TECHNICAL INFORMATION CAPTURE FOR FOOD PRODUCT INNOVATION IN THAILAND

A thesis presented in partial fulfilment of the requirements for the degree of

Doctor of Philosophy in Food Technology

at Massey University, Palmerston North, New Zealand

PRASONG SIRIWONGWILAICHAT

2001

Errata

- Page 15, paragraph 2, sentence 5: Statement " ...makes technology applied more sophisticated." should read "...makes the applied technology more sophisticated."
- Page 108, paragraph 1, sentence 2: The phrase "contract manufactures" should read "contract manufacturers".
- Page 138, line 4: The word "descendent" should read "descending".
- Page 152, paragraph 1, line 6: The word "important" should read "importance".

ABSTRACT

Since rapidly effective product design and launch requires advanced technical skills and as new knowledge is expanding at an exponential rate, it is critical that food technologists keep up to date with international scientific developments. This is significant in Thailand in which the food market has been developed as a result of greater industrialisation, changes in consumer lifestyle and higher demand for processed foods. This study has identified the main technical knowledge sources used by Thai food manufacturing companies to support their development of new branded food products. Data were obtained from interviews with sixty two food processing companies, forty three potential providers of technical information and services, and from three focus groups held with technical food product developers. Internal technical staff in the food manufacturing companies were the major source of technical knowledge for food product development. Food ingredient suppliers were the most important outside providers of knowledge to these technical staff. The main technical information and services provided by the food ingredient suppliers included ingredient specifications, food recipes, consultancy, and product testing. Technical information was mostly required to support product formulations, food processing, shelf life studies, and quality control. New products that were radically innovative required more external technical knowledge sources, usually equipment suppliers, than those that were incrementally innovative.

The main barriers to technical knowledge absorption were foreign language difficulties, time limitation and business secrecy. To strengthen food product development activities in Thailand, it is recommended that a company enhance internal technical staff's capabilities to absorb external technical knowledge more efficiently. In addition, the technical knowledge providers should also simplify technical information access to the food companies.

ACKNOWLEDGEMENTS

This thesis could not be achieved without financial support from the Royal Thai Government scholarship and cooperation from many people and organisations. The author would like to pay special gratitude to the following persons and organisations for their cooperation and contribution to his thesis production.

Prof. Ray J. Winger for his gratefully patient supervising throughout this research project;

Prof. Ken J. Kirkpatrick for his kind support and valuable comments;

Assoc. Prof. Vichai Haruthaithanasan for his suggestions and for facilitating industrial contacts in Thailand;

Prof. Mary D. Earle for her consistent support and suggestions on relevant literature from beginning to the end of the project;

Dr. Prisana Suwannaporn for her copy of Ph.D. thesis and suggested literature;

Staff from the Department of Food Technology, Silpakorn University, Thailand for their impressive assistance during data investigation in Thailand;

Mr. Thawat Theerawat from the Royal Thai Embassy in Wellington for the Thai food companies information;

Participating food companies in Thailand who took part in the surveys and the focus groups;

Assistant Prof. Hathairat Rimkiree and Dr. Thongchai Suwannsichon from the Department of Product Development, Kasetsart University; Mr. Thirawuth Pongprayoon from the Department of Chemical Engineering, KMITNB; Mr. Chaiyong Taechapairoj, and; Ms. Busarakorn Mahayothee from the Faculty of Industrial Technology, Silpakorn University for their assistance during focus groups in Bangkok.

Mr. Boonyarit Vichienpanthu for his help with transportation during interviews;

Mr. Wiwat Wangchareon, Ms. Wararat Ittiwibool, Mr. Wanchat Suwannakit, and Ms. Wanwadee Wongmongkol for their assistance in information search in Thailand;

Atawhai village friends for their companionship, joy and fun;

Finally, this thesis is profoundly dedicated to Siriwongwilaichat family for their moral support.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1 KNOWLEDGE CREATION IN PRODUCT DEVELOPMENT

1.1 INTRODUCTION

In an increasingly globalised world, companies are facing pressure from many rapid changes in both technology and the market. Product life cycles are cut-short by new and more advanced technology. To remain profitable and survive in this environment, a company has to continuously improve its existing products or introduce new products. The product development process cycle has to be as short as possible.

To ensure a company's long term competitive advantage, the product development process should be recognised as a process of knowledge creation and accumulation. Accumulated knowledge relies solely on company records and staff experience. However, the creation of new knowledge requires inputs from both inside and outside the company. In this chapter, the new product development process and its relation to knowledge creation are reviewed.

1.2 DEFINITIONS OF "NEW" PRODUCTS

New products can be defined in many different ways. Understanding the classification and definition of new products is important because each type requires different strategies and management.

Terminology depends very much on the domain within which it is used. For example, it is more likely to see those in the marketing and management domain use the term "new product development", those in the R&D domain use "innovation" and those in the engineering domain use "design". However, there is no clear-cut difference among these terms, and therefore, they tend to be used interchangeably (Craig and Hart, 1992).

Sometimes newness of a product would be defined according to those who perceive it. In the context of consumer goods like food products, there are three groups of actors, who may or may not regard a given product as new: consumers, distributors, and producers (Grunert et al., 1997).

There are also differences among authors in classification of new products. These classifications range from simple through varying degrees of complexity. For example, Song and Montoya-Weiss (1998) provided two categories of new products:

- Really new products;
- Incrementally new products.

More comprehensive views, involving six categories, have been provided by Booz-Allen and Hamilton Inc. (1982) and Prime Consulting Group Inc. (1997) (Table 1.1).

Table 1.1 Categories of new products

Booz-Allen and Hamilton Inc. (1982)	**Prime Consulting Group Inc. (1997)**
New-to- the-world products	Classically innovative products
New product lines	Equity transfer products
Additions to existing product lines	Line extensions
Improvements in/revisions to existing products	Clone or competitive entry products
Repositioning	Temporary items
Cost reductions	Conversion items

While these above classifications are generic in nature, several authors have focused specifically on consumer food products. Fuller (1994) classified seven categories:

- creative products;
- innovative products;
- new packaging of existing products;
- reformulation of existing products;
- new forms of existing products;
- repositioned existing products;
- line extensions.

Earle and Earle (2000) classified three broad levels of innovation: incremental changes, major changes and radical changes, but grouped into two categories: platform changes and derivative changes.

Platform changes: These are radically innovative products. These include new-to-world products, new-to-company products, new processes leading to new products.

Derivative changes are subdivided into two sub-categories:
Incremental changes: These are product changes, packaging changes, cost reductions, and product line extensions.
Major changes: These are major product changes for new markets or market segments, and product line repositioning.

There are two aspects underlying criteria for distinguishing new product classifications: those which are completely new to both the market and the producer (never-seen-before-products) and those which already exist in either the market or the producer (change from known products).

Technology orientation (technology-led) would be an appropriate strategy for completely new products since these have never before existed. Furthermore, customer needs and competitor capabilities cannot be clearly defined. On the other hand, incrementally new products are familiar to consumers and consequently the target market can be identified. In that case, market orientation would be the more appropriate strategy (Song and Montoya-Weiss, 1998).

For the purpose of this study, four new product types were defined according to the degree of product newness either to the market or the producer:

- Completely-new-to-the-Thai market products;
- New-to-company products;
- Value-added products;
- Line extensions.

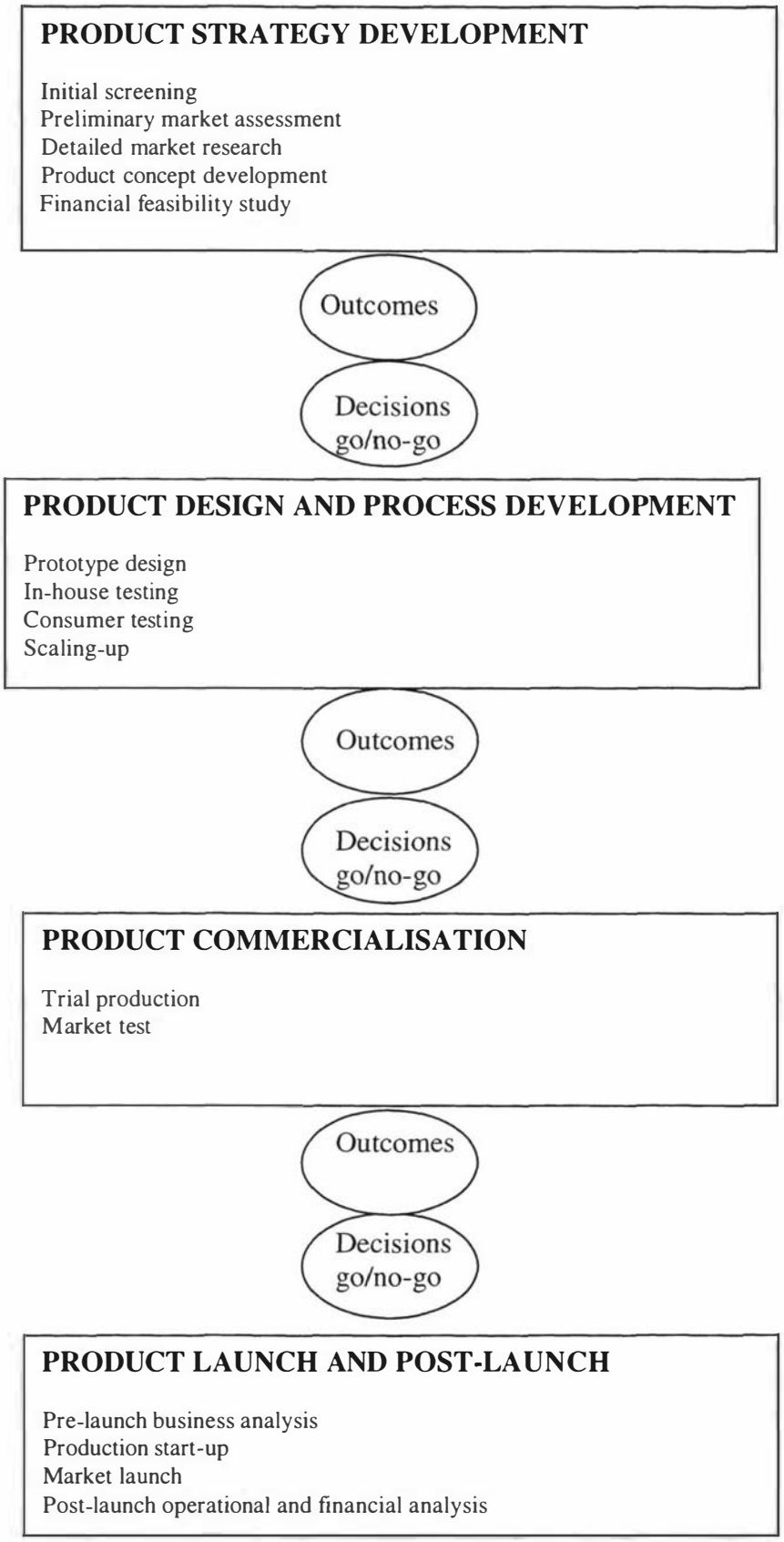
1.3 PRODUCT INNOVATION MODELS

Models defining product innovation or the product development process can be categorised as either normative models, or descriptive models (Cooper, 1983). The normative model provides major stages performed in the product development process, which can be used as a guide to other studies. The descriptive model has evolved from empirical studies of new product case histories. The latter lacks the detail and precision necessary for use as a normative model as it is based on actual practice. Thus, there is no guarantee that such practice itself is ideal and could stand as a guide to others. Hence, normative models are preferred for any study as an initial template.

The most widely referenced normative product development models are those of Booz-Allen and Hamilton Inc. (1982) and that of Cooper and Kleinschmidt (1986). While there is a variation in the number of stages performed in these models there are essentially four basic stages in every product development process. These include product strategy development, product design and development, product commercialisation, and product launch and post-launch. Each stage has activities which produce outcomes (information), and based on these outcomes the management decisions are made (Figure 1.1). These outcomes can be used as milestones to monitor progress against a planned set of goals, to review the next tasks, and anticipate problems, and to initiate programme changes (Rudolph, 1995).

In practice, some of the activities performed in the product development process can be truncated, or some stages can be omitted or avoided based on a company's accumulated knowledge and experience. This is determined by the degree of product newness and the product life cycle. Products which are incrementally new, such as product improvement and line extension, require less time to develop (Cooper and Kleinschmidt, 1986; Earle, 1997a). For short-life-cycle products or fads, speed of new product introduction is important, as changes in consumer needs are rapid (Hughes and Chafin, 1996; Neff, 1997). In this instance, relevant product requirements rather than new scientific results or advanced technology are sought. For long-life-cycle products, process innovation and cost control are important foci (Utterback and Abernathy, 1975).

Figure 1.1 Stages and activities in product development process



Source: Adapted from Earle and Earle (2000)

1.4 TRANSITION IN THE PRODUCT DEVELOPMENT PROCESS

The product development process changes over time. These changes are driven by the company's external environment, such as the market, technology, competitors, economics, and politics.

As companies grow and develop, their product development process also matures. This growth and maturity has been coined the "generation" of the product development process. These generations are influenced mainly by the innovation management strategy of an organisation and they are unique to a particular company.

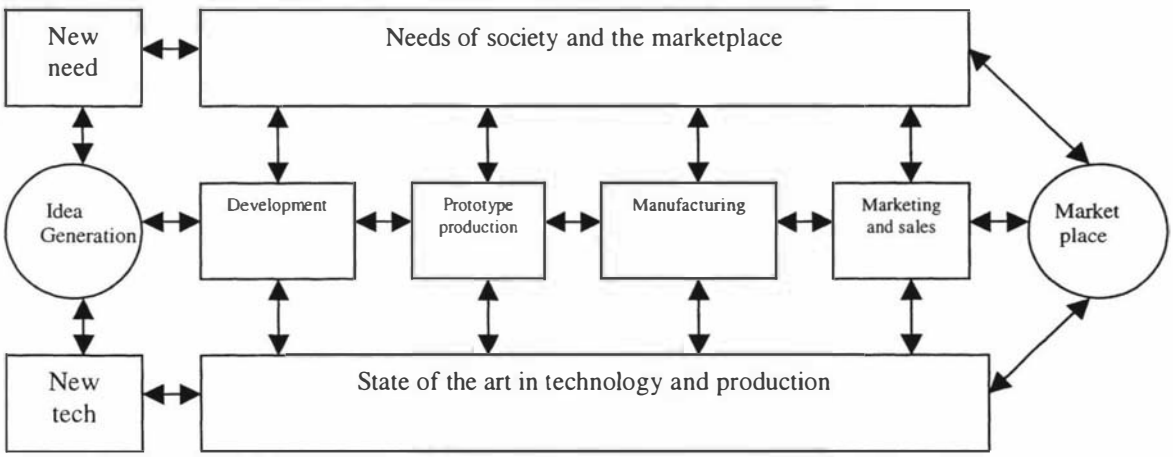
Some authors have classified generations based on the management approach and the interaction between R&D and the business functions. These included the three R&D generations of Roussel et al. (1991); four R&D generations of Miller and Morris (1999); five product development process generations of Rothwell (1994), and; changes in the product development process depicted by Earle (1997a). Albeit different in some detail, some common ideas can be drawn.

In early generations of the product development process, the research and development (R&D) project was not integrated into the business strategy of a company. The next stage was the recognition that new product development should begin with the business strategy, working through the product strategy, to the new product area definition. The purpose was to ensure that all risks affecting long-term business success were taken into account so costs and product failure could be minimised. In the final generation, new products were strategically planned at company level. Technology was considered a weapon for competitive advantage. It was also in this latest generation that the product development process was viewed as both a learning and a knowledge accumulation process in which both internal and external resources were important.

Thus, the product development process is not a simple linear or sequential process model. Rather it is complex, multidisciplinary and linked to accumulated knowledge of market, science and technology throughout the process in order to speed up and increase effectiveness of new product introductions (Kline and Rosenberg, 1986; Best, 1991; Kotler and Armstrong, 1996). The modern innovation model is viewed as an interactive model in which stages are interacting with and interdependent on each other. The

innovation process is a complex net of communication paths, both intra-organisational and extra-organisational, linking together the various in-house functions and the firm to the broader scientific and technological community, and to the marketplace (Figure 1.2).

Figure 1.2 The coupling model of innovation



Source: Rothwell (1992)

1.5 THE RISK OF NEW PRODUCT DEVELOPMENT

While the new product development (NPD) process is important to company survival and growth, there is evidence that it is poorly recognised in many companies. A survey of 149 UK and USA companies by Barclay (1992) indicated that much of the published work on the NPD process was unknown to product development managers. Amongst those who knew (6.7%), very few (5 companies) attempted to apply the results of the research.

NPD is risky. New products are more likely to fail in the market than succeed. In the USA, there were approximately 20,000 new food products introduced each year (Mathews, 1997; Prime Consulting Group Inc., 1997). Conventional industry wisdom estimated that about 80 to 90% of new products introduced to the market would fail within one year of introduction (Morris, 1993; Mathews, 1997; Prime Consulting Group Inc., 1997). There was little difference in failure rates across the sectors of the food

industry. The evidence was shown by the 1992 Annual Innovation Survey conducted by Group EFO Limited of Westport, C.T. in conjunction with Brandweek Magazine. The results revealed that only 8% of NPD projects actually survived to reach the marketplace. Of these surviving products, only 17% met their major business objectives. The accumulative effect was that less than 1% of NPD projects succeeded in the marketplace. In the other words, 99% of product development effort was wasted (Morris, 1993; Sloan, 1994).

However, the success and failure rate of new food products could vary according to criteria used to define the success and the new products. For example, Theodore (2000) reported (without clear definitions) that "new" products had a 72% failure rate, while line extensions had a 55% failure rate.

According to the market research conducted by Linton Matysiak & Wilkes in 1995, of 1,935 products introduced in the market, 174 new product items were classified as new and innovative products, and 1,761 were line extensions. New product items had a success rate of 52%, while the line extensions had a 78% success rate (Dornblaser, 1997).

The study by Prime Consulting Group Inc. (1997) classified new products into six categories: classically innovative; equity transfer; line extension; temporary; competitive entry, and; conversion. Only the first three categories were regarded as truly new products. A successful product was defined as one which achieved at least 80% of the 26 week sales per distributing store after two years. When these criteria were used, only 5,070 products (6% of all products) were truly new products. Of these 33% were successful, 42% were still in distribution but declining and 25% failed. "New brands" had a higher success rate (47%) than "line extensions" (28%). Although this success rate was defined more clearly than others had reported, the rate of failure was still high.

Some reasons for the main causes for NPD failures were: lack of product strategies; insufficient differentiation among new products; inadequate understanding of consumer needs; lack of market research; inefficient product development management; ineffective use of outside technology, and; ineffective internal communication (SPRU,

1972; Booz-Allen and Hamilton Inc., 1982; Baker et al., 1988; Morris, 1993; Sloan, 1994; Hoban, 1998). To reduce the risk and cost of new product failure, a food company therefore needs to recognise the importance of the NPD process and its management. High risk or poor new products should be identified and eliminated at early stages of the NPD process. To achieve a higher success rate, a company should integrate all the company functions into the NPD process and its business strategy, with consistent support from the top management.

The effective use of outside technology and scientific advice is one of the successful key features of product innovation (SPRU, 1972). The effective management of product innovation is not only dealing with creation and diffusion of internal knowledge but also knowledge external to the firm which involves the management of complementary skills, technological dependencies, and knowledge transfers through research links (Liyanage et al., 1999). The successful product development projects therefore were those which linked with not only the corporate strategies, but also the industry environment (Erickson et al., 1990).

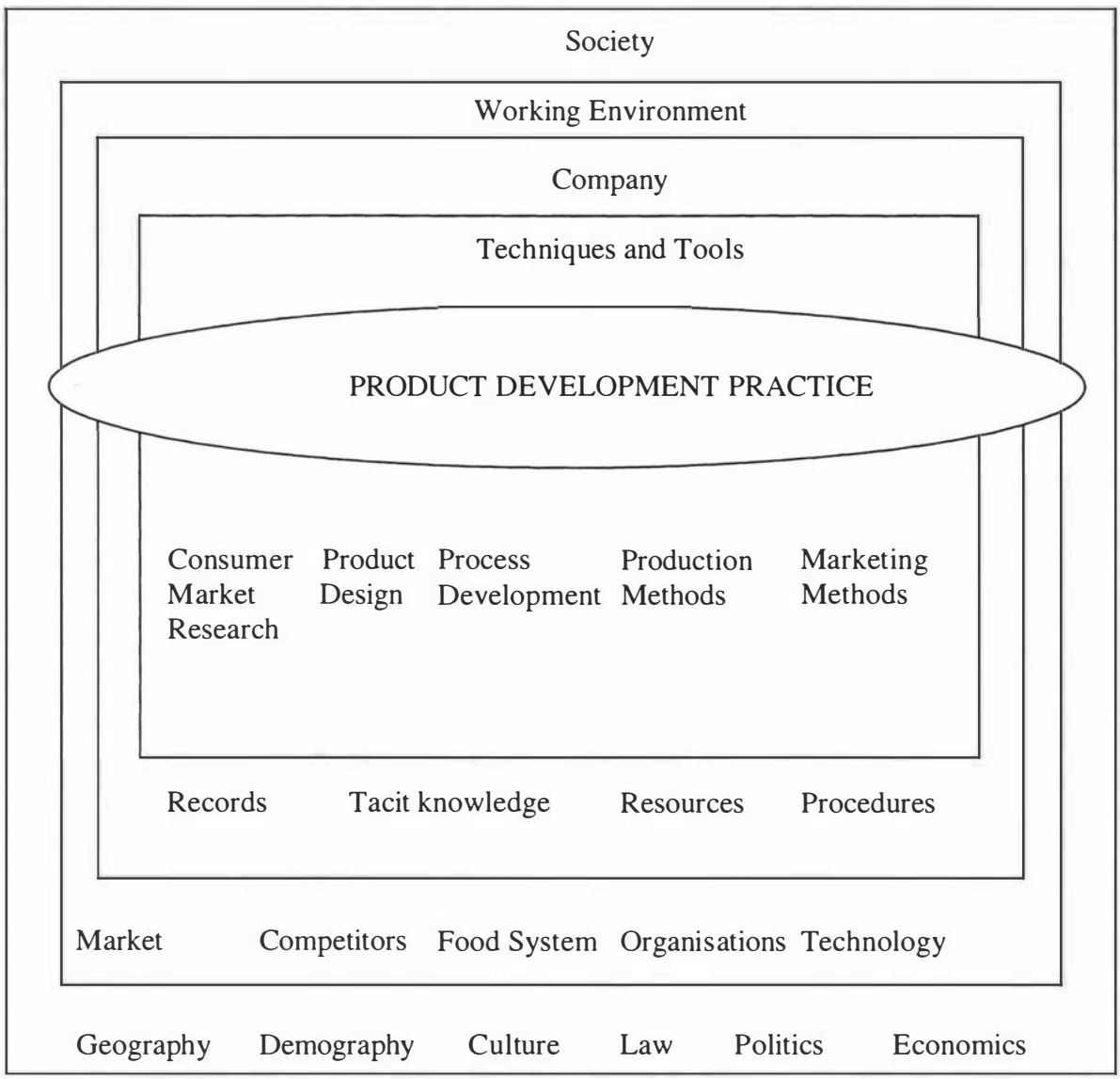
1.6 THE ENVIRONMENT OF PRODUCT INNOVATION

To strategically plan product development, companies need to be aware of changes in technology and society. It is important to recognise the total technology affecting the company's new product success (Earle, 1997b; Earle and Earle, 2000). Total technology includes the working environment, the company capability and the actual practice of product development (Figure 1.3). A company needs to be able to interrelate its own skills and knowledge with the complex ambience surrounding the company that leads to successful product development. Since there is a wide range of knowledge, companies have to be selective in their collection of knowledge to further their decision-making involving the total technology. The knowledge selected includes the tacit knowledge already held by individuals in the company and new knowledge from outside the company and from research (Earle and Earle, 1999a).

The success of a company in exploiting knowledge for product innovation depends not only on what it does to the company's innovation capabilities but also on what it does to the innovation capabilities of its value-added chain of suppliers, customers, and

complementary innovators. Any change in products by a company impacts these actors, be it incrementally or radically. Success depends on the compatibility resulting from that innovation (Afuah, 1998).

Figure 1.3 Total technology and product development



Source: Earle and Earle (2000)

1.7 KNOWLEDGE CREATION

Innovation activities represent organisational learning which is becoming important for competitive advantage. Learning is necessary for firms to cope with uncertainties through processes of adaptation and improvement. Facing a constantly changing competitive environment, food companies are required to extend their knowledge continually. The complexities of the NPD process, shortening product life-cycles, the development of science, government regulations, and the emergence of pervasive new technologies all demand that firms learn to do things in new ways (Dodgson, 1993; Bohn, 1994; Senker, 1996). Therefore, better management of knowledge is a key success for industry competitiveness through continuous innovation (Nonaka, 1991; Liyanage et al., 1999).

From the idea-generation phase to the launch phase, the creation of new knowledge can be viewed as the central theme of the NPD process (Madhavan and Grover, 1998). In this context, product innovation can be defined as the process of using new knowledge to offer a new product that customers want (Afuah, 1998).

However, there must be clear understanding of the difference between "knowledge" and "information". "Knowledge" is fundamental in an organisation in order to solve problems, to make decisions, to produce goods and services, for the marketing and sale of products, among others. The role of "information" in this context is to reveal or to create new knowledge, to maintain our basic level of knowledge, and to stimulate and increase our understanding of the processes of human relations, production, technology, organisation, and other systems (Kalseth, 1990). Nonaka and Takeuchi (1995) emphasised that knowledge, unlike information, is about beliefs, commitment and action. They also concluded that " *Information is a flow of message, while knowledge is created by that very flow of information*". In other words, information is an input in a knowledge creation process.

There are two types of knowledge: "tacit knowledge" and "explicit or codified knowledge" (Nonaka et al., 1996; Madhavan and Grover, 1998). Nonaka et al. (1996) pointed out that Westerners view knowledge as being "explicit" and can be taught through manuals, books, or lectures whilst Japanese regard it as being primarily "tacit" – something not easily visible and expressible. In the product development process,

creating a product concept involves a community of interacting individuals with different backgrounds and mental models in which human beings create working models of the world by making and manipulating analogies in their minds. In this context, Nonaka et al. (1996) regard tacit knowledge as a vital knowledge asset for organisational innovation. However, organisational knowledge is a result of continuous and dynamic interaction between tacit and explicit knowledge. The resulting new product knowledge stored in the product development team is regarded as *embodied knowledge* (Madhavan and Grover, 1998; Earle and Earle, 2000). The new product development process is therefore dealing with the transition from *organisational knowledge* to *embodied knowledge* in both new products and human resources. This entails collecting information and turning it into new products or services (Afuah, 1998).

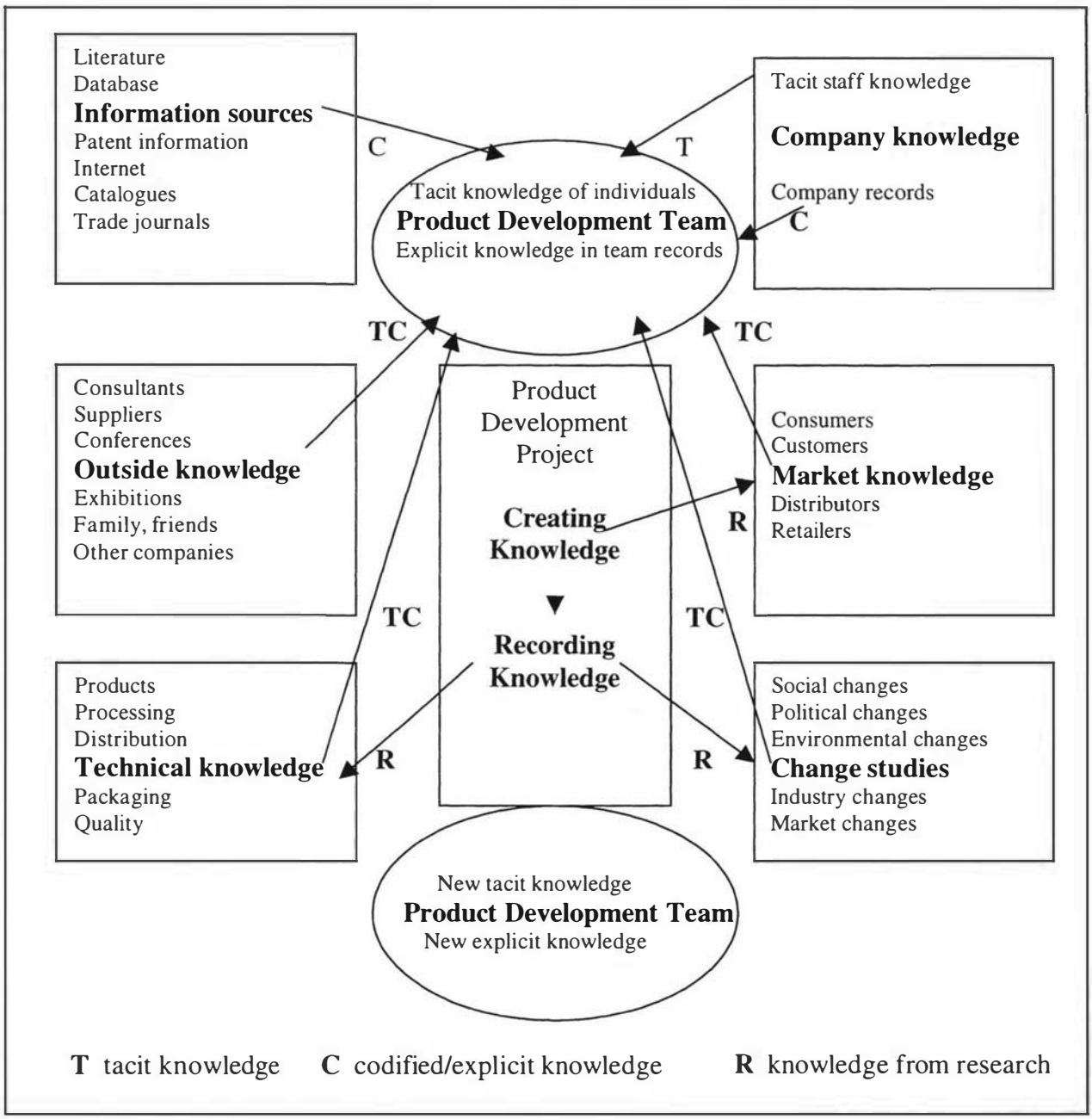
Knowledge of the industrial customer or consumer (market orientation), and knowledge of modern scientific discoveries and technological developments (R&D) are two major parts of product development. They are regarded as equally important, and they should be well integrated (Buisson, 1993a; Earle, 1997a; Earle and Earle, 1999b; Pszczola, 1999). Technological knowledge and market knowledge underpin a company's capabilities in introducing successful new products (Afuah, 1998).

Firms can create their own new knowledge by many different ways such as by conducting their own research and development (R&D), by training their own staff, by hiring individuals from outside, by installing capital goods, and by imitating inward investors. It is important for firms to learn continuously and to base their learning on multiple sources of knowledge. The diffusion of new knowledge needs to be well organised to ensure that knowledge which is received from external sources is communicated and utilised effectively throughout the organisation (Dodgson, 1993; Senker and Senker, 1994).

Thus, creating knowledge requires inputs from both internal and external sources as shown in Figure 1.4. It is important to build up the product development team as a knowledge base. This is because R&D departments accumulate knowledge over time and what they have done in the past may form the basis of new building blocks to be used in the future (Senker, 1988). At the end of each new product development project,

it is worthwhile for as much as possible of the knowledge created to be formally recorded (e.g. in databases) as a basis for future projects because tacit knowledge of individuals may be lost when they move on (Earle and Earle, 2000).

Figure 1.4 Knowledge in the product development team



Source: Earle and Earle (2000)

1.8 CONCLUSION

Although new products can be defined in many different ways, there are two aspects underlying classification criteria: those which are completely new to both the market and the food manufacturer and those which already exist in either the market or with the food manufacturer. For the purpose of this study, four new product categories were defined according to their degree of newness to either the market or the producer. These were Completely-new-to-the-Thai market products; New-to-company products; Value-added products, and; Line extensions.

The product development process in any industry comprises four basic steps: product strategy development; product design and process development; product commercialisation, and; product launch and post-launch. Each stage comprises numerous activities which are determined by the type of new product and the accumulated knowledge of the company.

The product development process is dynamic. It is driven by the company's internal activities and the external environment surrounding companies, such as the market, technology developments and competitors. Since the risk of new product introduction is high, the modern product development process is viewed as both a learning and a knowledge accumulation process to ensure the long term business success. With rapid changes in technology and the market, the creation of organisational knowledge is becoming even more important for a company to retain their competitive advantage with new products. Capturing and updating technical knowledge is thus becoming important to NPD activities. Because of a wide range of information available, a company needs to be selective in collecting knowledge.

To enable a comparison or clarification of the utilisation of technical knowledge sources in the food industry as opposed to other industries, specific characteristics of food product innovation and knowledge exploitation are described in the next chapter.

2 INFORMATION CAPTURE FOR PRODUCT DEVELOPMENT

2.1 INTRODUCTION

In the food industry just as in any other industry, new product development is considered a vital part, indeed the lifeblood, of business strategy as well as a research method. In other words, developing new food products is creating new knowledge for a company. New food product development represents a significant investment for a company, both in money and human resources (Fuller, 1994).

Facing rapid changes in the market and the ever fast development of technology, the product development process in the food industry needs to be flexible and fast. To establish a long term competitive strategy, a food company has to be aware of its skills and knowledge in relation to its environment. Two major interdependent environments directly involved in product development strategy are the consumer and the technology. While consumers' demands keep changing over time, technology needs to be responsive. In the food industry, increasing consumer demand for products with improvements in nutritional value, palatability, safety, and convenience, makes technology applied more sophisticated (McFarlane and McDonald, 1988). Thus, it is vital that a company consider technical knowledge as a key input to build up its long term competitive advantage to serve changing consumer demand. The use of known technology, rather than designing new technology, to produce commercially attractive new products is the key to commercial success in a rapidly changing technology environment (Atuahene-Gima and Lowe, 1994).

The propensity to use technical knowledge sources varies according to business types and their related technology development (Pavitt, 1984; Archibugi et al., 1991; Senker and Faulkner, 1992). While there were many studies focusing on technical knowledge sources in product innovation of various manufacturing enterprises (Johnson and Kuehn, 1987; Kennington, 1989; Atuahene-Gima and Lowe, 1994; Julien, 1995; Kuhn, 1995; Taylor and Lowe, 1997; Gomes, 1998; Belotti and Tunalv, 1999), very few of them discussed the differences among industry types.

In this chapter, the food product development system and characteristics are briefly described. Then the role of technology and technical information in food product development are discussed in greater detail.

2.2 CHARACTERISTICS OF FOOD PRODUCT DEVELOPMENT

The product development process in the food industry has some specific characteristics. Product innovation is determined by the interaction between consumer expectations and demand, and the role of technological opportunities (Galizzi and Venturini, 1996). Innovation in the food industry might be different from that in other industries due to following characteristics.

2.2.1 Degree of product newness

In the food industry true "never seen before" innovations are rare. Food product innovations tend to be incrementally innovative (Baron, 1980; Gallo, 1992; Galizzi and Venturini, 1996; Connor and Schiek, 1997; Gallo, 1999; Suwannaporn, 1999). Radical innovations in the food industry, however, can be driven by socio-demographic and socio-economic forces, as well as technology development. Migrations of Asian and Latin American to the USA during 1970s and 1980s, for example, affected rapid uptake of food from one culture to another. The introduction of the household freezer and microwave led to the development of many frozen and microwavable meals. Development of technology in some areas during 1970s and 1980s also provided alternative approaches for producing safety and convenience foods, such as irradiation, retort pouches, and aseptic processing technology (Best, 1991).

2.2.2 Consumers

Food processing is a consumer-driven industry which is highly susceptible to the vagaries of changing consumer demographics, tastes, fads, and mythologies (Best, 1991). Common basic consumer needs for food products are convenience, nutritional value and taste (Nystrom and Edvardsson, 1982; Zimmerman, 1989; Nystrom, 1990). Consumers of food products themselves tend to show "risk aversion". They want new products but the new product has to be familiar or similar to those they are used to.

There is tendency to better accept new products that change at the margin rather than radical or major changes. Food consumers have a long experience with certain tastes and eating habits, which are usually difficult and time consuming to change (Galizzi and Venturini, 1996). This explains why most new food products tend to be incrementally innovative.

2.2.3 Market structure

Because foodstuffs are easy to imitate, the time for an innovator to obtain monopolistic gains is short. Thus, the food market is more likely to be oligopolistic (Christensen et al., 1996). To survive in the market, food products need to be differentiated.

2.2.4 Technology and product development activities

The food industry is often defined as a low-technology sector, and R&D is usually dominated by a few large companies (Senker, 1988; Connor and Schiek, 1997). Patel and Pavitt (1995) identified percentage shares of patenting of small and large firms in various industries. They concluded that large firms predominate in the patent applications in R&D intensive sectors (chemicals, electrical-electronic, transport and equipment), whilst small firms predominate in capital goods (machinery, process, instrument, and metal products). These R&D intensive sectors are usually associated with high technology industries. In the food industry, compared to other industries, most companies are small and internal product development activities usually focus on process innovation (Archibugi et al., 1991; Harmsen et al., 2000). Only a few large multinational companies are dealing with modern and advanced technology such as Nestle′ (Nestle′, n.d.), Nabisco (O'Donnell, 1995), CPC International (O'Donnell, 1996), Unilever, and Kraft (Katz, 1998a).

In the food industry, major advances in technology occasionally occur, but diffuse rapidly across the industry. Important technical advances for food innovation often derive from embodied forms of technology from outside upstream industries such as equipment, ingredient and packaging suppliers (Anonymous, 1980; Mueller et al., 1982; Scherer, 1982; Pavitt, 1984; Baker et al., 1988; McFarlane and McDonald, 1988; Archibugi et al., 1991; Nicolas, 1996; Rama, 1996; Connor and Schiek, 1997; Grunert

et al., 1997; Evangelista, 1999; Suwannaporn, 1999). However, most technological development in the food industry is driven by needs generated within the sector itself, rather than by the adoption of ideas developed elsewhere for other purposes (Christensen et al., 1996).

It is also important to note that there are differences between sub-sectors within the food industry. The large scale intermediate foods manufacturers (e.g. flour milling or sugar refining) have been characterised by Pavitt (1984) as scale-intensive firms in which a high proportion of their own process technology was made. On the other hand, the processed convenience foods manufacturers generally conduct little in-house R&D on equipment and are similar to Pavitt's characterisation of suppliers-dominated firms (Senker, 1998).

Although the impact of technology on the food industry has been considered relatively low, this may not continue due to several factors, especially changes of consumer expectation. With increasing consumer awareness of, and demand for, products with specific sensory and nutritional attributes, the food industry is facing new technology that must be adapted and integrated into the processes, products and culture of a firm (McFarlane and McDonald, 1988).

2.2.5 Research and development (R&D) strategies

R&D is a part of the innovation process and related to the early activities of the innovation process, mostly concerning scientific development (Harmsen, et al., 2000). R&D in the food industry is a market-driven, application-oriented effort, directed toward specific products and based more on incremental technological innovations than on major changes from basic research (Baron, 1980; ACARD, 1982; McFarlane and McDonald, 1988; Archibugi et al., 1991; Kevin, 1994; Christensen et al., 1996). R&D expenditure in the food industry is quite low compared to some other higher science and technology based industries such as the chemical industry and the pharmaceutical industry. In the USA, food companies spent less than 4% of gross sales on R&D (Gorski, 1994; Kevin, 1994; Connor and Schiek, 1997). For multinational companies, Nestle' spent 1.2% of its sales on R&D in 1992 and that of Unilever was about 2% in 1993 (Tansey, 1994). According to Food Processing's 1998 top 100 R&D, no company

reported its R&D budget higher than 1.5% of its food sales (Meyer, 1998). R&D budgets in chemical companies ranged from 4% to 10% of sales (Rotman, 1996; Moore, 2000). In the pharmaceutical industry, the R&D budget was as high as 15% to 17% of sales (Cookson, 1996; Scott, 1999; Mirasol, 2000).

R&D expenditure in the food industry, however, varies across product categories. One study, for example, indicated that the R&D investments as a percent of sales were high in prepared foods and specialty food products, whereas they tended to be low in the confectionery and beverage industries (Best, 1991).

McFarlane and McDonald (1988) summarised R&D strategies employed in food industries as follows:

- R&D activities in food industries are dictated by opportunities in markets. Consumer preference, market size, profit margin, and capacity for effective response to competition are important criteria used to direct the R&D function.

- R&D activities are differentiated according to goals and situation, and allocated to strategic business units (SBUs) and central facilities. R&D employing process and product technology to develop new products or line extensions is usually assigned to SBUs. This allows immediate response to specific markets. In some cases, R&D is also done at the corporate level. This would aim at new markets, long term product development, development of technology with a major impact on the entire corporation or which could support multiple SBUs.

- Firms distinguish the purpose and impact of technologies and aim for internal or external development. Development of base or key technology is frequently done in-house. Pacing technology is frequently employed by means of joint ventures or acquisitions, rather than developed in-house. The decision on what is done internally and what method is employed for acquiring external technologies is important. External sources of technology can be obtained from literature, by funding academic research, through consultants, or from suppliers of ingredients, process machinery, and instruments.

• Successful product lines can be sustained in the market by R&D efforts focused on cost reduction, line extensions, and product renewal. The key is continued improvement based on consumer preference and new technology..

2.2.6 Product characteristics

A new food product can be categorised by its key product attributes. These are form (size, shape, density, packaging, stability); content (nutrition, additives, contaminants); palatability (taste, odour, colour, texture, social and identification culture), and; cost (raw materials, conversion, overhead costs). Each attribute should be considered as follows.

• Determine the consumer perception of the attribute, e.g. what the consumer perceives as the embodiment of the attribute in the product.
• Determine the actual or potential value of the attribute, e.g. nutritional value to each person may differ by individual diet and nutritional needs.
• Estimate market value in order to estimate market attractiveness. This requires consideration of questions such as: How large is the segment? How stable is consumer demand? What alternatives are there for a certain attribute? How does the attribute affect the other products sold?

An accurate technical characterisation of the attribute must be achieved, e.g. specification, process conditions, stability, packaging, and method of measuring the attribute for quality control purposes (McFarlane and McDonald, 1988).

2.3 NPD PARADIGM IN DIFFERENT COUNTRIES

The pattern of the food product development process tends to vary across countries due to differing organisational cultures. In the USA, because of considerable turnover of personnel, product development is formal and product knowledge is well documented. In Denmark and New Zealand, the product development process is less formal. A company's product knowledge is often not documented but resides with a single person or is considered joint informal knowledge. In Japan, continual technological and

marketing improvement around existing products are emphasised in order to increase the speed of new product introductions and reduce cost. The Japanese approach to product development regards the continuous understanding of the consumer needs as highly important (Buisson, 1995).

2.4 NPD OF MULTINATIONAL FOOD COMPANIES

Most leading multinational food companies have their own centre of excellence conducting basic research. They use multilevel basic research teams employing analytical chemists, protein, fat, and carbohydrate specialists, sensory experts, development engineers, flavour development personnel, and sometimes microbiologists, and increasingly, biotechnologists. They may work on technology "push" projects or marketing "pull" projects. After they have produced new information, the most successful companies have specialists that can comprehend technical language and translate it into marketing solutions. Interactive teams use the new technologies to build products suitable for specific markets (Katz, 1998a). Since food is culturally based, the ideal global food company is the one that is indeed global in its strategy, technology, and financial resources, but local in its marketing (Guardia, 1992). Some multinational companies also establish their local product application units to adapt products to suit local needs. Below are some examples of product development activities in multinational food companies.

RJR Nabisco Inc. was recognised as an industry leader in new product introduction in 1995. It recognised R&D as an integral part of its business strategy. The strategy focused on core competencies and outsourcing the others such as forming alliances with outside technical resources. Outside technical alliances included suppliers, universities, government laboratories and consultants. Basic research was regarded as important because they believed that developing a new technology led to a family of products while developing a new product provided only a single product. Cross training in fundamental research was provided to product development technologists and scientists of the company. Fundamental and applied efforts were tied together, and used to obtain consistency among researchers, increase technology transfer within the company and avoid duplication (O'Donnell, 1995).

