IRRADIATED FOOD: CONSUMER CONCERNS AND WILLINGNESS TO PURCHASE

A Thesis by

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Abstract

A national survey of households in New Zealand employed a systematic random sampling technique and conducted to determine the consumers' concern and willingness to purchase irradiated food. The characterization of the consumers based on willingness to pay and level of concern was analyzed using two separate econometric models. The first method used the dichotomous choice logit model for willingness to pay whilst the second model involving four point scaled level of concern employed the ordered logit model. Both models determined the demographic effects on willingness and concern.

The consumers level of concern for food irradiation was lower than the consumers' concern for pesticide and chemical residues in food and other food safety issues. The results also suggest that the likelihood of buying irradiated food was dependent on diet, sex, urbanisation, knowledge of food irradiation and consumer beliefs about the radioactivity, wholesomeness and health effects of irradiated food at different levels of significance. Concern was found to be directly effecting willingness to purchase and this concern could influence the consumer's buying behaviour. Concern level, on the other hand, was highly influenced by sex and the consumers knowledge of food irradiation. Higher level of concern was evident among those who were not willing to buy irradiated food. However, a significant number of the surveyed respondents were undecided about buying or not buying irradiated food.

The demographic information of this study is useful to the marketing of fresh produce in New Zealand, specially those who anticipate direct marketing activity of irradiated food. The results are also useful in designing policies related to irradiation of food products in New Zealand.

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Dennis M. Bautista

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Chapter 1

Introduction

There would be meat stored in great piles in rooms; and the water from leaky roofs would drip over it, and thousands of rats would race over it. It was too dark in these storage places to see well, but a man could run his hands over these piles of meat and sweep off handfuls of the dried dung of rats.

Upton Sinclair's *The Jungle*

1.1 Food Safety and Public Concern

Public concern about the safety and healthfulness of the food supply grew markedly during the 1980s. Over the past three years, concerns towards food safety have practically delved into public consciousness caused significantly by concerns over pesticide residues and other chemicals. The Alar scare in the US (Senauer, Asp and Kinsey 1991) is one of the most recent proof. Continuing debates over issues such as fungicide residues on produce, pesticide residues on imported foods, traces of dioxin in milk containers and the potential cancer-fighting value of foods like oat bran or cruciform vegetables, use of growth promotants in animals and plants suggest that these types of concerns aside from food irradiation will grow in prominence in the coming years.

Numerous government, academic, interest groups, and media reports questioning the adequacy of food safety regulatory system formed the basis for this

increase in concern. Relatively little research on the complex economic aspects of food safety and nutrition issues had been conducted up to the mid-1980s.

Consideration of the effectiveness of alternative regulatory programs and the impact of use of food safety and healthfulness as a marketing tool on food consumption patterns and competition in food markets comprise the supply side of the economics of food safety. On the demand side are consumers' perceptions of the risks associated with particular food products, influence of demographic characteristics on consumers' processing of risk information and subsequent changes in food demand behaviour, and the monetary value consumers might place on changes in the risk profiles of products. Associated with current food consumption patterns are the economic benefits and costs which serve as major determinants of demand for improved safety and dietary change through government regulation (Caswell, 1991). Increasing concerns over pesticides and other food safety issues has led to development of alternative technologies that could address health concerns.

1.2 Food Irradiation

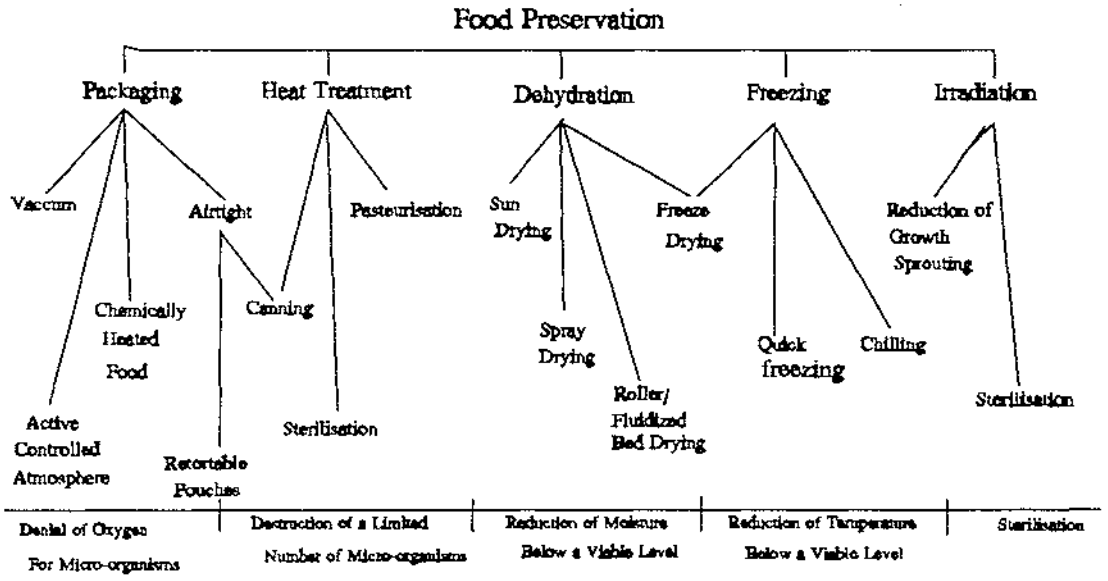
Food irradiation is a controversial process. Irradiation comes from the Latin word *radius* meaning ray is, to most consumers, the emission of harmful radioactivity. It is often associated to frightening images of destruction formed from reports of nuclear disasters in Japan, the United States (US) and the former United Soviet Socialist Republic (USSR). It is a subject which has an unprecedented extent of polarised opinions on its value and safety.

Food products may be exposed by gamma radiation from the radioactive sources cobalt-60 (^{60}Co) or caesium-137 (^{137}Cs), or through a machine source such as electron accelerator that emits electron beams and or x-rays. The dose of radiation measured in kilogray (kGy) a food product absorbs depends upon the length of time it is exposed to the radiation source (Jones 1992). It is a fact that most

preservation techniques usually affect the nutritional value, flavour or texture of a food. Food preservation methods involve processes with a common aim to create a hostile environment for the micro-organisms in food without unduly affecting its chemical composition and physical structure. It is a preservation technique that falls under the physical category of food preservation. Physical method, as differentiated from chemical method of food preservation, includes freezing, heat treatment, dehydration, vacuum and modified atmosphere packaging (Figure 1.01). Irradiation is actively lethal to bacteria and does not simply provide a hostile environment. This makes food irradiation differentiated from other physical food preservation techniques. It has less discernible effect upon food quality than any other preservation techniques but the process is inappropriate an technique for cleaning up food otherwise unsafe for human consumption (Robins 1991).

Induced chemical changes in irradiated foods has led to early legislations in the US classifying irradiation as an additive. Only recently has irradiation been classified as a process.

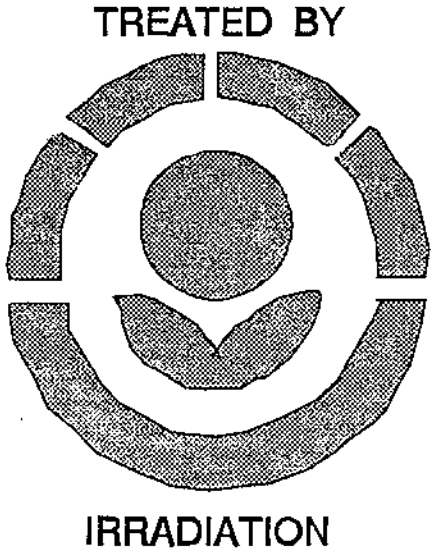
Figure 1.01 Physical Methods of Food Preservation



Source: Robins (1991)

First used in the Netherlands, the international irradiation symbol (Figure 1.02) together with the statement *treated by irradiation* or *treated with irradiation* is recognised internationally for food products sold in retail packages (Terry and Tabor 1990). The radura logo has an outer ring broken into five parts representing the rays coming from the energy source or the central solid circle. The two petals represent the food (Blackholly and Thomas 1989).

Figure 1.02 International Symbol for Irradiated Food



Source: Blackholly and Thomas (1989)

1.2.1 An Historical Development

The discovery of x-ray resulted in the recognition of ionizing radiation. Schwartz established the practical use of food irradiation in 1921 when he obtained a US patent on the use of x-rays to kill the parasite *Trichinella spiralis* in meat which is a cause of worm infection in humans. In 1930, Wust obtained a French patent for preservation of food by irradiation (Robins 1991).

The intent for modern research began in 1943 by the US Army's conduct of investigations at the Massachusetts Institute of Technology (Mc Ewan in Food Irradiation 1987). Ten years after England started to work on food irradiation in 1948, Russia became the first country to grant clearance for human consumption of irradiated potatoes. In the mid 1950s the US Army Quartermasters Corps sponsored research as part of President Eisenhower's 'Atoms for Peace' policy (Robins 1991; Jones 1992). The process became technically feasible only in the late 1950's and early 1960's.

The period of 1960 to 1970 witnessed the widespread researches on the wholesomeness and technical aspects of food irradiation. In 1970, the International Food Irradiation Project (IFIP) was launched by 19 countries exploring the combination of food irradiation with other preservatives (Diehl 1990). IFIP was replaced by the International Consultative Group for Food Irradiation (ICGFI) in 1984 by Food and Agricultural Organisation (FAO), the International Atomic Energy Agency (IAEA) and the World Health Organisation (WHO).

The JECFI or Joint FAO, IAEA and WHO Expert Committees on the Wholesomeness of Irradiated Food experimented on ten kilogray dose and less and found neither toxicological hazard nor microbiological problems on the irradiated food. The Codex Alementarius Commission adopted the *General Standard for Irradiated Food* and the *Recommended International Code of Practice for the Operation of Radiation Facilities Used for the Treatment of Food* (Diehl 1990).

The United States Food and Drug Administration (USFDA) approved a one kilogray treatment of raw pork to kill trichinae in 1985. Later in 1986, the US FDA permitted use of irradiation to inhibit growth and maturation of fresh fruit and to disinfest food adulterated with insects. Labelling was under strict regulation. In 1990, three kilogray dose was approved for poultry by the US FDA (Jones 1992).

The WHO declared food irradiation as *a powerful tool against preventable food loss and food borne illness*. Just before the explosion of the Chernobyl plant in the former USSR in 1986, the ACINF or the Advisory Committee on Irradiation of the British government also declared that *irradiation of any commodity up to an overall average dose of 10 kilogray presents no toxicological hazard; hence, toxicological testing of food so treated is no longer required* (Diehl 1990).

There has been worldwide interests coupled with controversies on food irradiation in the past. Seemingly, that interest has not trickled down and controversies have not gone unchecked by consumers worldwide. There are over 50 food products approved for irradiation in 36 countries (Jones 1992).

In New Zealand, Regulation 264 of the Food Regulations 1984 stated that:

> *no person shall sell any food that has been treated by ionising radiation unless the treatment is for the time being approved by the Minister*

The Minister of Health has given only one approval for the irradiation of one tonne of spices in 1985 treated to an average of absorbed dose of eight kilogray. The Food Standards Committee proposed that Ministerial approval warrants proper labelling (Food Irradiation 1987; Food Irradiation and Industrial Radiation Processing in New Zealand 1988). New Zealand has had a commercial non-food irradiator since 1966 at Upper Hut, Wellington. This plant was one of the first in the world dedicated to the sterilisation of medical products such as bandages, dressings and the like (Roberts and Sutton 1985).

The use of food irradiation in the food industry overseas is growing steadily, but it is likely to be several years before New Zealand industry makes extensive use of the process. So much interest on food irradiation has been devoted by New Zealand during the early 1980s. A national symposium was held at Massey

University, Palmerston North in 1984. The symposium was followed by the 56th Congress of the Australia and New Zealand Association for the Advancement of Science and a session devoted to food irradiation was included (Food Irradiation 1987; Food Irradiation and Industrial Radiation Processing in New Zealand 1988).

In February 1988, a discussion document titled *Food Irradiation and Industrial Radiation Processing in New Zealand* was made available to the public by the Ministry for the Environment. Three working groups looked into the irradiation uses in New Zealand, technical aspects associated with food irradiation and implications of food irradiation in New Zealand for local consumption, for export and the desirability of irradiating imported food (Food Irradiation 1987).

The proposal by a major company to build a large-scale irradiation plant in Auckland in 1984 gave rise to considerable public concern and an unprecedented number of town planning objections. Public concerns triggered by the proposal to build the large-scale plant at Mangere in the city of Manukau led to the preparation of the above document.

Some of the major concerns brought out by the proposal were related to the need for consumer understanding of food processing options relating to safety, wholesomeness and taste; consideration of the effectiveness and acceptability of the current quarantine process; projection of the New Zealand image overseas, both as a food exporter and as a tourist venue; and the need for information and effective labelling to provide for consumer choice.

There is a wide range of opinion. The Department of Health concluded that provided there are controls on the process, there are food that can be safely irradiated. The Food Standards Committee has prepared a proposal on the labelling of irradiated food, should irradiation treatment be permitted.

New Zealand legislation governing radiation safety is embodied in the *Radiation Protection Act 1965* and the *Radiation Protection Regulations 1982*. A requirement of the Act is that nobody may operate an irradiation facility unless a license under the Act has been issued for the purpose, or the operation is carried out on the instructions or under the supervision of the licensee. The licensee is personally responsible for ensuring the safe operation of the plant. The National Radiation Laboratory administers the Act and Regulations under delegated authority from the Director-General of Health and is the license issuing authority (Food Irradiation 1987).

The research for food irradiation became more intense and the interest on it became much more widespread when ethylene dibromide (EDB) was found to have health implications and banned in the US. To date, no chemical replacement for EDB has been found. Food irradiation may establish itself as new method of food preservation in the coming years, but application of the technology and its progress may be slow because of the need to reassure consumers that irradiated food are safe.

1.2.2 Role of Food Irradiation

In terms of time, money and effort spent to study a food preservation technique, irradiation probably has been more thoroughly studied than other techniques such as drying, canning, freezing and the use of chemicals. More research has been focused on the effects of irradiation on food than has been directed at any other form of food processing. This research has spanned more than 40 years and has been carried out in many countries. Irradiation below one kGy may provide a safe alternative to toxic gases or chemicals as a method of disinfestation, decontamination or sprout inhibition. There is a powerful incentive to use irradiation as an alternative to pesticides and disinfectants which can leave noxious residues. Fumigants, sterilising gas, and ethylene oxide which are facing strong consumer

concerns over its residues may be phased out. Food irradiation is a useful method when used as a combination treatments for food preservation.

A few of the known benefits of food irradiation are extension of shelf life by eliminating food spoilage organisms, reduction in the use of post harvest chemicals for preservation and pest control, elimination of insects and parasites and production of sterile products not requiring refrigeration, improved sanitary level of food which could lower health care costs due to reduced microorganisms and fewer food-borne illnesses (Roberts 1985), safe transfer of produce from insect quarantine areas, and replacement of less safe chemical fumigants (Diehl 1990). Furthermore, the following uses of food irradiation may be added to the above: inhibit sprouting of vegetables; delay ripening of fruits; kill insect pests in fruits, grains or spices and elimination of parasites; greater convenience and better quality food; and reduce food poisoning bacteria on some meats and sea food products (Diehl 1990; Pszczola 1990; Urbain 1989). Table 1.01 shows the dose rates used for the main uses of irradiation. Radiation treatments may be divided into the low dose methods (ten kilograys and above) which progressively reduce microbial populations. Complete sterility is not achieved below 50 kilograys, and this level is not customarily used in foodstuffs.

Table 1.01 Dose Rates Recommended in Food Irradiation

Process	Dose Range (kilogray)
Inhibition Sprouting	0.05 - 0.15
Delaying Ripening	0.20 - 0.50
Disinfestation	0.20 - 1.00
Shelf Life Extension	0.50 - 5.00
Elimination of Pathogens (non sporing)	3.00 - 10.0
Bacterial Sterilisation	50.00

Source: Robins (1991)

Food irradiation is perceived to consume less energy than freezing and refrigeration. This may be a big advantage in the light of the dwindling energy supplies. The safety of irradiated food generally overshadows any worries about its nutritional quality. Irradiation brought about fewer adverse chemical changes than did traditional heat processing of food (Jones 1992).

1.2.3 Arguments Against Food Irradiation

The chemical changes brought about in food by irradiation are perhaps the most contentious issue surrounding the introduction and acceptance of the technique. It is often claimed that the exact nature of the chemical changes induced are not well understood and it is possible that harmful substances are products of unknown but potential toxicity. It is possible that such effects will be subtle and only manifest themselves in the long term (Robins 1991). Wholesomeness reflected in nutritional quality is affected through destruction of some vitamins and major nutrient content (Robins 1991).

Food irradiation has a very minor role as an operative method of food preservation at the moment. There is uncertainty about the safety of food irradiated at high enough doses to prevent all microbiological spoilage (Robins 1991). Consumers may find difficulty choosing between fresh and irradiated food since there is no way to check whether food has been irradiated except for its label. In addition, reirradiation may cause an alarm to other consumers. The effect of irradiation on packaging materials used in irradiated food is another concern (Jones 1992). Moreover, the following are classified as adverse effects of food irradiation unique chemical changes; loss of vitamins and impairment of nutritional value; off-flavours and aromas; limited range of applicability; necessity for use of additives to offset undesirable effects; adverse health effects in animals and humans fed on irradiated food; potential for contamination of the environment by food irradiation facilities; potential hazards of transporting Co-60 and Cs-137 from its manufacturers to an

irradiation facility; and formation of new chemical substances or radiolytic products (Diehl 1990; Jones 1992; Robins 1991). The business sector may be hesitant due to unpredictability of the potential of food irradiation brought about by technical problems, high start-up costs and consumer resistance (Jones 1992). Table 1.02 summarises the advantages and disadvantages of food irradiation as viewed by consumers (Robins 1991).

1.2.4 Current Status of Food Irradiation

Food irradiation using ionizing energy offers to revolutionise the food industry. Irradiation is currently permitted in over 30 countries. In Western Europe, the Netherlands is the major user. France, Denmark, Belgium, Luxembourg, Spain and Italy permit irradiation. Ireland, Greece and Portugal on the other hand has no rules either permitting or forbidding the use. In December of 1989, the Food Safety Bill was being put through the House of Lords and proposals were put forward to adopt food irradiation in the United Kingdom.

In 1985, Belgium, the Netherlands and Japan are the only countries allowing food irradiation of selected commodities. The number of countries allowing irradiation has increased to 24 by 1989. These countries allow irradiation of food and/or food ingredients for commercial use (Jukes 1991). Some of the countries authorising food irradiation with clearances varying tremendously from permission for irradiation for experiments, for test marketing, for export only, for provisional periods to unconditional authorization include the United States of America, Japan, Argentina, Bangladesh, Brazil, Canada, Chile, China, India, Israel, Mexico, Norway, Philippines, South Africa, Thailand, Uruguay and various Eastern European countries (Robins 1991).

Table 1.02 Advantages and Disadvantages of Food Irradiation

For	Against
* Kills most of the bacteria in treated food, including salmonella, listeria and campylobacter.	* Bacterial toxins formed pre-irradiation will not be destroyed and could still cause food poisoning.
* Can replace potentially carcinogenic chemical fumigation to preserve food and destroy insect infestation of herbs and spices.	* Botulism will not be eliminated.
* Can increase the shelf life of many food, including vegetables, shellfish and poultry.	* Viruses and aflatoxin will not be destroyed.
* Reduces sprouting in stored potatoes and onions.	* Vitamin loss during processing occurs in addition to the normal storage and cooking losses. Extended shelf life will mean greater losses.
* Can delay ripening in some fruit and possibly introduce greater choice over a wider season.	* Vitamin E and B1 are seriously affected during irradiation.
* Could provide extra safety for pre-prepared meals.	* Some food, such as chicken, may suffer a loss of fatty acids - this can occur in mild heat treatment processes such as pasteurisation.
* Could improve the taste and texture of certain food.	* Old, dirty or previously unacceptably contaminated food could be disguised.
	* Despite claims to the contrary, pre-harvest pesticides will continue to be necessary and could become harmful in combination with irradiation.
	* With no test to determine whether or not food have been irradiated, accurate documentation with irradiation will be relied on.
	* Sterilisation by irradiation does not address the problems of unhygienic food handling and processing, which cause some of the contamination.

Source: Robins (1991)

In the United States and Canada, changes in federal regulations are paving the way for the introduction of irradiated food into the marketplace. However, many consumers are wary of the term irradiation and will not be easily convinced to purchase irradiated food. The US FDA has cleared the irradiation of pork and fresh fruit and vegetables to one kilogray, some products to ten kilogray and dried herbs and spices, seed, teas and seasonings to 30 kilogray. The US FDA has given its approval to irradiate poultry to control salmonella (Jukes 1991).

In Brazil, studies on disinfestation by irradiation involve all the important pests of stored grain and grain products. Cooperative work has begun to determine the commercial feasibility of grain irradiation. Disinfestation of both fresh and dried fruits, especially if the produce is intended for export, is also held to be of great economic importance. In the Brazilian environment, the use of food irradiation is considered most likely to be used for grain preservation, possibly as an alternative to the fumigation of nuts. China has invested heavily in the development of food irradiation and five demonstration plants. The Shanghai irradiation centre, opened in January 1986 can process up to 35,000 tonnes of vegetables a year or about 45 percent of the city's annual supply.

Irradiated food cannot be recognised by sight, smell, taste or feel. The only sure way for consumers to know if a food has been irradiated is for the product to carry a label that clearly announces the treatments in words, a symbol or both. Irradiated food need not be labelled on health grounds. No one method has yet been found that is suitable for wide and routine application in order to identify whether food have been irradiated. Techniques offering most promise in the detection of irradiated food are the measurement of electron spin resonance to identify irradiated bone and fat, the determination of conductivity differences for the identification of potatoes, the detection of malonaldehyde to identify irradiated starch and the measurement of certain radiolytic hydrocarbons in fats and fatty meat.

A number of expert committees or groups such as the Joint Expert Committee on Food Irradiation, UK Advisory Committee on Irradiated and Novel Food, US FDA, a Danish Working Group and the Science Council of Canada reflect the majority of opinion that there are food that can be safely irradiated. The governments of more than 30 countries appear to be satisfied with the safety of at least some irradiated food.

In December 1988, the FAO, WHO, IAEA and the International Trade Centre of the UN Conference on Trade and Development/General Agreement on Tariffs and Trade (GATT) organised a conference to review the methods for the trade of irradiated food. The UK government decided to permit food irradiation. The proposed Regulations laid on December 1990 before the UK Parliament came into operation on the first of January 1991. The legislation in UK has occurred except for Northern Ireland where separate legislation was being prepared (Jukes 1991).

While the UK is enthusiastic over its introduction, many countries are steadfastly against it, and those countries that favour it are in a definite minority. Several member states of the European Community have already permitted the use of food irradiation whilst in the others it is still banned. The European Parliament opposed the 1989 proposal for the legislation of food irradiation. The Commission who drafted the proposal revised the rejected proposal and made minor changes to the new proposal which now awaits the agreement of a common position in the European Parliament (Jukes 1991). It is also evident that the impact of food irradiation upon the international trade of food will be slight until some compromise is reached between exporting countries which permit it and importing countries which ban the irradiation of incoming food. The resolution of this conflict must be based upon a thorough evaluation of the usefulness of the technique and the safety of irradiated food (Robins 1991).

1.2.5 Trade in Irradiated Food

The International Conference on the Acceptance, Control of and Trade in Irradiated Food drafted *international trade in irradiated food would be facilitated by harmonization of national procedures based on internationally recognised standards for the control of food irradiation* (Jukes 1991). However, the ban by the European Parliament on food irradiation and the approval of food irradiation in the UK are contradictory given the current move for freer trade within member states. Nevertheless, the future prospects of food irradiation in Europe are now of interest. Without a common agreement among member states, trade will be under internal arrangements and countries forbidding trade of irradiated food will have to justify the ban to European courts which is likely to rule against the ban in favour of a new internal market programme (Jukes 1991).

There is a very limited extent of trade in irradiated food worldwide. It may account for only about five percent of processed food when fully developed due to practical and organoleptic limitations. Presently, it accounts for even less that five percent. Twenty countries out of the 36 permitting irradiation actually conduct commercial irradiation. The total commercial market is now some 500,000 tonnes per annum as indicated in Table 1.03.

The Netherlands and Belgium, the other major irradiating nations, are geared more to export than domestic consumption. Israel and Thailand produce very little commercially, but these countries have a wide range of approved food for irradiation. Unfortunately, there is no data on South African production where a wide range of food items may be irradiated. The sensitivity of governments and food producers to public concern over food irradiation has ensured that development of the process has been slow and piecemeal. It is difficult to see how any market can develop without either consumer acceptance or the harmonisation of international regulations which will follow.

Table 1.03 Practical Application of Food Irradiation

Country	Tonne per annum
Argentina	50
Belgium	10,000
Brazil	200
Chile	500
China	500
Cuba	500
Finland	no data available
France	5,200
East Germany	6,000
Hungary	400
Israel	120
Japan	20,000
South Korea	no data available
Netherlands	18,000
Norway	no data available
South Africa	no data available
Thailand	600
USA	3,300
USSR	400,000
Yugoslavia	100

Source: Robins (1991)

To achieve these, developing countries should demonstrate the viability of irradiation to its major producers of food items and demonstration of a rigorous regulatory framework for food irradiation to the consumer (Robins 1991).

1.3 The Statement of the Problem

Food irradiation may have significant impact on both the export and import sector of trading agricultural commodities to and from New Zealand. It is not certain, however, whether food irradiation faces strong opposition or acceptance from consumers overseas and within New Zealand as well. Thus, research is needed in

this area to establish or identify if there exists a market niche for irradiated food and further identify consumers concern and attitude toward irradiated food. The food business processing sector who may be interested in utilising food irradiation in place of chemical fumigants and pesticides should be provided with information about the attitude of consumers toward food irradiation. Consumer attitudes can determine the fate of the technology vis-a-vis the existing ones. Consumer acceptance is not the single most important factor to technology adoption but it indeed forms the foundation for effective marketing of commodities.

Food irradiation technology has been well researched as a food processing technique. Consumers knowledge is, however, limited and acceptance which is dependent on consumers perception of food irradiation remains a problem. In the event that New Zealand may be forced to accept irradiated food through international trade, the government should consider public perception regardless of its safety attributes.

No study has ever been conducted to evaluate the New Zealand consumers attitude towards food irradiation. New Zealand does not irradiate its food. Approval has to be made by the Health Minister. New Zealand is unlikely to implement this technology due to several reasons one of the most important of which is consumer acceptance. Thus, it is imperative to know whether consumers' concern for this technology will result in fundamental changes in consumer behaviour. Further implications can be inferred with the result as this will clarify some of the issues relevant for its possible implementation in the near future.

1.4 The Objectives of the Study

This study aims to address the issues related to food safety in New Zealand and the likely impact of change in consumer behaviour as a result of technology adoption.

Specifically the objectives are:

(1) to empirically evaluate food irradiation awareness and concerns of New Zealand consumers;

(2) to analyze the effect of socio-demographic factors on willingness to pay for irradiated food;

(3) to determine if specific concerns are translated into changes in consumer purchase behaviour;

(4) to evaluate the New Zealand consumers' willingness to pay for irradiated food;

(5) to compare consumer concern levels over irradiated food with other food safety concerns;

(6) to analyze the demographic differences of the concern over food irradiation; and

(7) to determine consumer confidence in various channels utilised for the communication of safety issues about irradiation in the produce supply.

1.5 The Hypotheses

It is hypothesized that consumers with different socio-demographic characteristics may have different attitudes towards the positive and negative attributes of a particular product. In view of this and based on the reviews of the past studies on food irradiation, the following factors were assumed to be significantly affecting the consumers' preference and willingness to pay for irradiated food and their concern levels. The corresponding expected signs were also hypothesized in Table 1.04. Due to insufficient empirical evidence about the relationships of some independent variables, the expected signs were left blank. The result of the modelling was assumed to explain their relationship.

Table 1.04 Expected Signs of Factors Affecting Consumers' Attitude and Willingness to Pay for Irradiated Food

Variable	Expected Sign	
	Willingness to Pay	Concern
Health		+
Diet		+
Education	+	+
Household income	+	+
Sex (Male)	+	-
Age	-	-
Household size	+	+
Organisational affiliation	+	
Knowledge level	+	+
Heard of irradiation	-	-
Urban		+
Belief on wholesomeness	-	
Belief on radioactivity	–	
Belief on health hazard	–	

1.5.1 Consumers who are highly concerned about food irradiation will reject the technology;

1.5.2 Concern for food safety and irradiation will be higher among females than among males;

1.5.3 Respondents will show a higher concern for the use of chemical sprays and pesticides on food than for irradiation;

1.5.4 Younger people are more concerned about chemical sprays and other food safety issues and irradiation; Older respondents will be less likely to accept irradiated food;

1.5.5 Those who have heard of irradiation previously will have less concern than those who have not.

1.5.6 Those with a higher level of education would be more likely to have heard of irradiation and therefore have lower level of concern; Knowledge level about irradiated food and education are assumed to have positive relationship with the acceptance of irradiated food;

These hypotheses were explored further in Chapter Four. A discussion in Chapter Four on the hypotheses was based on the results of similar surveys on food irradiation and the theoretical framework and some literatures reviewed.

