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DEVELOPMENT OF NUTRITIONALLY BALANCED AND ACCEPTABLE ARMY RATION PACKS

A thesis presented in partial
fulfilment of the requirements for
the degree of Master of
Technology in Product Development
at Massey University

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ABSTRACT

Nutritionally balanced and consumer acceptable one man ration packs were developed for the N.Z. Army. The rations were designed quantitatively, using firstly mixed integer linear programming and secondly, menu planning techniques with spread sheet analysis.

For the mixed integer linear programming model, nutritional and food quantity constraints were obtained from a literature search and from a consumer survey on the present ration packs. The four menus of the first prototype ration pack, developed using mixed integer linear programming model, were consumer tested with a small group of soldiers during a field exercise in New Zealand. Focus groups determined the soldiers' attitudes to the new pack. The results showed that the first prototype ration pack was superior to the present ration pack, though improvements were still required.

Redesigning of the ration pack menus included the selection of commercially available foods and the development of 5 canned meat meals with army personnel consumer groups. The final menu planning used spreadsheet analysis, as it provided a quicker output of results. A second prototype ration pack, with four menus, was finally developed.

This second prototype ration pack was consumer tested with larger groups of soldiers in Malaysia and New Zealand, on separate field exercises. Both trials indicated high acceptance of the second prototype ration pack, with only the weight and the bulkiness being major problems.

A final prototype ration pack was developed based on the foods included in the second prototype. This pack included two main meals in the form of canned meat meals, several snack foods and

beverages. The average weight and cost of this final prototype ration pack were 1.411 kg and $10.62, compared to 1.275 kg and $8.10 for the present ration pack.

The nutritional composition of this final prototype did not meet all the human requirements, as it was based on the foods in the second prototype ration pack. Some of these foods, particularly the canned meals, need to be reformulated to ensure that the pack provides the complete requirements of the soldiers over the period of an exercise.

Quote from Emperor Haile Selassie in 1935 before the Ethiopian Mobilisation order against Mussolini's forces in World War II:

> "Everyone will be mobilised and all boys old enough to carry a spear will be sent to Addis Ababa. Married men will take their wives to carry food and cook. Those without wives will take any woman without a husband."

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CHAPTER 1

THE USE OF ARMY RATIONS

1.1 A HISTORY OF USAGE

Army rations have supplied food to soldiers on the move or situated away from their normal home base, since the Greek armies of Alexander the Great (Tauber, 1969). Essentially it has been necessary to supply rations on the basis of:

* the individual,
* the group (squad or crew); and
* the large group (company size or larger).

In the last two hundred years there have been dramatic improvements in Army rations due to firstly, the invention of the can, then modern drying and freeze drying and today retort pouches.

The ration pack of today is very different from that of the United States Army (U.S. Army Natlabs, 1982) established by Congressional Resolution on November 4, 1775, which:

> **"Resolved, that a ration consists of the following: 1 lb beef or 3/4 lb pork, or 1 lb salt fish per day; 1 lb bread or flour per day; 3 pints of peas or beans; 1 pint of milk per man per day, or at the rate of 1/72 of a dollar; 1 half pint of rice or one pint of Indian meal per man per day; 1 quart of spruce beer or cider per man per day, or 9 gallons of molasses per company of 100 men per week; 3 lbs candles to 100 men per week for guards; 24 lbs soft or 8 lbs of hard soap for 100 men per week."**

Little improvement in the food ration was seen during the Civil

War with only coffee, tea, seasonings and potatoes when practical being issued (Food Technology Research Centre, 1985d).

In 1896, an individual emergency ration was established. This was followed quickly by the Garrison, Field and Travel rations. By World War I, the field ration had been replaced by a reserve ration, with also a special reserve ration being added.

The reserve ration, intended for individual use, provided 454 grams each of canned meat and hard bread, with coffee, salt, sugar, a cube of soup, and solidified alcohol. Each ration furnished approximately 3,300 kilocalories (kcal) in a gross weight of 1.25 kilograms (kg). The special reserve ration was designed for 25 men for one day and consisted of canned food which weighed in total 48.6 kg. The emergency ration contained three 3-ounce cakes of beef powder and cooked wheat, and three 1-ounce chocolate bars.

Major developments in food rations began in 1934 and resulted in them being used in World War II, Korea and to the present day (improved version). Between 1941 and 1945, 23 different rations and ration supplements were developed (U.S. Army Natlabs, 1982). Most of these exist today except in an improved form. Technology has made it possible today to have a highly sophisticated Ration Pack (Fennema, 1975). The process of Reversible Compression has resulted in foods being as compact as possible. Nutrient fortification has made food more nutritious, and food processing using retort pouches has made the food more acceptable. These three areas: compactness (weight and volume), nutritional adequacy, and consumer acceptability are important criteria in ration pack design.

Parallel to the work on the design of the ration pack has been work on measuring the sensory acceptability of foods. The theory of scales of measurement (Stevens, 1946) and the hedonic scale

method (Peryam and Pilgrim, 1957) were both developed by scientists working for the U.S. Army laboratories. In the past decade or so, numerous consumer studies have been made on the acceptability of army rations. These have primarily been made by U.S., British and Australian Army scientists. These studies include field evaluations of ration packs used on Army exercises (Australian Department of Defence, 1986).

It can be seen that developments have been occurring overseas, in terms of Ration Pack development. However, no similar developments have occurred for 25 year with the N.Z. Army. This study was carried out partly because of this lack of development, and also because of consumer information received that dissatisfaction was being felt by soldiers with the present set of Ration Packs. This dissatisfaction resulted in large amounts of the contents of ration packs being discarded, and being replaced by food bought at supermarkets and other stores by the soldiers. This information indicated that the ration packs used by the N.Z. Army would not be adequate under real combat conditions in the advent of war.

As a study of all the types of army ration packs could not be carried out at the same time, it was planned that research should initially be made on the one man, 24 hour combat Ration Pack (canned).

1.2 THE NEW ZEALAND ARMY

The New Zealand Army is one of the three defence services that make up New Zealand's Armed Forces. Its main purpose is to combat any threat from outside the country and to assist allied countries in overseas conflicts. Appendix 1 gives details of New Zealand's defence policy objectives.

1.2.1 The Population

The New Zealand Army is comprised of Regular Force, Territorial Force and Reserve elements.

The army is structured to provide operational forces as follows:

* a Ready Reaction Force based on an infantry battalion group consisting of Regular Force personnel;

* an Integrated Expansion Force of brigade group size, comprised of Regular and Territorial Force personnel;

* a Deployable Force Maintenance Group, comprised of Regular and Territorial Force personnel; and

* a Capability based on additional existing units to be expanded when required.

Table 1.1 shows the composition of the NZ Army. Table 1.2 compares the strength of the Army between 1982 and 1985.

Table 1.1: Composition of the New Zealand Army

Major Regular Force Units	2 Infantry Battalions (1 in Singapore) 1 Light Tank Squadron
Major Integrated Regular Force/ Territorial Force Units	6 Infantry Battalions 2 Artillery Regiments 3 Armoured Squadrons 4 Engineer Squadrons 4 Signal Squadrons 1 Special Air Services (SAS) Group 3 Transport Squadrons 2 Field Workshops 3 Supply Companies 2 Medical Battalions 1 Field Hospital

(Source: Department of Statistics, 1986)

Table 1.2: Number of Personnel in the New Zealand Army for 1982 to 1985

Category	As at 31 March			
	1982	1983	1984	1985
Regular Forces				
Officers (male and female)	712	786	802	778
Other ranks (male and female)	4 964	4 804	4 761	4 653
TOTAL	5 676	5 590	5 563	5 431
Non-Regular Forces				
Territorial Force (all ranks)	6 289	6 101	5 299	5 963
Officers Reserve	635	568	613	626
Other Ranks*	1 389	1 257	1 130	1 263
TOTAL	8 314	7 926	8 042	7 852

* Class A and Class B Reserves

(Source: Department of Statistics, 1986)

1.3 THE RECENT USAGE OF ARMY RATION PACKS BY THE NEW ZEALAND ARMY

The New Zealand Army uses a number of Ration Packs, but the one studied in this thesis was the One Man, 24 Hour Ration Pack (Canned).

1.3.1 New Zealand Army Ration Packs

The following are descriptions of ration packs used by the N.Z. Army.

* Ten Man Ration Pack - A composite ration of tinned foods. Designed for reheating in communal feeding in multiples of 10.

* One-Man 24 Hour Ration Pack (Lightweight) - An individual ration (one man/one day) for use when individual feeding is necessary, e.g. patrols. Suitable for continuous use up to seven days. As the items in this pack are dehydrated, it should not be used in areas where water is not available. Designed to provide three meals per ration pack.

* One-Man 24 Hour Ration Pack (Gruber Pack) - An individual ration (one man/one day) for use when individual feeding is necessary, e.g. patrols. These are used one day in five when either the Lightweight or Canned One Man, 24 Hour Ration Packs are being used.

* One-Man 24 Hour Ration Pack (Canned) - An individual ration (one man/one day) for use when individual feeding is necessary, e.g. patrols. Suitable for continuous use up to seven days. A combination of tinned and dry items designed for reheating although tinned food can be eaten hot or cold. There are three different menus related to this ration pack.

The amount of water required to reconstitute beverages and soup is one litre.

The set down energy value for all menus is 3,676 kcal per man/day. The menus should also provide sufficient vitamins and nutrients. The shelf life of the ration pack should be two years. Figures 1.1 and 1.2 show the packed and individual contents of this ration pack

1.3.2 The Use of the One Man 24 Hour Ration Pack (Canned)

The One Man, 24 Hour Ration Pack (Canned) is known as the Combat Ration Pack, and for simplicity, will be referred to as this in this thesis.

The Combat Ration Pack is the most widely used ration pack presently used by the N.Z. Army. Appproximately 60,000 Combat Ration Packs are used annually, with the main users being infantry battalions and the Special Air Services (SAS) group. The other sections of the N.Z. Army at one time or another also use the Combat Ration Pack. Other users are the Airforce, Navy, N.Z. Forestry Service, Civil Defence, St John's Ambulance, Police Force, Armed Defenders Squad, the Post Office and the Boy Scouts.

The infantry battalions and the SAS use the combat ration pack primarily for field exercises, which can be performed in climatic conditions ranging from the tropical, humid and wet conditions of Malaysia, to the sub-zero winter conditions of Lake Tekapo, New Zealand. Climatic conditions of a temperate nature are experienced in most places in New Zealand in the summer and also in the South Pacific.

The condition of the terrain can range from flat land in rubber plantations in Malaysia or the wide open spaces near Lake Tekapo, to steep mountains - either the mountain forests of Malaysia or

Figure 1.1: Photograph of the One Man, 24 Hour, Ration Pack (Canned)

Figure 1.2: Photograph of the Individual Contents of the One Man, 24 Hour Ration Pack (Canned)

the mountains in Tongariro National Park. An addition to these conditions is the high frequency of rain in most places.

The infantry or SAS soldiers are required to participate in field exercises that can be up to five weeks or more. On average, exercises carried out in New Zealand are of two to three weeks duration; with the soldiers based in Singapore being in the field for three to four weeks. The soldier, who is therefore isolated from the base (except maybe by long distance air and road transport), must have the necessary requirements to live in, at times, a harsh and stressful environment. The items that he commonly takes with him are a back pack, sleeping bag, some form of tent, wet weather gear, clothes and personal effects, rifle and ammunition, first aid kit, water bottles and last but not least, a food supply. This may mean that a soldier could be carrying up to 40 kg of weight. The supply of food being carried can vary from one to ten days. However, it is common for soldiers to be supplied with three to five days of rations, with a resupply of a similar amount at the appropriate time.

On top of the weight the soldier has to carry, he may have to live in wet conditions and in extreme hot or cold temperatures. He may have to climb up and down hills all day, or through leech infested swamps. He must combat snakes and crocodiles in the jungles of Malaysia and must be alert for the 'enemy' that he is fighting against. Lack of sleep goes with the job description as soldiers are rostered through the night to do sentry duty. Monotony plays a major part in the daily routine of the soldier.

These are the conditions that the soldier has to endure. Yet, there are many other aspects which cannot be briefly described. Psychological areas must be considered, as situations can be monotonous as well as stressful. Therefore, the design of a Ration Pack must take these factors into consideration.

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1.4 AIM, OBJECTIVES AND CONSTRAINTS FOR PROJECT

As can be seen, the development of a Combat Ration Pack must consider several aspects to meet the needs of the infantry soldier. The following aims, objectives and constraints were developed for the project.

1.4.1 Aim

To develop a nutritionally balanced and soldier acceptable One Man, 24 Hour, Ration Pack (Canned) for the New Zealand Army.

1.4.2 Objectives

The objectives were:

* to obtain information on the daily nutritional requirements of soldiers undergoing heavy work under varying climatic conditions;

* to obtain information on the use, the dissatisfaction and suggested improvements for the present Combat Ration Pack;

* to obtain nutritionally balanced menus containing foods which then can be tested for acceptability;

* to do a field evaluation of developed menus;

* to identify areas where food product development is required, and to then develop these products;

* to evaluate a prototype Combat Ration Pack in tropical and temperate conditions on a large scale; and

* to present a Combat Ration Pack that is acceptable to the majority of the soldiers.

1.4.3 Constraints

The project was being funded by the NZ Army who presented the project with a number of constraints (refer to Appendix 2). Several others were also identified for the project. All of these constraints referred to the actual ration pack.

1.4.3.1 Product (Ration Pack) Constraints

These consisted of the following:

* the ration pack should have items that are well known and acceptable to the soldiers;

* the ration pack should supply enough energy and nutrients for one man for one day undergoing heavy work;

* the intake should also be nutritionally balanced;

* the menu range should provide as wide a variety of food as practical;

* the ration pack must be able to be used for indefinite periods without reducing the soldiers' capability to fight;

* the cost of the new ration pack should be no more than the average standard pack price for the present range of ration packs;

* the weight of the complete ration pack shall not exceed 2.6 kg per man per 24 hours, including any water required to make-up the ration together with its beverages;

* the ration pack should have a minimum shelf life of two years;

* the food and beverages included in the ration pack should be those that require very little time in preparation;

* the portion sizes (e.g. main meals, snacks) of food and beverages should be designed around the eating habits of soldiers;

* the canned foods should be designed to allow them to be eaten hot or cold;

* the packaging for the foods should be waterproof, robust enough to withstand rough handling in soldiers' packs, should not be noisy and have a surface and colour that is not shiny or prominent; and

* foods should also be robust enough to withstand rough handling without breaking.

1.4.3.2 Processing Contraints

The processing constraints were:

* only known technology was to be used and new processing techniques were not to be looked at;

* commercially available foods were to be used as much as possible. The smaller the amount of new product development, the lower the required cost of the project; and

* Textured Vegetable Protein (TVP) was not to be used.

1.5 PROGRAMME FOR PROJECT

The project was planned to have seven main stages. These are outlined in Figure 1.3.

This project was funded by the New Zealand Army during the entire time. A number of reports were prepared during each stage which are cited in the bibliography (Food Technology Research Centre, 1985f, 1986abc, 1987abc)

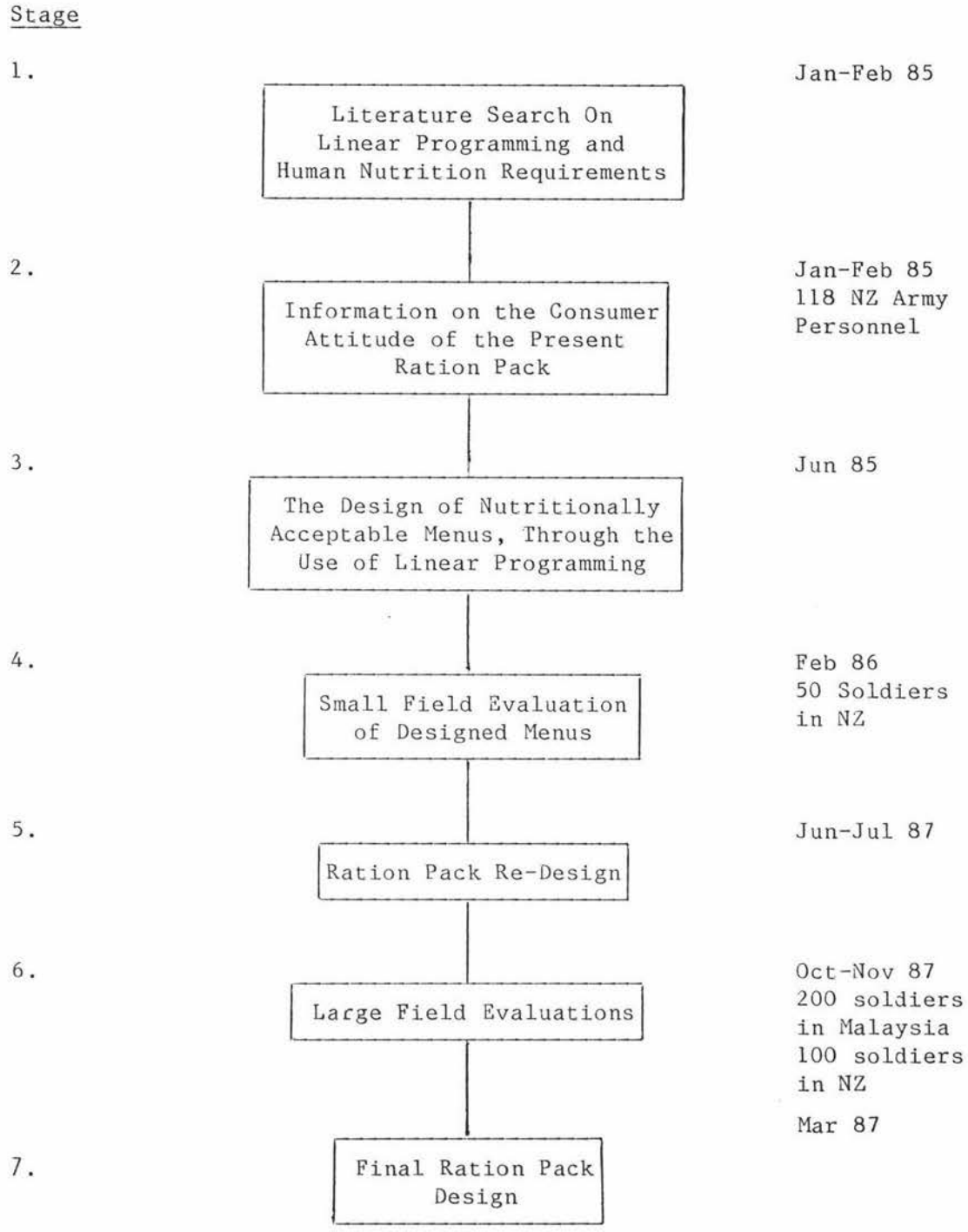

Figure 1.3: Programme for Combat Ration Pack Design

CHAPTER 2

MENU PLANNING FOR RATION PACK DEVELOPMENT

2.1 INTRODUCTION

In designing a menu plan for ration pack development, information on the nutritional requirements of soldiers was obtained from a computerised literature search. Information was also gathered from a consumer attitude survey. This involved New Zealand soldiers giving information on how they used the present ration pack, what they thought of it and improvements they would like implemented.

A list was made of the foods which could be selected to produce a menu based on a number of criteria. Nutritional composition of these foods were obtained.

A data matrix was then formed from all this information and mixed integer linear programming was used to produce several menus. An evaluation of the food components and of the nutritional composition of the menus was also done.

2.2 A REVIEW OF LINEAR PROGRAMMING APPLICATIONS IN MENU PLANNING

2.2.1 Linear Programming

Linear programming (LP) is a mathematical technique which determines the optimum allocation of a limited supply of resources - it is either used to maximise or minimise a specific objective. The simplest form of LP can be expressed in the following way:

$$\text{Maximise/minimise} \quad \sum_{j=1}^{n} C_j X_j$$

$$\text{Subject to} \quad \sum_{j=1}^{n} a_{ij} X_j \begin{matrix} \leq \\ \geq \end{matrix} b_i \text{ for } 1,2,\ldots m$$

$$\text{and} \quad X_j \geq 0$$

where m is the number of nutrients or rows

n is the number of food raw materials or columns

a_{ij} is the number of units of nutrient i in one unit of food raw material j

b_i is the specific number of units of nutrient i required

C_j is the cost of raw material j (cost is the specific objective, others can also be specified)

X_j is the number of units of raw material j in the solution.

2.2.2 Mixed Integer Programming

General linear programming assumes a linear relationship exists, e.g. one unit of raw material costs twice as much as half a unit (Vajda, 1981. Murtagh, 1981). Developing menus has no conflict with this concept. However, the use of fractions of raw materials or meals in menu planning do not always make sense or are not practical. In these cases, only whole numbers or integers are used. An example would be a problem of selecting the lowest cost food grocery list which would meet nutritional constraints. Purchasing fractions of food items would not be possible and hence one must specify in the problem that only whole items can be purchased. With reference to the mathematical expression for LP, the X would only be allowed to be whole

numbers.

A problem involving a combination of fractions and integers is called Mixed Integer Linear Programming. This method was used in developing the initial nutritionally acceptable combat ration pack menus.

With regard to the use of Linear programming or any of its variants, no literature was cited that dealt with the development of military rations of any kind. However, it has been used generally in the development of nutritionally balanced foods and menus.

2.2.3 A Review of Applications of Linear Programming in Nutritional Research

Linear programming with relation to food research in its simplest form is called the nutrition problem. The nutrition problem was instigated by Stigler (1945). Stigler was concerned with the determination of the cheapest way of buying the necessary nutrient requirements (e.g., calories, fat, proteins). Stigler set down the requirements for nine nutrients, and the quantities of these found in 77 selected food items. Having determined the price for each food, he sought by trial and error to find the minimum expenditure necessary to obtain a nutritionally adequate diet.

This trial and error approach gave a cost very close to the minimum that would have been obtained from LP. The main problem however with this least cost diet of wheat, flour, cabbage, spinach, evaporated milk and dried navy beans was that it was highly unpalatable.

Smith (1959) considered the problem of the palatability of menus developed by LP which basically selected foods based on their

cost rather than their palatability. In Smith's study, he allowed for the palatability problem by including eligible foods which were consumed by a large percentage of families. Peryam (1959) in his discussion of Smith's work, considered other methods of considering food palatability in menu planning using LP, e.g. including hedonic scales.

Smith also limited the quantity of particular foods. This protected the menu from becoming monotonous. The third constraint Smith included, was to have minimum quantities of well liked foods. This guaranteed to an extent, that part of the menu would be acceptable.

The method of selection of food for this study, which will be described later, is similar to that of Smith's.

The Simplex method on which most LP algorithms are based does not use trial and error, but uses a more efficient, iterative approach. It is because the LP algorithm is a mathematical expression, that the use of electronic computers for LP problems have become important. What would have taken Stigler days of hand calculations, can now be done on microcomputers in a matter of seconds.

More complex LP problems are now possible without the problem of error infested and time consuming calculations. Problems involving the determination of whole diets for many days can be solved, as shown by a recent study by Ngarmsak (1983). This study involved the development by LP of 25 cowpea dishes which were included in a seven day menu for villagers in Northeastern Thailand. The menus were low cost, protein - maximised, nutritionally balanced and met the requirements of 26 essential nutrients. The selection of dishes was done by using a variant of LP called mixed integer LP. The introduction of this seven day menu was found highly acceptable by the villagers.

These two studies by Smith and Ngarmsak show not only how LP can be used to develop low cost, nutritionally balanced diets but can be used to select diets that are acceptable to the consumer. Both examples also showed, how LP can be used to efficiently allocate food resources when these are of a limited nature. Ngarmsak in her thesis, gave a summary of development work in diet planning from Stigler up to the time of her thesis. Appendix 4 includes this summary plus additional research reported since 1983.

2.3 HUMAN NUTRITION REQUIREMENTS - A LITERATURE SEARCH

Before reviewing the results of the computer literature search, a definition of nutritional terms is given below:

* Recommended Dietary Allowances - The Recommended Dietary Allowances (RDA) are the levels of intake of essential nutrients considered, in the judgement of the Food and Nutrition Board (USA) on the basis of available scientific knowledge, to be adequate to meet the known nutritional needs of practically all healthy persons. It is for this reason that RDA's should not be confused with requirements, as they over estimate the requirements of the average person (except for Energy). (From National Academy of Sciences, 1980).

* Minimum Safe Intakes - The Minimum Safe Intake (MSI) is the clinical minimum amount of nutrients in the diet, for a person to function normally without risk to health. (From Nutrition Advisory Committee [Ministry of Health] and Nutrition Department, University of Otago, 1981).

* Adequate Daily Intakes - The Adequate Daily Intakes (ADI)

are similar to the RDAs except they refer to the New Zealand population. (From Nutrition Advisory Committee [Ministry of Health] and Nutrition Department, University of Otago, 1981)

The computer literature search involved searching through a number of computer literature databases; both civilian and military sources were used (Commonwealth Agricultural Bureaux Abstracts (CAB), Food Science and Technology Abstracts (FSTA), and National Technical Information Service (NTIS)).