At CPC International Inc., technical inputs were integrated into the business plan. While CPC's presence was strong in Central and South America and growing in Asia, European technical resources were some of the most sophisticated. CPC entered a country by buying an existing facility and introducing existing CPC brands or by exporting to it until local manufacturing could be established. CPC in all the developed countries had a local R&D function with a fair degree of autonomy. They believed that local people were best at determining what local people wanted. To handle broader R&D issues related to global or pan-European brands, CPC had 10 Centres of Excellence, each of which focused on a particular product group or brand. Effective networking and sharing access to fundamental technologies were established to maximise critical mass. Technology of the company was transferred to each country by providing information (*viz.* sourcing raw materials, formulas and the basic process); training programmes and electronic communications with experts were via e-mail. Reliance on the research centre depended on the benefit of the project. If a project benefited one country only, that business unit would usually use its own local R&D resources rather than a centre. The company focused on applied rather than basic research since speed was the key mission. Basic research was conducted only when there was a clear need, for example, to have competitive superiority in a key technology. Although CPC did not have a group for basic research, certain individuals spent more of their time in this area. All divisions had an external research budget for contracting with universities, independent laboratories and, to a limited extent, consultants. Access to suppliers' technology and cooperative relations were also important (O'Donnell, 1996).

Campbell Soup Company had 20 manufacturing sites in Europe, seven in Australia, and several more scattered from South America to the Far East to Canada and Mexico. Campbell centralised its "research" but decentralised the development of products to the regional market. Technology development was done in the company's research centre either in Camden, N.J. or in California. In contrast, product development was country-focused and was generally located in the regions where the market was. The product development team worked closely with regional marketing people to translate marketing needs into technology needs. To gain a competitive advantage in the marketplace, Campbell utilised outside technology such as buying new technology and assistance from ingredient suppliers for its new product development. Information

technology was also utilised as a facilitating tool for accumulation, analysis and utilisation of information in shorter periods of time (O'Donnell, 1997).

At Unilever, the team efforts were truly international-business-units in nutrition, confectionery, and baked foods combining market development with product development. Business managers and technical managers teamed up to get new projects identified and defined. Members of Unilever companies, particularly processors of food products, used the basic research developed at Colworth House in England and Vlaardingen research centre in the Netherlands. The areas that Unilever has declared to be core competencies are lipids, frozen dairy foods, and beverages. Basic research was done by the experts in Europe, where research was more affordable, partly because of the tax structure. It was accessible to Unilever's processing firms by transferring payments to the centres. The cutting-edge aspect of R&D kept the company out of the me-too mode, and enhanced the life cycle of products (Katz, 1998a).

Kraft Food's global activities centred in Europe, the Middle East, and Africa were coordinated by Kraft Foods International, New York. Its Latin American activities were coordinated by the Philip Morris Group, the parent company of the Kraft companies, in New York. The Asian business units operated through Hong Kong for the greater China food business. The business units operated through joint venture with local food companies in Japan (with Ajinomoto) and in Korea (with Dong Suh Foods). In Southeast Asia, it was headquartered in Manila, the Philippines. Australia was home to Kraft Australia.

The coffee business group of Kraft operated research units in England and Germany. There was a strong linkage among technology, basic science, and marketing of each of the key business units, and the groups often called on personnel with particular expertise to join a team for six months or more. The coffee group had a fairly formalised structure, called a World Council, that combined local marketing employees with formulators and researchers. Another World Council has been formed for the beverage group, and a third for cheese products. In addition to the three World Councils, Kraft Foods International had several less-formalised structures that formed teams for introduction of new products and improvement of the business unit worldwide. Kraft Foods International was able to identify experts in a wide variety of

food product areas and used those experts to speed new product development and to make the ideal translation of products for new areas. These experts resided in the countries where the company had the most experience in a given product area of interest (Katz, 1998a).

General Mills is the American leading food company in cereals and snack products. One of its international operations was in Canada. General Mills joined with other multinational companies for other regions of the world. This included a strategic alliance with Nestle' in 1989 to create Cereal Partners Worldwide (CPW), and a joint venture with PepsiCo in Europe for snack food. General Mills exported more than 650 different items to more than 100 different markets around the world (General Mills, n.d.).

The R&D centre for General Mills was located in the James Ford Bell Technical Centre. This R&D centre houses sensory laboratories, four pilot plants, cereal science classroom, a comprehensive research library and internet access. It also had a health research centre called the Bell Institute of Health and Nutrition. Its innovation strategies are aimed at balancing between breakthrough and incremental innovations. An example of both levels of its innovation was a fruit snack category which was claimed as breakthrough innovation. The breakthrough was inventing a novel drying process that stabilised the fruit while still maintaining taste and nutrition. Incremental innovations were the significant platforms which extended from this novel technology, such as Fruit by the Foot and additional flavours. All R&D plans were on a three-year basis. The R&D team was working as a multi-disciplined team. Core technologies were emphasised and closely linked to the business strategies. One area of great emphasis for General Mills was cereal science. New employees learnt about cereal science through classes and hands-on work in the pilot plant (Ohr, 1999).

Facing intense competition, Coca-Cola decentralised its organisational structure to local market by launching a series of local innovation centres around the world to develop new products for the specific market. At a local innovation centre, scientists worked directly with marketing executives to develop, package and sell new drinks for local markets, e.g. a pear-flavoured drink in Turkey, a berry-flavoured Fanta for Germany and a sport drink called Aquarius sold only in Belgium and the Netherlands (Byrnes, 2000).

The New Zealand Dairy Board (NZDB) had its two Strategic Business Units (SBUs): the consumer/food service SBUs and the ingredient SBUs. Its products were mainly exported. The R&D activities were involved from farm to processing of dairy products. At NZDB, 'market driven' rather than 'technology push' was the focus for new product strategies. To get R&D more closely aligned with the market, its manufacture research and development activities were carried out both in New Zealand at the New Zealand Dairy Research Institute and at five of its offshore companies: Swindon (UK); Santa Rosa (USA); Rellingen (Germany); Guadalajara (Mexico), and; Melbourne (NZDB, n.d.).

Nestle′ had its main research centre called the Nestle′ Research Centre (NRC) established in 1987 in Switzerland. The NRC created basic knowledge platforms for the whole group in both food and life sciences. The research areas covered plant science, food ingredient functionality, packaging systems, nutritional science, food safety, and quality assurance. Specialists in process research also provided technical knowledge of manufacturing technologies such as extraction, extrusion, sterilisation and drying to improve existing processes or proposed new alternatives. Apart from the basic research centre, Nestle′ also had eight Product Technology Centres (PTC) translating scientific ideas and findings into industrial applications. These centres provided technological know-how, manufacturing processes, and packing innovation for the different food and beverage sectors. The facilities provided in these centres included laboratories and pilot plants. To adapt products or processes to local needs in the markets, Nestle′ had established its so-called Regional Adaptation Centres, located in Singapore and in Abidjan (Ivory Coast). Whilst the centre in Singapore developed technologies for Asian cuisine for the entire world, that in Abidjan offered African culinary products. Realising the limitation of tasks performed in-house, Nestle′ also extended its capabilities by cooperating with external technical sources. These included research institutes, universities, suppliers of machinery, and equipment as well as raw materials and ingredients (Nestle′, n.d.).

Nestle′ has just entered a strategic alliance for the North and South American market with the New Zealand's biggest dairy conglomerate, the newly established "Fonterra Co-operative Group". This entity has incorporated the assets of the NZDB and the major dairy processing companies. The benefits from their alliance was in the following

areas: combined sales progression in existing and new markets; optimisation of capital expenditures through optimal use of each others' assets; cost efficiency through the use of their respective infrastructures; optimal use of resources; distribution and manufacturing strengths; purchasing synergies, and; optimal use of research and development as well as product development resources (Fonterra Co-operative Group, 2001).

Quaker Oats centralised its R&D activities at the John Stuart Research Laboratories in Barrington, USA. This R&D centre provided all product, process and packaging research for Quaker's entire line of domestic foods and beverages. It also received international support via satellite laboratories in Canada, Asia, Europe and South America. Cross-functional product development teams were emphasised at Quaker. Researchers were either assigned to work on specific product lines such as cereals, convenience foods or beverages, or were assigned to technical areas such as packaging, sensory evaluation or flavour technology. The product development team consisted of Marketing, R&D and Marketing research. Consumer needs research coupled with supplier involvement, marketing, and external consultants were used when launching new products. To expand its business, Quaker had a joint venture with Novartis to develop and market functional food brands in the USA, Canada, and Mexico (Ohr, 2000).

2.5 COMPANY ACQUISITIONS

Nowadays, food companies often simply acquire or merge with companies that have product potential. Such mergers and acquisitions commonly lead to a decrease in total R&D investment (Labuza, 1994). For example, Groupe Danone acquired Nabisco; Unilever acquired Bestfoods in 2000 (Anonymous, 2000a, 2000b).

Rapid economic liberalisation and relaxation of barriers to foreign investment have attracted international companies, which have gained strong positions in Asian markets through mergers and acquisitions. Since 1993, cross border mergers and acquisitions in the food companies in Asian countries have increased dramatically as leading multinational companies buy companies with good products and/or distribution. Even

large local companies are subject to take over if they are not strong enough to compete globally (Anonymous, 1994).

In the US and Japanese small firms, external technology acquisitions rather than in-house development is more likely when many other rivals are expecting to develop a similar product. In other words, the new technology will not give much competitive advantage. Buying technology through acquisition is also more likely when the needed technology is less related to the firm's core technology. The goals in external technology acquisitions are to shorten development time, reap short term profit, and maximise long term profits over the life of innovation (Kurokawa, 1997).

2.6 SOURCES OF TECHNICAL INNOVATION

While the consumer need is a marketing input, technology is the ability to fulfil that need by producing the desired product. The key combination of these two dimensions of knowledge provides product differentiation in the competitive market and changing consumer demand (Dodgson, 1989; Katz, 1999b; Linnemann et al., 1999). Technical knowledge appears to be important as an input and as a potential marketing strength (Ghingold and Johnson, 1997). Technology strategy is therefore important to the firm's long-term profitability and growth. This involves decisions about how technologies are to be developed, accessed and diffused. To build up a technical knowledge about new products, a company must be aware of how to effectively exploit technical sources available both internally and externally.

2.6.1 Sources of new product ideas

Every form of knowledge creation starts from an original idea. In the food product innovation process, new product ideas are an initial step. Most organisations use an unstructured approach to identify new ideas (West, 1980; Peterson, 1988). The primary sources of new product ideas come from either internal sources, external sources, or market analysis (Fuller, 1994). Customers and internal sources were found to be important sources for new product ideas (Baker et al., 1988; Cooper and Kleinschmidt, 1986; Sanchez and Elola, 1991; Deiaco, 1992; Smith and Vidvei, 1992; Kerr, 1994;

Faulkner et al., 1995; Frater et al., 1995; Gormley, 1995; Kotler and Armstrong, 1996; Hoban, 1998).

2.6.2 Technological knowledge sources

Technological knowledge is how to produce goods and services. Technological knowledge may be located in people's heads, passed by word of mouth, or maintained in written documents (such as in formal sheets for operators or handbooks), or embodied in machinery, firmware and software (Bohn, 1994; Earle 1997b; Evangelista, 1999). Although a company can acquire technology through purchasing a machine or tool, it provides only a marginal role to innovative activity. In this context, a stock of technological knowledge held by people and expressed in codified form is more significant in product innovation (Senker and Faulkner, 1992; Evangelista, 1999).

Technological knowledge can be obtained from internal sources and external sources. Internal sources include R&D, design and tooling-up, patents held. External sources are those related to technological-scientific information, e.g. professional organisations, technical centres, clients, trade fairs and exhibitions (Archibugi et al., 1991). In the food industry, external sources of scientific and technological knowledge are usually involved in capital goods from upstream industries such as equipment and raw materials (Pavitt, 1984; Archibugi et al., 1991).

However, it was reported from many studies across various industries that most knowledge used by companies in the course of innovation was derived from their own internal sources (Gibbons and Johnston, 1974; Johnson and Kuehn, 1987; Faulkner et al., 1995; Gormley, 1995; Johannessen and Dolva, 1995; Julien, 1995; Faulkner, 1998; Gomes, 1998; Campbell, 1999; Gormley and Mulas, 2000). This could well be explained by the fact that innovation is a complex process that requires the mobilisation of many kinds of scientific and technological knowledge as well as their contextual adaptation to the specific situation of a company's activity and business. This complexity means that codified knowledge is almost always an insufficient guide to practice. The human expert is always required to access and mobilise the meaning of the information (Fleck, 1998). Therefore, in-house technological expertise is required to deal with adoption and exploitation of technical resources for successful innovation

(SPRU, 1972; Anonymous, 1980; Dodgson, 1989; Senker, 1989; Rosenberg, 1990; Patel and Pavitt, 1995; Taylor and Lowe, 1997; Belotti and Tunalv, 1999). Thus, in-house R&D not only generates new information, but also enhances the firm's ability to assimilate and exploit existing information (Baldwin, 1962; Evenson and Kislev, 1973; Nelson, 1982; Mowery, 1983; Cohen and Levinthal, 1989; Fernandez et al., 1999; Watzke and Saguy, 2001).

An increase in competition calls for food businesses to create their own technology (Clausi, 1987). In this role, technical personnel are required not only to deal with the complexity of food ingredients and their behaviour during processing but also to assess all possible technical advantages and competition (Edelman, 1982; Clausi, 1987). There are three advantageous characteristics of in-house technical people in dealing with complex technology (Kline, 1991):

- Strong motivation to do the hard work needed;
- Sufficient in-house influence to get the necessary allocations of time, money, and facilities; and
- Mastery of the technological knowledge needed.

Faulkner (1998) attributed the dominant role of internal knowledge to the following four reasons:

- The need of firms to appropriate technology related to specific artefacts to gain assured monopoly profits of radical innovation;
- The cumulative nature of technological development requires a company to build on existing capability to facilitate the new knowledge generation;
- To catch up an unfamiliar technology, a firm needs in-house knowledge to identify, digest and utilise external knowledge;
- Internal knowledge enables a firm to access specific, as opposed to general, knowledge for its product differentiation in the market.

However, external knowledge sources are still important in product innovation. It was found from many studies that acquisition of external technical knowledge enhanced the innovation rate of companies (SPRU, 1972; Rothwell, 1977; Mackun and MacPherson, 1997; MacPherson, 1997a; MacPherson, 1997b; Belotti and Tunalv, 1999). External sources of information and innovation are usually used through informal contact with

suppliers and customers (von Hippel, 1988; Kennington, 1989; Chalmers, 1994; Klevorick et al., 1995). While internal knowledge sources play an important role in routine problem solving, external knowledge sources are significant inputs for idea generation or future innovation (Rothwell, 1975; Faulkner et al., 1995; Faulkner, 1998).

In the food industry, a range of outside R&D services is offered by independent consultants, private research organisations, government research laboratories and suppliers. Services may include product concept development, sensory evaluation services, product development, trouble-shooting, plant equipment and operation set-up, processing and packaging development, label information and regulatory approval, or consumer and market testing (Duxbury, 1993).

A survey in 1994 by Food Processing Magazine found that more than 90% of US food processors used part-time or temporary staff to supplement full-time staff in R&D departments. More than 75% of these food processors were outsourcing projects to outside R&D services, mainly suppliers (Kevin, 1994).

Surveys forrning part of the FLAIR-FLOW EUROPE project in 1994 and 1999 with 19 European countries showed consistently that in-house research and suppliers of food ingredients and equipment were the main technical information sources for the food product development activities of SMEs. Most technical information used was in the areas of food safety, quality management, process technology, and product modifications. In these two surveys, there was a shift of the companies' focus towards food safety due to an awareness of recent food safety scares such as *Escherichia coli* and Bovine Spongioform Encephalopathy (BSE) (Gorrnley, 1995; Gormley and Mulas, 2000).

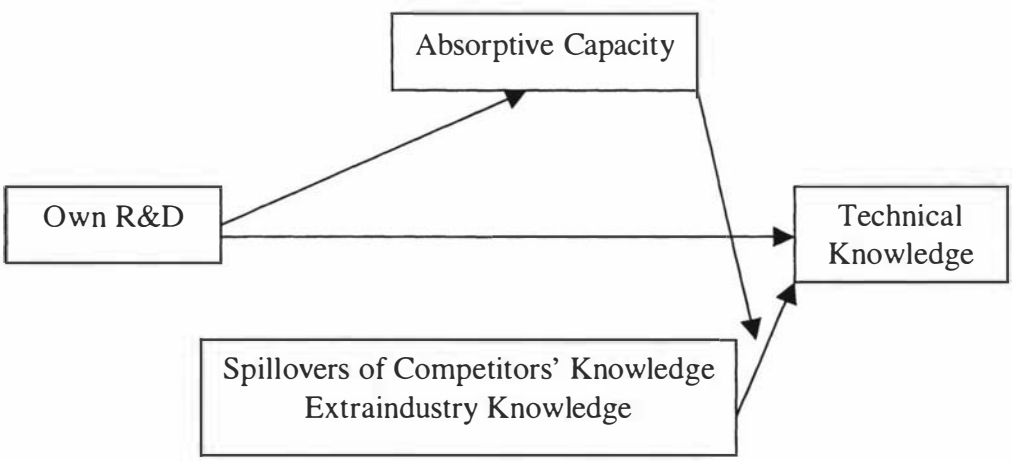
In Spain, the food and drink industry relied heavily on in-house technological capabilities, with external technical sources to complement product innovation (Garcia Martinez and Burns, 1999).

Internal and external integration of knowledge sources has become a central feature of the successful innovation process (Rothwell, 1994). To successfully exploit and integrate external expertise, a company needs to identify the core product competencies

and availability of similar types of expertise inside the firm itself (MacPherson, 1997a; Katz, 1998b).

The relationship of internal and external knowledge in technical knowledge creation was depicted in a simple model proposed by Cohen and Levinthal (1990). This model assumed that a firm exploited external knowledge through the interaction of its absorptive capacity with competitors' spillovers or other industry knowledge (Figure 2.1). To enable this interaction, a firm invested in its absorptive capacity by conducting R&D. The ability of a company to recognise and assimilate information and apply it to commercial ends, so-called absorptive capacity, is largely a function of its prior related knowledge.

Figure 2.1 Model of sources of a firm's technical knowledge



Source: Cohen and Levinthal (1990)

2.6.2.1 Role of suppliers to the food industry

The food industry imports and receives new knowledge and technology from several supplier sectors such as equipment, ingredient and packaging suppliers (Baker et al., 1988; McFarlane and McDonald, 1988; Hollingsworth, 1995; Grunert et al., 1997; Meyer, 1998; Suwannaporn, 1999). Services provided by suppliers may include selection and application of ingredients, packaging and equipment (Duxbury, 1993). Recent developments have provided new ingredients, new preservation techniques, new production techniques as well as new packaging techniques (Galizzi and Venturini,

1996). A company may obtain a recipe from an ingredient supplier. It may buy turnkey equipment from an equipment supplier. This implies that most new food products are restricted to derivative products (Earle and Earle, 2000). Earle and Earle (2000) also noted that technologies were often split into assembled and non-assembled products. Many packaged foods are assembled products, for example, frozen meals and cake mixes. It is quite common to bring in an outside designer for the product design of assembled products.

The knowledge exchange and the learning processes that are taking shape in the frame of customer-supplier relationships, and their importance for technological innovation in food companies have been highlighted in the literature (Duxbury, 1993; Kevin, 1994; Hood et al., 1995; Kuhn, 1995; Rama, 1996; Meyer, 1998; Garcia Martinez and Burns, 1999; Katz, 1999a; Smith, 2000; Taylor, 2001). Customers and suppliers can transfer important knowledge to a company, often in the frame of more formal or less formal co-operation programs (Belotti and Tunalv, 1999). It was more common for food manufacturers to seek the assistance of their ingredient suppliers from the beginning of the product development process (Kuhn, 1995). Many food manufacturers used the R&D facilities of ingredient suppliers for their testing purposes. One study based on foreign patents reported that most international food and beverage companies rely more on suppliers than on internal effort for technological innovations (Rama, 1996). This is also the case in small food companies, which don't have a large technical department (Sperber, 1993; Belotti and Tunalv, 1999). Some food companies also had formed multiple-supplier project teams to aid in new product development or to solve R&D problem. The close relationship between a food company and its suppliers was important in reducing product development cycle time and cost (Duxbury, 1993; Kevin, 1994; Morris, 1996a; Morris, 1996b; Meyer, 1998).

In the USA and North American food industry, ingredient suppliers were becoming important in the product development process (Duxbury, 1993; Kevin, 1994; Hood et al., 1995). A wide array of services provided by ingredient suppliers included:

- screening;
- idea generation;
- prototype development;
- ingredient sourcing, development and co-development;

- research projects and product optimisation;
- feasibility testing;
- technology assessment;
- risk evaluation;
- formulation and scale-up;
- product shelf life;
- processing aids;
- regulatory implications;
- sensory testing;
- engineering/equipment design;
- tolerance testing;
- commercialisation;
- start-up, marketing and/or advertising support;
- field audits;
- product maintenance;
- quality improvement;
- cost reduction.

In Asian countries, ingredient suppliers that worked through agents or sales offices with limited R&D facilities were investing more in laboratories and local sales forces (Mannion, 1996). Most of technical facilities of equipment suppliers and ingredient suppliers have been located in Singapore (Lundblad, 1991; Teo, 1992; Mannion, 1996). For example, the Alfa-Laval centre in Singapore has pilot plants in processing of tropical agricultural products and oriental foods (Lundblad, 1991).

2.6.2.2 Academic and research institutes

To help innovation and efficiency, the industry must improve its technical capability and the Government should underpin this with basic scientific research (ACARD, 1982). However, universities and public research institutes were usually regarded as less important technical sources (Johnston, 1991; Hollingsworth, 1995; Belotti and Tunalv, 1999).

It was reported that most food science and technology academic research programs have been doing more applied than basic research (Bhumiratana et al., 1992; Labuza, 1994; Suwannaporn, 1999). Yet, there were limited uses of technical information from these institutes in the food industry.

Because of the general reduction in technical resources at food companies, many universities in the USA have established technology research centres to assist food manufacturers in new products and process development (Anonymous, 1998). For example, the food research institute located in Rutgers University, funded by government, provided technical assistance to local small and medium-sized food and related business (Duxbury, 1993). However, only a few universities and food related research centres (6 out of 29) publicise their research findings according to a survey conducted by Cornell University, and USDA's Cooperative Research, Education and Extension Service (Anonymous, 1998). Food companies in the USA tended to use universities through alliances for only targeted basic research or applications for specific products (Hollingsworth, 1995).

In the European food industry, government research institutes and universities were main external agencies for research, development and training purposes (Gormley and Mulas, 2000).

In Thailand, only a limited amount of research done in these institutes has been implemented in the food industry. Most publications in Thailand were in the area of food processing, chemistry, nutrition, and post harvest handling of foods (Bhumiratana et al., 1992).

The lack of linkage between these institutes and the industry was due to a number of reasons. These included:

- the more important role of universities and research institutes in providing theoretical knowledge, scientific information and identifying capabilities for a particular situation rather than being involved with new innovations (Gibbons and Johnston, 1974; Arora and Gambardella, 1994; Chalmers, 1994; Faulkner, 1998);
- problems and constraints related to technologies, management and government policies (Kampempool, 1988);

- the lack of effective linkages between institutions and industry (Kline, 1991; Gormley, 1995).

2.6.2.3 Consultants

Companies have limited their use of consultants because they distrust external sources for fear of loss of confidentiality; consultants were often seen as too expensive, too general in their advice, and too slow to offer a practical solution (MacPherson, 1997a). Consultants tend to be involved in technical problem solving, not directly relevant to innovation activities (Gibbons and Johnston, 1974).

2.6.2.4 Food conferences, exhibitions and trade shows

Foreign or domestic food conferences, exhibitions or trade shows provide a wide array of technologies pertaining to foods and ingredients. Not only can food companies gain a broad range of new product ideas but also discuss their problems with technical sales representatives. At the technical meetings, food companies can make useful contacts with experts in various fields of technology (Fuller, 1994).

2.6.2.5 Libraries

Most public libraries have information on food recipes and cooking methods. Information on food science and technology and patents can be found in most technical libraries. Some companies may have their own libraries for technical staff. According to the study of Chalmers (1994), outside libraries were used if companies had personal connection which gave them entry. Most companies tended to return to the library of a previous educational institution or workplace.

2.7 FACTORS DETERMINING TECHNICAL INFORMATION SOURCES

Several factors need to be considered when understanding how companies acquire information for new product development. These include the pace of technology development, the size of the company, the degree of familiarity with a problem, information source characteristics, innovation orientation, and innovation strategies.

2.7.1 The pace of technology development

A greater pace of technological development increases the firm's incentives to build absorptive capacity to tap more external information (Cohen and Levinthal, 1990). In an area where there is a high level of research activity and rapid changes in technology, such as biotechnology, new knowledge is emerging all the time. Under this circumstance, the industry tends to be more reliant on external sources to keep abreast of technological advances (Senker and Faulkner, 1992).

2.7.2 The size of the company

The size of the company plays a role in technical information acquisition. Large companies tend to be able or more willing, to adapt their information acquisition practices to new requirements. Small firms tend to be limited by managerial resources, complementary assets and a lack of awareness to identify their needs and relevant information sources.

A number of studies indicated that small and medium sized manufacturing enterprises (SMEs) extensively rely on internal information sources: in-house staff and managerial input (Johnson and Kuehn, 1987; Johannessen and Dolva, 1995; Julien, 1995; Gomes, 1998; Campbell, 1999). On the other hand, larger organisations have a greater tendency to interact with external agencies than their smaller counterparts (Rothwell, 1975). However, the propensity of a company to use external knowledge sources depends also on the ability of its in-house technical staff to evaluate and utilise those sources (Arora and Gambardella, 1994; Donnelly, 2000).

2.7.3 The degree of familiarity with a problem

The R&D team may have little knowledge about a new technological issue. The team may also lack appropriate networks to identify the information. Thus, for a firm to innovate, it needs prior knowledge and exposure to the appropriate technology. External information sources are relatively important to assist with solving an unfamiliar problem, such as radical innovation (Fischer, 1979).

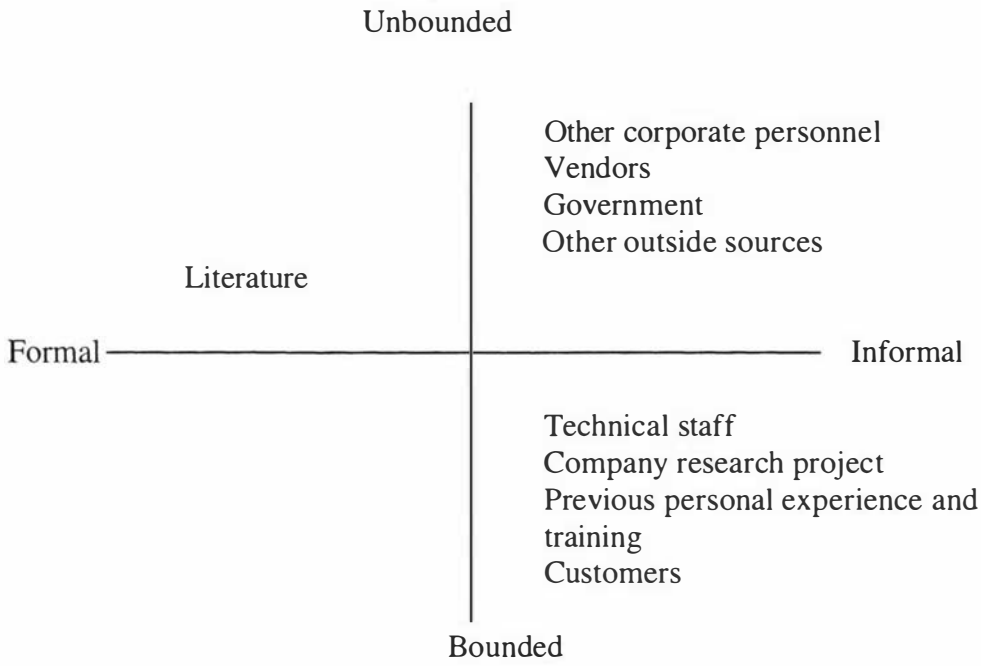
2.7.4 Characteristics of information sources

Fischer (1979) provided a two-dimensional representation of information sources, as shown in Figure 2.2.

- Bounded information is limited in number of subject areas.
- Unbounded information has the potential to provide information about a virtually unlimited number of topics.
- Formal information does not allow interaction between the information sender and receiver such as books, journals and other media.
- Informal information allows interpersonal means of obtaining information from its sources.

Information sources which are informal and unbounded would be of importance in unfamiliar situations. However, sources which are formal or bounded would have major limitations inherent in their use.

Figure 2.2 A two-dimensional representation of information sources



Source: Fischer (1979)

2.7.5 Innovation orientations

Orientation is a mental construct which guides and evaluates behaviour of companies in acquisition of skills and knowledge. There are two main orientations concerning scientific and technical development in innovation process: product orientation and process orientation (Harmsen et al., 2000). In product oriented companies, the product is thought of first instead of what it does for the customer. Innovations are concerned with creating more value so that superior products can be presented to customers with pride. In process orientation, companies are thinking of a set of processes and the whole food chain. Process oriented companies are concerned with optimising the production process, developing a lot of imitated products with low degrees of newness.

Harmsen et al. (2000) suggested that a product oriented company would develop most products in-house, while it might outsource process competencies as well. On the other hand, process-oriented companies tended to have strong links both up and downstream, and increasing value addition might be attempted by integrating additional links of the food chain into the company, not by trying to put more value into the products

manufactured. However, these proposed assumptions still requires empirical testing before generalisations can be made.

2.7.6 Innovation strategies

The propensity of a firm to use technical knowledge sources is also determined by its new product strategies (Christensen et al., 1996).

- **Offensive product development strategy**

This strategy aims at attaining technological and market leadership, especially when introducing products first in the market. Companies integrate both their own research and development and externally generated knowledge in the product development process.

- **Defensive product development strategy**

A defensive strategy is implemented when the company avoids large uncertainties from being the first in the market by developing or redesigning products, which have been introduced by others. This requires a strong in-house knowledge base in order to respond quickly to actions taken by competitors. Product differentiation is emphasised.

- **The dependent strategy**

Some companies may be linked to a larger firm such as subsidiary companies. These companies usually make only minor, incremental innovations, often at the request of the dominant company. The responses from customers are vital as information sources for innovation. R&D is most often absent or otherwise, it is often not in-house but most likely based in a parent-firm.

- **The imitative strategy**

This strategy focuses on cost advantages, superior distribution or marketing facilities in a specific market, or benefits from legislative conditions or public sector demand. To enhance this strategy, process innovations are ranked relatively higher than product

innovations. Although R&D is limited by this strategy, companies still need to keep up with technical information sources in order to know about optimal production or process techniques worth imitating.

There may exist different strategies in the same company at the same time, because some products may be developed with one strategy and some with another. This makes analysis of their influences difficult.

2.8 BARRIERS TO TECHNICAL INFORMATION ACQUISITION

Barriers to external information acquisition have been studied in the pharmaceutical industry (Sheen, 1992), the scientific instrument sector (MacPherson, 1997b), small and medium sized manufacturing enterprises (Gomes, 1998), and the food industry (Gormley and Mulas, 2000). Acquiring technical information can be limited by following factors.

- Limit of internal capability in understanding information, e.g. language barriers (Sheen, 1992; MacPherson, 1997b; Jirathana, 1998; Fernandez et al., 1999)
- Lack of internal support and effective management (Sheen, 1992; Gomes, 1998)
- Limit of resources and suitable information available (Chalmers, 1994; Gormley and Mulas, 2000)
- Resistance to sharing proprietary information (Hartley et al., 1997; Ragatz et al., 1997; Suwannaporn, 1999)

2.9 CONCLUSION

The food product development process has some specific characteristics in terms of degree of product newness, consumers, market structure, technology and R&D strategies, and product characteristics. The food industry can be defined as a sector predominated by small and medium sized business with incremental innovation, market driven, and low R&D intensity for new products.

Facing the pressure of rapid changes in technology and the market, food companies tend to seek strategies to reduce product development cost and time. Most common strategies used were company acquisitions and effectively mobilising technical knowledge sources. Due to the complexity of technical knowledge, internal tacit knowledge by the product development team is required to deal with information both inside and outside companies. Thus, effective integration of internal and external knowledge sources is necessary for successful product development.

There are a wide range of technical knowledge sources available for food companies such as suppliers, academic and research institutes, and consultants. However, utilisation of technical information sources is determined by the pace of technology development, business size, degree of problem familiarity, characteristics of information, innovation orientations and innovation strategies. To efficiently exploit external technical information, barriers such as availability, secrecy and communication difficulties must be overcome.

Because innovation and technical knowledge exploitation in the food industry are largely determined by the environment in which it is operating, the food industry, consumer market, economy, and R&D in Thailand are reviewed in the next chapter.

3 THE FOOD INDUSTRY ENVIRONMENT IN THAILAND

3.1 INTRODUCTION

The purpose of this chapter is to depict the environment of the food product development process in Thailand at the end of the 20th century. The environment includes the role of the food industry in Thai economic development, trends in the consumer food market, consumer demography, and the domestic food market. Changes in this environment impact on food companies and their product innovation.

3.2 AGRO-INDUSTRY IN THAILAND

Thailand, with area of 51,312 hectares, is a country of fertile land with productive natural resources. It grows many types of agricultural produce, reflecting its economic structure based on agriculture. In 1998, about 41% of land was used for agriculture (FAO, 2000). The contribution of agriculture to GDP between 1993 and 1999 was 12 to 14% (NESDB, 2000a).

Agro-industry also plays a vital and rapidly growing part in the Thai economy, supporting 24% of the population (NSO, 2001a). Between 1980 and 1990, the agro-industrial sector was responsible for about 10% of the GDP of Thailand (Isarangkura, 1993). This accounted for almost 50% of the manufacturing sector. According to The Seventh National Economic and Social Development Plan (1992-96), agro-industry was to establish its long term technological self-reliance by encouraging foreign investment, technology transfer and research and development to upgrade the quality of products in response to market demand (NESDB, n.d.1).

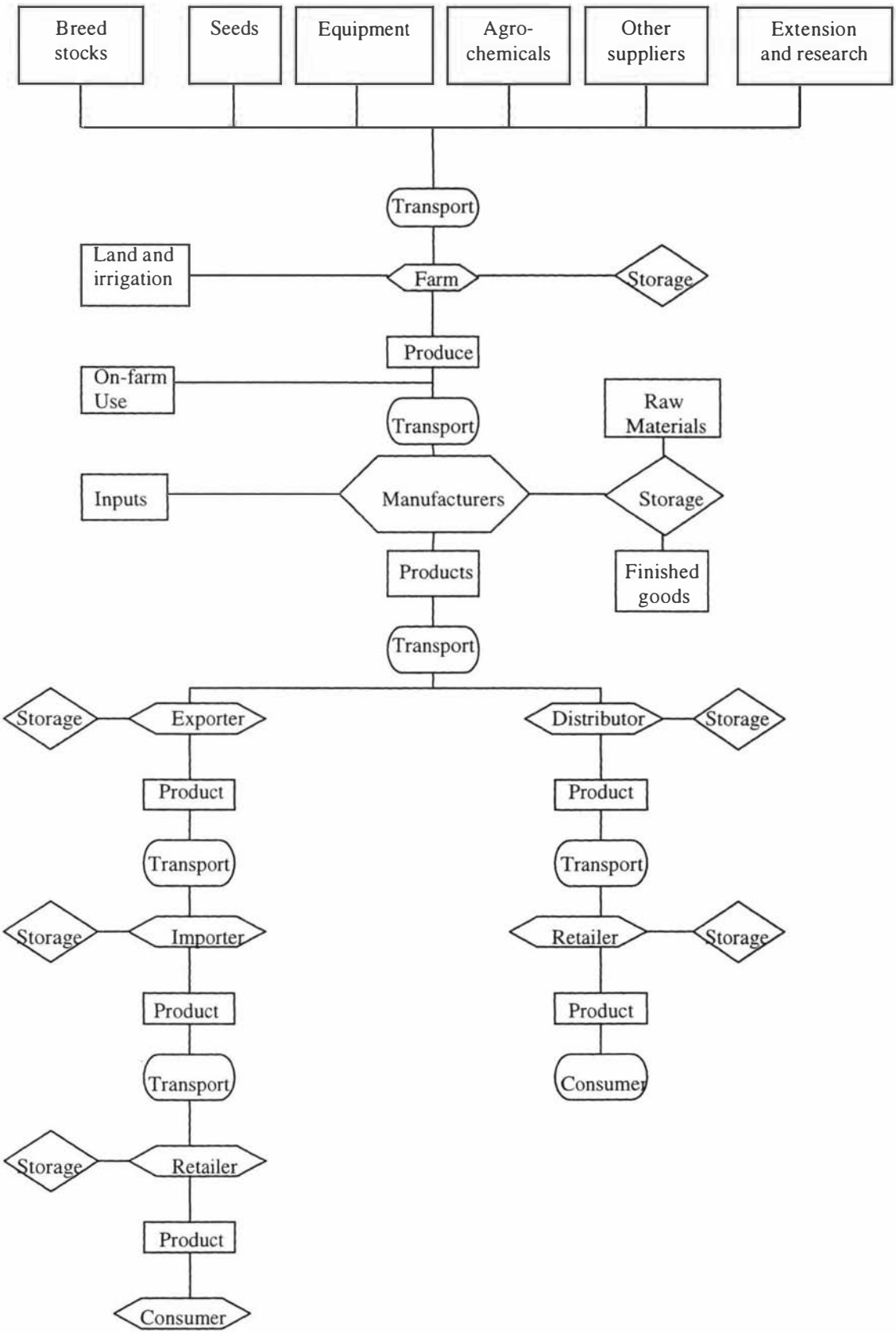
According to the definition given by Austin (1992), agro-industry enterprises process materials of plant or animal origin. Processing involves transformation and preservation through physical or chemical alteration, storage, packaging, and distribution to create an edible or usable product, to increase storability, to obtain a more easily or economically transportable form, and to enhance palatability, nutritional value, or consumer convenience. The degree of transformation can vary tremendously, ranging across

cleaning, grading, packaging, milling, cooking, mixing, and chemical alterations that create required characteristics of products. Capital investment, technological complexity, and managerial requirements increase as the degree of transformation rises.

Agro-industry is one part of the seed-to-consumer agribusiness system. Its operation is involved in the production chain system consisting of both production and service businesses as depicted in Figure 3.1.

Outputs from the agro-industry include food and non-food products (Hicks, 1993) which have three characteristics of their raw materials: seasonality, perishability and variability (Austin, 1992). The food industry is a subgroup of agro-industry. Tasks in the food industry are quite difficult due to not only the variability and perishability of many of the raw materials, but also the sophistication of the markets, the need for quality control, the high value added, the packaging requirements, and the strict regulations (Brown, 1994). Food and beverage industries were major sectors contributing to agro-industry in Thailand and contributing 14-18% to manufacturing GDP (Table 3.1).

Figure 3.1 Flow chart for agro-industry



Source: Austin (1992)

Table 3.1 The impact of manufacturing on Thailand's GDP

Sector	% of GDP by year						
	1993	1994	1995	1996	1997	1998	1999p
Food	8.10	8.20	7.57	7.79	8.06	9.70	8.78
Beverage	6.25	6.23	6.40	6.23	7.22	7.54	9.46
Tobacco	2.16	2.39	2.08	2.13	2.52	2.39	2.13
Textiles	8.59	7.96	7.69	6.69	6.47	7.32	6.76
Wearing apparel except footwear	11.15	11.51	11.29	11.65	12.01	11.52	11.13
Leather, leather products and footwear	4.06	4.10	3.72	3.18	3.44	3.59	3.82
Wood and wood products	0.83	0.99	0.74	0.64	0.55	0.41	0.32
Furniture and fixtures	3.07	3.02	2.83	2.61	1.88	1.45	1.35
Paper and paper products	1.29	1.39	1.45	1.64	1.82	2.20	2.21
Printing, publishing and allied industries	1.03	1.05	1.15	1.15	1.05	1.02	1.07
Chemical and chemical products	2.22	2.18	3.33	3.46	3.96	4.22	4.34
Petroleum refineries and petroleum products	6.31	6.25	6.41	7.57	9.21	10.29	8.45
Rubber and plastic products	2.41	2.73	3.11	2.64	2.73	3.09	2.93
Non-metallic mineral products	5.83	5.66	5.26	5.37	4.90	4.04	4.28
Basic metal industries	1.61	1.75	1.64	1.50	1.41	1.13	0.96
Metal products	2.54	2.53	2.54	2.73	2.69	2.88	3.01
Machinery	6.04	6.54	7.32	7.75	7.90	8.97	9.31
Electrical machinery and appliances	8.49	8.80	8.08	8.09	7.73	8.15	7.28
Transport equipment	9.35	7.79	8.56	8.66	6.46	2.66	4.64
Other industries	8.67	8.93	8.81	8.52	7.97	7.43	7.79
Total Value	100	100	100	100	100	100	100

Note: p = preliminary

Source: NESDB (2000a)

Among Asian countries, Thailand is one of the biggest producers and exporters of basic food commodities such as rice, seafood and pineapple (Table 3.2). Thailand was the biggest exporter of milled rice and the second largest exporter of seafood and pineapple in Asia. These reflect Thailand's industrial development strategy, which is focused in the establishment and growth of industries that emphasise exports (Artachinda, 1978; Isarangkura, 1993; Anonymous, 1996).

Table 3.2 Production and export of selected foods in Asia in 1998

Country	Product quantity (tonnes)					
	Milled rice		Seafood		Pineapple	
	Production	Export	Production	Export	Production	Export
Bangladesh	18,871,391	105	1,342,730	48,807	148,580	27
China	133,781,626	3,797,267	36,080,896	2,421,990	896,057	82,716
India	85,055,973	3,523,250	5,377,704	383,590	1,100,000	407
Indonesia	32,840,870	2,525	4,359,370	668,909	326,950	62,979
Japan	7,470,400	303,957	6,658,670	416,186	12,800	N/A
Philippines	6,827,412	167	2,134,742	167,075	1,495,120	582,691
Thailand	15,197,221	6,612,199	3,457,973	809,335	1,787,442	398,626
Vietnam	19,437,514	3,840,302	1,544,000	193,850	195,842	9,156
Asia (Total)	353,315,119	20,280,163	68,416,495	6,360,988	6,219,771	1,229,884

Note: N/A = Not available

Source: FAO (2000)

Economically, there are many problems faced by farmers who rely on the sale of agricultural commodities. Food manufacturing has become important for achieving higher value-added for agricultural produce, thereby enabling farmers to increase and diversify their sources of income. The food industry was therefore promoted and developed during the Third National Economic and Social Development Plan (1972-1976) (Artachinda, 1978) and subsequent plans. Agricultural and agro-industrial sectors have been stressed as important for sustainable economic development. This led to rapid growth of several industries, such as sugar, beer, vegetable oil, and processed milk (Table 3.3).

Table 3.3 Production of some food commodities in Thailand

Commodities	Production (thousand tonnes)		
	Year		
	1980	1990	2000
Sugar	1,098	3,505	5,721
Beer from barley	124	263	1,042
Vegetable oils and fats	104	407	808
Evaporated and condensed milk	14	16	32

Source: FAO (2001)

The number of food and beverage enterprises is approximately 15% of industrial enterprises in Thailand (Table 3.4). About 82% are small and medium sized enterprises (SMEs) with fewer than 100 employees. Most food and beverage manufacturing companies produce food products for the local market. In 1997, only 21% of food manufacturers were exporters (NSO, 1998a).

Table 3.4 Characteristics of manufacturing establishments in Thailand in 1996

Division of Industry	Total number of companies	Number of companies						
		Number of employees						
	23,677	10-19	20-49	50-99	100-199	200-499	500-999	>=1,000
Manufacture of food products and beverages	3,548	1564	1013	340	207	230	117	77
Manufacture of tobacco products	238	138	71	12	7	4	4	2
Manufacture of textiles	1,520	453	433	215	172	154	51	42
Manufacture of wearing apparel; dressing and dyeing of fur	1,877	897	415	199	177	121	45	23
Tanning and dressing of leather; manufacture of luggage, handbags, harness and footwear	832	376	198	96	61	59	25	17
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	945	339	315	134	93	51	12	1
Manufacture of paper and paper products	559	209	164	91	41	37	14	3
Publishing, printing and reproduction of recorded media	915	495	259	82	43	23	7	6
Manufacture of coke, refined petroleum products and nuclear fuel	42	11	11	3	10	4	1	2
Manufacture of chemicals and chemical products	936	228	267	205	129	82	18	7
Manufacture of rubber and plastic products	1,812	569	495	288	239	152	46	23
Manufacture of other non-metallic mineral products	2,509	1297	670	237	164	98	23	20
Manufacture of basic metals	475	149	136	76	60	45	5	4
Manufacture of fabricated metal products, except machinery and equipment	2,261	1076	677	239	143	90	26	10
Manufacture of machinery and equipment	982	352	312	144	82	59	16	17
Manufacture of office, accounting and computing machinery	58	3	8	5	3	14	7	18
Manufacture of electrical machinery and apparatus	442	84	115	93	48	65	19	18
Manufacture of radio, television and communication equipment and apparatus	258	29	45	38	30	42	37	37
Manufacture of medical, precision and optical instruments, watches and clocks	132	38	36	17	13	15	8	5
Manufacture of motor vehicles, trailers, and semi-trailers	1,095	495	308	120	73	48	34	17
Manufacture of other transport equipment	216	56	62	36	30	24	7	1
Manufacture of furniture	1,999	780	521	271	175	174	57	21
Recycling	26	11	11	3	-	1	-	-

Source: NSO (1999c)

In terms of total investment value, the majority of food processing plants were in sugar, bakery, cold storage, and beverage sectors (Table 3.5). There was a substantial increase in the number of food factories between 1990 and 1999. There was an increase of about fourfold in the total investment over that period. A large number of bakeries with a relatively low investment value indicated that there were many small sized factories in this category.