1.6 The Delimitations

This study attempted to evaluate New Zealand consumers' attitude toward food irradiation and their willingness to pay for irradiated food. It did not attempt to include the economic impact of food irradiation on the trading of agricultural commodities. Several literatures reviewed indicated the likely impact of food irradiation in the trade sector. The business sector's response was not explored. It was assumed that the food processing industry's reaction to food irradiation technology would be highly dependent on consumer acceptance or rejection of the process.

The technical aspect of food safety of food irradiation process was addressed based on available literatures. The author limited the focus of the study to determining the consumers side of the technology adoption under a hypothetical market situation.

1.8 The Importance of the Study

A number of literatures presented the pros and cons of this technology. The relatively new process of preserving food by irradiation complements, rather than competes with, the presently available traditional methods. A new process may be introduced because of its technical advantages but the question still remains whether such a new process will be generally accepted by the consumers.

Food preservation techniques are used increasingly to combat food loss and deterioration which can occur through storage of seasonal gluts and improvements

in international transportation which continually open up new export markets for a very wide range of foodstuffs. Many methods of food processing employ preservative techniques as an integral part of their technology. This trend is highlighted by the rapidly growing market for ready-to-eat meals, and the increasing of product shelf-life for many types of food. (Robins 1991). One alternative offered is food irradiation, but it is uncertain whether New Zealand would allow importing irradiated food or subject its agricultural exports for irradiation due to uncertain consumer perception and government rules and other factors.

Irradiation technology has important implications for New Zealand. However, its use in food processing could jeopardise food exports if the world continues to be concerned with food irradiation. The introduction of food irradiation in New Zealand for its export products may compromise its image as unpolluted, natural and nuclear free country. This image has been linked with the desirability of New Zealand product overseas.

The New Zealand government recognises the benefits of food irradiation, particularly on the trade sector. For New Zealand, any large scale irradiation processing appears at present more likely to be developed for agricultural quarantine purposes. Food irradiation is one of a number of possible alternative disinfestation measures if fumigants were to be considered undesirable. Adoption of the food irradiation processing would open New Zealand to the pressure from other countries to accept irradiated food imports. The potential advantage for New Zealand may be seen on the exports side by inhibiting food spoilage during transportation and by maintaining markets where fumigants such as ethylene dibromide (EDB) have been banned, as in the United States.

Several reasons are evident why the implementation of food irradiation may commence in New Zealand. They include the need for public and industry consultation, labelling agreements, international trade protocols and development

work on commodities of interest to this country. In addition, commercial decisions are required on when and where to deploy an irradiator and on the type of facility needed.

The likelihood of acceptance of irradiated food by New Zealand consumers is uncertain. Overseas evidence suggests that careful education is likely to increase consumer acceptance and that, regardless of a consumers perception of irradiated products, they want them labelled. Knowledge of consumer attitudes and concerns about irradiated food allows the food industry to efficiently employ its own resources given the risks that may surround it. Decisions will either be made for or against irradiation given the knowledge of public perception. Consumer acceptance will need to grow if the food industry is to gain confidence and invest in the process. For this to happen, consumers will have to be given a choice. The hypothetical situation demonstrates how consumers may actually response to a set of choice between irradiated and non irradiated food.

Consumer surveys have been the primary sources of information on consumer acceptability of irradiated food products. Such studies may indicate consumer attitudes toward such products and their supposed willingness to buy though it may not always reflect the true behaviour in the marketplace. Success of irradiated food products in the marketplace will depend upon their acceptability by consumers and marketing firms. Food firms will market irradiated food products if they are convinced that the image of their existing product lines will not be compromised by the introduction of products that may be unacceptable to many consumers.

Testing irradiated food for consumer acceptance is even more important in countries where a segment of the population may be apprehensive about anything pertaining to nuclear energy, thereby making decision makers in the business community reluctant to invest in this new process. It may open the door to imports from regions whose products are currently not allowed because of pests.

The results of this study could have some important implications especially for policies which may have some physical and financial impacts on food processors, the agricultural exports and trade industry, and the environment. The results should also contribute some important information which would help clarify a number of production and marketing issues of interest to both production and marketing sides of the fresh produce industry of New Zealand.

1.8 The Organization of the Thesis

This thesis consisted of six chapters. Chapter One presents the introductory part of the problem, the objectives , hypotheses and the significance of the study. Chapter Two reviews the literatures related to the methods used in several studies on willingness to pay for irradiated food and the key results determining consumer preference and willingness to pay for irradiated food. Chapter Three develops the general conceptual framework of the study. Particular emphasis was given on contingent valuation as a method to value consumers' willingness to pay. Chapter Four deals with the sampling procedure, questionnaire preparation and administration and the methodology used for analysing this study. Chapter Five discusses the results of the survey and concludes on important results. Lastly, Chapter Six summarises the study, concludes with the key results and brings out policy implications.

Chapter 2

Review of Literature

Tradition is a powerful if irrational factor in acceptance.

Stuart Thorne in *Food Irradiation*

Consumers' concern and willingness-to-pay for irradiated food have been studied using various methodologies. National mail and national telephone surveys are the most common approaches. Consumers demand for irradiated food has been investigated and observed in few countries through the test marketing mostly of irradiated fruits.

2.1 Approaches to Determining Consumers Concern and Willingness to Pay for Irradiated Food

Bruhn, Schutz, and Sommer (1986) examined the extent of attitude change through a pre-test and post-test questionnaire when consumers were given the opportunity to read about and discuss food irradiation among themselves. A group discussion was divided into different consumer types. Thirty five conventional consumers were compared with 31 ecologically sensitive consumers and discussions led by food irradiation expert were compared to discussions led by an irradiation novice using frequencies and averages. Multiple regression analysis was done to determine post discussion concern for irradiated foods by the two types of consumers. The study was conducted from September 1984 to February 1985 in Yolo County near Sacramento, California. Conventional consumers were taken from the Parents Teacher Association (PTA), church, and other groups while ecologically conscious alternative consumers were obtained from a food cooperative. In this study, food irradiation was defined as *low levels of electromagnetic energy which kills insects and microorganisms which may be on the food and extends the shelf life of the food.*

In another study, Bruhn, Schutz and Sommer (1988) dealt with attitudes toward food quality, food safety, and food irradiation, and correlated these attitudes with measurements of value hierarchy, locus of control, innovativeness, and demographic variables using a mailed questionnaire to distinguish between subjects expressing different levels of concern and willingness to buy irradiated food. They modified Kahle's List of Values. Respondents were asked to rate the importance of self-respect, security, sense of accomplishment, being well respected, self-fulfilment, warm relationships with others, fun and enjoyment, self determination-control over life, and an ecologically balanced world.

The three-page questionnaire of the Bruhn, Schutz and Sommer (1988) study was mailed in the fall of 1985 in the US to 600 respondents of Sacramento, California. The study followed Dillman's paradigm of conducting mail survey. Food irradiation was defined as *a method of treating food with low levels of electromagnetic energy produced by radioactive cobalt or caesium, or by x-ray machines* to *kill any insects and microorganisms that may be on the food and extend the shelf life of the food.* Arithmetic means and likelihood to buy irradiated strawberries, onions, spice, flour, fish, chicken, pork and bacon were calculated and correlated with the values. Stepwise discriminant analysis was used to further elucidate the influence of orientation toward life and demographic parameters on attitude toward food irradiation. Factor analysis was applied on values alone and values with locus of control questions to test the effects of value hierarchy and locus of control on irradiation concern and willingness to buy.

Cramwinckel and van Mazijk-Boklag (1989) surveyed 1,158 the Dutch home panels. They divided their respondents into subgroups based on the year of distribution of the questionnaire (June 1986 and June 1987), the content of information on the introduction of the questionnaire and treatment of mushrooms delivered together with the questionnaire to the respondents' home. Only half of the mushrooms delivered were irradiated but they were all labelled with the international

logo indicating that they had been irradiated with gamma rays. The questionnaire sent had either the extensive one-page of introduction or the short introduction with a remark that the public sometimes raises objections to food irradiation as a method of food preservation. Simple arithmetic means and frequency tabulation were done to attain the objectives of the study.

Schutz, Bruhn, and Diaz-Knauf (1989) investigated the effect of label statements and other information regarding the benefits of irradiation on consumer attitudes. They used a national mail survey of 2,000 respondents in the US employing a four-wave mailing technique of distributing six-page questionnaire in April and May 1988 that produced a 59 percent response rate. Irradiation awareness and concern, the influence of US FDA approval, the influence of label statements on judgements of quality, freshness perception, price expectation, safety, willingness to purchase, and the interest in purchase of specific irradiated food when benefits were given were evaluated. The same definition of food irradiation as in the study by Bruhn, Schutz and Sommer (1988) was presented to the respondents.

Malone (1990) evaluated consumer willingness to accept irradiated food products using national telephone interviews of 800 households in the spring of 1987 in the US. He investigated a number of socio-economic variables and their relationship to consumer willingness to buy and willingness to pay for more for two major benefits of irradiated food, the reduction of microorganisms that may eliminate food-borne illnesses and extension of shelf life using Chi Square analysis, probit model and ordered probit model. The products investigated were beef, chicken, pork, fish, strawberries, peaches and mushrooms.

2.2 Factors to Consumer Acceptance of Irradiated Foods

National surveys on food irradiation in the US incorporated samples that are predominantly white and disproportionately older and better educated. Bord (1991)

argued that this types of people are most likely to be involved in an issue such as food irradiation. There is evidence that those with lesser education are more opposed and that blacks and other minorities are becoming increasingly involved in facility siting conflicts and other environmental issues (Bord 1991). Urioste, Croci, and Curzio (1990) claimed that the success or failure of food irradiation depends on consumer acceptance. This has been agreed upon by all surveys on food irradiation.

Consumer resistance should be addressed in an active approach (Van Ravenswaay and Hoehn 1991). Economist and agribusiness leaders need to establish a proactive food irradiation research agenda to include operational efficiency, product characteristics and perceptions, consumer demand, international trade and social welfare topics (Tilley and Falk 1987).

In developing strategies for consumer acceptance studies, the political, legal, cultural, social, psychological as well as economic facets unique to food irradiation must be addressed, whether in addition to or in common with the usual factors for phasing any new food or food process into the economy. Bruhn, Schutz and Sommer (1987) opined that acceptance or hesitancy appeared to be a response to the safety of the irradiation process rather than the characteristics of a specific food. Wiese (1984) suggested that emphasis must be directed to testing done to prove the effectiveness and safety of the process. The differences in purchase behaviour on the particular product observed was attributed to the sensitivity of the survey instrument and the consumer in differentiating risks and benefits (Schutz, Bruhn and Diaz-Knauf 1989).

Consumer choice may be limited by the introduction of food irradiation, if the production of specific food types is controlled by a small number of operators who in turn are committed to irradiation processing. Bruhn, Schutz, and Sommer (1986) concluded that consumer response to new technology such as food irradiation should be based upon knowledge rather than uncertainty. Education of the public in connection with the food irradiation process provides information that helps consumers make

informed judgements about the value of food irradiation (Urioste, Croci, and Curzio 1990).

Malone (1990) indicated that consumers knowledge of food irradiation is scanty. Three fourths of those who had not heard of irradiation and 37 percent of those not willing-to-purchase irradiated food expressed insufficient information. A high percentage of people do not know how to respond to irradiated foods (Bruhn, Schutz and Sommer 1988). This percentage may have increased in later study in the US by Schutz, Bruhn and Diaz-Knauf (1989) where the result indicated that 60 percent had heard of food irradiation with only a small three percent responded 'don't know'.

Malone (1990) added that those who have not heard about food irradiation (77 percent) were not willing-to-purchase compared to 54 percent who had heard of food irradiation but were willing-to-purchase. In a study conducted in February 1990 by Corrigan, owner of Carrot Top Inc., a produce and grocery store in the Midwest of the US, that included only five questions, the survey reported that nearly three quarters (71 percent) of its the 2,500 shopper-respondents expressed that they had seen or read something about food irradiation in the US. However, an overwhelming 91 percent felt that they had not received enough information to develop an opinion about its use. Eighty percent of the people surveyed were not sure if they had been exposed to an irradiated product.

Tilyou (1990) hinted that positive explanation of food irradiation may reduce consumer resistance. The respondents previous knowledge of irradiation is not related to level of concern for the process (Bruhn, Schutz and Sommer 1987). Their knowledge of US FDA approval did not influence perceived concern for food irradiation (Schutz, Bruhn and Diaz-Knauf 1989).

Educational efforts increased stated willingness-to-buy irradiated foods regardless of the method of conveying information but not among those initially strongly opposed to the process (Bruhn, Schutz and Sommer 1987). Extended introduction about

irradiation did not influence answering the question on concern about food irradiation. Arguments in favour of irradiation are better accepted by the not concerned groups. General statements against food irradiation are more agreed upon by the very concerned respondents. The very concerned group was more sensitive to the argument that food becomes safer through irradiation. Thus, they concluded that *providing more information to concerned consumers increases their understanding of the goals of irradiation but does not lessen their concern toward the technical means of irradiation* (Cramwinckel and van Mazijk-Boklag 1989).

The effect of educational efforts to concern levels was further shown by Bruhn, Schutz and Sommer (1986). They stated that this influence is most effective when consumers can interact with someone knowledgeable about irradiation. In this aspect, an expert leader's opinion plays a major role. Increased level of concern was observed among alternative consumers after educational efforts whilst most conventional consumers adopted a minor concern attitude toward food irradiation after educational efforts. This suggested that conventional consumers can be positively influenced by educational efforts.

The feasibility of food irradiation is dependent upon consumer acceptance and its benefits relative to other food processing methods. Studies of consumers perceptions of food irradiation processing overseas tend to indicate that food irradiation is preferred over other methods such as fumigation, pesticide residues and chemical additives. Cramwinckel and van Mazijk-Boklag (1989) indicated that a significant correlation about concern for food irradiation with concern about the uses of food additives and pesticides and the possibility of becoming ill due to improperly processed food existed.

Harris (1985) found that those consumers with prior knowledge of irradiation preferred it to chemical sprays 39 percent compared to 24 percent. Wiese (1984) found that consumers were more concerned about pesticides (55 percent) and preservatives (43 percent) than irradiation (38 percent). Women were found to be significantly more

concerned about the use of chemicals, pesticides, and irradiation than men. The same trend of consumer concerns have been found by Bruhn, Schutz and Sommer (1986).

Generally, consumers ranked residues such as pesticides and herbicides among the highest as a serious hazard. Table 2.01 summarises the yearly rating of safety concerns conducted by the Food Marketing Institute. Consumers rated pesticides and herbicides as the most serious hazard with more than 75 percent rate. This concern has increased overtime. Concern over food irradiation has remained on the range of 36 percent to 43 percent. The use of additives and preservatives and artificial colouring were rated low among food safety concerns. Consumers also preferred irradiation to kill insects and treating spices and vegetables than fumigation and gas treatment (Schutz, Bruhn and Diaz-Knauf 1989). This preference may be influenced if irradiation is presented as an alternative to pesticides which has been observed in the Netherlands by and Young (1983) and Marcotte (1991). The results of Wiese's study may represent the general attitudes of consumers toward food processing. These studies showed that consumers were not comfortable with chemicals, sprays and preservatives used in their food.

According to Tilley and Falk (1987), irradiation technology will be adopted by firms if it creates products with characteristics for which consumers are willing to pay the costs of the process, reduces the cost of preserving, fumigating or processing without creating negatively perceived characteristics or facilitates access to export markets which prohibit imports of chemically treated products. From a social perspective, the issue will be whether the benefits exceed the costs.

Willingness to buy irradiated food was based more on the safety of the food process than the advantages from any specific food product. Consumers' willingness to buy increased as the consumer's perception of safety increased. Even some with major concerns were willing to try irradiated products (Bruhn, Schutz and Sommer 1986). Van Ravenswaay and Hoehn (1991) found in their study of the impact of health risk information on food demand looking into the case of the Alar scare in apples, that

Table 2.01 Consumers Rating of Various Food Safety Issues, 1984-1990

Concerns	Percent Rating as a Serious Hazard						
	1984	1985	1986	1987	1988	1989	1990
Residues, such as pesticides and herbicides	77	73	75	76	75	82	80
Antibiotics and hormones in poultry and livestock	na	na	na	61	61	61	56
Nitrites in food	na	na	na	38	44	44	42
Irradiated foods	na	na	37	43	36	42	37
Additives and preservatives	32	36	33	36	29	30	26
Artificial colouring	26	28	26	24	21	28	21

Source: Food Marketing Institute (1989); Senauer, Asp and Kinsey (1991); Stuart Thorne (1991)

note: May not add to 100 percent due to rounding
na means not asked

regardless of which risk perception assumption is used, the estimates of willingness to pay for reduced risks were surprisingly consistent with the estimates of willingness to pay for reduced risks found in studies of occupational risks, seat belt use, and purchases of products such as smoke detectors. This suggested that apple consumers reacted to risks from Alar in much the same way they do to other risks.

Malone (1990) revealed that among 800 households, 54 percent were not willing to purchase irradiated food. There were 36 percent willing to buy irradiated foods and ten percent were not sure. The reasons for unwillingness were concerns for food being "harmful or dangerous" (61 percent), "not enough information" (37 percent), and irradiated foods were not necessary or didn't know (three percent).

In a study of 1,000 consumers commissioned by the Canadian Department of Fisheries and Oceans (Gallup, 1984) and conducted in Quebec and Ontario, Canada to explore consumer attitudes to irradiated fish products, positive intent to purchase outweighed negative feedback on the ratio of three to one. The result may have indicated an overstated positive response because consumers were not informed of the nuclear associations of the process.

Studies indicated that irradiated foods would not face total rejection from consumers. Schutz, Bruhn and Diaz-Knauf (1989) found that majority of their respondents would choose irradiated poultry and pork against 18-19 percent choosing non-irradiated products. Untreated fruits were chosen by 33 percent of the respondents whereas 43 percent chose the irradiated fruits. The mushrooms that were actually irradiated were judged significantly better than the non-irradiated mushrooms (Cramwinckel and van Mazijk-Boklag 1989). An equal number of responses regarding willingness to pay and rejection was found in the Corrigan's study. Willingness to buy each food increased significantly for all but ecologically sensitive subjects after they were informed more fully about irradiation. Though likelihood to buy strawberries, onions, spices, and flour was significantly higher than the likelihood to buy fish, chicken, pork, and bacon, a general purchase patterns rather than commodity specific

response was evident (Bruhn, Schutz and Sommer 1987). Studies in Table 2.02 show the percentage distribution of willingness to buy irradiated food.

The Brand Group typology is regarded as the most quoted on how the public in the US is distributed with regard to attitudes toward food irradiation. Rejectors were estimated to be the five to ten percent of the population who have strong ecological and environmental concerns and are opposed to any use of nuclear power. There may be difficulty in influencing this type of group. The *undecided* or the confused consumers make up that 55-65 percent of the population who are comfortable with their level of knowledge about the technology. They are against the use of pesticides and may see irradiation as an alternative. Educational effort in addressing concerns of the undecided must be honest and forthright. Finally, comprising the 25-30 percent of the population are the acceptors who have fragile positive attitude that should be addressed in the same manner as the undecided group (Brand 1986 and Marcotte 1991).

Examining the level of concerns of respondents using various studies presented in Table 2.03 and relating it to the Brand typology would give an inconclusive relationship about acceptance or rejection. For instance, in Bruhn, Schutz and Sommer (1987) concern for irradiated foods was roughly evenly distributed with major concern (29 percent), minor concern (25 percent), undecided (19 percent) and no concern (16 percent). Mean concern for irradiation was significantly lower than concern for other food safety areas suggesting that attitudes were still on the formative stage. This finding is related to Cramwinckel and van Mazijk-Boklag (1989) study where 26 percent of the respondents were very concerned and 24 percent were somewhat concerned or half of the respondents were rather concerned about irradiated mushrooms.

Consumers' concern for irradiated food varied by definition used (Wiese 1984). Attitudes toward food irradiation have been assessed by Defesche (1983), Cramwinckel and van Mazijk-Boklag (1989) in Holland, Gallup (1984) in Canada and by Wiese (1984), Bruhn, Schutz and Sommer (1986, 1987, 1989), Schutz, Bruhn and Diaz-Knauf

Table 2.02 Willingness to Buy and the Likelihood of Trying Irradiated Foods in Several Studies, in Percent

Gidwani 1984		Bruhn, Schutz and Sommer 1986		Brand 1986		Schutz, Bruhn and Diaz-Knauf 1989		Bord and O'Connor 1989		Malone 1989	
Willing-to-buy	25	Likely	40	Definitely will try	22	Very Likely	15	Definitely will try	14	Willing-to-buy	36
Not sure	44	Uncertain	26	Probably will try	47	Likely	30	Probably will try	63	Not sure	10
Not willing-to-buy	28	Unlikely	34	Probably not	20	Uncertain	34	Probably won't	17	Not willing-to-buy	54
				Definitely not	11	Unlikely	13	Definitely won't	5		
						Very unlikely	9				

Source: Brand (1986); Bruhn, Schutz and Sommer (1986); Schutz, Bruhn and Diaz-Knauf (1989); Bord and O'Connor (1989); Malone (1989); Bord (1991)

note: Total may not add up to 100 percent due to rounding.

Table 2.03 Level of Concerns About Food Irradiation, in Percent

Item	Wiese 1984	Brand 1986	Opinion Research 1988	Bruhn, Schutz and Sommer 1986	Bruhn, Schutz and Sommer 1988	Schutz, Bruhn and Diaz-Knauf 1989
Have heard of irradiation	23	66	25	n.a.	45	60
Major Concern	42	27	36	45	29	25
Minor Concern				34	25	21
Undecided				6	19	34
No Concern				15	16	21

Source: Wiese (1984); Brand (1986); Opinion Research (1988); Bruhn, Schutz and Sommer (1986); Bruhn, Schutz and Sommer (1988); Schutz, Bruhn and Diaz-Knauf (1989)

note: Figures for Wiese (1984), Brand (1986) and Opinion Research (1988) are unavailable
n.a. means not asked.

(1989), Terry and Tabor (1990), Malone (1990) in the US and Urioste, Croci and Curzio (1990) in Argentina.

Defesche (1983) used focus groups and in-depth interviews. He found Dutch consumers responded with *fear* and *unfamiliar* response and had difficulty accepting the need to irradiate to improve product sanitation. The Dutch respondents believed that food which looked good could not be a carrier of disease. He added that a small group of housewives were critical of food irradiation but when informed about the purpose of food irradiation these housewives accepted its advantages.

Bruhn, Schutz and Sommer (1986) contrasted conventional consumers and the ecologically sensitive consumers. Higher post discussion 'major concern' response was observed among undecided consumers. More alternative than conventional consumers showed higher level of concern initially toward food irradiation. The authors also showed that ecologically sensitive people respond to risk with cautious avoidance, hence making these an important group to reach. In this regard, values were suggested to be considered in orienting consumer education in marketing and product promotion.

Irradiation concern has been found to be greater among the younger segments of the population. Youth was regarded an important demographic factor. Subjects concerned about one aspect of food safety will be concerned about food irradiation with significant correlation on other characteristics, gender, and age. Moreover, women were more concerned about each of the food safety issues and food irradiation than men (Bruhn, Schutz and Sommer 1987). The very concerned about food irradiation had the same judgement as the not concerned. Age effects with youngsters ages ten to 29 were significantly less concerned and answered more often 'no opinion'. However, the responses of the not concerned and the concerned did not depend significantly on age. The not concerned had more faith in experts' arguments in favour of food irradiation (Cramwinckel and van Mazijk-Boklag 1989). In Schutz, Bruhn and Diaz-Knauf's (1989) study, approximately 25 percent showed major concern with regard to irradiation with women and less educated respondents showing a higher level of concern. Another

study found sex and income variables were significantly related to consumers attitude about irradiated produce (Terry and Tabor 1990).

Bord (1991), summarises the public attitudes on irradiated foods:

2.2.1 *In surveys asking intent to purchase or use irradiated food a majority or near-majority of respondents fall into the middle, 'probably' or 'uncertain' categories' while 10-25 percent make up the accepting and rejecting ends of the scale.*

2.2.2 *Questions dealing with perceived hazards or general concerns about irradiated food result in a majority or near majority expressing considerable concern and doubt.*

2.2.3 *Food surveys, surveys on toxic substances, and general environmental concern survey indicate that the US public views hazardous chemicals as the most serious environmental problem affecting health and safety.*

2.2.4 *The impact of more information on consumer attitude is contingent on the type of information and the respondents' prior attitudes on a number of dimensions.*

2.2.5 *Multi-variate analysis of determinants of acceptance-opposition to food irradiation indicate a complex pattern having more to do with social attitudes than knowledge or level of education.*

2.2.6 *Consumers demand the proper labelling of irradiated food, more research on its health and nutrition effects, and more information on the topic.*

Byrne, Gempesaw II and Toensmeyer (1991) assessed the effects of demographic variables on consumer concerns with pesticide residues and the likelihood of consumer beliefs given different channels of information on produce safety and risks. The pesticide residue model results showed that although consumers in general were concerned with food safety, concern levels appear to decline on males, persons with at least a bachelor's degree and high income households. Older consumers and males indicated a greater willingness to purchase irradiated food (Schutz, Bruhn and Diaz-Knauf 1989).

Malone's (1990) probit analysis identified three variables, education, income and sex that were significantly related to willingness to purchase. However, the model did not significantly capture the attributes of consumers needed to permit a useful level of prediction of willingness to purchase such products. The probit analyses using polychotomous and dichotomous dependent variables for beef and chicken were found to be poor predictors of consumer willingness to pay. Income and education were found to be significant in a number of cases. The negative coefficient of education relative to willingness to pay more posed an interesting issue for potential uses of the food irradiation process.

Bruhn, Schutz and Sommer (1988) concluded that values are a productive area in the field of consumer research as it has been shown to be related to attitudes toward food safety and willingness-to-buy a food with potential perceived risk. The value, an ecologically balanced world, was found to be an important determinant and was also found to be independent from other values.

Byrne, Gempesaw II and Toensmeyer (1991) belief-logit model of pesticide residue indicated that safety information from the academic community had the highest likelihood of acceptance by consumers. Education was found to be an important variable in the belief-logit models for the university group and federal agencies. Age, gender and income were found to be important variables for the environmental groups, news media, health food store owners and public interest groups. Research examining multiple correlates of attitudes toward irradiated food indicated that decisions to use or serve to family hinge heavily on trust in industry and government. Individuals were

often willing to take risks that they would rather not expose their family members to that was apparently the case with irradiated food.

Labelling is perceived to be important and preferred to be mandatory by consumers. Majority of the consumers felt that an irradiated product should be clearly marked. Schutz, Bruhn and Diaz-Knauf (1989) offered the respondents several label descriptions. Results showed that over 25 percent of the respondents believed that irradiated product would be safer than the non-irradiated, while one to 18 percent indicated that the process would produce a less safe product. In the US, those with more education, younger, male respondents from the Western region had more positive attitudes towards label descriptions. These responses gave a clear indication of the potential influence of labelling on consumer perceptions and intentions to purchase. The labels explaining in a simple manner, the purpose of irradiation would result in more positive attitudes with regard to the process.

Studies indicated that consumers' fear of food irradiation must be taken seriously. It is uncertain if concern is against the goal of food irradiation to make food more safe. It will take the equivalent of a national advertising campaign to convince people that irradiation is perfectly safe, that irradiated food is wholesome, and above all, that it is not radioactive. Consumer acceptance is an important part of technology transfer but there are also important issues with high near-term priorities. Producer/processor acceptance is one of them. They can be considered judges of the value and the future of irradiation technology.

Consumers may be best reached through a presentation of the safety and improved sanitary aspects of irradiated foods (Bruhn, Schutz and Sommer 1986). Those wishing to influence consumers should act while concern is in the formative stage (Bruhn, Schutz and Sommer 1988). Further studies on food irradiation may eventually lead to consumer acceptance (Jones 1992). Beliefs and values may also improve the predictive ability of modelling consumer acceptance of irradiated food. Maybe a segment of the market that is receptive to the process is not willing-to-pay more for the product (Malone 1990).

2.3 Marketing of Irradiated Foods

Previous trials elsewhere in the world have shown that consumers soon recognise that irradiated produce is of a very high quality and demand for the products in all the trials outstripped supply. Consumer resistance should be addressed in an active approach. Preference for irradiated foods may be influenced if equated as an alternative to pesticides. This has been done in the Netherlands (Young 1983; Marcotte 1991). Positive explanation of food irradiation may likewise reduce consumer resistance (Tilyou 1990). Jones (1992) hinted that consumer acceptance may result from further study.

Acceptance of irradiated foods in South Africa is quite high. More than 90 percent of consumers reacted positively to irradiated produce in 1978-79 and marketing in 1981 continued to be successful (Webb 1983). Marcotte (1992) reported that the successful sale of strawberries in Florida was predictable from the results of previous market tests and consumer attitude surveys in the US. Potential customers did want

information and often had several questions, but once answered, consumers seemed to choose to buy or not buy an irradiated food using their usual food-buying parameters.

Market tests or in-store response of consumers provide strong evidence that consumers will accept or reject irradiated foods. Marketing studies do not indicate widespread opposition to irradiated fruit. Fruits clearly labelled as irradiated have been successfully sold in the US. Irradiated papayas were sold in Irvine and Anaheim, California on March 28, 1987 and irradiated mangoes were sold in Miami Beach, Florida on September 11, 1986. More recently, irradiated strawberries were sold at Laurenzo's supermarket in North Miami Beach, Florida.