2.3.1 Energy Requirements

Energy allocation is probably the most important consideration when determining diets as the intake has relatively quick effects on the level of activity of the person.

The amount and duration of heavy physical activity is the most important factor in determining the energy requirements of an individual. The energy requirement increases substantially as both the level of physical activity and the time spent in that activity increase. Temperature does not significantly affect energy requirements; only in extended periods of cold temperatures are higher energy requirements needed.

Historically, the energy content of Army rations has been very erratic, starting with 3,600 kilocalories (kcal) for the 1775 Army Ration mentioned in Chapter 1. In the rations of 1927 and 1933, the energy values were 5,500 and 5,000 kcal respectively. The energy value for the ration of 1957 was 4,100 to 4,300 kcal (a 15% allocation for waste was allowed) (Friedemann et al., 1959). Figure 2.1 shows the fluctuations in energy allocation.

The current US Army Technical Manual (TM 8-501, 1961) on nutrition gives an upper limit for men on heavy work at 3,800-4,000 kcal and 4,800-5,000 kcal for extremely heavy work (rarely

encountered). Several studies have looked at the effect of hard work on energy requirements. Friedemann et al., (1959) found that the average energy requirement for maintenance of weight in very young soldiers was 4,066 kcal and the average for moderately active soldiers was 3,175 kcal. Another study by Welch et al., (1958) involved the relationship between energy intake under conditions of moderate and heavy work and body weight. The findings were that for a 70 kg man, approximately 4,349 kcal and 2,340 kcal were respectively used for heavy and moderate work.

Appendix 3 summarises the energy requirements of people under varying climatic and physical conditions.

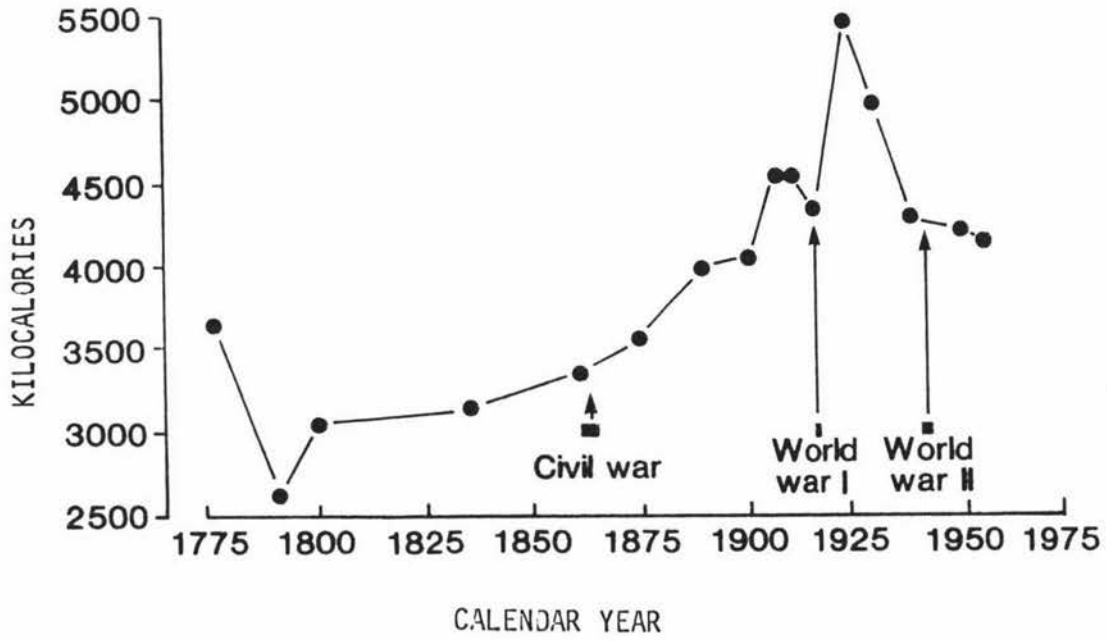

Figure 2.1: Calculated Kilocalories of Edible Portion of Prescribed Army Ration (USA), 1775-1957

Source: Friedmann et al., (1959)

2.3.2 Protein Requirements

The requirement for protein is due to the need for its amino acids which synthesise body proteins and many other tissue constituents. Table 2.1 compares the recommended daily allowances of protein for adult males.

Table 2.1: Comparison of Recommended Daily Allowances for Protein

COUNTRY OR ORGANISATION	PROTEIN G/PERSON/DAY
FAO/WHO	37 (RDA)
New Zealand	65 (ADI) 25 (MSI)
USA	70 (RDA)

Source: International Union of Nutritional Sciences, 1982

Protein requirements under conditions of more work or sports training are not substantially increased (National Academy of Sciences, 1980). No additional protein is required for cold climates. However, in hot environments, protein intake should be increased in relation to the temperature and the nature of the work performed (Petrasek, 1978). Increased rate of perspiration due to a hot environment means losses of urea and ammonia which will increase the requirement for non-essential protein in the diet.

2.3.3 Vitamin Requirements

The recommended daily allowances and intakes of fat soluble vitamins A, D and E, and water soluble vitamins C, B_6, B_{12}, Thiamin (vitamin B_1), Riboflavin (vitamin B_2), Niacin and Folacin for United States and New Zealand males are given in Table 2.2.

Under conditions of increased physical conditions, extreme temperatures, injury and stress, no additional requirements for vitamins are needed (Sharman, 1981). Only in extremely cold conditions are there requirements for additional amounts of the B vitamins, vitamin C and E (Herouse, 1981).

Table 2.2: Recommended Daily Vitamin Allowances[1] for United States Males and Recommended Daily Vitamin Intakes[2] for New Zealand Males

COUNTRY	AGE	FAT-SOLUBLE VITAMINS			WATER-SOLUBLE VITAMINS						
		Vitamin A (μg RE)	Vitamin D (μg)	Vitamin E (mg α-TE)	Vitamin C (mg)	Thiamin (mg)	Riboflavin (mg)	Niacin (mg NE)	Vitamin B_6 (mg)	Folacin (μg)	Vitamin B_{12} (μg)
USA	19-22	1000	7.5	10	60	1.5	1.7	19	2.2	400	3.0
	23-50	1000	5	10	60	1.4	1.6	18	2.2	400	3.0
New Zealand		MSI ADI	MSI ADI	MSI ADI	MSI ADI	MSI ADI	MSI ADI	MSI ADI	MSI ADI	MSI ADI	MSI ADI
	15-17	750	10	3.5 13.5	60	1.2	1.7	19	2.0	200	3.0
	Adult	600 750	10	3.5 13.5	10 60	0.4 1.2	1.0 1.7	5 18	1.25 2.0	50 200	1.0 3.0

1 Food and Nutrition Board, National Academy of Sciences - National Research Council, Recommended Dietary Allowances. Revised 1980. Designed for the maintenance of good nutrition of practically all healthy people in the USA.

2 New Zealand Recommended Daily Dietary Requirements (1981). Nutrition Advisory Committee (Ministry of Health) and Nutrition Department, University of Otago.

MSI = Minimum Safe Intake

ADI = Adequate Daily Intake

* Vitamin D - recommended relates to 'total provision' From both dietary and endogenous synthesis.

* Fibre - an adequate intake is important in the maintenance of health but no specific recommendation given.

2.3.4 Mineral and Trace Element Requirements

Recommended daily dietary allowances for males in the United States and recommended daily dietary intakes for males in New Zealand for minerals and trace elements are listed in Table 2.3.

Table 2.3: Recommended Daily Allowances and Intakes of Minerals and Trace Elements for Males in the United States and New Zealand

COUNTRY	AGE	CALCIUM (mg)		PHOSPHOROUS (mg)		MAGNESIUM (mg)		IRON (mg)		ZINC (mg)		Copper (mg)	
USA[1]	19-22	800		800		350		10		15		-	
	23-50	800		800		350		10		15		-	
		MSI	ADI	MSI	ADI	MSI	ADI	MSI	ADI	MSI	ADI	MSI	ADI
NZ[2]	15-17	400	800		12		400		12		15		2.5
	Adult	400	600	5	10	200	350	5	10	1.5	15	1.5	2.5

[1]National Academy of Sciences (1980).

[2]International Union of Nutritional Sciences 1982, Committee 1/5.

Little substantial information is available on the additional requirements of minerals and trace elements with regard to extreme temperatures and physical exercise. Body liquids lost

through perspiration [if produced in sufficient quantities], contain sodium chloride, potassium, and calcium in sufficient concentrations to cause significant depletions (Anon 1980). Iron losses by perspiration may also be important in iron depletion when dietary intake is inadequate.

2.3.5 Human Nutritional Requirements - Conclusions

Many of the recommended allowances for energy and nutrients are still very controversial due to insufficient and conflicting data. Also, the variation in individual requirements is so large that alternative standards have to be used, e.g. recommended dietary allowances for energy refer to groups of individuals rather than for particular individuals. This variation is also present in nutrient requirements which give conflicting results in separate studies on individuals; Consolazio (1983), for instance takes the view that an increase in physical activity will result in a proportional increase not only in energy but also in vitamins and minerals. This conflicts with studies already mentioned, in that little additional requirement is necessary. Birkbeck (1985), stated that one of the reasons for the conflict is the fact that most 'human nutritionists' are fundamentally linked to chemical sciences rather than to the biological sciences. Consequently, they have but a tangential familiarity with the principles of human biology or human genetic variation.

For this study, Table 2.4 lists the energy and nutritional requirements that were set down as appropriate for the development of a combat ration pack. These were based on a young male adult soldier, undergoing heavy work.

Table 2.4: Energy and Nutritional Requirements Used for Combat Ration Pack Development

NUTRIENT TYPE	REQUIREMENT
Energy (Kcal)	3800.0 - 4000.0
Protein (g)	65.0
Calcium (mg)	600.0
Magnesium (mg)	350.0
Iron (mg)	10.0
Copper (mg)	2.5
Zinc (mg)	15.0
Vitamin A (μg)	900.0
Vitamin D (μg)	12.0
Thiamin (mg)	1.44
Riboflavin (mg)	2.04
Niacin (mg)	21.60
Vitamin C (mg)	72.0
Vitamin E (mg)	16.2
Vitamin B_6 (mg)	2.4
Vitamin B_{12} (μg)	3.6

The energy requirement was based on the current US Army Technical Manual (TM 8-501, 1961). (The present standard set by the NZ Army is 3678 kcal). The other nutrients listed in Table 2.4 were based on NZ ADIs for an adult male (Nutrition Advisory Committee (Ministry of Health) et al., 1981). No extra allowance was considered for either extreme hot or cold conditions or increased physical activity. Allowance was however, made for losses of vitamins during two years of storage. These losses vary

according to the type of food, packaging and storage conditions (Food Technology Research Centre, 1985b, 1985c). It was decided that a 20% loss should be allowed for all vitamins. This allowance was then added to the NZ ADIs.

2.4 CONSUMER ATTITUDE SURVEY

It was important in designing a new ration pack, that information on the use of the existing ration pack be found. The study (Food Technology Research Centre, 1985e) involved 118 personnel from Waiouru and Burnham Military Camps, the majority being infantry men and the remainder, tank crew squadron personnel. Two phases were involved. Firstly, a survey questionnaire was completed which obtained information on demographics, present usage of ration packs, and suggested improvements. The second phase involved small group discussions with the personnel. This involved information gathering which would have been difficult to obtain through a written questionnaire.

2.4.1 Demographic Data of Respondents

The median age of the survey participants was 22 - this value is indicative of the average age of infantry men in the NZ Army. The median height and weight of participants were 178-181 cm and 75-78 kg, respectively.

2.4.2 Present Usage of Ration Packs

High dissatisfaction with the present combat ration pack was found with the participants. The main findings were:

* only 6% of the soldiers took the entire ration pack on exercise;

* a discard rate of 50% or more was associated with the honey, tea and plain biscuits;

* 56% of the soldiers discarded items because they were not liked, bought foods supplemented the soldiers' diets;

* on a cost basis, approximately 20% of the food was discarded, i.e. about $1.30 per ration pack (or $78,000 for an average of 60,000 ration packs per year);

* major complaints for particular ration pack items are listed in Table 2.5; and

* the daily diet of the soldier was found to comprise one main meal, a smaller one and a number of snack foods and beverages.

Table 2.6: Summary of Improvements to Present Ration Pack

RATION PACK ITEM	IMPROVEMENTS
1. Canned Meals	Reformulate meat meals to an acceptable level. Include canned fish and fruit. One large can and one smaller can in each ration pack
2. Rice	Replace rice with a freeze-dried form or use instant noodles
3. Beverages	Include a powdered fruit drink. Replace tea sachets with tea bags. Improve the milk powder or use condensed milk
4. Snack Foods	Have more snack foods. Improve the biscuits, sweets and a variety of chocolate types. Include a cereal bar. Jam and other spreads to add variety to the honey
5. Condiments	Include other spices and sauces such as chili powder, pepper, onion flakes, soya sauce, tomato sauce
6. Non-Food Items	Replace steel wool with non-rust cleaning cloth

2.5 SETTING UP THE LINEAR PROGRAMMING MODEL

The setting up of the model was done on a Prime 750 mainframe computer. The general procedure was to develop a data file in the correct format and then to run this file through the LP program.

2.5.1 The Objective Function

As stated in the section on LP, a specific objective must be laid down. This is either maximised or minimised. In most LP problems, cost or profit are usually the variables minimised or maximised. In this study, though cost minimisation was seen as important, the total weight of the combat ration pack was considered as a higher priority objective.

Therefore, the specified objective for this problem was to minimise the total weight of foods selected. The secondary objectives were to achieve a nutritionally balanced and acceptable menu.

2.5.2 The Data Matrix

A total list of 95 foods from which a menu could be made-up to meet the objective and the nutritional constraints was used (refer to Appendix 5).

The main criteria used in selecting these 95 foods was to include those foods that were thought to be suitable for a combat ration pack. The specific criteria were:

* The foods had to be acceptable to the soldier. (From the Consumer Attitude Survey, a number of foods were either found to be taken as perks by the soldier or ones which they would like to take).

* The food had to be suitable in terms of how easy it could be prepared.

* Physical aspects of the food were also considered, e.g., the storage life of the product, robustness, whether it was solid or liquid.

* The estimated cost of the food had to be at a low enough level to merit inclusion.

The purpose of this screening process was to increase the likelihood of obtaining menus from the LP technique which would be acceptable.

The nutritional composition data for the selected foods was obtained from a food database (Paul & Southgate, 1978) that was available on the PRIME computer. This database had comprehensive nutritional data on 1,000 commonly eaten foods. Nutritional data included were energy, fat, protein, carbohydrate, 10 minerals and 15 vitamins. Through computer file manipulation, it was possible to convert this information into the correct format for LP.

The requirement for the menu to have one large meal and one small meal meant that the foods representing these meals were allocated integer values. The large meal was classified as the main meal and the smaller one, lunch. Unless already specified, other food items could have fractional values.

Nutritional data for each food was generally written in the following form (called Mathematical Programming System Format, MPS):

MAINMEAL	kcal	431.3	Pro	40.9
MAINMEAL	Fat	22.7	CHO	16.3

Weight data and menu specification were similarly expressed:

MAINMEAL weight 454.0 Main 1.0

MAINMEAL represents the food item (or column) and kcal, Pro represent the nutritional (or row) values.

2.5.3 The Constraints

The constraints of the problem included several areas of the menu.

2.5.3.1 The Right Hand Side

The right hand side (RHS) specifies the limits of the row vectors, e.g., kcal, pro. The nutritional requirements listed in Table 2.4 acted as minimum constraints or lower bounds for the problem. Upper constraints for nutritional toxicity were not used. As the menu must have one and only one main meal and one small meal, the corresponding rows were set to a unit value. Other items such as snack foods and beverages were also set up in this way.

2.5.3.2 Bounds

The bounds specify limits on the food values or column vectors. Even though for example, the row vector MAINMEAL had been set to unity, it could be made up of fractions of main meals which sum to one. This was not suitable. Therefore, for each main meal, it was specified that it can only have values of zero or one.

It was known from the consumer attitude survey that several items were very popular with the soldiers. It was decided that these items be automatically selected by making them have a fixed value. Examples were Milo and Instant Noodles. Maximum values

were also set to limit the quantities of these particular foods. This reduced monotony by making the LP technique choose other foods to meet the nutritional constraints.

2.5.4 Data Format for Computer Solution

A simplified LP matrix of the problem is illustrated in Figure 2.2. This matrix was inputed into standard mathematical programming system format (MPS Format). (Refer to Scicon, 1981 for a full explanation). From this, the SCICONIC LP package was able to be run to obtain menu combinations.

COLUMNS / ROWS	MENU ITEMS (95)	CONSTRAINTS	
		LOWER BOUND	UPPER BOUND
Objective, Weight			
Energy		3800.00	∝
Protein		65.0	∝
Calcium		600.0	∝
Magnesium		350.0	∝
Iron		10.0	∝
Copper		2.5	∝
Zinc		15.0	∝
Vitamin A	Nutrient	900.0	∝
Vitamin D	Composition	12.0	∝
Thiamin	Matrix	1.44	∝
Riboflavin		2.04	∝
Niacin		21.6	∝
Vitamin C		72.0	∝
Vitamin E		16.2	∝
Vitamin B_6		2.4	∝
Vitamin B_{12}		3.6	∝
Main Meal	1.0 1.0 ...	1.0	1.0
Lunch	1.0 1.0 ...	1.0	1.0

Figure 2.2: Linear Programming Matrix for Army Menu Planning Problem

2.6 RUNNING THE PROGRAM

The linear programming computer package SCIOCONIC, which had a mixed integer linear programming facility was used to develop menu combinations.

The following list of commands gives a simplified example of how SCICONIC was used to obtain LP solutions from the data matrix:

* **INFILE = 'DATAMATRIX'** - this specifies the name of the data matrix file in MPS Format.

* **CONVERT** - this converts the data matrix file into binary format.

* **SETUP** - this loads the data matrix file ready for execution.

* **PRIMAL** - this executes the main LP algorithm for a continuous problem and puts the solution into a solution file.

* **PRINTSOLN** - prints the solution.

* **STOP** - ends the SCICONIC run.

Infeasibilities, or where constraints are not met, are sometimes encountered, in which case relaxing of constraints should be done. It is good policy to have relaxed constraints initially and then to add constraints as one obtains solutions.

In this study, only a few problems were encountered and an initial solution was obtained. A number of similar solutions were obtained by the procedure of fixing (pre-selecting) the values of particular foods so that they would be included in the

final solution.

2.7 SOLUTIONS OF THE MODEL

Overall, two main types of menus were developed, each having four different variations. Tables 2.7 and 2.8 give weight and cost information for variants of type 1 and type 2 menus.

The actual weights of food obtained from the LP solution were "rounded" to obtain values that could be practically managed e.g., 10 grams was raised to 16 grams as this weight, for this particular item, was found later to be the minimum requirement. In some cases, weights were so small that they were not practical. These were therefore eliminated from the menu list.

The result of this "rounding" meant the total nutritional content was changed to the extent that nutritional shortfalls appeared. However, if one considered the definition of RDAs these shortfalls became insignificant.

Table 2.7: Menus Developed by Mixed Integer LP - Type 1

COMMON ITEMS	WEIGHT (Grams)	COST (Cents)
1. Instant Noodles	85g	59*
2. Biscuits - Crispbread	50g	17
3. Biscuits - Oatcakes	50g	17
4. Biscuits - Short-sweet	50g	17
5. Chocolate - milk	55g	34
6. Raisins/Sultanas	80g	32
7. Peanuts - roasted	100g	100*
8. Sweets	35g	15
9. Coffee - Instant	7.2g	30
10. Tea	5g (2 Teabags)	6
11. Chocolate drink powder	33g	30
12. Condensed milk - sweet	55g (Plastic tube)	67+
13. Fruit drink (lemon)	100g	52*
14. Curry powder	3.5g	4
15. Dried peas	10g	11*
16. Salt	14g	4
17. Sugar	84g	24
18. Honey	55g	46+
19. Onion powder	5g	6*
20. Chili powder	1g	5*
TOTAL	847.5g	576
All costs are those associated with the present items in the ration pack (June 1985) unless otherwise indicated.		

MENU ITEMS	WEIGHT (Grams)	COST (Cents)
Type A		
Bolognaise meat sauce	454g	216#
Meat Hot Pot	300g	142#
Type B		
Bolognaise Meat Sauce	454g	216#
Sardines canned in oil	250g	115#
Type C		
Bolognaise meat sauce	454g	216#
Peaches canned	310g	73*
Type D		
Sliced Beef and Beans - Freeze-dried	100g	400#
Meat Hot Pot	300g	142#

* Wholesale prices April 1985.

\+ Prices for 1986 does not consider GST, inflation, or currency changes.

\# Estimated from present foods that in the ration packs (June 1985).

Table 2.8: Menus Developed by Mixed Integer LP - Type 2

COMMON ITEMS	WEIGHT (Grams)	COST (Cents)
1. Rice - Freeze-dried/Instant	60g	65
2. Muesli foodbar	80g	50*
3. Chocolate - moro	60g	33*
4. Raisins/Sultanas	80g	32
5. Peanuts - roasted	100g	100*
6. Sweets	35g	15
7. Coffee - instant	7.2g	30
8. Tea	5g (2 teabags)	6
9. Soup - oxtail	25g	28
10. Condensed Milk	55g (plastic tube)	67+
11. Fruit drink (blackcurrant)	100g	52*
12. Curry powder	3.5g	4
13. Salt	14g	4
14. Sugar	84g	24
15. Jam	55g	60+
16. Onion powder	5g	6*
17. Chili powder	1g	5*
TOTAL	767.5g	581
All costs are those associated with the present items in the ration pack (June 1985) unless otherwise indicated.		

MENU ITEMS	WEIGHT (Grams)	COST (Cents)
Type A		
Bolognaise meat sauce	454g	216#
Meat Hot Pot	300g	142#
Type B		
Bolognaise meat sauce	454g	216#
Sardines canned in oil	250g	115#
Type C		
Bolognaise meat sauce	454g	216#
Peaches canned	310g	73*
Type D		
Sliced Beef and Beans - Freeze - dried	100g	400#
Meat Hot Pot	300g	142#

* Wholesale prices April 1985.

\+ Prices for 1986 does not consider GST, inflation, or currency changes.

\# Estimates from present foods that are in the ration packs (June 1985).

2.8 DESCRIPTION OF DEVELOPED MENUS

The following describes the contents of the menus developed through the use of LP. It must also be reiterated that certain items were already pre-selected on the basis of their high consumer acceptance. Table 2.9 lists the possible menu combinations.

2.8.1 Carbohydrate Source

Two acceptable carbohydrate sources were included in the ration packs. These were:

* Instant Noodles (weight 85g) - This was the most popular of all food types in terms of civilian foods taken on exercise, and also suggested improvements of the combat ration pack. Its attributes were speed and ease of cooking, good taste, lightness and versatility.

* Rice - Freeze-Dried (weight 60g) - Though plain uncooked rice was very unpopular with the soldiers in the present ration pack, this was probably due to the length of time required for cooking rather than its quality or taste. It was decided that rice should be included to give variety but it should be in a form that could be quickly and easily cooked, e.g. freeze-dried.

Table 2.9: Possible Menu Combinations

COMMON ITEMS		MENU ITEMS	
Type 1	Type 2	Type A - Casserole Type Meals	Type B - Fish Meals
1. Instant Noodles	1. Rice - Freeze-dried	Can be used as either a main (454 g) and/or smaller (300 g) meal	Used as a snack or smaller meal (200 - 350 g)
2. Biscuits - assorted varieties	2. Muesli Foodbar - several types		
3. Chocolate - several varieties	3. Chocolate - several varieties	1. Bacon/beans and Tomato Sauce	1. Herrings canned in Tomato Sauce
4. Raisin/Sultanas	4. Raisin/Sultanas	2. Beef Stew	2. Mackeral canned in Oil
5. Peanuts - roasted	5. Peanuts - roasted	3. Bolognese Meat Sauce	3. Pilchards canned in Tomato Sauce
6. Sweets - several varieties	6. Sweets - several varieties	4. Chicken Chow Mein	4. Sardines canned in Oil
7. Coffee - instant	7. Coffee - instant	5. Chicken Casserole	5. Sardines canned in Tomato Sauce
8. Tea - teabags	8. Tea - teabags	6. Lasagna	6. Tuna canned in Oil
9. Chocolate drink powder	9. Soup - several varieties	Type C - Canned Fruit	Type D - Freeze-Dried Meals
10. Condensed milk - sweetened	10. Condensed milk - sweetened	Used as a snack or smaller meal (310 g)	Used as a main meal (100 g)
11. Fruit Drink powder - several varieties	11. Fruit Drink powder - several varieties	1. Peaches	1. Sweet and Sour Pork
12. Salt	12. Salt	2. Pears	2. Chicken Chow Mein
13. Sugar	13. Sugar	3. Apricots	3. Savoury Mince
14. Honey/Jam - several types	14. Honey/Jam - several types	4. Pineapple	
15. Spices/sauces - several types	15. Spices/sauces - several types		

To meet adequate daily intakes, Ration Packs can be made-up using any combination of the following Common and Menu Items:

1. (i) Common Items, Type 1
   (ii) One main meal either from Menu Items A or D
   (iii) One smaller meal, either from A, B, or C

2. (i) Common Items, Type 2
   (ii) One main meal, either from Menu Items A or D
   (iii) One smaller meal, either from A, B, or C

2.8.2 Snack Foods

A number of snack foods were included to allow for food to be eaten while soldiers were moving or stopping for short periods. These snack foods were:

* Biscuits (weight 150g) - biscuits were included as another carbohydrate and energy source. They are popular with the soldiers, versatile and readily available to eat. The large number of types of biscuits commercially available would also add variety to the packs. As wide a variety as possible within the three types of biscuits specified would again add variety. The inclusion of biscuits was also a way of adding dietary fibre. Storage time for biscuits can be a problem due to the onset of rancidity. However, with suitable packaging, most hard biscuit varieties will store for at least two years.