Table 3.5 Distribution of registered Thai food processing plants from 1990-1999

Type of industry	1990		1999	
	Investment (US$ Million)	Number of factories	Investment (US$ Million)	Number of factories
Sugar	1,369	5	1,346	192
Bakery	10.5	62	704	1,643
Beer	10.8	11	673	345
Cold Storage	29.5	27	635	501
Drinking Soda	N/A	N/A	517	19
Fruit and Vegetable products	49.3	52	489	587
Seafood	46.8	30	472	549
Meat products	13.9	42	368	619
Dairy products	9.7	2	286	102
Tea, Cocoa	15.0	35	238	556
Edible oils	4.7	10	220	297
Seasoning sources	50.6	16	200	469
Liquor	1.6	1	14.0	6
Total	1,611	293	6,161	5,885

Note: N/A = Not available

Source: DIW (1991, 2000)

Thailand's major food imports were frozen fish and dairy products (Table 3.6). Import of frozen fish was for both local consumption and further processing for export. Due to the growth in domestic consumption but inadequate local supply of dairy products, Thailand still relies on imports of dairy products, especially milk powder, mainly from Australia and New Zealand (Table 3.7). Although the Thai government is trying to boost local milk production, continued reliance on imports is expected not only because imports are cheaper but also because of Thailand's adverse climatic conditions makes dairy farming difficult (TRADENZ, 1997).

Table 3.6 Value of major imported food products to Thailand in 1998

Item	Value (US$ million)	Quantity (tonnes)
Frozen fish	608	514,014
Dairy products	279	139,568
Fats/oils and related products	212	957,487
Malt	52	141,113
Spirits and whiskies*	51	21,307
Apples	29	29,217

Note: * Quantity in thousand litres

Source: NSO (1999c)

Table 3.7 Imports of dairy products to Thailand in 1998

Countries	Quantity (tonnes)
Australia	45,762
New Zealand	32,179
U.S.A.	13,570
Netherlands	9,708
Ireland	5,347
The Czech and Slovak Federal Republic	4,591
Poland	3,530
Germany	3,000
Denmark	2,132
Belgium	436
Other countries	19,313
Total	139,568

Source: NSO (1999c)

3.3 CONSUMERS IN ASIAN COUNTRIES

The consumer is the driving force for change but at the same time can be led and motivated (Gentles, 1997). When consumers have sufficient safe food to satisfy their need for survival and their incomes rise, they usually begin to demand improved quality food, seek greater variety, and shift toward more processed foods (Baron, 1980; Tyler, 1998). Increasing numbers of supermarkets, modern distribution and transportation together with changes in eating habits and the globalisation of food products have resulted in substantial changes in food consumption patterns (Buisson, 1993b; Crippen and Oates, 1992). Modern retailing and changing consumer preferences foster demand for standardised products with consistent quality, longer shelf life, and better packaging. These changes have forced the food industry to continuously develop products to best meet consumer needs today and in the future.

The development of the processed food market in Asian countries has occurred for several reasons. These include changes in household income, employment, sociocultural awareness, and aspirations for the future (Buisson, 1993b; Tyler, 1998). Increasing sales of kitchen facilities such as refrigerators, microwaves and conventional ovens

have opened up new possibilities for sale of convenience and ready-to-eat products. All these changes have affected, especially, the market for branded food products (OECD, 1983).

Selwyn (1991) summarised consumer changes in Asian countries that would have ramifications for the food business.

- Westernised foods overtaking the historical Asian rural diet.
- Households were getting smaller with 3 or 4 people to an apartment with a tiny kitchen, thus stimulating demand for microwavable, processed, frozen and other convenience foods.
- Increasing female working population, meaning women had less time to cook.
- Asia's urban population was predominantly young people. Younger people were more likely to alter their eating habits than older people were.
- As a result of higher disposable incomes, urban people were travelling abroad more often, becoming exposed to different types of food.

More recently the development of the processed food market has involved closer attention to the differentiation of demand; no longer a broad mass market but rather segmented, with an element of customisation to meet niche needs (Tyler, 1998). Adapting the product to local tastes is also essential (Selwyn, 1991). New technologies and this perception of demand differentiation resulted in streamlined distribution chains and a wide variety of retail formats. Malaysia, Thailand, the Philippines, and Indonesia were expected to see the greatest development of the branded segment of their processed food (Tyler, 1998).

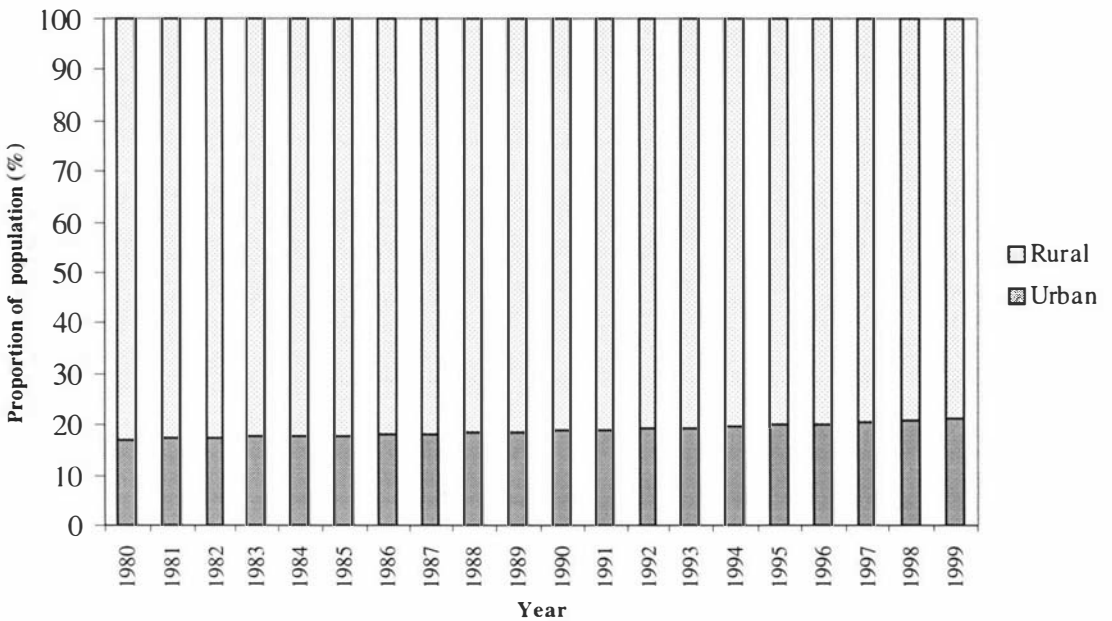
3.4 CONSUMERS IN THAILAND

3.4.1 Population and age structure

Key demographic features of Thailand are presented in (Figure 3.2 and Figure 3.3). The population of 61.7 million in 1999 was projected to increase to around 70.5 million by 2020 (NESDB, 2000b). The population in Bangkok and vicinity increased from 6.1 million in 1975 to 9.3 million in 1999, representing 15% of the total population (NSO, 2000b). The proportion of population in urban areas increased gradually between 1980

and 1999. It was projected that by 2030, about almost 40% of Thailand's population would be urban (FAO, 2000).

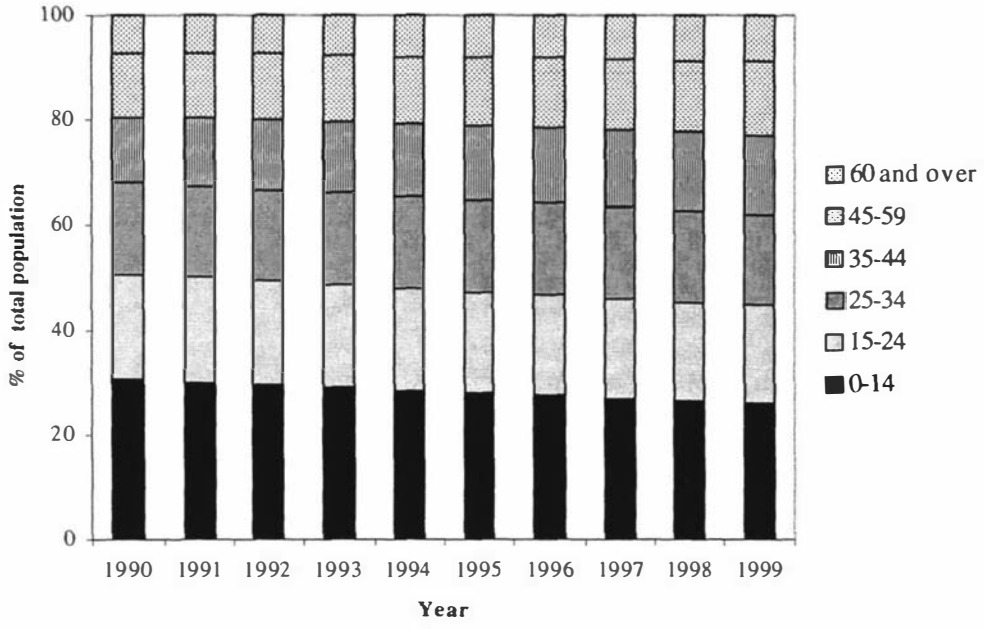
Figure 3.2 Thailand's urban and rural population



Source: FAO (2000)

As can be seen in Figure 3.3, there has been a significant move towards an older population. The average age of the population has moved from 27 years old in 1990 to 30 years old in 1999. This trend still remains as life expectancy of Thai people increases. Between 1980 and 1998, life expectancy of Thai male increased from 60 years (Mason and Campbell, 1993) to 66 years (Euromonitor Plc, 1999) while that of Thai female increased from 66 years (Mason and Campbell, 1993) to 72 years (Euromonitor Plc, 1999).

Figure 3.3 Population age structure of Thailand



Source: NSO (2000b)

3.4.2 Workforce

Between 1996 and 2000, about 71% of the female population participated in the labour force (Table 3.8). The proportion of both male and female workforce in the agricultural sector decreased dramatically between 1989 and 2000 (Figure 3.4). The proportion of female working in non-agriculture, as percentage of the total employed female workforce, increased from 32% in 1989 to 52% in 2000 (NSO, 2001a).

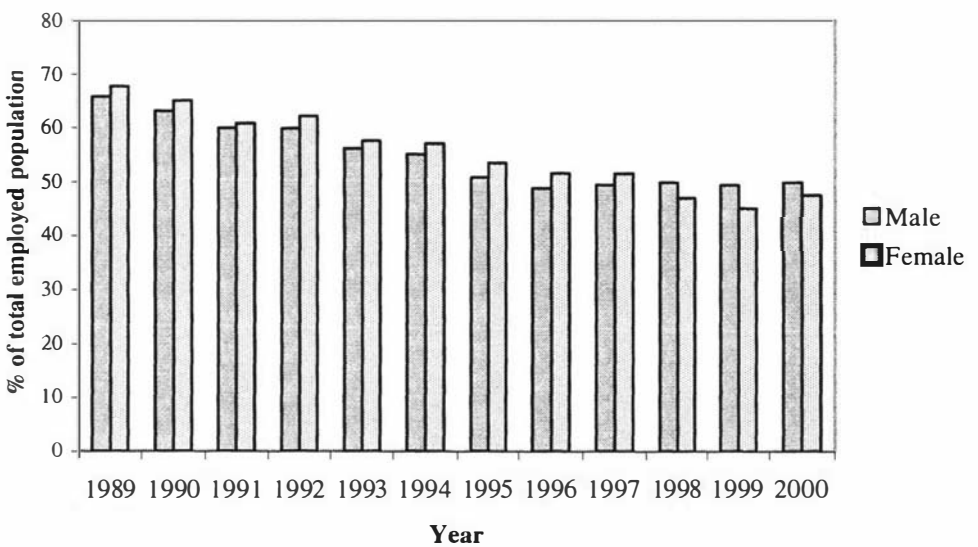
Table 3.8 Female labour force participation in Thailand

Year	Proportion (% of total population)
1996	71.7
1997	71.0
1998	70.9
1999	70.8
2000 e	70.8

Note: e = estimate

Source: PECC (2000)

Figure 3.4 Workforce in agricultural sector



Source: NSO (2001a)

3.4.3 Education

Most Thai people in the labour force have finished their education at an elementary/kindergarten level (Table 3.9). However, the proportion of people with higher education has increased over the last decade, especially to lower secondary school level. An increase in educational level of Thai people was driven by the

government policy in the Eighth National Economic and Social Development Plan (1997-2001) which aimed at increasing the schooling available in rural areas, and the development of vocational education program and open universities (NESDB, n.d.2).

Table 3.9 Educational qualifications of employed population in Thailand

Level of education	Employed population (%)						
	1993	1994	1996	1997	1998	1999	2000
None	4.33	4.12	4.50	4.14	3.57	3.86	3.42
Elementary and Kindergarten	76.00	74.68	72.25	70.88	67.25	65.38	65.00
Lower secondary	7.32	8.32	10.01	10.19	12.11	12.38	12.68
Upper secondary	3.00	3.07	3.14	3.67	4.41	5.06	5.59
Vocational	2.67	2.87	2.75	2.92	3.15	3.01	3.00
University	4.83	4.91	5.49	6.26	7.36	8.30	8.39
Teacher training	1.76	1.94	1.81	1.90	2.08	1.97	1.89
Short vocational course	0.04	0.02	0.02	0.02	0.02	0.02	0.01
Others	0.04	0.07	0.01	0.02	0.02	0.01	0.02
Unknown	0.01	0.00	0.00	0.00	0.03	0.01	0.00
Total employed Population	100	100	100	100	100	100	100

Source: NSO (1995b, 1996, 1997b, 1998c, 2001b)

3.4.4 Social conditions and life style

As Thailand has been shifting from its agricultural base to a greater degree of industrialisation, there have been many consequential changes. Industrialisation has an effect on consumers' lifestyle and their psychological needs towards more materialism and consumerism (Komin, 1995; Muscat, 1994).

Thailand has also been influenced by large-scale tourism, foreign products and associated advertising (Muscat, 1994). Mass media has become a powerful force in modern life. More people read newspapers and magazines and watch television for news, information and entertainment (Komin, 1995). There was an increase in household television from 58% of total households in 1992 to 96% of total households

in 1997 (Euromonitor Plc, 1999). Between 1995 and 1996, advertising expenditure in the mass media increased from US$667 million to US$864 million. Although the number of daily newspaper and magazines increased between 1992 and 1997, per capita sales volume remained unchanged (Table 3.10).

Table 3.10 Sales of newspapers and magazines in Thailand

Media	Sales	Year					
		1992	1993	1994	1995	1996	1997
Daily newspapers	Total sales (1,000 copies)	4,820	4,900	4,950	5,000	5,060	5,014
	Per capita (copies/1,000 persons)	83	84	84	84	84	82
Magazines	Total sales (million copies)	9,50	968	983	1,003	1,026	1,020
	Per capita (copies/person)	16	17	17	17	17	17

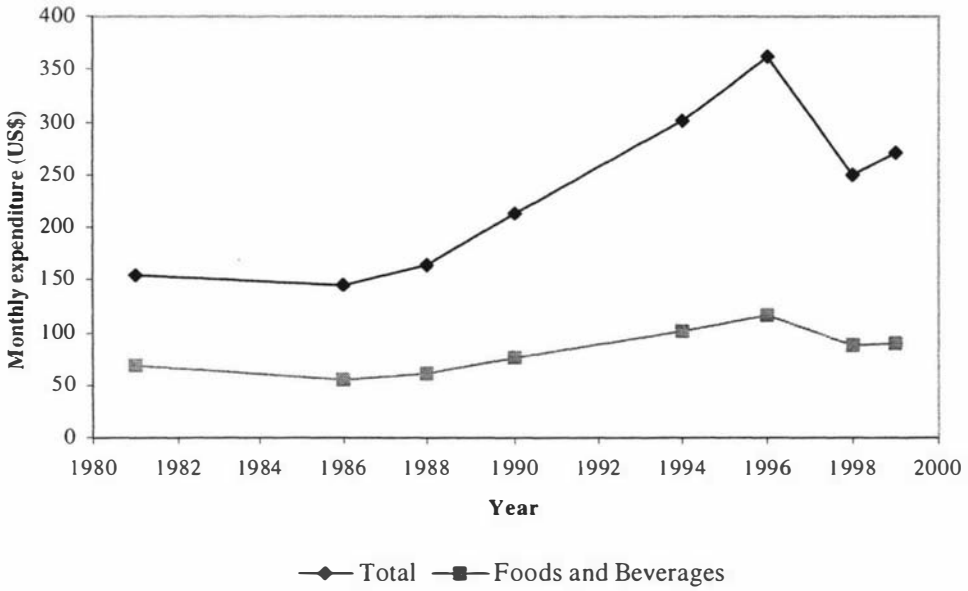
Source: Euromonitor Plc (1999)

Thai household size decreased from 4.5 members to 3.7 members between 1981 and 1999 (NSO, 2000a). Household monthly income increased from US$220 to US$336 between 1990 and 1999 (NSO, 2000a). As income increased, Thai demanded more value-added products. The proportion of household expenditure on food decreased from 44% to 33% between 1981 and 1999 (Figure 3.5). The decrease in the amount of expenditure in US$ was the result of the economic crisis in 1997.

Over the same period, the proportion of money spent on foods prepared away from home increased from 20% to 32% (Figure 3.6). In Bangkok, the figure was 46% (Anonymous, 1996). The growth rate of American style fast food restaurants was estimated to be 30 to 40% per year between 1990 and 1995 (Anonymous, 1996).

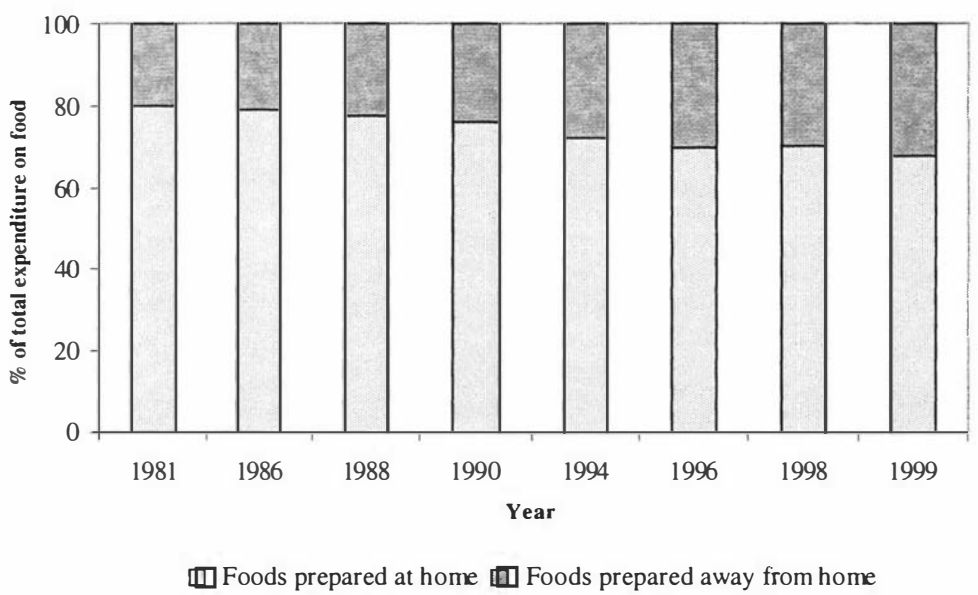
Food storage and kitchen facilities also provided greater convenience to Thai households. There was an increase in sales of refrigerators and freezers from 930,000 units in 1992 to 1,332,000 units in 1997. Sales of microwave ovens increased from 23,000 units to 46,000 units between 1992 and 1997 (Euromonitor Plc, 1999).

Figure 3.5 Household monthly expenditure in Thailand



Source: NSO (1982, 1987, 1989, 1991, 1995a, 1997a, 1999b, 2000c)

Figure 3.6 Proportion of monthly household expenditure on food in Thailand

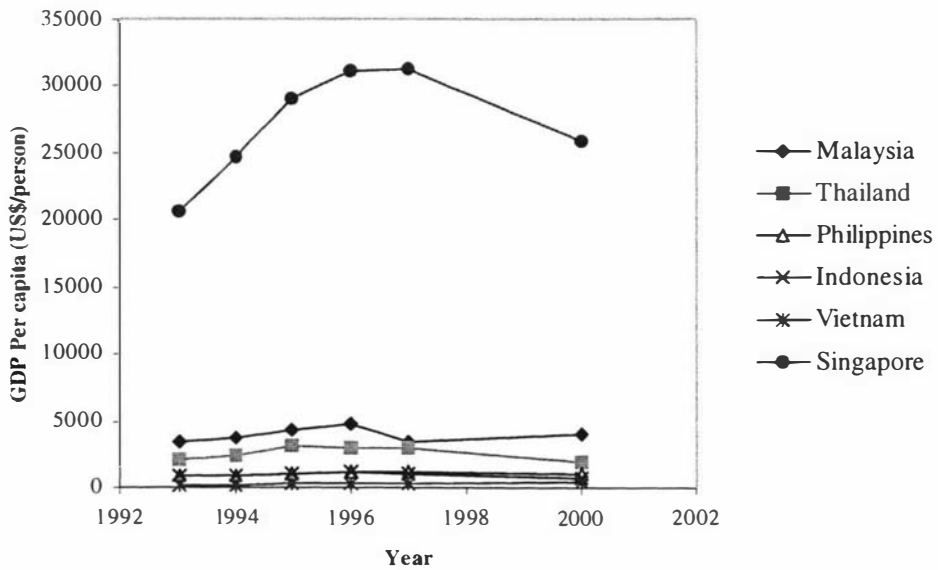


Source: NSO (1982, 1987, 1989, 1991, 1995a, 1997a, 1999b, 2000c)

3.5 ECONOMIC DEVELOPMENT IN THAILAND

The Gross Domestic Product (GDP) of Thailand was US$3,000 per person in 1997. GDP increased rapidly between 1993 and 1995, but declined slightly because of the Asian economic crisis (Figure 3.7).

Figure 3.7 Gross Domestic Product per capita of some ASEAN countries



Source: 1993-1997: Euromonitor Plc (1999);
2000: ASEAN (2001)

The Asian economic downturn in 1997 affected local food manufacturers through higher prices of imported raw materials. Large multinational companies were able to call on more efficient sourcing networks to mitigate the effect of these price rises (Cooke, 1998).

3.6 DOMESTIC FOOD MARKET IN THAILAND

Thailand exports more food than it imports. This can be seen in Table 3.11. The export value of food products was about 5 times of that of imported food whereas the reverse was true for most of other industrial commodities.

Thailand's domestic processed food market was predominantly in beverages and dairy products (Table 3.12). Rice is the staple food of Thais but its contribution to daily diet has tended to decrease (Table 3.13). On the other hand, the consumption of milk, meat, and seafood tended to increase. This indicated that there were some changes in Thai food consumption shifting away from a traditional menu.

Table 3.11 Eport:Import value ratio of main commodities of Thailand

Commodities	Year					
	1992	1993	1994	1995	1996	1997
Food	4.71	4.76	5.20	5.22	4.84	5.09
Beverages and tobacco	0.83	0.64	0.70	0.55	0.75	0.97
Crude materials	0.62	0.57	0.72	0.86	0.88	0.82
Mineral fuels and lubricants	0.10	0.11	0.09	0.08	0.14	0.23
Oils and fats	0.17	0.16	0.45	0.28	0.19	1.11
Chemicals	0.14	0.18	0.18	0.24	0.22	0.35
Manufactured goods	0.61	0.75	0.69	0.70	0.66	0.79
Machinery	0.50	0.52	0.58	0.55	0.60	0.74
Various manufactured goods	5.83	5.14	5.89	5.54	4.10	4.22
Various transactions and goods	0.33	0.34	0.31	0.40	0.37	1.61

Source: Euromonitor Plc (1999)

Table 3.12 Sales of processed food products in Thailand: 2000

	Sales	
Products	Value (US$ million)	Per capita volume (kilograms)
Alcoholic beverages*	2074	20.0
Soft drinks*	1232	29.8
Dairy products	877	N/A
Bakery products	437	3.9
Sauces, dressing, and condiments	436	4.9
Savoury snacks	273	0.7
Fats and Oils	240	3.8
Instant noodles	217	1.5
Baby foods	200	0.7
Hot drinks	159	0.3
Confectionery	145	0.5
Canned foods	126	0.9
Bottled water*	114	3.5
Breakfast cereals	18	0.04
Spreads	15	0.07
Chilled foods	12	0.06
Frozen foods	2	0.005

Note: N/A = Not available
*Volume in litres

Source: Euromonitor Plc (2001)

Table 3.13 Contribution of some food products to Thai diet

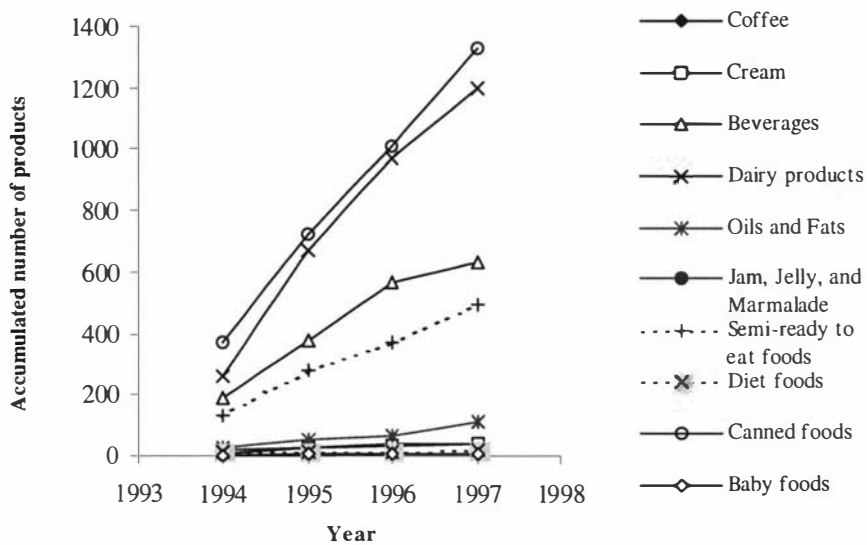
Products	Calories (%)			Protein (%)			Fat (%)		
	1980	1990	1998	1980	1990	1998	1980	1990	1998
Milled Rice	63.17	50.21	44.19	50.92	39.12	33.63	9.81	5.32	4.86
Milk products (exclude butter)	0.40	0.80	1.22	1.43	2.51	3.33	0.63	0.93	2.02
Meat	4.73	5.60	6.46	12.68	15.06	17.16	27.85	22.69	26.32
Seafood	1.52	1.84	2.56	10.84	12.34	17.69	3.80	3.24	4.25

Source: FAO (2000)

For processed food, it was reported that the total production was approximately US$8.3 billion in 1998, of which 55% was exported and 45% was consumed locally (Wongvarnrungruang, 1999).

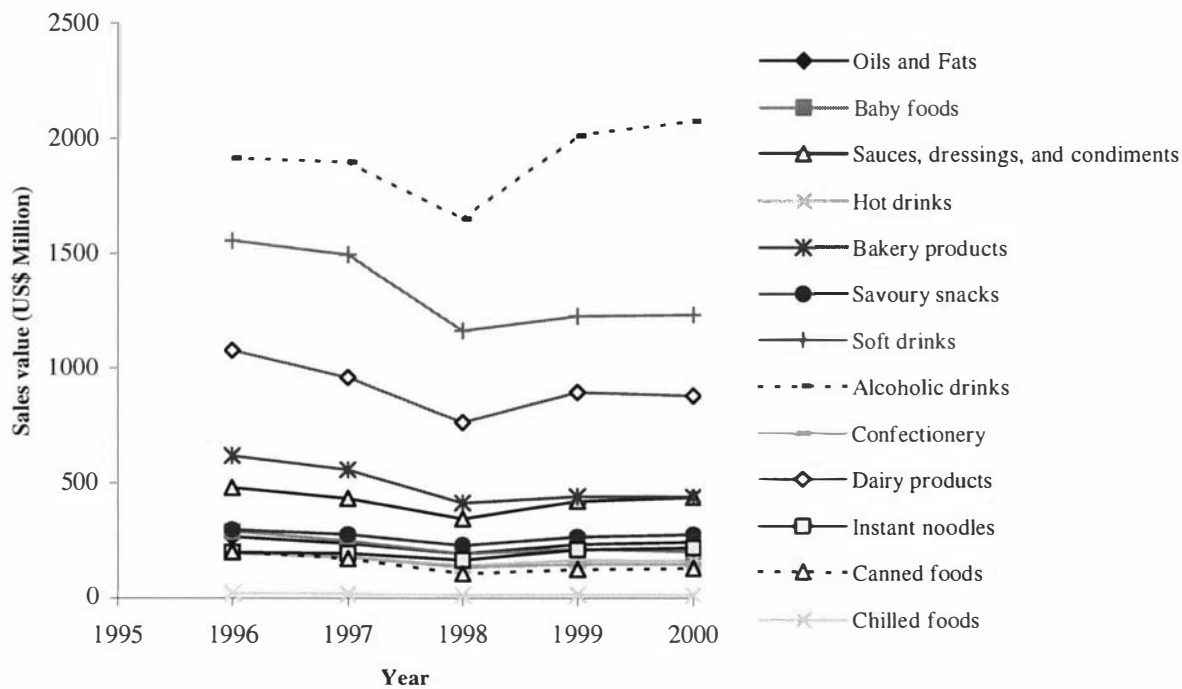
According to the accumulated number of food products registered with the Thailand Food and Drug Administration, growth in the number of new products was predominant in canned foods, dairy products, beverages, and semi-ready-to-eat foods (Figure 3.8). However, as shown in Figure 3.9, the domestic food products with the highest market value were beverages and dairy products.

Figure 3.8 Accumulated number of food products registered in Thailand



Source: FDA (1998)

Figure 3.9 Growth in market value of food products in Thailand



Source: Euromonitor Plc (2001)

Trends of domestic food products are described below.

• Dairy Products

An increasingly wealthy urban middle class has increased demand for Western style processed food products such as yoghurt and ice cream. Fresh milk consumption increased annually by 51.7% between 1985 and 1990 (Phithakpol, 1996). Growth of milk consumption in Thailand was also affected by government promotion to encourage milk consumption by children at school in the remote areas. The project was launched in 1992 with a sizeable budget (Table 3.14). This has led to continuing consumption by those children as they grow up, thus growth in overall demand has been seen.

Table 3.14 Governmental budget for promoting milk consumption at school

Year	Budget (US$ million)
1992	11
1993	14
1994	43
1995	68
1996	99
1997	144
1998	144

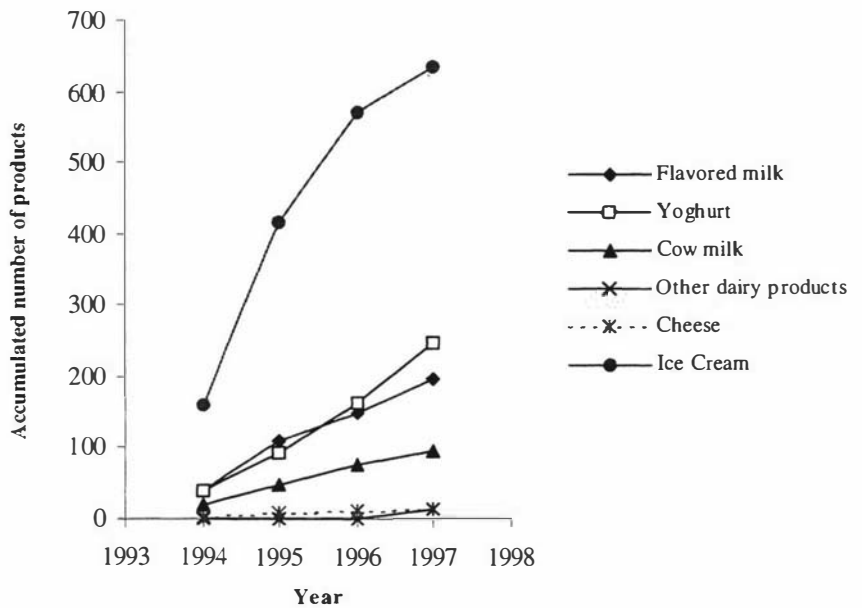
Source: Manager Information Services Co., Ltd. (1998)

Ready-to-drink milk was valued at US$789 million in 1996. UHT milk commands 46% of this category, followed closely by yoghurt drinks (27%), soya milk (12%), and pasteurised milk (11%) (Manager Information Services Co., Ltd., 1998).

Milk, ice cream and yoghurt grew dramatically from 1994 to 1997 (Figure 3.10). However, growth in both market value and sales volume started declining from 1998 to 2000 (Table 3.15 and Table 3.16).

The ice cream market can be best categorised by price: high, medium and low price. The market shares of each group were 10, 50 and 40 percent in 1994, respectively (Khookaeng (Public) Co., Ltd., 1995). The high priced ice cream is sold mostly in service food stores located in Bangkok and other big cities. There were four leading brands amongst the medium priced ice cream, of which "Wall's" brand of Unilever Groups gained the highest market share (60%) (Khookaeng (Public) Co., Ltd., 1995).

Figure 3.10 The growth of dairy products registered in Thailand



Source: FDA (1998)

Table 3.15 Growth in market value of dairy products

Year	Milk		Ice Cream		Cheese		Butter		Yoghurt	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)
1996	739.6	-	191.1	-	35.6	-	17.9	-	4.0	-
1997	661.2	-11	183.8	-4	30.1	-15	15.4	-14	3.3	-16
1998	530.0	-20	121.2	-34	22.0	-27	11.7	-24	2.2	-33
1999	625.3	18	106.6	-12	23.7	8	13.0	11	1.9	-15
2000	629.8	1	106.3	0	22.0	-7	12.5	-4	1.8	-3

Source: Euromonitor Plc (2001)

Table 3.16 Growth in sales volume of dairy products

Year	Milk		Ice Cream		Cheese		Butter		Yoghurt	
	Sales volume (Million litres)	Growth rate (%)	Sales volume (Million litres)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Million litres)	Growth rate (%)
1996	1423	-	36.7	-	1.7	-	2.6	-	0.3	-
1997	1605	13	43.1	17	1.8	6	2.8	8	0.3	0
1998	N/A	-	37.3	-14	1.7	-6	2.8	0	0.3	0
1999	N/A	-	30.0	-20	1.7	0	2.8	0	0.2	-33
2000	N/A	-	31.5	5	1.6	-6	2.8	0	0.2	0

Note: N/A not available

Source: Euromonitor Plc (2001)

- **Canned Foods**

Canned foods produced in Thailand are mainly for export. Their local market value, sales volume and growth rate are shown in Table 3.17 and Table 3.18. Facing high production costs during the economic crisis and trade difficulties, many food producers tended to focus on the local market (Manager Information Services Co., Ltd., 1998). As a result, some canned food products increased between 1999 and 2000.

Canned fish and seafood had the highest market value in this category. The major seafood product produced in Thailand is canned tuna. Most of the raw materials (80%) for canned tuna were imported (Anonymous, 1996). The local market consumes mainly canned sardine with its market share of 60 to 70% and growth rate of about 20% per year. The leading brand of canned sardine was "Poom Pui" with market share of about 80%. For canned fruits and vegetables, the leading brands were "Malee" with market share of 35% and "Pigeon" with market share of 25% (Khookaeng (Public) Co., Ltd., 1995).

Table 3.17 Growth in market value of canned foods

Year	Canned fish/seafood		Canned fruits		Canned vegetables		Canned meat and meat products		Canned soup	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)
1996	110.3	-	52.6	-	10.6	-	13.7	-	11.2	-
1997	110.2	-0.1	58.1	10	11.5	9	15.1	11	12.8	14
1998	102.9	-7	39.9	-31	10.9	-6	6.9	-54	9.0	-30
1999	111.8	9	45.4	14	11.6	7	7.7	11	6.8	-25
2000	122.3	9	50.9	12	12.2	4	7.9	3	6.4	-6

Source: Euromonitor Plc (2001)

Table 3.18 Growth in sales volume of canned foods

Year	Canned fish/seafood		Canned fruits		Canned vegetables		Canned meat and meat products		Canned soup	
	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)
1996	29.3	-	19.0	-	3.6	-	2.1	-	2.1	-
1997	28.8	-2	20.5	8	3.9	8	2.2	5	2.3	10
1998	26.7	-7	12.8	-38	3.7	-5	0.8	-64	1.5	-35
1999	28.6	7	14.4	13	3.9	5	0.9	13	1.1	-27
2000	30.7	7	15.8	10	4.0	3	0.8	-11	1.0	-9

Source: Euromonitor Plc (2001)

- **Beverages**

The main categories of non-alcoholic beverages in the Thai market are presented in Table 3.19 and Table 3.20. Overall, the market growth rate of these categories was high from 1995 to 2000. The highest growth rate was canned coffee drinks. Canned or ready-to-drink coffee was first introduced by Ajinomoto Sales Co., Ltd. in 1993. There were two brands in 1996 and 15 brands in 1997 (Manager Information Services Co., Ltd., 1998).

Main hot drinks in Thailand include coffee, tea, and chocolate drinks. The leading brand of coffee was "Nescafe'" with market share of 83% in 1994 (Khookaeng (Public) Co., Ltd., 1995). There were two leading brands of chocolate drink, of which "Ovaltine" was the leading brand with 63% of market share in 1997 (Manager Information Services

Co., Ltd., 1998). In 1997, there were approximately 35 brands of fruit juice in the Thai market (Manager Information Services Co., Ltd., 1998).

Main functional drinks were sport drinks and tonic drinks. There were two leading companies selling functional drinks in Thailand: Osotsapa Co., Ltd. and T.C. pharmaceutical Co., Ltd. Their market share combined was over 95% (Khookaeng (Public) Co., Ltd., 1996). For carbonated drinks, the market value in 2000 was about US$418 million (Euromonitor Plc, 2001). Cola shared the highest carbonated market of 55%. There were two brand leaders of cola: "Coke" and "Pepsi". For the other non-cola carbonated, there were four major competitors: Coca-Cola (Thailand) Co., Ltd.; Pepsi-Cola (Thai) Trading Co., Ltd.; Green Spot (Thailand) Co., Ltd.; and, Dara Neu-ah Co., Ltd. (Khookaeng (Public) Co., Ltd., 1996).

Table 3.19 Growth in market value of non-alcoholic beverages

Year	Soft drinks		Functional drinks		Hot drinks		Fruits and vegetables juice		Ready-to-drink coffee	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)
1995	1300.9	-	525.7	-	181.4	-	72.0	-	40.1	-
1996	1553.6	19	599.8	14	199.3	10	84.8	18	118.4	195
1997	1493.6	-4	576.0	-4	176.8	-11	78.4	-8	144.0	22
1998	1162.0	-22	393.2	-32	139.7	-21	67.1	-15	120.3	-17
1999	1226.3	6	464.0	18	161.6	16	74.3	11	145.3	21
2000	1232.5	0.5	466.0	0.4	159.0	-2	73.4	-1	152.7	5

Source: Euromonitor Plc (2001)

Table 3.20 Growth in sales volume of non-alcoholic beverages

Year	Soft drinks		Functional drinks		Hot drinks		Fruits and vegetables juice		Ready-to-drink coffee	
	Sales volume (Million litres)	Growth rate (%)	Sales volume (Million litres)	Growth rate (%)	Sales Volume (Thousand tonnes)	Growth rate (%)	Sales volume (Million litres)	Growth rate (%)	Sales volume (Million litres)	Growth rate (%)
1995	1658.5	-	220.3	-	14.1	-	68.0	-	20.0	-
1996	1865.0	13	238.0	8	15.8	12	75.8	12	59.5	198
1997	2014.6	8	275.5	16	16.9	7	84.1	11	73.0	23
1998	1997.6	-1	243.8	-12	17.9	6	87.1	4	76.0	4
1999	1774.5	-11	249.7	2	18.2	2	79.9	-8	82.5	9
2000	1833.4	3	260.4	4	18.5	2	81.2	2	89.6	9

Source: Euromonitor Plc (2001)

Alcoholic beverage supply increased from 10.2 kilograms per capita in 1980 to 31.5 kilograms per capita in 1998 (FAO, 2000). The growth of alcoholic beverages market was fluctuated between 1995 and 2000 (Table 3.21 and Table 3.22). The local beer market was dominated by a few large companies, the biggest being "Chang" from Carlsberge (Thailand) Co., Ltd. (46% market share) and "Singha" from Boonrawd Brewery Co., Ltd. (39% market share) (Anonymous, 2000c). About 50% of wine consumed in Thailand was imported (Khookaeng (Public) Co., Ltd., 1995).

Table 3.21 Growth in market value of alcoholic beverages

Year	Total alcoholic beverages		Beer		Wine	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)
1995	1754	-	33	-	70	-
1996	1914	9	53	61	76	7
1997	1896	-1	41	-23	61	-20
1998	1647	-13	21	-49	40	-35
1999	2011	22	33	58	53	34
2000	2074	3	38	14	52	-3

Source: Euromonitor Plc (2001)

Table 3.22 Growth of sales volume of alcoholic beverages

Year	Total alcoholic beverages		Beer		Wine	
	Sales volume (Million litres)	Growth rate (%)	Sales volume (Million litres)	Growth rate (%)	Sales volume (Million litres)	Growth rate (%)
1995	693	-	289	-	5	-
1996	723	4	330	14	7	51
1997	910	26	435	32	8	3
1998	1080	19	574	32	7	-8
1999	1127	4	572	0	10	41
2000	1235	10	621	9	12	18

Source: Euromonitor Plc (2001)

There was also growing demand for bottled drinking water (Table 3.23). There were about 1,700 brands of bottled drinking water in the Thai market (Anonymous, 2000d). The local leading brand was "Singha" (30% market share).

The mineral water market was valued at US$8 million in 1994 (Khookaeng (Public) Co., Ltd., 1995), increasing to US$13 million in 1998 (Anonymous, 1999). About 30% of mineral water was imported (Khookaeng (Public) Co., Ltd., 1995).

Table 3.23 Growth in market value and sales volume of bottled water

Year	Sales value		Sales volume	
	US$ million	Growth rate (%)	Million litres	Growth rate (%)
1995	83	-	185	-
1996	110	34	193	4
1997	119	8	205	6
1998	94	-21	208	2
1999	112	18	213	2
2000	114	2	218	2

Source: Euromonitor Plc (2001)

- **Cereal Products**

The main cereal consumed in Thailand is rice. Instant noodles would be considered as an alternative convenience staple food (Anonymous, 1995). Market values and sales volume of instant noodles and breakfast cereals are shown in Table 3.24 and Table 3.25. The main target markets were students and office workers (Anonymous, 1995; Phithakpol, 1996). In 1997, there were 3 brand leaders amongst a total of 9 brands. Breakfast cereal was first introduced during the last 10 years by imports. There were only two domestic manufacturers: Nestle' Products (Thailand) Co., Ltd. and Useful Foods Co., Ltd. together responsible for about 40% of market share in 1997. The market value of breakfast cereal dramatically decreased between 1997 and 1998.

Another convenience cereal product is instant rice gruel with US$5 million of market value in 1997 and 20 to 25% of growth rate per year (Manager Information Services Co., Ltd., 1998).

Table 3.24 Growth in market value of instant noodles and breakfast cereals

Year	Instant noodles		Breakfast cereals	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)
1996	197.3	-	22.4	-
1997	192.0	-3	18.9	-16
1998	163.5	-15	15.1	-20
1999	208.0	27	17.4	15
2000	216.6	4	17.6	1

Source: Euromonitor Plc (2001)

Table 3.25 Growth in sales volume of instant noodles and breakfast cereals

Year	Instant noodles		Breakfast cereals	
	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)
1996	59.6	-	2.5	-
1997	69.9	17	2.4	-4
1998	77.5	11	2.4	0
1999	86.0	11	2.4	0
2000	91.7	7	2.5	4

Source: Euromonitor Plc (2001)

- **Snack Foods**

Snack foods can be classified according to the main raw material. These include flavoured starch, potato chip, crispy bean, popcorn, dried flavoured squid, and prawn crackers. Flavoured starch was dominant in the market with 40% market share in 1996 (Manager Information Services Co., Ltd., 1998).