One of the first test on acceptance of irradiated food was done in December 1966 by the US Department of Defense. All of the consumers were military personnel and were asked to taste 'radappertised bacon'. Low scores were obtained when the consumers who were told beforehand that the bacon had been irradiated. Dr. E.S. Josephson confirmed that there was statistical significant finding that the consumer was negatively sensitive when informed that the product has been irradiated. Experiments in Israel without the radiation statement on the label or in the advertising supported successful marketing of potatoes by a major cooperative.

An in-store study of consumer response to irradiated papayas from Hawaii was conducted in two separate stores with different customers in the US in March 1987 (Bruhn and Noell, 1987). One had an upscale, middle-aged and relatively affluent or students market while the other had a newer middle-class neighbourhood of various ages

and mixed Anglo, Hispanic, and Asian descent. Irradiated papayas were displayed beside the traditional double-dipped treated papayas and clearly identified with the international symbol for irradiated food and the required sign 'treated by irradiation'. It was concluded that the tree-ripened irradiated papayas were more appealing than the double-dipped treated papayas. Consumers from the upscale market showed greater acceptance of the irradiated product. The difference may have been due to greater familiarity with papayas and different attitudes and values. The successful marketing of papayas outselling non-irradiated by a ratio of more than ten is to one took place in a supportive environment free of protesters where consumers could verify product quality by tasting and information materials supplied.

Two marketing tests of onion bulbs harvested in March 1986 were done in Argentina and carried out jointly by the Universidad Nacional del Sur zone (CORFO-Rio Colorado), a wholesale corporation (FOCO S.A.), and a supermarket (Cooperative Obrera Limitada). The onion bulbs were treated with an average dose of 50 Gy of gamma rays obtained from a Co-60 source by the National Atomic Energy Commission of Argentina (CNEA). Radio, television, newspaper, and magazines provided the information about the treatment of foodstuffs with ionizing radiation. Actual sales were done in August and October 1986 with extensive education campaigns included. Irradiated and non irradiated onions had the same price. In both trials, irradiated onions were sold at the rate of one metric ton per day. In Argentina, it can be assumed that both education campaigns and the Ministry of Health authorization served as the keys to the acceptance of irradiated commodities by consumers. The results encouraged the

implementing of irradiation technology in relation to onion bulbs in particular, as well as foodstuffs in general (Urioste, Croci and Curzio, 1986).

An opinion survey was conducted by telephone the week after the sale took place. Urioste, Croci and Curzio (1986) noted that treatment and appearance were important reasons for purchasing irradiated onions. Consumption rating for irradiated onion bulbs was high in August and low in October. The reason may be attributed to spoilage. The consumers also indicated very high willingness-to-buy irradiated foodstuffs in general. The negative response from some consumers to buying irradiated foods in general was based on their preference for foodstuffs that had not been subjected to any processing technique. Thus, the authors assumed that in Argentina, both education campaigns and the Ministry of Health authorization are the keys for the acceptance of irradiated food by consumers. The following Table 2.04 summarises the key results of the above three marketing tests for onion, papaya and apples in the US and Argentina.

Several market trials have been done in the US. One of the first was in September 1986 where 100 cases of irradiated mangoes from Puerto Rico were sold at Laurenzo's Market for one month next to mangoes disinfested by hot water dip. The USDA had allowed the sale of irradiated mangoes for that market test but further sales were not permitted pending the release of the USDA fruit inspection protocol (Marcotte 1992).

Table 2.04 Results of Marketing Trials of Irradiated Apples and Papayas in the US and Irradiated Onion Bulbs in Argentina, in Percent

	Market Test in Argentina for Irradiated Onion		Market Test in the US for Irradiated Papayas		Market Test in West Central Missouri for Irradiated Apples	
	August Sale	October Sale	Irvine Store	Anaheim Store		
Willingness to buy						
Would definitely buy	91	92	81	66	bought non-irradiated	44
May or may not buy	3	0	4	2	bought only irradiated	38
Would def. not buy	6	7	15	32	bought some of both types	18
Repurchase Decision						
Buying again (Yes)	98	88	80	66		
Not buying again (No)	2	12	20	34		

Source: Bruhn and Noell (1987); Urioste, Croci and Curzio (1986); Terry and Tabor (1990)

Results of an apple marketing study done by Terry and Tabor (1990) in West Central Missouri suggested three significant independent variables to consumers acceptance of irradiated apples, price of apples and two dummy variables for education. There was an inverse relationship between the price of apples and the probability of purchasing irradiated apples. Educational level of consumers positively influenced the probability of purchasing irradiated apples. Customers who attended college or graduated were more likely to purchase irradiated apples than shoppers having lesser amount of formal education.

Irradiated strawberries were marketed for the first time in January 1992 in the United States by the Laurenzo through the Vindicator Inc. of Mulberry, Florida, the

first commercial irradiation facility in the US. The successful sale of 1,000 pints of irradiated strawberries, faced with extensive media coverage of the sale and protests by anti-food irradiation activists, was *predictable from the results of previous market tests and consumer attitude surveys in the US* (Marcotte 1992).

In March 1992, Carrot Top, a store in the Midwest of US whose shoppers are primarily upper middle class from Chicago's North Shore suburbs, 55 percent of the families are living on two incomes and 57 percent have some college education started to offer irradiated strawberries, grapefruits and juice oranges for its customers. The fruits were irradiated by the Vindicator Inc. Prior to the selling of irradiated fruits, the store owner, Mr. James Corrigan conducted a survey of his customers in February 1990 through the store's newsletter. He observed from the 2,500 respondents that 71 percent had seen or read something about food irradiation, 91 percent felt they had not received enough information to develop an opinion about its use, most (80 percent) were not sure if they had been exposed to an irradiated product, equal responses for willingness to try sample irradiated foods to determine flavour levels, and rejection were observed with a few reported indecision, and majority (86 percent) agreed on clearly labelling the irradiated food (Pszcola 1992).

Chapter 3

Conceptual Framework

The value of a thing is just as much as it will bring.

Samuel Butler (1612-1680)

This study develops a conceptual framework based on several demand models applicable for analysing food safety issues. Particular emphasis was given contingent valuation method as a measure of willingness to pay for irradiated foods. Several socio-economic and demographic factors, including consumer attitudes, were assumed to have an influence on consumer choice for irradiated foods.

The likely adoption of food irradiation in the future is viewed to be a human activity reflective of individual choices and group behaviour. Consumer perception, belief and attitude toward consumption of a good like irradiated food motivates human behaviour either explicitly or implicitly. Public policy, business and institutional decisions affecting the environment and the agricultural industry are driven directly and indirectly by human beliefs, attitudes and perception.

Consumers' perception and attitudes were related to behavioural response evident in consumer choice. Contingent valuation was chosen to value consumers preference. Consumer behaviour is interpreted by how people acquire, organise, and utilise available information to make a choice (Fishbein and Ajsen 1975; Sternthal and Craig 1982; Kinnucan and Venkateswaran 1990).

A number of competing and complementary theoretical and empirical approaches have been developed in demand literature that are directly relevant for analysing food safety issues. This Chapter reviews the approaches and examines

their strengths and weaknesses. The topics discussed cover the classical demand models, characteristic demand models, models incorporating risk and information, willingness to pay and contingent valuation methods.

3.1 Consumer Demand for Food and Food Safety

Increasing concerns for food safety have been driving consumers to become more aware about the food they consume. The recent Alar scare in red apples, for example, has brought a number of concerns that echoed on other food safety issues. The range of commodities under scrutiny by consumers has widened and involves almost all commodities offered at the marketplace: fish and seafood (US federal inspection), poultry and fresh eggs (salmonella), pork (porcine somatotropine or PST in pork, subtherapeutic feeding of antibiotics), pesticide residue (fresh fruits and vegetables and animal feed), and bio-engineered growth promotants (bovine somatotropine or BST in milk) (Senauer, Asp and Kinsey 1991; Smallwood and Blaylock 1991; Caswell 1991). Health concerns under the guise of food safety, such as cholesterol, fat, sugar, alcohol, and cigarette smoking, can also be included (Smallwood and Blaylock 1991).

Following economic growth, welfare will increasingly depend on factors that are brought about by health. Health, being a luxury good (Falconi and Roe 1991) has income implications that are important since the growth in demand for health care and a food system which allocate more resources to control dietary exposure to health impinging factors can be disadvantageous for low income consumers. The cost of processing information, learning about, and searching for consumption goods that affect health increases due to the rising opportunity cost of time. The costs that tend to increase the demand for food away from home (Senauer 1979) also increases consumer exposure to a food supply whose dietary implications may be slightly known (Guenther and Chandler 1981, Morgan and Goungetas 1986).

Consumers beliefs, the certainty of beliefs, and the presence of information are important determinants of demand for goods as they are driven by the demand for health (Falconi and Roe 1991). The market for food safety differs from the market for most other attributes and characteristics because safety is not usually known to consumers at the time of purchase (Smallwood and Blaylock 1991).

Invisible hazards and imperfect knowledge and information, combined with impaired consumers perception about foodborne risks, make food safety a sensitive issue that can disrupt markets and bring considerable economic losses to all participants in the marketplace. Generally, demand analyses are useful for evaluating the impacts of food safety issues on the food system and for evaluating alternative private and public food safety strategies and initiatives for addressing those issues (Smallwood and Blaylock 1991).

3.2 Traditional Demand and Food Safety

The classical or traditional theory of consumer demand is expressed as

Maximise $U(Q_1, Q_2, ..., Q_n)$ [Eqn. 3.01]

subject to $Y = \Sigma P_i Q_i$, [Eqn. 3.02]

where U is the level of consumer utility or satisfaction, Q_i is the quantity of the ith good consumed, Y is the consumer income and Pi is the price of the ith good. The consumer seeks to maximise equation (3.01) with respect to the quantity consumed and subject to the income constraint, equation (3.02).

Consumers are assumed to have a well-defined set of preferences for market goods in the traditional theory of consumer demand. Bundles of less preferred goods can be differentiated from bundles that are more preferred (Deaton and

Muelbauer 1980). The consumer has limited income and his current information on market prices allow for distinguishing the most preferred bundle of goods available that can be bought. The optimal bundle of goods to purchase depends on the set of goods offered for sale. This set of goods is greatly affected by changes in income of consumers or any one or more of the market prices (Smallwood and Blaylock 1991).

The classical theory states that the quantity demanded of each good is affected by the price of the good in question, the price of all other goods or substitutes, and consumer income. The budget constraint inextricably links all commodities together such that the consumption level or price of one commodity changes as the consumption of at least one other commodity is changed (Tomek and Robinson 1981; Smallwood and Blaylock 1991).

Individual differences in preference and income level necessitates that the market demand or the sum of demands over all consumers in the market assume a function that is affected by several factors such as socio-demographic, ethnic, and income mix of consumers (Smallwood and Blaylock 1991).

The importance of measuring food consumption responses relative to changing economic conditions and consumer concerns can be very useful for assessing exposure levels to foodborne risks. The kinds, amounts, and variability of food consumption by the individuals in particular age, sex, geographic, ethnic, and other socioeconomic groups can be provided by consumption models that are usually derived from cross sectional surveys of consumers. These models are equally important for nutrition monitoring and assessment issues (Smallwood and Blaylock 1991).

3.3 Consumer Behaviour and Demand for Product Characteristics

Studies of consumer demand behaviour typically focus on the effects of prices and income on expenditure patterns. The theoretical basis of this approach comes from the utility maximization hypothesis and deriving the expenditure function. Extension of these demand studies has been made to include the effects of socio-demographic variables. Barnes and Gillingham (1984) have discussed the importance of demographic effects in demand analysis. Other studies have evaluated the impact of socio-demographic variables on US food demand (Senauer 1979; Salathe 1979).

Consumers are assumed to formulate their perception from available information, knowledge, experiences and include personal characteristics, social and cultural background and environmental factors (Huang 1993). Attitude is a learned predisposition to respond in a consistently favourable and or unfavourable manner given an object or a concept (Fishbein and Ajsen 1975). On the other hand, perception is the formation of an individual's state of mental awareness affected by internal and external factors such as cultural, social and economic influences. Perception may effect attitude via the cognitive process through converting perceptions into attitudes by evaluation. This conversion will lead to changes in perceptions and choice behaviour. Situations such as in advertising exhibit high consumer involvement where the *attitude-before-behaviour* paradigm (Huang 1993) may be applicable.

Emerging food safety issues can be addressed by modelling consumer demand for product attributes such as safety, appearance, nutrition, size, and convenience (Swartz and Strand 1981; Eastwood, Gray and Brooker 1986; Hammit 1986; Smith, Van Ravenswaay and Thompson 1988). A tradeoff between safety characteristics, price, appearance, and other product attributes is observed in many cases. Information on how consumers value these characteristics and their willingness to make tradeoffs would provide valuable insight into the marketing potential and

consequences of alternative strategies (Manalo 1989). Controlling risks in both public and private management entails knowledge of willingness to pay for additional food safety and/or particular types of safety (Zellner and Degner 1989). Moreover, the assessment of tradeoffs implies that social benefits be estimated and that welfare comparisons be made.

Two rival models of consumer behaviour which both had their origin in the earlier work of Gorman (1956) were developed during the mid 1960s and increased the methods available for evaluating consumer demand issues. The household production model of Becker (1965) and the product attribute or characteristics model of Lancaster (1966) state that consumers desire market goods not for themselves but for the attributes, characteristics, or commodities that can be produced from those goods.

3.3.1 Household Production Model

The Becker model of household production generally assumes non-joint linear homogeneous production functions (Deaton and Muelbauer 1980). Stigler and Becker (1977) implied that health or nutrition can be modelled as a form of human capital and not as an object of direct satisfaction. Health would be a production function and it would also enter into the production of household commodities (Smallwood and Blaylock 1991).

Consumer behaviour explicitly expressed in the household production model involves tradeoffs in consumer decisions to use or not to use particular products in the production of other commodities. Thus the consumers can vary the mix of inputs used in their health production function to produce a given level of health (Smallwood and Blaylock 1991).

Arguments noted that the model is inappropriate at addressing changes in information because counter intuitive results may arise where new information can lower utility. Others argued that this argument is invalid and the paradox can be easily reconciled by noting that consumers receive utility from current consumption as well as future consumption. Thus current utility may decline but future utility will increase because information and changing production have allowed for future consumption (Smallwood and Blaylock 1991).

Ippolito provided a model where information may be treated as a 'free' good purchased at zero price. The household limits its use of information, even if it is free, because time is scarce and must be used to produce household commodities (Ippolito 1981).

3.3.2 Product Characteristics and Attribute Model

The Lancaster demand model is sometimes referred to as the linear characteristics model because it assumes a joint production with fixed proportions (Deaton and Muelbauer 1980). The market goods are desired for the attributes that they contain (calorie, fat, sugar, convenience, safety, flavour, crispiness, packaging, nutritional values, colour, etc.). Different market goods contain different combinations of attributes (Smallwood and Blaylock 1991).

In contrast to the household production model of Becker, the characteristics or attributes in this model are assumed to be measurable. The models also differ significantly in the form assumed for the production functions for the desired attributes (Deaton and Muelbauer 1980).

The Lancaster model is easily adapted for econometric estimation. The market price of a commodity can be thought of as a sum of the values of the bundle of attributes contained in the product. Examining the products that have differing

combinations of characteristics results in the value of the individual components or attributes. This approach to valuing attributes is sometimes referred to as the hedonic method. The generalised Lancaster model formulates the consumer's problem as:

Maximise	$U (X_{01}, X_{02},... X_{0m})$	[Eqn. 3.03]
such that	$\Sigma P_i Q_i = Y$	
and	$X_{oj} = f_j(Q_1, Q_2,..., Q_n, X_{1j}, X_{1j},..., X_{nj})$	[Eqn. 3.04]

where U is the level of utility, Xij is the amount of characteristic j in a unit of good i with all m characteristics measured so their marginal utilities are non negative, Qi is the amount consumed of the ith good, Xoj is the consumption of the jth characteristic from all n goods, Pi is the price of good i, and Y is income. (Van Ravenswaay and Hoehn 1991). The model assumes that final choices of consumers are a direct result of utility maximization. However, it has limited application to attributes that are known to consumers. In the case of food safety issues (such as irradiated foods) the risks involved, if these exist, are not generally known to consumers (van Ravenswaay 1988; Hammit 1986; Byrne, Gempesaw II and Toensmeyer 1991).

Lancaster proposed that consumers demand products based on the characteristics or attributes of the products. In addition, socio-demographic variables have also been found to affect consumer demand. Thus the demand for a product depends on prices, income, attributes of the product, and socio-demographic variables (van Ravenswaay and Hoehn 1991).

The estimation of the parameters of the hedonic model requires that either the supply curve shifts in parallel with fixed demand curves or supply curves are perfectly elastic and the demand curves shift (Deaton and Muelbauer 1991).

It is hypothesized that consumers with different socio-demographic characteristics may have different attitudes towards the positive and negative attributes of a particular product. Differences in consumer attitudes can ultimately effect the quantity demanded of the product in question (Byrne, Gempesaw II and Toensmeyer 1991).

3.4 Risk and Food Demand

Demand for food safety cannot be derived from the conventional ordinal utility analysis. In this case, expected utility may be employed to derive the demands for *quantity* and *safety* based on cardinal preferences. The hazard in the risky good is assumed to decrease the probability of survival (state of good health). When safety is endogenous to consumers' decision over a consumption bundle, perfect safety is not optimal (Kwan Choi and Jensen 1991).

Under a perfectly competitive market where consumers get accurate information, government intervention is not necessary to attain a socially optimal level of food safety. The desired level of safety the policy maker chooses is exactly the level chosen by producers and consumers. In contrast to pure consumption goods which yield positive utility and have demand curves derived from conventional indifference curves, the consumption of risky goods have adverse effects on health or the life expectancy. Hence, the impurity of the risky good or other measure of hazard makes an important determinant of the demand for the risky good in addition to price and income variables. Food safety, as well as prices and income, affects the demand functions at a fixed level of hazard. The output occurs at a point where price exceeds marginal cost in an imperfectly competitive market (Kwan Choi and Jensen 1991). Thus if the food processing industry producing a potentially hazardous good is not competitive, the industry output will not be socially optimal (Falconi and Roe 1991; Kwan Choi and Jensen 1991).

For relatively unprocessed agricultural commodities such as meat, eggs, fresh fruits, and vegetables, application of the model of perfect competition may be safe. For other goods, such as processed products, public policy will need to address the issues of regulating firms that engage in risk differentiation (product differentiation by risk or safety) because such differentiation may be a new basis for acquiring and exercising market power. Moreover, willingness-to-pay for safety may also exceed the marginal cost of safety. In this case, it may be necessary for the government to regulate both quantity and safety levels. Regulating only the quantity on the supply side will not generally guarantee the optimal level of food safety.

When risks of consumption are taken into account, the probability of the individual's response to the hazard affects the usual price and income elasticities for the risky consumption of good. As such, traditional demand parameters are not sufficient to capture consumer response to changes in risks. Safety may be arrived at as a Giffen good. Conventional demand theory lacks predictive power and as such, price and income as explanatory variables are misspecified when risk is involved (Kwan Choi and Jensen, 1991).

Many food safety issue (like food irradiation) deviates from the classical demand model because the costs and benefits of any action are not fully known and may occur instantaneously. In general, perceptions of risks have been found to be related to characteristics of hazards such as: the incidence, severity, reversibility, and lag-time in the onset of outcomes; perception of consumer control; spatial and temporal dispersion of cases; and past experience with similar risks (Slovic, Fischhoff and Lichtenstein 1982; Viscusi and Magat 1987). Research relating consumer perception and attitudes toward risk characteristics provides valuable insight into understanding consumer response to information about different types of foodborne hazards such as chemical contaminants, microbial contaminants, and additives. This information is useful in evaluating public demand of new *risky* food technologies, and reaction

to new information about risk attributes of particular commodities (Covello, Sandman, and Slovic 1988).

The willingness of people to bear a risk is also influenced by their perception of the benefits of the activity or product. The lower the perceived benefits, the lower the tolerance for the resulting risk (Slovic 1987; Van Ravenswaay 1988). Viscusi (1986) opined that there is a strong negative relationship between individual wealth and the risks one will choose to accept. Clancy (1988) argued that the best approach to food safety issues is simply to provide the relevant information to consumers and allow them to make their own decisions concerning behaviour and products. However, the Food Marketing Institute (1989) argued that whereas consumer information has an important role to play in food safety issues, it is not a panacea.

Economic efficiency supports the argument of information approach. The imposition of a single level of safety by government regulation will be inefficient because individuals differ in their attitudes towards risk and their willingness to pay to reduce risks. It is more efficient to allow consumers to adjust their own behaviour and product purchases in terms of their own risk preferences (Dardis 1988).

3.5 Ippolito's Model of Consumption

Darby and Karni (1973) categorised consumer goods based on their characteristics into search goods, experience goods, and credence goods. The characteristics of search goods are known before purchase, exhibited by its appearance. Experience goods, as the name implies, have characteristics like taste that can be explained after consumption. Safety attributes of food generally fall into the credence good category because consumers cannot evaluate the good before and after consumption.

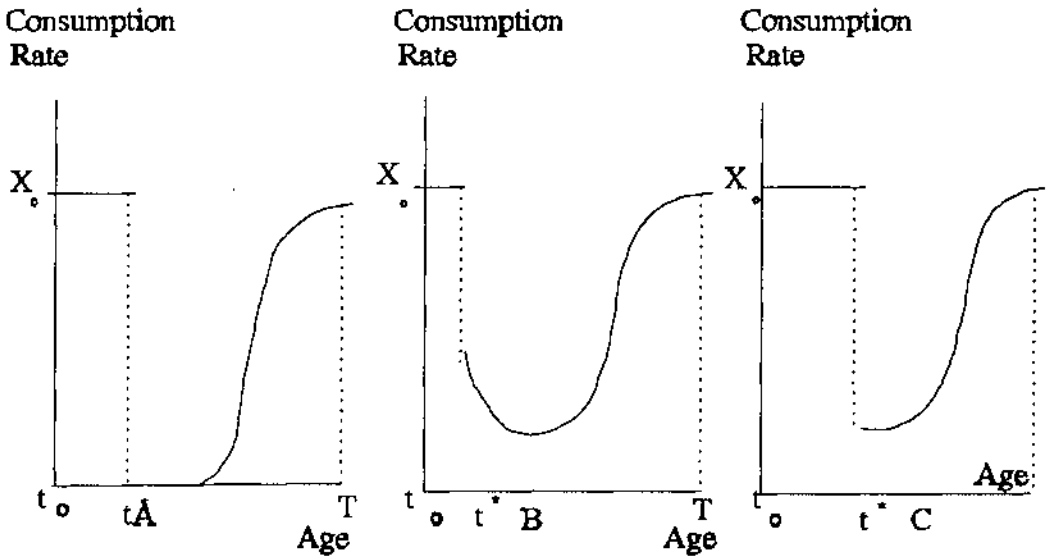
Ippolito's (1981) life cycle model of consumption highlighting a number of important aspects of consumer behaviour with regard to hazardous goods that need to be considered. The model explored the dynamics of optimal consumption of a hazardous good. It assumes that an individual gains utility from current and future consumption of a single good, X, which is hazardous and consumption of the good decreases the probability of survival. The individual then weighs the gains from current consumption against the expected costs of a shortened lifetime and hence lost future consumption.

The model was developed to explore how consumption behaviour changes in response to new information and how this response may differ depending upon the age at which new information is obtained. Consumption is not the only source of hazard. The model incorporates a known but exogenous hazard that is consistent with lifetime risks. The individual may or may not have complete information about the hazardous nature of the consumption item.

Three types of hazards are modeled. First is the instantaneous cumulative level of consumption. The model assumes that the probability of survival is inversely related to the cumulative level of consumption. Possible relationships may be evident between salt, cholesterol, cigarette smoking, or alcohol consumption and the probability of heart attack or stroke. The constant hazard or instantaneous non cumulative risk model assumes the probability of survival is determined completely by current level of consumption. Botulism poisoning or other severe food contamination that results in immediate death may be among the examples of this type of model. The third model, the latent cumulative risks model assumes delayed effects in survival by ten or 20 years as a result of current consumption. Latent cancer precipitated by earlier consumption of some toxic ingredient or contaminant is one example of this model.

The implications of the three models for the optimal lifetime profile of consumption can be shown graphically using Figure 3.01. A, B and C represent consumption patterns of a hazardous good given the supply of information to the consumer at age t^*. For example, a consumer who is given an information about the good as being hazardous at a young age under the instantaneous cumulative hazard model may have a consumption stream of A or B in Figure 3.01. If the same consumer is older at the time the information is supplied, he may have a consumption pattern reflected in either A or C. In all cases A, B or C, the level of optimal consumption is less than the optimal rate prior to the announcement of information.

Figure 3.01 The Optimal Lifecycle Consumption of Hazardous Good



Source: Ippolito (1981)

3.6 Willingness to Pay

The Lancaster model, Ippolito's model and the Stigler and Becker model provide framework for addressing food safety issues and food demand in general.

Economists continuously develop theoretical models to explain consumer behaviour. Demand models for food safety issues are data intensive. Newer models are requiring more detailed information on product characteristics, consumer perceptions, and information flows. In cases where it is not possible to observe market information, contingent valuation and conjoint analysis techniques are required to get consumer responses (Green and Srinivasan 1978; Bergstrom and Stoll 1989).

The consumer maximises total welfare through the utility of goods and services available. Economists have continuously tried to quantify utility to reflect the economic well being of individuals and the economy as a whole. Consumers are assumed to be the best judge of what's valuable to them. Benefits received will be reflected in the price they are willing to pay for a particular good or service (Harris 1983).

The value that a person places on a good or service usually reflects preference for that particular commodity based on the utility gained from its use. The willingness to pay is the aggregate of individual willingness to pay. Quantitatively, it is the amount of money that society would be willing to pay for a given quantity of good (Harris 1983). Society's willingness to pay for risk reduction is the conceptual basis for valuing risks reduction to life and death (Viscusi 1986). The concept of willingness to pay can be presented using the demand and supply curve showing the price and quantity relationships where P is the price of the good, Q is the quantity of the good, S is the supply curve and D is the demand curve. The optimum condition (E) in a perfectly competitive economy is where the marginal cost is equal to the marginal benefit which is equal to the price. Total consumer willingness to pay for the good is equal to the area under the demand curve but the actual amount paid by the consumers at price Pi is Pi X Qi (Harris 1983). It is assumed that individuals are rational and more specifically, they maximise subjective expected utility (Viscusi 1986).

3.7 Contingent Valuation Method

The most commonly used method of determining the willingness to pay is the compensating variation observed in the market place or in a hypothetical market generated through survey. The stated preference or contingent valuation method (CVM) of generating information through the survey questionnaire is getting more attention in recent years. It is based on the assumption that rational individuals maximise the expected net utility. An advantage of the contingent valuation approach is that it provides all necessary information for the respondent to assess the situation more objectively than what would be the case in real life situation. It also provides individual valuation of safety through direct questions on compensation required for risk changes (Guria 1991).

Survey techniques aim to measure changes in utility, in monetary terms, of a resource by simulating a hypothetical market situation to test consumer preferences (Forbes 1984). Thus valuation is based on a hypothetical situation rather than actual consumer behaviour, as has been exercised in surrogate market approaches (Hufschmidt 1983; Mitchell and Carson 1989). The hypothetical basis is that it enables one to obtain ex ante judgements that also measure option and existence values (Mitchell and Carson 1989).

The CVM is widely used survey technique. Uncertain circumstances will need ex ante valuation whereas other methods are usually considered ex post values estimated from decisions made after the certainty has been resolved (Kolstad and Braden 1991). There are several approaches within the broad grouping of CVM. Bidding games, open-ended question, dichotomous choice question and payment card format are some of them.

CVM is rapidly taking place among the dominant techniques for determining the demand for non market goods. CVM is a widely used method in the field of

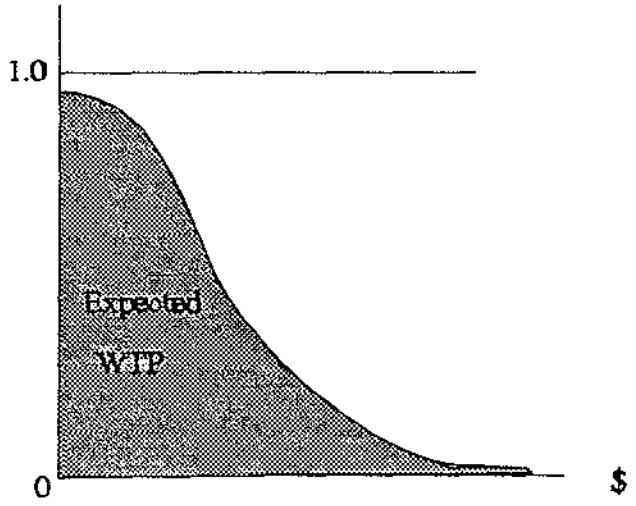
environmental economic research and other non traded goods (Nowell, Evans and McDonanld 1988; Cooper and Loomis 1992) and has increasingly found its way to address food safety issues. Conjoint analysis and contingent valuation are required to elicit consumer responses (Green and Srinivasan 1978; Bergstrom and Stoll 1989).