* Muesli Foodbar (weight 80g) - a muesli type foodbar was found to be very popular as a new snack idea and so was included. They are nutritious, are a source of dietary fibre, can be fortified with vitamins and add further variety. Like biscuits, storage life was thought to be critical.

* Chocolate bars (weight 55g/60g) - The dark chocolate included in the present ration pack was the most liked food of all the food items present. It was indicated that more was wanted, though this was probably due to the absence of other snacks. Chocolate is a high and rapid source of energy, tastes good, and is popular. Other types of chocolate bars can be used as long as they are similar in calorific value, e.g., milk chocolate, Moro bars. Further variety was added by having alternatives to dark chocolate. Storage life is also limited with fat crystallisation

occurring.

* Raisins/Sultanas (weight 80g) - It was indicated that more raisins would be liked so an extra packet (40g) was included.

* Peanuts - roasted and salted (weight 100g) - Peanuts are a new item and were popular with the soldiers. They were a good source of energy, protein and fat. Oxidation could be a problem.

* Sweets - It was decided that the present sweets, 'Sparkles', should be replaced with other types with less problems. Calorific value would be similar and variety could be added by using several popular flavours.

2.8.3 Beverages

The quantities of beverages were increased in two ways. Firstly, the quantity of some existing beverages were increased, and secondly, additional beverages were added. The serving size considered the size of the canteen cup used by the soldiers - 600 mls. A major criticism found from the consumer attitude survey, was that serving sizes were too small.

* Coffee (weight 7.2g) - The quantity of coffee was increased. Firstly, because of its popularity and secondly, so it could be made in a canteen cup.

* Tea (weight 5g) - The tea sachets in the present ration pack were replaced with tea bags.

* Chocolate Drink (weight 33g) - A chocolate powdered drink featured highly in terms of civilian foods taken on exercise and alternative beverages that would be liked by the

soldiers. Serving size: one canteen cup.

* Instant Soup (weight 25g) - Popular soups were mushroom, chicken noodle and tomato. Serving size: one canteen cup.

* Powdered Fruit Drink (100g) - A powdered fruit drink was included as an alternative beverage that the soldiers indicated they would like. The fruit drink selected by the LP program was a sucrose/glucose based drink, high in vitamin C. An alternative to this type of drink are those relatively low in energy (saccharine based) and low in vitamin C. They are considerably lighter, are cheaper and do not increase thirst. Both types are commercially available. The latter type was finally used for the next stage of this study because of the advantages just mentioned. The vitamin C content can be increased by the addition of ascorbic acid.

* Condensed Milk - Sweetened condensed milk was included to replace the present disliked milk powder supplied. Its sugar content would solve the soldiers' problem of there being not enough sugar in the present pack.

2.8.4 Condiments

Condiments were included so that the soldiers could add further variety and taste to the meals they prepare.

* Curry Powder (3.5g), Sugar (84g) and Salt (14g) - The quantities of curry powder, sugar and salt were left unchanged from those in the present ration pack.

* Honey/Jam (weight 55g) - The honey was retained and variety added by having jam as an alternative. The similarity in nutritional content meant they could be alternated in

different menus.

* Dried Peas (10g), Onion Powder (5g) and Chili Powder (1g) - Due to the small quantities of condiments such as dried peas, onion powder and chili powder, the nutritional factor is not significant. Other condiments which are popular could also be used, e.g., pepper, tomato sauce and soya sauce.

2.8.5 Menu Items

The menu items are the main meals within each menu type. They satisfy the requirement of one large meal and a smaller meal. The large meal (454g) is a type of casserole/stew. Several types could be used as long as they were met nutritional specifications, and were acceptable to the soldier. The smaller meals were also casserole/stew type foods, but also included canned fish meals and fruit.

A number of different combinations could be made up which would increase the variety.

2.9 EVALUATION OF NUTRITIONAL CONTENT OF MENUS

Tables 2.10 and 2.11 give the nutritional breakdown of Type 1 and Type 2 menus.

2.9.1 Energy

The average energy content of the two menu types of 4100 kcal (type 1) and 3757 kcal (type 2), were both acceptable with respect to the laid down minimum requirement of 3800 kcal. This compares with the present ration pack which has an energy value of approximately 2868 kcal.

Table 2.10: Nutritional Breakdown of Type 1 Menus

	TYPE1A	TYPE1B	TYPE1C	TYPE1D	AVERAGE
Energy (kcalories)	4106	4307	4034	3953	4100
Protein (g)	122	154	96	145	129
Fat (g)	151	169	138	119	144
Carbohydrate (g)	590	559	630	595	594
Dietary fibre (g)	30	25	28	29	28
Sodium (mg)	11467	11082	9460	9470	10370
Potassium (mg)	5621	5406	4796	4213	5009
Calcium (mg)	778	2087	725	660	1063
Magnesium (mg)	615	670	559	534	595
Iron (mg)	26.3	30.0	23.9	19.0	24.8
Copper (mg)	2.43	2.43	2.14	1.80	2.20
Zinc (mg)	21.0	23.4	15.9	12.6	18.1
Vitamin A (ug)	2488	1538	1667	1020	1678
Vitamin D (ug)	0.05	18.8	0.05	0.05	4.73
Thiamin (mg)	1.47	1.36	1.29	1.35	1.35
Riboflavin (mg)	1.80	2.41	1.57	1.26	1.76
Niacin (mg)	58.2	78.3	48.6	43.2	57.1
Vitamin C (mg)	250	235	248	249	245
Vitamin E (mg)	16.9	17.1	16.4	11.1	15.4
Vitamin B_6 (mg)	2.25	2.82	1.68	1.52	2.06
Vitamin B_{12} (ug)	7.81	74.8	4.81	3.27	22.7
Energy:					
Percentage from Protein	11.9	14.3	9.5	14.7	12.6
Percentage from Fat	33.1	35.3	30.9	27.1	31.6
Percentage from Carbohydrate	54.0	48.7	58.6	56.5	54.3

Table 2.11 Nutritional Breakdown of Type 2 Menus

	TYPE2A	TYPE2B	TYPE2C	TYPE2D	AVERAGE
Energy (kcalories)	3718	3819	3646	3844	3757
Protein (g)	113	130	87	142	118
Fat (g)	130	149	117	147	136
Carbohydrate (g)	533	504	573	515	531
Dietary fibre (g)	24	19	22	19	21
Sodium (mg)	11654	11394	9647	9644	10584
Potassium (mg)	5466	5202	4642	4177	4872
Calcium (mg)	1445	2529	1391	1379	1686
Magnesium (mg)	540	594	485	430	512
Iron (mg)	21.8	29.7	19.4	18.2	22.3
Copper (mg)	2.32	2.41	2.02	1.84	2.14
Zinc (mg)	18.8	20.5	13.7	13.7	16.7
Vitamin A (ug)	2485	1482	1664	1534	1791
Vitamin D (ug)	0.05	18.8	0.05	0.05	4.73
Thiamin (mg)	3.61	3.47	3.43	3.46	3.49
Riboflavin (mg)	1.68	2.08	1.44	1.38	1.64
Niacin (mg)	56.2	66.0	45.8	44.0	53.1
Vitamin C (mg)	467	452	465	457	464
Vitamin E (mg)	15.1	15.8	14.5	14.5	14.9
Vitamin B_6 (mg)	2.13	2.37	1.56	1.50	1.89
Vitamin B_{12} (ug)	8.04	40.0	5.04	5.04	14.54
Energy:					
Percentage from Protein	12.2	13.6	9.5	14.8	12.5
Percentage from Fat	33.5	35.2	28.9	34.4	32.5
Percentage from Carbohydrate	53.8	49.4	58.9	50.3	53.0

2.9.2 Protein, Fat and Carbohydrate

The quantity of protein, fat and carbohydrate in the menus were acceptable when one considered their contribution to the total energy content. Conversion factors used to calculate energy values for these three food constituents were 4 kcal per gram of protein, 3.75 kcal per gram of carbohydrate and 9 kcal per gram of fat (Paul & Southgate, 1978). Energy contribution from protein, fat and carbohydrate are usually expressed as a percentage of the total energy. These can be found at the bottom of Tables 2.7 and 2.9. As the conversion factors are averages of different foods, errors are inherent. This is the reason why the three percentage figures do not total to 100 percent.

In the diets of western countries, carbohydrate, fat and protein respectively, represent 46, 42 and 11-12 percent of the total energy source (National Academy of Sciences, 1980). Comparing the values obtained from the menus developed, the amount of carbohydrate was high, though this could not be considered significant considering the high carbohydrate diets of the past (National Academy of Sciences, 1980). Protein and fat also had acceptable values.

2.9.3 Essential Minerals

The values of zinc (type 1, 18.1 mg; type 2, 16.7 mg) and copper (type 1, 2.20 mg; type 2, 2.14 mg) were only marginally different from the requirements laid down for this study. Therefore, they could be considered acceptable.

Calcium (type 1, 1063 mg; type 2, 1618 mg), magnesium (type 1, 595 mg; type 2, 512 mg), and iron (type 1, 24.8 mg; type 2, 22.3 mg) exceeded the requirements laid down by large amounts. In some countries, average daily intakes of calcium are as high as 15000 mg per day (National Academy of Sciences, 1980). The

values therefore obtained from the menus were acceptable. For magnesium, estimates of requirements have been as high as 700 mg/day (Seelig, 1971). Therefore, magnesium values obtained could not be considered unacceptable. Diets of active males with iron intakes of 30 mg/day should not have any adverse consequences (National Academy of Sciences, 1980).

2.9.4 Vitamins

The values of the vitamins, thiamin, riboflavin, B_6 and E were only marginally different from the requirements laid down and could be considered acceptable.

All the other vitamins except for vitamin D had values well above the requirements laid down. It must however, be first pointed out when comparing these with toxic levels, that because a 20% loss during storage will probably occur, these values will actually be significantly less when food intake occurs. The toxic level for vitamin A is 2000µg, which would make the menu values for vitamin A, acceptable. High cost western diets on average can have up to 32 µg/day of vitamin B_{12} (Passmore and Eastwood, 1986), with low cost ones having 16µ g/day. The values for the menus developed were within this region, which indicates acceptability.

For vitamin C, the values for the menus were well below the toxic level of 4000 mg (Passmore and Eastwood, 1986). The values for Niacin were also well below the toxicity levels of 3-9000 mg/day (Nutrition Reviews, 1976).

The low level of vitamin D is not significant, considering that it is a fat soluble vitamin and that much of it is synthesised in the body through contact with sunlight. Soldiers during their field exercises, spend significant amounts of time in contact with sunlight and therefore would produce adequate amounts of

vitamin D.

2.10 EVALUATION OF WEIGHTS AND COSTS

Table 2.12 shows the comparison of weights and costs between the developed menus and the present ration pack. The developed menus were approximately 200 grams heavier than the present ration pack. This was because of the higher energy content they had. The high cost is also contributed to this and the higher quality of foods that were included. The acceptability of the weight would be found during the following field trial. The cost is acceptable when compared to the cost of lightweight pack of over 10 dollars.

Table 2.12: Comparison of Weights and Costs of the First Prototype and Present Ration Packs

	WEIGHT (kg)	COST ($)
1. Type 1A	1.601	9.34
2. Type 1B	1.551	9.07
3. Type 1C	1.611	8.65
4. Type 1D	1.248	11.18
5. Type 2A	1.521	9.39
6. Type 2B	1.471	9.12
7. Type 2C	1.531	8.70
8. Type 2D	1.167	11.23
Average of Type 1	1.503	9.56
Average of Type 2	1.423	9.61
Average of Present Ration Pack	1.256	5.77

2.11 CONCLUSIONS

Two types of menus were developed for the purpose of being used in ration packs by mixed integer linear programming. This was done first by selecting 95 foods which were thought acceptable in a ration. Secondly, a data matrix was compiled which included nutritional constraints and food constraints. The objective was to obtain a least weight menu. This was done using a LP program called SCICONIC on a mainframe computer.

The menus, though acceptable in terms of nutritional composition, weight and cost, still required evaluation by the soldiers in terms of sensory acceptability. The next Chapter discusses the procedure used to do this and the results that were obtained.

CHAPTER 3

TESTING OF THE FIRST PROTOTYPE RATION PACK

3.1 INTRODUCTION

Human beings (especially those in the western world) can quickly find food unappertising if the diet becomes repetitive. Monotony also can be induced by reducing the number of foods that can be consumed (Siegel and Pilgrim, 1971). Monotony in diet can result in the following (Siegel and Pilgrim, 1971):

* the palatability of a food item declines progressively as it is repeatedly eaten, this is significant in foods that initially are rated low, more so than for foods rated initially high;

* food will begin to be uneaten; and

* the eater may not recover from his dislike of a food item (the result of repeatedly eating it) for several months. This is proved by those who have worked at a food company for a period of time.

These are some of the problems that the Armed Forces have had to deal with in supplying military food rations to their troops. The need to continually develop new and different food rations has also required the need to measure the effectiveness of the changes that have taken place.

This section looks firstly at the evaluation of military food rations in the past. Moskowitz and Klarman (1977) stated '... menus developed by computer are only as good and acceptable as the rules which are used in the programming.' Therefore, the menus that were developed through linear programming in this work

were not necessarily the ideal ones and there was a need to consumer test them with the soldiers.

3.2 THE USE OF CONSUMER SURVEY METHODS

3.2.1 Hedonic Category Scale

Peryam and Pilgrim (1957) introduced the 9 point hedonic scale for food preference measurement while both were working at the U.S. Army Quartermasters Corps in Chicago. This scale was essentially a category one, whereby participants were required to categorise their liking of the food from either 1 to 9, or dislike extremely to like extremely. Since then, this method has become a standard method to assess liking/disliking.

The advantages with category scales is that panelists find them easy to use, minimal training is required and statistical analysis on data can be carried out (Cooper, 1981). The number of categories does not have to be 9 and can be as small or as big as the food developer requires. However, if too few categories are given, because panelists shy away from the ends of a scale, data can be very biased. If there are too many categories, panelists will tend to try and use all the categories equally. With some panelists, clustering of responses happens at either the low end, middle or top end of the scale.

The main disadvantage with category scales is that equal intervals are assumed between categories, which is not always so. Linearity therefore, cannot be assumed.

3.2.2 Focus Groups

The focus group (Zikmund, 1982) is a technique which involves six to twelve consumers drawn from the population which is of interest. They are guided by a moderator who starts the discussion usually with general questions, and then tends to become more specific during the discussion session. Interaction between the participants is just as helpful as that between the moderator and the participants. A homogeneous sample has been recommended to minimise conflict. Focus groups are usually taped and later transcribed for analysis.

3.2.3 Methods Used in the Armed Forces

The work done by the United States Quartermasters Corps in Chicago for the Armed Forces, the Letterman Army Institute of Research and the US Army Natick Research and Development Laboratories has included numerous studies on practically all aspects of food rationing; from studying the human physiology effects of nutrition, to developing new foods, to finally measuring the performance of soldiers in the field using ration packs. The latter is relevant to this study.

The study of human nutrition and performance is associated more with Carlo F. Consolazio than any other single person. From 1931-1976 he worked extensively on the performance of humans under various extreme conditions. His work also included evaluation of food and nutrition in relation to the armed forces personnel. His book 'Nutrition and Performance' (1983) which deals with the nutrition of man during physical stress summarises the work he achieved over 35 years.

The development of new foods required the need to quantify the palatability of the new food. The development of the 9 point like-dislike rating scale (hedonic scale) by Peryam and Pilgrim

(1957) filled this need. Both were working at the Quartermaster Food and Container Institute and since then, numerous techniques have been developed and used by the US Armed Forces Food Research establishments to measure food acceptability.

The field evaluation of ration packs uses both the techniques and findings of Consolazio, and of Peryam and Pilgrim. A recent field study by the US Army Natick Research and Development Laboratories (1981) was very comprehensive. The study involved the evaluation of an Arctic ration and the assessment of water discipline in the Arctic. The questionnaires that were used asked for information on the environmental symptoms of the soldiers (6 point hedonic scale), on body fluids (7 point hedonic scale) and acceptability of the food items consumed (9 point hedonic scale). A supplementary questionnaire asked information on the overall ration pack and its use.

For a number of years the Australian Army, through their Armed Forces Food Science Establishment, have also carried out a number of field evaluations. In their latest field evaluation (Australian Department of Defence, 1986) they reviewed the acceptability of their combat ration pack. The questionnaire used was designed to find faults with the ration pack. Questions generally were very short, requiring yes/no answers, and comments relating to the choice made. A 5 point hedonic scale was also used to determine the acceptance of the individual food items. No human physiology responses were requested.

A comparison of these two methods showed that the US study, though lengthy, required mainly that the soldier indicate his response by circling a number or letter. For the Australian study, though shorter, more written information was required. The decoding of such information would have been very difficult.

The response rate to both these questionnaires depends heavily

on the attitude of the soldier. He must be briefed on the purpose of the study, and the affect he has on the outcome.

3.3 QUESTIONNAIRE DESIGN FOR THE CONSUMER SURVEY

The aim of the field survey that was carried out in the next stage was mainly to determine the acceptability of the design of the menus developed by LP, and to obtain information on any improvements that could be made. A secondary aim was to get quantitative information on the actual use of the present ration pack.

Questionnaires were required to obtain information during the field evaluation. The first step in designing these questionnaires was to decide exactly what information should be collected.

A number of specific areas of information required were generated:

* Acceptability

  - To what degree were the foods/beverages, that had been included, liked?
  - Overall, how much was the pack liked?

* Acceptability of Quantity

  - How acceptable were the quantities of each of the foods/beverages that were consumed each day?
  - Overall, were there enough main meals?
  - Overall, were there enough snack foods?
  - Overall, were there enough beverages?
  - Overall, was there enough food to eat in the ration pack?

* Quantity Eaten

  - The frequency of use of the foods/beverages consumed each day.
  - The foods that were left behind and the reasons for doing so.
  - The foods that were not eaten and were kept to the end of the exercise. The associated reasons for having kept them.

* Water Requirements

  - Was there enough water for preparing food and beverage items?
  - How much water was used daily?

* Ration Pack Use

  - Were the main meals eaten hot or cold?
  - Overall, was the amount of food carried too heavy or too bulky?
  - How convenient was preparing particular foods?

It was important that the questionnaire be simply worded and simple to administer for the soldiers, e.g. circling letters or numbers for responses. Longer comments could be obtained from discussion groups. The low average formal education of the infantry soldier warranted this attention. As much information as possible was thought to be important at this stage to plan the next stages of the study.

All the information could not be gathered from one questionnaire and several were therefore developed which could be answered at different times by the soldiers. In total, five different questionnaires were designed. These determined the following:

questionnaires were designed. These determined the following:

* Foods not taken on the field exercise - this determined the quantity and reasons for soldiers not taking ration pack items.

* Diary of food eaten each day - this determined the quantity of food each day and the acceptability of each food item consumed (7 point hedonic). It also determined size acceptance of food items, convenience of food preparation and quantity of water used.

* Foods left over from the field exercise - this determined the quantity of ration pack items left-over from the field exercise and the corresponding reasons for doing so.

* Overall liking of ration pack - this determined the overall acceptability of the ration pack items (7 point hedonic).

* Overall preference - this determined the soldiers' preferences between the present and prototype ration packs.

A pre-test on the diary questionnaire was done with soldiers at Linton Military Camp, Palmerston North. The purpose of this was to determine whether or not the questions could be interpreted easily, and also to obtain suggestions for improvement. Appendix 6 has samples of all these questionnaires.

Four of the five questionnaires were designed so that quick coding for computer input could be done. A statistical sub-program was written for use with SPSS (Statistical Package for the Social Sciences, Nie et al, 1975). This decoded the inputed data into the form required for SPSS.

3.4 THE PACKING OF THE FIRST PROTOTYPE RATION PACK

The purpose of the consumer field trial was to test the acceptability of the type and quantity of foods in the developed menus. The specific food was not important (though it had to be of good quality). More important was the type it was, e.g. whether it was a main meal or snack food.

This objective enabled commercially available foods to be used in the trial. Therefore, no product development was required at this stage. Foods were obtained from supermarkets, wholesalers and manufacturers. The quantity and type of food obtained was matched as closely as possible with the menus developed. To ensure this, many of the foods obtained were specially packed; either by manufacturers or through a contract packer.

In total, four menus were made up - two menus from the two types. A limited variety was included in these menus as it was decided that the gathering of in-depth information on a fewer number of products was more important than superficial information on a large number of products. The small size of the field trial also highlighted the need to do this. Table 3.1 lists the four menus that were evaluated.

The foods were transported to Trentham Military Camp where army personnel were used to make up the prototype combat ration packs. The facilities were those used for packing of the present combat ration pack. Figures 3.1 and 3.2 illustrates the procedures involved in packing combat ration packs. In total, 600 prototype packs were made up.

Table 3.1: Menus of the First Prototype Ration Pack Evaluated on the Preliminary Trial

TYPE 1 MENUS

Common Items	Weight	Quantity
Biscuits - Fruit	50 gm	1
Biscuits - High Fibre	50 gm	1
Biscuits - Cabin Bread	60 gm	1
Sultanas	40 gm	2
Roasted Peanuts	125 gm	1
Coffee	4.2 gm	2
Tea	2.5 gm	2
Milo	33 gm	1
Condensed Milk - Sweetened	50 gm	1
Powdered Fruit Drink - Lime	10 gm	1
Salt	7 gm	2
Sugar	14 gm	6
Honey	50 gm	1
Curry Powder	3.5 gm	1
Dried peas	15 gm	1
Butter Spread	30 gm	1
Steel Cleaning Cloth		1
Toilet Paper	Sheets	5
Matches - Waterproof	Box	1
Can Opener		1

TYPE 2 MENUS

Common Items	Weight	Quantity
Muesli Foodbar	80 gm	1
Sultanas	40 gm	2
Roasted Peanuts	125 gm	1
Coffee	4.2 gm	2
Tea	2.5 gm Tea bags	2
Condensed Milk - Sweetened	50 gm	1
Powdered Fruit Drink - Lemon	10 gm	1
Salt	7 gm	2
Sugar	14 gm	6
Curry Powder	3.5 gm	1
Steel Cleaning Cloth		1
Toilet Paper	Sheets	5
Matches - Waterproof	Box	1
Can Opener		1

Menu Items

Menu A

Meatballs in Tomato Sauce	440 gm	1
Sardines	100 gm	1
Rice - Risone	100 gm	1
Chocolate - Moro Bar	60 gm	1
Chewing Gum	15 gm	1
Pepper	1 gm	1
TOTAL GROSS WEIGHT	1.65 KG	

Menu B

Savoury Mince	440 gm	1
Chicken Pieces	200 gm	1
Macaroni	100 gm	1
Chcocolate - Dark Chocolate	45 gm	1
Lifesavers - Peppermints	25 gm	1
Onion Flakes	5 gm	1
TOTAL GROSS WEIGHT	1.67 KG	

Menu Items

Menu C

Vegetables and Beef Casserole	450 gm	1
Fruit - Pears	310 gm	1
Rice - Freeze-dried	55 gm	1
Chocolate - Peanut	45 gm	1
Lifesavers - Five Flavours	25 gm	1
Soup Powder - Mushroom	60 gm	1
Jam - Blackcurrant	50 gm	1
Chili Powder	1 gm	1
TOTAL GROSS WEIGHT	1.75 KG	

Menu D

Ravioli in Beef & Tomato Sauce	450 gm	1
Fruit - Fruit Salad	310 gm	1
Instant Noodles	85 gm	1
Chocolate - Fruit	45 gm	1
Lifesavers - Mixed Berry	25 gm	1
Soup Powder - Chicken Noodles	55 gm	1
Jam - Apricot	50 gm	1
Tomato Sauce	8 gm	1
TOTAL GROSS WEIGHT	1.72 KG	

Figure 3.1: Photograph of the Packing of Combat Ration Pack Items

Figure 3.2: Photograph of Full Cartons of Combat Ration Packs

3.5 FIELD TESTING OF THE FIRST PROTOTYPE RATION PACK

The field trial was carried out on the West Coast of the South Island over a period of 12 days (10-22 February 1986). Two platoons of approximately 25 soldiers were involved; 11th and 12th Platoons, Delta Company, 2/1 Battalion, RNZIR, Burnham Military Camp. Both platoons were involved in close country patrols under wet, mild conditions. The present and the first prototype ration pack were both evaluated.