Snack foods can also be classified as chips/crisps and extruded snacks. Their market value, sales volume, and growth are presented in Table 3.26 and Table 3.27. It was reported that there were more than 20 new snack foods introduced in the Thai market each year but their life cycle was usually short. This was due to high competition and low consumer loyalty (Manager Information Services Co., Ltd., 1998).

Table 3.26 Growth in market value of snack foods

Year	Total snack foods		Chips/Crisps		Extruded snacks	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)
1996	295.8	-	75.1	-	83.0	-
1997	274.0	-7	70.0	-7	79.4	-4
1998	226.4	-17	57.9	-17	66.8	-16
1999	263.6	16	67.4	17	78.6	18
2000	272.9	4	69.7	4	82.2	5

Source: Euromonitor Plc (2001)

Table 3.27 Growth in sales volume of snack foods

Year	Total snack foods		Chips/Crisps		Extruded snacks	
	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)
1996	33.6	-	8.2	-	8.5	-
1997	37.6	12	9.3	13	9.9	17
1998	40.0	6	10.0	8	10.9	10
1999	41.7	4	10.5	5	11.6	6
2000	45.3	9	11.4	9	12.8	10

Source: Euromonitor Plc (2001)

• Spreads and Jams

Jams were main spread consumed in Thailand. The market value, sales volume and growth of spreads and jams are shown in Table 3.28 and Table 3.29. Jams were mainly produced in Thailand. The local brand leader, "Best Foods", had over 90% market share amongst the total of five major local brands (Manager Information Services Co., Ltd., 1998).

Table 3.28 Growth in market value of spreads and jams

Year	Total spreads		Jams	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)
1996	17.2	-	12.0	-
1997	15.4	-10	10.9	-9
1998	12.4	-19	8.9	-18
1999	14.3	15	10.4	17
2000	14.5	1	10.6	2

Source: Euromonitor Plc (2001)

Table 3.29 Growth in sales volume of spreads and jams

Year	Total spreads		Jams	
	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)
1996	3.4	-	2.9	-
1997	3.8	12	3.2	10
1998	4.0	5	3.4	6
1999	4.1	3	3.6	6
2000	4.4	7	3.8	6

Source: Euromonitor Plc (2001)

• Confectionery

Main confectionery products sold in Thailand were candy, chocolate confectionery, and chewing gum. Among these confectionery products, candy had the highest market value and sales volume (Table 3.30 and Table 3.31). There were about 14 main producers of candy in 1997. Hard candy was dominant (80%) but its growth rate was low (5% per annum) compared to that of soft candy (10% per annum) (Manager Information Services Co., Ltd., 1998).

Table 3.30 Growth in market value of confectionery products

Year	Total confectionery		Candy		Chocolate confectionery		Chewing gum	
	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales value (US$ million)	Growth rate (%)	Sales Value (US$ million)	Growth rate (%)
1996	192.8	-	99.3	-	48.0	-	45.5	-
1997	175.1	-9	88.9	-11	46.4	-3	39.8	-13
1998	133.5	-24	69.6	-22	33.3	-28	30.6	-23
1999	145.5	9	78.4	13	33.1	-0.6	34.1	11
2000	144.9	-0.4	79.2	1	31.8	-4	33.9	-0.4

Source: Euromonitor Plc (2001)

Table 3.31 Growth in sales volume of confectionery products

Year	Total confectionery		Candy		Chocolate confectionery		Chewing gum	
	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales volume (Thousand tonnes)	Growth rate (%)	Sales Volume (Thousand tonnes)	Growth rate (%)
1996	27.7	-	21.4	-	3.7	-	2.6	-
1997	29.5	7	22.5	5	4.2	14	2.8	8
1998	28.2	-4	21.8	-3	3.6	-14	2.8	0
1999	27.7	-2	21.8	0	3.2	-11	2.8	0
2000	29.2	5	23.0	6	3.2	0	3.0	7

Source: Euromonitor Plc (2001)

• Health Foods

Target consumers of health foods are usually those people with high incomes. Bangkok was the centre where average monthly per capita income was significantly higher (US$178) compared to other parts of the country (US$68) (NSO, 1999a). Young adults and middle aged-group were main target consumers (Table 3.32).

Table 3.32 Health food consumers in Thailand

Consumer Group	Age (years)	Proportion (%)	Dominant Products
School student	2-25	25	Vitamins
Young adults and middle aged-group	25-45	50	Chitosan, Fibre diet, Fat burners, Vitamins, Zinc, Selenium, Coenzyme Q10, Collagen, Green tea, Grape seed extract
Senior citizens aged-group	Over 45	25	Lecithin, Calcium, Shark cartilage, Royal jelly, Ginseng, Sprirulina, Bee Pollen

Source: Wongvarnrungruang, 1998

The market value of domestic health foods between 1996 and 1998 was around US$200 million (Table 3.33). Imports accounted for 30%, half of which was in bulk while the rest was in retail packets. Local Thai manufacturers tended to produce health foods that were already known in the market and products that required no high technology equipment. Distribution channels were both in retailing stores and direct sale (Wongvarnrungruang, 1998).

Table 3.33 Market value of health foods in Thailand

Source	Year/Value (US$)		
	1996	1997	1998
Import	79.6	57.0	62.7
Local Production	353.1	277.3	324.0
Export	215.7	144.3	158.8
Total Domestic Market	217.0	190.0	227.9

Source: Wongvarnrungruang, 1998

Chicken extract soup is one of well known health foods in Thailand. Its growth rate was high over the past 5 years but started to decrease in 1998 (Table 3.34), probably affected by an economic crisis. The brand leader, "BRAND", held over 85% of market share (Manager Information Services Co., Ltd., 1998).

Table 3.34 Growth in market value of chicken extract soup

Year	Value (US$ million)	Growth rate (%)
1993	26.86	-
1994	33.80	25.84
1995	39.33	16.36
1996	39.46	0.35
1997	38.40	-2.69
1998	30.06	-21.71

Source: Manager Information Services Co., Ltd. (1998)

3.7 FOOD RETAILING IN THAILAND

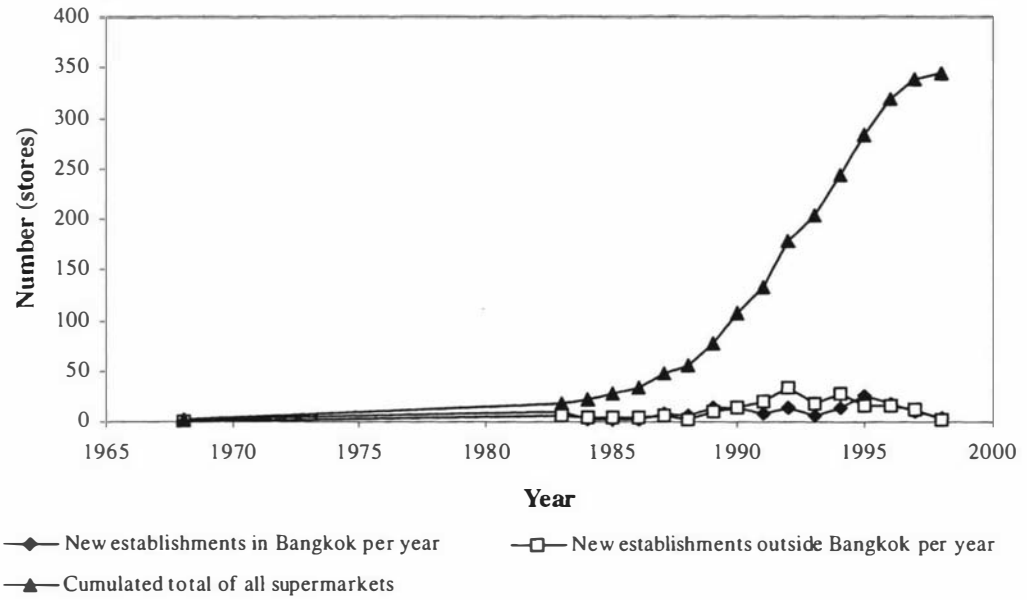
The number of food retailers increased from 218 thousands in 1996 to 268 thousands in 2000 (Euromonitor, 2001). Overall, there are two categories of retail food market in Thailand: traditional markets and modern markets (Anonymous, 1996; Anonymous, 2000e).

Traditional markets: These are wet markets and "mom and pop" stores, accounting for 75%.

Modern markets: These are developed to service the growing middle class with their demand for more sophisticated food stores and a greater variety of products, many of which are imported. They in turn can be subdivided into following categories:

- Supermarkets: In Thailand, the supermarket is developed as an integral part of a department store. There was only one supermarket in Bangkok registered with the Department of Commercial Registration, Ministry of Commerce in 1968. New establishments have resulted in an exponential increase in numbers between 1985 and 1998 (Figure 3.11). After the economic crisis in 1997, supermarkets tended to be largely stand-alone stores.
- Superstores: There were approximately 73 outlets of superstores in 1999.
- Convenience stores: There were approximately 3, 400 stores in 1999.

Figure 3.11 The growth of supermarkets in Thailand



Source: DCR (1996, 1999, 2000)

3.8 THE STATUS OF FOOD R&D IN THAILAND

The status of local R&D activities can be viewed from several perspectives. These include product development management, funding sources, technical sources and human resources.

3.8.1 Product development management

There have been very few studies published on food product development management in Thailand. The most recent one was conducted by Suwannaporn (1999). In this research, it was reported that Thai food companies relied mainly on external sources of technology. Most new products were incrementally innovative by modifying or improving existing products. Product ideas and screening criteria were made by top management. For a new product line or radically innovative products, buying embodied technology from suppliers or collaboration with well established large companies, such as multinational companies, tended to be used. Customer research was often absent in most local Thai food companies.

3.8.2 Funding sources

There are three major funding sources for food research in Thailand; Science and Technology Development Board (STDB); The National Centre for Genetic Engineering and Biotechnology (NCGEB) and The National Research Council of Thailand (NRCT) (Bhumiratana et al., 1992). The major support for research and development in Thailand comes from the government, through the NRCT. There was also some support from foreign sources such as the Government of Australia under the ASEAN-Australia Economic Cooperation Program between 1982-1990, in the research area of food processing and preservation, production and use of enzymes, technology transfer, and food standards and safety (Phithakpol and Chairat, 1992).

3.8.3 Technical sources

The Institute of Food Research and Product Development (IFRPD) has, in the past, been one of the most significant drivers of the modernisation of the Thai food industry (Bhumiratana et al., 1992). In addition, other university laboratories and the Department of Fishery and the Thailand Institute of Scientific and Technological Research (TISTR) have played important roles in supplying consultancy services for the food industry in Thailand (Bhumiratana et al., 1992). TISTR has mutual co-operation with other organisations, private industry and between some countries, working jointly for the development of technology transfer to industry. Areas of possible technology transfer include both hardware and software provided by TISTR for in-plant process improvement, product development, post harvest techniques for fruits and vegetables, process and plant design, consulting services, analysis and testing service, and a technical information service (Kampempool, 1988).

In 1996, The National Food Institute (NFI) was established through the collective efforts of the Department of Export Promotion, the Food Industry Club of the Federation of the Thai Industries and the National Science and Technology Development Agency (NSTDA). This Institute provides training and knowledge to food companies both on technical and marketing issues, and acts as a co-ordinating body within the food companies and public sector (NFI, n.d.).

However, public sector R&D results were poorly communicated to the private sector. Most public sector research is quite vague, too general, and not commercially viable, and is therefore poorly applied (TDRI, 1989; Bhumiratana et al., 1992; FAO and MAC, 1992; Chantramanklasri, 1995).

3.8.4 Technical human resources

Shortage of trained manpower and the lack of an indigenous scientific and technological base in Thailand were often identified in the last decade (TDRI, 1991; Bhumiratana et al., 1992). During that time, there were about 300 graduates/year from all bachelor programs directly related to food science and technology. This number increased to about 563 in 1997 (MUA, 1998).

Similar patterns of food research and development support were found in some other ASEAN countries such as the Philippines and Malaysia. In the Philippines, the large and a few small and medium food manufacturing firms have the financial and staff resources to conduct research and development activities. The majority of small and medium scale food companies, which dominate the industry, do not maintain research and development units and depend solely on government institutions for technical support. Government research and academic institutions and several private universities dominate research and development functions. Major research areas are on product formulation, food processing and food safety. Research findings are disseminated through lectures, demonstrations, actual training, and information materials/brochures (Alcasabas, 1985; Magtoto, 1992). In Malaysia, government agencies play a very important role in assisting the small food companies through several of its research, development and extension programs. New product development and innovation, as well as the upgrading and improvement of machinery and systems, were emphasised to provide help to small food companies (Zakaria and Husin, 1988).

3.9 CONCLUSION

Thailand is one of the ASEAN countries, which is shifting from an agricultural economy to a greater level of industrialisation. This leads to changes in consumers' lifestyle and higher demand for processed and convenience food products. This has resulted in high growth of many processed food products such as beverages, dairy products, and snack foods.

Under pressure of rapid changes in both consumer market and technology, the Thai food industry is challenged to maintain up-to-date technical knowledge in order to develop food products to meet changing consumer needs. In Thailand, technical knowledge sources available for the food industry were graduate food scientists, government agencies, and suppliers. The number of graduate food scientists has increased dramatically during the past few decades due to promotion of the Thai government. Some government agencies were also established to provide technical assistance to the Thai food companies. Although most food companies relied heavily on technological advances from suppliers, there were still no systematic reviews published that defined which technical sources and types of material played a major role in product innovation activities in the Thai food industry. The present study attempts to identify the main technical knowledge sources and types used by food companies in Thailand. The specific objectives of the study were:

- To identify the main technical knowledge sources and types used by food companies in Thailand to introduce their new branded food products to the Thai market;
- To compare the use of technical knowledge sources for different types of company ownership and different types of product introductions;
- To identify how technical food product developers in Thailand keep up-to-date in technical knowledge;
- To identify barriers to technical information acquisition.

The benefits of this research were expected to be information for the government policy process and to other technical providers to enhance new product development activities for food companies in Thailand by allocating appropriate resources. Knowing the sources of technical knowledge for product innovation also will allow firms involved in

the food innovation value-added chain such as suppliers and complementary innovators (Afuah, 1998) to improve their chance of recognising the potential of an innovation.

4 RESEARCH METHODOLOGY

4.1 INTRODUCTION

Because very few studies had been published on the food product development process in the Thai food industry, this research was somewhat exploratory in nature. Because the study of innovation activities is associated with characteristics of organisations, organisational research methods were reviewed and appropriate ones were selected for this study and described in greater detail.

4.2 RESEARCH METHODS FOR PRODUCT INNOVATION

Studying product innovation is very much concerned about the behaviour or activities of an organisation. Data can be obtained from the company's records or direct surveys.

4.2.1 Research design and research methods in organisational research

Bryman (1989) distinguished between research designs and research methods in organisational research (Table 4.1). Research designs are thought of as the overall structure and orientation of an investigation. Research methods are involved in data collection and analysis. Particular research designs tend to be associated with particular research methods or data collection. For example, data collection in survey research is usually performed either by interview or by questionnaire.

Table 4.1 Research designs and methods in organisational research

Designs	Methods
D1 Experiment	M1 Self-administered questionnaire
D2 Survey	M2 Structured interview
D3 Qualitative research	M3 Participant observation
D4 Case study	M4 Unstructured interviewing
D5 Action research	M5 Structured observation
	M6 Simulation
	M7 Archival sources of data

Source: Bryman (1989)

4.2.2 Data collection for product innovation research

Although many different research designs and methods have been employed in organisational studies, survey approaches tend to be used in most product innovation research. These approaches can be categorised as an objective approach or a subjective approach (Archibugi et al., 1994).

The objective approach takes the individual innovation as a unit of analysis. Information on product innovation can be collected from selected recorded items such as new products, innovation inventories, patents, bibliometric directories; or on the basis of expert opinions. Data are collected periodically, allowing time series comparisons.

The subjective approach involves collecting information directly from organisations, either by questionnaires or by interviews.

While the objective approach has advantages over the subjective approach by enabling comparisons of sectors over time, it has some limitations in that it does not cover all information about innovation activities. For example, not all inventions are patented. In addition, it limits comparisons amongst the entire population because non-innovating

firms are not included. The subjective approach provides information from a sample of enterprises which can be related to the entire population of companies available in published directories. Many researchers on product innovation and information utilisation of companies have tended to use subjective approaches either by mail questionnaires or by direct interviews. In some particular studies on innovation in international companies, an objective approach via patent search was employed (Table 4.2).

Table 4.2 Research approaches in innovation and information acquisition studies

Research approaches	Example of studies	Sectors
Objective		
Patents	Sources of innovation (Rama, 1996)	International food and beverage industry
Subjective		
Mail questionnaires	Product development practices (Kerr, 1994)	Small manufacturing companies (Food, Electronics, Light engineering, and Tourism)
	External technology acquisition in product development (Atuahene-Gima and Lowe, 1994)	Manufacturing firms (Engineering, Pharmaceutical and Chemical)
	The role of internal and external research design and development activity in innovation performance (MacPherson, 1997a)	Manufacturing firms in the scientific instrument sector
	The role of external technical support in the innovation performance (MacPherson, 1997b)	Scientific instruments producers
	The role of internal and external technical activity support in the product innovation (Mackun and MacPherson, 1997)	Industrial equipment manufacturers
	Information acquisition behaviour (Gomes, 1998)	SMEs (Electronics, Furniture, Marine and Plastics)
	Technological knowledge acquisition (Belotti and Tunalv, 1999)	SMEs (Manufacturing companies)
	Sources of technological development (Garcia Martinez and Burns, 1999)	Food and drink industry
Subjective		
Direct interviews	Product development practices (West, 1980)	Food industry
	Product development strategies and outcomes (Nystrom and Edvardsson, 1982)	Food processing companies
	The use of external information (Johnson and Kuehn, 1987)	Small businesses
	The use of Information (Kennington, 1989)	Small manufacturing firms
	Sources of scientific, innovative and technological information (Julien, 1995)	Small businesses
	Knowledge creation in product innovation (Campbell, 1999)	Manufacturing sectors (building products, consumer products and industrial products)

Although a mail questionnaire takes less time with lower cost, it introduces some drawbacks. These include ambiguities and misinterpretation of the questions, incompleteness of returns and possibly wrong information. A mail survey was therefore suitable for a simple questionnaire and general questions. In this study, a simple mail questionnaire was used to obtain information about companies' activities to allow company selection and screening.

When greater details were required, direct one-on-one interviews were more appropriate. This technique was also considered to be especially effective with busy executives, technical experts and leaders. It also required a small group of respondents for a given target population (Aaker et al., 1998). Comparisons between mail survey and one-on-one interviews are summarised in Table 4.3

Face-to-face interviews were advantageous over telephone interviews because they enabled quick correction of any confusion or misunderstanding by respondents. In addition, questions could be longer and more complex as interview aids such as show cards could be used.

Table 4.3 Comparisons between two survey methods

Survey methods	Advantages	Disadvantages
Mail or Self-administered questionnaires	- Low cost - Fast - Low effects influenced by the questions	- Limitation of amount of information required - No chance of clarifying ambiguous questions - No guarantee of the right respondents or key informants - Impossible to collect additional data
One-on-one interviews	- Ambiguous questions can be explained. - Greater details can be obtained. - Interviewees can be specified and known.	- High cost - Time consuming - Effects of personal and social characteristics of interviewers and respondents

Sources: Bryman (1989) and Aaker et al. (1998)

4.2.3 Focus groups

A focus-group discussion involves a group of people discussing possible ideas or solutions to a specified problem. The emphasis in this method is on the results of group interaction when focused on one or more topics introduced by a discussion leader or a moderator. The aim of this technique is to offer participants more stimulation to raise new ideas and make more meaningful comments, unencumbered by an individual interview technique. A focus group session was normally continued until there was very little new information to be gained from additional sessions. Three or four group sessions in which five to nine "target" people participated were usually sufficient (Aaker et al., 1998).

4.3 RESEARCH DESIGN AND METHODS FOR THE STUDY

Because each research method posses some drawbacks, the mixture of different approaches rather than a single method was used. This entailed confirmation and clarification of the findings. Methods of data collection included one-on-one interview with the food companies, technical information providers, and focus groups with industry technical product development staff.

4.3.1 Variable designs

The propensity of a company to use information sources was determined by various factors such as the pace of technology development, the company size, the degree of familiarity with a problem, characteristics of information sources, innovation orientations, and innovation strategies (Fischer, 1979; Johnson and Kuehn, 1987; Cohen and Levinthal, 1990; Senker and Faulkner, 1992; Christensen et al., 1996; Harmsen et al., 2000). The pace of technology development would be taken into account only when comparing different industries. Since this study focused on only one industry, these two variables were fixed. Company size tends to be directly associated with the intensity of conducting R&D (Mueller et al., 1982; Cohen et al., 1987; Acs and Audretsch, 1991) which enables a company to identify technical information.

The propensity to innovate was found associated with the company size and the company ownership (Baldwin and Sabourin, 2000). However, the way in which new products are managed and developed is more likely to be associated with the company ownership (Suwannaporn and Speece, 1998; Suwannaporn, 1999). The study of the Swedish food industry showed that locally owned private companies were more successful in their product development from a market and commercial point of view, while the foreign dominated companies were more successful from a technological point of view (Nystrom and Edvardsson, 1982; Nystrom, 1990). This reflects the impact of the company ownership on the innovation orientation which was also found associated with technical information sources used (Harmsen et al., 2000).

The degree of familiarity with a problem and the innovation strategies of a company were considered associated with the type of new product being introduced to the market. New product types, characterised by their degree of newness and sources of production (import, own manufacture or contract manufacture) were chosen to represent the degree of familiarity and a company's new product strategies. Therefore, company ownership, new product source, and degree of product newness were variables used in this study.

4.3.2 Data collection

The investigation started with a screening questionnaire to locate suitable companies for the study. An in-depth one-on-one interview was then conducted with selected food companies which had new products introduced in the Thai market over the previous three years. From that survey, the key technical information providers were identified. A third survey was designed to question these technical information providers. Following the third survey, three focus groups of company technical staff were used to verify and clarify the overall results of the previous two surveys.

4.3.2.1 Survey 1: Company selection

To obtain as much accurate and reliable information as possible for the purpose of this study, companies which had recently introduced new food products were chosen to provide information on their product development activities. The samples for the initial study were companies which had introduced new branded consumer food products in the Thai market over the previous three years. Because there was no information on companies' new food product introduction available, a non-probability sampling was employed to locate samples for the study. The results gained from these samples may not therefore statistically represent the whole population. Conclusions made from this survey were treated with caution.

Food companies in Thailand were identified from Board of Trade of Thailand's Directory 1998-1999 (Board of Trade of Thailand, 1998) and Thailand Industrial Buyer's Guide 1997-98 (The Business Publications (1985) Co., Ltd., 1997). To identify samples for the study, a letter of introduction outlining the purpose of the study (APPENDIX 1) was sent to the Chief Executive or Managing Director of each of 517 selected food companies in August, 1998. They were invited to participate the study by completing a short questionnaire (APPENDIX 2).

The criteria for selecting companies for the study were those:

- selling branded consumer food products;
- had introduced new branded food products in the Thai market during the previous three years.

From 191 companies that replied, 84 companies introduced new branded consumer food products to the Thai market over the previous three years, and they were consequently selected for a one-on-one interview.

4.3.2.2 Survey 2: Interviews with food manufacturers

A summary of the first survey results (APPENDIX 4) was sent to each of the 84 companies. In addition, each company was invited to participate in a direct interview. If the company accepted, they identified the person who was most involved in new food

product development. A follow-up phone call was made after 1 week to arrange a suitable interview time. Of the 84 companies which responded in the first survey, 55 companies were willing to participate further.

In addition, new food products in large supermarkets (Big C and Top Supermarkets) were reviewed by the research team. Some additional Thai manufacturers who did not participate in Survey 1 were identified. These included five companies who did not reply in Survey 1 and two companies who were not on the official lists above. These seven companies were also invited to participate in the one-on-one interview. Their acceptance resulted in a participating group of 62 companies.

4.3.2.3 Interview techniques

A face-to-face, semi-formal, questionnaire-based interview structure was chosen for the subjective survey. A mixture of both open-ended and closed-ended questions was used. Show cards were extensively used as a facilitating tool. When greater details were required, open-ended questions were used and the answers were tape-recorded.

4.3.2.4 Questionnaire design

The questionnaire was designed partly on previous studies (Cooper and Kleinschmidt, 1986; Sanchez and Elola, 1991; Kerr, 1994; Hoban, 1998), and then translated into Thai.

There were five sections in this questionnaire (APPENDIX 5). The questionnaire was pre-tested with five interviewees before being used on a large scale. Since there were only minor modifications of the questionnaire used in the large scale, pre-tested questionnaires were included in the subsequent data analysis.

Section I: Demographics of interviewee

The demographics of interviewee were asked in the first section. These included name, position in the company, age, educational background, working period in the company,

and command channels. Company ownership was also verified before specific questions were asked in the subsequent sections.

Section II: New product introduction

Based on new product classifications made by many authors (Booz-Allen and Hamilton Inc., 1982; Fuller, 1994; and Prime Consulting Group Inc., 1997), four new product types were clearly defined and explained to participants so that they could provide accurate information.

- Innovative Products-Completely New to the Thai Market *(ICNP)* were food products which were the first on the Thai market.
- Products-New to Company *(PNC)* were food products which were new to a company but already existed on the Thai market.
- Value Added Products *(VA)* were food products a company already sold on the Thai market but which the company improved the product characteristics (e.g. greater convenience, longer shelf life or cost reduction).
- Line Extensions *(LE)* were food products which extended the range of an existing product that a company already had on the Thai market.

Lists of products, brand names, launch year and the company's main competitors of each product were asked and filled out into separate sheets by respondents so that the data obtained could be verified and confirmed.

Section III: Specific questions on technical information for new food products

There were four possible ways a company could introduce a new product to the market: imported-ready to sell; own manufacture; contract manufacture, and; the "others". This set of questions was repeated and prepared separately for each of the four ways of introducing new products. Each of these question sets could be blank as each company might not use all of these ways of new product introduction. In each identical set of these questions, all sources of technical information possibly used for introducing the product type were firstly solicited. Once completed, the interviewee was asked to firstly identify the most important three sources, then the one most important.

Section IV: Generic questions

The list of technical information sources were repeated in this section to summarise technical sources used by a food company for each way of new product introduction. Since there could be many different sources used, only those identified as main sources for a company's new products as a whole were selected by each respondent for further detail.

Further questions seeking details of the main technical knowledge sources included lists of particular sources and their advantages/disadvantages. Information was sought on technical staff in greater detail. This included number of product development technical staff, product development facilities, and sources of technical knowledge for these staff.

Section V: Company's activities and demographics

Questions in this section include turnover per annum, number of employees, food products sold, and number of marketing and sales staff. A set of questions in this section was made to build an overall picture of the company's structure of new product development and to ensure that a wide range of food products and food companies were covered. The type of company ownership, a pre-determined variable, was verified in a separate section.

4.3.2.5 Data analysis

The association between the following variables was examined:

- Company ownership and New product type
- Company ownership and Technical knowledge sources
- New product type and Technical knowledge sources

Since all these variables were in nominal scales, the statistical analysis was limited to non-parametric statistical methods. The contingency table analysis was the appropriate statistical approach for that purpose (Aaker et al., 1998). The Chi-Square test of independence was employed to determine the statistical significance. However, there are some limitations of using the Chi-Square test:

- Because the Chi-Square test is based on the assumption that variables to be tested are statistically independent, only one frequency per individual observation or respondent is permitted (Runyon and Haber, 1984).

- The Chi-Square distribution is approximated to approach the normal distribution when a sample size is large enough. The quality of this approximation depends on: the sample size; the true distribution of marginal probabilities in the population; the number of cells in the contingency tables (RxC), and; the significance level employed (Bradley et al., 1979). Thus, the Chi-Square test of independence is valid only if the sample size is large enough to guarantee the similarity between the theoretically correct distribution and the Chi-Square sampling distribution (Howell, 1992). Small sample size usually results in small "expected cell frequencies" in the contingency tables. This makes the Chi-Square value less powerful in providing reliable estimates of statistical significance.

Although many published papers followed traditional approximations, e.g. Cochran's rule of thumb[1], there was no strong consensus on their accuracy. In addition, those restrictions were arbitrary and based more upon tradition than either mathematical or

[1] If no more than 20 % of expected frequencies fall below 5, and no expected frequency falls below 1, then the Chi-Square value obtained will be reasonably close to the actual probability (Cochran, 1954).

empirical evidence. Hence following those traditional rules limits the use of the Chi-Square test to some particular situations in which it provides a satisfactory approximation (Bradley et al., 1979).

To increase the "expected cell frequencies", some rows and columns in the contingency tables might be combined. However, this manipulation results in the loss of some of information required (Maxwell, 1961). Although some alternative modified Chi-Square methods including the Exact Test and the Likelihood Ratio can be used, they still do not guarantee the accuracy of the test (Bradley et al., 1979; Berry and Mielke, 1988).

Bradley et al. (1979) suggested that if association in the contingency tables rather than estimating exact cumulative multinomial probabilities were concerned, the Chi-Square test could be used at some maximum specifiable level of risk. Based on their computer-based sampling study on contingency tables ranging from 2x2 to 4x4, they found that the actual value of Type I errors (α) rarely exceeded 0.06. Thus, the Chi-Square test was acceptable if α was controlled below 0.06.

Non-responses and insufficient available information to locate the target sample were uncontrollable factors which limited the sample size of this study. As a result, there were many small "expected cell frequencies" in the contingency tables. Nevertheless, because α was controlled at 0.05 in this study, the Chi-Square test was still satisfactorily applicable. However, the "Likelihood Ratio" which is less affected by a small sample size (Howell, 1992) was also used in this study to confirm the normal Chi-Square test. In cases of where a statistical significance of association was found, the combining of insignificantly different rows was also employed to strengthen the analysis.

SPSS version 8.0 for Window (SPSS Inc., 1997) was used as a facilitating tool in the data analysis.

4.3.3 Survey 3: Interviews with technical knowledge providers

A special survey was conducted with the main technical knowledge providers, as identified by the food industry staff. The main purpose of this survey was to compile an independent perspective of the product development processes in Thailand as perceived from technical knowledge providers. In addition, the type and frequency of technical information and services provided by these organisations was assessed. The providers of technical knowledge to the food industry were grouped according to the results from Survey 2: food ingredient suppliers, food processing equipment suppliers, food packaging suppliers, consultants, research institutes and universities. Appropriate companies and organisations based in Bangkok were identified from food and beverage companies profiles in Thailand (Kompass International (Thailand) Co.Ltd., 1998). The respondents were recruited by telephone before interviews (APPENDIX 6). A letter was subsequently sent to each, outlining the intention of the research work and inviting the companies to participate (APPENDIX 7). Those accepting the invitation were contacted by phone to arrange a meeting. A face-to-face, semi-formal, questionnaire-based interview structure was used (APPENDIX 8). After each interview, each respondent was asked to identify the company's main competitors in Thailand. They were then contacted and included in the survey.

4.3.4 Focus groups with industrial technical staff

Product development staff from food companies participating in Survey 2 were contacted by phone and invited to attend one of three focus groups. This was aimed at verifying the results from Surveys 2 and 3 and also gaining more information about how technical staff learned about technical advances to update their knowledge. The participating panellists were contacted by telephone (APPENDIX 9). When needed, a formal letter was sent to their manager for authorisation. In each focus group, various types of company ownership were mixed to include different points of view. Three sessions with staff from 14 food companies were completed. For convenience, two sessions were held in Bangkok, and one session was held in Nakhon Pathom province close to many participating food companies. Participants were presented with brief results of Survey 2 (APPENDIX 10) so that they had a common understanding of the topic of discussion. The main topics discussed included:

- The views on Survey 2 results;
- The role of food ingredient suppliers;
- How technical staff update their technical information (not just product development);
- Limitation of technical inputs;
- Product development process.

(see details in APPENDIX 11)

These topics were used as a guideline for each session rather than as sequential questions. This was to ensure that all required information was discussed. Following the early session, any issues identified were documented for discussion at the next focus group session. All sessions were tape recorded and transcribed. The discussion sequence was altered at each focus group session to minimise question order bias.

5 THE SAMPLING OF FOOD COMPANIES IN THAILAND

5.1 INTRODUCTION

In this chapter, the characteristics of food companies participating in this current research were described and compared to the wider food industry in Thailand. Their new products introduction and the impact of company ownership will be compiled.

5.2 THE THAI FOOD INDUSTRY AND SURVEY SAMPLING STATISTICS

5.2.1 Company ownership

Table 5.1 summarises company details for this current research. Four types of company ownership were assessed in Survey 1. As discussed earlier (Table 3.4), the total number of registered food manufacturing establishments in 1996 was 3,548 companies (NSO, 1999c). However, details on company ownership could only be defined for 1418 companies from literatures (Board of Trade of Thailand, 1998; The Business Publications (1985) Co., Ltd., 1997; Kompass International (Thailand) Co., Ltd., 1998). The total number of each type of company ownership was therefore calculated from the proportion of companies from the literatures (column B of Table 5.1).

A total of 517 letters and questionnaires (APPENDIX 1-2) were sent to those companies identified in Board of Trade of Thailand's Directory 1998-1999 (Board of Trade of Thailand, 1998); Thailand Industrial Buyer's Guide 1997-98 (The Business Publications (1985) Co., Ltd., 1997). A total of 191 replies were reviewed. Of these 191 companies, 186 companies were still operating in food business, 4 companies did not do business on food anymore, and 1 company was closed down. The distribution and responses across company types of 186 food companies is shown in Table 5.1. Of these 186 companies, only 131 sold branded consumer food products in Thailand. The remaining 55 companies did not sell branded consumer food products in the Thai market but they did one or more of activities. These included exporters (52 companies), food manufacturers (37 companies), distributors/wholesalers (31 companies), food

ingredient suppliers (26 companies), and importers (16 companies). Of 131 companies selling branded consumer food products, only 84 companies had introduced new products in the previous three years.

Table 5.1 Summary of number of food companies in Thailand and those that participated in the research

	Survey 1					Survey 2		
	A	B	C	D	E	F	G	H
Ownership	[1]Total number of companies (%)	Estimated total number of companies (%Ax3548) / 100	Number of replies (%)	Number of companies selling branded food products to Thailand	Number of companies introducing new branded food products (NP)	Estimated total number of companies active in introducing NP (ExB/C)	Number of participating companies	% of representative based on total number of companies active in NP (G/F)x100
Thai private	1237 (87)	3087	119 (64)	84	50	1297	27	2
Thai public	39 (3)	106	20 (11)	17	11	58	7	12
Joint venture	110 (8)	284	31 (17)	19	12	110	11	10
Multinational	32 (2)	71	16 (9)	11	11	49	10	20
Total	1418 (100)	3548	186 (100)	131	84	1602	55[2]	3

Note: [1] Source: Board of Trade of Thailand (1998); The Business Publications (1985) Co., Ltd. (1997); Kompass International (Thailand) Co., Ltd. (1998)
[2] Total number of food company participating Survey 2 was 62 companies but only 55 companies were those which also participated in Survey 1.

To estimate the total number of companies that introduced new food products in Thailand in the previous three years, the fraction of the survey responding to the questionnaire was calculated. This was extrapolated to the estimated total number of companies in Thailand. For example, 50 Thai private owned companies had introduced new products from Survey 1. There were 119 of these companies responding to Survey 1. Thus, the estimated total Thai companies introducing new branded consumer food products was (50x3087/119) = 1297. These numbers of food companies were then used for calculating the percentage of representative of the sample of this current study

(column H of Table 5.1). As a result, the Thai private company sample was the lowest representative although its number of participation was high.

Of the 84 companies chosen from Survey 1, 55 agreed to continue in the study. In addition, a further 7 companies were selected following their identification through a review of supermarket products in Thailand. A total number of 62 companies were used for the remainder of the study.

Of the 62 companies participating in Survey 2, the company distribution is shown in Table 5.2.

Table 5.2 Company ownership distribution for the main survey

Ownership	Number of companies	Fraction of total companies surveyed (%)
Thai private	32	52
Thai public	8	13
Joint venture	12	19
Multinational	10	16
Total	62	100

5.2.2 Company size

According to the criteria used by the National Statistical Office, Thailand (NSO, 1998b), large manufacturing companies including food sector were those employing 100 and over employees. In this study, however, the size of a company was categorised by both annual turnover and number of employees in the survey. The survey results for these criteria are given in (Table 5.3) and (Table 5.4). For comparison, one million baht is equal to US$ 25,000. Most companies had higher than 250 million bahts (US$6 million) of annual turnover and more than 200 employees. Most companies tended to be large in both annual turnover and number of employees (Table 5.5). All companies in this survey had more than 50 employees. According to Table 3.4, about 27% of

manufacturing establishments in Thailand had more than 50 employees. When both number of employees and annual turnover were considered, the participating companies in this current study represented medium to large companies in Thailand.

Table 5.3 Annual turnover of participating companies

Turnover per annum (million bahts)	Number of companies (%)	Company ownership Number of companies, (%)			
		Thai private	Thai public	Joint venture	Multinational
<20	1 (2)	1 (3)	0	0	0
20-50	2 (3)	1 (3)	0	1 (8)	0
51-250	14 (23)	11 (34)	0	2 (17)	1 (10)
251-1,000	19 (31)	10 (31)	2 (25)	5 (42)	2 (20)
>1,000	26 (42)	9 (28)	6 (75)	4 (33)	7 (70)
Total	62 (100)	32 (100)	8 (100)	12 (100)	10 (100)

Table 5.4 Number of employees in participating companies

Number of employees (persons)	Number of companies (%)	Company ownership Number of companies, (%)			
		Thai private	Thai public	Joint venture	Multinational
51-200	16 (26)	9 (28)	1 (13)	2 (17)	4 (40)
201-500	26 (42)	11 (34)	4 (50)	5 (42)	6 (60)
>500	20 (32)	12 (38)	3 (38)	5 (42)	0
Total	62 (100)	32 (100)	8 (100)	12 (100)	10 (100)

Table 5.5 Distribution of number of employees across annual turnover of participating companies

Number of employees (persons)	Annual turnover (million bahts)					Total
	< 20	20-25	51-250	251-1,000	1,000	
51-200	1	1	6	5	3	16
201-500			8	8	10	26
>500		1		6	13	20
Total	1	2	14	19	26	62

5.3 COMPANY HISTORY

The length of time that companies had been in business varied widely in the study (Table 5.6). The majority of companies (70%) had been established and operating for more than 10 years.

Table 5.6 The length of time participating companies had been in business

Time since established in Thailand (years)	Number of companies	Fraction of total companies surveyed (%)
< 5	4	6
6-10	14	23
10-20	22	35
21-30	15	24
>30	7	11
Total	62	100

5.4 DETAILS OF RESPONDENTS FROM FOOD COMPANIES

Most respondents from food companies were between 30 and 40 years old (Table 5.7). Almost all of respondents (97%) held a bachelor or higher degree (Table 5.8). The majority of respondents had educational backgrounds in Food Science or Food Technology (Table 5.9). Three respondents (5%) had an educational background in Product Development.

Table 5.7 Age of respondents in Survey 2

Age (years)	Number of companies	Fraction of total companies surveyed (%)
<30	7	11
30-40	45	73
41-50	9	15
>50	1	2
Total	62	100

Table 5.8 Educational background of respondents in Survey 2

Education	Number of companies	Fraction of total companies surveyed (%)
Bachelor degree	34	55
Master degree	26	42
Others*	2	3
Total	62	100

Note: * Lower than high school (1) and Diploma (1)

Table 5.9 Educational background of respondents in Survey 2

Areas of study	Number of companies	Fraction of total companies surveyed (%)
Science	9	15
Food Science/Food Technology	34	55
Engineering	1	2
Business/Management	7	11
Marketing	2	3
Others*	9	15
Total	62	100

Note: * Product Development (3), Finance (2), Economics (1), Home Economics (1), Medical Microbiology (1), unspecified (1)

Most individual respondents had been working for their current company for more than 5 years (Table 5.10). Respondents had one to four direct reports. Over half of these respondents had positions directly involved in technical product development (Table 5.11).

Table 5.10 Respondents' working period in the current company

Working period (years)	Number of companies	Fraction of total companies surveyed (%)
<1	1	2
1-5	25	40
6-10	22	35
>10	14	23
Total	62	100

Table 5.11 Position of respondents in the company

Position	Number of companies	Fraction of total companies surveyed (%)
Technical product development	34	55
Plant manager	8	13
Production	3	5
Quality control	3	5
Marketing	3	5
Top manager/executive	11	18
Total	62	100

5.5 THE TYPES OF BRANDED CONSUMER FOOD PRODUCTS

The respondents were asked to identify all food product categories they were selling from the list presented in a small card (SHOWCARD 19, APPENDIX 5). They were then asked to list their key brands in each product category and rank each category according to its importance to their overall business.

There were 36% of companies that sold only a single product category. Very few companies sold more than 3 categories (Table 5.12). This indicates a clear focus on a narrow product range of food companies in Thailand.

The sampled companies as a whole covered a very wide range of product categories as shown in Table 5.13. Each product category was sold under various key brands. These product categories were highly significant to the companies.

Table 5.12 Number of food product categories sold by participating companies

Number of product categories per companies	Number of companies	Fraction of total companies surveyed (%)
1	22	36
2	18	29
3	12	19
4	5	8
5	2	3
6	1	2
7	1	2
9	1	2
Total	62	100

Table 5.13 Categories of branded consumer food products sold by participating companies

Product categories	Number of companies (%)	Number of companies							Number of key brands
		Ranks of product categories regarding an importance to companies							
	N = 62 (100)	1	2	3	4	5	6	7	
Beverage	18 (29)	5	11	2					24
Spice, sauce, and seasoning products	18 (29)	6	6	4	1	1			16
Jam, Jelly, and Confectionery products	17 (27)	10	3	2		2			30
Milk and dairy products	15 (24)	8	3	4					21
Fruit and vegetable products	14 (23)	8	4	2					20
Cereal products	11 (18)	6	1	2	2				13
Snack foods	11 (18)	4	2	3	1		1		20
Fishery products	8 (13)	5	3						10
Meat and meat products	8 (13)	1	3	2	2				8
Health foods	8 (13)	3	1	1		1	1	1	9
Bakery products	7 (11)	3	2		1	1			10
Fat and oil products	7 (11)	4	2		1				7
Egg and egg products	4 (6)		2		1	1			3

While the above data represented everything the companies currently sold, each company had introduced new branded consumer food products during the previous three years.

Each was asked to list all new food products introduced during the previous three years with brand name and number of varieties on the separate sheet. The number and categories of these new food products are shown in Table 5.14. Of a total of 581 new branded products, 463 products (80%) introduced were under existing key brands of the companies.

The respondents were also asked to classify these 581 new products into one of the four classifications chosen: ICNP; PNC; VA, and; LE. These results are presented in Table 5.15.

It is important to note that some respondents considered several products covered more than one of the four categories. In particular, 7 ICNPs, 19 PNCs, and 47 LEs were all considered to be VA as well. Thus, there were 73 "additional products" in Table 5.15. Clearly, LE represented the largest proportion of products launched by these companies. However, all categories were included in the survey.

Table 5.14 New branded consumer food product categories in the study

Products	Number of companies	New products introduced	
		Number of products	Key branded products
Beverage	8	29	19
Spice, sauce, and seasoning products	9	41	35
Jam, Jelly, and Confectionery products	17	123	101
Milk and dairy products	11	103	81
Fruit and vegetable products	9	60	38
Cereal products	16	68	58
Snack foods	8	51	40
Fishery products	5	20	16
Meat and meat products	3	44	38
Health foods	6	23	20
Bakery products	3	15	15
Fat and oil products	2	3	1
Egg and egg products	1	1	1
Total	62	581	463

Table 5.15 Types of new food products identified in Survey 2

New product types	Number	Fraction of total new products surveyed (%)
ICNP	61	9
PNC	164	25
VA	166	25
LE	263	40
Total	654	100

Note: ICNP = Innovative Products-Completely New to the Thai Market
PNC = Products-New to Company
VA = Value Added Products
LE = Line Extensions

5.6 MANUFACTURING METHODS FOR NEW PRODUCTS

All participating companies were asked to identify the method that they sourced their new products. The options were imported-ready to sell, own manufacture, contract manufacture, and "other". Of all companies involved in the survey, every company manufactured their own products. In addition, three companies had imported products ready to sell, seven used contract manufactures and one used an alternative source (imported and repacked in Thailand).

