m	22	27	4	
1-2m	29	24	0	
>2m	3	2	49	
shape				11
unbalanced	4		85	
balanced	85		4	
flower colour				28
bright	46		26	
soft	26		46	
bushiness				21
bushy	74		5	
not bushy	5		74	
leaf colour				57
dark green	29		14	
light green	14		29	

[1)]: 1 = most preferred, 3 = least preferred

APPENDIX I Two-way cross tabulations for respondent variables

Table I1 **Time spent on gardening by respondents living with or without children under 16 years of age**

% of respondents	time spent on gardening in hrs/wk <3	3 to 6	>6
without younger children	40.3	25.9	33.8
with younger children	49.3	26.4	24.3
average	44.8	26.1	29.1

Table I2 **Respondents living with or without children under 16 years of age, and belonging to different age categories**

age category in yrs	% of respondents: without younger children	with younger children
% of younger than 35	72.2	27.8
% of 35 - 44	51.4	48.6
% of 45 - 54	86.6	13.4
% of 55-64	97.0	3.0
% of 65 and over	99.6	0.4

Table I3 **Time spent on gardening by respondents who were part of a couple and by single respondents**

	time spent on gardening in hrs/wk		
	<3	3 to 6	>6
% of singles	43.7	26.9	29.4
% of couples	41.6	25.7	32.7
average	42.7	26.3	31.1

Table I4 **Gross household income of respondents belonging to different age categories**

	gross household income divided by $1000		
age category in yrs	<$30	$30 - $60	>$60
% of younger than 35	28.8	40.6	30.6
% of 35 - 44	15.4	40.8	43.7
% of 45 - 54	15.5	39.9	44.6
% of 55-64	51.3	30.8	17.9
% of 65 and over	69.6	22.7	7.7

Table I5 **Yearly expenditure on plants by respondents belonging to different gross income categories**

(gross household income)/1000	expenditure on plants in $/yr <120	120-300	>300
<$30	51.6	30.1	18.3
$30 - $60	26.9	38.5	34.6
>$60	11.2	29.8	59.0

APPENDIX J Estimated effects of the interaction between price and income

	price level			
income/1000	$6.95	$12.95	$18.95	$\|A_0-A_2\|$ [1]
<$30	0.424	-0.016	-0.482	0.906
$30-$60	0.231	0.145	-0.262	0.493
$60+	0.332	-0.119	-0.252	0.584

[1]: $|A_0-A_2|$ = the absolute value of the difference between the estimated effects of the interaction at price levels $6.95 and $18.95.

APPENDIX K Characteristics of respondents in Palmerston North (PN), Wellington (WN), and Auckland (AKL).

Table K1 Marital status of respondents in PN, WN, and AKL

	marital status	
area of interviewing	**single**	**couple**
Palmerston North	22.9	77.1
Wellington	23.3	76.7
Auckland	22.9	77.1

Table K2 Respondents in PN, WN, and AKL, living with or without children under 16 years

	children <16 yrs at home	
area of interviewing	**no**	**yes**
Palmerston North	87.1	12.9
Wellington	78.8	21.2
Auckland	78.9	21.1

Table K3 **Gender of respondents in PN, WN, and AKL**

	gender	
area of interviewing	female	male
Palmerston North	68.1	31.9
Wellington	65.5	35.5
Auckland	71.4	28.6

Table K4 **Age of respondents in PN, WN, and AKL**

	age category				
area of interviewing	<35	35-44	45-54	55-64	65+
Palmerston North	25.4	17.1	21.6	20.2	15.7
Wellington	23.5	22.0	24.0	16.0	14.5
Auckland	18.8	20.5	25.2	21.0	14.5

Table K5 **Employment status of respondents in PN, WN, and AKL**

	employment	
area of interviewing	no	yes
Palmerston North	38.5	61.5
Wellington	25.2	74.8
Auckland	30.9	69.1

Table K6 **House-ownership of respondents in PN, WN, and AKL**

	house-ownership	
area of interviewing	no	yes
Palmerston North	12.9	87.1
Wellington	25.2	74.8
Auckland	10.2	89.8

Table K7 **Ages of houses occupied by respondents in PN, WN, and AKL**

area of interviewing	age of house in years <5	5-9	10-14	15+
Palmerston North	11.8	8.3	9.0	70.8
Wellington	7.2	5.9	8.0	78.9
Auckland	12.2	9.3	11.8	66.7

Table K8 **Section sizes of respondents in PN, WN, and AKL**

area of interviewing	section size in m^2 <500	500-749	750-999	1000+
Palmerston North	10.1	30.6	20.1	39.2
Wellington	13.9	40.1	16.4	29.6
Auckland	13.0	22.9	18.3	45.8

Table K9 **Gross household income of respondents in PN, WN, and AKL**

	gross household income divided by $1000		
area of interviewing	**<$30**	**$30-$60**	**$60+**
Palmerston North	40.6	36.9	22.5
Wellington	24.9	38.9	36.2
Auckland	34.8	34.2	31.1

Table K10 **Expenditure on plants by respondents in PN, WN, and AKL**

	expenditure on plants in $/yr		
area of interviewing	**<120**	**120-300**	**300+**
Palmerston North	31.6	36.8	31.6
Wellington	29.3	33.8	37.0
Auckland	30.1	32.7	37.2