3.5.1 Organisation of the Field Trial

Before commencing, both platoons were briefed on the nature of the exercise. They were told not to take any "perks" (civilian foods purchased for themselves) with them as this would affect the results of the trial. The platoons were also instructed in the use of particular foods present in the prototype ration pack. To simplify the procedure and to remove error, the soldiers took the entire contents of the ration packs. This allowed soldiers to consume items with which they were not familiar. It was because of this that the questionnaire referring to foods left behind was not required to be filled in. This questionnaire relating to the present combat ration pack was filled in; however, it was not completed properly by the soldiers.

Eleventh Platoon consumed the present ration pack for seven days and then consumed the prototype ration pack for four days. Twelfth Platoon consumed the prototype ration pack for eight days and then the present ration pack for three days. The reasoning behind this was to remove any bias that would occur from just testing the prototype ration pack. A better comparison was therefore expected. Both platoons were issued with at least one of the four prototype menus. Three to four rations were issued at the start of the exercise with resupplying of similar quantities occurring during the exercise.

3.5.2 Data Collection

During the exercise, soldiers were required to fill out the daily questionnaire. Before the exercise, it was decided that an on site presence would be important. Therefore, the researcher lived with the soldiers for the duration of the exercise. This enabled further information to be collected informally between soldiers and the researcher. Observation of weather, water, working and other living conditions could also be made. Any problems with questionnaire completion and food preparation, could be solved immediately.

On the completion of the field exercise, both platoons were asked to complete the questionnaires on foods left over, the overall acceptability and the preference. Focus groups were also held after the field trial. For these discussions the platoons were divided into three groups; the lieutenants and non-commissioned officers forming one group, and the privates forming two groups of no more than 10 men. These small groups of similar rank avoided any difficulties that lower ranked or quieter soldiers would find when answering questions.

The purpose of these focus groups was to gain information, which would be difficult to obtain from a written questionnaire. A series of questions were asked on the different sections of the ration pack, e.g., the canned foods and snack foods. Comparisons were also made with the present ration pack.

3.6 RESULTS OF FIELD TESTING OF THE FIRST PROTOTYPE RATION PACK

As already mentioned, the questionnaires relating to the food items left behind were either not filled in or did not produce satisfactory data. No analysis was therefore attempted from

these questionnaires. Questionnaires based on foods left-over from the exercise were also poorly completed. Soldiers had problems recalling what they had left-over after two or three days. Also, the quantities left-over depended mainly on how many ration packs were issued on the last resupply. For these reasons, no analysis was done on these questionnaires.

3.6.1 Diary of Foods Eaten Each Day

Due to the nature of the working conditions of the soldiers, it was not always possible for soldiers to fill out a questionnaire each day. Therefore, this resulted in gaps being present in the data. To overcome this problem, soldiers were asked at the end of the trial to complete one of the diary questionnaires on all the types of foods consumed during the exercise. The sections in the questionnaire relating to food preparation and water usage were not analysed due to the interpretation of the questions. The method and time required to prepare food depended more on the situation rather than the food item. Completely different responses could be given by the same soldier for the same food because of this.

Water usage responses were also dependant on the particular conditions. These conditions, such as how often it rained and the tactical and working conditions of the soldier, determined the availability and usage of water.

Tables 3.2 and 3.3 respectively give the mean scores (m.s.) for liking and for size of the present and prototype ration packs. The m.s. represents averages calculated for all the soldiers. A m.s. for liking of 4 represents a "neither liking nor disliking" of the item. A m.s. for size of 3 represents "just right".

Table 3.2: Mean Scores for Items in the Present Ration Pack

ITEM	HOW LIKED			SIZE ACCEPTANCE		
	11TH PLATOON	12TH PLATOON	OVERALL	11TH PLATOON	12TH PLATOON	OVERALL
Beef Stew	4.3	3.4	3.9	2.5	2.7	2.6
Lamb & Peas	3.8	3.3	3.6	2.5	2.7	2.6
Beef Curry & Veg.	2.9	2.7	2.8	2.5	2.7	2.6
Beef Goulash	3.7	3.4	3.6	2.5	2.7	2.6
Spiced Mutton	3.8	3.0	3.4	2.5	2.6	2.6
Corned Beef & Veg.	4.7	4.1	4.4	2.5	2.7	2.6
Spaghetti & Sau.	5.3	5.1	5.2	2.6	2.8	2.7
Baked Beans & Sau.	4.9	4.8	4.8	2.6	2.7	2.7
Rice	2.8	2.9	2.8	3.4	3.7	3.6
Biscuits	3.4	4.3	3.8	3.1	3.0	3.0
Honey	3.0	3.3	3.2	3.6	3.3	3.4
Sparkles(average)	4.2	4.0	4.1	2.8	3.1	3.0
Chocolate	4.8	5.2	5.0	2.5	2.8	2.7
Sultanas	3.6	3.8	3.7	3.3	3.0	2.9
Coffee	6.1	5.7	5.9	2.9	2.9	2.9
Tea	4.7	4.4	4.6	2.9	3.0	2.9
Soup(average)	4.4	4.0	4.1	2.9	3.0	3.0
Salt	4.7	4.6	4.7	3.2	3.1	3.1
Sugar	5.4	5.5	5.4	3.0	3.0	3.0
Curry	3.4	3.9	3.6	3.0	3.0	3.0
Milk powder	4.4	4.0	4.2	2.6	3.0	2.8
Steel Wool	4.9	4.9	4.9	2.9	3.0	3.0
Toilet paper	3.8	5.2	4.6	2.3	2.6	2.5
Matches	4.7	4.8	4.7	2.9	3.0	3.0
Can Opener	4.5	4.8	4.7	2.7	2.7	2.7

KEY

1 = terrible
4 = neither like nor dislike
7 = excellent

1 = much too small
3 = just right
5 = much too big

Table 3.3: Mean Scores for Items in the First Prototype Ration Pack

ITEM	HOW LIKED			SIZE ACCEPTANCE		
	11TH PLATOON	12TH PLATOON	OVERALL	11TH PLATOON	12TH PLATOON	OVERALL
Meatballs in t/s	4.7	5.2	5.0	3.7	3.3	3.5
Savoury mince	3.7	3.9	3.8	3.7	3.5	3.6
Vege & Beef Cass.	5.5	5.7	5.6	3.6	3.3	3.4
Ravioli	3.3	4.6	4.0	3.8	3.5	3.6
Sardines	6.3	5.4	5.9	2.6	2.8	2.7
Chicken pieces	5.5	5.8	5.7	2.6	2.8	2.7
Canned pears	6.8	6.6	6.7	2.6	2.8	2.7
Canned Fruit salad	6.8	6.6	6.7	2.5	2.9	2.7
Instant Noodles	5.8	6.2	6.0	2.9	3.1	2.9
Rice - Risone	4.1	3.7	3.9	3.0	3.8	3.4
Rice - F/dried	5.1	3.8	4.3	3.1	3.3	3.3
Macaroni	5.5	4.4	5.0	3.0	3.5	3.3
Biscuits - Fruit	6.2	6.1	6.1	2.6	3.0	2.8
Biscuits - Fibre	6.1	4.8	5.5	2.8	3.3	3.1
Biscuits - Cabin	6.3	5.7	6.0	2.6	3.1	2.9
Muesli Foodbar	5.9	5.1	5.5	2.8	2.8	2.8
Choc. - Moro	6.3	6.3	6.3	2.4	2.7	2.6
Choc. - Rich&dark	6.3	6.0	6.1	2.2	2.9	2.6
Choc. - Peanut	6.2	6.2	6.2	2.3	2.7	2.5
Choc. - F/cream	6.4	6.5	6.4	2.2	2.7	2.5
Sultanas	4.1	4.1	4.0	3.5	3.2	3.3
Peanuts	6.1	5.5	5.8	3.1	3.4	3.3
Chewing gum	6.4	5.5	6.0	2.6	3.0	2.8
Lifesavers						
- peppermints	5.4	4.4	4.8	2.9	3.1	3.0
- five fruits	5.7	4.6	5.1	3.1	3.1	3.1
- mixed berry	6.0	4.6	5.3	3.2	3.1	3.1
Coffee	6.4	5.9	6.1	2.9	3.0	3.1
Tea	6.1	5.4	5.7	2.9	3.2	3.0
Milo	6.5	6.5	6.5	3.1	2.9	3.0
Soup - Mushroom	5.8	5.3	5.6	3.1	3.3	3.3
Soup - C/noodle	5.7	5.1	5.4	3.1	3.3	3.2
Condensed milk	6.6	6.7	6.7	2.4	2.5	2.4
Lime Drink	6.3	4.6	5.5	3.0	3.5	3.2
Lemon Drink	6.3	5.3	5.8	3.1	3.5	3.3
Salt	5.0	4.9	5.0	3.3	3.2	3.2
Sugar	5.6	5.8	5.7	3.2	3.0	2.9
Honey	3.7	4.1	4.0	3.2	3.1	3.1
Jam - Apricot	5.7	5.7	5.7	2.8	3.0	2.9
Jam - Blackcurrant	6.1	5.4	5.8	2.8	3.0	2.9
Butter spread	6.2	5.7	5.9	2.6	2.9	2.7
Curry	3.5	4.0	3.8	3.1	3.1	3.1
Pepper	4.0	4.1	4.0	3.2	3.1	3.1
Onion flakes	5.6	5.1	5.3	2.5	2.8	2.7
Dried peas	4.8	4.6	4.6	3.0	3.0	3.0
Chilli powder	4.5	4.3	4.3	2.9	2.9	2.9
Tomato sauce	5.5	4.6	5.0	2.6	3.0	2.8
Steel cloth	6.3	6.1	6.2	2.5	2.5	2.5
Toilet paper	4.9	5.7	5.3	2.2	2.7	2.5
Matches	5.2	4.9	5.1	3.1	3.2	3.2

KEY

1 = terrible
4 = neither like nor dislike
7 = excellent

1 = much too small
3 = just right
5 = much too big

For the present ration pack, only four food or beverage items had a m.s. for liking of 5 or more. These were spaghetti and sausages (m.s. 5.2), chocolate (m.s. 5.0), coffee (m.s. 5.9) and sugar (m.s. 5.4). Only six other food/beverage items had m.s. above 4.0.

For the first prototype ration pack, only six major food items had a m.s. for likng of less than 5. These items were savoury mince, ravioli, rice risone, freeze-dried rice, sultanas and honey

The size of many items in the present ration pack were indicated from the m.s. as being slightly too small. However, for the first prototype ration pack, the m.s. indicated that several items were slightly too large.

3.6.1.1 Canned Meals

For the present ration pack, all the canned foods except spaghetti and sausages (m.s. 5.2) had a mean liking score of less than 5 (like moderately). For the first prototype ration pack of the large cans only, meatballs in tomato sauce (m.s. 5.0) and vegetables and beef casserole (m.s. 5.6) scored a mean liking score above 5. The smaller cans all had a mean liking score above 5.

With reference to the size of the cans in the present ration pack (each pack has two cans at 225 g and one can at 310 g), the soldiers indicated that they were too small. The large cans (450 g) in the first prototype ration pack were found to be too big. The small cans (100 - 310 g) in this prototype were found to be too small.

3.6.1.2 Carbohydrate Source

In the present ration pack, rice was disliked moderately (m.s. 2.8). In the first prototype ration pack, Instant Noodles was the most popular (m.s. 6.0), followed by macaroni (m.s. 5.0), freeze-dried rice (m.s. 4.3) and rice-risone (m.s. 3.9).

The size of Instant Noodles was found to be acceptable with all the other carbohydrate sources found to be too big.

3.6.1.3 Snack Foods

Chocolate was the most popular snack food in the present ration pack (m.s. 5.0). The biscuits (m.s. 3.8), sultanas (m.s. 3.7) and the sweets (brand name 'Sparkles') (m.s. 4.1) were neither liked nor disliked.

The biscuits, muesli foodbar, the four varieties of chocolate, the sweets and peanuts in the first prototype ration pack, all had m.s. above 5.0. Sultanas was the only snack food that was rated below this.

In both packs, the chocolate was found to be slightly too small. In the first prototype ration pack, the peanuts were found to be slightly too large. The sizes for the other snack foods were found to be just right.

3.6.1.4 Spreads

Honey for both packs had a liking m.s. of 4 or less (depending on which platoon) and size was slightly too large. Both the jams and the butter spread had a liking score of 5 and above. The amount of jam was just right and for the butter spread, it was slightly too small.

3.6.1.5 Beverages

In the present ration pack, coffee was the most popular beverage (m.s. 5.9), followed by tea (m.s. 4.6) and instant soup (m.s. 4.1). The milk powder was neither liked nor disliked (m.s. 4.2).

For the first prototype ration pack, milo was the most popular (m.s. 6.5), followed by coffee (m.s. 6.1), lemon drink (m.s. 5.8), lime drink (m.s. 5.7), tea (m.s. 5.7), mushroom soup (m.s. 5.6) and chicken noodle soup (m.s. 5.4). The condensed milk was very much liked with a m.s. of 6.7.

The popular condensed milk, was the only beverage item found to be be too small. The instant soups and the fruit drinks in the first prototype ration pack were the only items found to be too big.

3.6.1.6 Condiments

Salt and sugar present in both ration packs were basic commodities. These were found to be moderately liked with their sizes being about right. Curry which was also included in both packs, was neither liked nor disliked. Only onion flakes and tomato sauce had a liking m.s. of 5 or more. Sizes for all condiments were about right except for onion flakes which was slightly too small.

3.6.1.7 Non-Food Items

The only difference in the non-food items area between the two ration packs was the introduction of a non-rust cleaning cloth. This was liked very much (m.s. 6.2) though it was slightly too small. The steel wool in the present ration pack was liked moderately (m.s. 4.9), with the size being just right. The toilet paper, matches and can opener were all liked moderately

though the toilet paper and can opener were thought to be slightly too small.

3.6.2 The Acceptability of Amounts of Food

The purpose of the questionnaire relating to the overall liking of the ration packs was to evaluate the food categories. This dealt with particular groups of items rather than the individual items within the packs as in the diary questionnaire.

Table 3.4 summarises the analysis of results from this questionnaire.

Table 3.4: Summary of Results for Both Platoons on the Quantities in the Present and the First Prototype Ration Pack

	% of Soldiers	
	Present Ration Pack	First Prototype Ration Pack
Adequate Number of cans?		
Yes	87.5	72.9
No	12.5	27.1
Adequate Number of Snack Foods?		
Yes	50.0	93.7
No	47.5	4.2
No response	2.5	2.1
Adequate Amount of Food?		
Yes	85.0	93.7
No	15.0	6.3
No response	-	
Adequate Amount of Beverages?		
Yes	55.0	89.6
No	32.5	4.1
No response	12.5	6.3
Adequate Amount of Water?		
Just enough	60.0	52.1
Slightly too little	25.0	33.3
Far too little	0.0	6.3
No response	15.0	8.3
Adequate Amount of Condiments?		
Yes	55.0	81.3
No	22.5	12.5
No response	22.5	6.2
Adequate Non-Food Items?		
Yes	50.0	64.6
No	39.5	29.2
No response	10.5	6.2

The following sections discuss these overall results and the information obtained from the field trial and the subsequent focus groups.

3.6.2.1 Number of Canned Foods

Comparison of results shows that the size and number of cans in the present pack were more adequate than those in the prototype pack. This indicates that the three cans in the present ration pack was the more acceptable concept. However, the can sizes in this pack were found to be slightly too small. This was also found in the diary questionnaire, the focus groups and also in the "Consumer Attitude Survey" (Food Technology Research Centre, 1985e).

Canned fruit and corned beef, popular with the soldiers, were mentioned frequently in the questionnaires and the focus groups as foods they would like included more in the prototype pack.

3.6.2.2 Number of Snack Foods

The soldiers found the amount of snack foods in the prototype ration pack more acceptable than the present ration pack. Some soldiers indicated in the questionnaire and and in the focus groups that there were too many snacks. However, in exercises involving much stress, large amounts of snacks would be eaten.

3.6.2.3 Total Amount of Food

As found in the "Consumer Attitude Survey" (Food Technology Research Centre, 1985e), the present ration pack did not seem to have enough food. In some cases, respondents thought there was too much food in the first prototype pack.

3.6.2.4 The Number of Beverages

The introduction of more and different beverages in the prototype ration pack was found to have increased the adequacy of this area in the combat ration pack. There were indications from the focus groups that there were too many beverages. However, in some exercise situations they would all be used; if not, they could be swapped among soldiers. The light weight of the beverage sachets was a positive factor in having more beverages.

3.6.2.5 The Amount of Water

The prototype ration pack did require more water for preparation of food/beverages. This was due to more beverages. It was not intended that all the beverages be used by each soldier, but by providing a variety the soldiers' preferences could be met more adequately.

3.6.2.6 The Amount of Condiments

As with the beverages, the introduction of several different condiments was accepted well by the soldiers. There were certain spices that were not liked by the soldiers, however this is normal. Many soldiers have trained in Asia and have obtained a liking for spicy foods, while others have not. The presence of condiments in the ration pack has three main advantages; they can add significant flavour and variety to meals, they can be used according to the personal tastes of the user, and lastly, as with beverages, they are light to carry.

3.6.2.7 Adequacy of Non-Food Items

The introduction of the non-rust cleaning cloth was met with wide acceptance. Much of the ill-feeling felt in this area was the small quantity of toilet paper issued. Also, the waterproof

matches become non-functional when the striker on the box gets wet. The can opener is adequate though it is too small and is easily lost.

3.6.3 Overall Liking of the First Prototype Ration Pack

Table 3.5 and Figure 3.3 show clearly that the prototype ration pack was overall liked more than the present ration pack. Two areas mentioned in the discussion groups which contributed to this was the variety and quality of the foods - variety in terms of the number of different items, and quality in terms of the taste of the food. This latter point was particularly stressed in discussion on the canned foods used in this trial.

Table 3.5: Overall Liking of the First Prototype Ration Pack

	% of Soldiers	
	Present Ration Pack	First Prototype Ration Pack
Overall Liking of Ration Pack?		
Terrible	5.0	0.0
Very much dislike	17.5	0.0
Moderately dislike	22.5	4.1
Neither like nor dislike	20.0	0.0
Moderately like	17.5	27.1
Very much like	2.5	39.6
Excellent	2.5	22.9
No response	12.5	6.3

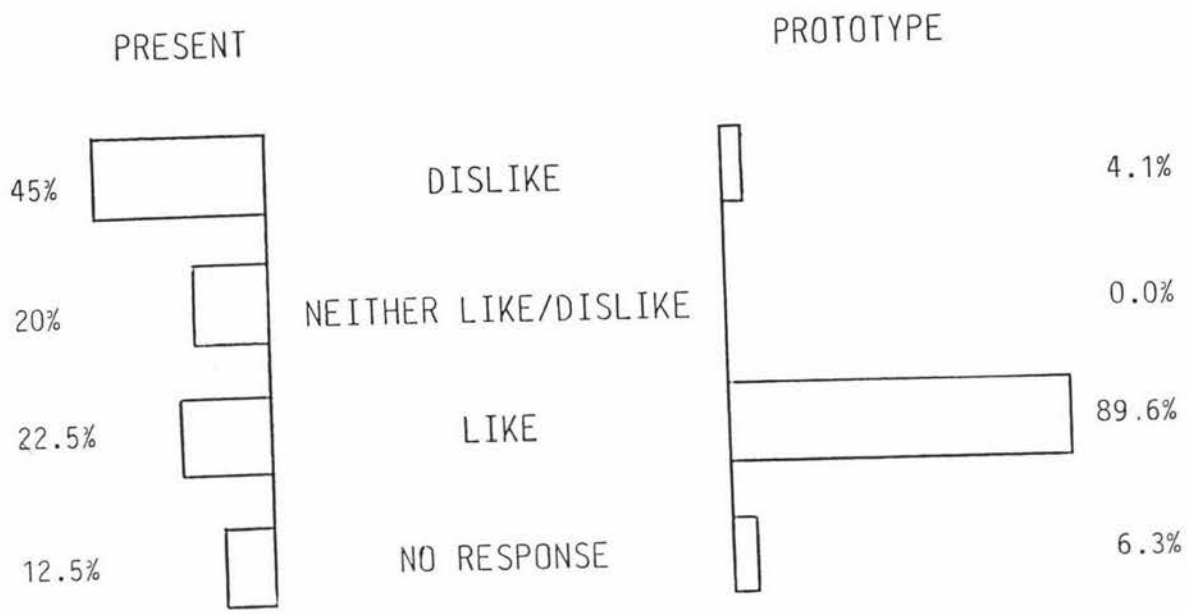

Figure 3.3: Comparison of Acceptability of the Present and First Prototype Ration Packs

3.7 EVALUATION OF RESULTS

3.7.1 Canned Foods

All the canned foods in the present ration pack, except for spaghetti and sausages, were found to be unacceptable and were not included in the second prototype pack. Similar meat meals to those in the first prototype ration pack would be developed. A three can concept (each approximately 300 g) was adopted, with one can containing fruit and the other two meat meals. These meat meals would include various meats e.g. pork, chicken, beef, lamb and fish.

3.7.2 Carbohydrate Source

Instant noodles and macaroni were the only main carbohydrate sources that were acceptable enough to be included in the second prototype. The weight of 85 grams for instant noodles was the same, and for macaroni it was reduced from 100 grams to 75 grams.

3.7.3 Snack Foods

From the results, it was found that the biscuits in the present ration pack needed to be replaced. The replacement biscuits were similar in type and size as those evaluated in the prototype pack.

The variety of chocolates included in the first prototype ration pack were well received; because of this, more than one type was to be included in the second prototype pack. The quantity was kept at 60 g.

Sultanas and Sparkles were found to be unpopular so they were excluded from the next prototype pack. The Lifesaver sweets were well liked, but because they were not individually wrapped,

foreign matter was picked up and became a problem. Stickiness also became a problem. Chewing gum, though popular, was thought not to be tactically correct by some of the soldiers due to noise level and method of disposal. Alternatives would have to be found, between 25 and 35 grams.

Peanuts were not to be included in the next prototype pack due to their limited storage life. The problem of too many snacks was solved by deleting this item.

3.7.4 Spreads

Overall, the honey was not well liked; the major reasons mentioned were due to monotony (it is included in all present ration packs), and there being too much of it. The second prototype pack had a combination of jam and honey spreads (same sizes as those evaluated). Cheese of various kinds were also mentioned as being popular and one type was included in the next prototype pack. The butter spread was also included due to it being able to be used for a number of situations. The quantity was increased to 40 grams.

3.7.5 Beverages

All the beverage sachets and tea bags to be used in the next prototype pack would be standard, commercially available ones (except for the fruit drink), i.e., enough dry beverage solids to make up 200 mls of liquid. The small portions gave the soldier the flexibility of either using one portion for a small drink or two or three portions for a larger one. The use of a large sachet had the problem of resealing if only a part of the contents were used.

The number of coffee sachets was reduced from six in the first prototype pack to three in the second one. Two Milo sachets were

included in each menu. This would increase the overall total number of sachets from six to eight, in four menus. Tea bags rather than tea sachets, were used. One sachet of instant soup was included in each menu, using popular varieties. The instant soup powder was very useful as it was often used as a flavouring for meals. A powdered fruit drink (10 g - enough to make 1 litre of beverage) was also included in each menu and popular varieties used.

Sweetened condensed milk was used in the next prototype, with the quantity increased to 65 grams.

3.7.6 Condiments

The quantity of salt and sugar for the next prototype was the same as that in the present and first prototype packs. Several condiments were used, with a mixture of curry (3.5 g), stock cubes (6 g), chili powder (5 g), pepper (1 g), onion flakes (7 g) and dried peas (16 g) being included.

3.7.7 Non-Food Items

The non-food items were the same as those in the first prototype, except twice as much toilet paper (10 sheets) was included.

3.8 CONCLUSIONS

The results of the field evaluation showed that the overall acceptability of the present ration pack was very low, with several individual items contributing to this. The first prototype combat ration pack was found to be significantly more acceptable. Also, a higher preference for this pack over the present pack was indicated. The composition of the prototype pack, e.g., the number of snack foods and beverages, were also

more acceptable. Most individual items were also rated higher.

As much of the foods in the prototype ration pack were from commercial sources, there was a need to develop products which could be made especially for the New Zealand Army. This is because the commercial products are made for the local market and do not always meet the required specifications of size of packaging, content of food and nutritional composition. Information from the field evaluation indicated what products needed to be developed or improved within the prototype pack.

Another area of development work required was that of questionnaire design. Attention was given to the fact that some of the questionnaires were difficult for the soldiers to answer by the soldiers. More consideration was required so that questionnaires were more simpler and therefore more easily answer.

CHAPTER 4

DESIGNING THE SECOND PROTOTYPE RATION PACK

4.1 INTRODUCTION

The aim at this stage of the project was to design a second prototype ration pack which would be field tested on a large scale in Malaysia and New Zealand. Menu planning criteria (Eckstein, 1973) were used in doing this.