All food products new to the Thai market (ICNP) were introduced in the previous three years by manufacture in Thailand, either by the company or a contract manufacturer. All value-added products (VA) were achieved by companies manufacturing for themselves in Thailand. Line extensions and products new to companies (LE and PNC) were obtained from all four sources: imported-ready to sell, own manufacture, contract manufacture, and "other". This other source of obtaining new products was imported and repacked in Thailand (Table 5.16).

Table 5.16 New product sources versus new product types

New product Types	New product sources (Total number of company = 62)			
	Imported-ready to sell (n = 3)	Own manufacture (n = 62)	Contract manufacture (n = 7)	Others* (n = 1)
ICNP	0	24	1	0
PNC	2	32	5	1
VA	0	39	0	0
LE	1	45	2	1

Note: ICNP = Innovative Products-Completely New to the Thai Market
PNC = Products-New to Company
VA = Value Added Products
LE = Line Extensions
* imported and repacked in Thailand

The respondents were then asked to identify where they first found the original data for the new product. Clearly, the only meaningful results are for the "own manufacture" data. It is important to note that respondents were able to select more than one option for new idea generation, if they were unsure. The results are presented in Table 5.17.

For companies that manufactured their own products (own manufacture), the main sources of new product ideas were from their own staff, or products that were seen by staff while travelling overseas, or products seen by staff in Thailand.

There were insufficient data from companies who imported, used contract manufacturers or "other" to reach meaningful conclusions.

Table 5.17 Sources of new product ideas

New product idea sources	Product Sources Frequencies, (%)				Total
	Imported-ready to sell n = 3	Own Manufacture n = 62	Contract Manufacture n = 7	Other n = 1	N = 73
The company thought of the product	1 (33)	43 (69)	3 (43)	0	47 (64)
Saw products overseas	1 (33)	41 (66)	2 (28)	1 (100)	45 (61)
Saw products in Thailand	1 (33)	33 (53)	6 (86)	1 (100)	41 (56)
Customer made requirements	1 (33)	19 (31)	1 (14)	0	21 (29)
A market research company identified the need	0	11 (18)	1 (14)	0	12 (16)
Saw products in magazine	1 (33)	8 (13)	1 (14)	0	10 (14)
Another Thai food company saw the opportunity and offered	1 (33)	7 (11)	0	0	8 (11)
Conferences, trade exhibitions	0	7 (11)	0	0	7 (10)
Others	1 (33)	6 (10)	0	0	7 (10)
Food ingredient suppliers		3			
Food packaging suppliers		1			
Internet		1			
Overseas company	1				
Overseas regulations		1			

5.7 THE IMPACT OF COMPANY OWNERSHIP

Because there were not sufficient data from other methods of obtaining new products for meaningful interpretations and statistical analysis, only those from companies' "own manufacture" were used from now on.

There was little difference among the four types of companies in the type of products that they introduced. Thai public companies tended to favour introducing imitation or "me-too" food products (PNC) whilst foreign-owner-dominated companies were more likely to focus on their product improvements (VA). There was a significant relationship between company ownership and PNC; and VA product types (Table 5.18).

Table 5.18 Company ownership versus new product type

Company ownership	New product types							
	ICNP		PNC		VA		LE	
	Introduced	Not Introduced	Introduced	Not Introduced	Introduced	Not Introduced	Introduced	Not Introduced
Thai private (n = 32)	13	19	16	16	16	16	20	12
Thai public (n = 8)	2	6	8	0	5	3	6	2
Joint venture (n= 12)	4	8	5	7	11	1	11	1
Multinational (n = 10)	5	5	3	7	7	3	8	2
Total	**24**	**38**	**32**	**30**	**39**	**23**	**45**	**17**
Pearson Chi-Square	1.367		9.879 *		6.754 *		4.131	
Likelihood Ratio	1.395		13.006*		7.726 *		4.606	
Contingency Coefficient	0.147		0.371		0.313		0.250	

Note : * $p < 0.05$
ICNP = Innovative Products-Completely New to the Thai Market, PNC = Products-New to Company, VA = Value Added Products, and LE = Line Extensions.

5.8 CONCLUSION

Data for this initial survey was obtained from participating companies which had introduced new branded food products in the Thai market during the previous three years. Participating food companies in this survey predominated in medium to large size and long establishment. They were classified according to business ownership as Thai private own company, public company, joint venture company, and multinational company. Most new food products introduced by these companies were beverage, confectionery, sauces and seasonings, and dairy products. These new products were defined and categorised into four types: ICNP; PNC; VA, and; LE. Four company types were identified and used in the study. These included Thai private, Thai public, Joint venture, and Multinational companies.

New food products were obtained by various means: import, own manufacture, and contract manufacture. In this study, most new products were own manufactured as all companies had their own manufacturing facilities. The results from this study thus mainly represented product development activities of food manufacturers.

6 TECHNICAL KNOWLEDGE SOURCES

6.1 INTRODUCTION

The product development process is a process of new knowledge creation (Nonaka and Takeuchi, 1995; Afuah, 1998; Madhavan and Grover, 1998; Earle and Earle, 2000). In this context, information is a major input of the process. In the product development process, both marketing and technical information are important. Since technology is a key input for the competitive advantage of products in the market, technical information is needed for creating new products. In the rapidly changing consumer market such as that in Thailand, technical knowledge needs to be well integrated for successful production of foods to best meet consumers' demand. Therefore, it is interesting to investigate how the food industry in Thailand obtains its technical knowledge to support its product development activities.

In this chapter, the main technical information sources for food product development of the food companies in Thailand are compiled. As mentioned in Chapter 5, only data from own manufactured products were sufficient for interpretation and statistical analysis. Other methods of obtaining new products will be excluded in this chapter.

6.2 TECHNICAL INFORMATION FOR NEW FOOD PRODUCTS

6.2.1 Technical information used for new food products

Respondents were asked to identify what technical information was used for their new food product introductions. Technical information was mainly used to support food formulations, shelf life studies, quality control and food processing (Table 6.1).

Table 6.1 Uses of technical information in Thai food companies

Types of technical information	Number of companies N = 62 (%)
Food formulations	55 (89)
Food shelf life studies	46 (74)
Food quality control	44 (71)
Food processing	47 (76)
Food packaging	38 (61)
Food labelling	33 (53)
Food sanitation	20 (32)
Others	3 (5)

Note: Others: Product promotion (2) and Cost reduction (1)

6.2.2 Sources of technical knowledge for product development

The sources of technical information for new food products are summarised in Table 6.2. Respondents were asked to identify every information source they had used in the previous three years to introduce their new products. The main technical information sources were company technical staff and food ingredient suppliers. Other significant sources used were food packaging suppliers, food processing equipment suppliers, libraries, consultants, food manufacturers, universities, and research institutes.

Table 6.2 Technical knowledge sources for new food product introduction

Technical Knowledge Source	Number of companies N = 62 (%)
Technical staff	61 (98)
Food ingredient suppliers	45 (73)
Food packaging suppliers	25 (40)
Local libraries	23 (39)
Food processing equipment suppliers	22 (35)
Thai consultants	15 (24)
Food manufacturers in Thailand	9 (15)
Companies' libraries	13 (21)
Thai universities	12 (19)
Overseas food manufacturers	10 (16)
Overseas consultants	7 (11)
Thai research institutes	4 (6)
Overseas universities	2 (3)
Others	18 (29)
Overseas joint venture companies	7
Parent companies	6
Internet	2
Company's handbook	1
Text book	1
Seminar	1

Thai owned companies and public companies tended to use a wider range of knowledge sources compared to joint venture and multinational company (Table 6.3). However, there was no significant association between company ownership and use of technical knowledge source ($p > 0.05$) (see Chi-Square test in APPENDIX 12).

Because company ownership was not a factor in the sourcing of technical knowledge in Thailand, it was excluded from further consideration in analysing the data.

Table 6.3 Technical knowledge sources versus company ownership

Technical knowledge sources	Company ownership				
	Thai private No. (%)	Thai public No. (%)	Joint venture No. (%)	Multinational No. (%)	Total No. of companies (%)
Technical staff	31 (97)	8 (100)	12 (100)	10 (100)	61 (98)
Food ingredient suppliers	22 (69)	7 (88)	11 (92)	5 (50)	45 (73)
Food packaging suppliers	13 (41)	6 (75)	2 (17)	4 (40)	25 (40)
Local libraries	12 (38)	5 (63)	3 (25)	3 (30)	23 (37)
Food processing equipment suppliers	11 (34)	5 (63)	4 (33)	2 (20)	22 (36)
Thai consultants *	11 (34)	4 (50)	0	0	15 (24)
Companies libraries	6 (19)	3 (38)	2 (17)	2 (20)	13 (21)
Thai universities	5 (16)	3 (38)	2 (17)	2 (20)	12 (19)
Overseas food manufacturers	5 (16)	3 (38)	1 (8)	1 (10)	10 (16)
Food manufacturers in Thailand	4 (13)	2 (25)	2 (17)	1 (10)	9 (15)
Overseas consultants	4 (13)	0	1 (8)	2 (20)	7 (11)
Thai research institutes	2 (6.3)	2 (25.0)	0	0	4 (7)
Overseas universities	2 (6)	0	0	0	2 (3)
Others *	3[a] (9)	2[b] (25)	6 [c] (50)	7 [d] (70)	18 (29)
Number of company	32 (100)	8 (100)	12 (100)	10 (100)	62 (100)

Note: * Significant association indicated by Chi-Square test ($p < 0.05$)
a = internet (1), textbooks (1), and seminar (1); b = internet (1) and overseas shareholding company (1);
c = overseas joint venture companies (6); d = parent companies (6) and company's handbook (1)

6.2.2.1 The main technical sources

Technical staff were the main internal technical knowledge source for manufacturing food companies. Of 62 participating companies, 60 companies (97%) had their own product development technical staff (Table 6.4). Of these 60 companies, 54 companies (90%) had their own research and development laboratories and 19 companies (32%) had their own pilot plant facilities. These staff updated their technical knowledge by attending seminars both in Thailand (57 companies, 95%) and overseas (27 companies, 45%). Overseas seminars attended were mostly in Singapore (13 companies), Japan (9 companies), Germany (6 companies), and the USA (5 companies). Other countries included France (3), the Philippines (3), Switzerland (3), Australia (2), Italy (2), Malaysia (2), Taiwan (2), UK (2), Belgium (1), Canada (1), Dubai (1), Hong Kong (1), Netherlands (1), and Sweden (1).

Table 6.4 Number of product development technical staff of food manufacturing companies

Number	Number of companies	Fraction of total companies surveyed (%)
0	2	3
1-2	11	18
3-5	35	56
>5	14	23
Total	62	100

In addition, respondents from 60 companies with product development technical staff were asked about their expectations from a seminar. Most companies expected new technical knowledge and information which could be applied to their new product development. Other expectations from seminars were to gain new product ideas, to share their knowledge and experiences with others, to have new contacts for future linkages and to improve their knowledge (Table 6.5).

Table 6.5 Expectations of food companies from seminars

Expectations	Number of companies N = 60	Fraction of companies (%)
To gain new technical knowledge	29	48
To gain knowledge to improve and develop products	17	28
To gain new product ideas	9	15
To share experiences and knowledge with others in the same area	9	15
To make contacts with others	8	13
To encourage staffs to improve their abilities	2	3

Of the 60 companies with product development technical staff, 18 companies also provided information on technical training providers (Table 6.6). Most companies gained training mainly through food ingredient suppliers, their own companies, and food processing equipment suppliers.

Information provided by 28 R&D managers indicated that 16 companies (57%) had product development sections working independently under top management. Of 62 companies, most companies had product development marketing staff (82%) but not many of them (27%) had sales staff involved in new product development activities (Table 6.7 and Table 6.8).

Table 6.6 Training sources for technical staff

Training sources	Number of companies[1] N = 18	Fraction of companies (%)
Food ingredient suppliers	15	83
Own companies	13	72
Food processing equipment suppliers	9	50
Food science and technology associations	7	39
Science and technology research institutes	7	39
Universities	6	33
Food packaging suppliers	5	28
Others[2]	2	11

Note: [1] Information in this table was provided by 18 out of 60 companies with technical staff.
[2] Consultants (1), Overseas joint venture company (1)

Table 6.7 Product development marketing staff of food manufacturing companies

Number (persons)	Number of companies	Fraction of total companies surveyed (%)
0	11	18
1-2	17	27
3-5	15	24
>5	19	31
Total	62	100

Table 6.8 Product development sales staff of food manufacturing companies

Number (persons)	Number of companies	Fraction of total companies surveyed (%)
0	45	73
1-2	5	8
3-5	3	5
>5	9	15
Total	62	100

6.2.2.2 Suppliers and other external sources

Suppliers were identified as the most important external sources of technical information for new food product development in Thailand. These were food ingredient, food processing equipment and packaging suppliers. Food ingredient suppliers were the most important.

Of 62 participating companies, 43 companies regarded food ingredient suppliers as important to their new products as a whole. They were asked to identify specific types of food ingredient suppliers who provided technical information. Most of these food ingredient suppliers were selling flavours, stabilisers, and starches (Table 6.9).

Only a few companies (5 of 62 companies) used consultants as the most important information source for new food products.

Universities, research institutes and libraries were used but they were not rated as important for new food products. Amongst these three sources, libraries, either outside or inside company, were mostly used. Thai universities were used more often than overseas universities. Few companies used Thai research institutes (Table 6.3).

Table 6.9 Types of food ingredient suppliers providing technical information

Types of food ingredient suppliers	Number of participating food companies (%) N = 43 (100)
Flavours	31 (72)
Stabilisers	12 (28)
Starches	9 (21)
Seasonings	7 (16)
Emulsifiers	5 (12)
Colouring agents	3 (7)
Protein isolated	3 (7)
Pectins	3 (7)
Carageenans	2 (5)
Calcium salts	2 (5)
Gelatine	2 (5)
Gums	2 (5)
Vitamins	2 (5)
Binding agents	1 (2)
Clouding agents	1 (2)
Antioxidants	1 (2)
Sweeteners	1 (2)

6.2.3 Advantages and disadvantages of technical knowledge sources

Using their answers from technical knowledge sources listed in Table 6.3, each respondent was then asked to choose the three most important technical information sources for their company. They were asked to describe the advantages and disadvantages of these groups. Table 6.10 summarises the results of all companies. More details are provided in APPENDIX 13.

Technical staff were experienced and skilful with in-house technology and products. These staff were fast and convenient. In addition, product confidentiality could be kept. However, these technical staff had some limitations in keeping up-to-date with new and advanced knowledge. It was time consuming to rely on technical staff for innovative products. They had limitations with creativity and innovative ideas and their turnover was high.

Food ingredient suppliers could provide information that companies were looking for. It was also fast to obtain, was quite varied, accurate, and reliable. However, technical information from ingredient suppliers was limited by the knowledge and understanding of the suppliers in the process of food manufacture. Information from food ingredient

suppliers needed modification to be successfully implemented. These advantages and disadvantages were similar when technical information from food equipment and packaging suppliers was used (APPENDIX 13).

Thai consultants mainly provided additional knowledge and ideas but they had some limitations in working hours and practical knowledge. Their high cost was also claimed as one drawback for both Thai and overseas consultants. A communication barrier (language) was another disadvantage in using overseas consultants.

Universities were regarded as a good knowledge guide and a reliable source but the information obtained was usually not compatible with the company's processing function. The Thai research institutes were reliable but costly. Local libraries provided a wide variety and reliability of information but information needed was hard to search, not updated and inconvenient. Companies' libraries were ready to use and provided adequate information needed but difficult to understand because it was usually in a foreign language.

Table 6.10 Advantages and disadvantages of main technical knowledge sources

Knowledge sources	Advantages	Number	Disadvantages	Number
Technical staff		(n = 47)		(n = 45)
	Experienced and skilful in in-house technology and products	23	Limit of new and advanced knowledge	34
	Fast	12	Take time for trial and error for innovative products	4
	Convenient/Simple	7	High turnover of staff	3
	Keep confidential	6	Little creative and limit of innovative knowledge	3
Food ingredient suppliers		(n = 39)		(n = 39)
	Fast and time saving	10	Limit of understanding of the process of users	13
	Supply technical information needed for new products	14	Unreliable	9
	Variety of knowledge	4	Not completely applicable or ready to use/ Suggestions don't match the process of users/ Inaccurate	8
	Accurate and reliable	3	Time consuming for applying to company's products	5
	Provide and suggest new ideas applied to company's products	3	Time consuming waiting for information needed	2
Thai consultants		(n = 8)		(n = 8)
	Provide additional knowledge	3	Limit of working time	4
	Keep confidentiality	1	Limit of advanced knowledge	2
	All information of company can be disclosed to consultant	1	Not much practical	2
	Fast	1	High cost	2
	Provide new ideas	1		
	Experienced	1		
	Provide general ideas	1		
	Useful for very innovative products	1		
Thai universities		(n = 1)		(n = 1)
	Suggest knowledge sources	1	Suggestion was not compatible with company's process	1
Thai research institutes		(n = 1)		(n = 1)
	Reliable	1	High cost	1
Local libraries		(n = 9)		(n = 11)
	Provide wide variety of information	3	Time consuming	6
	Provide principle knowledge	2	Hardly find information needed	5
	Provide good references	2	Information is not updated	4
	Convenient	1	Not convenient	2
	Reliable	1		
Companies' libraries		(n = 1)		(n = 1)
	Ready to use	1	Language barriers	1
	Enough good and new References	1		
	Reliable	1		

Note: n = number of companies providing information

6.2.4 Degree of product newness and technical knowledge sources

Following the discussion on advantages/disadvantages of the three most important technical information sources, each respondent was then asked to select the single most important information source for each new product type. The results are shown in Table 6.11. Thai universities, Thai research institutes, local libraries and overseas universities were not recognised as important sources for any new product type. It appeared that company technical staff and food ingredient suppliers remained the two major important sources but their degree of use tended to vary across new product types. There were no significant associations among the type of company, the most important technical knowledge sources, and new product types ($p > 0.05$). For details on this statistical analysis, see APPENDIX 14.

Table 6.11 The most important technical knowledge sources for the Thai food industry

New product types	Technical knowledge sources	Company ownership							
		Thai private		Thai public		Joint venture		Multinational	
		3IS	MIS	3IS	MIS	3IS	MIS	3IS	MIS
ICNP	Technical staff	12	7	2	0	4	1	5	4
	Food ingredient suppliers	7	0	1	0	2	0	3	0
	Food processing equipment suppliers	2	1			2	1		
	Food packaging suppliers			1	0				
	Food manufacturers in Thailand	1	0						
	Overseas food manufacturers			1	1				
	Thai consultants	6	3						
	Thai universities	1	0						
	Thai research institutes	1	0						
	Local libraries	2	0			1	0	2	0
	Companies' libraries	2	1						
	Overseas consultants	1	1					1	0
	Overseas universities								
	Others	1	0	1	1	3	2	3	1
	Number of companies (n)	13	13	2	2	4	4	5	5
PNC	Technical staff	14	9	8	3	5	5	3	2
	Food ingredient suppliers	10	2	5	0	3	0	2	0
	Food processing equipment suppliers	4	1	3	2	2	0		
	Food packaging suppliers	2	0	1	0			1	0
	Food manufacturers in Thailand	3	1	1	1				
	Overseas food manufacturers	1	0	1	1				
	Thai consultants	3	1	1	0				
	Thai universities	1	0			1	0		
	Thai research institutes								
	Local libraries	1	0						
	Companies' libraries	3	1						
	Overseas consultants	1	1			1	0		
	Overseas universities								
	Others	1	0	2	1			2	1
	Number of companies (n)	16	16	8	8	5	5	3	3

Table 6.11 *(Continued)*

New product types	Technical knowledge sources	Company ownership							
		Thai private		Thai public		Joint venture		Multinational	
		3IS	MIS	3IS	MIS	3IS	MIS	3IS	MIS
VA	Technical staff	16	11	5	4	11	8	7	4
	Food ingredient suppliers	7	2	2	0	7	2	2	1
	Food processing equipment suppliers			2	1	4	0	1	0
	Food packaging suppliers	2	1	1	0			2	1
	Food manufacturers in Thailand							1	0
	Overseas food manufacturers	1	0						
	Thai consultants	3	1						
	Thai universities							1	0
	Thai research institutes	1	0						
	Local libraries	2	0						
	Companies' libraries	1	0	1	0	1	0		
	Overseas consultants	1	1						
	Overseas universities								
	Others			1	0	6	1	4	1
	Number of companies (n)	16	16	5	5	11	11	7	7
LE	Technical staff	20	13	6	4	11	10	8	7
	Food ingredient suppliers	10	4	3	1	7	1	4	1
	Food processing equipment suppliers	3	0	3	1	3	0		
	Food packaging suppliers	2	0	1	0			1	0
	Food manufacturers in Thailand	1	0						
	Overseas food manufacturers	2	0	1	0	1	0		
	Thai consultants	4	1	1	0				
	Thai universities								
	Thai research institutes			2	0				
	Local libraries	3	0	1	0			1	0
	Companies' libraries	1	1			1	0		
	Overseas consultants	2	1						
	Overseas universities								
	Others	1	0			5	0	4	0
	Number of companies (n)	20	20	6	6	11	11	8	8

Note: 3IS = Compiled by combining each respondent's answer to the three most important sources
MIS = Compiled by combining each respondent's single most important source
ICNP = Innovative Products-Completely New to the Thai Market
PNC = Products-New to Company
VA = Value Added Products
LE = Line Extensions

Because the use of technical knowledge source for all new product types was not significantly associated with company ownership, data could be combined across company ownership. The data were then assessed by comparing product type and technical knowledge source, as shown in (Table 6.12). In this instance, there are significant differences in the table ($p < 0.05$).

Table 6.12 The most important technical knowledge sources for each type of new product introduction

Technical knowledge sources	New product types				
	ICNP	PNC	VA	LE	Total
Technical staff	12	19	27	34	92
Food ingredient suppliers	0	2	5	7	14
Food processing equipment suppliers	2	3	1	1	7
Food packaging suppliers	0	0	2	0	2
Food manufacturers in Thailand	0	2	0	0	2
Overseas food manufacturers	1	1	0	0	2
Thai consultants	3	1	1	1	6
Companies' libraries	1	1	0	1	3
Overseas consultants	1	1	1	1	4
Others	4	2	2	0	8
Total	24	32	39	45	140
Pearson Chi-Square = 38.245, Likelihood Ratio = 40.572, $p < 0.05$ Contingency Coefficient = 0.463					

Note: ICNP = Innovative Products-Completely New to the Thai Market
PNC = Products-New to Company
VA = Value Added Products
LE = Line Extensions
Others = parent companies, overseas joint venture companies, and internet

By comparing each product type to each other, the following statistical results were obtained:

- ICNP and PNC were the same
- VA and LE were the same
- ICNP and PNC were significantly different to VA and LE

Details can be seen in APPENDIX 15. Thus for further analysis, ICNP and PNC data were combined, as were the data for VA and LE. These new categories of products were termed "Radically Innovative Products" and "Incrementally Innovative Products", respectively. The combined data are shown in Table 6.13.

Table 6.13 Combined new product types versus technical knowledge sources

Technical knowledge sources	New product types		
	Radically innovative products (ICNP, PNC)	Incrementally innovative products (VA, LE)	Total
Technical staff	31	61	92
Food ingredient suppliers	2	12	14
Food processing equipment suppliers	5	2	7
Food packaging suppliers	0	2	2
Food manufacturers in Thailand	2	0	2
Overseas food manufacturers	2	0	2
Thai consultants	4	2	6
Companies' libraries	2	1	3
Overseas consultants	2	2	4
Others	6	2	8
Total	56	84	140
Pearson Chi-Square = 22.512, Likelihood Ratio = 22.009, $p < 0.05$ Contingency Coefficient = 0.372			

Note: ICNP = Innovative Products-Completely New to the Thai Market
PNC = Products-New to Company
VA = Value Added Products
LE = Line Extensions
Others = Parent companies, Overseas joint venture companies, and Internet

An anomaly in the data became apparent in this table. The data represent the single most important knowledge source for a company, but this was identified on a product type basis. Thus, it was possible for one company to have more than one "most important knowledge source" when these data were combined. Hence, the frequencies in Table 6.13 were greater than the number of companies in the survey. To correct this discrepancy, frequencies were changed to "companies", such that each company had only one entry per technical knowledge source as shown in Table 6.14.

Clearly, company technical staff remained the major sources of both new product categories. Nevertheless, some external sources were also significant to each new product type. Whilst food ingredient suppliers were mainly involved with companies' incrementally innovative products, food processing equipment suppliers and consultants were used more frequently for radically innovative products.

Table 6.14 Technical knowledge sources for different levels of product newness

Technical knowledge sources	New product types[1]			
	Radically innovative products[2]		Incrementally innovative products[3]	
	Frequencies	Number of companies (%)	Frequencies	Number of companies (%)
Technical staff	31	27 (60)	61	43 (78)
Food ingredient suppliers	2	2 (4)	12	12 (22)
Food processing equipment suppliers	5	5 (11)	2	1 (2)
Food packaging suppliers	0	0	2	2 (4)
Food manufacturers in Thailand	2	2 (4)	0	0
Overseas food manufacturers	2	1 (2)	0	0
Thai consultants	4	3 (7)	2	1 (2)
Companies' libraries	2	1 (2)	1	1 (2)
Overseas consultants	2	2 (4)	2	1 (2)
Others	6	[4]4 (9)	2	[5]2 (4)
Total	56	45 (100)	84	55 (100)

[1] Food companies identified these sources as their single most important to each new product type.
[2] Totally new products to the company or Thailand (ICNP and PNC)
[3] Value added products and line extensions (VA and LE)
[4] Overseas joint venture companies (2), Parent company (1), and Internet (1)
[5] Parent company (1) and Overseas joint venture company (1)

6.3 CONCLUSION

It was quite obvious that most food companies in Thailand relied heavily on internal technical resources. Technical staff were the main technical knowledge source. During early stage of product development, new product ideas were mostly from companies' own staff and products seen in the market. Technical information was mainly used in product design and process development stage for food formulations, shelf life studies, quality control, and food processing.

Type of company had no impact on technical information used. However, there was a significant association between new product type and technical information source. Where there was a need for a technological advance (e.g. introducing a new process or equipment) as might be the case for radical innovation, external technical sources such as equipment suppliers and consultants became much more important. Food ingredient suppliers were the main external information source when new food products were incrementally innovative.

Notwithstanding their significant role in food product development, technical staff had limitations in keeping aware of new and advanced knowledge. They mostly received new and advanced knowledge through seminar and training courses provided mainly by food ingredient suppliers. This again emphasised the important role of food ingredient suppliers in providing not only technical information directly relevant to new food product development but also updated information to technical product development staff.

This survey on food processing companies was limited by small sample size. Although over one half of respondents who provided information in this survey were technical product development staff, inaccurate and biased answers could not be avoided. To reduce these errors as much as possible, the views of technical providers identified in this survey were used to verify the results as presented in the next chapter.

7 TECHNICAL KNOWLEDGE PROVIDERS

7.1 INTRODUCTION

From Chapter 6, key external knowledge sources were identified by food processing companies. In this chapter, the types of technical information and services provided by these sources were evaluated to verify the consistency of the results.

7.2 TECHNICAL KNOWLEDGE PROVIDERS AND THEIR ACTIVITIES

The key providers of technical knowledge were defined by food company staff, as outlined in Table 6.14. These providers were identified from various sources. To obtain information from those main companies, however, most participants were identified during interviews. The respondents were asked to identify their companies' main competitors. Apparently, most of main ingredient suppliers were not in the official publication. They were contacted and included in this current study.

Forty three participants took part in this survey. They were asked to identify their activities for the Thai food industry using the questionnaire in APPENDIX 8. The results are summarised in Table 7.1.

Table 7.1 Activities performed for the Thai food industry by technical knowledge providers

Activities	Total number of companies/ organisations identified from literature	Participating companies in the survey		
		Number of companies/ organisations from literature (% of total number)	Number of participating companies/ organisations identified during interviews	Total number of participating companies (%) N= 43 (100)
Food ingredient suppliers	43 [1]	5 (12)	18	23 (53)
Food processing equipment suppliers	106 [1]	4 (1)	1	5 (12)
Food packaging suppliers	100 [1]	4 (4)	2	6 (14)
Consultants	N/A	11	-	11 (26)
Universities	17 [2]	6 (35)	-	6 (14)
Research institutes	3 [3]	3 (100)	1	4 (9)
Others [4]	N/A	5	-	5 (12)

Note: [1] The number was identified from Kompass International (Thailand) Co., Ltd. (1998). There were 23 companies performing both food processing equipment suppliers and packaging suppliers.

[2] MUA (1998)

[3] Bhumiratana et al. (1992)

[4] teaching, plant construction, technology supplier, food analysis, and training

N/A = not available

The food ingredient suppliers represented the majority in this survey (53%) as these companies were considered the most important external technical information providers by the food industry (Table 6.14). The most numerous companies in this group identified in the official publication were suppliers of flavouring/colouring agents and starch suppliers (Table 7.2). This was reflected in the sample taken for this survey and consistent with information provided by the food industry in Chapter 6 (Table 6.9).

Six main universities providing food technology courses were interviewed. Four of these universities interviewed were located in Bangkok, another was in the North and the final one was in the North East of Thailand. Four main food research institutes and three individual consultants who were academic staff also participated the survey.

Table 7.2 Food ingredient suppliers participating the survey

Ingredients supplied	Number of companies from official publication [1] (%) N = 43 (100)	Number of participating companies (%) N = 23 (100)
Flavouring/colouring agents	29 (67)	17 (74)
Starches/Modified starches	16 (37)	8 (35)
Spices/Seasonings	2 (5)	9 (39)
Stabiliser/Emulsifiers/Binding agents	3 (7)	8 (35)
Antioxidants/Preservatives	3 (7)	6 (26)
Micronutrients/Vitamins/Functional foods	2 (5)	6 (26)
Sweeteners	0	2 (9)

Note: [1] Kompass International (Thailand) Co., Ltd. (1998)

7.3 TYPES OF TECHNICAL INFORMATION PROVIDED TO THE FOOD MANUFACTURING AND PROCESSING INDUSTRY

The key information requested by the food industry and that provided by the technical knowledge providers are shown in Table 7.3.

Table 7.3 has been arranged to rank in descending order of the most frequently provided technical information from all companies and organisations interviewed (i.e. column A). Clearly, the results were heavily influenced by the ingredient suppliers, who had the highest frequency of sampling. The shaded boxes identify all technical resources provided to the food manufacturing and processing companies where the frequency exceeds 50% of all technical knowledge providers in the category.

There were few data for consultants, universities and research institutes. However, the frequency distributions were identical for each of these groups and the three categories were combined in the last column of Table 7.3.

Food ingredient suppliers often provided food ingredient specifications and product formulation datasheets or food recipes. Food processing equipment suppliers and food packaging suppliers usually provided equipment manuals and packaging manuals. Consultants, universities and research institutes most often provided copies of journal articles. All consultants were either from a university or a research institute. Most technical information types requested by the food industry were those provided by these technical knowledge providers.

Table 7.3 Technical information types provided by technical knowledge providers and requested by food industry in Thailand

Technical information	Technical knowledge providers Number, (%)																			
	Total				Food ingredient suppliers				Food processing equipment suppliers				Food packaging suppliers				Consultants, Universities and Research institutes			
	Provide		Ask for		Provide		Ask for		Provide		Ask for		Provide		Ask for		Provide		Ask for	
	A Freq.	B Occ.	C Freq.	D Occ.	E Freq.	F Occ.	G Freq.	H Occ.	I Freq.	J Occ.	K Freq.	L Occ.	M Freq.	N Occ.	O Freq.	P Occ.	Q Freq.	R Occ.	S Freq.	T Occ.
Ingredient specifications (datasheets)	19 (44)	8 (19)	21 (49)	9 (21)	18 (78)	4 (17)	20 (87)	3 (13)	0	1 (20)	0	3 (60)	0	1 (17)	0	2 (33)	1 (8)	4 (31)	1 (8)	4 (31)
Product formulation datasheets (recipes)	16 (37)	18 (42)	16 (37)	19 (44)	13 (57)	9 (39)	14 (61)	8 (35)	0	4 (80)	0	4 (80)	0	3 (50)	0	3 (50)	3 (23)	6 (46)	2 (15)	8 (62)
Own produced technical sheets/journals/reports	11 (26)	16 (37)	10 (23)	19 (44)	4 (17)	12 (52)	3 (13)	14 (61)	2 (40)	1 (20)	2 (40)	0	2 (33)	0	1 (17)	1 (17)	4 (31)	3 (23)	5 (38)	4 (31)
Copies of journal articles	9 (21)	15 (35)	10 (23)	14 (33)	2 (9)	10 (43)	1 (4)	12 (52)	1 (20)	1 (20)	2 (40)	0	0	1 (17)	1 (17)	0	6 (46)	4 (31)	7 (54)	2 (15)
Equipment manuals and techniques for use	8 (19)	14 (33)	7 (16)	20 (47)	2 (9)	6 (26)	2 (9)	11 (48)	5 (100)	0	4 (80)	0	5 (83)	0	3 (50)	1 (17)	0	8 (62)	2 (15)	8 (62)
Packaging manuals	6 (14)	3 (7)	3 (7)	11 (26)	2 (9)	2 (9)	1 (4)	8 (35)	4 (80)	0	3 (60)	1 (20)	4 (67)	0	3 (50)	1 (17)	0	1 (8)	0	1 (8)
Other	1 (2)	3 (7)	2 (5)	3 (7)	0	1 (4)	1 (4)	2 (9)	0	0	0	0	1 (17)	0	1 (17)	0	0	2 (15)	0	1 (8)
N	43 (100)				23 (100)				5 (100)				6 (100)				13 (100)			

Note: Freq. = Frequently; Occ. = Occasionally

Some companies and institutions performed more than one activity:

One company performed three activities (food ingredient suppliers, food processing equipment suppliers, food packaging suppliers);

Two companies performed two activities (food processing equipment suppliers, food packaging suppliers);

Five institutions performed university and consultancy;

Two institutions performed research institute and consultancy;

One institution performed research institute, university and consultancy.

7.4 TYPES OF TECHNICAL SERVICE PROVIDED TO THE FOOD MANUFACTURING AND PROCESSING INDUSTRY

Frequently provided technical services as defined by technical knowledge providers interviewed are shown in Table 7.4. As before, the table has been structured to rank in descending order of the most frequently provided services from all companies and organisations interviewed (i.e. column A). The shaded boxes identify all technical services provided to the food industry where the frequency exceeds 50% of all technical knowledge providers in the category.

The most common technical services provided to the food industry in Thailand were consultancy, product testing and analysis. Consultancy was mainly provided by food packaging suppliers, food processing equipment suppliers, consultants, universities, and research institutes. Services in product testing and analysis were mostly provided by consultants, universities and research institutes.

Table 7.4 Types technical service provided by technical knowledge providers and requested by food industry in Thailand

Technical services	Technical knowledge providers Number, (%)																			
	Total				Food ingredient suppliers				Food processing equipment suppliers				Food packaging suppliers				Consultants, Universities and Research institutes			
	Provide		Ask for		Provide		Ask for		Provide		Ask for		Provide		Ask for		Provide		Ask for	
	A Freq.	B Occ.	C Freq.	D Occ.	E Freq.	F Occ.	G Freq.	H Occ.	I Freq.	J Occ.	K Freq.	L Occ.	M Freq.	N Occ.	O Freq.	P Occ.	Q Freq.	R Occ.	S Freq.	T Occ.
Consultancy	20 (47)	16 (37)	25 (58)	13 (30)	9 (39)	8 (35)	11 (48)	8 (35)	4 (80)	1 (20)	3 (60)	2 (40)	5 (83)	1 (17)	4 (67)	1 (17)	7 (54)	6 (46)	9 (69)	4 (31)
Product testing/analysis	19 (44)	9 (21)	17 (40)	21 (49)	8 (35)	5 (22)	6 (26)	16 (70)	1 (20)	1 (20)	0	3 (60)	1 (17)	1 (17)	1 (17)	2 (33)	9 (69)	3 (23)	10 (77)	3 (23)
Product formulation trials	10 (23)	21 (49)	13 (30)	22 (51)	8 (35)	10 (43)	8 (35)	14 (61)	1 (20)	2 (40)	1 (20)	3 (60)	1 (17)	2 (33)	1 (17)	2 (33)	1 (8)	8 (62)	4 (31)	6 (46)
Joint Research and Development project	8 (19)	18 (42)	3 (7)	22 (51)	4 (17)	9 (39)	1 (4)	13 (57)	0	1 (20)	0	1 (20)	1 (17)	0	1 (17)	0	3 (23)	8 (62)	1 (8)	8 (62)
Seminars	8 (19)	25 (58)	7 (16)	21 (49)	2 (9)	12 (52)	1 (4)	13 (57)	1 (20)	3 (60)	0	5 (100)	1 (17)	3 (50)	1 (17)	3 (50)	4 (31)	9 (69)	5 (38)	4 (31)
Workshops	7 (16)	20 (47)	7 (16)	23 (53)	2 (9)	11 (48)	2 (9)	14 (61)	0	0	0	2 (40)	0	0	1 (17)	2 (33)	4 (31)	9 (69)	4 (31)	8 (62)
Pilot plant scale facilities	5 (12)	18 (42)	9 (21)	16 (37)	2 (9)	6 (26)	3 (13)	6 (26)	1 (20)	3 (60)	1 (20)	3 (60)	1 (17)	1 (17)	2 (33)	2 (33)	2 (15)	9 (69)	4 (31)	6 (46)
Others	0	2 (5)	3 (7)	1 (2)	0	1 (4)	0	0	0	0	0	0	0	0	2 (33)	0	0	1 (8)	1 (8)	1 (8)
N	43 (100)				23 (100)				5 (100)				6 (100)				13 (100)			

Note: Freq. = Frequently; Occ. = Occasionally

Some companies and institutions performed more than one activity:

One company performed three activities (food ingredient suppliers, food processing equipment suppliers, food packaging suppliers);

Two companies performed two activities (food processing equipment suppliers, food packaging suppliers);

Five institutions performed university and consultancy;

Two institutions performed research institute and consultancy;

One institution performed research institute, university and consultancy.

7.5 CONTACT NETWORKS IN THE FOOD INDUSTRY

Not all knowledge providers interact directly with product development staff in food companies. Many of these providers, although providing technical information, are not providing product development information.

To assess the network linkages, technical knowledge providers were asked to identify their key clients in the food companies. The results are summarised in Table 7.5. The table has been ranked in descending order of the persons most frequently contacted by all companies and organisations interviewed (i.e. column A). The shaded boxes indicate contact points where the frequency exceeds 50% of all technical knowledge providers in the category.

The major points of contact within companies were the technical product development staff, technical managers and purchasing staff. Technical product development staff were mostly contacted by food ingredient suppliers. Due to the heavy reliance by companies on their own technical staff for product innovation, this result therefore indicated that food ingredient suppliers were strongly involved in new product development activities of the food companies.

Most food processing equipment and packaging suppliers contacted top management or technical manager. This would be because most equipment and packaging are involved with high investment on which decisions are usually made by top management. Processing equipment and packaging are usually under responsibility of production managers or technical managers who deal with technical problems. Thus, these contacts tended to aim at business purposes or technical problems rather than being directly involved in new product development activities.

Consultants, universities and research institutes mostly contacted Q.C. staff. Although they often provided consultancy and product testing to the food companies, these were more likely to deal with technical problems in the production system.

Table 7.5 Frequently contacted persons in food companies

Contact Persons	A Total (%)	B Food ingredient suppliers	C Food processing equipment suppliers	D Food packaging suppliers	E Consultants, Universities and Research institutes
Technical product development staff	25 (58)	20 (87)	1 (20)	1 (17)	4 (31)
Technical manager	21 (49)	12 (52)	3 (60)	3 (50)	4 (31)
Purchasing staff	21 (49)	20 (87)	2 (40)	1 (17)	0
Technical Q.C. staff	16 (37)	6 (26)	1 (20)	2 (33)	7 (54)
Production manager	13 (30)	5 (22)	2 (40)	3 (50)	3 (23)
Chief executive officer	12 (28)	3 (13)	3 (60)	2 (33)	6 (46)
Marketing/sales manager	2 (5)	1 (4)	0	1 (17)	0
Marketing/sales staff	2 (5)	1 (4)	0	1 (17)	0
N	43 (100)	23 (100)	5 (100)	6 (100)	13 (100)

Note: Some companies and institutions performed more than one activity:
One company performed three activities (food ingredient suppliers, food processing equipment suppliers, food packaging suppliers);
Two companies performed two activities (food processing equipment suppliers, food packaging suppliers);
Five institutions performed university and consultancy;
Two institutions performed research institute and consultancy;
One institution performed research institute, university and consultancy.

7.6 SOURCES OF TECHNICAL INFORMATION FOR TECHNICAL KNOWLEDGE PROVIDERS

While these companies were key providers of technical information to the food manufacturing and processing industry, it was important to identify where these companies obtained their technical resources. The most common sources of technical information are given in Table 7.6. Once again, the table has been ranked in descendent order of the frequencies of technical information sources used by all companies and organisations interviewed (i.e. column A) and shaded boxes highlight frequencies greater than 50% of companies in those categories. Seminars, magazines/journals, conferences, own database, trade shows, suppliers/producers, own R&D staff, own libraries and universities were the main technical information sources for these

technical information providers. Parent companies were another major technical information source for food ingredient, food processing equipment and food packaging suppliers as these tended to be multinational.

Technical knowledge providers were also asked to provide information on their technical staff. Of 23 food ingredient suppliers surveyed, 20 companies (87%) had food technologists providing technical assistances to the food industry.

Table 7.6 Sources of technical information used by technical knowledge providers

Technical Information Sources	A Total (%)	B Food ingredient suppliers (%)	C Food processing equipment suppliers (%)	D Food packaging suppliers (%)	E Consultants, Universities and Research institutes (%)
Seminars	34 (79)	18 (78)	3 (60)	3 (50)	13 (100)
Magazines/Journals	32 (74)	17 (74)	3 (60)	2 (33)	13 (100)
Conferences	31 (72)	16 (70)	2 (40)	2 (33)	13 (100)
Own database	30 (70)	15 (65)	4 (80)	4 (67)	9 (69)
Trade shows	29 (67)	14 (61)	3 (60)	4 (67)	11 (85)
Suppliers/producers	28 (65)	15 (65)	3 (60)	4 (67)	9 (69)
Own R&D staff	24 (56)	13 (57)	2 (40)	2 (33)	8 (62)
Own libraries	23 (53)	9 (39)	1 (20)	2 (33)	12 (92)
Universities	22 (51)	10 (43)	3 (60)	2 (33)	10 (77)
Overseas parent companies	21 (49)	16 (70)	4 (80)	3 (50)	0
Others	10 (23) *	3 (13)	0	1 (17)	6 (46)
Consultants	9 (21)	2 (9)	2 (40)	1 (17)	5 (38)
N	43 (100)	23 (100)	5 (100)	6 (100)	13 (100)

Note: * Other sources are internet (5), company's training centre (1), production and Q.C. manager (1), postgraduate students (1), patent (1), and government agencies (1).

7.7 CONCLUSION

The results reflected the conclusions reached from the previous food company interviews (Chapter 6). While many external agencies had reasonably regular contact with food companies, only the food ingredient suppliers had close links to product development technical staff. Therefore, the food ingredient suppliers were the most important external source of technical knowledge for technical product development staff. Food ingredient suppliers provided a wide range of information and services mainly relevant to product design. These included ingredient specifications, product recipes, consultancy and product testing. Most of these food ingredient suppliers had their own local technical staff and knowledge base in overseas parent companies.

8 TECHNICAL PRODUCT DEVELOPMENT STAFF

8.1 INTRODUCTION

In this chapter, views and activities of product development technical staff of food companies are discussed. These include their perspectives on results from the industry survey, uses of technical information and product development process.

8.2 FOCUS GROUPS

Technical staff from companies who participated in industry survey (Survey 2) were invited to discuss their perspectives on the results and their technical knowledge acquisition.

There were three sessions of focus groups conducted. Each group was a mixture of different types of company ownership as shown in Table 8.1.

Table 8.1 Focus group components

Session	Number of participants	Number of companies	Type of company ownership			
			Thai private	Thai public	Joint venture	Multinational
1	6	6	4	1	1	-
2	6	3	1	1	1	-
3	5	5	-	2	2	1

The issues from combined discussions of the three groups are summarised below:

8.3 FOCUS GROUP PERSPECTIVES OF RESULTS FROM INDUSTRY QUESTIONNAIRE

All participants agreed with the outcome and conclusions from the industry questionnaire. Technical information and advice from ingredient suppliers was used more often than any other external sources, especially when their new products were incrementally innovative. This was because ingredient suppliers provided them with updated international information which helped them develop their new products faster. Equipment suppliers played a more important role when new products were very innovative and different from a company's existing processes. For multinational and joint venture companies, the parent company was a major technical information source. Internet was also a technical information source used by those companies with internet access.