Bidding games assume that the price of good or services varies in response to a change in the equilibrium quantity or quality of the goods supplied (Bohm 1972; Sinden and Worrel 1979). This entails asking people for their willingness to pay for an improved bundle of goods (compensating variation) or willingness to accept an inferior bundle of goods (equivalent variation) (Hufschmidt 1983). A positive answer to the amount respondents were willing to pay leads to higher bids until a negative answer is obtained. Then the interviewer lowers the bid progressively until the respondent reaches an acceptable amount (Hufschmidt 1983; Bishop and Heberlein 1987; Boyle and Bishop 1988). The bidding game approach may offer a starting point bias that may influence respondents to have an upward valuation of good.

An alternative method that allows a mail survey to be undertaken and avoids influencing respondents using the starting bid is the open ended question approach. This approach asks how much a respondent would be willing to pay to avoid the loss of an additional unit of the good or the willingness to accept compensation to receive an inferior good without bidding. The need for a good description of the product and the payment vehicle would reduce the high standard deviation from the mean which usually arises in this type of approach, especially if there is no indication given of the expected range of answers (Hufschmidt 1983). The reason for this is that most people have not valued such a resource or good before and may never have considered what their economic worth might be (Cummings, Brookshire and Schulze 1986).

Mitchell and Carson developed the payment card method as another alternative to the bidding game approach. This approach involves providing the

Figure 3.02 Expected Willingness to Pay



Source: Kerr (1986)

respondent with a visual aid containing a large array of potential willingness to pay amounts beginning at zero and increasing at fixed intervals (Boyle and Bishop 1988). The respondent is then asked what amount on the card represents the willingness to pay for the good proposed. This response is final and no bidding is involved. The approach may also give an anchor point bias that may be indistinguishable from the bidding game procedure when valuing the same environmental assets (Bishop and Heberlein 1987; Boyle and Bishop 1984; Harris 1983). Mitchell and Carson concluded however, that anchors did not have an effect (Boyle and Bishop 1988).

The mail survey method can be done in dichotomous choice format of CVM. This method was first used by Bishop and Heberlein (Boyle and Bishop 1988). The approach does not require the use of visual aids to bid the consumers willingness to pay. Instead, prices are randomly assigned to respondents so that it is possible to predict the probability for any person of given characteristics being willing to pay a given amount. A simple yes or no answer is expected of the respondent on the question asked. (Kerr 1986; Carson 1991). The probability of being willing to pay is plotted against the dollar amount nominated as illustrated below.

The dichotomous choice method may free itself from the influence of strategic behaviour by merely answering yes if the respondent is willing to pay more or equal to the amount asked and no if otherwise. The simplicity of the approach is an advantage of the method but it requires more sophisticated statistical procedures than does the analysis of numerical responses obtained from bidding games and payment cards (Boyle and Bishop 1988).

The data from bidding games, open-ended question and the payment card approaches normally allows for simple straight forward analysis. The concept of willingness to pay is theoretically valid. Utilising a survey approach to value a hypothetical situation as with contingent valuation presents some unique problems. There are two major problems. The first is that responses are related to hypothetical situations. Secondly it assumes that most respondents have the ability to assess the risks objectively to determine a marginal rate of substitution at which their individual utility is maximised (Guria 1991).

The problem of surveys using CVM in hypothetical situations is well recognised by researchers in the field. It is based on the assumption that people would behave differently if they face the same situation in real life. The mean value is much higher than the median in most cases. This is due to the fact that a very few high values can significantly increase the mean. Non market valuation may produce unrealistic responses creating another source of bias. A carefully designed questionnaire may closely approximate the hypothetical and actual condition (Thayer 1981). An alternative is to use the median. If the responses are not a proper assessment of the risk reductions and found to be significant, then no statistic is necessarily a valid estimator (Guria 1991).

Appropriate consistent tests are necessary to check the problem and sort out the outlier. There are three factors in each question which influence the responses: the initial risk level; the reduction in risk; and the instrument to be used for the

reduction. It is quite possible that the third factor has the most influence on the responses (Guria 1991). The payment mechanism and the starting point bid used in surveys may lead to instrument bias. As in most surveys, the choice of bid payment method can effect the response or bid of respondents (Harris 1983). A carefully designed questionnaire may address this bias and testing will alleviate most of the problem (Randall, Ives and Eastman 1974).

Respondents may be 'sensitive' to the vehicle used (OECD 1989) in the survey. The choice of 'vehicle' or the instrument of payment used in the approach may lead to another bias, the instrument bias. Careful design and testing should be done because instrument bias has been shown to significantly affect the willingness to pay (Randall, Ives and Eastman 1974).

Information bias results from incomplete or misleading statements about the proposed changes (Hufschmidt et al 1983). The nature of a hypothetical situation may not enable respondents to completely visualize all changes or predict the actions of others (Kerr 1986). To avoid biases, the linkage within the contingent market between the environment attributes, institutional setting and the bidding instrument which must be realistic and acceptable to the respondents should be built. The need to establish a concise contingent market i.e. 'good' must be well defined (Schulze, D'Arge and Brookshire 1980).

Information bias arises because a hypothetical situation provides less information than an actual information and lead to large differences in bids (Harris 1983). Visual aids may ensure consistent interpretation (Randall, Ives and Eastman 1974; Brookshire, Ives and Schulze 1976) specially in valuing quality change.

Mitchell and Carson (1989) presented that strategic bias may be avoided by making suggestions that the good will be provided whatever the respondents says and there should be no evidence that this contingency lacks credibility. Strategic bias

occurs when a respondent gives a willingness to pay amount that differs from the true willingness to pay amount conditional on the perceived information in an attempt to influence the provision of the good and/or the respondent's level of payment for the good. For example, if respondents believe that the actual fee will be contingent on their offer they tend to bid lower than their true value.

Reducing the incentive to bias would mean emphasizing the hypothetical nature of the survey (Kerr 1986). Empirical tests of strategic bias have, however been found not to be a major problem (Bohm 1972; Scherr and Batt 1975). Strategic bias occurs when the respondent is approximately aware of the magnitude of the average bid and is prepared to respond with a dishonest bid. The influence of strategic bias has been found to be negligible in some studies (Rowe, D'Arge and Brookshire 1980; Bohm 1972; Scherr and Babb 1975) whilst others found it to be considerable (Brookshire, Ives and Shulze 1976).

The existence of these biases does not necessarily invalidate the results obtained. Rather, it indicates that the contingent valuation method cannot be used for economic decision making, but it does provide some information on the likely values of non-market goods and services which is useful in decision making (Kerr 1986).

Another important area to be considered while formulating the questions is the value of a risk change that willingness to pay (WTP) for a risk reduction or willingness to accept (WTA) for an increase in risk. Empirical analyses suggest that the willingness to pay for a risk reduction differs considerably from the willingness to accept for a risk increase of the same magnitude. The latter is usually larger than the former (Guria 1991). Mitchell and Carson (1989) compared the two approaches. They found that risk averse respondents will tend to be willing to pay less for a risk reduction than the amount they would be willing to accept for a risk increase. The value function is steeper for losses than for gains which is a prospect theory

argument. A theoretical analysis by Hanemann (1991) indicates that for public goods with a low elasticity of substitution relative to the income elasticity, the difference between WTP and WTA can be very large. Jones-Lee (1989) concluded in his reviews that the willingness to pay *constitute the appropriate basis for the definition of values of safety improvement.*

Problems may arise when there are zero bids or extreme value bids of willingness to pay which need to be analyzed without hampering the level of representativeness of the sample. Randall, Hoehn and Tolly (1981) asserted that estimates from the CVM surveys may be affected by the procedures employed to determine the final sample used in the analysis of responses. Zero bids may be interpreted as a legitimate expression of the value of the good indicating that the value of the good is not worth anything or that this is all the respondent could afford (Guria 1991).

Zero bids may be regarded as a protest reaction toward the payment vehicle or a rejection of the idea of assigning a dollar value to the valuation item (Devousges, Smith and Fisher 1987). For these reasons, valid zero bids can be included in the data analysis while others are excluded. In practice, it requires follow up questions to ascertain whether the respondents really place no value on the resource or are expecting a protest (Bishop and Heberlein 1987).

The CVM suffers from a number of shortcomings. One of which concerns the accuracy of the result due to potential biases (Hufschmidt, James, Meister, Bower and Dixon 1983; Mitchell and Carson 1989). Kerr (1986) and Thayer (1981) suggested a carefully designed questionnaire should approximate a realistic situation and payment instrument to reduce the possibility of hypothetical bias occurring or actual market inexistent. This bias may result in respondents not being able to assess the true value of the public goods and give disincentive to determine their own preferences.

It has been shown that given correct design and implementation, the biases can be proved insignificant (Thayer 1981) over a wide variety of non market goods (Randall, Ives and Eastman 1974). Harris (1983) reviewed the literatures on CVM. He suggested that biases may be reduced by providing sufficient information to allow better understanding by consumers of the commodity being valued, correct design of survey questionnaire, testing of the survey and checking or evaluation of the outlier and a more realistic and credible approach that closely resembles the real market behaviour.

Chapter 4

Methods

Whichever you please my little dears:
You pays your money and you takes your choice
You pays your money and what you see is
A cow or a donkey just as you please

Anonymous

4.1 The Sampling Procedure

This study utilised a systematic random sampling technique of 1,000 respondents taken from the *1992 Electoral Rolls*. The response rate of 42.6 percent produced 404 useful questionnaires after eliminating those questionnaires with no answers and irrelevant information. The national survey was conducted through mail.

4.2 Pre-testing of Questionnaire

The pre-testing of questionnaire was done in Palmerston North for 30 respondents whose names were taken from *The Telephone Directory Manawatu 1992.* Palmerston North was included in the final survey and the names of the respondents who were included in the pre-testing were not included in the total population where the sample was taken.

4.3 The Questionnaire

The definition of irradiated food used in this study was adopted from Bruhn, Schutz, and Sommer (1986) and Wiese (1984) surveys which elicited the lowest level of concern and where food irradiation was mentioned by name. For the purpose of getting the level of concern about food irradiation, it was defined as *the low level of electromagnetic energy which kills insects and microorganisms which maybe on the*

food and extends the shelf life of the food. The questionnaire was a ten-page, back to back booklet with the introduction on the cover page (Appendix 1). Incorporated on the cover page of the questionnaire was an introduction about a raffle draw for an *Ansett Mystery Weekend for Two.* This raffle draw was included to encourage greater participation of the respondents in answering and returning the questionnaire to increase the response rate.

The questionnaire contained information about the demographic characteristics of the respondents. A special note on the top of the third page of the booklet-questionnaire requested the respondent to be the person who shops for food for the household. Thus, the respondent was the major decision maker in the household when it comes to food shopping. The questionnaire asked about the households' income, age, education, household size, employment, sex, marital status, ethnic origin, type of diet observed, religion and organisational affiliation. Other information on level of concerns about food irradiation and their willingness to pay were also incorporated.

Prior to these questions, they were asked about their general health condition, responsiveness to new food products being introduced to the supermarket, general perception of the quality of fresh food and vegetables in the supermarket, preference for organically grown produce and level of knowledge about several food safety issues such as residues resulting from herbicides and pesticides, antibiotics found in poultry and livestock, growth promotants in poultry and livestock, nitrites in food, food additives and preservatives, artificial food colouring and food irradiation. Another rating was made for their perception of the hazardous effect of the same food concerns. The choices for rating the degree of hazard of the food safety issues were serious hazard, something of a hazard, not a hazard at all and not sure.

Ten commodities that can be irradiated were enumerated in the questionnaire. The consumers were asked to fill out their weekly consumption of strawberries,

mushrooms, pears, potatoes, bananas, onions, beef, pork, chicken and fish. After they answered the question on willingness to buy, they were asked to proceed to their respective questions. Those who were willing to buy irradiated food were asked to circle their bids for how much they are willing to spend above the current price for the irradiation of the food they only consume. Likewise, those who answered may or may not buy irradiated food were also asked to bid. Current prices for the food products used in this survey were taken from the average prices in selected supermarkets in Palmerston North: *Foodtown, Woolworth and Pak and Save.* For meat products, the prices of selected cuts were used to represent the current average prices for beef, chicken and pork. These average prices were assumed to be the current prices of the enumerated commodities in their respective areas where they usually buy these food products.

Consumers were questioned whether they have heard or read any news report about food irradiation. They were also requested to indicate their source of information. Respondents rated their knowledge level on various food concerns using high, moderate, low and none at all categories. Statements about food irradiation were enumerated and were answered using strongly disagree, disagree, agree, strongly agree and do not know or not sure choices. Whether the concerns were translated into change in consumer behaviour was addressed by further asking those very concerned and those who were somewhat concerned whether their concern would change their shopping behaviour. The consumers' level of concern were based on several choices: very concerned, somewhat concerned, somewhat unconcerned, not concerned and do not know or not sure. The last part of the questionnaire was centred on the consumers' level of confidence on several possible sources of information consumer groups, environmental groups, public health officials, university food scientists, doctors, health food store owners and news media. For these sources of information, they were asked whether they believe, do not believe or were neutral about health information that the sources listed provide.

4.4 Administration of Questionnaire

The letter requesting the respondents' view on food irradiation together with the questionnaire and the reply-paid envelope were mailed in the winter of 1993 (June 1993). The follow-up letter (Appendix 2) without enclosed questionnaire was sent after ten days of distribution of the questionnaire requesting the respondents to accomplish the questionnaire and return it. The cut-off date was set at 24 June 1993.

4.5 The Methods

The CVM is carried out by setting a hypothetical market for goods which otherwise no market exists. People are confronted with the hypothetical market and are asked how much they would be willing to pay to obtain a higher quality good or how much would they be willing to pay for increased safety of particular product. The *ex ante* valuation by participants allows uncertainty to be introduced in the framework while assuming that participants in a constructed market naturally take into account both the uncertainty in their demand and revealed uncertainty of supply when they make their decisions (Carson 1991). Moreover, besides valuing the good in question, a contingent valuation is also able to evaluate the institutional context in which it would be provided (Pearce and Turner 1990; Mitchell and Carson 1989). This method lends itself to a mail survey which means saving time and money compared to other survey techniques such as personal interviews and telephone surveys.

Devousges, Smith and Fisher (1987) used t-tests to examine the prospects for differences in means between zero and non-zero bidders. Logit analysis was applied to determine the potential determinants of zero bids. Extreme values that may have indicated false bids (Brookshire, Ives and Schulze 1976) can be identified by employing a statistical index based on the influence that each observation has on the estimated regression coefficient (Devousges et. al. 1983). Edwards and Anderson

(1987) revealed sample related biases in estimates of aggregation benefits resulting from sampling errors and non-response biases. Both problems can be handled by using systematic approaches such as Chi^2 comparisons of distributions among variables between the sample and the non-respondents respectively.

Data analysis in the dichotomous choice approach calls for econometric models such as the logit model to predict the probability of accepting an offer as a function of the stated price and other socio-economic variables. Subsequently, the probability is used to calculate either the mathematical expectation or the maximum willingness to pay or the median value (Bishop and Heberlein 1987).

Most recent studies used the iterative bidding procedures arguing that it is more similar to the situation the consumer faces in a market and does not burden the consumer with having to value a product which the consumer is often not familiar with. Iterative bidding approaches allow consumers to research their preferences. Another area of choice is the means by which willingness to pay is elicited. The choices are between an open-ended approach in which the maximum amount consumers are willing to pay is elicited through either a single bid or through an iterative bidding procedure or a closed-ended approach in which consumers are asked whether or not they would pay a specified amount which is varied across consumers for the product being valued.

4.5.1 Statistical Procedures Employed

In this study, the respondents were presented with will buy, will not buy, may or may not buy and not sure choices about food irradiation if this process is allowed in New Zealand. Those who answered will buy and may or may not buy were requested to proceed with their respective questions where the food items that can be irradiated together with their current prices were enumerated for bidding. The bidding was done using the tabulated amount found in question Q15 of Appendix 1.

The consumers were asked to circle their respective willingness to pay valued at $0.10, $0.25, $0.50, $0.75 and $1.00 per unit. If the amount they were willing to pay was not among the choices shown, they were allowed to put the value of their willingness to pay in the corresponding space provided which was an open-ended bidding.

One goal of this study was to evaluate the relativity of socio-demographic variables to product attribute (food irradiation). However, because actual measurement of food irradiation was not included and not practised at the moment, the relationships of socio-demographic characteristics with their perceptions of food irradiation concerns were evaluated.

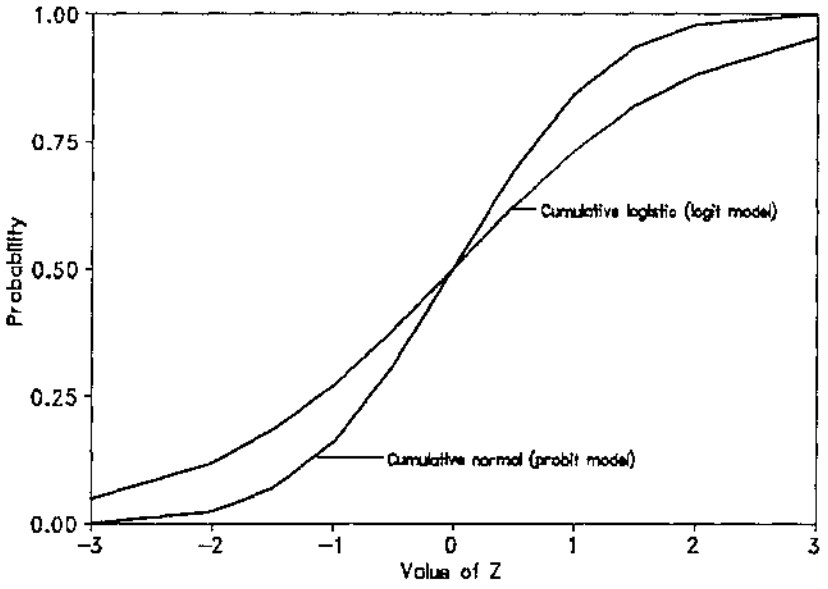
Means were calculated for consumer responses to various socio-demographic variables such as age, weight, income and household size. In most of the questions asked of the respondent, frequency analyses showed the comparative statistics between groups. Groupings was based on the concern levels of the consumers and their willingness to pay. Thus, those who were very concerned were compared with those respondents with different level of concerns. Consequently, the characteristics of the respondents who were willing to buy irradiated food were contrasted with the respondents who were either not willing to buy irradiated food or were not sure about it.

The dichotomous nature of the dependent variable, consumers preference for irradiated food or non irradiated food, required that a binary choice model be used. Three alternative qualitative response models are commonly used in empirical analyses of discrete choice. These are the linear probability model, the logit model and the probit model. Econometric problems associated with linear probability models are well recognised (Amemiya 1981) and necessarily limit its suitability for empirical work. Although ordinary least squares regression can be used to estimate a binary choice model, it has at least two statistical drawbacks which make it

inappropriate in this situation. First, the error term in a linear probability model is heteroscedastic, or the variance of the error term is not constant across observations making the test of a coefficient's statistical significance nonsensical. Thus making non normal residual errors. Second, the estimated coefficients in the linear probability model can lead to predicted values of the dependent variable that are not required to lie between zero to one (0-1) boundaries (Pindyck and Rubinfeld 1981).

The goal of this analysis was to determine the effects of various exogenous factors on the decision of a consumer to purchase irradiated food. Qualitative response models relate the probability of the occurrence of an event to various independent variables. Since the dependent variable was qualitative, logit or probit regression can be used. Such models are often useful in assessing consumer characteristics that are associated with purchase decisions (Capps, Moen and Branson 1988). Although there are subtle differences, (Figure 4.01) the probit and logit specifications usually yield nearly identical results and are thus difficult to distinguish

Figure 4.01 Comparison of Probit and Logit Models



Source: Pindyck and Rubinfeld (1981)

from one another statistically (Amemiya 1981; Pindyck and Rubinfeld 1981; Capps and Kramer 1985) except that the logistic has slightly fatter tails. Given this equivalence, the logit specification was arbitrarily chosen for the empirical analyses undertaken in this paper.

4.5.2 The Logit Model

The logit model appeared to be preferred for analysing dichotomous choice models and the model is based on a statistical structure that is compatible with most choice theories. The model assumes that the probability of willingness to buy, P_i, depends on a vector of independent variables (X_is) associated with consumer i, and a vector of unknown parameters ß. A dichotomous random variable y_i, for which y_i = 1 if the consumer was willing to buy irradiated food and y_i = 0 otherwise, was defined. For the logit model, this probability was determined by:

$$P_i = F(Z_i) = F(\alpha + \beta X_i) = \frac{1}{1 + e^{-Z_i}} \qquad \text{[Eqn. 4.01]}$$

where $F(Z_i)$ represents the value of the standard normal density function associated with each possible value of the underlying index Z_i.

P_i = probability that an individual will make a certain choice (e.g. will buy or will not buy); given knowledge of X_is (independent variables);

e = base of natural logarithms approximately equal to 2.7182;

Z_i = underlying index number or βX_i; and

α = the intercept

The underlying index number, βx_i is a linear combination of independent variables. Thus,

$$Z_i = \log \frac{P_i}{1-P_i} = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n + \epsilon \qquad \text{[Eqn. 4.02]}$$

where i = 1, 2, ... , I are observations;

Z_i = the unobserved index level or the log odds of choice for the ith observation;

X_n = the nth explanatory variable for the ith observation;

ß = the parameters to be estimated;

ϵ = error term or disturbance term.

The dependent variable in the above equation [4.02] is the logarithm of the odds that a particular choice will be made. The slope of the cumulative logistic distribution is greatest at P = 0.50. This implies that changes in independent variables will have the greatest impact on the probability of choosing a given option at the midpoint of the distribution. The low slopes near the endpoints of the distribution imply that large changes in X are necessary to bring about a small changes in probability (Pindyck and Rubinfeld 1981).

The parameter themselves do not represent directly the change in the independent variables. Such probability changes depend on the original probability and thus on the initial values of all the independent variables and their coefficients (Judge, Griffiths, Hill, Lutkepohl and Lee 1982). For the logit model, the change in probability that $Y_i = 1$ (P_i) brought about by a change in the independent variable, X_{ij} is given by:

$$\frac{\partial P_i}{\partial X_{ij}} = \frac{\beta_j e^{-\beta X_i}}{(1 + e^{-\beta X_i})} \qquad \text{[Eqn. 4.03]}$$

However, when independent variables are of qualitative nature, as is the case for most of the explanatory variables in this model, $\frac{\partial P_i}{\partial X_{ij}}$ does not exist in that X_{ij} is discrete and thus cannot vary continuously. In this case, probability changes must be obtained by evaluating P_i at the alternative values of X_{ij}. Thus,

$$\frac{\partial P_i}{\partial X_{ij}} = \frac{P\ (Y_i \mid X_j = 1) - P\ (Y_i \mid X_j = 0)}{1 - 0} \qquad \text{[Eqn. 4.04]}$$

4.5.3 The Ordered Logit Model

The ordered logit model procedure using the maximum likelihood estimator (MLE) was used as the methodology of choice to achieve the objective of the study relating to concern levels. Amemiya (1985) suggests that the ordered logit model is the best procedure for capturing the magnitude of independent variable effects for polynomial ordered models of qualitative dependent variable. One of the objectives of this study is to analyze the demographic effects on concern for food irradiation and not to predict the concern of individuals because good parameter estimates of the true dependent variables are needed for characterisation of the population. MLE was chosen to maximise the combined density of the observed dependent variables as opposed to classical regression where estimates are chosen to maximise the fitting of the dependent variable prediction and thus maximising the R^2.

Considering a multiple choice of j = 0, 1, 2, and 3, as it was the case for level of concern about food irradiation, the equations were formulated as:

$P_{0i} = \alpha_0 + ß_0 X_i;$ [Eqn. 4.05]

$P_{1i} = \alpha_1 + ß_1 X_i;$

$P_{2i} = \alpha_2 + ß_2 X_i;$

$P_{3i} = \alpha_3 + ß_3 X_i;$

where P_{ij} is the probability that individual i will choose the jth option, while X_i is the value of the X for the individual.

Overall probabilities are calculated at their means using the estimated intercepts and the coefficients with the respective means. The probability (P) for each outcome has the formula:

$$P(Y = 0) = P_0 = \frac{e^{\alpha^0+\beta X}}{1 + e^{\alpha_0+\beta X}} \qquad \text{[Eqn. 4.06]}$$

$$P(Y = 1) = P_1 = \left[\frac{e^{\alpha_1+\beta X}}{1+e^{\alpha_1+\beta X}} \right] - \left[\frac{e^{\alpha_0+\beta X}}{1+e^{\alpha_0+\beta X}} \right] \qquad \text{[Eqn. 4.07]}$$

$$P(Y = 2) = P_2 = \left[\frac{e^{\alpha_2+\beta X}}{1+e^{\alpha_2+\beta X}} \right] - \left[\frac{e^{\alpha_1+\beta X}}{1+e^{\alpha_1+\beta X}} \right] \qquad \text{[Eqn. 4.08]}$$

$$P(Y = 3) = P_3 = 1 - \left[\frac{e^{\alpha_2+\beta X}}{1+e^{\alpha_2+\beta X}} \right] \qquad \text{[Eqn. 4.09]}$$

where α_is are intercepts; i is the choice; ß' is the vector of coefficient estimates and X_i is the vector of independent variables.

Marginal effects for the continuous variables were derived for the ordered logit using:

P_0: $\quad \beta_j \{P_0 (1 - P_0)\}$

P_1: $\quad \beta_j [\{(P_0 + P_1)(1 - P_0 - P_1)\} - \{P_0 (1 - P_0)\}]$

P_2: $\quad \beta_j [\{(P_0 + P_1 + P_2)(1 - P_0 - P_1 - P_2)\} - \{P_0 + P_1)(1 - P_0 - P_1)\}]$

P_3: $\quad -\beta_j [P_0 + P_1 + P_2)(1 - P_0 - P_1 - P_2)$

Marginal effects for qualitative variables like sex were computed as:

$P_i [Y = 0] - P_i [Y = 1]$

It is not necessary to run all four of the probability regressions since the estimated probabilities are constrained to one. To check the calculations, the sum of the probabilities was equal to one, $\sum_{k=0}^{3} P_i = 1$ and the sum of the marginal effects was equal to zero, $\sum_{k=0}^{3} \frac{\partial P_k}{\partial X_{ij}} = 0$.

4.5.4 The Econometric Models

Two models were developed to determine the demographic effects on willingness to buy and concern about food irradiation. These were the dichotomous and the polychotomous logit models.

The probability P_i resulting from the dichotomous logit probability model in the study has the function of:

$$\begin{aligned} \text{Choice} = {} & ß_0 + ß_1\text{Health} + ß_2\text{Diet} + ß_3\text{Knowledge} + ß_4\text{Age} \\ & + ß_5\text{Belief1} + ß_6\text{Belief2} + ß_7\text{Belief3} + ß_8\text{Urban} \\ & + ß_9\text{Education2} + ß_{10}\text{Education3} + ß_{11}\text{Household} + ß_{12}\text{Sex} \\ & + ß_{13}\text{Income2} + ß_{14}\text{Income3} + ß_{15}\text{Income4} + ß_{16}\text{Organisation1} \\ & + ß_{17}\text{Organisation2} + ß_{18}\text{Organisation3} \end{aligned} \qquad \text{[Eqn. 4.10]}$$

where choice was one if the respondent indicated willingness to buy irradiated food and zero if otherwise. Note that with the logit specification, the cumulative distribution function (CDF) is represented by the transformed logistic distribution. The choice to buy irradiated food was hypothesized to depend upon a variety of

demographic as well as economic factors. In particular, the willingness to pay for irradiated food may be strongly tied to demographic factors such as individual age, income level, household size, education and sex.

The variables are defined in Table 4.01. Note that some of the explanatory variables are also of qualitative nature. Consumption of these newly introduced food might also depend upon traditions or other cultural influences associated with age. Older consumers may show a stronger preference for the willingness to buy irradiated food. Irradiated food may be considered a new food that may cater to particular ethnic groups. In this light, an individual ethnic heritage may be an important factor in influencing decision of buying or not buying irradiated food. A variable that attempts to capture this ethnic effect was included in the logit model. If the suggested ethnic effect is present, this variable should exert a positive influence on the likelihood of an individual purchasing irradiated food. However, initial result showed highly insignificant relationship of ethnic and willingness to buy. Hence, the ethnic variable was deleted.

Differences in the probability of willingness to purchase irradiated food may exist across different income groups. In particular, high income groups may be more likely to afford increase in the current price of the food in exchange for perceived health benefits that they may derive from the consumption of irradiated food. Qualitative variables representing income were included in the logit model.

Household size may also have a significant influence on the willingness to purchase irradiated food due to the greater financial burden of feeding larger families. A consumer's educational level might also have a significant influence on the likelihood to purchase irradiated food. A higher level of educational attainment might imply an enlightened and more receptive attitude toward unusual food on the part of the consumer. Redman (1980) noted that a positive association exists between education and the nutritional consciousness of the consumer. A well-

educated consumer may also be more cognizant of irradiated food's attributes. It is also possible that educational attainment is highly correlated with other omitted socio-economic variables that influence the consumption of food.