The design of the second prototype ration pack was based on the consumer information from, firstly, the consumer attitude survey, and secondly, the field evaluation with a small number of soldiers. From this information quantities of foods for the ration pack were determined and it also provided helpful ideas for product development.

Commercially available food products were used in the second prototype ration pack as much as possible. This decreased the amount of new product development required. The commercially available food products were selected by screening firstly on their performance in the small field evaluation, and then on other factors such as storage life, packaging and costs. The new products developed were five canned meat meals. The packaging for all the products was designed to give the protection needed during storage and in the field. Menus were developed by selecting foods which would give variety within and between menus. Spread sheets were used to aid this development and also to determine the nutritional compositions of the menus.

4.2 SELECTION AND TESTING OF COMMERCIAL PRODUCTS

The commercially available products that were selected for the second prototype ration pack were those that performed well during the previous field evaluation and those that were suggested by the soldiers.

4.2.1 Canned Foods

The canned spaghetti and sausages is in the present ration pack and was included in the second prototype ration pack because of the high acceptability during the field evaluation. The canned corned beef was included because it was a common "perk" with the soldiers. One particular brand name was mentioned by the soldiers and so this was used in the pack. Tuna was included as it was a locally produced product and easy to purchase; it was assumed that it would be as popular as canned sardines. Canned fruit produced in New Zealand for the local market was also included.

4.2.2 Carbohydrate Sources

Instant noodles and quick cooking macaroni were popular with the soldiers and were both commercially available products. Their characteristic of being quickly prepared for eating was the main reason for their popularity.

4.2.3 Snack Foods

With regard to biscuits, discussions with biscuit manufacturers in New Zealand indicated that to have more than one type of specially made of biscuit included in the final designed ration pack would be uneconomical because of the small amount of product involved. Alternatives were to either specially pack biscuits that were already being produced for the local market, or to

obtain biscuits types being manufactured and packed in Australia for the Australian Army. The latter alternative was chosen as it would avoid the problems New Zealand manufacturers have in obtaining and holding specialised packaging. This decision however, was subject to the availability of the Australian biscuits, which could mean using locally made biscuits in the next field trials.

There were a large variety of muesli bars commercially available, and therefore it was necessary to select an appropriate bar. Appendix 7 describes the procedure used and the results obtained in this selection. The product that was finally selected was a fruit filled bar. This was a high fibre cereal bar, filled with dried fruit, e.g., apricot and figs.

For ration packs being used in New Zealand, only the dark chocolate and the milk chocolate which had a two year storage life could be used. Both types were included in the second prototype ration pack to give variety.

For ration packs being used in Malaysia, a high temperature chocolate was needed. The small quantities required for the field trial in Malaysia made it uneconomic for it to be specially produced. It was decided to obtain a product from Australia that was being produced by manufacturers for the Australian Army.

From the field evaluation, it was found that sweets should be individually wrapped. An outer bag would also be necessary to act as a further barrier against moisture and to keep the sweets together.

4.2.4 Beverages

All the beverages used in the first prototype ration pack were commercially available. All of these performed well, except that

the sachet size for instant soups was too large. Condensed milk, which was also popular in the field evaluation, was commercially available, but a suitable container had to be found.

4.2.5 Spreads

Jam, processed cheese and butter concentrate were all commercially available and like condensed milk, required only to be placed in a suitable packaging container.

4.2.6 Condiments

Several condiments were available commercially which were either already packaged or could be packaged easily.

4.2.7 Final Commerical Products Selected

The commercial products that were finally selected for the second prototype ration pack were:

* Spaghetti and Sausages - canned, 300 g
* Corned Beef - canned, 340 g
* Tuna - canned, 185 g
* Peaches - canned, 310 g
* Pears - canned, 310 g
* Fruit Salad - canned, 310 g
* Macaroni - 75 g
* Biscuits, Cabin Bread - 60 g
* Biscuits, Fruit Digestives - 50 g
* Biscuits, Superwine - 32 g
* Biscuits, Choc-o-Chip - 40 g
* Biscuits, Peanut Crunch - 40 g
* Muesli Bar, Fruit Bar, Fig - 36 g
* Muesli Bar, Fruit Bar, Apricot - 36 g
* Chocolate, Dark - 50 g
* Chocolate, Dairy Milk - 50 g
* Chocolate, High Temperature Resistant - 50 g
* Sweets, Several Flavours - 35 g
* Coffee - 3 x 1.4 g sachets
* Milo - 2 x 11 g sachets
* Tea - 2 x 2.5 g tea bags
* Instant Soup, several types - 17-20 g
* Powdered Fruit Drink - 1 x 10 g sachet
* Condensed Milk, metal tube - 65 g
* Jam, Apricot, Plum, Strawberry and Blackcurrant varieties, metal tube - 55 g
* Cheese, metal tube - 50 g
* Butter Concentrate, metal tube - 40 g
* Condiments, several types - 1-10 g.

It was found just before the second prototype ration pack was made up, that obtaining biscuits from Australia was not possible. Therefore, locally available biscuits were used. Unfortunately, these were more fragile than what was required.

4.3 DEVELOPMENT OF NEW PRODUCTS

The new products to be developed were all canned food products. In total, eight canned meat meals were required for the second prototype ration pack (two in each of the four menus). Three of these were commercially available so five canned food products had to be developed.

Of these five products developed, three were chosen from the new ideas for main meals suggested by the soldiers in the Consumer Attitude Survey (1985e). These were:

* Sweet and Sour Pork
* Chicken Casserole
* Beans and Bacon in Tomato Sauce

The vegetable and beef casserole used in the field evaluation was very popular so a similar product in a smaller can (310 g) was the fourth product developed. The fifth product was mutton curry. This would meet the needs of the soldiers who were, or had been, stationed in Singapore and had a taste for spicy foods.

The steps used in developing these five canned meat meals is as follows:

* General product characteristics were established from past information (Food Technology Research Centre, 1985e).

* Initial formulations based on the product characteristics

and adaptions of known recipes (Komarik, et al., 1974) were made.

* These products were sensory evaluated by soldiers to identify areas needing further formulation.

* Further formulation and sensory evaluation continued until the product became acceptable.

Appendix 8 describes in detail the product development procedure used in developing these five canned meat meals.

4.4 SELECTION OF PACKAGING FOR COMMERCIAL PRODUCTS

The packaging materials used for the commercial products had been designed for the local market. In some cases, this packaging material was not suitable, i.e., it was not robust enough and would not ensure a two year storage life.

The products with suitable packaging were the canned foods, the chocolate varieties, the beverages (except tea) and the stock cubes (condiments).

The first of the commercial products with unsuitable packaging was the instant noodles. Vegetables oils used in manufacturing this product were expected to go rancid inside the present cellophane wrapping. A packaging material that had high oxygen barrier properties, was non-transparent, could be vacuum packed and was robust, was required. A foil polyester laminate fitted these criteria.

For macaroni, a storage life of two years did not seem to be a major problem and the present packaging of durable cellophane was

thought suitable. However, special single portions of 75 grams had to be packed.

The commercial biscuits used were packed in cellophane and this would not give the required storage life and would not be durable enough. However, because of the length of time required to pack these biscuits in suitable packaging, only double wrap cellophane was used. The muesli bar was in the same situation and cellophane was also used.

The sweets used were commercially available individually wrapped in cellophane, with an outer cellophane bag to keep them together. This system was used for the second prototype ration pack, except smaller portions were required.

The condensed milk, cheese, butter concentrate (anhydrous milk fat) and the jam were packed inside aluminium tubes to provided the required two year storage life. The other advantages were that the tube was robust, it aided in the dispensing of the product and it was resealable.

The condiments were packed in various laminates. Dried peas were packed in paper/foil/polypropylene laminate, pepper and cayenne pepper in cellophane and onion flakes in polypropylene. Salt, sugar and curry powder were the same as those used in the present ration pack. These are packed in polypropylene.

4.5 DEVELOPMENTS OF MENUS FOR THE SECOND PROTOTYPE PACK

Some food and beverage items included in the second prototype ration pack were common to all menus, e.g., coffee, milo and tea. In addition to these items, were menu items. Menu items were variations of a particular food type. For example, for canned foods, there were eight variants of meat meals and three variants for fruit.

The main criteria used to select foods for different menus was therefore to first select foods which would be common to all menus, e.g., the beverages. The selection of menu items then followed, with a different variant of a food type being included in each menu. For example, beef casserole which was included in Menu A would not be included again in the same menu or any of the other three menus. This was not the case in all aspects because of the limited variants of some food types. However, menu items were selected to give as much variation within menus as well as variation between menus.

The second prototype ration pack is shown in Table 4.1.

Table 4.1: Menu and Common Items of the Second Prototype Ration Pack

Four menus are involved, A,B,C, and D.

A		B		C		D	
Beef Casserole	1x310g	Chicken, Tomato & Vegetables.	1x310g	Spaghetti & Sausages	1x300g	Beans & Bacon	1x310g
Tuna in Oil	1x185g	Sweet & Sour Pork	1x310g	Corn Beef	1x340g	Mutton Curry	1x310g
Peaches	1x310g	Pears	1x310g	Fruit Salad	1x310g	Peaches	1x310g
Instant Noodles	1x85g	Instant Noodles	1x85g	Macaroni	1x75g	Macaroni	1x75g
Fruit Digestive Biscuits	1x50g	Fruit Digestive Biscuits	1x50g	Choc O Chip Biscuits	1x40g	Peanut Crunch Biscuits	1x40g
Superwine Biscuits	1x32g	Shortbread Biscuits	1x40g	Cabin Bread	1x60g	Cabin Bread	1x60g
Fruit Bar, Fig	2x36g	Fruit Bar, Fig	2x36g	Fruit Bar, Apricot	2x36g	Fruit Bar, Apricot	2x36g
Chocolate, Dairy Milk	1x50g	Chocolate, Dairy Milk	1x50g	Chocolate, Energy	1x50g	Chocolate, Energy	1x50g
Barley Sugar	1x35g	Butterscotch	1x35g	Crystal Mints	1x35g	Fruit Refreshers	1x35g
Jam, Apricot	1x55g	Jam, Plum	1x55g	Jam, Strawberry	1x55g	Jam, Blackcurrant	1x55g
Soup, Chicken	1x17g	Soup, Tomato	1x20g	Soup, Beef	1x20g	Soup, Mushroom	1x18g
Curry Powder	1x3.5g	Cayenne Pepper	1x5g	Pepper	1x1g	Onion Flakes	1x7g
Oxo Cube, Chicken	1x6g	Oxo Cube, Chicken	1x6g	Oxo Cube, Beef	1x6g	Oxo Cube, Beef	1x6g

Common Items

Condensed milk	1x65g	Salt	2x7g
Cheese	1x50g	Sugar	6x14g
Butter Concentrate	1x40g	Dried Peas	1x16g
Coffee	3x1.4g	Steel Cleaning Cloth	1xpad
Tea bags	2x2.5g	Toilet paper	1x10sheets
Milo	2x11g	Matches	1xbox
Fruit drink	1x10g	Can Opener	1

in each menu. For example, beef casserole which was included in Menu A (refer to Table 4.1) would not be included again in the same menu or any of the other three menus. This was not the case in all aspects because of the limited variants of some food types. However, menu items were selected to give as much variation within menus as well as variation between menus.

4.5.1 Canned Foods

The five meat meals that were developed plus the three commercially available meat products were allocated to the four menus, two to each menu. Three variants of canned fruit were also used between the four menus (two menus, A and D had peaches, Menu B had pears, and Menu C had fruit salad - refer to Table 4.1).

4.5.2 Carbohydrate Source

Instant Noodles were included in two menus and macaroni in the other two menus.

4.5.3 Snack Foods

The biscuits actually used, were the best alternatives, but some did not fit the criteria of robustness. It was expected that problems such as crumbling and breaking would be encountered in the field evaluation.

Two types of biscuits were included in each menu of the prototype. The initial criteria was to have one of these two types to be cabin bread (non-sweet) and a sweet biscuit, either fruit digestives or peanut crunch. The cabin bread could be eaten by itself or eaten with a meat meal, e.g., tuna and cornbeef. Problems in obtaining the correct amount of both types of biscuits occurred, which resulted in more sweet biscuits being

included. This would result in there being too many spreads in some of the menus because there was no cabin bread to use with them, i.e. for menus A and B.

Two types of fruit bars were used in the prototype menus; fig was included in menus A and B; and apricot in menus C and D. Two types of chocolate were also used; Dairy milk in menus A and B, and Dark Chocolate in menus C and D. One different type of confectionery was used in each menu.

4.5.4 Spreads

One different variety of jam was included in each menu. Cheese and the butter concentrate were common items for all menus.

4.5.5 Beverages

One different type of instant soup was included in each menu. Coffee, tea, milo, orange fruit drink and sweetened condensed milk were common items.

4.5.6 Condiments

Two types of condiments were varied within the four menus. Either curry powder, cayenne pepper, pepper or onion flakes was included in one of the four menus. The other condiment that was varied was 'Oxo' stock cubes. A chicken flavoured 'Oxo' cube was included in menus A and B, and a beef flavoured 'Oxo' cube was included in menus C and D. Salt, sugar and dried peas were common to all four menus.

Figure 4.2 shows the individual contents of the second prototype pack that was field evaluated on a large scale. Figure 4.3 shows the second prototype ration pack when packed. The contents are enclosed in a resealable plastic bag.

Index:

1. Sugar
2. Coffee
3. Blackcurrant Jam
4. Processed Cheese
5. Butter Concentrate
6. Condensed Milk
7. Waterproof Matches
8. Milo
9. Orange Drink
10. Tea bags
11. Foodbar
12. Cabin Bread
13. Peanut Crunch
14. Toilet Paper
15. Salt
16. Chocolate
17. Sweets
18. Dried Peas
19. Oxo Cube
20. Onion Flakes
21. Fruit Salad
22. Mutton Curry
23. Sweet and Sour Pork
24. Mushroom Soup
25. Macaroni
26. Steel Cleaning Cloth

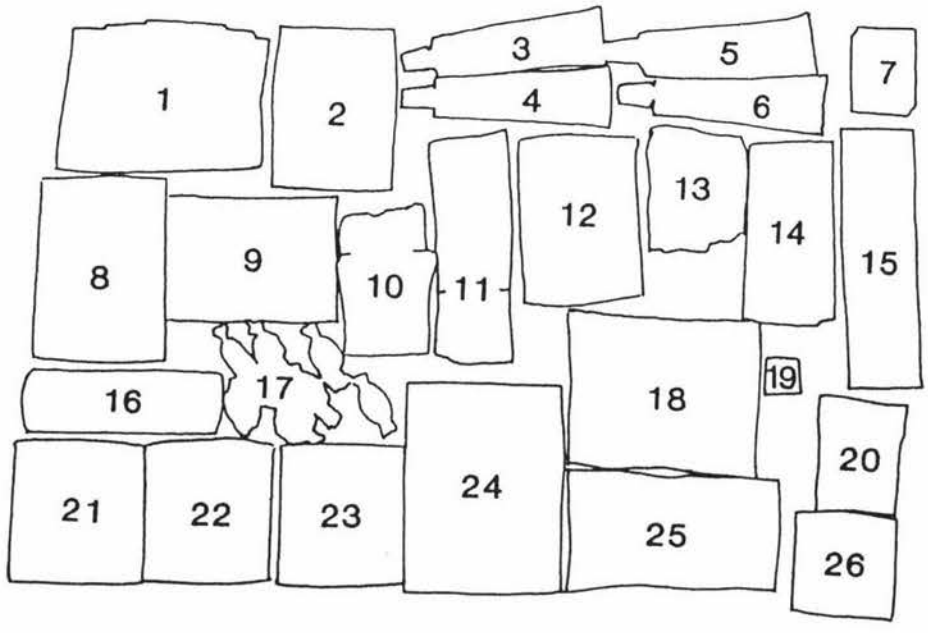

Figure 4.1: Photograph of the Second Prototype Ration Pack

Figure 4.2: Photograph of the Individual Contents of the Second Prototype Ration Pack

4.6 NUTRITIONAL ANALYSIS USING SPREADSHEETS

The analysis of results from the field evaluation gave valuable information on types and quantities of food, the next step was to analyse the nutritional contribution of the foods. To do this spreadsheet analysis was used (Microsoft Corporation, 1983).

4.6.1 Spreadsheets

A spreadsheet is basically a grid of entries with each entry being identified by a column and row descriptor. For example, the protein content of cheese; - protein and cheese would be the descriptors for the protein value. Spreadsheets lay out the information in clearly labelled rows and columns. Totals of rows and columns can be made; mathematical formulae can be included. Spreadsheets can be used to analyse the sensitivity of the information, e.g. if one increases the amount of cheese in a menu by 20% how is the total amount of protein affected?

In the past, spreadsheets were written by hand and calculations were done by a calculator. If an entry had to be changed, then it was likely to affect other entries also and these would also have to be changed. The result could be a spreadsheet which took a great deal of time to produce and which had several errors.

The introduction of the electronic spread sheet on personal computers has made things simpler. The majority of the calculations can be done by using a spreadsheet computer program. If needed, entries can be linked with other entries by mathematical formulae. The electronic spreadsheet is therefore capable of having one of its entries changed, and any other entries associated with it are automatically changed. For example, if one has a column of entries that contain protein values for a number of foods, these can be linked with an entry at the bottom which denotes the total protein contributed by

these foods. The editing of any one of the protein values, will automatically result in changing the total value (this is done by the spreadsheet program). Various other capabilities are available within the spreadsheet program and these vary between the different software packages. Detailed information can be found in the user manual of the relevant electronic spreadsheet (Lotus Corporation, 1986).

4.6.2 Setting Up the Spreadsheet for the Second Prototype Ration Pack

The setting up of a spreadsheet for the second prototype ration pack was found to be relatively easy. This fact is indicative of the simplicity behind the spreadsheet program.

The spreadsheets included several columns of information. The first column listed the food type and the succeeding columns recorded information about the food, e.g. the weight of the food that was going to be included in the ration pack, price and nutritional information. Near the bottom, a row was included which gave the total of the columns. These totals were compared with the recommended nutritional intakes used as constraints for the LP calculations.

The initial spreadsheet included all the different types of foods that would be used in the four menus of the second prototype ration pack. The weight of each food was obtained from the field evaluation results and the nutritional information was obtained from Paul and Southgate, 1978. This initial spreadsheet was called the Master File as it was from this file that succeeding spreadsheets were developed. This master file is seen in Appendix 9a. This Appendix lists all the foods selected for menu development in left-hand column. The succeeding columns have the portion weights and nutritional compositions of these foods.

By selecting different foods within this Master File, several menus were developed. The mechanics behind this was to delete food items in the Master File which were not in the pre-determined menu. Nutritional totals were automatically calculated.

Appendices 9b, 9c, 9d and 9e list the four menus developed, and their nutritional compositions.

Table 4.2 summarises the weight and nutritional composition of the four menus. The following nutrients were below the RDA - for menu A, vitamins A and D were lower than the RDAs; for menu B, energy vitamins D and E were lower than the RDA; for menus C and D, vitamins C, D and E

The low energy value in menu B can easily be increased, e.g. increasing the fat content of the canned foods. The levels of vitamins A, C and E, if needed, can be increased by food fortification. The level of vitamin D in the four menus does not include the quantity produced by the body after contact with sunlight. For New Zealand and tropical conditions, the vitamin D requirement would be met by sunlight.

The setting up of the spreadsheet made it possible to clearly see what foods were contributing each nutrient, and what nutrient was lacking. The ability to re-design the menu by either changing a weight or deleting, or subtracting foods was easily done.

At this stage of the development of a food Ration Pack, nutritional requirement that were not met by these menus were not seen as crucial. It was expected that several changes would be necessary after the analysis of results from the second field evaluation. Therefore, final menu adjustments to give the nutritional requirements was done after this evaluation.

TABLE 4.2: Summary of the Nutritional Composition of the Four Menus of the Second Prototype Ration Pack

	WEIGHT (x 100g)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
TOTAL FOR:																					
MENU A	15.257	3813	121.47	144.23	515.16	912.35	365.85	24.00	2.101	16.27	535.57	2742.64	992.67	6.26	1.046	1.328	59.729	27.81	14.848	1.543	11.804
MENU B	16.852	3454	87.35	106.73	556.47	949.36	352.26	19.20	2.284	9.90	628.45	2063.10	1622.30	0.55	1.662	1.726	43.336	49.47	3.962	1.160	1.162
MENU C	17.062	4004	140.93	158.74	562.22	1006.81	355.29	27.49	2.748	25.35	548.45	1572.22	810.49	0.47	0.868	1.589	48.505	10.63	4.848	0.526	7.545
MENU D	16.872	3761	111.72	109.45	606.18	1008.05	400.80	23.96	2.304	13.49	536.45	2075.21	882.32	0.46	1.441	1.325	36.546	35.09	3.473	0.893	2.864
TOTAL	66.043	15032	461.47	519.16	2240.03	3876.58	1474.19	94.65	9.436	65.00	2248.92	8453.18	4307.78	7.75	5.018	5.967	188.115	123.00	27.130	4.122	23.375
AVERAGE	16.511	3758	115.37	129.79	560.01	969.14	368.55	23.66	2.359	16.25	562.23	2113.30	1076.94	1.94	1.254	1.492	47.029	30.75	6.783	1.030	5.844
RDA		3900	65.00			600.00	350.00	10.00	2.5	15			900	12	1.44	2.04	21.6	72	16.2	2.4	3.6
%RDA		96.36	177.49			161.52	105.3	236.63	94.36	108.34			119.66	16.14	87.11	73.13	217.73	42.71	41.87	42.94	162.33

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4.7 CONCLUSIONS

Four menus for the second prototype ration pack were developed. The development work used all the consumer information obtained in the previous stages, plus that obtained during evaluation of the new products.

However, it must be realised that the last two sources of consumer information (the small field evaluation, and the sensory panels) were obtained from relatively small groups of men. The redesigned menus of the second prototype ration pack needed to be evaluated by a larger number of soldiers.

CHAPTER 5

TESTING OF THE SECOND PROTOTYPE RATION PACK

5.1 INTRODUCTION

This stage concentrated on the testing of the second prototype ration pack. Approximately 4,000 prototype ration packs were made. The ration pack items were obtained from several different sources: specially manufactured; from food manufacturers and wholesalers; and from Army food supplies. The packing was carried out at Trentham Military Camp.

Two thousand ration packs were evaluated by 200 New Zealand soldiers engaged in exercises in Malaysia. Another 1,000 ration packs were evaluated by New Zealand soldiers on the West Coast of the South Island.

During both exercises, the soldiers completed questionnaires. Focus groups were also carried out after the field exercises.

5.2 THE PROCESSING AND PACKAGING OF FOOD ITEMS

5.2.1 Processing of Canned Foods

The new canned foods developed were processed in the factory of Salmon-Smith Biolab Ltd, Palmerston North. Several problems were encountered during processing:

* For Bacon and Beans in Tomato Sauce, the haricot beans were left to soak for too long before can filling. This resulted in the beans becoming very soft and the sauce very thick.

* The sauce for Sweet and Sour Pork was thinner than desired.

* The relatively small quantity of chicken meat required for the chicken, tomato and vegetables meant that the only appropriate machine available to cut it was one that minced the meat.

It was expected that these differences in product quality would quickly be identified by the soldiers on the second field evaluation.

5.2.2 Specialised Food Packaging

During the specialised packaging of commercially available foods, a number of problems were either encountered or identified. These were:

* The butter concentrate and the cheese were difficult to obtain from the aluminium tubes during cold temperatures. Also, the seeds of the blackcurrant jam sometimes blocked the tube opening. The condensed milk was found to be of poor quality and did not dissolve fully in hot water.

* Due to the relatively short notice given to the biscuit and food bar manufacturers, the packaging that was used was a thin film cellophane.

5.2.3 Packing of Prototype Ration Packs

As with the first prototype ration pack, the packing was carried out at Trentham Military Camp. The inappropriate packaging material of some items resulted in them being damaged during transport, e.g. biscuits. The use of a resealable outer bag was used. The purpose of using this type of bag was to aid the soldier in keeping the contents of the outer bag together after it was first opened. The seal of the bag was a problem however,

in that it slowed the packing down as the seal had to be broken to enable the ration pack items to be packed. The bag then had to be resealed at the end, which also slowed the packing.

As was seen in Figure 4.3, the second prototype ration pack was slightly bulkier than the present ration pack. This was due to two main reasons; firstly, like the first prototype ration packs, there was more food; and secondly, the outer bag was slightly too big which resulted in items being loosely packed. Once packed, the second prototype ration packs were transported to Christchurch, New Zealand, and Singapore, for the two large scale field evaluations.

5.3 METHOD OF EVALUATION

5.3.1 Product Testing

For the testing of the second prototype ration pack larger groups of soldiers were used, compared with the number in the evaluation of the first prototype. However, for both the field evaluations, one in Malaysia, the second in New Zealand, similar information was required to that on the first prototype. Information that was collected concentrated on the second prototype ration pack as it was thought that sufficient information had been obtained on the present ration pack.