Occasionally, some other technical sources were used by some companies, such as consultants from academic staff and research institutes. Consultants usually provided basic technical knowledge, advice, or they did research to solve problems. These consultants were sometimes contacted personally, for example, as technical staff's previous lecturers. A research institute was viewed as a technical source providing fundamental and not readily applied product development information.

8.4 ROLE OF FOOD INGREDIENT SUPPLIERS

Most new products were developed by food manufacturers, in-house. Food ingredient suppliers mainly provided them with basic food recipes, technical datasheets, technical advice, and ingredient specifications. In some cases, flavour houses took product samples without flavour added from food companies to formulate a required flavour, but food companies eventually created their own product recipe. Food ingredient suppliers also sometimes provided services on food formulations, which were later modified to suit the process by the food companies themselves. Food ingredient suppliers also provided product testing and analysis as well as searching technical

information from other sources for food companies. When food companies faced technical problems, they usually consulted either their own experienced staff or suppliers, depending on the sort of problem.

8.5 UPDATED TECHNICAL INFORMATION FOR TECHNICAL STAFF

Product development technical staff in the Thai food industry seem to rely on technical information from overseas rather than that available in Thailand. This was because they felt that information in Thailand was neither up-to-date nor reliable. They usually updated their new technical information from overseas through suppliers, a parent company, seminars, journals and the internet. Seminars were usually held by food ingredient suppliers, research institutes and government agencies. Journals were claimed to be not really applicable to most technical staff because most of them were in English. There were few Thai journals available. Time limitation was also raised as a major problem for technical staff to access journals and the internet.

8.6 LIMITATION OF TECHNICAL INFORMATION AND SERVICES

Although technical staff were the major technical source of the Thai food industry, it was claimed that their number and technical knowledge were insufficient. When using external technical services, they usually faced the loss of confidentiality. This limited their product development efficiency because they could not reveal all information to external agencies thus hindering technical assistance. They would like to see a technical information or database centre in Thailand, which would enable them to find all updated technical information needed.

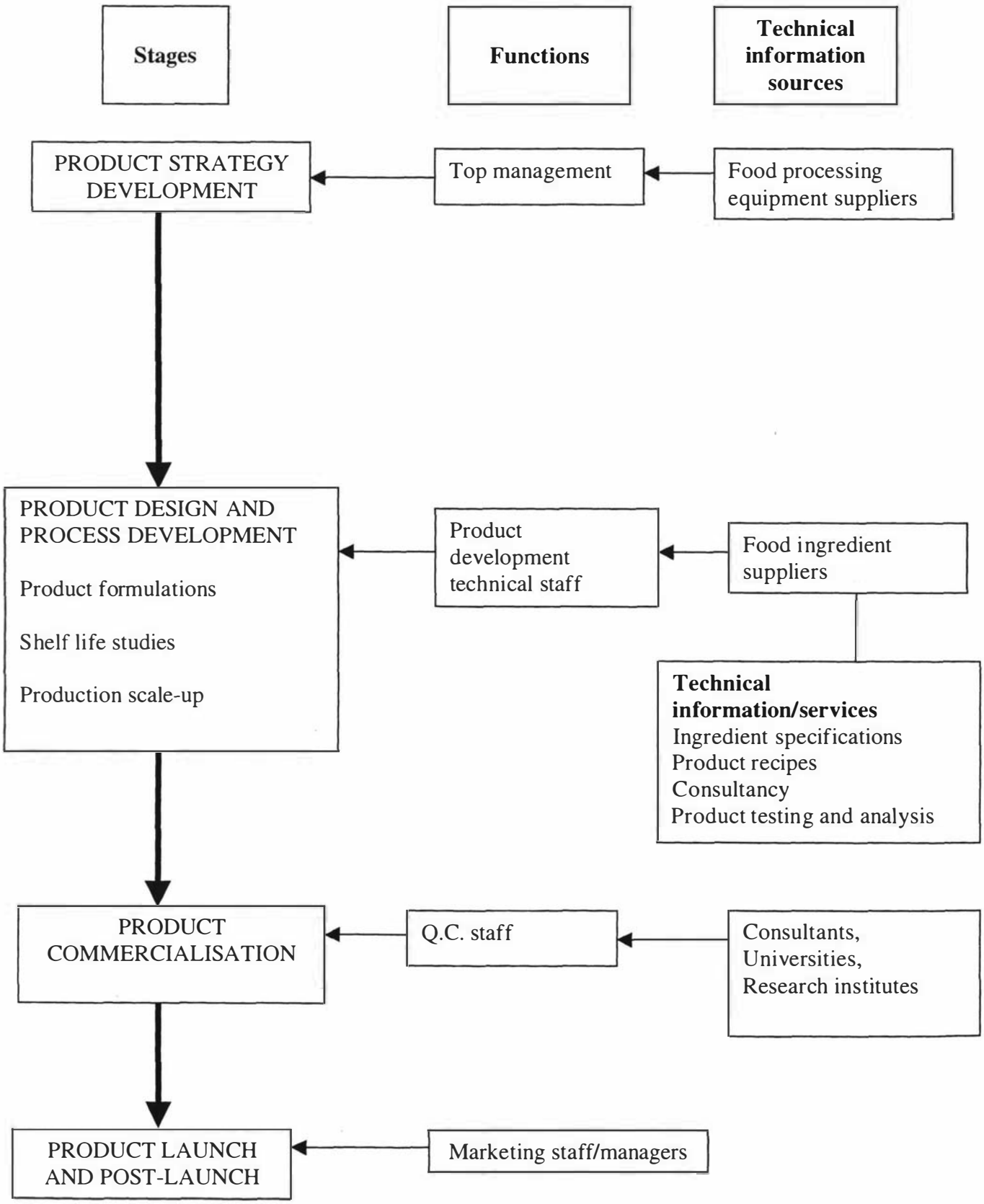
8.7 PRODUCT DEVELOPMENT PROCESS AND RELEVANCE OF TECHNICAL INFORMATION

New food product development in the Thai food industry seems to aim at full utilisation of existing in-house technology. For multinational and joint venture companies, new food products could be adopted from those done by the overseas research centre of the parent companies. Local technical staff's activities were involved in the modification of formulae to suit the local market. Top management and marketing were the two main

functions who usually provided new product ideas and made decisions. In some companies, the new product projects were proposed to top management. Most new product ideas were then roughly screened by top management and then passed to product development technical staff who did product formulations, product stability tests and production scale-up. During these steps, food companies obtained most technical information and services from food ingredient suppliers. Production staff were then involved in production scale-up and full-scale production. New products after launch were mostly the responsibility of the marketing function which also provided feedback to product development technical staff.

Based on information obtained from surveys and focus groups, it can be concluded that new product development was done mainly in-house by technical staff. These staff gain additional technical information mainly from ingredient suppliers especially for their formulations during the product design stage. The relevance of technical information sources is depicted in Figure 8.1. Food processing equipment suppliers and consultants were also linked to food companies but not directly involved in product development activities. Food processing equipment suppliers usually contacted top management for other business purposes such as purchasing new equipment. Consultants, universities and research institutes usually contacted Q.C. staff concerning technical problems in the processing line.

Figure 8.1 Relevance of technical information to food product development process in Thailand



8.8 CONCLUSION

There were concordant views of technical product development staff with the findings from interviews with food companies and technical information providers. Food ingredient suppliers were clearly involved in product formulations during product design, especially of incrementally new products. Apart from helping search technical information, food ingredient suppliers also provided services on formulating food ingredients to suit the products of the food companies. However, new products were actually designed and applied to the process line by in-house technical staff of the food company itself. The technical staff therefore played a major role in acquiring external technical information to facilitate their new product development activities.

However, these technical staff were limited by their own knowledge capability and business secrecy when dealing with external assistance. They gained modern technical information through many channels such as seminars, suppliers, parent companies, journals, and internet. Overseas technical sources were considered more reliable and up-to-date. However, foreign language and limited time availability were claimed as major problems in updating their knowledge. They were looking for technical information centre in which they can find all technical information needed.

The main purpose of developing new food products in Thailand tended to be fully utilising existing in-house technology. This would explain why most new products were incrementally innovative. Although local in-house technical staff were also important in multinational companies, they tended to be involved in modification of products which might already be available in other markets to suit local market rather than inventing radically innovative products. The parent companies were consequently one of the major sources of technical information for these types of companies in addition to food ingredient suppliers.

9 CONCLUSION AND DISCUSSION

9.1 INTRODUCTION

Many rapid changes in economics and demographics have driven growth in new branded consumer food products in the Thai market. To maintain a competitive advantage, the Thai food industry has needed to use technical knowledge to serve these changing consumer demands. Thus, the aim of this study was to identify the main technical knowledge sources used by food companies in Thailand for their food product development activities. In this chapter, the findings of research are compared to other industries and other countries with implications and recommendations.

9.2 NEW FOOD PRODUCTS INTRODUCTION IN THAILAND

According to this study, new branded consumer food products introduced in the Thai market were mainly beverages, dairy products, and condiments (Figure 3.8, Figure 3.9, and Table 5.14). This trend was similar to that in the US market. Of 15,006 new food products introduced to the US grocery stores in 1994, 22% (3,271 products) were new condiments. Other new products included 2,250 beverages (15%), 1,600 bakery products (11%), 1,300 dairy items (9%), and 2,500 candies, gums, and snacks (17%) (Gallo, 1995). Thus, the shift of food consumption of Thais is towards Western foods.

Most companies were more likely to introduce incrementally innovative products. In this current study, the incrementally innovative products accounted for over half (65%) of all new products. The survey conducted by the Prime Consulting Group Inc. (1997) reported 22% of new food products introduced in the US market were new brands/segments (radical innovations) and 78% were line extensions (incremental innovations). This, again, confirms the general characteristics of product development in the food industry.

Because of the shelf space limitation in the food retailers, however, new food products with incremental changes such as new sizes, shapes, and tastes will pose a problem of

introduction (Gallo, 1999). To survive in the market, the new food products thus need to be more innovative.

9.3 SOURCES OF NEW PRODUCTS

New food products introduced in the Thai market were obtained by various means: imported-ready-to-sell, own manufacture, and contract manufacture. Most companies had their own manufacturing facilities and new food products were usually produced in-house. Some food manufacturing companies, however, used contract manufacturers or imported-ready-to-sell food products when introducing new products. There was no strong evidence of company acquisitions and alliances in this study.

9.4 SOURCES OF NEW PRODUCT IDEAS

Food companies in Thailand obtained new product ideas from both internal and external sources. Internal staff and products seen in either the domestic market or overseas were primary sources of new product ideas for food companies in Thailand. Not many companies used consumer and marketing information to identify new product ideas. This supported the findings of Suwannaporn (1999) that customer research was often absent in the Thai food industry.

9.5 MAIN TECHNICAL KNOWLEDGE SOURCES FOR FOOD PRODUCT DEVELOPMENT IN THE THAI FOOD INDUSTRY

It was quite clear that food companies in Thailand relied heavily on knowledge from their own technical staff in new product development. These technical staff were concentrating on food product formulations and shelf life studies. They usually gained external technical assistance for product development mainly from food ingredient suppliers who provided them food ingredient specifications, product recipes, product testing, and consultancy. Food ingredient suppliers played an important role especially to incrementally innovative products. They would seek other external sources such as equipment suppliers or consultants when they introduced radically innovative products, which usually required new technological advances.

The new food product development activities in Thailand thus required the tacit knowledge of in-house technical staff to deal with external technical knowledge. Although the main external technical knowledge was information about product recipes and specifications they still needed their own knowledge and the food ingredient supplier's knowledge in their product design. These findings support general views made by many authors that in-house expertise is required not only to generate new information but also exploiting information in product innovation (Baldwin, 1962; SPRU, 1972; Evenson and Kislev, 1973; Anonymous, 1980; Nelson, 1982; Mowery, 1983; Cohen and Levinthal, 1989; Dodgson, 1989; Senker, 1989; Rosenberg, 1990; Patel and Pavitt, 1995; Taylor and Lowe, 1997; Faulkner, 1998; Belotti and Tunalv, 1999; Fernandez et al., 1999).

They are also in accordance with general pattern of any innovative organisation in that new product ideas can be originated outside the company or the industry. Nevertheless, the majority of innovations are developed, tasted, marketed, or incorporated in existing operations by companies themselves (Zaltman et al., 1973).

9.6 FACTORS DETERMINING TECHNICAL INFORMATION SOURCES

The company ownership and the new product type were two variables analysed in this study. The use of technical information sources was not associated with the company types. Rather, it was determined by the degree of product newness. Food companies tended to seek more external technical information sources when their new products were dramatically changed from their existing products. Food processing equipment suppliers and consultants played an important role for radically innovative products.

The association between the degree of product newness and the technical information sources can be explained by the degree of familiarity with a problem (Fischer, 1979). A company will usually seek external information sources when it faces an unfamiliar problem which is the case for radical innovations.

9.7 BARRIERS TO TECHNICAL INFORMATION ACQUISITION

Some barriers to technical information utilisation such as internal knowledge capabilities, managerial support and business secrecy seem to be common not only in the food industry in Thailand but also in other science-based and high technology industries (Sheen, 1992; MacPherson, 1997b; Ragatz et al., 1997).

Because most Thai food companies rely on overseas technical information, foreign languages were the major problem for technical staff. In addition, these technical staff were usually too busy with other work that they did not have sufficient time to spend on updating their knowledge of new and advanced technologies. When they gained external technical assistance in their product development, mainly from food ingredient suppliers, they were impeded by the business secrecy.

9.8 INTERNATIONAL COMPANIES AS OPPOSED TO LOCAL THAI OWNED COMPANIES

It was found in this study that there was no significant difference amongst different types of company ownership in utilising technical information sources. Although most multinational companies usually have their own R&D centres at their overseas parent companies, they still require a local product development unit to adapt their new products to suit the local taste. They also employ local food technologists to modify or even develop their new products for local markets. Although these technical staff could gain access to technical information provided by the R&D centre of their companies themselves, they still required technical information from other sources, especially food ingredient suppliers.

Thai consultants were apparently used by only local Thai food companies. These consultants usually provided technical assistance not directly involved with new product development. Local consultants could be of less importance for joint venture companies and multinational companies in which technical assistance could be provided from their overseas parent companies.

9.9 INTER-INDUSTRY COMPARISON

The food industry, especially processed convenience foods, has been classified as a suppliers-dominated sector, characterised by significant technological transfers from other upstream industrial sectors such as materials and specialised equipment suppliers (Anonymous, 1980; Scherer, 1982; Pavitt, 1984; Baker et al., 1988; McFarlane and McDonald, 1988; Archibugi et al., 1991; Nicolas, 1996; Rama, 1996; Grunert et al., 1997; Senker, 1998; Evangelista, 1999; Suwannaporn, 1999).

However, due to the complexity of technology and the cumulative nature of knowledge, a company still needs internal capabilities in order to assimilate and deal with technological advances. The utilisation of technical information in the Thai food industry also tended to follow the pattern of small and medium sized enterprises in which in-house staff are important internal information sources (Johnson and Kuehn, 1987; Johannessen and Dolva, 1995; Julien, 1995; Gomes, 1998; Campbell, 1999). This was also true for some other advanced technology industries such as biotechnology, engineering ceramics and parallel computing (Faulkner et al., 1995). Thus, there seems to exist a general pattern of technical inputs for industrial innovation across various industries.

External technical information for the food industry is usually from suppliers of materials and machinery. This was consistent with some other non-food studies that most technical information used in innovation was related to design and properties of materials and components (Gibbons and Johnston, 1974; Faulkner, 1998). The significant role of ingredient suppliers as external technical knowledge sources for product innovation in the food industry in Thailand was in accordance with the role of material suppliers in other various industries (Gibbons and Johnston, 1974; Klevorick et al., 1995). This would be explained by less R&D effort required to absorb knowledge from suppliers than government and university laboratories (Cohen and Levinthal, 1989).

9.10 INTER-COUNTRY COMPARISON

Heavy reliance on in-house technical staff of the Thai food manufacturers was supported by evidence found in some other countries such as Spain, the USA and European countries (Garcia Martinez and Burns, 1999; Hoban, 1998; Kevin, 1994; Hood et al, 1995; Senker, 1986; Gormley, 1995; Gormley and Mulas, 2000). In Spain, in-house technical knowledge as opposed to external sources was found to be of great important to enhancing product innovative performance and technological autonomy in the food and drink industry (Garcia Martinez and Burns, 1999). In the USA, food manufacturers gained new product ideas and technologies mostly from own market research and internal R&D (Hoban, 1998). They also used part-time staff and outsourced some activities to supplement their R&D departments (Kevin, 1994). Ingredient suppliers emerged as very important to the product development activities in the USA and North American regions (Kevin, 1994; Hood et al., 1995). Internal technical staff were also important to product innovation of big retailers with their own-label products in the UK. These retailers had large food technology departments, employing food technologists who collaborated with their suppliers to develop new products to meet consumer food requirements and legal obligations (Senker, 1986; Omar, 1995). These findings implied the significant role of internal tacit knowledge in new food product innovation. If this is the case, a food company to be successful and maintain competitive advantage of their new product development needs to recognise the importance of internal technical staff.

External technical knowledge sources are also important to product innovation in the food industry. There was quite strong evidence of the contribution of suppliers in the food product innovation across countries. Links to ingredient suppliers and machinery and equipment in the food industry were obvious not only in Thailand but also in European countries (Gormley, 1995; Traill and Grunert, 1997; Gormley and Mulas, 2000) and North American countries (Duxbury, 1993; Kevin, 1994; Hood et al., 1995; Meyer, 1998).

However, there were some contrasting points in using technical information for product development in Thailand and European countries. While product formulations and shelf life studies were focused in Thailand, European food industry tended to emphasise on food safety issues (Gormley and Mulas, 2000). The main external agency providing

technical training for the Thai food industry was the food ingredient suppliers. On the contrary, the European food industry often used private agencies/associations and consultants for this purpose (Gormley, 1995).

9.11 LIMITATIONS OF THE RESEARCH

It is important to note that these research results related specifically to the technical knowledge sources for introduction of new food products on the market place. Only food companies introducing new food products during the specific period of the study were included. This study did not include companies who were only exporters because the Thai domestic market was the focus. Since all participating companies had their own manufacturing facilities, this research represented mainly food manufacturers. Manufacturers are generally considered the main actor in the new product development and introduction cycle from the initial idea through mass production (Hoban, 1998). Although there is an increasing importance of own-label food retailing in the UK (Senker, 1986; Hughes, 1994; Omar, 1995), there was still no clear evidence in Thailand.

9.12 IMPLICATIONS AND RECOMMENDATIONS

It was observed that most companies introducing new food products in the Thai market had their own technical staff. This would imply that technical human resources were important in-house knowledge for the Thai food companies' capability of introducing new products. This supports the cumulative nature of technical knowledge that demands companies to set up strategies both to develop existing core technologies and to access technology (Garcia Martinez and Burns, 1999). This is because a company's capability of technical knowledge exploitation is largely related to its prior accumulated knowledge (Cohen and Levinthal, 1990). In this context, food companies need an in-house capability to accumulate and acquire related knowledge in order to maximise the benefits from externally generated technological advances. If this is the case, to be proactive in product innovation, a Thai food company needs to realise the importance of internal technical staff in their new product development activities.

Technical staff in the Thai food industry focus more on product modifications than on basic research for the company's technical knowledge base. Technical knowledge of their new products was thus a result of mobilising various sources. These include their tacit knowledge, in-house accumulated knowledge and external embodied and disembodied knowledge. However, these staff still lacked adequate advanced technical knowledge and capability of acquiring technological advances. Overseas technical information was regarded as more advanced and reliable to these technical staff. Although they could gain access to some sources, main barriers such as foreign language and time availability limited their new knowledge assimilation. This would suggest that communication skill and flow of complementary technical information to enable these technical staff in absorbing technical information should be recognised in the Thai food industry. Because most product development technical staff employed in the Thai food industry were university graduates, their focusing on food formulations and shelf-life studies should be taken into account in designing food science and technology curriculum in Thailand.

Their heavy reliance on food ingredient suppliers reflects huge market and intense competition in food ingredients, especially flavour houses, starches and stabilisers. These findings thus suggest that to be successful in introducing food ingredients to the Thai food industry, the vendors need to be aware of providing technical assistance to food companies in their new product development activities, especially for food formulations and shelf life studies.

The adoption process of new food ingredients is another area, which needs further exploration. In this research, food ingredients were those mainly involved with functional chemical products such as flavours, spices and modified starch. However, agricultural raw materials are also important to food product characteristics but they seem to be overlooked in new product development in Thailand. While genetically modified products are becoming a big issue in many countries, it is still unclear how they affect food product innovation in value-added chain in Thailand. Further studies in these areas are recommended.

In sum, it was obvious that the food manufacturing companies in Thailand rely heavily on internal technical staff in their new product development. These technical staff gain

external technical knowledge mainly from food ingredient suppliers. This suggests the opportunity for food ingredient suppliers to develop a stronger business relationship with the Thai food companies by allowing an easy access to technical information, for example, translating technical information into Thai language. However, the knowledge of food ingredient suppliers is limited to some certain areas.

To enable the Thai food industry to gain a wider range of technical knowledge, the relevant government agencies such as research institutes and universities could provide more accessible and applicable technical information to food companies as well. This would require strengthened linkage between the industry and the government agencies. The technical information might be provided in the form of a database, which is linked to all food research institutes and universities, and available for an electronic access. Nevertheless, technical staff usually have limited time to search for new information. To enhance the capability of gaining new and advanced technical knowledge, the food companies would need to provide resources for a quick information access with sufficient time to their technical staff.

More interaction with multilingual expert staff in the institutions is another possibility. A more active general programme of seminars, workshops, and continuing education could also contribute to enhanced results for Thailand. For this to be effective, food companies and their technologists would need to identify priority areas. Key new areas of science and technology would need to be identified by universities and institutes, so as to focus on the most important opportunities.

REFERENCES

Aaker, D. A., Kumar, V. and Day, G. S. 1998. Marketing research. 6th ed. New York: John Wiley & Sons, Inc. 776 p.

[ACARD] Advisory Council for Applied Research and Development. 1982. Report on the food industry and technology. London: Her Majesty's Stationery Office. 45 p.

Acs, Z. J. and Audretsch, D. B. 1991. R&D, firm size and innovative activity. In: Acs, Z. J. and Audretsch, D. B., editors. Innovation and technological change: an international comparison. New York: Harvester Wheatsheaf. p 39-59.

Afuah, A. 1998. Innovation management: strategies, implication, and profits. New York: Oxford University Press. 403 p.

Alcasabas, D. 1985. Food technology research and development in the Philippines. ASEAN workshop on food technology research and development, September.

Anonymous. 1980. The food industry: innovation and industrial structure. OECD Observer, September, 18-23.

Anonymous. 1994. Food industry merger and acquisition action shifts to emerging markets. Bangkok Post, August 10.

Anonymous. 1995. Instant noodles: strong and steady. Asia Pacific Food Industry, June, 78-81.

Anonymous. 1996. Annual marketing plan: market information report. American Embassy, Bangkok, Thailand. Retrieved September 13, 2000, from http://www.tradeport.org/ts/countries/thailand/fdmrkt.html

Anonymous. 1998. University-based food research. Prepared Foods, 167(12):108.

Anonymous. 1999. Cover story (in Thai). Khookaeng, 19(248):25-9.

Anonymous. 2000a. CATALYST: Nestle considering a cash bid for Nabisco holdings. Retrieved June 15, 2000, from http://www.datamonitor.com/viewnewstory.asp?id=561&pg=CG

Anonymous. 2000b. Unilever finally agreed to buy Bestfoods on 6th June, after protracted negotiations in a deal worth. Retrieved June 15, 2000, from http://www.datamonitor.com/viewnewsstory.asp?id=546&pg=CG

Anonymous. 2000c. Intense beer war between Chang and Singha (in Thai). Money Magazine, 2(17):46-9.

Anonymous. 2000d. Nestle challenges Singha in drinking water market (in Thai). Brand Age, 1(6):23-4.

Anonymous. 2000e. The food retailing sector in Thailand. Agriculture and Agri-Food Canada, Canadian Embassy, Bangkok, Thailand. Retrieved August 21, 2000, from http://atn-riae.agr.ca/public/htmldocs/e2813.htm

Archibugi, D., Cesaratto, S. and Sirilli, G. 1991. Sources of innovative activities and industrial organization in Italy. Research Policy, 20(4):299-313.

Archibugi, D., Cohendet, P., Kristensen, A. and Schaffer, K-A. 1994. Evaluation of the community innovation survey (CIS)-phase I, EIMS Publication no. 11. European Innovation Monitoring System (EIMS). IKE Group, Department of Business Studies, AALBORG, Denmark. 139 p.

Arora, A. and Gambardella, A. 1994. Evaluating technological information and utilizing it: scientific knowledge, technological capability, and external linkages in biotechnology. Journal of Economic Behavior and Organization, 24(1):91-114.

Artachinda, S. 1978. Food processing industry in Thailand. Research Report No. 4, Centre for Applied Economics Research, Kasetsart University, Bangkok, Thailand.

ASEAN [Association of Southeast Asian Nations]. 2001. GDP in market prices in US dollar, 1996-2000. Retrieved June 25, 2001, from http://www.aseansec.org/macroeconomic/gdpMarketUS.htm

Atuahene-Gima, K. and Lowe, J. F. 1994. The role of external technology acquisition in product development: Attitude-behaviour inconsistency among small firms. Asia Pacific Journal of Marketing and Logistics, 6(3):26-47.

Austin, J. E. 1992. Agroindustrial project analysis: critical design factors. 2nd ed. London: The Johns Hopkins University Press. 258 p.

Baker, R. C., Hahn, P. W. and Robbins, K. R. 1988. Fundamentals of new food product development. New York: Elsevier. 287 p.

Baldwin, J. and Sabourin, D. 2000. Innovative activity in Canadian food processing establishments: the importance of engineering practices. International Journal of Technology Management, 20(5,6,7,8): 511-27.

Baldwin, W. L. 1962. Contracted research and the case for big business. The Journal of Political Economy, 70(3):294-8.

Barclay, I. 1992. The new product development process: past evidence and future practical application, part 1. R&D Management, 22(3): 255-63.

Baron, C. G. 1980. Technology, employment and basic needs in food processing in developing countries. New York: Pergamon Press. 371 p.

Belotti, C. and Tunalv, C. 1999. Acquisition of technological knowledge in small and medium-sized manufacturing companies in Sweden. International Journal of Management, 18(3, 4):353-71.

Berry, K. J. and Mielke, P. W., Jr. 1988. Monte Carlo comparisons of the asymptotic Chi-square and likelihood-ratio tests with the nonasymptotic Chi-Square test for sparse rxc tables. Psychological Bulletin, 103(2): 256-64.

Best, D. 1991. Designing new products from a market perspective. In: Graf, E. and Saguy, I. S., editors. Food product development from concept to the marketplace. New York: International Thomson Publishing. p 1-27.

Bhumiratana, S., Tatchayapong, M., Youvittaya, T. and Siriwatanayothin, S. 1992. The status of food processing industry in Thailand. Food Ingredients Asia, May.

Board of Trade of Thailand. 1998. Board of Trade of Thailand's Directory 1998-1999. Bangkok, Thailand. 1077 p.

Bohn, R. E. 1994. Measuring and managing technological knowledge. Sloan Management Review, 36(1):61-73.

Booz-Allen and Hamilton, Inc. 1982. New product management for the 1980s. New York. 27 p.

Bradley, D. R., Bradley, T. D., McGrath, S. G. and Cutcomb, S. D. 1979. Type I error rate of the Chi-Square test of independence in RxC tables that have small expected frequencies. Psychological Bulletin, 86(6):1290-7.

Brown, J. G. 1994. Agroindustrial investment and operations. Washington, D.C.: The World Bank. 310 p.

Bryman, A. 1989. Research methods and organization studies. London: Unwin Hyman Ltd. 283 p.

Buisson, D. H. 1993a. Marketing-technical interaction and interdependency in product development process. Food Technology in New Zealand, 28(1):26-31.

Buisson, D. H. 1993b. The Asia Pacific food market opportunities and challenges. The Manufacturing Confectioner, February, 39-44.

Buisson, D. 1995. Developing new products for the consumer. In: Mashall, D.W., editor. Food choice and the consumer. London: Blackie Academic and Professional. p 182-215.

Byrnes, N. 2000. Brands in a bind. Business Week, August 28, 234-8.

Campbell, H. 1999. Knowledge creation in New Zealand manufacturing. Master thesis. Massey University, New Zealand.

Chalmers, A. 1994. Finding out. Case studies of New Zealand managers and business information: a summary. National Library of New Zealand, Wellington.

Chantramanklasri, N. 1995. Technology transfer and capability development for industrial competitiveness (in Thai). Annual conference 1995, TDRI, Thailand.

Christensen, J.L., Rama, R. and von Tunzelmann, N. 1996. Innovation in the European food products and beverage industry. EIMS Publication No. 35. European Innovation Monitoring System (EIMS), IKE Group, Aalborg University, Denmark. 146 p.

Clausi, A. 1987. Corporate expectations of R&D. In: Kroger, M. and Shapiro, R., editors. Changing food technology: innovation and commercialization: partners for progress in the food industry. Selected papers from the forth Eastern food science and technology conference. USA: Technomic Publishing Company, Inc. p 35-40.

Cochran, W.G. 1954. Some methods for strengthening the common χ^2 tests. Biometrica, 10(4):417-51.

Cohen, W.M. and Levinthal, D.A. 1989. Innovation and learning the two faces of R&D. The Economic Journal, 99(3):569-96.

Cohen, W.M. and Levinthal, D.A. 1990. Absorptive capacity: a new perspective on learning and innovation. Administrative Science Quarterly, 35(1):128-52.

Cohen, W.M., Levin, R.C. and Mowery, D.C. 1987. Firm size and R&D intensity: a re-examination. The Journal of Industrial Economics, 35(4):543-65.

Connor, J.M. and Schiek, W.A. 1997. Technological change. In: Food processing: an industrial powerhouse in transition. 2nd ed. New York: John Wiley & Sons Inc. p 369-95.

Cooke, S. 1998. Crumbs of comfort in the economic crisis. Ingredients and Analysis International, 19(1):9.

Cookson, C. 1996. International R&D. Chemical Week, S15.

Cooper, R. G. 1983. A process model for industrial new product development. IEEE Transactions on Engineering Management, 30(1):2-11.

Cooper, R. G. and Kleinschmidt, E. J. 1986. An investigation into the new product process: steps, deficiencies, and impact. Journal of Product Innovation Management, 3(2):71-85.

Craig, A. and Hart, S. 1992. Where to now in new product development research? European Journal of Marketing, 26(11):1-49.

Crippen, K. and Oates, C. 1992. Changing far East food preferences: implications on new product development. In: Foodtech Asia'92. p 1-15.

[DCR] Department of Commercial Registration, Ministry of Commerce. 1996. Report of firms by business code. Bangkok, Thailand.

[DCR] Department of Commercial Registration, Ministry of Commerce. 1999. Report of firms by business code. Bangkok, Thailand.

[DCR] Department of Commercial Registration, Ministry of Commerce. 2000. Report of firms by business code. Bangkok, Thailand.

Deiaco, E. 1992. New views on innovative activity and technological performance: the Swedish innovation survey. Science Technology Industry Review. No. 11, December, 35-62.

[DIW] Department of Industrial Works, Ministry of Industry. 1991. Statistics of factory. Bangkok, Thailand.

[DIW] Department of Industrial Works, Ministry of Industry. 2000. Statistics of factory. Bangkok, Thailand.

Dodgson, M. 1989. Technology strategy and the firm: management and public policy. UK: Longman Group. 252 p.

Dodgson, M. 1993. Organizational learning: a review of some literatures. Organization Studies, 14(3): 375-94.

Dornblaser, L. 1997. Success at the top. New Product News, 33(4):8.

Donnelly, W. J. 2000. Public research: managing the innovation process. International Journal of Dairy Technology, 53(4): 149-55.

Duxbury, D. D. 1993. Let's send out for R&D. Food Processing, May, 30-7.

Earle, M. D. 1997a. Changes in the food product development process. Trends in Food Science and Technology, 8(1):19-24.

Earle, M. D. 1997b. Innovation in the food industry. Trends in Food Science and Technology, 8(5):166-75.

Earle, M. D. and Earle, R. L. 1999a. Creating new foods: the product developer's guide. England: Chandos Publishing (Oxford) Limited. 190 p.

Earle, M. D. and Earle, R.L. 1999b. Innovation in the food industry: where are we going? Food Technology in New Zealand, 34(6):11-2, 22.

Earle, M.D. and Earle, R.L. 2000. Building the future on new products. England: Leatherhead Publishing. 112 p.

Edelman, J. 1982. Food, chemistry and cuisine: tenant memorial lecture. Chemistry and industry, July, 481-3.

Erickson, T. J., Magee, J. F., Roussel, P. A. and Saad, K. N. 1990. Managing technology as a business strategy. Sloan Management Review, 31(3):73-8.

Euromonitor Plc. 1999. Consumer Asia. 6th ed. London, Great Britain. 629 p.

Euromonitor Plc. 2001. Global market information database. London, Great Britain.

Evangelista, R. 1999. Knowledge and Investment. USA: Edward Elgar, Publishing Ltd., 205 p.

Evenson, R. E. and Kislev, Y. 1973. Research and productivity in wheat and maize. Journal of political economy, 81:1309-29.

[FAO] Food and Agriculture Organization. 2000. FAOSTAT database. Retrieved February 20, 2001, from http://apps.fao.org/page/collections?subset=agriculture

[FAO] Food and Agriculture Organization. 2001. FAOSTAT database. Retrieved February 20, 2001, from http://apps.fao.org/page/collections?subset=agriculture

[FAO and MAC] Food and Agriculture Organization and Ministry of Agriculture and Cooperatives of Thailand. 1992. Policy formulation and planning for agro-industrial development in Thailand: main report, October.

Faulkner, W. 1998. Knowledge flows in innovation. In: Williams, R., Faulkner, W. and Fleck, J., editors. Exploring expertise: issues and perspectives. London: Macmillan Press Ltd. p 173-95.

Faulkner, W., Senker, J. and Velho, L. 1995. Knowledge frontiers: public sector research and industrial innovation in biotechnology, engineering ceramics, and parallel computing. Oxford: Clarendon Press. 265 p.

[FDA] Food and Drug Administration, Ministry of Public Health. 1998. Statistics of food registration (in Thai). Nonthaburi, Thailand.

Fernandez, E., Montes, J. M., Perez-Bustamante, G. O., and Vazquez, C. J. 1999. Competitive strategy in technological knowledge imitation. International Journal of Technology Management, 18(5,6,7,8):535-48.

Fischer, W. A. 1979. The acquisition of technical information by R&D managers for problem solving in nonroutine contingency situations. IEEE Transactions on Engineering Management, 26(1):8-14.

Fleck, J. 1998. Expertise: Knowledge, power and tradeability. In: Williams, R., Faulkner, W. and Fleck, J., editors. Exploring expertise: issues and perspectives. London: Macmillan Press Ltd. p 143-71.

Fonterra Co-operative Group. 2001. Agreement with Nestle'. Retrieved September 4, 2001, from http://fonterra.com

Frater, P., Stuart, G., Rose, D. and Andrews, G. 1995. The New Zealand innovation Environment. A report on a project to identify the factors that influence the interest and ability of enterprises to innovate. The BERL Foundation Business and Economic Research, Ltd., Wellington. 196 p.

Fuller, G. W. 1994. New food product development from concept to marketplace. USA: CRC Press, 257 p.

Galizzi, G. and Venturini, L. 1996. Economics of innovation: The case of food industry. Germany: Physica-Verlag, 406 p.

Gallo, A. E. 1992. Record number of new products in 1991. Food Review, 15(2):19-21.

Gallo, A. E. 1995. Food marketing sales, mergers, and new product introductions rose in 1994. Food Review, 18(2):24-5.

Gallo, A. E. 1999. Fewer food products introduced in last 3 years. Food Review, 22(3):27-9.

Garcia Martinez, M. and Burns, J. 1999. Sources of technological development in the Spanish food and drink industry: a supplier-dominated industry? Agribusiness, 15(4):431-48.

General Mills. n.d. Company overview. Retrieved August 3, 2001, from http://www.generalmills.com/explore/overview

Gentles, P. 1997. Marketing services to New Zealand exporters: a European and UK overview. A presentation at New Zealand Food and Beverage Exporters Council, Inc., London: Taylor Nelson AGB, Plc.

Ghingold, M. and Johnson, B. 1997. Technical knowledge as value added in business markets: Implications for procurement and marketing. Industrial Marketing Management, 26(3):271-80.

Gibbons, M. and Johnston, R. 1974. The role of science in technological innovation. Research Policy. 3(3):220-40.

Gomes, C. M. 1998. A Study of the information acquisition behaviour of small and medium sized manufacturing enterprises in New Zealand. Master thesis, Department of Consumer Technology, Massey University, New Zealand.

Gormley, T. R. 1995. RTD needs and opinions of European food SMEs. Farm and Food, 5(2):27-30.

Gormley, T. R. and Mulas, J. E. 2000. FLAIR-FLOW EUROPE: a focused dissemination system for small food companies. Food Research International, 33(3,4): 289-93.

Gorski, D. 1994. Investing in dairy. Dairy Foods, 95(12):28-30.

Grunert, K. G., Harmsen, H., Meulenberg, M., Kuiber, E., Ottowitz, T., Declerck, F. Traill, B. and Goransson, G. 1997. A framework for analysing innovation in the food sector. In: Traill, B. and Grunert, K. G., editors. Product and process innovation in the food industry. London: Blackie Academic and Professional. p 1-37.

Guardia, E. J. 1992. Food research in the global company: a perspective. Food Technology, 46(2):72-5.

Harmsen, H., Grunert, K. G. and Declerck, F. 2000. Why did we make that cheese? An empirically based framework for understanding what drives innovation activity. R&D Management, 30(2):151-66.

Hartley, J. L., Meredith, J. R., McCutcheon, D. and Kamath, R. R. 1997. Suppliers' contributions to product development: an exploratory study. IEEE Transactions on Engineering Management, 44(3):258-67.

Hicks, P. A. 1993. Policies and strategies for development of food and agricultural product processing industries in Asia/Pacific. In: Hicks, P. A., editor. Policies and strategies for agro-industries in the Asia Pacific region part II 1993/23, Food and Agriculture Organization of the United Nation, Bangkok, Thailand. p 333-50.

Hoban, T. J. 1998. Improving the success of new product development. Food Technology, 52(1):46-9.

Hollingsworth, P. 1995. Food research cooperation is the key. Food Technology, 49(2):65, 67-74.

Hood, L. L., Lundy, R. J. and Johnson, D. C. 1995. New product development: North American ingredient supplier's role. British Food Journal, 97(3):12-7.

Howell, D. C. 1992. Statistical methods for psychology. 3rd ed. USA: Duxbury Press. 693 p.

Hughes, D. 1994. Breaking with tradition: building partnerships and alliances in the European food industry. UK: Wye College Press. 218 p.

Hughes, G. D. and Chafin, D. C. 1996. Turning new product development into continuous learning process. Journal of Product Innovation Management, 13(2):89-104.

Isarangkura, R. 1993. Policies and strategies for agro-industrial development in Thailand. In: Hicks, P. A., editor. Policies and strategies for agro-industries in the Asia Pacific region part II 1993/23, Food and Agriculture Organization of the United Nation, Bangkok, Thailand. p 319-28.

Jirathana, P. 1998. Constraints experienced by developing countries in the development and application of HACCP. Food Control, 9(2,3):97-100.

Johannessen, J-A. and Dolva, J. O. 1995. Innovative companies' external information search in Russia. International Journal of Information Management, 15(5):367-76.

Johnson, J. L. and Kuehn, R. 1987. The small business owner/manager's search for external information. Journal of Small Business Management, July, 53-60.

Johnston, R. 1991. Technology strategy in New Zealand industry, Report no. 12, Ministry of Research, Science and Technology, Wellington, New Zealand.

Julien, P-A. 1995. New technologies and technological information in small businesses. Journal of Business Venturing, 10, 459-75.

Kalseth, K. 1990. Strategic uses of information: challenges for the information services department, Bulletin of the American Society for Information Science, 17(1):22-3.

Kampempool, S. 1988. A regime of technology transfer from R&D institute to industry. Food Science and Technology in Industrial Development, October, 1023-9.

Katz, F. 1998a. How international companies use research teams. Food Technology, 52(4):40-4

Katz, F. 1998b. How major core competencies affect development of hot new products. Food Technology, 52(12):46-50, 52.

Katz, F. 1999a. How purchasing styles affect new product development. Food Technology, 53(11): 50, 52.

Katz, F. 1999b. Marketing pull vs Technology push. Food Technology, 53(8):62-3, 67.

Kennington, D. 1989. The use of information in small firms in the United Kingdom. Library Management, 10(6):7-14.

Kerr, G. 1994. A study of the product development practices of small manufacturing companies in New Zealand, Master thesis, Department of Consumer Technology, Massey University, New Zealand.

Kevin, K. 1994. No news is good news. Food Processing, August, 52-9.

Khookaeng (Public) Co., Ltd. 1995. Marketing information (in Thai). Khookaeng Research Centre, Bangkok, Thailand.

Khookaeng (Public) Co., Ltd. 1996. Marketing information (in Thai), Khookaeng Research Centre, Bangkok, Thailand.

Klevorick, A. K., Levin, R. C., Nelson, R. R. and Winter, S. G. 1995. On the sources and significance of interindustry differences in technological opportunities. Research Policy, 24, 185-205.

Kline, S. J. 1991. Styles of innovation and their cultural basis. CHEMTECH, 21(8):654-9.

Kline, S. J. and Rosenberg, N. 1986. An overview of innovation. In: Landau, R. and Rosenberg, N., editors. The positive sum strategy: harnessing technology for economic growth. Washington, D.C.: National Academy Press. p 275-305.

Komin, S. 1995. Changes in social values in the Thai society and economy: a post-industrialization scenario. In: Krongkaew, M. Thailand's industrialization and its consequences. New York: St. Martin's Press. p 251-66.

Kompass International (Thailand) Co., Ltd. 1998. Kompass direct: Thailand, food and beverage 1998. 130 p.

Kotler, P. and Armstrong, G. 1996. Designing products: new-product development and product life-cycle strategies. In: Learning guide: Principles of Marketing, 7th ed. Englewood Cliffs, N.J.: Prentice Hall. p 310-26.

Kuhn, M. E. 1995. Great expectations: processors look to suppliers for more. Food Processing, 56(8):53.

Kurokawa, S. 1997. Make-or-buy decision in R&D: Small technology based firms in the United States and Japan. IEEE Transactions on Engineering Management, 44(2):124-34.

Labuza, T. P. 1994. Shifting food research paradigms for the 21st century. Food Technology, 48(12):50, 52-6.

Linnemann, A. R., Meerdink, G., Meulenberg, M. T. G. and Jongen, W. M. F. 1999. Consumer-oriented technology development. Trends in Food Science and Technology, 9(11,12):409-14.

Liyanage, S., Greenfield, P. F. and Don, R. 1999. Towards a fourth generation R&D management model-research networks in knowledge management. International Journal of Technology Management, 18(3,4): 372-93.

Lundblad, B. 1991. R and D in Singapore. Food Manufacture International, March/April, 22-3.

Mackun, P. and MacPherson, A. D. 1997. Externally-assisted product innovation in the manufacturing sector: the role of location, in-house R&D and outside technical support. Regional Studies, 37(7):659-68.

MacPherson, A. D. 1997a. A comparison of within-firm and external sources of product innovation. Growth and Change, 28(3):289-308.

MacPherson, A. D. 1997b. The role of external technical support in the innovation performance of scientific instruments firms: empirical evidence from New York state. Technovation, 17(3):141-51.

Madhavan, R. and Grover, R. 1998. From embedded knowledge to embodied knowledge: New product development as knowledge management. Journal of Marketing, 62:1-12.

Magtoto, E. R. 1992. The Philippine's national and international support for the development of food science and technology. ASEAN Science and Technology Week. p 98.

Manager Information Services Co., Ltd. 1998. Marketing database, Bangkok, Thailand.

Mannion, P. 1996. Asia: the formulator's frontier. The World of Ingredients March/April:16-8.

Mason, A. and Campbell, B. D. 1993. Demographic change and the Thai economy: an overview. In: Campbell, B. O., Mason, A. and Pernia, E. M., The economic impact of demographic change in Thailand, 1980-2015: an application of the HOMES household forecasting model. Hawaii: University of Hawaii Press. p 1-52.

Mathews, R. 1997. Efficient new product introduction: shattering the myths. Progressive Grocer, July, 8-12.

Maxwell, A. E. 1961. Analysing qualitative data. New York: John Wiley & Sons Inc. 163 p.