Table 4.01 Variable Definitions for the Dichotomous Choice Logit Model

Variable	Definition
Dependent variable:	
Choice	1 if the household is willing to buy irradiated food; 0 otherwise
Independent Variable:	
Diet	1 if the respondent observes a particular diet; 0 otherwise
Knowledge	4 if high; 3 if moderate; 2 if low and 1 if none
Health	5 if excellent; 4 if very good; 3 if good; 2 if fair; and 1 if poor
Education	
Education1	1 if the respondent has a formal education; 0 otherwise
Education2	1 if the respondent has primary education; 0 otherwise
Education3	1 if the respondent attended university or postgraduate study; 0 otherwise
Household size	Number of people in the household
Age	Age of the respondent
Sex	1 if the respondent is female; 0 if male
Organisation	
Organisation1	1 if the respondent is affiliated with an environmental group; 0 otherwise

Organisation2	1 if the respondent is affiliated with a consumer group; 0 otherwise
Organisation3	1 if the respondent is affiliated with any organisation (e.g. the environmental group, the consumer group or any social group); 0 otherwise
Urban	1 if respondent lives in urban area; 0 otherwise
Income	
Income 1	1 for income range of $20,000 and below; 0 otherwise
Income 2	1 for income range of $20,001 to $40,000; 0 otherwise
Income 3	1 for income range of $40,001 to $60,000; 0 otherwise
Income 4	1 for income range of $60,000 and above; 0 otherwise
Beliefs	scaled on the basis of: -2 for strongly agree; -1 for agree; 0 for do not know; 1 for disagree; and 2 for strongly disagree
Belief 1	scaled as beliefs above based on the statement 'Food irradiation could make the food radioactive'
Belief 2	scaled as beliefs above based on the statement 'Food irradiation could affect the wholesomeness of the food (e.g. taste and nutritional value)'
Belief 3	scaled as beliefs above based on the statement 'Food irradiation could be hazardous to your health'

Qualitative variables for household size,income ranges and education were also included in the logit model. The sex of consumers may also have an influence on the decision to buy irradiated food because of traditional sociological norms that female consumers may possess a greater knowledge of the nutritional characteristics of food in general as well as greater expertise in the preparation of specialty products. The respondents perceived attributes of irradiated food in terms of radioactivity, wholesomeness and health effects were assumed to have direct effect on their willingness to buy. Consumers who have negative perception about radioactivity, wholesomeness and health effects based on the statements provided were expected to show a high degree of concern and lesser likelihood of buying irradiated food. This study did not argue on the technical safety of irradiated food. The statements

were provided to serve as a gauge to know how consumers would react to irradiated food based on the statements provided to them.

Finally, the logit model contains qualitative variables that distinguish locations of the consumers. These variables were included to allow for consumer differences that vary by city but are not captured by variables that are included in the model.

For estimation purposes, the level of concern about food irradiation was aggregated into the following to run the ordered logit of polychotomous choice: Concern = 0 for the not concerned; Concern = 1 for somewhat concerned; Concern = 2 for somewhat unconcerned; and Concern = 3 for very concerned. Thus the model used to analyze the dependence of concern levels on demographic characteristics was specified as:

$$\begin{aligned}\text{Concern} = {} & \beta_0 + \beta_1\text{Health} + \beta_2\text{Diet} + \beta_3\text{Knowledge} + \beta_4\text{Age} \\ & + \beta_5\text{Heard} + \beta_6\text{Urban} + \beta_7\text{Education2} + \beta_8\text{Education3} \\ & + \beta_9\text{Household} + \beta_{10}\text{Sex} + \beta_{11}\text{Income2} + \beta_{12}\text{Income3} \\ & + \beta_{13}\text{Income4} + \beta_{14}\text{Organisation1} + \beta_{15}\text{Organisation2} \\ & + \beta_{16}\text{Organisation3}\end{aligned} \qquad \text{[Eqn. 4.11]}$$

The independent variables included in the ordered logit model above are defined in the same manner as the independent variables in the dichotomous choice model. Another dummy variable, heard was introduced to represent whether the respondent have heard and or read anything about food irradiation.

4.5.5 Statistical Tests of Significance

The significance of all or a subset of the coefficients in the logit model was tested using the chi-square distribution or the log likelihood ratio test. The test statistics was:

$$W = -2\,(\log L_0 - \log L_{max}) = -2\log\lambda \qquad \text{[Eqn. 4.12]}$$

where: $\lambda = \frac{L_0}{L_{max}}$; [Eqn. 4.13]

Log L_0 was the value of the log likelihood function when all the parameters except the constant (or certain parameter) was set equal to zero. Log L_{max} was the value of the log likelihood function with all the variables and a constant in the model. The -2 log likelihood statistic indicates that the amount of variation explained by the model is significantly different from zero; the test follow chi-square distribution with k degrees of freedom (Capps and Kramer 1985).

To measure the predictability of the model, an R statistic was computed. The R statistic is similar to the multiple correlation coefficient in the normal setting with due correlation made for the number of parameters estimated. The form was:

$$R^2 = (W-2p)/(-2L(0)) \quad \text{[Eqn. 4.14]}$$

where:

W was the model chi^2, p was the number of variables in the model excluding the intercept and L(0) was the maximum log-likelihood with only intercepts in the models. If the 2p is ignored, R has a value of zero if the model is of no value and one if the model fits perfectly.

Where there are competing models which have different numbers of parameters, one should make adjustment for degrees of freedom. Akaike proposed the simple formula which is called Akaike Information Criterion (AIC) that is defined as:

$$AIC = -2\log L + 2\,(k+s) \quad \text{[Eqn. 4.15]}$$

where k was the number of ordered values for the response and s was the number of explanatory variables (Amemiya 1981). The formula has to be used when

comparing different models from the same data and a lower value of the statistic indicates a more desirable model.

Another measure in selecting the best model was through the Chi-square Score Statistic which gives a test for the joint significance of the explanatory variables in the model. The test considered only the independent variables and the formula was defined as:

$$U'(\tau)\ I^{-1}(\tau)\ U(\tau) \qquad \text{[Eqn 4.16]}$$

where: $U'(\tau)$ was the vector of partial derivatives of the log likelihood with respect to the parameter vector τ;

$I(\tau)$ was the matrix of the negative second partial derivatives of the log likelihood with respect to τ;

In this test, the hypothesis (Ho) was formulated as Ho: $\tau = \tau$. This formula has an asymptotic chi^2 distribution with r degrees of freedom; r was the dimension of τ.

Predicting the correctness of the model involved another criterion called percent of correct prediction. This method was used to check whether or not an event will occur given a set of values for the explanatory variables. Based on this usage, a summary measure was the percent of successful prediction within the given sample (Judge, Griffiths, Hill, Lutkepohl, and Lee 1982). For the binary response model, the outcome is labelled as an event if the ordered response was equal to one and no event if the ordered response was equal to two. The probability of an event was $p = F(\alpha + \beta x)$. The response was predicted to be an event if the estimated value of p was greater or equal to 50 percent. However, the percent prediction was only possible for dichotomous logit model.

Chapter 5

Results and Discussions

I know of no safe depository of the ultimate powers of the society but the people themselves, and if we think them not enlightened enough to exercise that control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion.

Thomas Jefferson, *letter, 1820*

5.1 Profile of the Respondents

A total of 404 respondents was found useful after eliminating those with incomplete answers and missing information. Table 5.01 shows the summary statistics of demographic characteristics of the respondents. The average respondent was 45 years old and weighed 71 kilograms. Nearly half (46 percent) of the respondents had either some university, completed university course, had trade, vocational or polytechnic training or other higher education. Unemployment was high at 30 percent. This may be because the respondents were composed of major food shop buyers for the household. Most of them were from the North Island (71 percent) and were living in urban areas.

The average household size was three. One half of the household size was employed and total earnings for the household fell on the mode between the income range of $ 30,001 to $ 40,000. Twenty five percent of their household income was spent on food. Majority of the respondents were female (71 percent) and married (75 percent) of European origin (82 percent). Furthermore, more than half (63 percent) were affiliated with an organisation.

Table 5.01 The Demographic Characteristics of the Respondents

Characteristic	Description
Age	45 years
Sex	71 percent female
Weight	71 kilograms
Household size	3 people
Household income	$ 30,000 - $ 40,000 per year range; 37 percent earned $40,001 and above
Number of persons employed in the household	1.60 persons
Employment status	70 percent employed
Ethnic origin	82 percent of European origin
Education	22 percent with some university and or higher education
Proportion of household income spent on food	25 percent
Residence	71 percent were in the North Island; 76 percent were from urban areas

New Zealand population is predominantly of European origin (Table 5.02). There are approximately equal number of males and females with females outnumbering the males by only one percent. Most of the population lives in the North Island where 26 percent alone are concentrated in Auckland. Of the total population, 85 percent reside in the urban areas. In the 1991 household survey conducted by the Department of Statistics, 37 percent of the households surveyed

belonged to income range of $40,000 and above. The average weekly household income was $759 of which 13 percent was spent for food. Classification of urban and non-urban areas was based on 1991 Census of Population of the Department of Statistics.

Table 5.02 Statistical Profile of the New Zealand Population, 1991

Item	Description
Sex	51 percent female
Age	median of 31.6 years
Marital Status	31 percent single; 46 percent married
Geographic location	74 percent from the North; 85 percent from main and secondary urban areas; 69 percent from the main urban areas
Ethnicity	12.9 percent Maori; 4.6 percent Pacific Islander
Unemployment	9.9 percent of total labour force
Household Income	$759 per week; 37 percent belongs to $40,000 and above per year
Food Expenditure*	13 percent of total weekly household income
Household size	2.72 persons
Religious Profession	22 percent Anglican; 16 percent Presbyterian; 15 percent Roman Catholic; 20 percent no religion; 8 percent object; 19 percent other specified religion

Source: *New Zealand Official 1993 Yearbook; 1991 Census of the Department of Statistics*

* includes consumption away from home

This study (Table 5.01) was compared with the statistical profile of the New Zealand population (Table 5.02). The resulting sample is over representative of the female population, older population, the married and the unemployed. However, it approximates the 1991 income distribution, the household size, religious profession, ethnic origin and geographic distribution of the New Zealanders.

5.1.1 Grouping of Respondents

Table 5.03 presents the categories used in analysing the results of this study. Respondents were grouped based on their level of concern and their willingness to buy irradiated food. Respondents level of concern were divided into very concerned, somewhat concerned, somewhat unconcerned, not concerned and do not know categories. More than half (55 percent) of the respondents expressed either very concerned or somewhat concerned attitude toward irradiated food. The not concerned (15 percent) were nearly the same as the very concerned (17 percent) in terms of concern levels. A significant number of the respondents fell on the somewhat concerned category (38 percent).

Faced with a choice between irradiated and non irradiated food, the householders have an ambivalent reaction. Respondents were asked to choose among will buy, will not buy, may or may not buy and do not know options if irradiated food were introduced in the market. The may or may not buy and do not know choices were then combined together to form the not sure group. This group represented the biggest proportion of the total sample. Most of the not sure group (69 percent) answered may or may not buy irradiated foods (47 percent), the rest (22 percent) answered do not know. A mere seven percent would be willing to buy irradiated food whilst almost one fourth (24 percent) would reject irradiated food.

As expected, the very concerned were not willing to buy irradiated food. Likewise, those who were not concerned were mostly (79 percent) open to the

introduction of irradiated food and some (14 percent) were not sure. A large percentage of those who answered somewhat concerned (75 percent) and a majority of the somewhat unconcerned (91 percent) were not sure. Grouping the very concerned and the somewhat concerned groups produced 55 percent expressing greater concerns compared to the grouping of the somewhat unconcerned and the not concerned groups which comprised 26 percent likely acceptance of irradiated food. The remaining 18 percent were undecided.

Table 5.03 Respondents Level of Concern and their Willingness to Buy Irradiated Food.

Level of Concern	Will Buy		Will Not Buy		Not Sure		All	
	no.	%	no.	%	no.	%	no.	%
Very concerned	0	0	52	55	16	6	68	17
Somewhat concerned	1	3	38	40	115	41	154	38
Somewhat unconcerned	4	14	0	0	42	15	46	11
Not concerned	23	79	1	1	38	14	62	15
Do not know/not sure	1	3	3	3	69	25	73	18
Total	29	7	94	23	280	69	403	100

5.1.2 Comparing Demographic Characteristics Based on Concern Levels and Willingness to Buy Irradiated Food

Those who expressed unwillingness to buy irradiated food had slightly larger household size (Table 5.04) than those who were willing to buy irradiated food (3.7 versus 3.0) slightly larger than the average household size of three persons. They were also older by two years and had almost similar weight as those who were

Table 5.04 Frequency Distribution and Demographic Statistics of Repsondents Belonging to Willingness to Buy Category

Item	Will Buy		Will Not Buy		Not Sure		All	
	no.	%	no.	%	no.	%	no.	%
Average:								
Household size (number)	3.0		3.7		3.1		3.1	
Number of children below 15 years old in the household	0.7		0.9		0.7		0.7	
Number of people employed in household	1.3		1.8		1.6		1.6	
Household income (range) *	4.7		4.7		4.2		4.2	
Proportion of income spent on food	21.4		30.9		24.9		24.7	
Age (years)	48.6		50.5		44.9		44.8	
Weight (kilograms)	76.8		78.5		71.4		70.6	
Sex								
Male	16	55	14	15	85	30	115	28
Female	13	45	81	85	192	69	286	71
Marital Status								
Single	6	21	8	8	42	15	56	14
Married	22	76	79	83	203	73	304	75
Divorced	1	3	7	7	17	6	25	6
Widowed	0	0	1	1	14	5	15	4
Education								
No formal education	0	0	0	0	2	1	2	0
Completed primary school	0	0	1	1	8	3	9	2
Some secondary school	6	21	10	11	47	17	63	16
Completed secondary school	4	14	34	36	93	33	131	32
Some university	5	17	12	13	26	9	43	11
Completed university degree	5	17	5	5	16	6	26	6
Some postgraduate school	1	3	3	3	8	3	12	3
Completed postgraduate degree	0	0	2	2	6	2	8	2
Trade/vocational/Polytechnic training	7	24	26	27	64	23	97	24
Geographic location **								
North Island	17	59	67	73	195	72	279	71
South Island	12	41	25	27	75	28	112	29
Urban areas	23	79	71	77	201	74	295	75
Non-urban areas	6	21	21	23	69	26	96	25

* average income was based on numerical range from 1 to 7 where 4 is equal to $ 30,001 to $40,000 range and 5 is equal to $ 40,001 to $ 50,000 (refer to Table 5.06 for details)

** based on 1991 Census classification of the Department of Statistics

willing to buy irradiated food. Both had almost the same income level but those who were willing to buy spent only 21 percent of their household income on food compared to 31 percent spent on food by those who were not willing to buy. In addition, those who were willing had more education (38 percent with either some university schooling and or higher education) than those who did not want to try irradiated food.

Based on the level of concern, those who were not concerned had the smallest household size (2.7), least number of people employed in their household (1.7) and weighed more than those who expressed very and somewhat concerned attitudes. Higher education was also observed among those who were not concerned (Table 5.05) when compared with the very concerned, somewhat concerned and those who did not express any concern level at all.

Those who were married may have been more cautious about buying irradiated food as they may have children to look after. Only eight percent of those who were not willing to buy were single whilst 21 percent of those who were willing to buy irradiated food were single (Table 5.04). Concern levels for single respondents was lower than the married, divorced and widowed respondents. Married respondents expressed greater concern over food irradiation.

The sex of the respondents was regarded as a key factor to the attitude of the households. The proportion of males in the not concerned category was higher than in the other level of concerns (Table 5.05). The percentage of female respondents increased in each group as the level of concern increased. Consequently, the percentage of the males increased as the level of concern decreased. A greater number of those who answered do not know were females. Fifty five percent of those who were willing to buy were males whilst 85 percent of those who were not willing to buy were females. Among the not sure group, 69 percent were female.

Table 5.05 Frequency Distribution and Demographic Statistics of the Respondents by Level of Concern

Item	Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know		All	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Average:												
Household size (number)	3.1		3.2		3.2		2.7		3.0		3.1	
Number of children below 15 years in the household	0.6		0.8		0.6		0.6		0.8		0.7	
Number of people employed in the household	1.5		1.7		1.9		1.3		1.4		1.6	
Household income (range)	3.8		4.4		4.7		4.3		3.7		4.2	
Proportion of income spent on food	28.4		23.1		21.2		24.0		27.9		24.7	
Age (years)	46.7		42.7		42.1		46.8		47.0		44.8	
Weight (kilograms)	68.5		69.0		78.0		75.4		67.1		70.6	
Sex												
Male	11	16	38	25	17	37	35	56	14	19	115	29
Female	56	82	118	77	28	61	27	44	58	79	287	71
Marital Status												
Single	7	10	19	12	8	17	12	19	10	14	56	14
Married	53	78	124	81	32	70	44	71	52	71	305	76
Divorced	3	4	9	6	3	7	6	10	4	5	25	6
Widowed	3	4	4	3	2	4	0	0	6	8	15	4
Education												
No formal education	0	0	1	1	0	0	0	0	1	1	2	0
Completed primary school	1	1	4	3	0	0	2	3	3	4	10	2
Some secondary school	8	12	22	14	8	17	7	11	19	26	64	16
Completed secondary school	35	51	60	39	9	20	24	39	19	26	147	36
Some university	9	13	17	11	5	11	7	11	7	10	45	11
Completed university degree	2	3	12	8	5	11	7	11	5	7	31	8
Some postgraduate school	3	4	5	3	5	11	1	2	3	4	17	4
Completed postgraduate degree	1	1	3	2	1	2	1	2	1	1	7	2
Trade/vocational/Polytechnic trng.	15	22	43	28	15	33	16	26	16	22	105	26
Geographic Location												
North Island	45	68	108	71	31	70	42	69	53	77	279	71
South Island	21	32	44	29	13	30	19	31	16	23	113	29
Urban areas	51	77	115	76	33	75	46	75	51	74	296	76
Non-urban areas	15	23	37	24	11	25	15	25	18	26	96	24

Table 5.06 and Table 5.07 show the detailed characteristics of the respondents pertaining to employment status, number of persons employed in the household and annual household income categorised into willingness to buy and level of concern. Most of the respondents were employed on full time (45 percent) and part time (21 percent) jobs. The percentage of unemployment was higher among those who were not concerned (37 percent) and those who were willing to buy (38 percent) than any other groups. However, the same group had a higher percentage of full employment compared to other groups. It should be noted that total unemployment of the respondents was 30 percent whereas household unemployment was 20 percent. The mode of number of people employed in the household was two. Those who will buy irradiated food had the largest percentage (48 percent) in their particular group of two people earning and employed. The distribution of people employed on the basis of level of concern did not vary as much except for the not concerned who exhibited the highest household unemployment of 31 percent. Annual household income for those who were willing to buy was higher than any other categories with 45 percent of them having annual household income of more than $40,000. Similarly, those unconcerned about food irradiation were found to belong to higher household income range than those with higher level of concern.

Concern levels may be associated with the occupation of the respondents. A significant number of respondents (Table 5.08) were homemakers (24 percent), professionals (18 percent), had clerical jobs (13 percent) and retired from work (12 percent). The major occupation of those who were willing to buy (Table 5.08) irradiated food were involved with professional and managerial works (41 percent) whilst those who were not willing to buy irradiated food were mostly either professional (20 percent) or homemaker (21 percent). Higher level of concern (Table 5.08) was observed among the homemakers and those with clerical jobs than those who had retired and were professionals.

Table 5.06 Employment Status, Number of Persons Employed in the Household and Annual Household Income by Willingness to Buy

Item	Will Buy		Will Not Buy		Not Sure		All	
	no.	%	no.	%	no.	%	no.	%
Employment Status								
Full time	17	59	34	36	130	46	181	45
Part time	0	0	25	26	59	21	84	21
Not at work	1	3	7	7	5	2	13	3
Not employed	11	38	28	29	83	30	122	30
Number of people employed in the household								
None	8	28	16	17	56	20	80	20
One	6	21	27	28	63	23	96	24
Two	14	48	38	40	120	43	172	43
Three	1	3	7	7	20	7	28	7
Four and above	0	0	7	7	16	6	23	6
Household Size								
One	3	10	6	6	27	10	36	9
Two	12	41	33	35	92	33	137	34
Three	3	10	20	21	52	19	75	19
Four	7	24	14	15	53	19	74	18
Five and above	3	10	20	21	49	18	72	18
Annual Household Income								
$10 000 and below	0	0	12	13	15	5	27	7
$10 001 to $20 000	4	14	10	11	43	15	57	14
$20 001 to $30 000	4	14	13	14	56	20	73	18
$30 001 to $40 000	7	24	15	16	53	19	75	19
$40 001 to $50 000	4	14	13	14	27	10	44	11
$50 001 to $60 000	3	10	7	7	20	7	30	7
$60 001 and above	6	21	16	17	53	19	75	19

Table 5.07 Employment Status, Number of People Employed in the Household and Annual Household Income by Level of Concern

Item	Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know		All	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Employment Status												
Full time	28	41	70	45	23	50	31	50	29	40	181	45
Part time	14	21	38	25	10	22	7	11	17	23	86	21
Not at work	4	6	6	4	1	2	0	0	1	1	12	3
Not employed	21	31	42	27	11	24	23	37	25	34	122	30
Number of people employed in the household												
None	15	22	24	16	6	13	19	31	16	22	80	20
One	15	22	40	26	10	22	12	19	19	26	96	24
Two	28	41	68	44	19	41	24	39	34	47	173	43
Three	2	3	13	8	7	15	4	6	2	3	28	7
Four and above	5	7	10	6	4	9	3	5	1	1	23	6
Annual Household Income												
$10 000 and below	10	15	8	5	1	2	2	3	5	7	26	6
$10 001 to $20 000	9	13	20	13	5	11	8	13	15	21	57	14
$20 001 to $30 000	13	19	26	17	5	11	13	21	16	22	73	18
$30 001 to $40 000	11	16	27	18	9	20	15	24	13	18	75	19
$40 001 to $50 000	5	7	19	12	8	17	7	11	5	7	44	11
$50 001 to $60 000	3	4	15	10	4	9	4	6	4	5	30	7
$60 001 and above	12	18	33	21	10	22	12	19	10	14	77	19

Table 5.08 Respondents Occupation by Willingness to buy and Level of Concern

Item	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Management	3	10	5	5	17	6	5	7	6	4	4	9	5	8	6	8	26	6
Professional	9	31	23	24	48	17	12	18	31	20	13	28	12	19	15	21	83	21
Clerical	0	0	12	13	32	11	14	21	20	13	4	9	7	11	8	11	53	13
Tradesperson	1	3	0	0	14	5	1	1	9	6	3	7	4	6	1	1	18	4
Homemaker	4	14	20	21	51	18	17	25	44	29	7	15	8	13	20	27	96	24
Retired	6	21	9	9	33	12	8	12	14	9	4	9	14	23	10	14	50	12
Self-employed	2	7	4	4	24	9	4	6	18	12	4	9	6	10	5	7	37	9
Sales and Personal Services	1	3	2	2	11	4	3	4	4	3	2	4	5	8	5	7	19	5
Labourer, agric. worker, craftsman	2	7	5	5	21	8	3	4	17	11	5	11	3	5	3	4	31	8
Other	1	3	3	3	8	3	0 5	7	3	2	2	4	1	2	3	4	14	3
Total	29	100	83	87	259	93	72	106	166	108	48	104	65	105	76	104	427	106

Some respondents reported more than one answer

The household size, number of persons below 15 years old, ethnic origin and organisational affiliation are presented in Tables 5.09 and 5.10. Most of the respondents lived with two person household. Only nine percent of the total respondents were single household. Bigger size of household of three and above was observed among those who were unwilling to buy irradiated food (57 percent) compared to 44 percent for those who will buy. On the other hand, concern level seemed to be lower among the single householders than those with two and more persons in the household. The respondents generally had the same distribution of number of persons below 15 years old in their households. It was hypothesized that household with bigger number of persons below 15 years old in the household will show greater concern and unwillingness to try irradiated food but the distribution proved inconclusive. Perhaps, the age limit should have been lowered further to capture the number of children under the lower age brackets who were directly under the care of the major food shop buyer in the household.

The distribution of the respondents using the ethnic origin were similar to all classes of comparison (Table 5.09 and Table 5.10) dominated by New Zealander of European origin. The householders who belong to consumer movements or environmental organisation indicated greater unwillingness to buy irradiated food and higher level of concern. Thirty two percent of those who will not buy irradiated food were either members or affiliated with the consumer and environmental groups. In comparison, only 16 percent of those who were not concerned have affiliation or membership to either consumer movement or environmental organisations. The very concerned groups had 26 percent indicating membership or affiliation to either the consumer or environmental groups. Among the 94 respondents affiliated to the consumer and environmental groups, 47 percent were members of the *Greenpeace*, 17 percent belong to the *Forest and Bird Society*, and 18 percent were either members and/or subscribers of the *Consumer Institute*. The remaining respondents were members of other organisations like *Peace Movement Aotearoa, New Zealand Association for Environment, World Wildlife Fund,* and *Botanical Society*.

Table 5.09 Household Size, Number of Persons Below 15 Years Old in the Household, Ethnic Origin and Organizational Affiliation by Willingness to Buy

Item	Will Buy		Will Not Buy		Not Sure		All	
	no.	%	no.	%	no.	%	no.	%
Household Size								
One	3	10	6	6	27	10	36	9
Two	12	41	33	35	92	33	137	34
Three	3	10	20	21	52	19	75	19
Four	7	24	14	15	53	19	74	18
Five and above	3	10	20	21	49	18	72	18
Number of persons below 15 years old in the household								
None	18	62	60	63	173	62	251	62
One	4	14	12	13	42	15	58	14
Two	6	21	13	14	35	13	54	13
Three	0	0	7	7	20	7	27	7
Four and above	1	3	3	3	7	3	11	3
Ethnic origin								
New Zealand/European	25	86	75	79	233	83	333	82
New Zealand/Maori	1	3	7	7	20	7	28	7
European	1	3	6	6	9	3	16	4
Asian annd Pacific	1	3	4	4	8	3	13	3
New Zealander (not specified)	1	3	2	2	6	2	9	2
Organisational Affiliation								
Consumer movement	3	10	8	8	15	5	26	6
Environmental organisation	4	14	23	24	40	14	67	17
Civic/social club	6	21	14	15	71	25	91	23
Sports club	14	48	34	36	93	33	141	35
No organisational affiliation	8	28	38	40	105	38	151	37
Name of Organisation								
Greenpeace	2	7	17	18	22	8	41	10
Forest and Bird Society	0	0	2	2	14	5	16	4
Consumer Institute (includes subscriber)	1	3	7	7	10	4	18	4
Other organisations	2	7	4	4	3	1	9	2

Table 5.10 Household Size, Number of Persons Below 15 Years Old in the Household, Ethnic Origin and Organisational Affiliation by Level of Concern

Item	Very Concerned		Somewhat Concerned		Somewhat Unconcerne		Not Concerned		Do Not Know		All	
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Household Size												
One	3	4	12	8	1	2	11	18	9	12	36	9
Two	31	46	49	32	16	35	18	29	24	33	138	34
Three	12	18	27	18	11	24	12	19	13	18	75	19
Four	7	10	34	22	7	15	12	19	14	19	74	18
Five and above	12	18	33	21	9	20	6	10	12	16	72	18
Number of childre below 15 15 years old in the household												
None	44	65	95	62	28	61	42	68	43	59	252	63
One	8	12	22	14	10	22	8	13	10	14	58	14
Two	7	10	19	12	5	11	9	15	14	19	54	13
Three	4	6	15	10	3	7	2	3	3	4	27	7
Four and above	2	3	5	3	0	0	1	2	3	4	11	3
Ethnic origin												
New Zealand/European	55	81	130	84	39	85	52	84	59	81	335	83
New Zealand/Maori	5	7	8	5	3	7	4	6	8	11	28	7
European	3	4	8	5	0	0	3	5	1	1	15	4
Asian and Pacific Island	2	3	7	5	0	0	1	2	3	4	13	3
New Zealander (not specified)	2	3	3	2	2	4	1	2	1	1	9	2
Organisational Affiliation												
Consumer movement	7	10	8	5	4	9	3	5	4	5	26	6
Environmental organisation	11	16	29	19	11	24	7	11	10	14	68	17
Civic/social club	8	12	36	23	17	37	15	24	15	21	91	23
Sports club	29	43	46	30	20	43	25	40	24	33	144	36
No organisation	24	35	67	44	10	22	19	31	30	41	150	37
Name of Organisation												
Greenpeace	8	12	19	12	6	13	6	10	5	7	44	11
Forest and Bird Society	0	0	8	5	4	9	0	0	4	5	16	4
Consumer Institute	4	6	7	5	2	4	2	3	2	3	17	4
Other organisations	6	9	2	1	0	0	4	6	1	1	13	3

There was no distinct pattern that may relate to religion as a factor to willingness to buy and level of concern about food irradiation as most of the distribution as shown in Table 5.11 were similar in almost all classifications except for the respondents who belong to the religious group Jehovah's Witness who were more concerned and were not willing to buy or not sure with their answers.

Three fourths of the respondents believed they were either in a very good or excellent health condition though more than half (53 percent) were not observing a particular diet (Table 5.12 and Table 5.13). Most of those who were willing to buy opined that they were of excellent health condition (45 percent) whereas those who were not sure and will not buy irradiated food indicated that the same percentage of respondents were in a very good health state. Similarly, a higher percentage of the not concerned believed their health was excellent (39 percent) in contrast to 28 percent of those who were very concerned expressing the same health condition (Table 5.12). The respondents who were on a particular diet observed low fat or low cholesterol (30 percent), low salt (11 percent), low sugar or sugar free (11 percent) and low calorie or weight loss (7 percent) diets. Regardless of level of concern and willingness to buy irradiated food, respondents expressed similar pattern of diet observed. It should be noted however, that less householders were not observing diet in the willing to buy group than in the unwilling and not sure groups.