5.3.1.1 Organisation of the Tests

For both field evaluations the collection of information, involved the use of questionnaires. These were given to soldiers at various stages of the field exercise; before, during and after.

Before the start of both exercises, soldiers were briefed on the nature of the exercise, given a contents list of the second prototype ration pack and shown the contents.

The issuing of the second prototype ration pack was done similarly to that which is normally done, i.e., between 3-5 ration packs are given to soldiers at the beginning of the field exercise, re-supplying of further ration packs is done during the exercise. Two minor exceptions were however carried out. The first was that a variety of menus were to be given out each time ration packs were supplied. This would allow soldiers to experience all four menus and have a varied diet. The second exception was that in the field evaluation in New Zealand all the contents of the second prototype ration pack were taken by soldiers. This was done to get the soldiers to evaluate the total contents of the pack. Normally soldiers discard items that they do not require. This was necessary in the field evaluation in Malaysia because of the high priority of minimum weight due to the tropical climate and the rough terrain.

As many of the foods were new to the soldiers, they were encouraged to use them at least once so as to obtain information on them.

Soldiers were not allowed to carry "perk rations", as this would give misleading results.
The field exercise in Malaysia was on Exercise Pemburu Rusa II (11-31 October 1986). The exercise was just before the Malaysian monsoon season, so the weather was hot and humid with frequent rain storms and cool nights. The terrain ranged from flat ground in rubber plantations to rugged steep mountain forests.

Both the second prototype and the present combat ration packs were used. Two companies, Alpha and Bravo (each of 100 men) from 1 RNZIR, were the trial participants. Alpha company were given a

questionnaire to complete, in which they were required to list the foods they discarded. Alpha Company consumed the second prototype ration pack for the first 10 days of the exercise. For the last 10 days, they reverted to using the present ration pack. Bravo Company also used the two types of ration packs but in the reverse order to Alpha Company. The purpose of doing this was to remove any bias that was present.

During the field exercise, a diary questionnaire was completed by soldiers; this dealt with the acceptability of the second prototype ration pack. Completed forms were collected at the end of the exercise. A third questionnaire, called the ration pack items questionnaire, was completed by soldiers at the end of the exercise.

The field exercise in New Zealand was on the West Coast of the South Island on Exercise Loth Lorien (1-23 November 1986). Conditions were typical for the West Coast at the time of the year; wet and mild.

Approximately 100 soldiers from Delta Company, 2/1 Battalion, Royal New Zealand Infantry Regiment (RNZIR), were the trial participants. This company was involved in a small field evaluation in February 1986. The soldiers consumed the prototype ration pack for the entire period of the exercise. Soldiers were asked to take the whole ration pack to enable them to evaluate all the contents.

As was done on the field exercise in Malaysia, soldiers on the New Zealand exercise completed the diary and the ration pack items questionnaires.

5.3.1.2 Questionnaires

The three questionnaires used during the field evaluations were

designed to obtain information during all stages. In the questionnaire that dealt with the foods discarded by soldiers in Malaysia, soldiers wrote down the number of items that they discarded beside the product name listed in the questionnaire (Appendix 10a gives an example of this questionnaire).

For the diary questionnaire, it was found that in the evaluation of the first prototype ration pack, soldiers did not have enough time to complete it. It was decided to simplify this as much as possible.

This was done with the use of one sheet of paper as the diary questionnaire for the entire testing period. This solved the problem of the soldier having several different questionnaire sheets.

This one sheet questionnaire was divided into three main sections. The first section required the soldier to rate the acceptability of the second prototype ration pack he consumed that day on a 7 point hedonic scale. To do this, all that the soldier had to do was to circle a number between 1 and 7 (1 = terrible, 7 = excellent). The second section required the soldier to list down any foods that he disliked during the testing period. The last section asked the soldier what foods he had left over from the field exercise (Appendix 10b gives an example of this questionnaire).

The third questionnaire obtained information on the overall acceptability and product size of individual ration pack items, and also the overall acceptability of types of foods in the second prototype ration pack. This questionnaire was a combination of the diary questionnaire and the overall acceptance questionnaire used in the first field evaluation. However, it was simpler as it used only a three point hedonic scale as opposed to seven. No information on food preparation or water

availability was sought. The length of the questionnaire was therefore smaller than the one previously used (Appendix 10c gives an example of this questionnaire).

5.3.2 Focus Groups

Immediately after the completion of the exercises, focus groups were carried out with 5-8 trial participants. This involved two groups of soldiers with the main rank being that of private, and one group involving higher ranks.

The purpose of these focus groups was to obtain information which otherwise would have been impossible or difficult to obtain through a written questionnaire. Though information can be subjective, however, common areas can be cited when a large proportion of respondents agree on them.

Discussions were informal and interaction between the moderator and the participants and between the participants themselves was encouraged. Initial questions asked the soldier their responses to the overall liking of the second prototype ration pack. Following questions were more specific and concentrated on individual ration pack items.

For the Malaysian Exercise, 26 soldiers were involved in the focus groups, and 30 in the New Zealand Exercise.

The focus group discussions were recorded on tape and also written notes were taken for future analysis.

5.3.3 Analysis of Results

The analysis of results was done using SPSS (Nie et al., 1975). The completed questionnaires were coded by hand and then decoded by using SPSS. The statistics carried out were primarily

frequencies and means. The category data for the hedonic scales was assumed to be linear. This is not absolutely correct, however, the means that were generated were used only as guidelines for further design.

5.4 RESULTS FROM MALAYSIAN FIELD TRIAL

5.4.1 Questionnaire Results

5.4.1.1 Ration Pack Items Discarded

Information on foods discarded at the beginning of the field exercise by Alpha Company is shown in Table 5.1. Seventy three soldiers completed the questionnaires; of these, 19 (26%) retained everything in the prototype ration packs.

Table 5.1: Percentage of the 73 Soldiers Discarding Ration Pack Items

Percentage of Soldiers	Ration Pack Item
0-10	Chicken casserole, sweet & sour pork, mutton curry, beans & bacon, peaches, fruit salad, pears, instant noodles, fig bar, apricot bar, fruit refreshers, condensed milk, Milo, fruit drink, onion flakes.
10-20	Beef casserole, spaghetti & sausages, cabin bread, chocolate, butterscotch, barley sugar, crystal mints, tea, chicken soup, tomato soup, beef soup, mushroom soup, sugar, curry powder, cayenne pepper, pepper, cleaning cloth.
20-30	Tuna, macaroni, biscuits, peanut crunch, cheese, strawberry jam, plum jam, blackcurrant jam, apricot jam, coffee, salt, oxo cube, toilet paper.
30+	Shortbread, choc-o-chip, superwine, matches.

The main points from Table 5.1 to note are:

* The canned foods, condensed milk, milo and the fruit drink were very popular.
* Cabin bread, sweets, chocolate, tea, instant soups and condiments had a moderate discard rate.
* The sweet biscuits and jams had high discard rates.

5.4.1.2 Individual Rating of Ration Pack Items

Table 5.2 lists the scores of individual Ration Pack items which rated low with 26 soldiers involved in the focus groups. Appendix 11 shows the ratings for all the Ration Pack items.

Table 5.2: Ration Pack Items That Were Rated Low

	No Response	Disliked	Neither Liked Nor Disliked	Liked
	%	%	%	%
Mutton Curry	0.0	11.5	42.3	46.2
Macaroni	0.0	26.9	26.9	46.2
Jam Blackcurrant	7.6	26.9	19.2	46.2
Tea	0.0	7.6	50.0	46.2
Chicken Soup	3.8	19.2	30.8	46.2
Tomato Soup	3.8	23.0	26.9	46.2
Can Opener	0.0	23.0	30.8	46.2
Beef Soup	7.6	23.0	26.8	46.2
Salt	3.8	3.8	53.8	38.5
Cayenne Pepper	7.6	34.6	19.2	38.5
Chicken Casserole	7.6	34.6	23.0	34.6
Crystal Mints	0.0	30.8	34.6	34.6
Beans & Bacon	0.0	42.3	26.9	30.8
Oxo Cube - Chicken	3.8	46.2	30.8	19.2
Oxo Cube - Beef	3.8	50.0	30.8	15.4
Matches	7.6	38.5	42.3	11.5

5.4.1.3 Overall Rating of Ration Pack

Tables 5.3 and 5.4 show the rating for the second prototype ration pack during its ten days usage by Alpha and Bravo Companies respectively.

Alpha Company rated the second prototype ration pack very good for the initial stages of the field exercise. After 10 days it was still rated very high, with only a small percentage of soldiers finding it unacceptable.

Bravo Company, who used the second prototype ration pack during the last 10 days of the field exercise, generally rated the pack very good throughout the period.

The similar responses from both companies tend to indicate that the second prototype ration pack was acceptable for moderately long periods.

Table 5.3: Overall Rating of the Second Prototype Ration Pack Over Ten Days Used by Alpha Company (100 Soldiers)

Day	No Response %	Terrible %	Dislike Very Much %	Dislike Moderately %	Neither Like Nor Dislike %	Like Moderately %	Like Very Much %	Excellent %
1	0.0	0.0	0.0	0.0	5.0	7.5	50.0	37.5
2	0.0	0.0	0.0	1.25	3.75	16.25	42.5	36.25
3	0.0	0.0	0.0	0.0	5.0	13.75	43.75	37.5
4	0.0	0.0	0.0	3.75	6.25	15.0	41.25	33.75
5	0.0	0.0	0.0	6.25	6.25	16.25	43.75	27.5
6	5.0	0.0	1.25	3.75	7.5	13.75	42.5	30.0
7	2.5	1.25	1.25	3.75	6.25	16.25	40.0	27.5
8	0.0	2.5	1.25	5.0	6.25	18.75	37.5	27.5
9	0.0	2.5	0.0	2.5	10.0	18.75	37.5	28.75
10	0.0	1.25	0.0	5.0	8.75	18.75	37.5	27.5

Table 5.4: Overall Rating of the Second Prototype Ration Pack Over Ten Days Use by Bravo Company (100 Soldiers)

Day	No Response %	Terrible %	Dislike Very Much %	Dislike Moderately %	Neither Like Nor Dislike %	Like Moderately %	Like Very Much %	Excellent %
1	0.0	0.0	0.0	0.0	2.0	18.0	36.0	44.0
2	0.0	0.0	0.0	0.0	8.0	12.0	40.0	40.0
3	0.0	0.0	0.0	0.0	6.0	10.0	48.0	34.0
4	2.0	0.0	0.0	2.0	4.0	10.0	46.0	36.0
5	2.0	0.0	0.0	0.0	6.0	16.0	40.0	36.0
6	0.0	2.0	0.0	2.0	2.0	6.0	42.0	42.0
7	6.0	2.0	0.0	0.0	2.0	10.0	42.0	38.0
8	10.0	0.0	0.0	0.0	6.0	12.0	34.0	38.0
9	12.0	0.0	0.0	0.0	4.0	6.0	46.0	32.0
10	16.0	0.0	0.0	2.0	2.0	4.0	38.0	38.0

5.4.1.4 Reaction to Quantities and Types of Food

The soldiers' responses to the number of main meals (meat meals) were that 88.5% of the 26 soldiers thought there were just enough while 11.5% thought there were too many. The soldiers overall, thought there were slightly too many snacks, with 3.8% indicating there were not enough, 76.9% enough, and 19.2% too many. In terms of the overall quantity of food, the soldiers thought there was too much, with 65.4% indicating enough food, and 34.6% too much food.

Slightly too many beverages was indicated, with 7.7% of the soldiers indicating there was not enough, 69.2% enough, and 23.1% indicating there were too many. The quantity of spices was thought too low by the soldiers. No response was given by 3.8% of the soldiers, 23.1% indicated not enough spices, 69.2% enough, and 3.8% though there were too many. More variety of spices was suggested, such as chili powder and soya sauce.

A low acceptance of the non-food items was indicated, with 19.2% of the soldiers not responding, 19.2% thought they were adequate, and 61.5% indicating they were not adequate.

5.5 RESULTS FROM NEW ZEALAND FIELD TRIAL

5.5.1 Questionnaire Results

The following sections are the results obtained from the questionnaires that the soldiers completed in New Zealand.

5.5.1.1 Individual Rating of Ration Pack Items

Table 5.5 lists the ration pack items that were rated low (less than 50% liked it) by the 73 soldiers who completed the questionnaire. Appendix 12 lists the rating of all the ration pack items. The main points to note from this Table are:

* All the instant soups were rated low.
* The canned foods - mutton curry, beans and bacon, and chicken casserole were rated low.
* Several condiments were rated low.
* Macaroni was rated low.

Table 5.5: Ration Pack Items That Were Rated Low (73 Soldiers)

	No Response	Disliked	Neither Liked Nor Disliked	Liked
	%	%	%	%
Onion Flakes	13.7	13.7	23.3	49.3
Chicken Soup	21.9	8.2	21.9	47.9
Mushroom Soup	23.3	12.3	17.8	46.6
Salt	11.0	6.8	38.4	43.8
Matches	6.8	26.0	23.3	43.8
Toilet Paper	15.1	17.8	24.7	42.5
Blackcurrant Jam	16.4	19.1	21.9	42.5
Fig Bar	6.8	27.7	26.0	42.5
Curry Powder	13.7	30.1	15.1	41.1
Chicken Oxo Cube	19.2	13.7	26.0	42.5
Beef Oxo Cube	16.4	13.7	28.8	41.1
Butter Concentrate	12.3	24.7	23.3	39.7
Tomato Soup	17.8	21.9	20.5	39.7
Beef Soup	21.9	15.1	23.3	39.7
Mutton Curry	12.3	28.8	19.1	39.7
Apricot Jam	17.8	13.7	30.1	38.4
Cayenne Pepper	26.0	31.5	9.5	32.9
Crystal Mints	4.1	34.2	30.1	31.5
Beans and Bacon	11.0	35.6	23.3	30.1
Macaroni	6.8	31.5	31.5	30.1
Chicken Casserole	2.7	49.3	19.1	28.8
Dried Peas	15.1	41.1	27.4	16.4

Table 5.6 lists the Ration Pack items that were unused by the soldiers. Reasons for this were due to the item either being disliked or there was too much of that particular item or the packaging was inadequate. Appendix 13 has this information for all ration pack items. Table 5.6 gives similar information to that of Table 5.5. All the instant soups, jams and condiments

are included in both Tables, which indicates low acceptance of these items.

Table 5.6: Unused Ration Pack Items (73 Soldiers)

Ration Pack Item	% of Soldiers
Apricot Jam	28.8
Blackcurrant Jam	28.8
Plum Jam	27.4
Strawberry Jam	26.0
Butter Concentrate	24.7
Dried Peas	24.7
Macaroni	20.5
Chicken Oxo Cube	20.5
Beef Oxo Cube	20.5
Tea	20.5
Cheese	17.8
Coffee	17.8
Tomato Soup	16.4
Chicken Soup	15.1
Beef Soup	15.1
Mushroom Soup	15.1

5.5.1.2 Overall Rating of Ration Pack

Table 5.7 shows the overall rating for the prototype ration pack during its ten days of use by participants. The second prototype ration pack was rated consistently throughout the trial period, with between 60-90% of the participants liking it moderately to excellent.

Table 5.7: Overall Rating of the Second Prototype Ration Pack During Ten Days Use (77 Soldiers)

Day	No Response %	Terrible %	Dislike Very Much %	Dislike Moderately %	Neither Like Nor Dislike %	Like Moderately %	Like Very Much %	Excellent %
1	2.3	0.0	0.0	3.5	5.8	18.6	54.7	15.1
2	1.2	0.0	0.0	0.0	9.3	23.3	52.3	14.0
3	1.2	0.0	0.0	4.7	3.5	25.6	51.1	14.0
4	3.5	0.0	0.0	1.2	5.8	26.7	44.1	18.6
5	4.7	0.0	1.2	3.5	9.3	19.8	44.1	17.4
6	5.8	0.0	0.0	0.0	4.7	31.4	47.7	10.5
7	5.8	0.0	0.0	2.3	4.7	22.1	50.0	15.1
8	9.3	0.0	0.0	0.0	4.7	25.6	47.7	12.8
9	18.6	0.0	0.0	3.5	5.8	18.6	40.7	12.8
10	33.7	0.0	0.0	3.5	4.7	17.4	33.7	9.3

5.5.1.3 Reaction to the Quantities and Types of Food

Overall the number of main meals was thought to be enough by the 73 soldiers. No response was given by 1.4%, 9.6% thought there was not enough, 87.7% enough, and 1.4% thought there were too many. For the snack foods overall, soldiers indicated that there were slightly too many. No response was given by 1.4%, 13.7% thought there was not enough, 64.4% enough, and 20.5% thought there were too many.

Slightly too many beverages was indicated, with 4.1% of the soldiers indicating not enough, 78.1% enough, and 17.8% too many. For the response to the number of spices, two groups of similar size were split between the opinions of too few and too many spices. No response was given by 4.1%, 17.8% indicated too few, 65.8% enough, and 12.3% indicated too many. A low acceptance of

the non-food items was indicated with a no response from 5.5%, 38.3% indicating the non-food items were adequate, and 56.2% indicating they were not adequate. The main problems mentioned were the low quality and quantity of toilet paper, inadequate waterproof matches and the small can opener.

The response to the total quantity of food showed that there was an acceptable amount of food, with 4.1% of the soldiers indicating not enough, 89% enough, and 6.8% too much.

5.6 RESULTS - FOCUS GROUPS

The following sections summarise the response of the soldiers to different areas of the ration pack, obtained from the focus groups. The results from the Malaysia and New Zealand field evaluation have been combined due to their similarity.

5.6.1 Overall Ration Pack

The soldiers generally found the second prototype ration pack very good and far superior to the present ration pack. They found it had a larger variety, especially in the beverages and snack foods. The quality of food was higher and quantities of food types were acceptable.

The food packaging was found to be a problem, especially the strength of the resealable outer bag, the packaging for biscuits, sweets and macaroni. The metal tubes were good, though they had problems of leaking at the bottom and puncturing other packaging. It was suggested that a small metal tin be used to protect the snack foods from being crushed.

The weight and the bulkiness of the pack were found to be

slightly too much with soldiers in Malaysia. These soldiers also found that there was slightly too much food.

5.6.2 Canned Foods

The beef casserole, corned beef and tuna were well liked, mainly because of the large chunks of meat present. The mutton curry, beans and bacon, and the chicken casserole were not liked, especially when eaten cold. However, overall the variety was well liked, and the canned foods were easy to prepare. The can sizes of meat meals were found to be slightly too large for the soldiers in Malaysia, especially the one for the corned beef.

The canned fruit were well liked as quick snacks. It was suggested that canned pineapple be included.

5.6.3 Carbohydrate Source

The instant noodles were well liked by a large majority of the soldiers and was preferred over the macaroni. Many of the soldiers would like them included in every menu, while some would still like it in combination with the macaroni. Little interest was indicated for other types of high carbohydrate foods, except for freeze-dried rice.

5.6.4 Snack Foods

Cabin bread was well liked, and the soldiers indicated they would like more. The sweet biscuits were also well liked though they were found to crumble easily. The fruit bars were moderately well liked. The high temperature resistance chocolate used in Malaysia was well liked, so was the Dairy Milk chocolate used in New Zealand. The Butterscotch, Barley Sugar and refresher sweets were moderately liked, while the crystal mints were disliked. All the sweets became sticky in the heat. Overall, slightly too

many snack foods made up the total contents of the pack.

5.6.5 Beverages

The soldiers liked the variety and quantity of beverages included in each pack. In particular, the Milo and Fruit Drink were very well liked. More Milo was wanted, and also the inclusion of an energy/mineral replacement drink such as Sustagen. Milo was a preferred drink over Coffee and Tea. The tea bags were well liked. The Instant Soups were not frequently used, and when used, were used as a flavouring rather than as a drink. Slightly too many beverages was mentioned. The condensed milk went lumpy and stuck to the canteen cup. However it was still very popular and more was wanted.

5.6.6 Spreads

The jams were well liked, though the blackcurrant jam was difficult to dispense because of the seeds blocking the tube opening. Equal numbers of soldiers either thought there were too many jams or that there was just the right amount.

The cheese and butter were liked by a moderate number of soldiers. Both these foods became difficult to dispense when their viscosities increased in cold temperatures.

5.6.7 Condiments

Onion flakes and the curry powder were well liked. Other condiments such as the Oxo cubes, cayenne pepper and dried peas were not liked. Suggested replacements were; chili powder and sauces, soya sauce and tomato sauce.

5.6.8 Non-Food Items

The steel cleaning cloth was liked. The matches were not liked as the box collapsed and the striker became useless when it became wet. The can opener was clumsy because it was too small. The toilet paper was of low quality and there was not enough of it.

5.7 CONCLUSIONS

It was found that the length of the daily questionnaire was well accepted, with several soldiers making extra comments due to the small amount of time required to complete the questionnaire. It was found that the fewer questionnaires the soldiers had to complete, the more they understood what was required of them, which resulted in them being more co-operative.

In general, the results from the two field evaluations were very similar. In both, the prototype was well accepted, though several problems were pointed out. The next stage was therefore, to combine the results of these two evaluations and set down final specifications for the final designed ration pack.

CHAPTER 6

PROJECT EVALUATION

6.1 INTRODUCTION

The purpose of this section is to compare and summarise the findings of the two large scale field evaluations in Malaysia and New Zealand. From the results of the field evaluations, the final prototype combat ration pack was developed. Also discussed is the necessary future work that is required to meet the recommendations that are listed.

6.2 DEVELOPMENT OF THE FINAL PROTOTYPE RATION PACK FROM THE RESULTS OF THE TWO FIELD EVALUATIONS

As stated in the previous chapter, the overall acceptance of the second prototype ration pack from the two field evaluations was good and generally very similar in both evaluations. However, concerning the individual items, there were some differences in opinions and questionnaire results. Therefore, there was a need to compare the results to obtain a combat ration pack that would suit both the soldiers in Malaysia as well as in New Zealand.

6.2.1 The Overall Second Prototype Ration Pack

The only conflict between the results from the two groups of soldiers concerning the overall second prototype pack was its weight and bulk. Soldiers in Malaysia indicated that there was too much food in the prototype, resulting in too much weight and bulk; while in New Zealand, bulkiness was the only problem with the soldiers. The differences can be attributed to the different living conditions of the soldiers. The jungles and climate of Malaysia is considerably harsher than that in New Zealand, and

soldiers training there would be more concerned about the weight of their back packs than soldiers in New Zealand.

As the final prototype ration pack will be used in the future in both environments, a compromise was made. It was decided to reduce the weight of the final prototype, but to a level which would not significantly effect the energy (kcal.), nor the total amount of food acceptable for soldiers in New Zealand. However, it would still be slightly heavier than the present ration pack. The problem of bulkiness would also be solved after this reduction in weight.

6.2.2 Canned Foods

A complete agreement was found with the canned foods liked and disliked by the two main groups of soldiers. The canned foods that were liked were:

* Beef Casserole
* Corned Beef
* Tuna in Oil
* Spaghetti and Sausages
* Sweet and Sour Pork
* Peaches
* Pears
* Fruit Salad.

All these were included in the final prototype pack. Canned pineapple was also included to add variety to the fruit type products.

The remaining three canned meat products; Chicken Casserole, Mutton Curry, and Beans and Bacon, were all very much disliked. The disliking of the chicken casserole can be attributed to the problem of the mincing of the meat during processing. It was

decided that this was a major factor in it being disliked, and it should still be included in the final prototype ration pack. The mutton curry was also included in the final pack, but reformulation would be needed. From the discussion groups, Beans and Bacon was found to be too similar to Baked Beans and Sausages, which was not highly liked in the present ration pack. It was decided to replace this product with canned luncheon which was highly rated in the Consumer Attitude Survey (Food Technology Research Centre, 1985).

The acceptance of the can sizes used in both field evaluations differed. This related to the weight problem dealt with in the previous section. The size was acceptable in the New Zealand field evaluation but was found to be too big in the Malaysian one. It was decided to reduce the size of the specially canned meat meals to that of the size of the cans in the present ration pack, i.e., 225 grams. This would help in reducing the overall weight of the final prototype pack. The commercially available canned products would be left as they were, due to their size acceptance. An exception to this was the canned corned beef which was found to be too big. Attempts would be made to reduce its size to 225 grams.

Each of the four menus of the prototype ration pack will include two meat meals and one can of fruit.

6.2.3 Carbohydrate Source

Instant noodles have been popular in the past with the soldiers and no indications of the contrary were found during the field evaluation. They were included in the final prototype ration pack. They will be vacuum packed in metalised plastic laminate to ensure a two year storage life and the weight will be 85 grams.

The quick cooking macaroni was new to the soldiers and so hesitancy in using it was present. This, plus the poor packaging, resulted in it being rated very low. During the discussion groups, a number of soldiers who ate it commented that they liked it and that it should be included in the final prototype ration pack. It was therefore decided it would be included, the size being kept the same, and the packaging improved to a stronger plastic. However, due to the nearly unanimous preference for instant noodles, instant noodles would be included in three of the four menus and macaroni in only one menu of the final prototype ration pack.