Table K11 **Time spent on gardening by respondents in PN, WN, and AKL**

area of interviewing	time spent on gardening in hrs/wk <3	3-6	>6
Palmerston North	43.8	28.1	28.1
Wellington	46.3	26.6	27.1
Auckland	38.6	24.9	36.4

APPENDIX L Analyses of variance results for plant profile ratings of respondents in different areas

Table L1 **ANOVA table[1] for Palmerston North data**

source	df	ss	ms	F	Pr > F
model	325	3992.55	12.28	6.79	0.0001
error	1402	2537.40	1.81		
total	1727	6529.95			

R-square = 0.61

source	df	ss	ms	F	Pr > F
respondent	287	827.79	2.88	1.59	0.0001
A (price)	2	40.32	20.16	11.14	0.0001
B (health)	2	1342.15	617.07	370.79	0.0001
C (suitable)	2	719.17	359.58	198.68	0.0001
D (height)	2	40.23	20.11	11.11	0.0001
E (shape)	1	516.45	516.45	285.36	0.0001
F (fl colour)	1	0.018	0.018	0.01	0.9194
G (bushiness)	1	276.32	276.32	152.68	0.0001
H (lf colour)	1	14.63	14.63	8.08	0.0045
A*B	4	31.94	7.99	4.41	0.0015
A*C	4	20.32	5.08	2.81	0.0245
A*D	4	112.08	28.02	15.48	0.0001
A*E	2	5.34	2.67	1.48	0.2291
A*F	2	2.09	1.05	0.58	0.5613
A*G	2	3.53	1.76	0.97	0.3775
A*H	2	4.82	2.41	1.33	0.2647
E*G	1	20.32	20.32	11.23	0.0008
F*H	1	0.14	0.14	0.08	0.7809
A*E*G	2	11.43	5.71	3.16	0.0429
A*F*H	2	3.46	1.73	0.96	0.3848

[1]: df=degrees of freedom; ss=sums of squares; ms=mean square; Pr>F = probability of getting a larger value of F than the tabulated F value, if the parameter is truly equal to zero.

Table L2 **ANOVA table[1] for Wellington data**

source	df	ss	ms	F	Pr > F
model	613	9294.72	15.16	7.57	0.0001
error	2842	5691.70	2.00		
total	3455	14986.42			

R-square = 0.62

source	df	ss	ms	F	Pr > F
respondent	575	2136.58	3.72	1.86	0.0001
A (price)	2	124.86	62.43	31.17	0.0001
B (health)	2	3338.83	1669.42	833.58	0.0001
C (suitable)	2	2279.79	1139.90	569.18	0.0001
D (height)	2	85.78	42.89	21.42	0.0001
E (shape)	1	534.77	534.77	267.02	0.0001
F (fl colour)	1	5.22	5.22	2.61	0.1064
G (bushiness)	1	286.47	286.47	143.04	0.0001
H (lf colour)	1	55.26	55.26	27.59	0.0001
A*B	4	11.75	2.94	1.47	0.2097
A*C	4	99.07	24.77	12.37	0.0001
A*D	4	262.56	65.64	32.78	0.0001
A*E	2	41.16	20.58	10.28	0.0001
A*F	2	1.31	0.65	0.33	0.7218
A*G	2	0.38	0.19	0.10	0.9089
A*H	2	1.36	0.68	0.34	0.7112
E*G	1	20.24	20.24	10.10	0.0015
F*H	1	0.08	0.08	0.04	0.8384
A*E*G	2	1.47	0.74	0.37	0.6924
A*F*H	2	7.77	3.88	1.94	0.1440

[1]: df=degrees of freedom; ss=sums of squares; ms=mean squares; Pr>F = probability of getting a larger value of F than the tabulated F value, if the parameter is truly equal to zero.

Table L3 **ANOVA table[1] for Auckland data**

source	df	ss	ms	F	Pr > F
model	901	12277.30	13.63	5.97	0.0001
error	4282	9768.94	2.28		
total	5183	22046.25			

R-square = 0.56

source	df	ss	ms	F	Pr > F
respondent	863	3919.58	4.54	1.99	0.0001
A (price)	2	550.26	275.13	120.60	0.0001
B (health)	2	2481.61	1240.81	543.88	0.0001
C (suitable)	2	2345.57	1172.79	514.07	0.0001
D (height)	2	222.77	111.39	48.82	0.0001
E (shape)	1	1628.00	1628.00	713.60	0.0001
F (fl colour)	1	11.15	11.15	4.89	0.0271
G (bushiness)	1	691.98	691.98	303.32	0.0001
H (lf colour)	1	28.44	28.44	12.47	0.0004
A*B	4	10.02	2.50	1.10	0.3559
A*C	4	60.61	15.15	6.64	0.0001
A*D	4	245.21	61.30	26.87	0.0001
A*E	2	13.61	6.80	2.98	0.0508
A*F	2	5.36	2.68	1.17	0.3093
A*G	2	8.40	4.20	1.84	0.1588
A*H	2	0.70	0.35	0.15	0.8573
E*G	1	43.30	43.30	18.98	0.0001
F*H	1	5.37	5.37	2.35	0.1250
A*E*G	2	4.11	2.06	0.90	0.4060
A*F*H	2	1.24	0.62	0.27	0.7625

[1]: df=degrees of freedom; ss=sums of squares; ms=mean squares; Pr>F = probability of getting a larger value of F than the tabulated F value, if the parameter is truly equal to zero.