5.2 General Food Attitudes

The households perceived that the general quality of fresh food and vegetables offered by the supermarket was good (49 percent) or very good (23 percent) (Table 5.14). Perceived quality of fresh food and vegetables available in the supermarket was highest in the willing to buy group (45 percent believed that fresh food and vegetables were very good). The same perception was observed among the not concerned group. Most of those who will not buy and those who belonged to higher level of concern believed that fresh food and vegetables in the supermarket were

Table 5.11 Religious Profession of the Respondents

Religion	Willingness to Pay						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Presbyterian	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	1	0
Anglican	7	24	21	22	57	20	16	24	33	21	5	11	14	23	18	25	86	21
Catholic	7	24	22	23	60	21	10	15	37	24	15	33	11	18	16	22	89	22
Mormon (Latter Day Saints)	4	14	9	9	37	13	9	13	17	11	6	13	9	15	9	12	50	12
No religion	0	0	0	0	3	1	0	0	2	1	0	0	0	0	1	1	3	1
Christian (did not specify)	7	24	21	22	70	25	11	16	42	27	12	26	18	29	15	21	98	24
Jehovah's Witness	0	0	8	8	8	3	8	12	3	2	1	2	0	0	4	5	16	4
Ratana	0	0	0	0	3	1	0	0	1	1	1	2	1	2	0	0	3	1
Refuse, Object	0	0	0	0	2	1	0	0	2	1	0	0	0	0	0	0	2	0
Open Brethren	3	10	2	2	8	3	2	3	1	1	1	2	5	8	4	5	13	3
Buddhist	0	0	0	0	2	1	0	0	2	1	0	0	0	0	0	0	2	0
Salvation Army	0	0	0	0	1	0	0	0	0	0	1	2	0	0	0	0	1	0
Other specified	1	3	5	5	20	7	5	7	12	8	3	7	3	5	3	4	26	6
Total	29	100	89	94	271	97	62	91	152	99	45	98	61	98	70	96	390	97

Table 5.12 Respondents' Perceived General Health Condition

Condition	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Excellent	13	45	32	34	78	28	19	28	49	32	13	28	24	39	19	26	124	31
Very Good	8	28	43	45	125	45	31	46	67	43	22	48	23	37	33	45	176	44
Good	5	17	17	18	61	22	12	18	33	21	11	24	12	19	15	21	83	21
Fair	2	7	3	3	15	5	6	9	6	4	0	0	2	3	6	8	20	5
Poor	1	3	0	0	0	0	0	0	0	0	0	0	1	2	0	0	1	0
Total	29	100	95	100	279	100	68	100	155	100	46	100	62	100	73	100	404	100

Table 5.13 Types of Diet Observed by the Respondents

Diet	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Not Observing a particular diet	10	34	44	46	159	57	37	54	77	50	24	52	35	56	41	56	214	53
Low calorie/weight loss	3	10	6	6	19	7	5	7	11	7	2	4	6	10	5	7	29	7
Low fat/cholesterol	10	34	31	33	79	28	18	26	52	34	18	39	12	19	20	27	120	30
Low salt	3	10	14	15	26	9	9	13	19	12	6	13	4	6	7	10	45	11
Low sugar/sugar free	6	21	13	14	17	6	8	12	20	13	6	13	5	8	6	8	45	11
Diabetic	1	3	4	4	4	1	3	4	1	1	0	0	2	3	3	4	9	2
Other diets	5	17	7	7	13	5	3	4	15	10	2	4	3	5	2	3	25	6
Total	38	131	119	125	317	113	83	122	195	127	58	126	67	108	84	115	487	121

* Some respondents expressed more than one answer.

Table 5.14 Respondents' Perception of the General Quality of Fresh Foods and Vegetables Offered by the Supermarket

Perceived Quality	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Very Good	13	45	24	25	54	19	18	26	29	19	8	17	24	39	12	16	91	23
Good	6	21	44	46	147	53	26	38	84	55	21	46	24	39	42	58	197	49
Average	10	34	26	27	78	28	24	35	41	27	17	37	14	23	18	25	114	28
Poor	0	0	1	1	1	0	0	0	1	1	0	0	0	0	1	1	2	0
Total	29	7	95	24	280	69	68	17	155	38	46	11	62	15	73	18	404	100

either average or good. Consciousness in labelling regarding food ingredients was evident on the 55 percent of the sample expressing often and always checking of ingredients label in food (Table 5.15). Those who will not buy were keen about ingredients label in the food they buy. Respondents with stronger concerns about irradiated food were the ones who were more particular about checking ingredients label in food offered for sale in the market.

Sixteen percent of the household consumers (Table 5.16) indicated preference for organically grown fresh food and vegetables (12 percent for often and 4 percent for always). Most of the respondents had either occasional or seldom preference whilst 23 percent did not prefer organically grown fresh food and vegetables. Those who will buy and not concerned showed the strongest dislike for organically grown fresh food and vegetables. Those who preferred organically grown fresh food and vegetables expressed an unwillingness to buy irradiated food. More respondents had no preference for organically grown fresh food and vegetables (38 percent) in the willing to buy group than in the unwilling group (19 percent). Similar pattern was reflected on the basis of concern level. The not concerned group had higher percentage indicating seldom and never choices of preferences with regard organically grown products than in any other level of concern.

Consumers innovativeness measured in terms of their response to newly introduced food products in the supermarket was not as strong with 28 percent of the respondents answering among the first to try newly introduced food product (Table 5.17). The measure of innovativeness did not reflect an association with the willingness to buy irradiated food and the level of concern. In fact, 44 percent of those who will buy irradiated food indicated that they were among the last to try newly introduced food product in the supermarket against 34 percent for the willing to buy group and 31 percent for the not sure group.

Table 5.15 Frequency of Respondents Checking About Ingredients Label in Food

Frequency of Checking	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Always	4	14	24	25	26	9	12	18	25	16	6	13	4	6	6	8	53	13
Often	14	48	47	49	107	38	30	44	75	49	22	48	20	32	22	30	169	42
Occasionally	8	28	13	14	94	34	16	24	39	25	8	17	24	39	29	40	116	29
Seldom	1	3	6	6	36	13	5	7	15	10	7	15	8	13	8	11	43	11
Never	2	7	5	5	14	5	4	6	3	2	2	4	5	8	7	10	21	5

Table 5.16 Respondents' Preference for Organically Grown Fresh Food and Vegetables

Choice	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Always	0	0	5	5	12	4	5	7	8	5	0	0	1	2	3	4	17	4
Often	1	3	18	19	28	10	10	15	18	12	5	11	5	8	9	12	47	12
Occasionally	9	31	31	33	79	28	17	25	52	34	14	30	16	26	20	27	119	30
Seldom	8	28	22	23	98	35	18	26	48	31	17	37	18	29	27	37	128	32
Never	11	38	18	19	62	22	18	26	28	18	10	22	22	35	13	18	91	23
Total	29	7	94	23	279	69	68	17	154	38	46	11	62	15	72	18	402	100

Table 5.17 Respondents' Attitude Towards Newly Introduced Food Product in the Supermarket

Attitude	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Among the first to try	6	22	23	25	80	29	15	22	48	31	18	39	14	23	14	20	109	27
No change in purchase practice	8	30	34	37	103	38	22	32	57	37	13	28	26	42	27	39	145	36
Among the last to try	12	44	32	34	84	31	25	37	46	30	14	30	20	32	23	33	128	32
Never tries	1	4	4	4	7	3	4	6	3	2	0	0	0	0	5	7	12	3
Total	27	100	93	100	274	100	66	16	154	38	45	11	60	15	69	17	394	98

5.3 Consumer Knowledge and Concerns over Food Irradiation

Diet and environmental exposure to substances are becoming increasingly important due to growing demand for better health and an increase in supply of substances that affect health. Food irradiation is not new to all households. Half of the respondents who have heard and or read about food irradiation identified (Table 5.18) newspaper (45 percent), televisions (45 percent), magazine (36 percent) and radio (21 percent) as their major sources of information.

Household consumers' knowledge of irradiated food was compared with their knowledge of residues resulting from pesticides and herbicides application in fresh food and vegetables, antibiotics found in poultry and livestock, growth stimulants in poultry and livestock, nitrites in food, food additives and preservatives and artificial food colouring (Table 5.19). It was found that household respondents knowledge about irradiated food was comparably similar to their knowledge of antibiotics and growth stimulants found in poultry and livestock, and nitrites in food. Consumers were more knowledgeable about food additives and food preservatives (4 percent expressing none at all), artificial food colouring (4 percent expressing none at all) and the residues from pesticides and herbicides (14 percent expressing none at all). Twenty percent of the respondents expressed high knowledge of additives and preservatives and artificial food colouring.

One of the major reason for neither choosing nor rejecting irradiated food was that households had no information about irradiation or that they had no sufficient knowledge of what food irradiation is all about. In all groups of willingness and level of concern (Table 5.20), the respondents' knowledge of irradiated food closely resembled that of their knowledge of antibiotics found in poultry and livestock, growth stimulants in poultry and livestock and nitrites in food. Those who were not sure about their choice were found to have poor knowledge of food irradiation (42 percent expressed no knowledge at all about food irradiation). The respondents who

Table 5.18 Sources of Information About Food Irradiation and Effect of Concern on Buying Behaviour

Item	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Have you heard about food irradition?																		
Yes	19	66	53	56	122	44	33	49	90	58	21	46	28	45	23	32	195	48
No	10	34	42	44	152	54	33	49	67	44	24	52	33	53	47	64	204	51
Source of Information																		
Television	8	42	23	43	56	46	12	36	41	46	11	52	12	43	11	48	87	45
Radio	3	16	12	23	25	20	9	27	19	21	3	14	3	11	5	22	39	20
Magazine	12	63	20	38	38	31	10	30	33	37	8	38	13	46	6	26	70	36
Newspaper	10	53	27	51	51	42	18	55	39	43	6	29	14	50	11	48	88	45
Doctor	1	5	1	2	0	0	0	0	1	1	0	0	1	4	0	0	2	1
Word of mouth	1	5	2	4	2	2	0	0	4	4	0	0	1	4	0	0	5	3
Book and other literatures	1	5	1	2	4	3	0	0	4	4	1	5	1	4	0	0	6	3
Relatives and friends	0	0	2	4	5	4	4	12	2	2	1	5	0	0	0	0	7	4
Government agency	0	0	1	2	0	0	1	3	0	0	0	0	0	0	0	0	1	1
Does your concern affect on your buying behaviour?																		
Yes	2	7	90	95	107	25	65	96	133	86							198	90
No	1	3	0	0	20	25	1	1	20	13							21	10

Table 5.19 Respondents Knowledge Level of Various Food Safety Issues

Item	High		Moderate		Low		None at all		All
	no.	%	no.	%	no.	%	no.	%	no.
Residues resulting from pesticides or herbicides	23	6	153	39	160	41	58	15	394
Antibiotics found in poultry and livestock	15	4	156	40	79	20	144	37	394
Growth stimulants in poultry and livestock	15	4	149	38	102	26	125	32	391
Nitrites in foods	13	3	118	30	97	25	161	41	389
Irradiated foods	14	4	152	39	76	20	145	37	387
Additives and preservatives	82	21	80	20	217	55	18	5	397
Artificial colouring	84	21	84	21	210	53	18	5	396

Table 5.20 Respondents' Rate of their Knowledge of Food Irradiation by Willingness to Buy and Level of Concern

Item	High		Moderate		Low		None at all		All
	no.	%	no.	%	no.	%	no.	%	no.
Will Buy	1	3	8	28	14	48	5	17	28
Will Not Buy	8	9	31	34	26	28	27	29	92
Not Sure	5	2	113	42	36	13	113	42	267
Very Concerned	6	9	17	27	25	39	16	25	64
Somewhat Concerned	5	3	31	20	67	44	50	33	153
Somewhat Unconcerned	2	5	7	16	16	36	19	43	44
Not Concerned	1	2	16	26	17	28	27	44	61
Do Not Know	0	0	5	8	27	41	34	52	66

did not indicate their level of concern were also found to have poor knowledge with 52 percent of them expressing no knowledge about food irradiation. In all of the cases, the respondents knowledge of additives and preservatives and artificial colouring was found to be distributed on the low, moderate and high knowledge levels indicating that they were more commonly known issues.

Those who will buy irradiated food have greater knowledge of food irradiation than those who were not willing to buy irradiated food. Thirty percent of those who will not buy had no knowledge of irradiated food whilst 17 percent of those who will buy had no knowledge about food irradiation as well. However, the level of knowledge of the not concerned was comparably poor. Forty percent of the not concerned group had no knowledge about irradiated food. The very concerned had 25 percent expressing no knowledge about irradiated food. Those who did not indicate their level of concern showed the greatest lack of knowledge (52 percent reported no knowledge at all) about irradiated food.

The rest of the issues such as residues from pesticides and herbicides, antibiotics and growth hormones, nitrites in food, food additives and food colouring were found to show a similar pattern as the irradiated food. Willingness to buy may be related to households' knowledge of irradiated food. The results however lacked the ability to reflect the type of information received by the respondents. In this case, their perception of the hazardous effect and their perception about the statements asked of the respondents about food irradiation may shed some understanding into explaining the behavioural aspect of their willingness and concern about food irradiation. The statements provided about food irradiation were assumed to reflect the belief of individual respondents. Irradiated food was further assumed to have these attributes that may indicate preference by respondents.

In terms of perceived level of hazard, the residues resulting from pesticides and herbicides were ranked first among the seven food safety issues included in the

survey (Table 5.21). Food irradiation was ranked low (fifth) as a serious hazard and ranked last (seventh) as something of a hazard. However, about 39 percent expressed that they were not sure whether irradiated food was hazardous or not. The respondents perceived pesticides and herbicides as hazardous. More than three fourths (85 percent) of the respondents indicated that the residues resulting from pesticides and herbicides as either serious hazard (43 percent) or something of a hazard (42 percent).

The widely known or the 'more common' food safety issues such as pesticides or herbicides, additives and preservatives and artificial colouring had been ranked higher in terms of their perceived level of hazard. This may be attributed to increasing news reports on television about the use of chemical sprays in food and increased emphasis on organically grown food products. Those who will buy irradiated food perceived residues from pesticides as the most serious hazard. The very concerned group regarded food irradiation as the least among the serious hazard.

As expected, a number of respondents (41 percent) who were willing to buy considered irradiated food not as a hazard (Table 5.22). They were dominated by respondents who were not sure about any hazardous effect in nitrites in food (45 percent) and antibiotics found in poultry and livestock (41 percent). Those who will not buy accounted residues resulting from pesticides and herbicides application to food as the most serious hazard.

Respondents emerged to be certain about the hazardous effects of residues from chemical applications, additives and preservatives and artificial food colour. These can be implied from the percentages of not sure answers in all groups of respondents. The somewhat concerned and the somewhat unconcerned groups described that residues from chemicals posed the most serious hazard among the food safety issues listed in the questionnaire. The percentage of respondents who noted

Table 5.21 Respondents Perceived Level of Hazard of Various Food Safety Issues

Item	Serious Hazard		Something of a Hazard		Not a Hazard at all		Not Sure		All
	no.	%	no.	%	no.	%	no.	%	no.
Residues resulting from pesticides and herbicides	172	43	169	42	6	1	51	13	398
Antibiotics found in poultry and livestock	77	19	181	45	19	5	115	28	392
Growth stimulants in poultry and livestock	78	19	155	38	37	9	122	30	392
Nitrites in foods	38	9	141	35	33	8	172	43	384
Irradiated foods	53	13	132	33	43	11	157	39	385
Additives and preservatives	55	14	242	60	57	14	36	9	390
Artificial colouring	48	12	225	56	74	18	44	11	391

Table 5.22 Respondents Rate of their Perception of the Level of Hazard of Food Irradiation by Willingness to Buy and Level of Concern

Item	Serious Hazard		Something of a Hazard		Not a Hazard at all		Not Sure		All
	no.	%	no.	%	no.	%	no.	%	no.
Will Buy Irradiated Food	2	7	4	14	12	41	11	38	29
Will Not Buy	30	33	48	52	5	5	9	10	92
Not Sure	21	8	80	30	26	10	137	52	264
Very Concerned	23	35	29	44	4	6	10	15	66
Somewhat Concerned	21	14	68	46	8	5	51	34	148
Somewhat Unconcerned	3	7	14	32	13	30	14	32	44
Not Concerned	2	3	6	10	17	28	36	59	61
Do Not Know	3	4	15	22	2	3	47	70	67

that food irradiation was not a hazard was notably larger in the somewhat unconcerned group than in the somewhat concerned group.

The respondents were generally divided into their level of concern over food irradiation. Fifty five percent of the respondents answered very concerned (17 percent) and somewhat concerned (38 percent). Eighteen percent could not decide about their level of concern whilst only 15 percent were not concerned at all. Asked if their level of concern would effect their buying behaviour, 90 percent of the respondents of the very concerned and somewhat concerned declared their agreement (Table 5.11). More respondents had prior information about food irradiation among those who will buy irradiated food than among those who will not buy. In the two groups, more respondents have heard and/or read something about food irradiation.

Almost all of the respondents were aware of New Zealand's observing of a nuclear-free policy (Table 5.23). Their awareness may be reflective of their level of concern and their willingness to buy because 69 percent of the very concerned indicated that this awareness influenced their concern level whilst 76 percent of the not concerned indicated that their awareness did not influence their level of concern. Similarly, those who will buy irradiated food indicated that their level of concern was unaffected by the nuclear-free policy of New Zealand. The opposite was true among those who will not buy. New Zealand's nuclear free policy affected their concern over food irradiation. This may be indicative of the level of awareness about food irradiation. Fifty percent of the respondents have not heard and/or read anything about food irradiation. Thirty nine percent expressed that their awareness of the nuclear free policy did not affect their concern about food irradiation. With regard labelling, almost all of the respondents (97 percent) agreed that irradiated food should be properly labelled.

Table 5.23 Respondents Attitude Toward Labelling of Irradiated Food and the Relevance of New Zealand's Nuclear Free Policy to the Respondents' Level of Concern

Item	Willingness to Buy						Level of Concern										All	
	Will Buy		Will Not Buy		Not Sure		Very Concerned		Somewhat Concerned		Somewhat Unconcerned		Not Concerned		Do Not Know			
	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%	no.	%
Are you aware that New Zealand observes a nuclear-free policy?																		
Yes	29	100	92	97	275	98	64	94	155	101	44	96	61	98	73	100	397	99
No	0	0	2	2	2	1	3	4	1	1	0	0	0	0	0	0	4	1
Does this affect your concern over food irradiation?																		
Yes	1	3	65	68	58	21	47	69	58	38	7	15	2	3	11	15	125	31
No	25	86	22	23	109	39	11	16	54	35	25	54	47	76	19	26	156	39
Not Sure	2	7	3	3	103	37	4	6	41	27	12	26	10	16	41	56	108	27
Irradiated foods should be labelled																		
Yes	28	97	94	99	268	96	65	96	155	101	45	98	55	89	71	97	391	97
No	1	3	0	0	8	3	0	0	2	1	0	0	6	10	1	1	9	2

5.4 Consumers Perception of Food Irradiation

Statements about food irradiation had been provided to the respondents to relate the consumers perception about food irradiation and their level of concern and willingness to pay for irradiated food. Table 5.24 summarises the results of the statements cited in the questionnaire. A significant number of respondents (52 percent) were not sure about radioactivity in irradiated food. A little less than one fourth perceived radioactivity in irradiated food whilst one fourth either disagreed or strongly disagreed with radioactivity in irradiated food. Incorporating strongly agree and agree responses resulted in respondents ranking hazard to workers at irradiation plant as the highest concern with 48 percent. More than one third of the respondents accepted treating imported food by irradiation instead of chemical fumigants to disinfest food from undesirable pests and to treating agricultural products for exports by irradiation instead of chemical fumigants to reduce spoilage during transport. More respondents thought that food irradiation will bring environmental hazards (37 percent agreed and strongly agreed).

Those who will buy irradiated food generally had clear disagreements with regard to environmental effects, radioactivity, effect on the wholesomeness of food, effect on the welfare of the workers in irradiation plants and effect on own health (Table 5.25 to Table 5.29). They were also agreeable to treating both the imported food and agricultural food for export by irradiation rather than by chemical fumigants (Table 5.30). The opposite was noticed among those who will not buy and those who were very concerned for the provided statements where strong agreements were shown for the environmental effect, workers at irradiation plants, wholesomeness in food, radioactivity and own health effects of food irradiation. They also put greater emphasis on the dangerous health implications of food irradiation followed by hazardous effect on plant workers at irradiation plants.

Table 5.24 Respondents Perception of the Statements Asked About Food Irradiation

Statement	Strongly Agree		Agree		Disagree		Strongly Disagree		Do Not Know Not Sure		All
	no	%	no	%	no	%	no	%	no	%	no
Brings about environmental hazards	27	8	105	29	54	15	8	2	162	46	356
Radioactivity in irradiated food	10	3	73	19	77	20	21	6	195	52	376
Affect wholesomeness such as taste and nutritional value	34	10	101	29	54	15	12	3	153	43	354
Hazardous to workers at plants	38	11	133	37	27	8	11	3	147	41	356
Hazardous to health	38	9	111	28	58	14	10	2	184	46	401
Imported food infested with undesirable pests should be treated by irradiation instead of chemical fumigants	26	7	124	33	49	13	16	4	157	42	372
Agricultural product for exports should be treated by irradiation instead of chemical fumigants to prevent food spoilage during transport	14	4	133	36	58	16	17	5	144	39	366

Table 5.25 Food Irradiation Could Bring About Environmental Hazards

Group	Strongly Agree		Agree		Disagree		Strongly Disagree		Do Not Know Not Sure		All
	no	%	no	%	no	%	no	%	no	%	no
Will Buy	2	7	5	17	16	55	3	10	3	10	29
Will Not Buy	21	22	43	45	5	5	1	1	25	26	95
Not sure	4	2	57	30	33	17	4	2	181	95	191
Very Concerned	1	3	1	3	30	103	17	59	18	62	67
Somewhat Concerned	1	1	9	6	57	36	7	4	83	53	157
Somewhat Unconcerned	2	4	13	28	7	15	0	0	24	52	46
Not Concerned	4	7	29	48	4	7	2	3	22	36	61
Do Not Know	0	0	2	3	7	10	1	1	63	86	73

Table 5.26 Food Irradiation Could Make the Food Radioactive

Group	Strongly Agree		Agree		Disagree		Strongly Disagree		Do Not Know Not Sure		All
	no	%	no	%	no	%	no	%	no	%	no
Will Buy	0	0	2	7	15	52	8	28	4	14	29
Will Not Buy	8	8	36	38	9	9	1	1	41	43	95
Not sure	2	1	35	18	53	28	12	6	176	92	191
Very Concerned	0	0	4	14	25	86	8	28	29	100	66
Somewhat Concerned	7	4	25	16	37	24	2	1	86	55	157
Somewhat Unconcerned	3	7	16	35	6	13	0	0	21	46	46
Not Concerned	11	18	24	39	2	3	0	0	24	39	61
Do Not Know	0	0	8	11	2	3	0	0	63	86	73

Table 5.27 Food Irradiation Could Affect the Wholesomeness (e.g. taste and nutritional value) of the Food

Group	Strongly Agree		Agree		Disagree		Strongly Disagree		Do Not Know/ Not Sure		All
	no	%	no	%	no	%	no	%	no	%	no
Will Buy	0	0	2	7	19	66	4	14	4	14	29
Will Not Buy	27	29	42	45	2	2	1	1	22	23	94
Not sure	7	4	57	30	33	17	7	4	175	92	191
Very Concerned	0	0	1	3	25	86	21	72	19	66	66
Somewhat Concerned	3	2	14	9	53	34	10	6	77	49	157
Somewhat Unconcerned	2	4	9	20	7	15	1	2	27	59	46
Not Concerned	7	11	25	41	5	8	0	0	24	39	61
Do Not Know	0	0	5	7	10	14	2	3	56	77	73

Table 5.28 Food Irradiation Could be Hazardous to the Health of those Working at Irradiation Plants

Group	Strongly Agree		Agree		Disagree		Strongly Disagree		Do Not Know/ Not Sure		All
	no	%	no	%	no	%	no	%	no	%	no
Will Buy	2	7	4	14	11	38	3	10	9	31	29
Will Not Buy	26	27	48	51	1	1	1	1	19	20	95
Not sure	10	5	81	43	15	8	7	4	165	87	190
Very Concerned	0	0	1	3	29	53	21	72	16	55	67
Somewhat Concerned	5	3	5	3	66	42	13	8	68	43	157
Somewhat Unconcerned	2	4	5	11	16	36	0	0	22	49	45
Not Concerned	3	5	15	25	6	10	3	5	34	56	61
Do Not Know	1	1	1	1	16	22	1	1	54	74	73

Table 5.29 Irradiated Food Could be Hazardous to Your Health

Group	Strongly Agree		Agree		Disagree		Strongly Disagree		Do Not Know/ Not Sure		All
	no	%	no	%	no	%	no	%	no	%	no
Will Buy	0	0	2	7	17	59	6	21	4	14	29
Will Not Buy	31	33	47	49	1	1	1	1	15	16	95
Not sure	7	4	62	33	40	21	3	2	165	87	190
Very Concerned	0	0	1	3	27	93	24	83	15	52	67
Somewhat Concerned	4	3	10	6	67	43	11	7	65	41	157
Somewhat Unconcerned	0	0	16	36	6	13	1	2	22	49	45
Not Concerned	6	10	28	46	4	7	0	0	23	38	61
Do Not Know	0	0	3	4	7	10	1	1	61	85	72

Table 5.30 Respondents Perception About the Use of Food Irradiation

Group	Strongly Agree		Agree		Disagree		Strongly Disagree		Do Not Know/ Not Sure		All
	no	%	no	%	no	%	no	%	no	%	no
Imported food infested with undesirable pests should be treated by irradiation instead of chemical fumigants											
Will Buy	8	28	19	66	1	3	1	3	0	0	29
Will Not Buy	1	1	11	12	28	31	9	10	40	45	89
Not sure	17	9	94	49	20	11	6	3	141	74	190
Very Concerned	7	24	19	66	9	31	1	3	27	93	63
Somewhat Concerned	5	3	25	16	42	27	6	4	77	50	155
Somewhat Unconcerned	1	2	1	2	18	40	6	13	19	42	45
Not Concerned	2	3	1	2	37	61	10	16	11	18	61
Do Not Know	1	1	2	3	19	26	3	4	48	66	73
Agricultural product for exports should be treated by irradiation instead of chemical fumigants to prevent food spoilage during transport											
Will Buy	7	24	19	66	0	0	0	0	2	7	28
Will Not Buy	0	0	16	17	30	33	13	14	33	36	92
Not sure	7	4	98	60	28	19	4	3	140	114	190
Very Concerned	12	41	20	69	11	38	0	0	22	76	65
Somewhat Concerned	4	3	28	18	41	26	5	3	77	50	155
Somewhat Unconcerned	0	0	2	4	22	49	2	4	19	42	45
Not Concerned	0	0	4	7	39	65	6	10	11	18	60
Do Not Know	1	1	3	4	22	30	1	1	46	63	73

Another measure was done by putting the disagree and strongly disagree responses together. The method produced low disapproval of the statements that were supplied of the respondents. Approximately one fourth of the respondents disagreed on radioactivity in irradiated food. The respondents who were not sure, somewhat concerned and somewhat unconcerned were found to be on the middle of their decision of agreement or disagreement.

5.5 Willingness to Pay for Irradiated Fresh Produce

5.5.1 Average Household Food Consumption

The average household food consumption of strawberries, mushrooms, pears, potatoes, bananas, onions, beef, pork, chicken and fish is shown in Table 5.31. A number of respondents did not report their average household consumption for food items like strawberries. Seasonality and unavailability were cited as the main reasons. Consumption statistics may also differ between concern levels and willingness to pay for irradiated food. Those who will buy and will not buy irradiated food and the very concerned group consumed more than the overall average consumption for every commodity.