6.2.4 Snack Foods

In many cases, the size of the snack foods were found to be slightly too small. However, to increase them, means effectively increasing the overall weight of the pack, which is not required. It was therefore decided that the sizes should remain the same and other food types reduced.

Cabin bread was popular in both field evaluations and more was wanted. The sweet biscuits were also popular, however, the major drawback with these was their brittleness. The idea of obtaining biscuits from Australia in the future may prove difficult, as they are made at different times of the year. It was therefore decided to use commercially available biscuits that would be

suitable in terms of robustness, etc.

Cabin bread would fit into this category, though storage trials would need to be carried out to determine its storage life. A metalised plastic laminate would be used for packaging. The quantity would remain the same; however, it would be included in all four menus.

A sweet biscuit would also be included in each menu, and like the cabin bread, storage trials would be required and a metalised plastic laminate for packaging used. Investigations in future will determine exactly the type of biscuit(s) used. Economic considerations may mean only one or two sweet biscuit varieties being used.

The apricot fruit bar was liked in both field evaluations and would remain in two of the menus. The fig fruit bar was not so popular, and another type would need to be found, e.g. raisin. Metalised plastic laminate packaging would be used to package the same size bar.

The two commercially available chocolates; dairy milk and dark chocolate, were both popular in the New Zealand trial, with dairy milk being very popular. Both these chocolates would be included in the final prototype ration pack. The heat resistant chocolate was also popular, but its future use is very much dependent on the New Zealand Army's exercise schedule, now that they have decided to withdraw their battalion from Singapore. It is recommended that this type of chocolate is used for tropical based army exercises.

All the sweets, except for crystal mints, were moderately liked. Stickiness due to heat and humidity were a problem, and some further work to overcome this would be required. It was decided that chewing gum would replace crystal mints. The tactical

problem of noise with chewing gum was not seen as significant during discussions with soldiers.

The quantity of sweets would remain the same, with the chewing gum obtained from commercial sources (15 grams).

6.2.5 Beverages

Milo was very popular with soldiers in both field evaluations and more was wanted. Coffee and tea were moderately popular, but soldiers tended to prefer drinking milo and this resulted in there being too much coffee and tea left over. It was decided therefore, to increase the milo to three sachets, to reduce the coffee to two sachets, and only have one tea bag in each menu.

The packaging for milo and coffee would be the same as that used by manufacturers for the local market. The tea bag would be packed in a plastic bag to ensure waterproofing.

The condensed milk was generally quite popular in both field evaluations. Low ratings were the result of the low quality of the condensed milk which did not dissolve in hot water. Allowances were made for this problem which resulted it being included in the final prototype ration pack. The packaging would still be the metal tube, though further work will be needed to improve the dispensing of the product (not only for this product but for others also). The quantity would remain at 65 grams.

The orange drink was popular in both field evaluations. The quantity was slightly too much so it was decided that it should be reduced to the amount for a canteen cup i.e. 6 grams or 600 mls of drink. Another flavour, such as lime, would replace the orange flavour in two of the menus. The packaging would be a paper, plastic, foil laminate.

The instant soups were generally disliked by both groups of soldiers. However, inclusion of one sachet in two of the menus has been made because they were popular in flavouring meals. Mushroom and tomato varieties were chosen. The sachet size and packaging would remain the same.

6.2.6 Spreads

Overall, the jams, cheese and butter concentrate were moderately liked by the soldiers in both field evaluations. In the trial in Malaysia, all these products had high initial discard rates. In the New Zealand trial, these same products were left-over by a large percentage of the soldiers. It was decided therefore, that these products should still be included, but in smaller metal tubes. The cheese and jams were reduced from 50 grams to 35 grams, and the butter concentrate from 40 grams to 25 grams. Honey has also been included in one of the menus to add variety. Other spreads such as peanut butter and marmite, will be considered in the future.

6.2.7 Condiments

Except for the onion flakes and the curry powder, the other condiments, which were new in the second prototype ration pack, were disliked.

Condiments mentioned in the discussion groups have been included in the final prototype ration pack, e.g. soya sauce, tomato sauce, chili sauce and worcester sauce. The quantities vary depending on the particular condiment but would be equivalent to a single serve. The packaging material would be a plastic foil laminate.

6.2.8 Non-food Items

For various reasons, the majority of the soldiers carry their own supply of toilet paper. In the field evaluations, the toilet paper was generally not liked. It was of a lower quality than what the soldiers took, and generally there was not enough. It is recommended that a better quality paper be included in the final prototype ration pack and the quantity should be 10 sheets.

The steel cleaning cloth was found to be very good, but was a bit small for both groups of soldiers. A slightly larger cloth has been included in the final prototype ration pack.

The soldiers indicated that the box of waterproof matches were inadequate when the striker became wet, which was quite often. Also, there were far too many matches for a day's supply. It is recommended that a small booklet of waterproof matches, enclosed in a waterproof bag, be included in the final prototype ration pack.

Overall, the soldiers found the can opener too small. It is recommended that a larger one be included in the final prototype ration pack.

6.3 EVALUATION OF THE FINAL PROTOTYPE RATION PACK

Tables 6.1, 6.2, 6.3 and 6.4 give the weight, cost and nutritional information on the four menus of the final prototype ration pack. Nutritional values for some foods were based on the foods used in the last field evaluations, as these were the latest available. Therefore the nutritional values may not reflect the true nutritional composition of the final prototype ration pack. As it is assumed that in the future all four menus

would be used equally during a military exercise (this is not the case with the present ration pack), the following evaluations were based on the four menus in total. Table 6.5 is a summary of Tables 6.1, 6.2, 6.3 and 6.4.

Table 6.1: Menu A of the Final Prototype Ration Pack

FOODTYPE	WEIGHT (x 100g)	COST/UNIT (cents)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
BEEFCASS	2.250	165.00	299.25	25.76	16.58	11.68	32.63	31.30	4.10	0.311	7.29	0.00	966.65	161.11	0.00	0.058	0.297	8.890	10.22	0.783	0.326	1.618
TUNAINOIL	1.850	169.00	534.65	35.15	37.00	0.00	12.95	51.80	2.04	0.167	1.48	0.00	0.00	0.00	5.80	0.074	0.204	31.820	0.00	11.655	0.814	9.250
CHEESE	0.350	75.00	108.85	7.53	8.75	0.00	245.00	8.40	0.18	0.175	1.12	84.00	42.00	91.00	0.05	0.007	0.102	1.796	0.00	0.000	0.000	0.000
PEACHES	3.100	84.00	269.70	1.24	0.00	70.99	12.40	18.60	1.24	0.186	0.00	0.00	775.00	129.17	0.00	0.031	0.062	1.860	12.40	0.000	0.062	0.000
INSTANT NOODLES	0.850	65.00	313.56	11.26	0.80	69.68	18.76	29.48	1.07	0.214	0.80	0.00	0.00	0.00	0.00	0.027	0.000	3.216	0.00	0.000	0.027	0.000
BISCUITS:																						
SULTANA	0.500	22.00	200.00	2.10	5.10	35.80	0.00	0.00	0.00	0.000	0.00	0.00	7.50	1.25	0.00	0.081	0.000	0.000	0.00	0.000	0.000	0.000
CABINBREAD	0.600	25.00	213.00	6.00	1.44	43.50	9.00	0.00	0.42	0.000	0.00	0.00	0.00	0.00	0.00	0.044	0.042	0.060	0.00	0.000	0.000	0.000
FRUITBAR	0.700	28.00	222.64	3.54	3.24	46.36	21.71	39.91	1.44	0.140	0.69	30.98	276.69	77.09	0.03	0.105	0.042	2.233	0.00	0.343	0.147	0.000
CHOCOLATE	0.500	45.00	262.50	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
SWEETS	0.350	15.00	114.45	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.028	14.00	2.80	0.41	0.00	0.31	4.48	10.92	0.12	0.001	0.01	0.00	0.00	0.00	0.00	0.000	0.003	0.697	0.00	0.000	0.001	0.000
MILO	0.330	27.00	140.58	4.19	3.86	22.44	162.69	0.00	6.60	0.000	0.00	30.36	26.07	56.43	0.00	0.635	0.000	0.000	0.00	0.000	0.000	0.000
TEABAGS	0.025	3.00	2.00	0.20	0.00	0.00	0.00	2.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.020	0.200	0.00	0.000	0.000	0.000
FRUITDRINK	0.060	15.00	18.00	0.00	0.00	31.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	18.00	0.000	0.000	0.000
COND.MILK	0.650	75.00	209.30	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	96.20	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	8.00	0.00	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	31.00	330.96	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
JAM	0.350	75.00	91.35	0.14	0.00	24.26	4.20	1.75	0.35	0.042	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BUTTERCONC.	0.250	75.00	185.00	0.10	20.50	0.00	3.75	0.50	0.04	0.008	0.04	187.50	117.50	207.08	0.19	0.000	0.000	0.028	0.00	0.500	0.000	0.000
CURRY	0.035	5.00	8.16	0.33	0.38	0.91	22.40	9.80	2.63	0.036	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
TOMATO SAUCE	0.150	11.00	12.90	0.36	0.77	1.22	4.20	2.10	0.11	0.018	0.06	4.50	184.50	35.25	0.04	0.012	0.008	0.150	1.50	0.210	0.017	0.000
STEEL CLOTH		20.00																				
TOILETPAPER		10.00																				
MATCHES		10.00																				
CANOPENER		10.00																				
TOTAL:	13.908	1082.00	3539.65	106.05	118.87	545.57	790.80	315.40	21.81	1.736	12.24	401.69	2447.75	857.91	6.17	1.161	1.131	52.959	43.42	14.014	1.416	11.193

Table 6.2: Menu B of the Final Prototype Ration Pack

FOODTYPE	WEIGHT (x 100g)	COST/UNIT (cents)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT B6 (mg)	VIT B12 (ug)
CHICKCASS	2.250	165	198	15.50	7.38	17.06	27.11	37.17	2.16	0.297	1.84	0.00	896.65	149.44	0.00	0.115	0.180	9.585	22.77	1.260	0.398	0.000
SWEET&SOUR	2.250	165	144	10.87	4.59	14.85	29.45	27.22	1.44	0.290	1.88	0.00	70.40	11.73	0.00	0.428	0.209	6.698	9.92	0.225	0.254	0.608
CHEESE	0.350	75	109	7.53	8.75	0.00	245.00	8.40	0.18	0.175	1.12	84.00	42.00	91.00	0.05	0.007	0.102	1.796	0.00	0.000	0.000	0.000
PEARS	3.100	79	245	1.24	0.00	62.00	15.50	18.60	0.93	0.124	0.00	0.00	31.00	5.17	0.00	0.031	0.031	1.860	3.10	0.000	0.031	0.000
INSTANT NOODLES	0.850	65	314	11.26	0.80	69.68	18.76	29.48	1.07	0.214	0.80	0.00	0.00	0.00	0.00	0.027	0.000	3.216	0.00	0.000	0.027	0.000
BISCUITS:																						
SULTANA	0.500	22	200	2.10	5.10	35.80	0.00	0.00	0.00	0.000	0.00	0.00	7.50	1.25	0.00	0.081	0.000	0.000	0.00	0.000	0.000	0.000
CABINBREAD	0.600	25	213	6.00	1.44	43.50	9.00	0.00	0.42	0.000	0.00	0.00	0.00	0.00	0.00	0.044	0.042	0.060	0.00	0.000	0.000	0.000
FRUITBAR	0.700	28	223	3.54	3.24	46.36	21.71	39.91	1.44	0.140	0.69	30.98	276.69	77.09	0.03	0.105	0.042	2.233	0.00	0.343	0.147	0.000
CHOCOLATE	0.500	45	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
SWEETS	0.350	15	114	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.028	14	3	0.41	0.00	0.31	4.48	10.92	0.12	0.001	0.01	0.00	0.00	0.00	0.00	0.000	0.003	0.697	0.00	0.000	0.001	0.000
MILO	0.330	27	141	4.19	3.86	22.44	162.69	0.00	6.60	0.000	0.00	30.36	26.07	56.43	0.00	0.635	0.000	0.000	0.00	0.000	0.000	0.000
TEABAGS	0.025	3	2	0.20	0.00	0.00	0.00	2.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.020	0.200	0.00	0.000	0.000	0.000
TOMATO SOUP	0.200	32	74	1.60	1.40	13.50	28.00	8.00	0.40	0.060	0.20	0.00	0.00	0.00	0.00	0.040	0.040	0.600	0.00	0.000	0.000	0.000
FRUITDRINK	0.060	15	18	0.00	0.00	31.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	18.00	0.000	0.000	0.000
COND.MILK	0.650	75	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	96.20	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	8	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	31	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
JAM	0.350	75	91	0.14	0.00	24.26	4.20	1.75	0.35	0.042	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BUTTER CONC.	0.250	75	185	0.10	20.50	0.00	3.75	0.50	0.04	0.008	0.04	187.50	117.50	207.08	0.19	0.000	0.000	0.028	0.00	0.500	0.000	0.000
PEPPER	0.010	5	3	0.09	0.07	0.68	1.30	0.45	0.10	0.011	0.02	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SOYA SAUCE	0.100	11	7	0.56	0.13	0.95	8.20	0.00	0.48	0.000	0.00	0.00	0.00	0.00	0.00	0.002	0.025	0.040	0.00	0.000	0.000	0.000
STEEL CLOTH		20																				
TOILETPAPER		10																				
MATCHES		10																				
CAN OPENER		10																				
TOTAL:	14.433	1105	3086	73.07	77.71	569.81	815.79	293.24	17.22	1.801	7.35	397.19	1519.66	698.73	0.33	1.602	1.046	29.023	55.09	2.851	0.881	0.933

Table 6.3: Menu C of the Final Prototype Ration Pack

FOODTYPE	WEIGHT (x 100g)	COST/UNIT (cents)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
CORNBEEF	2.250	165	488	50.85	41.58	0.00	31.50	33.75	6.53	0.540	12.60	0.00	0.00	0.00	0.00	0.000	0.518	20.250	0.00	1.755	0.135	4.500
SPAG&SAUS	3.000	87	265	9.81	9.37	37.73	81.06	35.10	1.70	0.489	1.45	0.00	0.00	0.00	0.00	0.030	0.080	3.669	0.00	0.120	0.060	0.420
CHEESE	0.350	75	109	7.53	8.75	0.00	245.00	8.40	0.18	0.175	1.12	84.00	42.00	91.00	0.05	0.007	0.102	1.796	0.00	0.000	0.000	0.000
PINEAPPLE	2.250	67	173	0.68	0.00	45.45	29.25	18.00	0.90	0.113	0.00	0.00	90.00	15.00	0.00	0.113	0.045	0.450	27.00	0.000	0.158	0.000
INSTANT NOODLES	0.850	65	314	11.26	0.80	69.68	18.76	29.48	1.07	0.214	0.80	0.00	0.00	0.00	0.00	0.027	0.000	3.216	0.00	0.000	0.027	0.000
BISCUITS:																						
SULTANA	0.500	22	200	2.10	5.10	35.80	0.00	0.00	0.00	0.000	0.00	0.00	7.50	1.25	0.00	0.081	0.000	0.000	0.00	0.000	0.000	0.000
CABIN	0.600	25	213	6.00	1.44	43.50	9.00	0.00	0.42	0.000	0.00	0.00	0.00	0.00	0.00	0.044	0.042	0.060	0.00	0.000	0.000	0.000
FRUITBAR	0.700	28	223	3.54	3.24	46.36	21.71	39.91	1.44	0.140	0.69	30.98	276.69	77.09	0.03	0.105	0.042	2.233	0.00	0.343	0.147	0.000
CHOCOLATE	0.500	45	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
CHEWINGGUM	0.150	20	48	0.00	0.00	14.28	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.028	14	3	0.41	0.00	0.31	4.48	10.92	0.12	0.001	0.01	0.00	0.00	0.00	0.00	0.000	0.003	0.697	0.00	0.000	0.001	0.000
MILO	0.330	27	141	4.19	3.86	22.44	162.69	0.00	6.60	0.000	0.00	30.36	26.07	56.43	0.00	0.635	0.000	0.000	0.00	0.000	0.000	0.000
TEABAGS	0.025	3	2	0.20	0.00	0.00	0.00	2.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.020	0.200	0.00	0.000	0.000	0.000
FRUITDRINK	0.060	15	18	0.00	0.00	31.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	18.00	0.000	0.000	0.000
COND.MILK	0.650	75	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	96.20	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	8	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	31	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
HONEY	0.350	75	288	0.14	0.00	26.74	1.75	0.70	0.14	0.018	0.00	0.00	0.00	0.00	0.00	0.000	0.018	0.070	0.00	0.000	0.000	0.000
BUTTER	0.250	75	185	0.10	20.50	0.00	3.75	0.50	0.04	0.008	0.04	187.50	117.50	207.08	0.19	0.000	0.000	0.028	0.00	0.500	0.000	0.000
CHILISAUCE	0.050	11	1	0.05	0.03	0.20	0.45	0.00	0.03	0.000	0.00	0.00	286.80	47.80	0.00	0.000	0.005	0.030	1.50	0.000	0.000	0.000
ONIONFLAKE	0.100	10	35	1.01	0.10	8.07	36.30	12.20	0.26	0.000	0.23	0.00	0.00	0.00	0.00	0.041	0.006	0.064	1.47	0.000	0.000	0.000
STEELCLOTH		20																				
TOILETPAPER		10																				
MATCHES		10																				
CANOPENER		10																				
TOTAL:	13.973	993	3507	105.60	115.23	538.43	880.58	299.11	20.77	2.104	17.70	397.19	898.41	595.19	0.33	1.170	1.231	34.773	49.27	3.241	0.550	5.245

Table 6.4: Menu D of the Final Prototype Ration Pack

FOODTYPE	WEIGHT (x 100g)	COST/UNIT (cents)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
LUNCHEON	2.250	165	704	28.35	60.53	12.38	33.75	18.00	2.48	0.743	4.95	0.00	0.00	0.00	0.00	0.158	0.270	4.050	0.00	0.248	0.045	2.250
MUTTONCURRY	2.250	165	317	23.83	14.20	23.60	31.48	42.14	3.70	0.340	3.85	0.00	243.83	40.64	0.00	0.115	0.281	9.473	6.43	0.281	0.239	1.618
CHEESE	0.350	75	109	7.53	8.75	0.00	245.00	8.40	0.18	0.175	1.12	84.00	42.00	91.00	0.05	0.007	0.102	1.796	0.00	0.000	0.000	0.000
FRUTSALAD	3.100	88	295	0.93	0.00	77.50	24.80	24.80	3.10	0.093	0.00	0.00	930.00	155.00	0.00	0.062	0.031	0.930	9.30	0.000	0.031	0.000
MACARONI	0.750	14	277	9.95	0.71	61.62	16.59	26.07	0.95	0.190	0.71	0.00	0.00	0.00	0.00	0.024	0.000	2.844	0.00	0.000	0.024	0.000
BISCUITS:																						
SULTANA	0.500	22	200	2.10	5.10	35.80	0.00	0.00	0.00	0.000	0.00	0.00	7.50	1.25	0.00	0.081	0.000	0.000	0.00	0.000	0.000	0.000
CABINBREAD	0.600	25	213	6.00	1.44	43.50	9.00	0.00	0.42	0.000	0.00	0.00	0.00	0.00	0.00	0.044	0.042	0.060	0.00	0.000	0.000	0.000
FRUITBAR	0.700	28	223	3.54	3.24	46.36	21.71	39.91	1.44	0.140	0.69	30.98	276.69	77.09	0.03	0.105	0.042	2.233	0.00	0.343	0.147	0.000
CHOCOLATE	0.500	45	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
SWEETS	0.350	15	114	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.028	14	3	0.41	0.00	0.31	4.48	10.92	0.12	0.001	0.01	0.00	0.00	0.00	0.00	0.000	0.003	0.697	0.00	0.000	0.001	0.000
MILO	0.330	27	141	4.19	3.86	22.44	162.69	0.00	6.60	0.000	0.00	30.36	26.07	56.43	0.00	0.635	0.000	0.000	0.00	0.000	0.000	0.000
TEABAGS	0.025	3	2	0.20	0.00	0.00	0.00	2.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.020	0.200	0.00	0.000	0.000	0.000
MUSE.SOUP	0.180	32	71	2.80	1.40	12.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
FRUITDRINK	0.060	15	18	0.00	0.00	31.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	18.00	0.000	0.000	0.000
COND.MILK	0.650	75	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	96.20	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	8	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	31	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BUTTER CONC.	0.250	75	185	0.10	20.50	0.00	3.75	0.50	0.04	0.008	0.04	187.50	117.50	207.08	0.19	0.000	0.000	0.028	0.00	0.500	0.000	0.000
MARMITE	0.150	75	27	6.21	0.11	0.27	14.25	27.00	0.56	0.045	0.32	0.00	0.00	0.00	0.00	0.465	1.650	10.050	0.00	0.000	0.195	0.075
CHILI	0.035	10	12	0.53	0.35	1.93	8.75	0.00	0.53	0.000	0.00	0.00	0.00	455.00	0.00	0.000	0.035	0.350	0.00	0.000	0.000	0.000
WORSTERSAUCE	0.100	11	8	0.10	0.00	1.80	10.00	0.00	0.60	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
STEEL CLOTH		20																				
TOILETPAPER		10																				
MATCHES		10																				
CAN OPENER		10																				
TOTAL:	14.138	1068	3721	104.51	140.63	557.93	822.88	308.59	22.20	2.172	12.44	397.19	1695.44	1183.03	0.33	1.782	2.828	34.720	35.03	1.895	0.704	4.268

Table 6.5: Summary Information of the menus in the Final Prototype Ration Pack

	WEIGHT (x 100g)	COST/UNIT (cents)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
TOTAL:	13.908	1082	3540	106.05	118.87	545.57	790.80	315.40	21.81	1.736	12.24	401.69	2447.75	857.91	6.17	1.161	1.131	52.959	43.42	14.014	1.416	11.193
TOTAL:	14.433	1105	3086	73.07	77.71	569.81	815.79	293.24	17.22	1.801	7.35	397.19	1519.66	698.73	0.33	1.602	1.046	29.023	55.09	2.851	0.881	0.933
TOTAL:	13.973	993	3507	105.60	115.23	538.43	880.58	299.11	20.77	2.104	17.70	397.19	898.41	595.19	0.33	1.170	1.231	34.773	49.27	3.241	0.550	5.245
TOTAL:	14.138	1068	3721	104.51	140.63	557.93	822.88	308.59	22.20	2.172	12.44	397.19	1695.44	1183.03	0.33	1.782	2.828	34.720	35.03	1.895	0.704	4.268
TOTAL	56.452	4248	13854	389.22	452.44	2211.74	3310.05	1216.34	82.00	7.813	49.73	1593.24	6561.26	3334.85	7.14	5.714	6.235	151.475	182.81	22.001	3.552	21.638
AVERAGE	14.113	1062	3464	97.31	113.11	552.93	827.51	304.09	20.50	1.953	12.43	398.31	1640.32	833.71	1.79	1.429	1.559	37.869	45.70	5.500	0.888	5.410
RDA			3900	65			600	350	10	2.5	15			900	12	1.44	2.04	21.6	72	16.2	2.4	3.6
% RDA			88.81	149.70			137.92	86.88	205.00	78.13	82.88			92.63	14.88	99.21	76.41	175.32	63.47	33.95	37.00	150.26
FROM:																						
PROTEIN				11.24																		
FAT					29.39																	
CARBOHY						59.87																

6.3.1 Weight and Volume

The average weight of the final prototype ration pack was 1.411 kg. This compares with an average weight of the present ration pack of 1.275 kg and 1.650 kg of the second prototype ration pack. Bearing this in mind, it is not expected that this extra weight above the present ration pack and the associated volume would be significant enough to affect the soldier's acceptance of it.

6.3.2 Cost

The average cost of the final prototype ration pack is $10.62. This compares with $8.10 for the present ration pack. The increase is due to the higher quality of food and the extra food required to meet the energy levels.

6.3.3 Nutritional Composition

The nutritional composition of the four menus found in Tables 6.1, 6.2, 6.3 and 6.4 were based on products used in the large field trials. These may be changed when the final prototype ration pack is introduced.

6.3.3.1 Energy

The average energy of the four menus was 3464 kcal. (partly due to the abnormal low value of sweet and sour pork in Menu B). This is lower than the requirement of 3800-4000 kcal. However, this average energy value can be increased by reformulation of the canned meat meals, e.g., sweet and sour pork and chicken casserole.

Menu B was taken as an example to show how product reformulation can change the energy, protein, fat and carbohydrate content of

the menu without weight changes. The sweet and sour pork was composed of 38.5% cooked pork meat, with pork having an approximate composition of 12.5% protein, 5.4% fat and 82.1 moisture. The first change was to increase the fat level to 15% and the protein level to 20%. Also, pasta (10% by weight) would be included (less water included). These two changes would increase energy level of the product (225 grams) from 144 kcal to 362 kcal, protein from 15.50 grams to 23.15 grams, fat from 4.59 grams to 15.18 grams, and carbohydrate from 14.85 grams to 33.75 grams.