McFarlane, J. F. and McDonald, D. W. 1988. Research and development in the food processing industry: current status and future opportunities. International Journal of Technology Management, 3(6):721-33.

Meyer, A. 1998. The 1998 top 100 R&D survey. Food Processing, August, 32-40.

Miller, W. L. and Morris, L. 1999. 4th generation R&D: managing knowledge, technology, and innovation. New York: John Wiley & Sons, Inc. 347 p.

Mirasol, F. 2000. Pfizer bags Warner-Lambert to form #2 global pharma giant. Chemical Market Reporter, 257(7):1, 20.

Moore, S. K. 2000. R&D Management: finding the right formula. Chemical Week, 162(16):29-33.

Morris, C. E. 1993. Why new products fail. Food Engineering, 65(6):132-6.

Morris, C. E. 1996a. Beyond the box with new manufacturing alliances. Food Engineering, 68(4):63-70.

Morris, C. E. 1996b. Cut to the core: food companies reassess engineering competencies. Food Engineering, 68(11):57-67.

Mowery, D. C. 1983. The relationship between intrafirm and contractual forms of industrial research in American manufacturing, 1900-1940. Explorations in Economic History, 20(4):351-74.

Mueller, W. F., Culbertson, J. and Peckham, B. 1982. Market structure and technological performance in the food manufacturing industries. Monograph no. 11. Madison, WI: North Central Project. NC-117. 140 p.

[MUA] Ministry of University Affairs. 1998. Report of public higher education. Information centre, department of policy and higher education plan. Bangkok, Thailand.

Muscat, R. J. 1994. The fifth tiger. A study of Thai development policy. Finland: United Nations University Press. 339 p.

Neff, J. 1997. Food service R&D steps up to the plate. Food Processing, 58(8):35-8.

Nelson, R. R. 1982. The role of knowledge in R&D efficiency. Quarterly Journal of Economics, 97(3):453-70.

[NESDB] Office of The Economic and Social Development Board. n.d.1. The Seventh National Economic and Social Development Plan (1992-1996). Office of the Prime Minister, Bangkok, Thailand.

[NESDB] Office of The Economic and Social Development Board. n.d.2. The Eighth National Economic and Social Development Plan (1997-2001). Office of the Prime Minister, Bangkok, Thailand.

[NESDB] Office of The Economic and Social Development Board. 2000a. National income of Thailand. Office of the Prime Minister, Bangkok, Thailand.

[NESDB] Office of The Economic and Social Development Board. 2000b. Population projections, natural growth rate, TFR, NRR, CBR, CDR and IMR for Thailand: 1990-2020. Office of the Prime Minister, Bangkok, Thailand.

[NFI] National Food Institute, Ministry of Industry. n.d. Organisation introduction pamphlet. Bangkok, Thailand.

Nestle'. n.d. The Nestle' R&D network. Retrieved August 6, 2001, from http://www.nutrition.nestle.com/discovery/network

Nicolas, F. 1996. Combined Roles of Process and Product Innovations in the Food Industries. In: Galizzi, G. and Venturini, L., editors. Economics of innovation: The case of food industry. Germany: Physica-Verlag. p 341-54.

Nonaka, I. 1991. The knowledge-creating company. Harvard Business Review, 69(6):96-105.

Nonaka, I. and Takeuchi, H. 1995. The knowledge creating company: how Japanese companies create the dynamics of innovation. New York: Oxford University Press. 284 p.

Nonaka, I., Takeuchi, H. and Umemoto, K. 1996. A theory of organizational knowledge creation. International Journal of Technology Management, 11(7/8):833-45.

[NSO] National Statistical Office. 1982. Report of the household socio-economic survey: Table 1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1987. Report of the household socio-economic survey: Table 3.1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1989. Report of the household socio-economic survey: Table 3.1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1991. Report of the household socio-economic survey: Table 3.1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1995a. Report of the household socio-economic survey: Table 3.1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1995b. Statistical yearbook: Thailand. No. 42. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1996. Statistical yearbook: Thailand. No. 43. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1997a. Report of the household socio-economic survey: Table 3.1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1997b. Statistical yearbook: Thailand. No. 44. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1998a. Report of the 1997 industrial census whole kingdom. Table 10 Number and percent of manufacturing establishments by exporting and division of industry. p 126.

[NSO] National Statistical Office. 1998b. Report of the survey on operation and employment in manufacturing sector 1998 (in Thai). Office of the Prime Minister, Bangkok, Thailand. 56 p.

[NSO] National Statistical Office. 1998c. Statistical yearbook: Thailand. No. 45. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1999a. Per capita monthly income and expenditure by region: 1981-1998. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1999b. Report of the household socio-economic survey: Table 3.1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 1999c. Statistical yearbook: Thailand. No. 46. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 2000a. Average monthly income and expenditure of household. Retrieved February 7, 2001, from
http://www.nso.go.th/eng/stat/socio/soctab1.htm

[NSO] National Statistical Office. 2000b. Key statistics. Statistical Data Bank and Information Dissemination Division, Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 2000c. Report of the household socio-economic survey: Table 3.1 Average monthly expenditure per household for goods and services by region and community type. Office of the Prime Minister, Bangkok, Thailand.

[NSO] National Statistical Office. 2001a. Number of employed person by industry and sex: 1989-2000. Retrieved February 7, 2001, from http://www.nso.go.th/eng/stat/lfstab9.htm

[NSO] National Statistical Office. 2001b. Number of employed person by level of educational attainment for the whole kingdom. Retrieved February 7, 2001, from http://www.nso.go.th/eng/stat/lfs/tab5.htm

Nystrom, H. 1990. Product development strategies for Swedish food processing companies. In: Technological and market innovation: strategies for product and company development. New York: John Wiley & Sons. p 197-210.

Nystrom, H. and Edvardsson, B. 1982. Product innovation in food processing- a Swedish survey. R&D Management, 12(2):67-72.

[NZDB] New Zealand Dairy Board. n.d. Corporate. retrieved August 6, 2001, from http://www.nzdb.com/cda/content/corporate

O'Donnell, C. D. 1995. Nabisco R&D manages resources. Prepared Foods, 164(10):43-9.

O'Donnell, C. D. 1996. CPC's excellent (R&D) adventure. Prepared Foods, 165(10):40-4.

O'Donnell, C. D. 1997. Campbell's R&D cozies up to the consumer. Prepared Foods. 166(10):26-30.

[OECD] Organisation for Economic Co-Operation and Development. 1983. OECD food industries in the 1980s. Paris: OECD. 187 p.

Ohr, L.M. 1999. Champions of innovation. Prepared Foods, 168(8):45-50.

Ohr, L.M. 2000. Sound science, tasty nutrition. Prepared Foods. 169(9):51, 54, 56.

Omar, O.E. 1995. Retail influence on food technology and innovation. International Journal of Retail and Distribution Management, 23(3):11-6.

Patel, P. and Pavitt, K. 1995. Patterns of technological activities: their measurement and interpretation. In: Stoneman, P., editor. Handbook of the economics of innovation and technological change. UK: Basil Blackwell Ltd. p 14-51.

Pavitt, K. 1984. Sectoral patterns of technical change: towards a taxonomy and a theory. Research Policy, 13, 343-73.

[PECC] Pacific Economic Cooperation Council. 2000. Pacific food outlook 2000-2001. USA: Farm Foundation. p 106.

Peterson, R. T. 1988. An analysis of new product ideas in small business. Journal of Small Business Management, 26(2):25-31.

Phithakpol, B. 1996. Thailand. In: Changing dietary intake and food consumption in Asia and the Pacific. Asian Productivity Organisation. p 445-67.

Phithakpol, B. and Chairat, V. 1992. Research and development in food science and technology in Thailand. ASEAN Science and Technology Week. p 94-7.

Prime Consulting Group Inc. 1997. Getting the numbers straight. Progressive Grocer. July (Supplement). p 44-6.

Pszczola, D. E. 1999. How push-pull has affected four foods. Food Technology, 53(8):64-5.

Ragatz, G. L., Handfield, R. B. and Scannell, T. V. 1997. Success factors for integrating suppliers into new product development. Journal of Product Innovation Management, 14(3):190-202.

Rama, R. 1996. Empirical study on sources of innovation in international food and beverage industry. Agribusiness, 12(2):123-34.

Rosenberg, N. 1990. Why do firms do basic research (with their own money)? Research Policy, 19, 165-74.

Rothwell. R. 1975. Information patterns in innovation. In: Roberson, A. and Rothwell, R., editors. Scientific and technical information needs in R&D laboratories, Science Policy Research Unit, University of Sussex. p 39-52.

Rothwell, R. 1977. The characteristics of successful innovators and technically progressive firms (with some comments on innovation research). R&D Management, 7(3):191-206.

Rothwell, R. 1992. Successful industrial innovation: critical factors for the 1990s. R&D Management, 22(3):221-38.

Rothwell, R. 1994, Towards the fifth-generation innovation process. International Marketing Review, 11(1):7-31.

Rotman, D. 1996. Bullish R&D budgets planned for 1996. Chemical Week, 158(12):40.

Roussel, P. A., Saad, K. A. and Erickson, T. J. 1991. Third generation R&D: managing the link to corporate strategy. Boston: Harvard Business School Press. 192 p.

Rudolph, M. J. 1995. The food product development process. British Food Journal, 97(3):3-11.

Runyon, R. P. and Haber, A. 1984. Fundamentals of behavioral statistics. 5th ed. New York: Newbery Award Records, Inc. 494 p.

Sanchez, A. M. and Elola, L. N. 1991. Product innovation management in Spain. Journal of Product Innovation Management, 8(1):49-56.

Scherer, F. M. 1982. Inter-industry technology flows in the United States. Research Policy, 11, 227-45.

Scott, A. 1999. Enter Aventis, tech giant. Chemical Week, 161(1):46.

Selwyn, M. 1991. The new food chain. Asian Business, 27(12):26-34.

Senker, J. M. 1986. Technological co-operation between manufacturers and retailers to meet market demand. Food Marketing, 2(3):88-100.

Senker, J. 1988. A taste for innovation: British supermarkets' influence on food manufacturers. UK: Horton Publishing. 221 p.

Senker, J. 1989. Food retailing, technology and its relation to competitive strategy. In: Dodgson, M., editor. Technology strategy and the firm: management and public policy. UK: Longman Group Ltd. p 134-44.

Senker, J. 1996. National systems of innovation, organizational learning and industrial biotechnology. Technovation, 16(5):219-29.

Senker, J. 1998. The contribution of tacit knowledge to innovation. In: Williams, R.; Faulkner, W.; Fleck, J., editors. Exploring expertise: issues and perspectives. London: Macmillan Press Ltd. p 223-44.

Senker, J. and Faulkner, W. 1992. Industrial use of public sector research in advanced technologies: a comparison of biotechnology and ceramics. R&D Management, 22(2):157-75.

Senker, P. and Senker, J. 1994. Transferring technology and expertise from universities to industry: Britain's teaching company scheme. New Technology, Work and Employment, 9(2):81-92.

Sheen, M. R. 1992. Barriers to scientific and technical knowledge acquisition in industrial R&D. R&D Management, 22(2):135-43.

Sloan, A. E. 1994. Why new products fail. Food Technology, 48(1):36-7.

Smith, C. M. 2000. Strategies for growth in the food industry. Food Australia, 52(1,2):48-51.

Smith, K. and Vidvei, T. 1992. Innovation activity and innovation outputs in Norwegian industry. Science Technology Industry Review, 11, 11-34.

Song, X. M. and Montoya-Weiss, M. M. 1998. Critical development activities for really new versus incremental products. Journal of Product Innovation Management, 15(2):124-35.

Sperber, B. 1993. The heroes of the new product revolution. Food Processing, 54(11): 45, 48, 50.

[SPRU] Science Policy Research Unit. 1972. Success and failure in industrial innovation. Centre for the Study of Industrial Innovation, University of Sussex, UK. 36 p.

SPSS Inc. 1997. SPSS 8.0 for Windows. USA.

Suwannaporn, P. 1999. New product development in the Thai food industry. Ph.D. Thesis. School of Management, Asian Institute of Technology (AIT), Bangkok, Thailand.

Suwannaporn, P. and Speece, M. 1998. Organization of new product development in Thailand's food processing industry. International Food and Agribusiness Management Review, 1(2):195-226.

Tansey, G. 1994. Food policy in a changing food system. British Food Journal, 96(8):4-12.

Taylor, M. J. 2001. The role of innovation in the agrifood chain. Food Australia, 53(1,2): 32-5.

Taylor, P. and Lowe, J. 1997. Are functional assets or knowledge assets the basis of new product development performance? Technology Analysis and Strategic Management, 9(4):473-88.

[TDRI] Thailand Development Research Institute. 1989. Final report: The development of Thailand's technological capability in industry, Volume 6. Overview and recommendations. Bangkok, Thailand.

[TDRI] Thailand Development Research Institute. 1991. Final report: The management of the R&D system to support industrial development. Science and Technology Development Program. Bangkok, Thailand.

Teo, K. S. 1992. Integrated process and product development. Quality management in the food industry. Singapore Quality Institute, ASEAN Food Handling Bureau. 12 p.

The Business Publications (1985) Co., Ltd. 1997. Thailand industrial buyer's guide 1997-1998. 16th ed. Bangkok: Louis Printing Co., Ltd. 684 p.

Theodore, S. 2000. Heads or tails? Beverage Industry, September, NP4.

[TRADENZ] New Zealand Trade Development Board. 1997. Market information: Thailand. Auckland, New Zealand.

Traill, B. and Grunert, K. G. 1997. Product and process innovation in the food industry. New York: Blackie Academic and Professional. 242 p.

Tyler, L. 1998. Asia beyond 2000: reviewing trends and eating habits. The World of Ingredients, March-April, 48-54.

Utterback, J. M., and Albernathy, W. J. 1975. A dynamic model of process and product innovation, OMEGA: The International Journal of Management Science, 3(6):639-56.

von Hippel, E. 1988. The sources of innovation. New York: Oxford University Press. 218 p.

Watzke, H. J. and Saguy, I. S. 2001. Innovating R&D innovation. Food Technology, 55(5):174-88.

West, S. J. 1980. Product development and the New Zealand food industry. Thesis for Master degree in Agricultural Business and Administration, Department of Marketing, Massey University, New Zealand.

Wongvarnrungruang, P. 1998. Health foods: industry analysis in Thailand. U.S. and Foreign Commercial Service and U.S. Department of State. Retrieved September 13, 2000, from http://www.tradeport.org/countries/thailand/isa/isar0013.html

Wongvarnrungruang, P. 1999. Food processing and packaging equipment: Thailand. U.S. and Foreign Commercial Service and U.S. Department of State. Retrieved September 13, 2000, from
http://www.tradeport.org/ts/countries/thailand/isa/isar0004.html

Zakaria, H. H. and Husin, A. 1988. Advances and innovations in the small food industry manufacturing system: a Malaysian experience. In: Maneepun, S., Varangoon, P. and Phithakpol, B., editors. Food science and technology in industrial development, proceeding of the food conference'88, Bangkok, Thailand, October 24-26. p 1030-43.

Zaltman, G., Duncan, R. and Holbek, J. 1973. Innovations and organizations. New York: John Wiley & Sons. 212 p.

Zimmerman, R. A. 1989. The importance of new products and product technology. In: Kroger, M. and Freed, A., editors. Changing food technology 2: Food technology for a dynamic marketplace: Selected papers from the fifth Eastern food science and technology conference. USA: Technomic Publishing Company, Inc. p 9-15.

APPENDIX 1 A LETTER OF INVITATION FOR SURVEY 1

Institute of Food, Nutrition and-
Human Health,
Massey University
Private Bag 11222,
Palmerston North
New Zealand

August 1, 1998

Attachments: 1. Questionnaire
2. An empty envelope with stamp

Dear Managing Director/ Manager

My name is Prasong Siriwongwilaichat, presently doing Ph.D. study under the Royal Thai Government Scholarship in the area of Food Product Development. My Thai supervisor is Associate Professor Vichai Haruthaithanasan. My research is directed at discovering the effectiveness of new food product development in Thailand, particularly the relevance of technical information services to the product development process of food manufacturers and to establishing successful product development strategies. The research is expected to be useful as a guide to food companies in Thailand to improve the product development system and so achieve highest efficiency.

This research will be successful if there is participation from food companies in Thailand, including your company, as respondents. All companies participating in this study will receive a summary and comment on the results.

You can be assured of complete confidentiality of all information you provide. No information about your company will be disclosed. Only overall aggregated and average information will be disclosed. No individual company name will be published. All individual company information provided will be destroyed at the end of the study.
Could you please, therefore, complete the attached questionnaire and return it by

August 31, 1998. This would be very valuable for the Thai food industry to compete more effectively and efficiently. Your kind co-operation will be greatly appreciated. Thank you very much.

Yours sincerely,

Prasong Siriwongwilaichat

APPENDIX 2 QUESTIONNAIRE FOR SURVEY 1

Confidential Questionnaire No.....

Please complete the following questionnaire by ticking (☑) the answers that apply to your company.

Section A: Company's products and activities

Total number of respondents (N = 191)

1. Is your company involved in the food business?

☐ Yes (186) ☐ No (4) closed down (1) (191)

(If your answer is "No", you can stop here. Thank you for your time)

2. Is your company a food manufacturer?

☐ Yes (160) ☐ No (26) (186)

3. Is your company an exporter?

☐ Yes (167) ☐ No (19) (186)

4. Is your company an importer?

☐ Yes (89) ☐ No (97) (186)

5. Is your company either a food distributor or wholesaler?

☐ Yes (137) ☐ No (49) (186)

6. Is your company an industrial food ingredient supplier?

☐ Yes (111) ☐ No (75) (186)

7. Is your company producing or selling Branded Consumer Food Products?

☐ Yes (153) ☐ No (33) (If the answer is "No", please go to section B) (186)

8. How many different Branded Consumer Food Products is your company producing or selling in the Thai market?

☐ 0 ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 ☐ 6-10 ☐ More than 10

(22) (8) (11) (12) (5) (6) (38) (51) (153)

9. What proportion of your total sales is the Branded Consumer Food Products business in your company?

☐ Less than 25 % (45)

☐ 25-50% (18)

☐ More than 50% (86) Blank (4) (153)

10. Do you have your own technical staff?

☐ Yes (129) ☐ No (14) Blank (10) (153)

If the answer is "Yes", how many of them are involved in product development?

☐ 0 ☐ 1 ☐ 2-5 ☐ More than 5

(6) (18) (65) (44) Blank (20) (153)

11. Do you have your own marketing staff?

☐ Yes (132) ☐ No (10) Blank (11) (153)

If the answer is "Yes", how many of them are involved in product development?

☐ 0 ☐ 1 ☐ 2-5 ☐ More than 5

(8) (15) (72) (40) Blank (18) (153)

12. Has your company introduced new consumer food products to the Thai market in the last twelve months?

☐ Yes (67) ☐ No (54) Blank (32) (153)

If the answer is "Yes", then how many new products have you introduced?

1 product (19), 2 products (11), 3 products (6), 4 products (5),

5 products (5), 6 products (2), 7 products (1), 10 products (2),

40 products (1) Blank (15) (67)

If the answer is "No", when did you last introduce new product to the Thai market? (During the last 3 years (17))

Section B: Company's characteristics

1. Is your company classified as follows?

1.1 Private company (not on stock exchange)	☐ Yes	(162)	☐ No (23)	(185)
1.2 Public company (on stock exchange)	☐ Yes	(20)	☐ No (158)	(178)
1.3 100% Thai owned company	☐ Yes	(121)	☐ No (54)	(175)
1.4 Subsidiary of multinational	☐ Yes	(16)	☐ No (161)	(177)

If the answer is "Yes", please give parent's name.

_____

1.5 Joint venture ☐ Yes (31) ☐ No (148) (179)

If the answer is "Yes", what percentage of Thai ownership? _____%

1.6 Other (Please specify) _____(Co-operative (1))

2. What is your company's turnover per annum?

☐ Less than 20 million bahts	(20)	☐ 20-50 million bahts	(17)	
☐ 51-250 million bahts	(51)	☐ 251-1000 million bahts	(48)	
☐ More than 1000 million bahts	(40)	Blank (10)		(186)

3. How many employees are there in your company?

☐ Less than 25 persons	(28)	☐ 25-50 persons	(13)	
☐ 51-200 persons	(42)	☐ 201-500 persons	(52)	
☐ More than 500 persons	(48)	Blank (3)		(186)

In case I want to talk with you about the questionnaire, may I have your contact information please?

Name: .....

Telephone number: ..... Fax number:.....

Thank you very much for your time

APPENDIX 3 A LETTER OF INVITATION FOR SURVEY 2

Institute of Food, Nutrition and-
Human Health, Massey University
Private Bag 11222,
Palmerston North, New Zealand

[Date]

Subject: Thank you for research co-operation
Reference: The letter dated on August 1, 1998
Attachment: Summary of survey on food companies in Thailand

Dear Sir/Madam

According to the referred letter, your company was invited to participate in the survey for my doctoral research fulfilment by completing questionnaire containing general question about company. I would like to thank you for your kind cooperation by providing completed and useful information. As promised, I attached herewith the summary of the results from this survey. I hope that these results would be beneficial for your company in the future.

Since your company has been considered as a valuable company which can provide further information regarding new food product development process to fulfil this research, I would like to invite you to participate in the next stage of the research by providing me an opportunity to perform an interview with a person who is most involved in new product development. The interviews will take place from January 1999 to July 1999. I will contact you during November 1998 to follow up on my request and obtain the name of the most involved person and a convenient time for an interview. Your kind co-operation will be greatly appreciated. Thank you very much.

Sincerely yours,

Prasong Siriwongwilaichat

APPENDIX 4 SUMMARY OF QUESTIONNAIRE FROM SURVEY 1 FOR PARTICIPATING FOOD COMPANIES

The Relevance of Technical Knowledge Sources to the Food Product Development Process in the Branded Consumer Food Market in Thailand

Prasong Siriwongwilaichat

The survey of food companies located in Thailand was conducted in August, 1998. Two-page questionnaires were sent to 517 companies. A pleasing response of 191 companies (37%) replied as shown in Figure 1. Among 191 companies, 131 companies (69%) sold branded food products in the Thai market. Of these 131 companies, 70% had more than 25% of sales from such products in the Thai market. The majority of these companies were owned by 100 percent Thai (64%) (Figure 2). Most companies (39%) sold more than 10 branded food products in the Thai market. The majority of companies (85%) had product development technical staff. Of these companies, 51% had 2-5 product development technical staff and 37% had more than 5 product development technical staff. A similar result was obtained for product development marketing staff: 85% of companies had product development marketing staff, 52% had 2-5 product development marketing staff and 34% had more than 5 product development marketing staff. The relative annual turnover rates and number of employees of the 131 companies replying are shown in Figure 3.

The next step of the survey is to investigate the relevance of technical knowledge sources and their impacts on new food products introduction in Thai market.

Figure 1 Response rate of food companies in Thailand

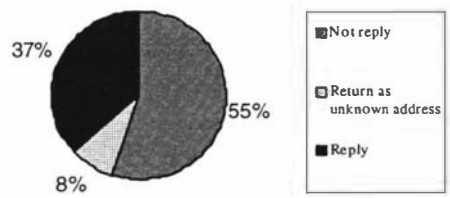


Figure 2 Ownership of companies selling branded food products in the Thai market

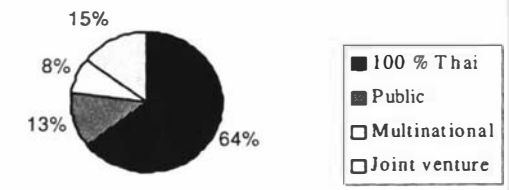
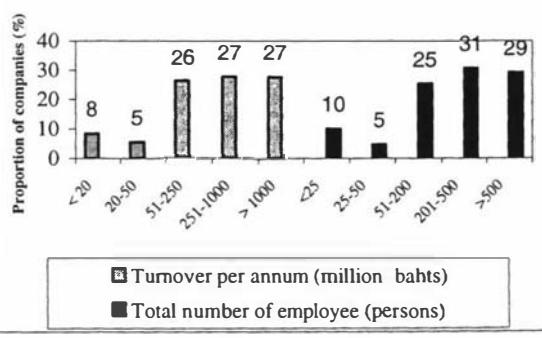


Figure 3 Company turnover per annum and total number of employees per company



APPENDIX 5 QUESTIONNAIRE FOR SURVEY 2

CODE NO.....

The Relevance of Technical Knowledge Sources to the Food Product Development Process in the Branded Consumer Food Market in Thailand

Introduction

Before we start the interview, please be assured that everything you say will be treated strictly as confidential. Answers to these questions will be combined with all other respondents and therefore individual company results will be unrecognisable. The purpose of this survey is to gain an insight into your company's use of technical information sources and how that impacts on your introduction of new food products to the Thai market.

SECTION I: DEMOGRAPHICS OF INTERVIEWEE

1.1 Name and position of an interviewee (If business card can be obtained, staple it to the front of questionnaire and skip this question.)

Name: .....

Position in company: .....

1.2 In which band is your age? (SHOWCARD 1)

1. Below 30 years old ☐
2. 30-40 years old ☐
3. 41-50 years old ☐
4. Above 50 years old ☐

1.3 What is your highest educational qualification? (SHOWCARD 2)

1. High school ☐
2. Vocational certificate ☐
3. Bachelor degree ☐
4. Master degree ☐
5. Doctoral degree ☐
6. Other (Please specify)..... ☐

1.4 What is your field of study? (SHOWCARD 3)

1. Science ☐
2. Food Science/ Food Technology ☐
3. Engineering ☐
4. Business/Management ☐
5. Marketing ☐
6. Others (Please specify) ☐

1.5 How long have you worked in this company?

1. Less than 1 year ☐
2. 1-5 years ☐
3. 6-10 years ☐
4. More than 10 years ☐

1.6 What is the title of your immediate supervisor? .....

1.7 How many staff directly report to you? .....

COMPANY VERIFICATION

Here is a classification of companies. In the last survey, your company was classified as:

1. Private company with 100% Thai owner ☐
2. Public company ☐
3. Joint venture company ☐

(Thai share holder ……..%, Overseas share holder ……..%)

4. Multinational company ☐

(Thai share holder ……..%, Overseas share holder ……..%)

5. Other ☐

(please specify)……

Is this the best way to describe your company? ☐ Yes ☐ No

If "No", which one best describes your company? (SHOWCARD 4)

Does your company have different office or manufacturing facilities throughout Thailand? ☐ Yes ☐ No

If "Yes", for this questionnaire, how are you going to answer questions about your company?

Are you going to answer on behalf of all facilities in Thailand? ☐ Yes ☐ No

If "Yes", what is the name of this local facility? ……...

If "No", how are you going to answer? ……

……

SECTION II: NEW PRODUCT INTRODUCTION

This questionnaire is looking at four different types of new product introductions to the Thai market over the last 3 years (1996-1999). These four types are as follows (SHOWCARD 5-8, PRESENT ONE AT A TIME):

The first are *Innovative Products-Completely New to the Thai Market;* food products which your company was the first to introduce to the Thai market. (SHOWCARD 5)

The second are *Products-New to Company;* food products which were new to your company but they existed on the Thai market before you introduced yours. (SHOWCARD 6)

The third are *Value Added Products;* food products you already sold on the Thai market. However, you have significantly improved the products for better characteristics, more convenience, longer shelf life or cost reduction. For example: new ingredients, new packaging. (SHOWCARD 7)

The fourth are *Line Extensions;* food products you already have on the Thai market. You have extended your product range, e.g. new flavours. (SHOWCARD 8)

Now, can you see the distinction between each of these categories?
(IF "No", REPEAT ABOVE MEANINGS UNTIL THEY ARE CLEAR TO RESPONDENT.)

2.1 Have you introduced any *Line Extension Products* in the last 3 years? (SHOWCARD 8)
□ Yes □ No

2.2 Have you introduced any *Value Added Products* in the last 3 years? (SHOWCARD 7)
□ Yes □ No

2.3 Have you introduced any *Products-New to Company* in the last 3 years? (SHOWCARD 6) □ Yes □ No

2.4 Have you introduced any *Innovative Products-Completely New to the Thai Market* in the last 3 years? (SHOWCARD 5)

□ Yes □ No

Now, may I have a list of new products you have introduced in the last 3 years? (LET RESPONDENT FILL ANSWERS OF 2.5-2.7 IN TABLE ON SEPARATED SHEET 1)

2.5 What are the brands you have used to introduce these new products?

2.6 What products are introduced under each brand?

2.7 When were they launched to the market?

2.8 In which way were these products first introduced to the Thai market? (SHOWCARD 9)

2.9 In which way are these products introduced now? (SHOWCARD 9)

Product Number	Product Introduction								
	1. Imported-ready to sell to market		2. Manufactured by own company		3. Contract manufactured in Thailand		4. Other (please specify and use space below for details)		No longer available
	1st	Now	1st	Now	1st	Now	1st	Now	
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									

Others.....

.....

.....

2.10 Who are your main competitors of these products on the market today?

(LET RESPONDENT FILL DETAILS IN TABLE ON SEPARATED SHEET 2)

SECTION III: SPECIFIC QUESTIONS ON 4 CATEGORIES OF NEW PRODUCTS

I am now going to focus on each product category that you have introduced over the last 3 years (SHEET 1).

Just to recapitulate: You have said that you have ..... new products introduced over the last 3 years (SHEET 1). Among these products, ... products are imported and sold to the market,.....products are own manufactured, ...products are contract manufactured in Thailand and .....products are obtained by other means (.....).

Is that correct? (IF "No", VERIFY AND CORRECT.)

QUESTION SET ON TECHNICAL INPUT (SECTION III)*

Imported-ready to sell to the market	☐
Own manufactured	☐
Contract manufactured	☐
Others (specify).....	☐

3.1 Where did you first get the new idea for these products? (SHOWCARD 10)

1. Saw products overseas ☐
2. Saw products in Thailand ☐
3. Saw products in magazine ☐
4. Your company thought of the product. ☐
5. A market research company identified the need. ☐
6. Another Thai food company saw the opportunity and offered it to you. ☐
7. Customers made requirements. ☐
8. Conferences, trade exhibitions ☐
9. Others (please specify) ..... ☐

* This set of questions was repeated four times, once for each of the four sources of new products (imported-ready to sell, own manufacture, contract manufacture and others).

3.2 Did you acquire technical information about the product before introducing these new products? ☐ Yes ☐ No

If "Yes",

3.3 Where did you get this information from? (SHOWCARD 11)

1. Own technical staff ☐
2. Food ingredient suppliers ●
3 Food processing equipment suppliers ☐
4. Food packaging suppliers ☐
5. Food manufacturing companies in Thailand ☐
6. Overseas food manufacturing companies ☐
7. Thai consultants ☐
8. Thai universities ☐
9. Thai research institutes ☐
10. Local libraries ☐
11. Company's library ☐
12. Overseas consultants ☐
13. Overseas universities ☐
14. Others (please specify) … ☐

3.4 Which are the most important 3 sources of information?

3.5 Which was the most important?

	3 important sources			The Most Important Source
LINE EXTENSIONS	……..	……..	……..	……..
VALUE ADDED PRODUCTS	……..	……..	……..	……..
PRODUCTS-NEW TO COMPANY……..	……..	……..	……..	……..
INNOVATIVE PRODUCTS-COMPLETELY NEW TO THE THAI MARKET	……..	……..	……..	……..

3.6 What do you use that information for? (SHOWCARD 12)

1. Food labelling ☐
2. Food formulations ☐
3. Food processing ☐
4. Food sanitation ☐
5. Food quality control ☐
6. Food packaging ☐
7. Food shelf life studies ☐
8. Others (please specify) ..... ☐

SECTION IV: GENERIC QUESTIONS

In the previous section, you said your company used following sources of technical information.

	Imported Products	Own Manufactured Products	Contract Manufactured Products	Others
1. Own technical staff	☐	☐	☐	☐
2. Food ingredient suppliers	☐	☐	☐	☐
3. Food processing equipment suppliers	☐	☐	☐	☐
4. Food packaging suppliers	☐	☐	☐	☐
5. Food manufacturing companies in Thailand	☐	☐	☐	☐
6. Overseas food manufacturing Companies	☐	☐	☐	☐
7. Thai consultants	☐	☐	☐	☐
8. Thai universities	☐	☐	☐	☐
9. Thai research institutes	☐	☐	☐	☐
10. Local libraries	☐	☐	☐	☐
11. Company's library	☐	☐	☐	☐
12. Overseas consultants	☐	☐	☐	☐
13. Overseas universities	☐	☐	☐	☐
14. Others (please specify)	☐	☐	☐	☐

Is that correct? (IF "No", VERIFY AND CORRECT.)

There are too many options for us to discuss. Can you think in terms of your company as a whole across all of these products, which are the main sources of technical information for your company?

SOURCES OF INFORMATION

1. Own technical staff ☐
2. Food ingredient suppliers ☐
3. Food processing equipment suppliers ☐
4. Food packaging suppliers ☐
5. Food manufacturing companies in Thailand ☐
6. Overseas food manufacturing companies ☐
7. Thai consultants ☐
8. Thai universities ☐
9. Thai research institutes ☐
10. Local libraries ☐
11. Company's library ☐
12. Overseas consultants ☐
13. Overseas universities ☐
14. Others (please specify) ..... ☐

4.1 Which particular ones of each source do you get technical information to support your new product introduction?

THAI UNIVERSITIES (SHOWCARD 13)

1. Burapa	☐	8. Mahidol	☐
2. Chulalongkorn	☐	9. Songkla	☐
3. Chiang Mai	☐	10. Silpakorn	☐
4. Kasetsart	☐	11. Thamasat	☐
5. Khon Kaen	☐	12. Thonburi	☐
6. KMITL	☐	13. Others	☐
7. KMITN	☐	(please specify).....	

THAI RESEARCH INSTITUTES (SHOWCARD 14)

1. TISTR	☐
2. IFRPD	☐
3. KAPI	☐
4. Others (please specify).....	☐

.....

.....

.....

.....

4.2 What are advantages and disadvantages of information sources used?

(TAPE RECORD)

Sources	Advantages	Disadvantages

TECHNICAL STAFF

4.3 How many technical staff are involved in new product development? (SHOWCARD 15)

1. 1-2 persons ☐
2. 3-5 persons ☐
3. More than 5 persons ☐

4.4 Do you have your own food research and development laboratory? ☐ Yes ☐ No

4.5 Do you have your own food pilot plant? ☒ Yes ☐ No

NOW, I WOULD LIKE TO LEARN ABOUT THE TRAINING AND DEVELOPEMENT THAT YOUR TECHNICAL STAFF UNDERGO.

4.6 Do you have any technical training program for these staff? ☐ Yes ☒ No

If "Yes", by whom is it mostly held? (SHOWCARD 16)

1. Your company ☐
2. Food ingredient suppliers ☐
3. Food processing equipment suppliers ☐
4. Food packaging suppliers ☐
5. Universities ☐
6. Food science and technology associations ☐
7. Science and technology research institutes ☒
8. Others (please specify)..... ☐

4.7 Do these staff attend conferences or seminars in Thailand? ☐ Yes ☒ No

4.8 Do these staff attend conferences or seminars overseas? ☐ Yes ☒ No

If "Yes", which country? .....

.....

4.9 What do you expect your technical staff to learn from conferences or seminars? (TAPE RECORD)

.....

.....

.....

.....

.....

.....

.....

.....

SECTION V: COMPANY'S ACTIVITIES AND DEMOGRAHICS

5.1 How much is turnover per annum of your company? (SHOWCARD 17)

1. Don't know ☐
2. Less than 20 million bahts ☐
3. 20-50 million bahts ☐
4. 51-250 million bahts ☐
5. 251 – 1,000 million bahts ☐
6. More than 1,000 million bahts ☐

5.2 How many permanent employees do you have? (SHOWCARD 18)

1. Don't know ☐
2. Fewer than 25 persons ☐
3. 25-50 persons ☐
4. 51-200 persons ☐
5. 201-500 persons ☐
6. More than 500 persons ☐

5.3 How long has your company been established? ..... year(s)

5.4 Which food product categories do you sell? (SHOWCARD 19)

5.5 Which brands of each category are most important to your company?

Please rank product categories according to their significance to company.

Product categories	Sold (tick) 5.4	Key Brands 5.5	Priority to company (rank)
1. Bakery products			
2. Cereal products			
3. Fishery products			
4. Meat and meat products			
5. Milk and dairy products			
6. Egg and egg products			
7. Beverages			
8. Fruit and vegetable products			
9. Snack foods			
10. Jam, Jelly, and Confectionery products			
11. Health foods			
12. Spice, sauce, and seasoning products			
13. Fat and oil products			
14. Others (please specify).....			

5.6 Do you have marketing staff? ☐ Yes ☐ No

If "Yes", how many of them are involved in new product introduction?

(SHOWCARD 20)

1. 0 persons ☐
2. 1-2 persons ☐
3. 3-5 persons ☐
4. More than 5 persons ☐

5.7 Do you have sales staff? ☐ Yes ☐ No

If "Yes", how many of them are involved in new product introduction?

(SHOWCARD 20)

1. 0 persons ☐
2. 1-2 persons ☐
3. 3-5 persons ☐
4. More than 5 persons ☐

SHEET 1
LIST OF NEW PRODUCTS INTRODUCTION OVER THE LAST 3 YEARS

Product Number	Brand	Product	Number of Varieties	New product category	Launch year
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					

SHEET 2
LIST OF COMPETITORS

Product Number	Competitors		Top Brand
	Company	Brand name	
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

****

SHOWCARD 1

AGE

1. Below 30 years old
2. 30-40 years old
3. 41-50 years old
4. Above 50 years old

****

SHOWCARD 2

EDUCATION LEVEL

1. High school
2. Vocational certificate
3. Bachelor degree
4. Master degree
5. Doctoral degree
6. Other (Please specify).....

****

SHOWCARD 3

FIELD OF STUDY

1. Science
2. Food Science/ Food Technology
3. Engineering
4. Business/Management
5. Marketing
6. Others (Please specify)

****

****

SHOWCARD 4

OWNERSHIP OF COMPANY

1. Private company with 100% Thai owner
2. Public company
3. Joint venture company
4. Multinational company
5. Others (please specify)

****

SHOWCARD 5

Innovative Products-Completely New to the Thai Market

Food products which your company was the first to introduce to the Thai market.

****

SHOWCARD 6

Products-New to Company

Food Products which were new to your company but they existed on the Thai market before you introduced yours.

****

SHOWCARD 7

Value Added Products

Food products you already sold on the Thai market. However, you have significantly improved the products for better characteristics, more convenience, longer shelf life or cost reduction. For example: new ingredients, new packaging.

****

****

SHOWCARD 8

Line Extensions

Food products you already have on the Thai market. You have extended your product range, e.g. new flavours.

****

SHOWCARD 9

WAYS THAT PRODUCTS ARE INTRODUCED TO THE THAI MARKET

1. Imported-ready to sell
2. Manufactured by your own company in Thailand
3. Manufactured by another company, on your behalf, in Thailand
4. Others (please specify)

****

SHOWCARD 10

MAJOR SOURCES OF NEW PRODUCT IDEAS

1. Saw products overseas
2. Saw products in Thailand
3. Saw products in magazine
4. Your company thought of the products.
5. A market research company identified the need.
6. Another Thai food company saw the opportunity and offered it to you.
7. Customers made requirements.
8. Conferences, trade exhibitions
9. Others (please specify)

****

****

SHOWCARD 11

SOURCES OF SCIENTIFIC AND TECHNOLOGICAL INFORMATION

1. Own technical staff
2. Food ingredient suppliers
3. Food processing equipment suppliers
4. Food packaging suppliers
5. Food manufacturing companies in Thailand
6. Overseas food manufacturing companies
7. Thai consultants
8. Thai universities
9. Thai research institutes
10. Local libraries
11. Company's library
12. Overseas consultants
13. Overseas universities
14. Others (please specify)

****

SHOWCARD 12

USE OF INFORMATION

1. Food labelling
2. Food formulations
3. Food processing
4. Food sanitation
5. Food quality control
6. Food packaging
7. Food shelf life studies
8. Others (please specify)

****

****

SHOWCARD 13

THAI UNIVERSITIES

1. Burapa University
2. Chulalongkorn University
3. Chiang Mai University
4. Kasetsart University
5. Khon Kaen University
6. King of Mongkut Institute of Technology, Ladkrabang
7. King of Mongkut Institute of Technology, North Bangkok
8. Mahidol University
9. Prince of Songkla University
10. Silpakorn University
11. Thamasat University
12. Thonburi University of Technology
13. Others (please specify) .....

****

SHOWCARD 14

THAI RESEARCH INSTITUTES

1. Thailand Institute of Science and Technology Research
2. Institute of Food Research and Product Development
3. Kasetsart Institute of Agro-Industrial Product Development and Improvement
4. Others (please specify)

****

****

SHOWCARD 15

NUMBER OF PRODUCT DEVELOPMENT TECHNICAL STAFF

1. 1-2 persons
2. 3-5 persons
3. More than 5 persons

****

SHOWCARD 16

TECHNICAL TRAINING PROVIDERS

1. Your company
2. Food ingredient suppliers
3. Food processing equipment suppliers
4. Food packaging suppliers
5. Universities
6. Food science and technology associations
7. Science and technology research institutes
8. Others (please specify).....

****

SHOWCARD 17

TURNOVER PER ANNUM

1. Don't know
2. Less than 20 million bahts
3. 20-50 million bahts
4. 51-250 million bahts
5. 251 – 1,000 million bahts
6. More than 1,000 million bahts

****

****

SHOWCARD 18

NUMBER OF PERMANENT EMPLOYEES

1. Don't know
2. Fewer than 25 persons
3. 25-50 persons
4. 51-200 persons
5. 201-500 persons
6. More than 500 persons

****

SHOWCARD 19

FOOD PRODUCT CATEGORIES SOLD

1. Bakery products
2. Cereal products
3. Fishery products
4. Meat and meat products
5. Milk and dairy products
6. Egg and egg products
7. Beverages
8. Fruit and vegetable products
9. Snack foods
10. Jam, Jelly, and Confectionery products
11. Health foods
12. Spice, sauce, and seasoning products
13. Fat and oil products
14. Others (please specify)

****

****

SHOWCARD 20

NUMBER OF STAFF

1. 0 persons
2. 1-2 persons
3. 3-5 persons
4. More than 5 persons

****

APPENDIX 6 TELEPHONE CONTACT GUIDE FOR SCREENING TECHNICAL KNOWLEDGE PROVIDERS (SURVEY 3)

Company name..... Date.....

Address.....

Phone ( )..... Fax ( )..... .

Hello, my name is Prasong Siriwongwilaichat from Silpakorn University. I am doing a Ph.D. at Massey University, New Zealand. I am doing a research project on the technical resources used by the Thai food industry. I would like to conduct a short questionnaire with your company to learn more about your company's activities in the food industry. Would you be prepared to help me with this survey please?

( ) Yes

( ) No [THANK YOU AND TERMINATE]

[IF YES]

I will be sending you a letter in a few days inviting your company to participate the survey. May I verify your contact information please?

Company name.....

Address.....

.....

Phone ( )..... Fax ( )..... .

Thank you and good-bye.

APPENDIX 7 A LETTER OF INVITATION FOR TECHNICAL KNOWLEDGE PROVIDERS (SURVEY 3)

Department of Food Technology
Faculty of Industrial Technology
Silpakorn University,
Amphur Muang
Nakhon Pathom 73000

[Date]

[Name and address of participant]

My name is Prasong Siriwongwilaichat from Silpakorn University. I am doing a Ph.D. at Massey University, New Zealand. I am conducting a survey on technical information used by food industry in Thailand. From a recent survey I conducted as part of my research, it was found that food companies in Thailand gathered technical knowledge from a wide range of sources, e.g. their own technical staff, food ingredient suppliers, food processing equipment suppliers, food packaging suppliers, food manufacturers, consultants, universities and research institutes.

Since your company has been identified as an important source of technical information to the food industry in Thailand, I would like to ask you about your technical services provided to food manufacturing companies.

The questionnaire will not ask for confidential, commercial information. All information collected will remain strictly confidential to me. Only data compiled across all companies surveyed will be used for my reports.

Your kind co-operation is highly appreciated.

Sincerely yours,

Prasong Sirwongwilaichat

APPENDIX 8 QUESTIONNAIRE FOR TECHNICAL KNOWLEDGE PROVIDERS

CODE NO……..

The Relevance of Technical Knowledge Sources to the Food Product Development Process in the Branded Consumer Food Market in Thailand

Company name: ……

Address: ……

Contact number: ……

Interview date: ……..

INTRODUCTION

Before we start the interview, please be assured that everything you say will be treated strictly as confidential. Answers to these questions will be combined with all other respondents and therefore individual company results will be unrecognisable. The purpose of this survey is to gain an insight into the kinds of technical information you supply to the food industry in Thailand.