5.5.2 Willingness to Purchase Irradiated Food

Table 5.32 shows the number of bids and the average amount of value that respondents put in each item of irradiated food. The bids were only from those who were willing to buy irradiated food and those who expressed may or may not buy irradiated food and bid when they were asked to do so. Most of the bids fell on the 50 cents and below values. Generally, the respondents put higher amount for the elimination of food borne diseases and other microorganisms of meat products such as beef (28 cents), pork (29 cents), chicken (33 cents) and fish (29 cents) than for extending the shelf life of fruits such as strawberries, bananas and pears and for

Table 5.31 Average Household Food Consumption Per Week in Kilograms of Various Food Items

Food	Willingness to Buy			Level of Concern					All
	Will Buy	Will Not Buy	Not Sure	Very Concerned	Somewhat Concerned	Somewhat Unconcerned	Not Concerned	Do Not Know	
Strawberry	0.25	0.15	0.14	0.33	0.12	0.02	0.12	0.13	0.14
Mushroom	0.33	0.40	0.31	0.40	0.27	0.29	0.30	0.40	0.32
Pear	0.66	0.65	0.50	0.66	0.53	0.33	0.39	0.59	0.52
Potato	3.57	3.65	3.22	3.27	3.19	3.59	2.75	3.34	3.20
Banana	2.02	1.96	1.51	1.85	1.60	1.51	1.43	1.47	1.58
Onion	0.89	0.99	0.81	0.88	0.80	0.84	0.72	0.88	0.82
Beef	1.76	1.88	1.69	1.76	1.51	1.87	1.72	1.82	1.67
Pork	0.45	0.45	0.47	0.45	0.43	0.51	0.42	0.45	0.44
Chicken	1.82	1.74	1.40	1.69	1.41	1.43	1.49	1.25	1.44
Fish	1.08	1.00	0.73	0.94	0.74	0.94	0.72	0.69	0.78

Tabl 5.32 Number of Bids and Mean Willingness to Pay for Several Irradiated Food

Food	Number of Bids							Mean Price
	0 cent	10 cents	25 cents	50 cents	75 cents	$ 1.00	All bids	
Strawberry	42	42	19	16	1	13	133	$0.23
Mushroom	45	64	25	19	4	9	166	$0.21
Pear	44	57	24	22	2	3	152	$0.18
Potato	53	77	35	19	10	11	205	$0.22
Banana	48	64	38	38	7	10	205	$0.24
Onion	53	83	32	24	2	7	201	$0.18
Beef	49	56	41	25	6	23	200	$0.28
Pork	46	45	33	24	6	22	176	$0.29
Chicken	44	53	35	30	16	25	203	$0.33
Fish	48	51	21	26	7	22	175	$0.29

vegetables such as mushrooms, potatoes and onions. Extended shelf life may be of greater interest to firms engaged in marketing and distribution than for many consumers. Extended shelf life with relatively low costs of irradiation could reduce distribution costs sufficiently so as not to result in higher prices to consumers. Among the fruits and vegetables, banana and strawberry commanded the highest value of willingness to pay at 24 cents and 23 cents respectively. This may be attributed to the perishability of strawberry and banana. Those who were willing to buy irradiated food value fish (48 cents) among the highest followed by chicken at 45 cents. Onion was given the smallest bid at 24 cents (Table 5.33) maybe because of its availability throughout the year.

Those who answered may or may not buy irradiated food were also asked to bid on the food item listed. The bids concentrated on the low amount with significant respondents unwilling to pay more than the current price. The average bids demonstrated to be highest for chicken (31 cents) followed by pork at 27 cents and fish and beef both at 26 cents. The pattern was generally the same among those who were willing to buy except that the margin of the bids among those who answered may or may not was narrower than the margin of the bids among those who were willing to buy. Among the fruits and vegetables considered, banana commanded the highest average bid at 24 cents per kilogram above the current price. A small number (five) of the respondents bid from the very concerned group (Table 5.34). The somewhat concerned group centred on the 25 cents and below bids. Their mean price bids did not go beyond 25 cents in all commodities. The somewhat unconcerned focused on wider range of bids compared to other groups' bids as shown by their mean price bids for all food items considered in this study. They placed higher offers on meat products and fish more than they priced the fruits and vegetables. Most of the not concerned proposed on the 10 cents and below bids. The bids of those who will buy irradiated food were higher than the mean price bids of all other groups. This means that their demand for irradiated food was higher than the other groups' demand for it.

Table 5.33 Number of Bids and Average Willingness to Pay for Several Irradiated Food by Willingness to Buy

Food	Number of Bids							Mean Price
	0 cent	10 cents	25 cents	50 cents	75 cents	$ 1.00	All bids	
Will Buy								
Strawberry	3	6	4	6	0	1	20	$0.28
Mushroom	3	5	6	5	0	3	22	$0.34
Pear	3	5	6	8	0	0	22	$0.27
Potato	4	6	9	5	1	1	26	$0.27
Banana	4	6	8	7	1	1	27	$0.29
Onion	5	7	8	5	0	1	26	$0.24
Beef	3	6	8	6	1	4	28	$0.37
Pork	2	2	7	5	1	4	21	$0.44
Chicken	2	4	8	6	1	6	27	$0.45
Fish	1	5	4	5	2	5	22	$0.48
May or May Not Buy								
Strawberry	39	36	15	10	1	12	113	$0.22
Mushroom	42	59	19	14	4	6	144	$0.19
Pear	41	52	18	14	2	3	130	$0.16
Potato	49	71	26	14	9	10	179	$0.21
Banana	44	58	30	31	6	9	178	$0.24
Onion	48	76	24	19	2	6	175	$0.17
Beef	46	50	33	19	5	19	172	$0.26
Pork	44	43	26	19	5	18	155	$0.27
Chicken	42	49	27	24	15	19	176	$0.31
Fish	47	46	17	21	5	17	153	$0.26

Table 5.34 Number of Bids and Average Willingness to Pay for Several Irradiated Food by Level of Concern

Food	Number of Bids							Mean Price
	0 cent	10 cents	25 cents	50 cents	75 cents	$ 1.00	All bids	$
Very Concerned								
Strawberry	1	1	1	1	0	0	4	0.21
Mushroom	1	1	0	2	0	0	4	0.28
Pear	1	3	1	0	0	0	5	0.11
Potato	1	4	1	0	0	1	7	0.24
Banana	1	3	1	1	0	0	6	0.18
Onion	1	3	1	1	0	0	6	0.18
Beef	2	1	0	0	0	2	5	0.42
Pork	1	1	0	0	0	2	4	0.53
Chicken	2	2	1	0	1	0	6	0.20
Fish	2	2	0	0	1	0	5	0.19
Somewhat Concerned								
Strawberry	21	16	7	4	1	8	57	0.25
Mushroom	21	30	7	7	2	2	69	0.17
Pear	21	29	8	8	1	2	69	0.17
Potato	27	33	12	8	4	5	89	0.21
Banana	25	28	13	15	4	4	89	0.23
Onion	25	39	12	8	2	4	90	0.18
Beef	25	24	17	12	3	6	87	0.24
Pork	23	21	14	9	1	7	75	0.24
Chicken	23	23	12	15	8	5	86	0.28
Fish	25	22	7	12	3	6	75	0.24
Somewhat Unconcerned								
Strawberry	7	9	4	2	0	0	22	0.13
Mushroom	7	12	6	2	1	2	30	0.22
Pear	8	8	5	4	0	0	25	0.16
Potato	8	16	4	1	4	2	35	0.23
Banana	7	10	8	6	2	2	35	0.27
Onion	9	12	7	4	0	1	33	0.18
Beef	5	11	5	4	1	5	31	0.33
Pork	5	7	5	4	2	4	27	0.35
Chicken	5	11	6	3	2	6	33	0.35
Fish	5	10	5	3	0	5	28	0.31
Not Concerned								
Strawberry	9	11	6	8	0	3	37	0.26
Mushroom	12	15	9	5	0	3	44	0.21
Pear	10	13	8	8	0	1	40	0.21
Potato	11	15	15	8	1	2	52	0.23
Banana	10	15	12	13	1	3	54	0.27
Onion	13	17	11	8	0	1	50	0.19
Beef	12	13	15	6	2	7	55	0.30
Pork	11	10	11	10	2	6	50	0.33
Chicken	9	9	14	10	4	10	56	0.40
Fish	11	8	8	9	3	8	47	0.37
Do Not Know								
Strawberry	4	5	1	1	0	3	14	0.30
Mushroom	4	6	3	3	1	2	19	0.29
Pear	4	6	2	2	1	0	15	0.19
Potato	6	9	3	2	1	1	22	0.20
Banana	5	8	4	3	0	1	21	0.20
Onion	5	12	1	3	0	1	22	0.18
Beef	5	7	4	3	0	3	22	0.28
Pork	6	6	3	1	1	3	20	0.28
Chicken	5	8	2	2	1	4	22	0.32
Fish	5	9	1	2	0	3	20	0.26

5.5.3 Consumption Response to the Introduction of Irradiated Food

The number of respondents who bid varied from 157 for strawberries to 200 for chicken (Table 5.35). A majority of the respondents who bid would not change their current consumption level if irradiated food was introduced in the marketplace. Those who bid were asked about their consumption reaction as a consequence of the availability of irradiated food in the food shops where they buy their food. Only a small portion of the respondents who signified their intention to bid were considering to increase or decrease their current consumption level. Only a very few respondents indicated to consume less as a result of the introduction of irradiated food.

The number of respondents who indicated their willingness to buy irradiated food were further divided in terms of their consumption response due to the introduction of irradiated food. Those who will buy irradiated food showed positive response by answering that they would consume more of the products presented if they were offered irradiated food (Table 5.36). The opposite was observed among those who answered may or may not buy because they exhibited average negative consumption response to reflect that they will consume less of the irradiated food offered. Aggregating these two categories resulted in average negative consumption response for most of irradiated food except for mushroom, chicken and fish (Table 5.38). It should be noted however that the resulting statistics may be relatively small and insignificant compared to the total sample size of 404. Nevertheless, it provided some important information into the likely reaction of some consumers through the expression of different types of responses to irradiated food.

Table 5.35 Respondents Consumption Response to the Introduction of Irradiated Food

Food	Consumption Response						All
	More		Less		No Change		
	no	%	no	%	no	%	no
Strawberry	20	13	13	8	124	79	157
Mushroom	21	12	18	10	137	78	176
Pear	15	9	17	10	137	81	169
Potato	7	4	21	11	169	86	197
Banana	22	11	22	11	153	78	197
Onion	6	3	20	10	171	87	197
Beef	6	3	21	11	165	86	192
Pork	6	3	19	11	153	86	178
Chicken	13	7	20	10	167	84	200
Fish	21	11	19	10	149	79	189

Table 5.36 Number of Respondents Reporting Consumption Response to Irradiated Food by Willingness to Buy

Group/Food	Consumption Response			All
	More	Less	No Change	
Will Buy				
Strawberry	6	0	19	25
Mushroom	7	0	19	26
Pear	3	0	25	28
Potato	3	1	25	29
Banana	6	0	22	28
Onion	1	1	26	28
Beef	1	0	27	28
Pork	2	0	26	28
Chicken	4	0	25	29
Fish	10	0	19	29
May or May Not Buy				
Strawberry	14	13	105	132
Mushroom	14	18	118	150
Pear	12	17	112	141
Potato	4	20	144	168
Banana	16	22	131	169
Onion	5	19	145	169
Beef	5	21	138	164
Pork	4	19	127	150
Chicken	9	20	142	171
Fish	11	19	130	160

Table 5.37 Number of Respondents Reporting Consumers Consumption Response to the Introduction of Irradiated Food by Level of Concern

Group/Food	Consumption			
	More	Less	No Change	All
Very Concerned				
Strawberry	0	1	3	4
Mushroom	0	1	2	3
Pear	0	1	3	4
Potato	0	1	3	4
Banana	0	2	2	4
Onion	0	2	2	4
Beef	0	1	3	4
Pork	0	1	3	4
Chicken	0	1	3	4
Fish	0	2	3	5
Somewhat Concerned				
Strawberry	6	11	48	65
Mushroom	2	14	55	71
Pear	4	14	53	71
Potato	1	15	69	85
Banana	5	18	61	84
Onion	1	14	67	82
Beef	2	17	61	80
Pork	1	16	54	71
Chicken	3	16	64	83
Fish	3	15	60	78
Somewhat Unconcerned				
Strawberry	5	0	20	25
Mushroom	7	1	23	31
Pear	5	1	21	27
Potato	1	3	30	34
Banana	6	1	26	33
Onion	3	2	29	34
Beef	2	1	31	34
Pork	0	0	29	29
Chicken	2	1	31	34
Fish	4	1	27	32
Not Concerned				
Strawberry	5	0	38	43
Mushroom	6	0	41	47
Pear	3	0	42	45
Potato	3	0	49	52
Banana	7	0	45	52
Onion	1	0	51	52
Beef	1	0	50	51
Pork	3	0	47	50
Chicken	6	0	48	54
Fish	10	0	41	51
Do Not Know				
Strawberry	2	1	15	18
Mushroom	4	2	15	21
Pear	1	1	18	20
Potato	1	2	18	21
Banana	3	1	19	23
Onion	0	1	22	23
Beef	1	1	20	22
Pork	2	1	19	22
Chicken	2	1	20	23
Fish	3	1	18	22

Table 5.38 Percentage Change in Consumption due to Introduction of Irradiated Food

Food	Willingness to Buy		Level of Concern					All
	Will Buy	May or May Not Buy	Very Concerned	Somewhat Concerned	Somewhat Unconcerned	Not Concerned	Do Not Know	
	%	%	%	%	%	%	%	%
Strawberry	13	-7		-18	6	13	15	-3
Mushroom	32	-2	no	-34	38	30	23	6
Pear	20	-17	answer	-38	2	20	100	-12
Potato	5	-13		-36	-27	6	100	-15
Banana	9	-7		-32	6	14	100	-4
Onion	0	-13		-39	25	0	0	-21
Beef	0	-38		-38	0	0	100	-18
Pork	33	-22		-33	0	10	58	-6
Chicken	16	-8		-20	25	9	63	3
Fish	25	-12		-12	50	19	38	17

5.6 Willingness to Pay for Irradiated Food and Selected Socio-Demographic and Other Relevant Variables

Estimation of the logit model of qualitative choice was accomplished using the maximum likelihood techniques in the procedure logistic of the *Statistical Analysis System* (SAS) program. Parameter estimates, standard error, changes in probability and other significant statistics are shown in Tables 5.39a to 5.43. Models were differentiated by the explanatory variables included. Three levels of significance were chosen for this analysis: five, ten and 20 percent. Other hypothesized independent continuous variables such as number of persons below 15 years old and number of persons employed in the household and qualitative variables such as heard of irradiation, marital status, employment status, ethnic group and religious profession were deleted from the final model due to highly insignificant statistics shown by these variables. Inclusion of these variables distorted the results of the model. Insignificant variables were arrived after initially running all the variables together and convergence was not possible in most of the cases. Hence, elimination was exercised.

Table 5.39a shows the complete set of independent variables defined in the choice logit model of the Chapter on Methods. The parameter estimates corresponded to a probability of purchasing irradiated food of 0.000912 calculated at the sample mean values. Goodness of fit statistic for the maximum likelihood estimates of the logit model was also included. Mc Fadden's R^2 with a value of 0.79 demonstrated a good fit of the model developed. The Chi^2 for covariates or the likelihood ratio of 92.20 with 16 degrees of freedom exceeded the Chi^2 critical value at the 0.0001 level of significance. The combined effect of all independent variables was significant based on the Chi^2 statistic. Similarly, based on the -2 log likelihood, the combined effect of all independent variables was significant at 0.0001. This rejected the null hypothesis that all slope parameters are simultaneously equal to

Table 5.39a Maximum Likelihood Estimates of the Logit Model for the Willingness to Buy Irradiated Food: Model One

Variable	Parameter Estimate	Standard Error	Changes in Probability
Intercept	-9.19[17]	6.74	-0.008
Health condition	-1.40[n]	1.34	-0.001
Diet	4.73[8]	2.74	0.004
Knowledge of irradiation	2.81[4]	1.43	0.003
Age	-0.11[14]	0.08	-0.000
Belief 1 (Radioactivity)	-2.90[17]	2.14	-0.003
Belief 2 (Wholesomeness)	-6.09[7]	3.43	-0.006
Belief 3 (Health hazard)	-3.18[10]	1.94	-0.003
Urban	9.24[6]	4.91	0.002
Education 2 (Secondary education)	0.51[n]	1.61	0.001
Education 3 (Univ. and higher)	-2.26[n]	2.35	-0.002
Household size	1.34[15]	0.95	0.001
Sex (Male)	2.82[14]	1.94	0.007
Income 2 ($20,001 to $40,000)	-2.22[n]	2.63	-0.002
Income 3 ($40,001 to $60,000)	-0.81[n]	2.92	-0.001
Income 4 ($60,001 and above)	3.41[n]	3.84	0.013
Organisation 3 (Membership to group)	-5.62[10]	3.49	-0.029

Number of observations	103
Akaike Information Criterion (AIC)	58.19
Schwartz Criterion (SC)	102.98
-2 Log L intercept only	116.39
-2 Log L intercept and covariates	24.19
Chi-Square for covariates (p=0.0001)	92.20
Degrees of freedom	16
Mc Fadden's R square	0.79
Adjusted R square	0.52
Percent correct prediction	82.50

Superscripts of parameter estimates indicate the level of significance and n stands for not significant at 20 percent level.
The formula for calculating the changes in probability can be found in the Chapter on Methods.
This model used the Mc Fadden's R^2 statistic and another R^2 was adjusted with the number of independent variables included in the model.

zero. These statistics indicated that the logit model should be of significant value in explaining the willingness or unwillingness to buy irradiated food.

A number of explanatory variables were found to be significant in the first model. These included knowledge, diet, urban, wholesomeness, health hazard, and organisational affiliation which were significant at ten percent level and less. Other variables were found to be significant at 14 to 20 percent levels. They were age, sex, household size and radioactivity. Those who were on a special diet were more likely to buy irradiated food. The respondents perception of their health, represented by the variable health in the model, did not significantly affect the likelihood of buying irradiated food. The better they perceived their health to be, the less was the probability of buying irradiated food. The level of knowledge of the respondents about irradiated food affected the likelihood in the positive direction. The higher they perceived their knowledge about irradiated food, the more they were likely to buy it. This variable was found to be highly significant at four percent level. However, the dummy variables for education showed different direction of parameters. Higher education may be associated to lesser likelihood to buy irradiated food. This was shown by the education dummy, education 3 for university and postgraduate education. Those who had some secondary or completed secondary education were more likely to buy irradiated food. It should be noted however, that these education dummies were insignificant. Hence, the effect of education was regarded as inconclusive in affecting the willingness to buy. In this light, the type of information supplied to the consumers may have significant impact on the willingness of the consumers to buy and or consume irradiated food. This was not captured by the survey.

In agreement with prior expectations, sex showed positive relationship with the probability of buying irradiated food whilst age displayed a negative coefficient indicating that younger people were more likely to buy irradiated food. *The Economist* reported that young people are more likely to change their eating habits

than older ones. This may explain the behaviour of the consumers. The sex parameter was found to be a significant factor to deciding the choice of buying or not buying irradiated food. Females had been shown to have the greater degree of concern over irradiated food and other food safety issues like chemical residues and pesticide use than males. This finding further confirmed the results of various studies done in other countries (Malone 1990: Terry and Tabor 1990).

Household size demonstrated a positive relationship with the probability of buying irradiated food. Larger households were found to be more likely to buy irradiated food. The probability of purchase for a household with four members was 0.0012 lower than that of a household with three members. Respondents from urban areas were more likely to buy irradiated food. The variable urban showed significance at six percent level. Like education and health, the coefficients for income dummies were not significantly different from zero. Irradiated foods however appeared desirable to the highest income bracket of $60,000 and above and the probability decreased with income earners ranging from $20,001 to $60,000. However, due to low degree of statistical significance, this effect cannot be confirmed. Educational attainment was likely to be correlated to income. The direct effect of education on the purchase of irradiated food may be difficult to discern due to the likely presence of multicollinearity between education and income. Organisational affiliation with any group, be it with the environmental group, consumer organisation, social clubs or civic group proved to be a negative factor to the likelihood of buying irradiated food. This variable, organisation 3 was found to be significant at 10 percent level and a change in probability of -0.03, *ceteris paribus*.

The respondents beliefs represented by the three belief variables corresponding to radioactivity, wholesomeness and health hazard were found to be significant and negatively influencing the probability of buying irradiated food. These variables may have been perceived to be direct attributes of irradiated food. The variables were

found to be significant at seven, ten and six percent respectively. Those who either strongly agreed or agreed that food irradiation could make the food radioactive, affect the wholesomeness of the food in terms of taste and nutritional value and that food irradiation is a possible health hazard showed strong rejection to buying irradiated food. The variable health hazard was assumed to be a proxy variable for utility.

Based on the questions asked, the respondents were assumed to have considered the belief statements to be negative statements which was expected. The distribution of the answers based on frequency analysis proved that it would be safe to assume this condition. A separate logit model was run for the three variables alone and they were found to be highly significant at five percent level and captured a high likelihood ratio indicating that these variables alone could explain considerably the probability of buying irradiated food. For instance, the variable belief 3 (health hazard) captured a Chi^2 value of 70 at 0.0001 level of significance. However, strong correlation of 0.60 and higher was observed among the three belief variables and concern levels (Table 5.39b). This explained the reduced significance of the three belief variables when put altogether in one final model.

Table 5.39b Correlation Matrix for the Three Belief Variables and Concern Level

Variable	Belief 1 (Radioactivity)	Belief 2 (Wholesomeness)	Belief 3 (Health Hazard)	Level of Concern *
Belief 1	1.00	0.69	0.71	0.60
Belief 2		1.00	0.85	0.69
Belief 3			1.00	0.74
Concern				1.00

* Concern for this correlation matrix was based on four point scale of 4 for very concerned; 3 for somewhat concerned; 2 for somewhat unconcerned; and 1 for not concerned. Belief variables were scaled based on the description on the Chapter on Methods of this study.

A final measure of the goodness of fit of the logit model involved an in sample evaluation of the predictive power of the estimated model. Such statistic classified the predictive value of the dependent variable, Y_i as one if the probability, P_i was greater than or equal to 0.50 and zero otherwise. A disadvantage of such an evaluation technique is that, when an event Y_i equals one takes place, an individual who classified the probability to be 0.49 is penalised likewise the individual who claimed to be zero (Amemiya 1981). The logit model correctly classified 82.50 percent of the individual responses on the basis of a simple 50-50 classification rule. Eighty three percent of the individuals in the sample were correctly classified as either buying or not buying irradiated food using the logit specification. A classification table based on a 50-50 classification scheme is presented in Table 5.39c. The logit model has a false positive rate (predicted positive that were actually negative) of 35.70 percent and a false negative rate (true positives that were predicted to be negative) of 10.70 percent.

Table 5.39c Classification Table for the First Logit Model in Table 5.39a

		Predicted		
		Event	No Event	Total
Observed	Event	18	8	26
	No Event	10	67	77
	Total	25	75	103
Correctly specified	82.50 percent			
Sensitivity	69.20 percent			
Specificity	87.00 percent			
False positive rate	35.70 percent			
False negative rate	10.70 percent			

Models two to five differed according to the combination of independent variables included in the model. The variable health was omitted in the second model as shown in Table 5.40 and Organisation 3 was replaced by Organisation 1 to check the relationship of the organisational affiliation of the respondents. The second model showed several undesirable results compared to the first model. The introduced variable Organisation 1 exhibited negative relationship with the likelihood of buying irradiated food. Members of consumer organisations were shown to be less likely to buy irradiated food but this was not a significant factor to consider. The significance level of the variables were reduced and R^2 and adjusted R^2 were lower compared to the first model. AIC, which is a measure of comparison between models showed higher value than the first model. Just like the SC, AIC is used primarily for comparing different models for the same data. In general, when comparing models, the lower value of these two statistics indicate a better model.

Model three in Table 5.41 introduced another dummy variable for another organisational affiliation of the respondent, Organisation 2, the environmental group membership. Just like the first and second model membership to environmental organisation was a negative factor though insignificant to the probability of buying irradiated food. Models four and five (Tables 5.42 and 5.43) had the highly insignificant variables removed out from the system. Consistent with the earlier results, six variables were found to be significant: diet, knowledge level, wholesomeness, health hazard, urban and sex.

Table 5.40 Maximum Likelihood Estimates of the Logit Model for the Willingness to Buy Irradiated Food: Model Two

Variable	Parameter Estimate	Standard Error	Changes in Probability
Intercept	-8.93	4.87	-0.245
Diet	2.62^{7}	1.48	0.072
Knowledge of irradiation	2.15^{6}	1.16	0.059
Age	-0.07^{15}	0.05	-0.002
Belief 1 (Radioactivity)	-0.69^{n}	1.20	0.019
Belief 2 (Wholesomeness)	-2.63^{8}	1.51	-0.072
Belief 3 (Health hazard)	-2.33^{7}	1.32	-0.064
Urban	5.82^{6}	3.13	0.039
Education 2 (Secondary education)	-0.14^{n}	1.42	-0.003
Education 3 (University and higher)	-0.13^{n}	1.55	-0.003
Household size	0.34^{n}	0.40	0.009
Sex (Male)	1.29^{n}	1.34	0.046
Income 2 ($20,001 to $40,000)	-2.30^{n}	2.19	-0.049
Income 3 ($40,001 to $60,000)	-2.82^{n}	2.60	-0.047
Income 4 ($60,001 and above)	0.15^{n}	2.24	0.004
Organisation 1 (Consumer group)	-3.66^{n}	4.87	-0.034

Number of observations	103
Akaike Information Criterion (AIC)	60.78
Schwartz Criterion (SC)	102.94
-2 Log L intercept only	116.39
-2 Log L intercept and covariates	28.78
Chi-Square for covariates (p=0.0001)	87.61
Degrees of freedom	15
Mc Fadden's R square	0.75
Adjusted R square	0.49
Percent correct prediction	87.40

Superscripts of parameter estimates indicate the level of significance and n stands for not significant at 20 percent level.
The formula for calculating the changes in probability can be found in the Chapter on Methods.
This model used the Mc Fadden's R^2 statistic and another R^2 was adjusted with the number of independent variables included in the model.

Table 5.41 Maximum Likelihood Estimates of the Logit Model for the Willingness to Buy Irradiated Food: Model Three

Variable	Parameter Estimate	Standard Error	Changes in Probability
Intercept	-7.75[5]	3.70	-0.280
Diet	1.89[9]	2.85	0.068
Knowledge of irradiation	1.43[4]	4.12	0.052
Age	-0.04[n]	0.93	-0.001
Belief 2 (Wholesomeness)	-2.55[4]	3.85	-0.092
Belief 3 (Health hazard)	-1.67[12]	2.40	-0.060
Household size	0.28[n]	0.65	0.010
Urban	3.32[n]	1.47	0.047
Sex (Male)	1.84[9]	2.82	0.110
Organisation 2 (Environmental group)	-0.87[n]	0.48	-0.025

Number of observations	109
Akaike Information Criterion (AIC)	52.26
Schwartz Criterion (SC)	79.18
-2 Log L intercept only	122.04
-2 Log L intercept and covariates	32.26
Chi-Square for covariates (p=0.0001)	89.77
Degrees of freedom	9
Mc Fadden's R square	0.74
Adjusted R square	0.59
Percent correct prediction	89.90

Superscripts of parameter estimates indicate the level of significance and n stands for not significant at 20 percent level.
The formula for calculating the changes in probability can be found in the Chapter on Methods.
This model used the Mc Fadden's R^2 statistic and another R^2 was adjusted with the number of independent variables included in the model.

Table 5.42 Maximum Likelihood Estimates of the Logit Model for the Willingness to Buy Irradiated Food: Model Four

Variable	Parameter Estimate	Standard Error	Changes in Probability
Intercept	-7.66[4]	3.79	-0.253
Diet	1.82[10]	1.12	0.060
Knowledge of irradiation	1.42[3]	0.69	0.047
Age	-0.04[n]	0.04	-0.001
Belief 2 (Wholesomeness)	-2.44[4]	1.22	-0.081
Belief 3 (Health hazard)	-1.73[9]	1.04	-0.057
Household size	0.18[n]	0.30	0.006
Urban	3.66[14]	2.48	0.044
Sex (Male)	2.01[5]	1.06	0.118

Number of observations	111
Akaike Information Criterion (AIC)	50.77
Schwartz Criterion (SC)	75.15
-2 Log L intercept only	123.16
-2 Log L intercept and covariates	32.77
Chi-Square for covariates (p=0.0001)	90.40
Degrees of freedom	8
Mc Fadden's R square	0.73
Adjusted R square	0.60
Percent correct prediction	89.20

Superscripts of parameter estimates indicate the level of significance and n stands for not significant at 20 percent level.
The formula for calculating the changes in probability can be found in the Chapter on Methods.
This model used the Mc Fadden's R^2 statistic and another R^2 was adjusted with the number of independent variables included in the model.

Table 5.43 Maximum Likelihood Estimates of the Logit Model for the Willingness to Buy Irradiated Food: Model Five

Variable	Parameter Estimate	Standard Error	Changes in Probability
Intercept	-7.29[7]	4.14	-0.262
Diet	1.95[9]	1.15	0.070
Knowledge of irradiation	1.41[4]	0.70	0.050
Age	-0.04[n]	0.04	-0.001
Belief 2 (Wholesomeness)	-2.33[6]	1.27	-0.084
Belief 3 (Health hazard)	-2.04[8]	1.20	-0.073
Household size	0.20[n]	0.31	0.007
Urban	4.01[18]	2.99	0.050
Sex (Male)	2.11[4]	1.07	0.137
Organisation 3 (Membership to group)	-1.22[n]	1.13	-0.053

Number of observations	109
Akaike Information Criterion (AIC)	51.56
Schwartz Criterion (SC)	78.47
-2 Log L intercept only	122.04
-2 Log L intercept and covariates	31.56
Chi-Square for covariates (p=0.0001)	90.48
Degrees of freedom	9
Mc Fadden's R square	0.74
Adjusted R square	0.59
Percent correct prediction	90.80

Superscripts of parameter estimates indicate the level of significance and n stands for not significant at 20 percent level.
The formula for calculating the changes in probability can be found in the Chapter on Methods.
This model used the Mc Fadden's R^2 statistic and another R^2 was adjusted with the number of independent variables included in the model.

In general, almost the same parameters were found to be significant in all of the five models. The parameter estimates from the logit model indicated the direction of change in the probability caused by a change in the independent variable. Since the parameters themselves do not represent the direct change in the independent variable, the changes in the probabilities of the independent variables were calculated in every model.