SECTION I: DEMOGRAPHICS OF INTERVIEWEE

Name and position of interviewee (If business card can be obtained, staple it to the front of questionnaire and skip this question.)

Name ……..

Position in company/institute ……

SECTION II: TECHNICAL INFORMATION AND SERVICE

Q.1 What general activity (or activities) do you perform for the food industry in Thailand? (may tick more than one box) (SHOWCARD 1)

1. Food ingredient supplier (go to Q.2) ☐
2. Food processing equipment supplier ☐
3. Food packaging supplier ☐
4. Consultant ☐
5. University ☐
6. Research institute ☐
7. Others (please specify) ..... ☐

FOR FOOD INGREDIENT SUPPLIER

Q.2 What food ingredients is your company selling to food manufacturers in Thailand? (SHOWCARD 2)

1. Flavouring/Colouring Agents ☐
2. Starches/Modified Starches ☐
3. Stabilisers/Emulsifiers/Binding Agents ☐
4. Antioxidants/Preservatives ☐
5. Sweeteners ☐
6. Spices/Seasonings ☐
7. Micronutrients/Vitamins/Functional foods ☐
8. Others (please specify)..... ☐

Q.3 Whom in food companies do you contact? (SHOWCARD 3-4)

	Occasionally	Frequently
1. Chief executive officer	☐	☐
2. Production manager	☐	☐
3. Technical manager	☐	☐
4. Technical Q.C. staff	☐	☐
5. Technical product development staff	☐	☐
6. Marketing/sales manager	☐	☐
7. Marketing/sales staff	☐	☐
8. Purchasing staff	☐	☐
9. Administrative staff	☐	☐
10. Others (Please specify).....	☐	☐

Q.4 What is available and provided from your company/institution?

Technical Information

	Available	**Provide**	
		Occasionally	*Frequently*
1. Product formulation datasheets (recipes)	☐	☐	☐
2. Ingredient specifications (datasheets)	☐	☐	☐
3. Equipment manuals and techniques for use	☐	☐	☐
4. Packaging manuals	☐	☐	☐
5. Copies of journal articles	☐	☐	☐
6. Own company/institution produced technical sheets/journals/reports	☐	☐	☐
7. Others (please specify).....	☐	☐	☐

Technical Services

1. Pilot plant scale facilities	☐	☐	☐
2. Product testing/analysis	☐	☐	☐
3. Product formulation trials	☐	☐	☐
4. Joint Research and Development project	☐	☐	☐
5. Seminars	☐	☐	☐
6. Workshops	☐	☐	☐
7. Consultancy	☐	☐	☐
8. Others (please specify).....	☐	☐	☐

Q.5 What do Thai food companies ask you for?

Technical Information

	Occasionally	Frequently
1. Product formulation datasheets (recipes)	☐	☐
2. Ingredient specifications (datasheets)	☐	☐
3. Equipment manuals and techniques for use	☐	☐
4. Packaging manuals	☐	☐
5. Copies of journal articles	☐	☐
6. Your own produced technical sheets/journals/reports	☐	☐
7. Others (please specify).....	☐	☐

Technical Services

1. Pilot plant scale facilities	☐	●
2. Product testing/analysis	☐	☐
3. Product formulation trials	☐	☐
4. Joint Research and Development project	☐	☐
5. Seminars	☐	☐
6. Workshops	☐	☐
7. Consultancy	☐	☐
8. Others (please specify).....	☐	☐

Q.6 Where do you get technical information from? (SHOWCARD 5)

1. Overseas parent company ☐
2. Your own library ☐
3. Your own database ☐
4. Suppliers/producers ☐
5. Magazines/Journals ☐
6. Your own R&D staff ☐
7. Universities ☐
8. Consultants ☐
9. Trade shows ☐
10. Seminars ☐
11. Conferences ☐
12. Others (please specify) ..... ☐

Q.7 How many technical staff do you have? ..... persons
(If there exist any technical staff, probe more on their academic background, their roles in the Thai food industry, e.g. working as consultant, research contract.)

.....
.....
.....
.....

****

SHOWCARD 1

Activities

1. Food ingredient supplier
2. Food processing equipment supplier
3. Food packaging supplier
4. Consultant
5. University
6. Research institute
7. Others (please specify)

****

SHOWCARD 2

Food ingredients

1. Flavouring/Colouring Agents
2. Starches/Modified Starch
3. Stabilisers/Emulsifiers/Binding Agents
4. Antioxidants/Preservatives
5. Sweeteners
6. Spices/Seasonings
7. Micronutrients/Vitamins/Functional foods
8. Others (please specify)

****

SHOWCARD 3

Contact person

1. Chief executive officer
2. Production manager
3. Technical manager
4. Technical Q.C. staff
5. Technical product development staff
6. Marketing/sales manager
7. Marketing/sales staff
8. Purchasing staff
9. Administrative staff
10. Others (Please specify).....

****

SHOWCARD 4

Frequency

1. Occasionally
2. Frequently

****

****

SHOWCARD 5

Sources of technical information

1. Overseas parent company
2. Your own library
3. Your own database
4. Suppliers/producers
5. Magazines/Journals
6. Your own R&D staff
7. Universities
8. Consultants
9. Trade shows
10. Seminars
11. Conferences
12. Others (please specify)

****

APPENDIX 9 TELEPHONE CONTACT GUIDE FOR FOCUS GROUP

Company name..... Date.....
Address..... Phone ( ).....

Hello, my name is Prasong Siriwongwilaichat, a Ph.D. student at Massey University, New Zealand. May I talk to [a person participating Survey 2].

[IF AVAILABLE THEN CONTINUE]

Hello, I am Prasong Siriwongwilaichat, a Ph.D. student at Massey University, New Zealand. Thank you for your last participation in the recent survey of my research on technical information used by food company in Thailand. Now, I have summarised the results and I would like you to join a group of product development technical staff, who also participated last survey from other food companies in Thailand to discuss the findings. No commercial purpose but your point of view will be involved. It will be held on [Date], at [Place]. The meeting will be over at [Time]. Will you be available to attend?

( ) Yes
( ) No [THANK AND TERMINATE]

[IF YES]

Name..... Phone:.....
Appointment: Date..... Time.....

If for some reason you find you are not able to attend, please let me know as soon as possible. My contact number is ..... Thank you and good-bye.

APPENDIX 10 SUMMARY OF SURVEY 2 FOR PARTICIPATING COMPANIES

The Relevance of Technical Knowledge Sources to the Food Product Development Process in the Branded Consumer Food Market in Thailand

Prasong Siriwongwilaichat

This survey was conducted between February and June 1999. It involved direct interviewing participants from 62 companies, which had launched new branded consumer food products in the Thai market during the last 3 years. There were four types of company ownership and the proportion involved in this survey is shown in Figure 1.

Four different new branded consumer food product types were defined.[1] Of these product types, LE represented the largest proportion launched by these companies (40%). Other types included PNC (25%), VA (25%) and ICNP (9%). Every company surveyed had their own manufacturing facilities. In addition, 11% used contract manufacturers for some of their production, 5% imported products already prepared for the market place and 2% used some alternative means of obtaining products.

All ICNP were introduced in the last 3 years by manufacture in Thailand, either by the company or a contract manufacturer. All VA were achieved by companies manufacturing for themselves in Thailand. LE and PNC were obtained from all sources: imported-ready to sell; own manufacture; contract manufacture, and; "other". This other source of obtaining new products was imported and repacked in Thailand.

New product ideas came from many sources (Figure 2). The main sources were ideas from their own staff (69% of companies surveyed used this method), products seen while travelling overseas (66% of companies), and products seen in Thailand (53% of companies).

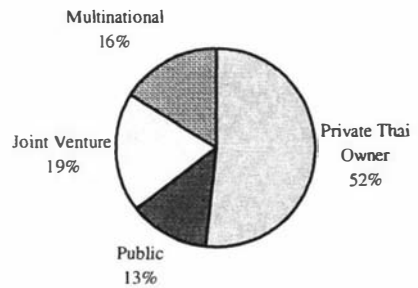


Figure 1 Proportion of Company Ownership

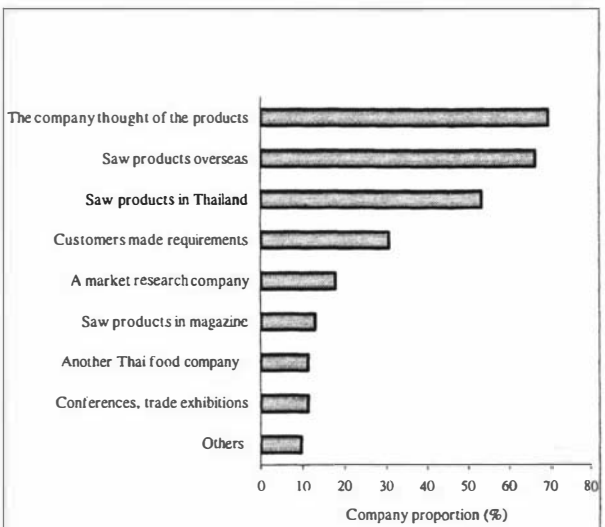


Figure 2 Sources of New Product Ideas

[1] *ICNP (Innovative Products-Completely New to the Thai Market)*: food products, which were the first on the Thai market.
PNC (Products- New to Company): food products which were new to a company but already existed on the Thai market.
VA (Value Added Products): food products a company already sold on the Thai market but which the company improve the product characteristics (greater convenience, longer shelf- life or cost reduction).
LE (Line Extensions): food products, which extended the range of an existing product that a company already had on the Thai market.

The major technical knowledge sources used to support these new product introductions were company's own technical staff and food ingredient suppliers. The parent company or overseas joint venture company was another major technical knowledge source for Multinational companies and Joint venture companies. Technical knowledge sources were mainly used for the purpose of food formulations, shelf-life studies, quality control and food processing (Figure 3).

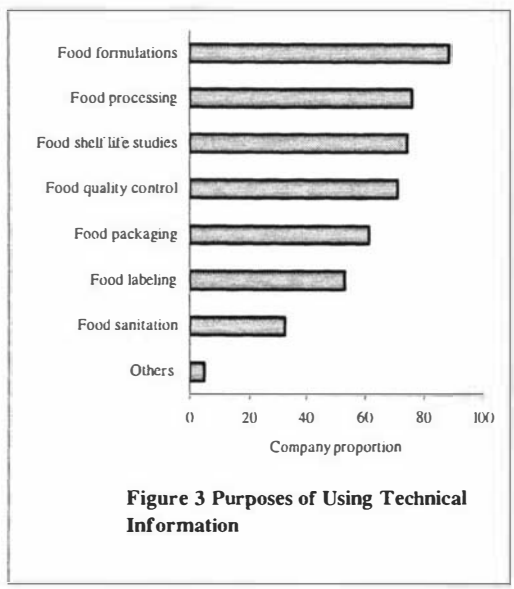


Figure 3 Purposes of Using Technical Information

Sixty companies had their own product development technical staff. These staff received their post-employment technical knowledge through food ingredient suppliers (83%) and by attending seminars both in Thailand (95%) and overseas (45%). Most of these companies had their own research and development laboratory (90%).

Technical staff were considered useful because they were experienced and skilful with in-house technology and products. However, they have some limitations in keeping aware of new and advanced knowledge. Ingredient suppliers were useful at supplying application information. However, these data needed modification to be successfully implemented in the company's own manufacturing plant.

Analysis of the interactions evaluated in this study showed that there was a significant association between the new branded food product type and the technical knowledge source. There was no significant association amongst company ownership or the method of obtaining (or manufacturing) new products. Of the four types of products being introduced to the market, the technical knowledge sources for ICNP and PNC were identical. Similar those sources for VA and LE were identical but significantly different to the other two product types. While only two categories of technical knowledge source (technical staff and ingredient suppliers) played major roles in VA and LE, four categories of technical knowledge source (technical staff, food processing equipment suppliers, Thai consultants and other sources) were significant in ICNP and PNC. Food products which were radically innovative (ICNP and PNC) tended to involve more technical knowledge sources than those incrementally innovative ones (VA and LE). Suppliers seemed to be important technical knowledge sources, second to the company's own technical staff.

It appears that in-house technical staff are the major knowledge asset of food companies in Thailand. The study will attempt to understand how these technical staff maintain their awareness of external R&D trends and modern advances so they can apply these new issues to their company.

APPENDIX 11 PRODUCT DEVELOPMENT TECHNICAL STAFF FOCUS GROUP

Good (morning/evening) and welcome to our session today. Thank you for taking your time to join our discussion on the use of technical knowledge sources for new food product development. My study is sponsored by the Royal Thai Government Scholarship. I will be working as a lecturer at the Department of Food Technology, Silpakorn University after my graduation. Assisting me is ..... Before we start discussion, I would like to present you the results from previous survey. After that, I would like to have your opinion on the findings. We have invited product development technical staff from various food companies. We are particularly interested in your views. There are no right or wrong answers but rather differing point of view. So please feel free to share your point of view even if it differs from what others have said. Now, let's start my presentation of the results.

[REREARCH RESULTS PRESENTAION, 10 MINUTES]

Now, let me share some ground rules. This is strictly a research project for my Ph.D. study only and there are no commercial purposes involved. Please speak up-only one person should talk at a time. We are tape recording the session because we don't want to miss any of your comments. We will use your first name today, and in our later reports no name will be attached to comments. You may be assured of complete confidentiality. Please keep in mind that we are just as interested in negative comments as positive comments, and at times the negative comments are the most helpful.

Our session will last about an hour and a half. Let's begin. We have placed your name on the table in front of you to help us remember each other's names. Please tell us your name and role in the company.

[START DISCUSSION]

DISCUSSION GUIDES:

- Ask participants for comments on the research findings

- The role of food ingredient suppliers

- How technical staff update their technical information (not just product development)

- Limitation of technical inputs

- Product development process

- Let's summarise the key points of our discussion.

- Does this summary sound complete? Do you have any changes or additions?

- The goal of this discussion is to verify the research findings and to find out critical issues on technical knowledge sources used by food manufacturing companies in Thailand to support their product development activities. Have we missed anything? What advice do you have for us?

APPENDIX 12 COMPANY OWNERSHIP AND USE OF TECHNICAL KNOWLEDGE SOURCES (ONLY FOR OWN MANUFACTURED PRODUCTS)

TABLE 1 COMPANY OWNERSHIP AND USE OF TECHNICAL STAFF

Ownership	Technical staff		
	Used	Not used	Total
Thai	31	1	32
Public	8	0	8
Joint venture	12	0	12
Multinational	10	0	10
Total	61	1	62

Pearson Chi-Square = 0.953 (p = 0.813), Likelihood Ratio = 1.338 (p = 0.720), df = 3
Contingency coefficient = 0.123

TABLE 2 COMPANY OWNERSHIP AND USE OF INGREDIENT SUPPLIERS

Ownership	Food ingredient suppliers		
	Used	Not used	Total
Thai	22	10	32
Public	7	1	8
Joint venture	11	1	12
Multinational	5	5	10
Total	45	17	62

Pearson Chi-Square = 5.889 (p = 0.117), Likelihood Ratio = 6.311 (p = 0.097), df = 3
Contingency coefficient = 0.295

TABLE 3 COMPANY OWNERSHIP AND USE OF FOOD PROCESSING EQUIPMENT SUPPLIERS

Ownership	Food processing equipment suppliers		
	Used	Not used	Total
Thai	11	21	32
Public	5	3	8
Joint venture	4	8	12
Multinational	2	8	10
Total	22	40	62

Pearson Chi-Square = 3.639 (p = 0.303), Likelihood Ratio = 3.596 (p = 0.309), df = 3
Contingency coefficient = 0.235

TABLE 4 COMPANY OWNERSHIP AND USE OF FOOD PACKAGING SUPPLIERS

Ownership	Food packaging suppliers		
	Used	Not used	Total
Thai	13	19	32
Public	6	2	8
Joint venture	2	10	12
Multinational	4	6	10
Total	25	37	62

Pearson Chi-Square = 6.790 (p = 0.079), Likelihood Ratio = 7.112 (p = 0.068), df = 3
Contingency coefficient = 0.314

TABLE 5 COMPANY OWNERSHIP AND USE OF FOOD MANUFACTURERS IN THAILAND

Ownership	Food manufacturers in Thailand		
	Used	Not used	Total
Thai	4	28	32
Public	2	6	8
Joint venture	2	10	12
Multinational	1	9	10
Total	9	53	62

Pearson Chi-Square = 1.023 (p = 0.796), Likelihood Ratio =0.938 (p=0.816), df = 3
Contingency coefficient = 0.127

TABLE 6 COMPANY OWNERSHIP AND USE OF OVERSEAS FOOD MANUFACTURERS

Ownership	Overseas food manufacturers		
	Used	Not used	Total
Thai	5	27	32
Public	3	5	8
Joint venture	1	11	12
Multinational	1	9	10
Total	10	52	62

Pearson Chi-Square = 3.524 (p = 0.318), Likelihood Ratio = 3.075 (p = 0.380), df = 3
Contingency coefficient = 0.232

TABLE 7 COMPANY OWNERSHIP AND USE OF THAI CONSULTANTS

Ownership	Thai consultants		
	Used	Not used	Total
Thai	11	21	32
Public	4	4	8
Joint venture	0	12	12
Multinational	0	10	10
Total	15	47	62

Pearson Chi-Square = 11.735 (p = 0.008), Likelihood Ratio = 16.335 (p = 0.001), df = 3, Contingency coefficient = 0.399

TABLE 8 COMPANY OWNERSHIP AND USE OF THAI UNIVERSITIES

Ownership	Thai universities		
	Used	Not used	Total
Thai	5	27	32
Public	3	5	8
Joint venture	2	10	12
Multinational	2	8	10
Total	12	50	62

Pearson Chi-Square = 2.031 (p = 0.566), Likelihood Ratio = 1.781 (p= 0.619), df = 3 Contingency coefficient = 0.178

TABLE 9 COMPANY OWNERSHIP AND USE OF THAI RESEARCH INSTITUTES

Ownership	Thai research institutes		
	Used	Not used	Total
Thai	2	30	32
Public	2	6	8
Joint venture	0	12	12
Multinational	0	10	10
Total	4	58	62

Pearson Chi-Square = 6.080 (p = 0.108), Likelihood Ratio = 5.703 (p = 0.127), df = 3 Contingency coefficient = 0.299

TABLE 10 COMPANY OWNERSHIP AND USE OF LOCAL LIBRARIES

Ownership	Local libraries		
	Used	Not used	Total
Thai	12	20	32
Public	5	3	8
Joint venture	3	9	12
Multinational	3	7	10
Total	23	39	62

Pearson Chi-Square = 3.183 (p = 0.364), Likelihood Ratio = 3.136 (p = 0.371), df = 3
Contingency coefficient = 0.221

TABLE 11 COMPANY OWNERSHIP AND USE OF COMPANIES' LIBRARIES

Ownership	Companies' libraries		
	Used	Not used	Total
Thai	6	26	32
Public	3	5	8
Joint venture	2	10	12
Multinational	2	8	10
Total	13	49	62

Pearson Chi-Square = 1.554 (p = 0.670), Likelihood Ratio = 1.386 (p = 0.709), df = 3
Contingency coefficient = 0.156

TABLE 12 COMPANY OWNERSHIP AND USE OF OVERSEAS CONSULTANTS

Ownership	Overseas consultants		
	Used	Not used	Total
Thai	4	28	32
Public	0	8	8
Joint venture	1	11	12
Multinational	2	8	10
Total	7	55	62

Pearson Chi-Square = 1.927 (p = 0.588), Likelihood Ratio = 2.710 (p = 0.439), df = 3
Contingency coefficient = 0.174

TABLE 13 COMPANY OWNERSHIP AND USE OF OVERSEAS UNIVERSITIES

Ownership	Overseas universities		
	Used	Not used	Total
Thai	2	30	32
Public	0	8	8
Joint venture	0	12	12
Multinational	0	10	10
Total	2	60	62

Pearson Chi-Square = 1.937 (p = 0.585), Likelihood Ratio = 2.708 (p = 0.439), df = 3 Contingency coefficient = 0.174

TABLE 14 COMPANY OWNERSHIP AND USE OF OTHER TECHNICAL KNOWLEDGE SOURCES

Ownership	Other sources		
	Used	Not used	Total
Thai	3	29	32
Public	2	6	8
Joint venture	6	6	12
Multinational	7	3	10
Total	18	44	62

Pearson Chi-Square = 16.771 (p = 0.001), Likelihood Ratio = 16.940 (p = 0.001), df = 3, Contingency coefficient = 0.461

APPENDIX 13 ADVANTAGES AND DISADVANTAGES OF TECHNICAL KNOWLEDGE SOURCES

Knowledge sources	Advantages	Number	Disadvantages	Number
1. Technical staff		(n = 47)		(n = 45)
	Experienced and skilful in in-house technology and products	23	Limit of new and advanced knowledge	34
	Fast	12	Take time for trial and error for innovative products	4
	Convenient/Simple	7	High turnover of staff	3
	Keep confidential	6	Little creative and limit of innovative knowledge	3
	Ability to solve problems in time	5	Lack of skill	2
	Especially useful for incrementally innovative products	4	Limit of number of staff	1
	Provide technical information about products	4	Limit of accuracy	1
	Know local consumers well	3	Lack of advanced tools	1
	Reliable	2		
	Ability of self improvement	2		
	Flexible	2		
	Familiar with team work	1		
	Save cost	1		
	Leading to production	1		
	Meet objective	1		

APPENDIX 13 *(Continued)*

Knowledge sources	Advantages	Number	Disadvantages	Number
2. Food ingredient suppliers	Fast and time saving	(n = 39) 10	Limit of knowledge and understanding of the process of users well	(n = 39) 13
	Supply technical information needed for new products	14	Unreliable	9
	Variety of knowledge	4	Not completely applicable or ready to use/ Suggestions don't match the process of users/ Inaccurate	8
	Accurate and reliable	3	Time consuming for applying to company's products	5
	Share knowledge and ideas Gained from outside or other companies.	3	Danger to confidentiality	3
	Provide and suggest new ideas applied to company's products	3	Time consuming waiting for information needed	2
	Knowledge is updated	2	Too much monopoly and reliance of ingredients	2
	Useful for product improvement	1	Limit of knowledge in other areas	2
	Help solve technical problems	1	Not consistent	1
3. Food processing equipment suppliers	Provide technical support from R&D centre from overseas	(n = 5) 1	Need time to adapt to local process	(n = 4) 1
	Provide guideline and initial information	1	Unreliable information due to business purpose	1
	Time saving	1	Danger to confidentiality	1
	Reliable	1	Limit of food knowledge	1
	Updated information	1		

APPENDIX 13 *(Continued)*

Knowledge sources	Advantages	Number	Disadvantages	Number
4. Food packaging suppliers	Provide new ideas	(n = 5) 2	Danger to confidentiality	(n = 5) 2
	Support information needed quickly	1	Limit of knowledge about food products	1
	Expert	1	Limit of knowledge in other areas	1
	Provide training	1	High cost	1
5. Food manufacturing companies in Thailand	Expert in products	(n = 5) 2	No confidentiality	(n = 5) 2
	Provide food recipes	1	Limit of knowledge about product concepts of using company	1
	Fast	1	High cost	1
	Low loss and risk	1	Little co-operative	1
	Easy to apply for similar Technology	1		
6. Overseas food manufacturing companies	Keep confidentiality	(n = 2) 1	Need time to search	(n = 3) 1
	Good know-how	1	Very different technology	1
			Communication barriers	1
7. Thai consultants	Provide additional knowledge needed	(n = 8) 3	Limit of working time	(n = 8) 4
	Keep confidentiality	1	Limit of advanced knowledge	2
	All information of company can be disclosed to consultant	1	Not much practical	2
	Fast	1	High cost	2
	Provide new ideas	1		
	Experienced	1		
	Provide general ideas	1		
	Useful for very innovative Products	1		

APPENDIX 13 *(Continued)*

Knowledge sources	Advantages	Number	Disadvantages	Number
8. Thai universities	Suggest knowledge sources	(n = 1) 1	Suggestion was not compatible with company's process and equipment	(n = 1) 1
	Reliable	1		
9. Thai research institutes	Reliable	(n = 1) 1	High cost	(n = 1) 1
10. Local libraries	Provide wide variety of information and everything needed	(n = 9) 3	Time consuming	(n = 11) 6
	Provide principle knowledge	2	Hardly find information needed	5
	Provide good references	2	Information is not updated	4
	Convenient	1	Not convenient	2
	Reliable	1		
11. Companies' libraries	Ready to use	(n = 1) 1	Language barriers	(n = 1) 1
	Enough good and new references	1		
12. Overseas consultants	New and diversified technical knowledge	(n = 3) 2	Communication barriers	(n = 2) 1
	Useful for innovative products	1	High cost	1
13. Overseas universities				
14. Others				
14.1 Overseas joint venture companies	Ready to use and transfer	(n = 4) 1	Communication barriers	(n = 3) 2
	Expert	1	Limit of local knowledge	1
	Complete facilities	1	Not convenient	1
	Provide expert staff	1		
	Gain right information	1		
14.2 Parent companies	Provide better technology	(n = 1) 1	Communication barriers	(n = 1) 1
14.3 Overseas shareholding companies	Time saving	(n = 1) 1	Communication barriers	(n = 1) 1
14.4 Overseas customers	More accurate and complete information	(n =1) 1	*No comment*	-
14.5 International exhibitions	*No comment*	-	High cost	(n = 1) 1
			Language barrier	1

APPENDIX 14 ASSOCIATION BETWEEN COMPANY OWNERSHIP AND MOST IMPORTANT TECHNICAL KNOWLEDGE SOURCES WITHIN EACH NEW PRODUCT TYPE (ONLY FOR OWN MANUFACTURED PRODUCTS)

TABLE 1 ASSOCIATION BETWEEN OWNERSHIP AND TECHNICAL KNOWLEDGE SOURCES FOR ICNP

Technical knowledge sources	Company ownership				
	Thai private	Thai public	Joint venture	Multinational	Total
Technical staff	7	0	1	4	12
Food processing equipment suppliers	1	0	1	0	2
Overseas food manufacturers	0	1	0	0	1
Thai consultants	3	0	0	0	3
Companies' libraries	1	0	0	0	1
Overseas consultants	1	0	0	0	1
Others	0	1	2	1	4
Total	13	2	4	5	24
Pearson Chi-Square = 25.792 (p = 0.105), Likelihood Ratio = 23.506 (p = 0.172), df = 18, Contingency Coefficient = 0.720					

TABLE 2 ASSOCIATION BETWEEN OWNERSHIP AND TECHNICAL KNOWLEDGE SOURCES FOR PNC

Technical knowledge sources	Company ownership				
	Thai private	Thai public	Joint venture	Multinational	Total
Technical staff	9	3	5	2	19
Food ingredient suppliers	2	0	0	0	2
Food processing equipment suppliers	1	2	0	0	3
Food manufacturers in Thailand	1	1	0	0	2
Overseas food manufacturers	0	1	0	0	1
Thai consultants	1	0	0	0	1
Companies' libraries	1	0	0	0	1
Overseas consultants	1	0	0	0	1
Others	0	1	0	1	2
Total	16	8	5	3	32
Pearson Chi-Square = 19.421 (p = 0.729), Likelihood Ratio = 20.883 (p = 0.646), df = 24, Contingency Coefficient = 0.615					

TABLE 3 ASSOCIATION BETWEEN OWNERSHIP AND TECHNICAL KNOWLEDGE SOURCES FOR VA

Technical knowledge sources	Company ownership				
	Thai private	Thai public	Joint venture	Multinational	Total
Technical staff	11	4	8	4	27
Food ingredient suppliers	2	0	2	1	5
Food processing equipment suppliers	0	1	0	0	1
Food packaging suppliers	1	0	0	1	2
Thai consultants	1	0	0	0	1
Overseas consultants	1	0	0	0	1
Others	0	0	1	1	2
Total	16	5	11	7	39
Pearson Chi-Square = 15.390 (p = 0.635), Likelihood Ratio = 15.080 (p = 0.656), df = 18, Contingency Coefficient = 0.532					

TABLE 4 ASSOCIATION BETWEEN OWNERSHIP AND TECHNICAL KNOWLEDGE SOURCES FOR LE

Technical knowledge sources	Company ownership				
	Thai private	Thai public	Joint venture	Multinational	Total
Technical staff	13	4	10	7	34
Food ingredient suppliers	4	1	1	1	7
Food processing equipment suppliers	0	1	0	0	1
Thai consultants	1	0	0	0	1
Companies' libraries	1	0	0	0	1
Overseas consultants	1	0	0	0	1
Total	20	6	11	8	45
Pearson Chi-Square = 11.704 (p = 0.701), Likelihood Ratio = 10.373 (p = 0.796), df = 15, Contingency Coefficient = 0.454					

APPENDIX 15 ASSOCIATION BETWEEN NEW PRODUCT TYPES AND MOST IMPORTANT TECHNICAL KNOWLEDGE SOURCES WITHIN EACH NEW PRODUCT TYPE (ONLY FOR OWN MANUFACTURED PRODUCTS)

TABLE 1 ICNP AND PNC VERSUS TECHNICAL KNOWLEDGE SOURCES

Technical knowledge sources	New product types		
	ICNP	PNC	Total
Technical staff	12	19	31
Food ingredient suppliers	0	2	2
Food processing equipment suppliers	2	3	5
Food manufacturers in Thailand	0	2	2
Overseas food manufacturers	1	1	2
Thai consultants	3	1	4
Companies' libraries	1	1	2
Overseas consultants	1	1	2
Others	4	2	6
Total	24	32	56
Pearson Chi-Square = 6.436 (p = 0.599), Likelihood Ratio = 7.920 (p = 0.441), df = 8, Contingency Coefficient = 0.321			

Note: ICNP = Innovative Products-Completely New to the Thai Market

PNC = Products-New to Company

VA = Value Added Products

LE = Line Extensions

TABLE 2 VA AND LE VERSUS TECHNICAL KNOWLEDGE SOURCES

Technical knowledge sources	New product types		
	VA	LE	Total
Technical staff	27	34	61
Food ingredient suppliers	5	7	12
Food processing equipment suppliers	1	1	2
Food packaging suppliers	2	0	2
Thai consultants	1	1	2
Companies' libraries	0	1	1
Overseas consultants	1	1	2
Others	2	0	2
Total	39	45	84
Pearson Chi-Square = 5.737 (p = 0.571), Likelihood Ratio = 7.642 (p = 0.365), df = 7, Contingency Coefficient = 0.253			

Note: ICNP = Innovative Products-Completely New to the Thai Market

PNC = Products-New to Company

VA = Value Added Products

LE = Line Extensions

APPENDIX 16 FOCUS GROUP DISCUSSION

FOCUS GROUP 1 (18/03/00)

Participants:

Company	Company ownership
1. C1	Thai private
2. C2	Thai public
3. C3	Thai private
4. C4	Joint venture
5. C5	Thai private
6. C6	Thai private

What do you think about the previous survey on technical information sources for new food product introduction in Thailand?

C1: I agree with the results but I have additional opinions. In our company, we usually do process development according to problems we have. For example, we had a problem with dissolving stabilisers. We designed bladder to enable better powder dispersion. We have developed and modified our own machines. We do use two main sources of technical information, i.e. our own staff and equipment suppliers.

C5: Our technical staff are very important to new products of which process doesn't change from our existing one. When new product is completely new to our company, we need to find out new equipment but we still have our technical staff do product formulations.

C3: It really depends on what kind of new product we are developing. If a new product has the same base as our existing products, we really need help from ingredient suppliers. We usually need technical information from ingredient suppliers during our laboratory scale trials.

C2: Many ingredient suppliers seem to compete in serving technical information to their customers. This leads to benefits to us because we can gain information quickly. Overseas technical information enables us to keep updated and improve our knowledge.

C3: Ingredient suppliers help us keep updated in new technology, which is developed very fast at the present time.

Sorts of technical information and service ingredient suppliers or any other sources provide

C6: There are two kinds of that service. One is done by ingredient suppliers, and then it is adapted to our process by our own. The other is that ingredient suppliers provide us basic food recipes. We are usually informed about new ingredients, especially those help us reduce our product cost. We use technical information sources according to the sort of a problem. For example, if we need new packaging, we will consult packaging suppliers. In some cases, we ask our consultant to find solution for us when we have problems. For example, our imported wine had unusual taste. We ask our consultants to conduct research to find the cause of this problem.

C5: Ingredient suppliers provide us technical datasheets about ingredient specifications, basic recipes and its applications. Suppliers, especially the flavour houses, sometimes bring our base and develop ingredients for us. Sometimes we are presented with samples from overseas. If we are interested, we can ask for formulation datasheets with samples.

C4: In some cases when we are not sure about applying new ingredients for our products, we usually ask suppliers to do trial for us. We just give them our product base.

C3: Some ingredient suppliers have their own R&D staff and pilot plants which are available for us to use but usually in overseas. We also sometimes ask ingredient suppliers to develop ingredients for us, and then we formulate products by ourselves.

C2: We find that raw materials in Thailand are inconsistent. So sometimes we give suppliers our product sample to be tested in overseas laboratory. We find that this kind of co-operation help us develop our products faster. We get assistance from consultants as well but they provide us only suggestions for our new product projects.

When you have technical problems about your products, where do you usually find solutions?

C1: We consult both ingredient suppliers and equipment suppliers, depending on sorts of problem. Ingredient suppliers provide us solution for food formulations and equipment suppliers help us solve problems relating to food processing.

C3: It depends on sorts of problem. We use various means such as studying from textbook, consulting academic staff who used to teach us. Since we don't have various forms of products, we usually consult our own experienced staff.

Are there any other technical information sources you would like to mention?

C3: We used to use research institute but we found that their information was not applicable to our process. We usually found that kind of technical information was not the right answer for us. We are always approached by ingredient suppliers and we found that they gave us much more right solutions. We don't have to find them but they usually contact us first.

C6: We also used to join research institute but we found many constraints of their abilities to provide us the right solution. This is because we cannot disclose all of our process due to our business confidentiality. In addition, their expertise is not applicable to our area. Therefore, we tend to rely on our own technical staff to take care all of these activities.

C5: Ingredient suppliers usually come to help us. Some ingredient suppliers even provide knowledge to academic staff by arranging seminar. So we almost don't have to find any other technical information sources.

C2: Ingredient suppliers play very important role to our new products, especially value-added products. They provide us readily applicable technical information. We also had consultants from academic staff who can provide us fundamental knowledge. So we integrated these knowledge sources to enhance our product development activities.

How important ingredient suppliers are to your new product development?

C4: Our main products are instant noodles. So we use a lot of seasonings and ingredient. Suppliers help us a lot.

C1: We usually obtain basic recipes and technical datasheet from ingredient suppliers but we develop our own food recipes.

How do you know about new and advanced technology in food products?

C1: We usually get it from ingredient suppliers and seminars held by Ministry of Science, Technology and Environment.

C2: We subscribe some journals. We also get new techniques from internet, e.g. new varieties and designs of cake and bakery as well.

C3: We attend seminars both in Thailand and overseas. We also subscribe both local and overseas journals. Equipment suppliers also help us find journal sources from overseas. We also use an internet and sometimes we get information from food associations. Some of our products are under license and we get a lot of technical information from overseas licensors.

C4: We subscribe journals, get some information from ingredient suppliers and from internet.

C5: We subscribe overseas journals. Suppliers, especially flavour houses from overseas provide us their own produced journals. We also attended seminars sometimes.

C6: We learn from various sources, e.g. journals, seminars, and suppliers.

Please tell us briefly about steps you go about new food product development.

C6: We first find where we can make use of our processing equipment capacity. The aim is to fully utilise our production capacity we have. Then we offer the new product projects to the top management. If our new products are very new to our company, we need help from suppliers.

C5: We try to extend our new products using existing equipment so that we can launch our products faster.

C4: We gain new product ideas from marketing and our top management. Then we develop and design products. The samples are tested by marketing department.

C3: New product ideas are from our customers but our managing director will make decision. We test product in laboratory before scale-up in production line. Our market research provides us consumer information. We have GO-NO GO decision at all steps.

C2: We have new product meeting two times a week. New product ideas are from top management and marketing staff. We develop a product and ask top management to taste it and make decision. We are required to launch at least one new product/month. Marketing department will provide feedback after new products have been launched.

C1: We gain new product ideas from our customers and marketing staff. Apart from that, we deal with modifications of machine, raw materials and packaging more often.

What would you expect from technical information sources available in Thailand?

C3: There is no right technical information in Thailand for us. We usually find valuable information overseas. In addition, technical information in Thailand is not updated and too late for us.

C6: We are much concerned about our confidentiality. Since ingredient suppliers have many contacts, our confidential information would be disclosed to other companies. Information from University is too general to be applied to our company.

C1: We would like to see technical information centre in Thailand where we can find and search information needed.

FOCUS GROUP 2 (24/03/00)

Participants:

Company	Company ownership
1. C11, C12 (2 participants)	Thai public
2. C2	Joint venture
3. C31, C32, C33 (3 participants)	Thai private

Main technical information sources when new food products are introduced

C12: We usually go to libraries or ask ingredient suppliers when we develop new products.

C31: Our company usually launches not completely new products. So we tend to rely on our own technicians.

C2: Our staff are the main technical source. Marketing staff also supply new product ideas from overseas to our staff. We also gain technical information from suppliers, especially that related to our products.

Sorts of technical information and service ingredient suppliers or any other sources provided

C2: We are provided with basic food recipes with technical datasheets and ingredient specifications.

C11: Food ingredient suppliers also help find technical information for us. They also offer to do shelf life studies for us but we have never tried that service.

C31: Food ingredient suppliers provide us consultancy when we have technical problems on our products. Sometimes they give us ingredient samples with technical reports.

When you have technical problems about your products, where do you usually find solutions?

C11: We have to find out from textbooks and information searches but we find out that suppliers and academic staff can give us much more faster solutions.

C2: We usually find technical problems in production line and we need to consult our engineers. Sometimes, we have to verify if information from suppliers is applicable to our process or not. Then we will provide feedback to suppliers.

C31: We either consult our expert staff or suppliers.

Are there any other technical information sources you would like to mention?

C2: We used to use hot line information from The National Food Institute which serves its member. We also get information from subscribed journals.

C11: We can consult by personal contact with known persons and academic staff in the university from which we have graduated. We do use textbooks a lot.

C33: We virtually use our in-house technology and our technical staff can develop product by their own.

How do you know about new and advanced technology in food products?

C12: We attend seminars or workshops. We also get information from subscribed local journals and newspapers. Seminars we attended were either held by the food ingredient suppliers or the research institutes.

C2: We gain a lot of information from our overseas customers and subscribed journals. We also visit some web sites on internet.

C33: We subscribe many overseas journals such as confectionery.

C31: We used to attend seminars held by ingredient suppliers.

Please tell us briefly about steps you go about new food product development.

C2: The marketing department provides new product ideas to the R&D department. Then R&D designs and prepares sample for the marketing department. If a product is acceptable, we then send the product to production line. R&D task will be over after the first batch of new product is launched. We also used to ask packaging suppliers to test new packaging materials for our products.

C11: Our new product ideas come from CEO, Marketing or R&D. R&D will design new product and marketing will approve.

C33: We do market survey first to find out market segment. We then formulate our new products in laboratory and then scale up. Technicians from suppliers also assist us in technical problems solving.

How would you comment on technical information sources available in Thailand?

C31: We have time constraints to search information from other sources.

C12: We also don't have enough time to obtain other information.

C33: Most libraries in Thailand are closed too early. We usually don't have time during office hour. A lot of information are also kept and not released.

C2: Since we don't have much time to search information outside, we subscribe journals so that we don't have to travel and we can find information whenever we need.

FOCUS GROUP 3 (1/04/00)

Participants:

Company	Company ownership
1. C1	Multinational
2. C2	Thai public
3. C3	Thai public
4. C4	Joint venture
5. C5	Joint venture

Main technical information sources when new food products are introduced

C4: We have knowledge from school. We also obtain information from textbooks, our parent company and suppliers. We also have to do experiment by ourselves. We have to modify information obtained as it is not readily applicable. Since we don't have time to go to the library, we usually have our own books. So we actually acquire basic information for our work. We also consult specialists because they save our time a lot. Specialists are suppliers, technical staff from overseas parent or affiliated company.

C5: We sometimes use the internet which provides information needed, e.g. recipes and nutrition. Although we have technical information from overseas, we need to modify products to suit local market.

C1: Our company conducts consumer research worldwide and implement in each local or regional market. We just do process development in Thailand.

C4: We rely on our local technical staff because local people understand local market better.

C3: We basically have our own staff develop our new products. We do have internet access in our company but we don't have much time to go about it.

(Note: All companies in this group have internet access.)

Sorts of technical information frequently used

C1: Textbooks, manuals (recipe and process) available in our company. We also have technical record of recipe and process chart so that anyone in our company can use.

C2: It depends on what we are doing with our products. If we need new ingredients, we have to contact ingredient suppliers providing overseas information. We also get consultancy from government agencies (research institutes) doing research relating to our product areas when we have some technical problems.

C3: We are also doing the same.

C4: We also have experienced persons in our company and affiliated companies to share experiences and information.

C5: Our overseas parent company has R&D centre providing technical inputs but when applied to our process we need to consult suppliers.

Let's summarise: There are 2 types of technical information, fundamental and applied information. (DRAW A CHART)

Fundamental information
Research institute
Internet

Applied information
Specialists: Ingredient suppliers, Parent company, Joint venture, Academic staff
Internet
Government agencies

Specialists:

C5: We sometimes talk to academic staff in university or known person but we didn't pay for consultancy. Sometimes we just meet and approach them in seminar meeting.

C3: We consult academic staff by personal contact and relationship while we were studying.

Internet:

C4: Internet provides both fundamental and applied technical information.

Government agencies:

C5: We deal with government agencies when we need to register our food products, e.g. Thailand FDA.

C5: Research institutes, e.g. the nutrition institute or the food research institute provides us fundamental information.

What sorts of technical information do ingredient suppliers provide?

C4: Ingredient applications, product shelf life studies.

C1, C5: Technical sheets, clinical data, and certificates of food ingredients.

How important ingredient suppliers are to your new product development?

C5: We meet ingredient suppliers almost every week. They help us a lot in developing our new products.

C4: We are quite satisfied with information they provide because it is updated and diversified.

C5: They help us save product development time and production cost.

C1, C3, C4: Flavour houses usually offer prototypes for us and we just try them for our products.

C1-C5: We provide our product base, then ingredient suppliers will formulate flavour for us.

C1, C3: When we need or deal with new packaging, we really have to ask packaging suppliers for technique as we cannot find anywhere else.

C5: Some packaging suppliers provide quite complete information, both recipes and processing procedure.

How do you know about new and advanced technology in food products?

C4: Seminars provide us a lot of information and update our technical knowledge.

C1-C5: Journals and magazines.
We have problems that we don't have time to read all journals. Most journals are in English. We don't find many Thai journals. Seminars seem to be most applicable because we don't need much time to read.

C1: Our company has research centre overseas in which there are many specialists. We are provided with interesting new technical information from time to time.

C5: Standardisation organisation, such as the Joint FAO/WHO Codex Alimentarius Commission, supplies us food standard information from time to time. Our company is one of the representative committee for standardisation.

By which organisation are seminars mostly held?

C4: University, ingredient suppliers, packaging suppliers (mostly aseptic package), parent company, TISI (Thai Industrial Standards Institute).

C3: Food Technologist Association of Thailand, equipment and packaging suppliers

C1: Internal training and workshops

C5: Government agencies responsible for food products, e.g. Ministry of Agriculture, Department of Livestock

Are there any comments on factors which affect your new product development to be on target or objective?

Facility:

C1-C5: We don't have enough facilities, especially pilot plant scale.

Staff:

C5: Not sufficient number. Not many technical staff understand that new product development takes time.

C4: Insufficient knowledge and research skill.

C4, C5: The policy aims at marketing rather than technical research and development.

Top management:

C4, C5: Lack of technical background to understand technical problems and pay less attention.

C4: New product concept is not clear

C3, C5: We have problems with internal communications amongst different functions.

Please tell us briefly about steps you go about new food product development.

C1: We have to propose a project. Then the project will be approved by the top management. If a similar new product has been done somewhere else in affiliated companies, we just adopt it. Then all we need to do is stability and shelf life studies.

C2: We start from sample (prototype), then analyse composition. We formulate our products in the laboratory before trying them in the production line. Then, the products will be approved by the marketing department.

C3: We do a lot of stability or shelf life tests.

C4: We got new product ideas from overseas and also consumer trends. We do internal test with 40-50 testing panels to approve recipe and do shelf life studies in parallel. We also conduct consumer research before discussing with marketing department prior launching. We also need to co-operate with the production department.

C5: We have got new product ideas from marketing staff, brainstorming and suppliers. We set project priority. The parent company usually provides recipes to us. We also do internal sensory tests. If the internal tests are consistent, we will try a small batch of product in the production line. Then we do consumer test and food registration in parallel.