5.7 Level of Concerns and Selected Demographic Variables

The ordered logit was applied to determine the socio-demographic effects on the level of concern of individual respondents. The technique was done because when a single dichotomous equation of willingness to buy was done with concern levels as independent variable, the equation showed significant statistics. The concern levels were then considered but were not included in the willingness to buy models because the concerns were assumed to have been represented by the more detailed components of concerns, the belief variables. It has been shown in Table 5.39b that concern levels and belief statements were highly correlated thus inclusion of concern and belief statements in a single model distorted the result. Hence, collective concerns rated by the respondents were assumed to have represented the general belief levels and overall concerns about irradiated food. The need was established by the highly significant relationship of concern level and willingness to pay for irradiated food.

The ordered logit model for the level of concern was done using the procedure logistic in SAS. The model has significant overall Chi^2 value of 55.46 at the 0.001 level (Table 5.44). The probability to indicate at least some concern was 31 percent calculated at the sample means. As shown, the marginal effects show that concern substantially decreases with males. Although the variable knowledge was found to be significant at one percent level, its marginal effect for concern shows relatively small impact compared to the variable sex. The sex variable has the highest marginal effect in all probability levels. The not concerned group has a marginal effect of 0.149 whilst the very concerned group has a marginal effect of -0.196. The knowledge level increases the willingness to buy. It also increases the concern level due probably to increased awareness.

Table 5.44 Ordered Logit Overall Probabilities and Demographic Effects for Consumer Concern Ratings of Irradiated Food

Variable	Parameter Estimate	(P=0) Not Concerned	(P=1) Somewhat Unconcerned	(P=2) Somewhat Concerned	(P=3) Very Concerned
	Overall	0.176	0.515	0.135	0.174
Intercept 1	-0.99[n]				
Intercept 2	1.35[13]				
Intercept 3	2.10[1]				
Health	-0.18[20]	-0.027	-0.013	0.013	0.026
Diet	-0.25[n]	-0.036	-0.018	0.017	0.037
Knowledge	0.37[1]	0.054	0.026	-0.026	-0.054
Heard	-0.10[n]	0.015	0.007	-0.007	-0.015
Urban	0.13[n]	-0.018	-0.010	0.009	0.019
Education 2	0.04[n]	-0.006	-0.003	0.003	0.006
Education 3	-0.03[n]	0.004	0.002	-0.002	-0.004
Household size	0.08[n]	0.011	0.005	-0.005	-0.011
Sex (Male)	-1.18[1]	0.149	0.117	-0.071	-0.196
Income 2	-0.45[16]	0.064	0.034	-0.031	-0.067
Income 3	-0.57[15]	0.074	0.053	-0.037	-0.090
Income 4	-0.46[n]	0.061	0.041	-0.030	-0.071
Age	0.003[n]	0.000	0.000	-0.000	0.000
Organisation 1	0.84[9]	-0.151	-0.000	0.057	0.095
Organisation 2	0.04[n]	-0.006	-0.003	0.003	0.006
Organisation 3	-0.22[n]	0.033	0.014	-0.015	-0.031

Number of observations	285
Akaike Information Criterion	717.27
Schwartz Criterion	786.67
-2 Log L intercept only	718.54
-2 Log L intercept and covariates	679.27
Chi-Square for covariates	39.27
Degrees of freedom	16
Level of significance	0.001
Score test for proportional odds	55.46

Superscripts of parameter estimates indicate the level of significance. n stands for not significant at 20 percent level. The formula for calculating the overall probabilities and marginal effects of independent variables are presented on the Chapter on Methods.

Concern levels were found to be significantly influenced by the respondents level of knowledge and sex at high level of significance (one percent). Other variables were found to have minor influences at nine to 20 percent significance levels. These included the respondents membership to consumer organisations, income variables 1 and 2 for income range of $20,000 to $60,000 and health. The rest of the variables were insignificant determinants of level of concern. Interestingly, income levels did not influence concern levels at the five percent level. It may be inferred that concerns do not depend on income as much as on sex and knowledge levels about food irradiation.

Diet, heard of irradiation, university degree and higher education and membership to any organisation has a negative effect on the level of concern although the effects were not significant. Diet was viewed as a result of concern rather than as an influencing factor to concern. On the other hand, positive relationships exist between level of concern and secondary education, urban, household size, age and membership to environmental organisation. Again, these variables were found to have insignificant influences on the level of concern of the sample respondents. For instance, the marginal effect of the age variable was zero in all levels of concern. Insignificant variables showed very low or near zero marginal effects in all directions or whether increasing or decreasing level of concern.

5.7 Reasons and Some General Comments about Food Irradiation

The respondents' perception and their unwillingness to buy irradiated food may be reflected by their wanting more information about food irradiation and its effect on food quality (58 responses in Table 5.45). Some of respondents disliked the idea of extending the shelf life of food because they preferred fresh and natural foods (39 responses). This may be attributed to the availability of fresh produce in the supermarkets all over New Zealand. Hence, consumers may not see the need

Table 5.45 Number of Respondents Reporting General Comments About Food Irradiation

Reason	Willingness to Buy		Level of Concern					All
	Will Not Buy	Not Sure	Very Concerned	Somewhat Concerned	Somewhat Unconcerned	Not Concerned	Do Not Know	
Need more information on effect on food quality	7	51	7	19	5	2	25	58
Like fresh and natural	6	34	15	19	2	2	1	39
Just another health hazard	2	32	19	11	0	0	4	34
Grow own food at farm/backyard	1	9	2	7	0	0	1	10
Would wait for more evidence	0	8	5	2	1	0	0	8
Fear of radioactivity	0	4	2	1	0	0	0	3
Lack taste and nutrition/vitamins	0	3	2	1	0	0	0	3
Cancer causing	0	2	1	0	0	0	0	1
Other reasons:	1	14	7	6	0	0	4	17
Too expensive	0	6	4	2	0	0	1	7
Endanger my family's health	1	0	1	1	0	0	0	2
General ignorance	0	2	0	1	0	0	1	2
Irradiation sounds evil; unhealthy connotation	0	2	0	1	0	0	1	2
An unnecessary process	0	1	1	0	0	0	0	1
Nuclear free image of New Zealand	0	1	0	1	0	0	0	1
Suspect a price increase	0	1	1	0	0	0	0	1
Possible accident	0	1	0	0	0	0	1	1

Some respondents reported more than one answer

for extending the shelf life of agricultural commodities. Food irradiation was also perceived by some respondents to be just another health hazard (34 responses). The very concerned perceived food irradiation as just another health hazard. They preferred fresh and natural food products over irradiated food. The somewhat concerned needed more information and also preferred fresh and natural food products.

5.9 Information Channels and Levels of Belief

Respondents relied more on doctors (73 percent), university food scientists (65 percent) and public health officials (64 percent) than they relied on consumer groups (51 percent), environmental groups (33 percent), health food store owners (21 percent) and news media (12 percent). A significant proportion of the respondents were neutral about health food store owners, news media and environmental groups (Table 5.46). The high percentage of not believing the news media seems to contradict the fact that it is the most popular form of information by the public. Those who will buy believed more on doctors and public health officials and university food scientists whilst those who will not buy added the consumer groups on their list of sources of information (Table 5.47).

The results imply that information about food irradiation may be channelled through the sources of information that were considered in this study. The information about food irradiation may be favourably perceived by consumers if passed through proper sources or where there is greater level of confidence among the households. For instance, a large proportion of the unsure group depend largely on public health officials, doctors and academic community for information about food safety issues. It should be noted that with regard food safety, the news media becomes an unpopular source of information.

Table 5.46 Respondents Level of Confidence on Several Sources of Information

Source	Believe		Do Not Believe		Neutral		All
	no	%	no	%	no	%	no
Health food store owners	79	21	54	14	242	65	375
Public health officials	244	64	21	5	118	31	383
News Media	46	12	91	24	240	64	377
Doctors	279	73	9	2	92	24	380
Consumer groups	194	51	23	6	164	43	381
Environmental groups	125	33	37	10	216	57	378
University food scientists	247	65	7	2	126	33	380

Table 5.47 Respondents Level of Confidence on Several Sources of Information by Willingness to Buy

Source	Believe		Do Not Believe		Neutral		All
	no	%	no	%	no	%	no
Will Buy							
Health food store owners	6	21	9	32	13	46	28
Public health officials	20	69	1	3	8	28	29
News Media	6	21	8	28	15	52	29
Doctors	23	79	1	3	5	17	29
Consumer groups	13	45	2	7	14	48	29
Environmental groups	8	28	7	24	14	48	29
University food scientists	21	72	0	0	8	28	29
Will Not Buy							
Health food store owners	27	31	10	11	51	58	88
Public health officials	53	60	6	7	30	34	89
News Media	5	6	24	27	60	67	89
Doctors	62	70	1	1	25	28	88
Consumer groups	51	56	6	7	34	37	91
Environmental groups	40	45	5	6	44	49	89
University food scientists	59	66	3	3	27	30	89
Not Sure							
Health food store owners	46	18	35	14	178	69	259
Public health officials	171	65	14	5	80	30	265
News Media	35	14	59	23	165	64	259
Doctors	194	74	7	3	62	24	263
Consumer groups	130	50	15	6	116	44	261
Environmental groups	77	30	25	10	158	61	260
University food scientists	167	64	4	2	91	35	262

Table 5.48 Respondents Level of Confidence on Several Sources of Information by Level of Concern

Source	Believe		Do Not Believe		Neutral		All
	no	%	no	%	no	%	no
Very Concerned							
Health food store owners	19	31	5	8	37	61	61
Public health officials	32	52	7	11	23	37	62
News Meadia	4	6	17	27	41	66	62
Doctors	44	72	2	3	15	25	61
Consumer groups	31	51	4	7	26	43	61
Environmental groups	30	48	4	6	28	45	62
University food scientists	40	65	4	6	18	29	62
Somewhat Concerned							
Health food store owners	31	21	21	14	93	64	145
Public health officials	103	69	7	5	40	27	150
News Meadia	18	12	35	24	93	64	146
Doctors	105	71	4	3	39	26	148
Consumer groups	81	54	7	5	63	42	151
Environmental groups	51	35	9	6	86	59	146
University food scientists	95	64	3	2	50	34	148
Somewhat Unconcerned							
Health food store owners	7	16	7	16	30	68	44
Public health officials	25	56	4	9	16	36	45
News Meadia	6	14	10	23	28	64	44
Doctors	33	73	0	0	12	27	45
Consumer groups	21	47	4	9	20	44	45
Environmental groups	12	27	7	16	25	57	44
University food scientists	27	60	0	0	18	40	45
Not Concerned							
Health food store owners	8	13	15	25	37	62	60
Public health officials	42	69	1	2	18	30	61
News Meadia	9	15	14	23	38	62	61
Doctors	44	73	2	3	14	23	60
Consumer groups	31	52	5	8	24	40	60
Environmental groups	13	21	13	21	35	57	61
University food scientists	40	66	0	0	21	34	61
Do Not Know							
Health food store owners	14	21	6	9	46	70	66
Public health officials	43	65	2	3	21	32	66
News Meadia	10	15	14	22	41	63	65
Doctors	54	81	1	1	12	18	67
Consumer groups	30	46	3	5	32	49	65
Environmental groups	19	29	4	6	43	65	66
University food scientists	44	68	0	0	21	32	65

Chapter 6

Summary and Conclusion

This study used two separate econometric models, the dichotomous logit model for the willingness to pay for irradiated food and the ordered logit procedure for the concern level about food irradiation. The empirical applications of the qualitative choice models offer valuable insights into the factors that influence the likelihood of consumption decisions regarding irradiated food and its effect on concern level. In light of the often strong concern commonly exhibited when considering 'non-conventional food' such as irradiated food, it is of interest to identify and quantify economic and demographic factors that influence irradiated food consumption in the future if the technology will find its way to the market.

This study successfully provided the socio-demographic characteristics of the consumers who were willing to buy irradiated food. Consequently, it also provided the socio-demographic profiles and other factors that may explain consumers' resistance to irradiated food. The classification of these types of consumers is essential in analysing consumer behaviour and in developing specific marketing programmes. In addition, the feasibility of the technology as a whole has its success relying heavily on consumer acceptance. As such, rejection by a majority of consumers would mean infeasibility of the technology.

Other countries are now reviving interest in this technology of irradiating food, the knowledge and perception of the kind of market that can be explored locally and the appropriate approach may help overcome resistance, rejection, or acceptance of irradiated food. This study is helpful in providing information about consumer characteristics. A consumer study prior to commercial introduction of a new product is imperative because of possible adverse public reaction caused by fear and insufficient knowledge about a product. The application of food irradiation

techniques to preserving food can enhance the quality and efficiency of food production and food marketing only if consumers recognise such technologies as scientifically sound, nutritionally wholesome, healthy and free of hazard.

In particular, the information derived from this study is useful for processors and producers alike in New Zealand who want to anticipate future market changes and demand for longer shelf life food by irradiation. Equally useful is the application to the policy side where control and adoption may be imminent in the future. Designing policies related to irradiation of food products is one of the concern of the government. The acceptability and adaptability of the process in New Zealand is another point of interest for the government and the consumers alike.

The results of the study indicate several points of interest. The results showed that food irradiation was among the least of the food concerns of the households surveyed relative to other food safety issues such as pesticide and chemical residues in fresh produce and antibiotics found in poultry and livestock. This study further confirmed some of the earlier findings of Bruhn, Schutz and Sommer (1986; 1987), Bruhn, Sommer and Schutz (1986), Mc Nutt (1985) and Wiese (1984) where subjects indicated higher concern for food treated with chemical sprays and other food safety issues than for irradiated food. The result of this study regarding higher concern of women about food irradiation was consistent with that of Wiese (1984) and Bruhn, Schutz and Sommer (1987). In contrast, with this high concern, the sample was distributed among very concerned, somewhat concerned, somewhat unconcerned, not concerned and do not know in response to irradiated food. This implies that a high percentage of people do not know how to respond to irradiated food.

A very small proportion of the sample population was willing to buy irradiated food. A significant number were undecided about their choice. The dichotomous choice model for willingness to buy showed that the likelihood of buying irradiated food is highly influenced by the consumers knowledge of the

irradiation process, sex, urbanisation, age, household size, organisational affiliation, diet and perceived attributes related to wholesomeness (taste or nutritional value), effect on health and perceived radioactivity in irradiated food at different levels of significance.

Concern on the other hand influences the willingness to buy irradiated food and was found to be significantly influenced by sex and knowledge about the irradiation process. Higher concern was shown by those who have a high level of knowledge about irradiation. Females were found to have higher degree of concern about food irradiation than males.

Two scenarios are possible for New Zealand. The first would involve the use food irradiation which necessitates the building of irradiation plant. The second would be the total ban of irradiation and the import of irradiated food from countries that irradiate food. In either case, the government has to consider the consumers' attitudes and concerns about food irradiation. The first case necessitates a market focus on women, with particular emphasis on irradiated food's wholesomeness, radioactivity, and health implications. This demographic characterisation could serve as a signal to those who anticipate direct marketing activity in the event that food irradiation is allowed. Moreover, the older consumers, those less knowledgeable about irradiated food, those who were not on a diet, smaller households and rural consumers can be the focus of a marketing strategy.

Another implication emphasises the importance of disseminating university research results on food safety issues in general, and food irradiation in particular. Consumer response to new technology should be based upon knowledge rather than uncertainty. Food safety information may be best presented by university scientists in an understandable manner to both the scientific community and the public. The academic community may tap other channels of communication in its extension programmes. The government may regulate the level of food safety and disseminate

information about risk characteristics products are disseminated to consumer. It can also regulate the industry output directly in order to reduce hazards to the public. Kwan Choi and Jensen (1991) opined that the role of the government should be limited to verifying claims about the hazard content, and should not extend to regulating the levels of food safety or output when the market is perfectly competitive.

Before regulation could occur, and is the likely need before food irradiation is permitted in New Zealand and allowed in most countries, the consumers' concern should be addressed first by the government. Safety attributes referring to the negative perception of radioactivity, wholesomeness and health effects of irradiated food create an atmosphere of fear among the uninformed consumers. Alleviating this fear could be done through discussions and other means by which academics are tapped as informed sources. The willingness to buy model suggests that these are the issues needing the greatest attention because they will eventually determine consumer willingness to pay and because knowledge levels were found to have a significant positive impact on the likelihood to buy irradiated food. An information campaign would have to focus on women as results indicated that overall, they were more concerned than males over issues that covered food safety, and food irradiation, in particular.

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Appendix 1: The questionnaire

SCHOOL OF
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ECONOMICS

MASSEY
UNIVERSITY

CONFIDENTIAL SURVEY QUESTIONNAIRE

This questionnaire is for the exclusive use of the
Department of Agricultural Economics and Business
Massey University, Palmerston North

We are carrying out a national survey to find out about New Zealand consumers' attitudes towards food irradiation.

We are very much aware that some of the answers you provide should be treated confidentially. Your answers to all the questions will be undisclosed and a code number will be used in the place of your name. This questionnaire will only be used for the purposes of this study and will be held in the possession of the researcher at all times.

If you answer this survey, you could

WIN AN ANSETT MYSTERY WEEKEND FOR TWO

To show our appreciation for your participation in this survey, we have organised for all participants to enter a lucky draw for an **ANSETT MYSTERY WEEKEND FOR TWO**, with a value of $458, which can be taken within the 12 months following 27 June 1993.

To be eligible for the draw, all you have to do is complete the survey and entry slip at the end of the survey form and return it to us by **24 June 1993** in the enclosed reply-paid envelope. No stamp is necessary. The winner will be drawn and notified by mail or telephone and the results published in the *Dominion Sunday Times* on 27 June 1993.

For further information or enquiries contact the undersigned at the

Department of Agricultural Economics and Business
Massey University, Palmerston North
Room 375, AgHort. Building
Phone number (06) 356 90 99, extension 7020
Fax number (06) 350 56 42

Thank you very much for your cooperation.

Yours sincerely,

Dennis M. Bautista
Postgraduate student

Dr. Rodolfo M. Nayga Jr.
Lecturer

Department of Agricultural
Economics and Business
Massey University
Private Bag 11222
Palmerston North
New Zealand

Telephone 0-6-356 9099
Facsimile 0-6-350 5642

[Is the person to whom this correspondence was addressed the same person who shops for food for the household? If not, will you please give this to him or her and let him/her complete the questionnaire.]

Q1 How would you describe the general quality of fresh food and vegetables offered by the supermarket? (circle only one number)

1 very good
2 good
3 average
4 poor
5 very poor

Q2 How frequently do you choose fresh food and vegetables that are grown organically? (circle only one number)

1 always
2 often
3 occasionally
4 seldom
5 never

Q3 How would you classify yourself in terms of trying a newly introduced food product in the supermarket? (circle only one number)

1 among the first to try
2 no change in purchase practice
3 among the last to try
4 never tries

Q4 In general, is your health

1 excellent
2 very good
3 good
4 fair
5 poor
6 do not know

Q5 Which type of diet do you observe? (circle appropriate number)

1 not observing a particular diet
2 low calorie/weight loss
3 low fat/cholesterol
4 low salt
5 low sugar/sugar free
6 diabetic
7 other, please specify _____

Q6 How would you rate your knowledge of the following items? (circle only one number per issue)

Item	High	Moderate	Low	None at all
Residues resulting from pesticides or herbicides	1	2	3	4
Antibiotics found in poultry and livestock	1	2	3	4
Growth stimulants in poultry and livestock	1	2	3	4
Nitrites in food	1	2	3	4
Irradiated food	1	2	3	4
Additives and preservatives	1	2	3	4
Artificial colouring	1	2	3	4

Q7 How would you rate the following? (circle only one number per issue)

Item	Serious hazard	Something of a hazard	Not a hazard at all	Not sure
Residues resulting from pesticides or herbicides	1	2	3	4
Antibiotics found in poultry and livestock	1	2	3	4
Growth stimulants in poultry and livestock	1	2	3	4
Nitrites in food	1	2	3	4
Irradiated food	1	2	3	4
Additives and preservatives	1	2	3	4
Artificial colouring	1	2	3	4

Q8 What is your approximate household consumption of the following food?
Write in your approximate household consumption in **kilogram(s) per week**

strawberry	_____	onion	_____
mushroom	_____	beef	_____
pear	_____	pork	_____
potato	_____	chicken	_____
banana	_____	fish	_____

Q9 Have you heard and or read any news report about food irradiation?

1 yes
2 no (If no, go to question Q11.)

Q10 What is your source of information? (circle appropriate number)

1 television
2 radio
3 magazine
4 newspaper
5 doctor
6 other source, please specify _____

Q11 Food irradiation is described as low levels of electromagnetic energy which kills insects and microorganisms commonly found in food and extends the shelf life of food. If food irradiation were used in the food you eat to eliminate food-borne diseases and to extend the storage life of food, how would you react? (circle only one number)

1 very concerned
2 somewhat concerned
3 somewhat unconcerned
4 not concerned
5 do not know/not sure

(If you circled either 1 or 2, go to question Q12.)
(If you circled either 3, 4 or 5, skip question Q12 and go to question Q13.)

Q12 If you are either very concerned or somewhat concerned, would this change your shopping behaviour?

1 yes
2 no

Q13 If food irradiation is allowed in New Zealand, to what extent would you buy and consume food that are irradiated? (circle only one number)

1 will buy
2 may or may not buy
3 will not buy
4 do not know/not sure

(If you circled 1 or 2, go to question Q15.)
(If you circled 3 or 4, go to question Q14 and skip questions Q15a, Q15b and Q16.)

Q14 Please state your reason(s) why you will not buy irradiated food and are not sure in question Q13, then go directly to question Q17.

_____

_____

_____

Q15 Provided below are the prices of the some commodities we included in this questionnaire. Please assume that these are the existing prices in the supermarket where you buy your food. These prices are aimed to assist you in filling this part of the questionnaire. The current prices are as follows:

strawberry --	$22.90/kg.	onion --	$ 1.99/kg.
mushroom --	$ 7.99/kg.	beef --	$16.24/kg.
pear --	$ 2.99/kg.	pork --	$12.24/kg.
potato --	$ 1.49/kg.	chicken --	$ 7.07/kg.
banana --	$ 1.99/kg.	blue cod fish --	$19.99/kg.

The price of beef is the average for rump steak and sirloin steak. The price of pork is the average for loin chop and leg roast and the price of chicken is based on a whole chicken.

Q15a) Given the current prices above, how much would you be willing to pay above the current price for extending the shelf life of the following food through irradiation? (circle only one choice per food item)

Food	How much would you be willing to pay per kilogram above the current price? Circle only one number per row or write in your answer (only for food that your household consumes).					
	$0.10	$0.25	$0.50	$0.75	$1.00	other, specify
strawberries	1	2	3	4	5	_____
mushrooms	1	2	3	4	5	_____
pears	1	2	3	4	5	_____
potatoes	1	2	3	4	5	_____
bananas	1	2	3	4	5	_____
onions	1	2	3	4	5	_____

Q15b) Given the current price of beef, pork, chicken and fish above, how much would you be willing to pay for the elimination of food-borne diseases and other microorganisms of the following food through food irradiation? (circle only one choice per food item)

Food	How much would you be willing to pay per kilogram above the current price? Circle only one number per row or write in your answer (only for food that your household consumes).					
	$0.10	$0.25	$0.50	$0.75	$1.00	other, specify
beef	1	2	3	4	5	_____
pork	1	2	3	4	5	_____
chicken	1	2	3	4	5	_____
blue codfish	1	2	3	4	5	_____

Q16 If the following food are allowed to be irradiated, how would your household consumption be: more, less or no change? Circle only one number per food item and write in the space provided how much more or less of your weekly household consumption. Do not write anything if you circle no change(3). **Do not answer this part if you circled 3 or 4 in question Q13.**

Food	More	Less	No change	How much more or less in percentage of your weekly household consumption?
strawberry	1	2	3	_____
mushroom	1	2	3	_____
pear	1	2	3	_____
potato	1	2	3	_____
banana	1	2	3	_____
onion	1	2	3	_____
beef	1	2	3	_____
pork	1	2	3	_____
chicken	1	2	3	_____
fish	1	2	3	_____

Q17 What do you think of the following statements:

a.) Food irradiation could bring about environmental hazards. (circle only one number)

1 strongly disagree
2 disagree
3 agree
4 strongly agree
5 do not know/unsure

b.) Food irradiation could make the food radioactive. (circle only one number)

1 strongly disagree
2 disagree
3 agree
4 strongly agree
5 do not know/unsure

c.) Food irradiation could affect the wholesomeness (e.g. taste, nutritional value) of the food. (circle only one number)

1 strongly disagree
2 disagree
3 agree
4 strongly agree
5 do not know/unsure

d.) Food irradiation could be hazardous to the health of those working at irradiation plant. (circle only one number)

1 strongly disagree
2 disagree
3 agree
4 strongly agree
5 do not know/unsure

e.) Irradiated food could be hazardous to your health. (circle only one number)

1 strongly disagree
2 disagree
3 agree
4 strongly agree
5 do not know/unsure

f.) Imported food infested with undesirable live pests should be treated by irradiation instead of chemical fumigants. (circle only one number)

1 strongly disagree
2 disagree
3 agree
4 strongly agree
5 do not know/unsure

g.) Agricultural products for export should be treated by irradiation instead of chemical fumigants to prevent food spoilage during transportation. (circle only one number)

1 strongly disagree
2 disagree
3 agree
4 strongly agree
5 do not know/unsure

Q18 Are you aware that New Zealand observes a 'nuclear-free' policy?

1 yes
2 no

Q19 If you are aware, does this affect your concern over food irradiation? (circle only one number)

1 affect
2 does not affect
3 do not know/ not sure

Q20 How frequent do you check the ingredient label on the food you buy? (circle only one number)

1 always
2 often
3 occasionally
4 seldom
5 never

Q21 Do you think that irradiated food being sold at the retail shops should be labelled as irradiated?

1 yes
2 no

General questions

Q22 What is the highest level of education you have achieved? (circle only one number)

1 no formal education
2 completed primary school
3 some secondary school
4 completed secondary school
5 some university
6 completed university degree
7 some postgraduate school
8 completed postgraduate degree at university
9 trade/vocational/polytechnic training

Q23 Which category of employment do you belong? (circle only one number)

1 employed, full time
2 employed, part time
3 employed, not at work
4 not employed
5 other, please specify _____

Q24 What is your occupation? (circle appropriate number)

1 professional
2 management
3 clerical
4 tradesperson
5 homemaker
6 retired
7 self-employed
8 sales and personal services
9 labourer, agricultural worker, craftsman
10 other, please specify _____

Q25 Number of persons, including yourself in the household _____

Q26 How many in your household are below 15 years old? _____

Q27 How many in your household are employed? _____

Q28 Your religious profession?

1 Presbyterian
2 Anglican
3 Roman Catholic
4 other, please specify _____
5 no religion

Q29 What was your **annual household gross income** before tax in 1992? (circle only one number)

1 $ 10,000 and below
2 $ 10,001 to $ 20,000
3 $ 20,001 to $ 30,000
4 $ 30,001 to $ 40,000
5 $ 40,001 to $ 50,000
6 $ 50,001 to $ 60,000
7 $ 60,001 and above

Q30 What proportion of your **monthly household income** is spent on food? _____ (in percentage)

Q31 In what town or city are you living? _____

Q32 Your present age _____ (in years)

Q33 Your approximate weight _____ (in kilograms)

Q34 Your sex

1 Male
2 Female

Q35 Your present marital status

1 never married
2 married/defacto
3 divorced
4 widowed

Q36 Ethnic origin/race

1 New Zealander/European
2 New Zealander/Maori
3 other, please specify _____

Q37 Are you affiliated with any of the following? (circle appropriate number)

1 consumer movement
2 environmental organisation
3 civic/social group
4 sports club
5 no affiliation

Q38 If you answered either 1 or 2 or both in question Q37, write in the name(s) of your organisation(s).

_____

_____

Q39 Food safety issues are normally addressed by different groups. How would you respond to the statements and information provided by the following groups? (circle only one number per row)

Source of information	Believe	Do not believe	Neutral
Health food store owners	1	2	3
Public health officials	1	2	3
News media	1	2	3
Doctors	1	2	3
Consumer groups	1	2	3
Environmental groups	1	2	3
University food scientists	1	2	3

[_____]

THANK YOU VERY MUCH, for your cooperation in this research effort. If you wish to join the lucky draw, please fill out this form below and return this to us together with the completed questionnaire in the reply-paid envelope on or before 24 June 1993.

Name _____

Postal address _____

_____

Phone number _____

Your assistance is genuinely appreciated.

Appendix 2: The Follow-up Letter

SCHOOL OF
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—
MASSEY
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16 June 1993

Dear Householder,

You should have received in the mail a copy of a questionnaire in regard to our study on food irradiation. To date, we have not received any reply from you so this letter is to kindly urge you to fill in the questionnaire and return it in the postage-paid envelope as soon as possible.

Your reply is extremely important to both the success of the survey and the ongoing research. Your opinion and view, which will be treated confidentially are imperative to help evaluate the consumers' attitudes toward food irradiation.

May I reiterate that you could win an ANSETT New Zealand Mystery Weekend Trip[for Two by completing the questionnaire, filling out the from at the end and returning them both.

If you have queries that you want clarified, please do not hesitate to contact us at:

Department of Agricultural Economics and Business
Massey University, Palmerston North
Room AH 375, AgHort. Building
Telephone number 356 9099, extension 7020

If you already returned your completed questionnaire, please ignore this letter.

Thank you very much for your cooperation.

Yours sincerely,

Dennis M. Bautista
Postgraduate student

Dr. Rodolfo M. Nayga Jr.
Lecturer

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