The second reformulation would be to simply increase the level of fat in the chicken casserole from the present 3.28% to 10% by the addition of chicken fat. This would increase the energy level of the product (225 grams) from 198 kcal to 340 kcal.

These two changes would result in Menu B having levels for energy of 3445 kcal, protein of 85.51 grams, fat of 104.05 grams, and a carbohydrate level of 618.14 grams. This would increase the average energy levels of the four menus from 3464 kcal to 3553 kcal. Similar reformulations of the Beef casserole and Mutton curry can be done to increase this energy level further.

6.3.3.2 Protein, Fat and Carbohydrate

The average protein of 97.3 grams for the four menus meets the RDA of 65 grams. This average value is not excessive when one considers some groups of people in the world who have daily intakes of protein in excess of 200 grams without serious effects.

The contribution to the total energy from protein, fat and carbohydrate as mentioned previously, is a good measure of the balanced nature of the diet. Only the value of 59.9% of energy contributed by carbohydrate may seem excessive. However, when

one considers the affluent diets (40% energy from carbohydrate) and the diets of the poor (85% energy from carbohydrate), both undesirable extremes, this average value is acceptable (Passmore and Eastwood, 1986). The average value of energy from fat of 29.6% is below the 35% limit that is desirable (National Academy of Sciences, 1980).

6.3.3.3 Essential Minerals

The average values for calcium (137.9 mg) and iron (20.5 mg) are above their respective RDA's but are not excessive (National Academy of Sciences, 1980). The average values for magnesium (304.1 mg), copper (1.9 mg) and zinc (12.4 mg) are slightly less than their respective RDA's. However, these can be seen as insignificant, when it is recalled that the RDA's are over-estimates of the average requirements.

6.3.3.4 Vitamins

The average values for Vitamins A (834 µg) and thiamin (1.4 mg) and Riboflavin (1.69 mg) are only slightly less than their respective RDA's. The average value for Vitamin D (1.8 mg) is very low, but does not consider the contribution from sunlight which is significant.

The average values for Vitamin C (46 mg), Vitamin E (5.5 mg) and Vitamin B_6 (0.9 mg) are also slightly low. Attention will be made to these values in the further work to be carried out on the final prototype ration pack. Vitamin C can be increased with the addition of ascorbic acid in the powdered fruit drink. Vitamins E and B_6 can be increased by reformulating the meat meals so that the values for these vitamins are increased.

The average values for Niacin (37.9 mg) and Vitamin B_{12} (5.4µg) are above their respective RDA's, but are not excessive.

6.4 DISCUSSION

The following sections discuss future work required to be carried out to complete the design of the final prototype ration pack. Following this, is a review of the LP and spreadsheet techniques used in ration pack design, and also a review on the consumer evaluation methods used.

6.4.1 Future Work

Several areas of future work will be required before the final prototype ration pack can be put into full production (Specific changes to the present ration pack are listed in Appendix 14) These are:

* Develop two canned meat meals that are acceptable to Army soldiers.

* Solve the nutritional shortfalls (Vitamins C, E and B_6) by either reformulation, e.g. in the meat meals or fortification, e.g. add ascorbic acid in the fruit drink.

* Implement storage trials, e.g. instant noodles, biscuits and fruit bar.

Also required will be the need to prepare final specifications on all the ration pack items so that standards can be set. From these specifications, a Quality Assurance programme will be developed.

Once the final prototype ration pack is introduced, there is a need to follow-up on its acceptance. This will involve a full-scale field evaluation by several hundred soldiers. Figure 6.1 summarises this future work.

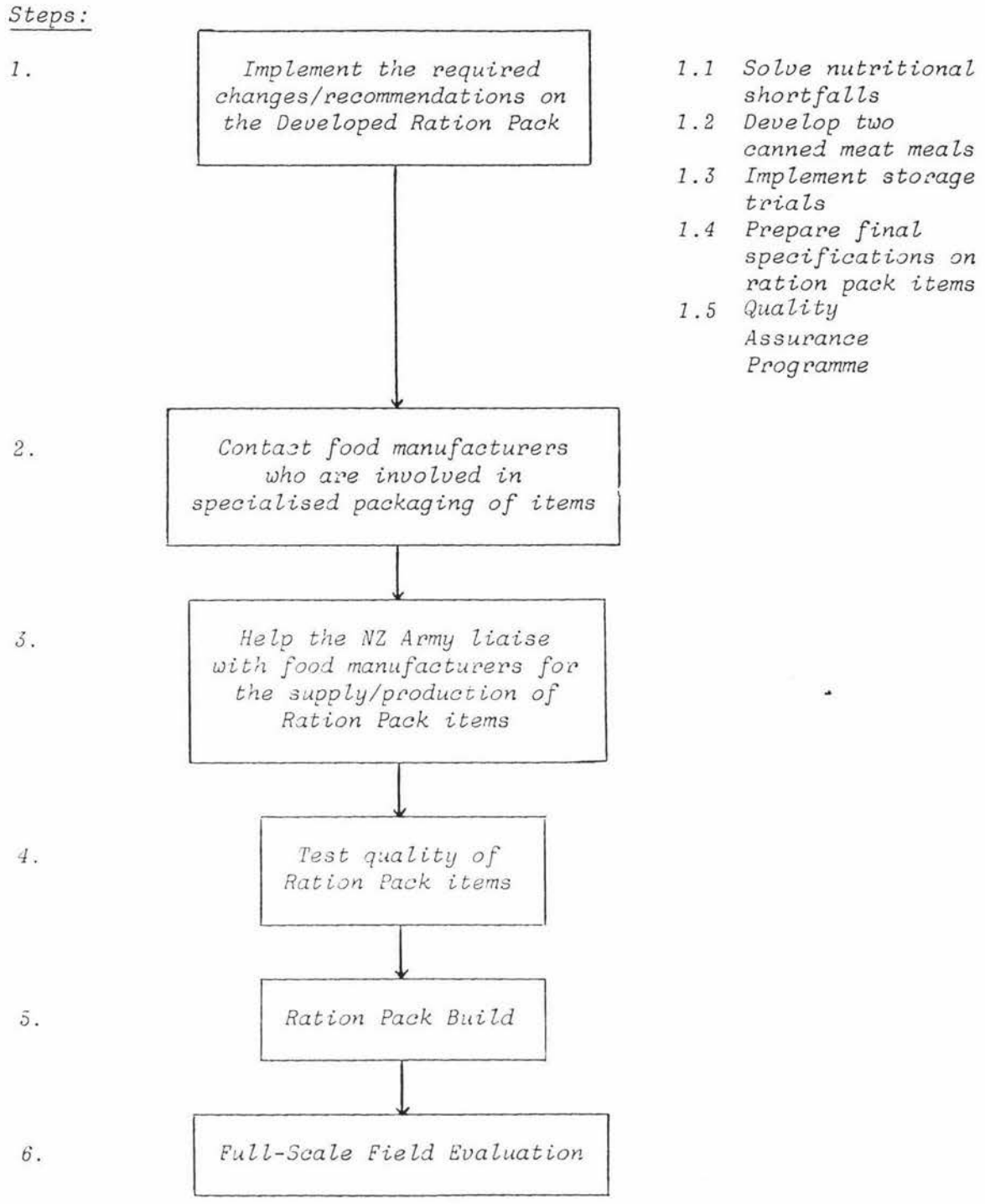


Figure 6.1: Summary of Future Work Required

6.4.2 Comparison of the Use of Linear Programming and Spread Sheets in Ration Pack Design

The mixed integer Linear Programming technique, that was used initially in the development of menus in the first prototype ration pack, was found to have a few drawbacks. The first of these was that, even though the selection of foods by LP was from a number of well liked foods, this did not guarantee overall consumer acceptance of the menus. The criteria of food weights and overall nutritional composition were also subject to consumer acceptance. Another drawback that can be encountered in LP is that one can have an over-constrained problem. This results in the problem being unsolvable, in which case there is a need to relax some of the constraints that have been defined. Trial and error is sometimes required in these cases. It should however be stated, that the use of LP in menu planning is helpful in providing initial menus which one can consumer test. It is a relatively fast method of selecting foods for a menu for which there are certain constraints and objectives to be met e.g. nutrition and weight.

The use of spread sheets as another method of designing menus, was found to be very useful. Initially, time is required to input the data for the spread sheet, but once this has been done, numerous manipulations can be made very quickly. The main advantage in using spread sheets in menu planning is that the system is interactive i.e. it gives the user fast responses to the decisions he makes in selecting menu items. If a decision is made to include a certain weight of food, then this can be quickly done, and immediately the result of the inclusion can be seen e.g. its effect on total weight, and nutritional composition.

Though spread sheet analysis does not allow one to meet constraints such as levels of nutrients (as LP does) it does show what menu items are contributing what nutrients. It also shows

what nutrients are lacking overall. This information can be used to decide whether another food should be increased in weight or added to the menu list; with maybe the final option of fortifying some of the menu items.

The main differences therefore between these two methods of menu planning is the degree of decision making or selection of menu items carried out by the user. In LP a certain amount of menu item selection can be decided by the user during the setting-up of the LP model, but the majority is done by LP. With spread sheet analysis all the decision making is done by the user.

One of the main problems encountered in developing an acceptable ration pack was the inter-relationships that were present in the food items. For example, if one increases the amount of cabin bread included in a menu type, then one has to decide whether more butter and spreads are required. Also, if this was done, does the quantity of other biscuits need to be decreased, and how is the total weight and nutritional composition affected? The effect of this type of decision could quickly be seen using spread sheet analysis, but with LP this could not be done so rapidly. In conclusion then, the use of spread sheet analysis in developing a ration pack was found to be a better method than LP, although LP was helpful in obtaining initial menus.

6.4.3 Consumer Evaluation Techniques Used

A consumer test of the menus developed from LP and spread sheet analysis was essential to measure their acceptance with the soldiers. It was found during the field evaluations that the questionnaires needed to be simple, and to require a minimal amount of time to complete. This was difficult, due to the large number of menu items involved. The questionnaires used were found to be successful with soldiers if they concentrated on gathering measurable information e.g. using a Hedonic category

scale for the acceptability of menu items. It was left to the focus groups to obtain subjective opinions on the menus.

It was important in these focus groups that the number of subjects be less than 10. Shyness to speak is present in any group, and the army soldiers are no exception. Also important, was the need not to have a high ranking officer involved as a mediator. His position in the army immediately causes some bias in the discussions that follow.

6.5 FINAL CONCLUSIONS

The questionnaire results from the evaluation of the second prototype ration pack indicated high acceptance by the soldiers over a ten day period. The question therefore arises in the final part of this thesis - what has attributed to this high acceptance? Was it the use of LP or spread sheets or some other design technique? Also, how can this technique be used in similar problems?

The answer is not in the actual techniques used, but on the information that was put into these techniques. From the initial Consumer Attitude Survey (Food Technology Research Centre, 1985e), to the sensory evaluation during product development, to the final field evaluations, information from the soldiers was obtained. Therefore, having designed a ration pack based on what the soldier requires, it was not surprising that they found it acceptable.

The use of LP and spread sheets stored the acceptance and other consumer information and they were also able to design a ration pack that met other criteria, e.g. minimum weight and nutritional requirements.

Finally, it should be stated that the final prototype ration pack has been designed on the likes and preferences of current soldiers in the New Zealand Army. Firstly, familiarity in the use of this ration pack in the future will lessen its acceptability (Kamen and Peryam, 1961). Secondly, changing food likes and preferences will occur through a changing soldier population and due to new food products being available.

Therefore, it is inevitable that there is a need to continually redesign the combat ration pack as acceptability decreases. This acceptability therefore needs to be measured on a routine basis.

BIBLIOGRAPHY

Anon, 1980. Nutritional Demands Imposed by Stress. Dairy Council Digest 51 (6) 31-35.

Australian Department of Defence, 1986. Field Evaluation of Australian Ration Packs; Revision of Combat Ration One Man. AFFSE Report 1/86.

Birkbeck, J.A., 1985. The Importance of Anthropometric and Nutritional Data in the Formulation of Field Rations. A paper presented at the CDSO Conference in the United Kingdom.

Cooper, H.R., 1981. Sensory Evaluation of New Zealand Commercial Whole Milk Powders. Phd Thesis. Massey University, Palmerston North.

Consolazio, C.F., 1983. Nutrition and Performance. Progress in Food and Nutrition Science, Volume 7, Number 1/2.

Department of Statistics, 1986. N.Z. Official Yearbook, 1986-1987, Department of Statistics, Wellington.

Eckstein, E.F., 1973. Menu Planning. The AVI Publishing Company, Inc., Westport Conneticut.

Fennema, O.R., 1975. Principles of Food Science, Part III; Physical Principles of Food Preservation. Marcel Dekker, Inc. New York.

Food Technology Research Centre, 1985a. Human Nutritional and Energy Requirements. A Report compiled for the N.Z. Army. Massey University, Palmerston North.

Food Technology Research Centre, 1985b. The Effect of Processing on the Nutritive Value of Food Products, 1985. A Report

compiled for the N.Z. Army. Massey University, Palmerston North.

Food Technology Research Centre, 1985c. The Effect of Storage on the Nutritive Value of Food Products. A Report compiled for the N.Z. Army. Massey University, Palmerston North.

Food Technology Research Centre, 1985d. Survey of Army Rations, Types, Contents, Nutritional Quality and Acceptability. A Report compiled for the N.Z. Army. Massey University, Palmerston North

Food Technology Research Centre, 1985e. Consumer Attitude Survey. A Report compiled for the N.Z. Army. Massey University, Palmerston North

Food Technology Research Centre, 1985f. Development of Menus/Meals for Nutritionally Complete Sustaining Army Survival Ration Packs and Fieldpack Rations. A Report compiled for the N.Z. Army. Massey University, Palmerston North

Food Technology Research Centre, 1986a. Preliminary Results for the One Man, 24 Hour Combat Ration Pack. A Report compiled for the N.Z. Army. Massey University, Palmerston North.

Food Technology Research Centre, 1986b. The Design of the One Man, 24 Hour, Combat Ration Pack. A Report compiled for the N.Z. Army. Massey University, Palmerston North.

Food Technology Research Centre, 1986c. Proposed Design for the One Man, 24 Hour, Combat Ration Pack. A Report compiled for the N.Z. Army. Massey University, Palmerston North.

Food Technology Research Centre, 1987a. Field Evaluation of the

One Man, 24 Hour, Combat Ration Pack in Malaysia. A Report compiled for the N.Z. Army. Massey University, Palmerston North.

Food Technology Research Centre, 1987b. Field Evaluation of the One Man, 24 Hour, Combat Ration Pack in New Zealand. A Report compiled for the N.Z. Army. Massey University, Palmerston North

Food Technology Research Centre, 1987c. Executive Summary: The One Man, 24 Hour, Combat Ration Pack (Canned). A Report compiled for the N.Z. Army. Massey University, Palmerston North

Friedemann, T.E., Kraybill, H.F., and Consolazio, C.F., 1959. The Uses of Recommended Dietary Allowances in Military Nutrition. American Journal of Public Health 49 (8) 1006-1012.

Herouse, O., 1981. Nutrition in Cold Environments. In "CRC Handbook of Nutritional Requirements in a Functional Context. Volume II, Hermatopoiesis, Metabolic Function, and Resistance to Physical Stress". 523-542. Editor M. Recheigl Jr. CRC Press, Florida, New York.

International Union of Nutritional Sciences, 1982. Recommended Dietary Intakes Around the World. Nutritional Abstracts and Reviews, 53, (11).

Kamen, J.M., and Peryam, D.R., 1960. Acceptability of Repetitive Diets. Food Technology 14 173-177.

Komarik, S.L.; Tressler, D.K., and Long, L., 1974. Food Product Formulary, Volume 1, Meat, Poultry, Fish, Shellfish. AVI Publishing Co., Westport, Conneticut.

Lotus Corporation, 1986. Lotus 123, Release II.

Microsoft Corporation, 1983. Microsoft Multiplan: User Manual.

Moskowitz, H.R., and Klarman, L., 1977. Food Compatibilities and Menu Planning, Canadian Institute of Food Technology Journal 10 (4) 257-264.

Murtagh, B.A., 1981. Advanced Linear Programming; Computation and Practice. McGraw Hill, New York.

National Academy of Sciences, 1980. Recommended Dietary Allowances (9th Edition). National Academy of Sciences, Washington D.C.

Nie, N.H., Hull, C.H., Jenkins, J.G., Steinbrenner, K., and Bent, D.H., 1975. SPSS: Statistical Package for the Social Sciences (2nd Edition). McGraw Hill Book Co., N.Y.

Ngarmsak, T., 1983. A System of Meal Planning for Self-Improvement of the Diet of Villagers in Northeastern Thailand. Thesis, Ph.D. Massey University, Palmerston North, New Zealand.

Nutrition Advisory Committee (Ministry of Health) and Nutrition Department, University of Otago, 1981. New Zealand Recommended Daily Dietary Requirements.

Nutrition Reviews, 1976. Present Knowledge in Nutrition. The Nutrition Foundation Inc., Washington D.C.

Passmore, R., and Eastwood, M.A., 1986. Davidson and Passmore, Human Nutrition and Dietetics, (8th Edition). Churchill Livingston, New York.

Paul, A.A., and Southgate, D.A.T., 1978. McCance and Widdowson's. The Composition of Foods (4th Edition). Elsevier/North Holland, Biomedical Press, Amsterdam.

Peryam, D.R., and Pilgrim, F.J., 1957. Hedonic Scale Method of Measuring Food Preferences. Food Technology, 11 9-14.

Peryam, D.R., 1959. Discussion: Linear Programming Models for the Determination of Palatable Human Diets. Journal of Farm Economics 41 302-305.

Petrasek, R., 1978. Influence of Climatic Conditions on Energy and Nutrient Requirements. Progress in Food and Nutrition Science, 2 505-514.

Scicon Computer Services, 1981. Scicon/VM User Guide Scicon Computer Services, Milton Keynes.

Seelig, M.S. 1971. Human Requirements of Magnesium; factors that Increase Needs. Presented at 1st International Symposium on Magnesium Deficit in Human Pathology, Vittel, France.

Sharman, I.M., 1981. Nutritional Factors and Physical Performance in Man. In "CRC Handbook of Nutritional Requirements in a Functional Context. Volume II, Hermatopoiesis, Metabolic Function, and Resistance to Physical Stress". 463-468. Editor M. Recheigl Jr. CRC Press, Florida, New York.

Siegel, P.S. and F.J. Pilgrim., 1958. The Effect of Monotony on the Acceptance of Food. Am. J. Psychol. 71 756.

Smith, V.E., 1959. Linear Programming Models for the

Determination of Palatable Human Diets. Journal of Farm Economics, 41 (2) 272-283.

Stevens, S.S., 1946. On the Theory of Scales of Measurement. Science, 103, 677-680.

Stigler, G.J., 1945. The Cost of Subsistence. Journal of Farm Economics. 27 303-314

Tauber, F.W., 1969. The Contribution of Packaging to the Storage and Delivery of Foods. In Proceedings: Symposium on Feeding the Military Man.

Technical Manual 8-501, April, 1961. Nutrition. Department of the U.S. Army.

United States Army Natick Research and Development Laboratories, 1981. The Emergency/Assault Food Packet with the Arctic Supplement - An Evaluation of an Arctic Ration and Assessment of Water Discipline in the Arctic. IL162724AH99/BB036.

United States Army Natick Research and Development Laboratories, 1982. Operational Rations: Current and Future of the Department of Defence. Technical Report. Natick/TR-82/031.

Vajda, S., 1981. Linear Programming: Algorithms and Applications. Chapman and Hall, New York.

Welch, B.E., Buskirk, E.R., and Iampietro, P.F., 1958. Relation of climate and Temperature of Food and Water in Man. Metabolism 7 141-147.

Zikmund, W.G., 1982. Exploring Marketing Research. The Dryden Press, Chicago.

Appendix 1: New Zealand's Defence Policy Objectives

(a) To provide forces capable of quick response to any threat to New Zealand itself, of controlling the Exclusive Economic Zone, and at the same time of upholding New Zealand's wider national interests in the area of prime concern - the New Zealand region and the South Pacific.

(b) To maintain trained, mobile, and self-sufficient forces to provide, on request, military assistance, technical aid, surveillance of outside activities, search and rescue, and disaster relief services in the South Pacific.

(c) To achieve the greatest possible degree of interaction with the Australian Defence Force.

(d) To participate effectively alongside allied units in military exercises.

(e) To maintain a capability for limited support of national research and other interests in Antarctica.

(f) To undertake limited joint training and exercises by invitation in South-East Asia, as a demonstration of continuing interest in stability and security in that region, and to continue to respond to requests from the ASEAN and South Pacific countries for limited military training in New Zealand.

(g) To provide a capability to contribute to international peacekeeping operations.

(h) To provide assistance to the New Zealand community.

Source: Department of Statistics, 1986.

APPENDIX 2: ORIGINAL TERMS OF REFERENCE.

ANNEX A TO
ARMY 18970/1/LOG C
DATED · · / NOV 84

TERMS OF REFERENCE (TOR) FOR THE DESIGN, DEVELOPMENT AND TESTING OF THE RATION PACK FEEDING SYSTEM FOR THE NEW ZEALAND ARMY

Aim

1. The aim of the project is to provide field diets for the New Zealand soldier for training and operations in New Zealand and overseas, which will ensure:

   a. a satisfactory calorific intake;

   b. a balanced nutritional intake;

   c. a menu range which, provides as wide a variety as practicable;

   d. consumer acceptability; and

   e. they can be used for indefinite periods without reducing the soldiers capability to fight.

Limitations

2. Cost. The cost of the new ration packs should be no more than the average standard ration pack price for the present range of ration packs.

3. Weight. The weight of the complete ration shall not exceed 2.6 kg per man per 24 hours, including any water required to make up the ration together with its beverages.

4. Storage. The ration packs should have a minimum shelf life of two years.

Ration Pack Types

5. A minimum of two types of ration packs are envisaged:

   a. Field Ration. This type of ration must be suitable for preparation by Army cooks for unit messing during exercises or in base areas during operations or by soldiers cooking in groups during exercises.

   b. Combat Ration. This ration will

be eaten normally hot but must be palatable cold. It must be able to be prepared by individual soldiers in a field environment. However, extra types may be considered necessary after analysis has been completed.

Rationing Size

6. The total number of rations contained in a pack must be examined, eg, 10 men for 24 hours, one man for 24 hours and the alternatives in-between.

Bulk

7. The maximum cubic dimension of any complete 24 hour ration, not including any water separately required to make it up, shall be .0035m^3. The packs shape must allow personal load carrying equipment to be properly utilised.

NBC Feeding

8. Nuclear, Biological and Chemical (NBC) feeding is not to be addressed.

TVP Content

9. Textured Vegetable Protein (TVP) is not to be used.

Finance

10. All costs should be kept within the estimated budget of:

a. $30,000 in FY 1984/85.

b. To be advised in FY 1984/85.

11. All accounts are to be presented to the Project Officer for payment.

Project Phasing

12. The project is to be split into three parts:

a. Part 1. Comprising:

(1) information search;

(2) consumer attitude survey; and

(3) development of dietary combinations.

b. Part 2. Progress evaluation and report completed by 25 March 1984.

c. Part 3. Comprising:

(1) develop samples of selected products with a small Army consumer survey;

(2) redesign and retest;

(3) large consumer survey; and

(4) final pack design and presentation of product, specification and quality control programme completed by March 1986.

13. The widest consultation as practical throughout the New Zealand Army is to be sought at all stages.

Project Sponsor

14. The Director of Ordnance Services is the Sponsor for this project.

15. The Director of Transportation, Movements and Catering is the sub-sponsor with a particular interest in the Field Ration Pack.

Project Officer

16. Major N.A. Hitchings, RNZAOC, has been appointed Project Officer and all contact between Massey University Food Technology Research Centre and Army should be via the Project Officer. He is responsible to the Project Sponsor.

17. Captain R.J. Stacy, RNZAMC, Directorate of Army Training, is a project team member.

18. Second Lieutenant F. Gilbertson, RNZCT, is available for attachment to the project as arranged through the RNZCT Directorate.

Compliance With TOR

19. If it is found that these TOR cannot be met for any reason, the Project Sponsor is to be advised.

Appendix 3: Summary of Energy Requirements of Humans Under Various Conditions

Stress	Age (years)	Body Weight (kg)	Energy intake or requirements	
			kcal/man/day	MJ/man/day
Normal FAO/WHO	Adult Male	65.0	3000	12.6
Normal FAO/WHO	Adult Female	55.0	2200	9.2
Normal New Zealand	Adult male	-		11
Normal New Zealand	Adult Female	-		8.5
Normal USA	19-22 Male	70	2900	12.2
Normal USA	23-50 Male	70	2700	11.3
Normal USA	19-22 Female	55	2100	8.8
Normal USA	23-50 Female	55	2000	8.4
US Normal Military	Adult Male	-	3200	13.4
US Normal Military	Adult Female	-	2200	9.2
US Army Heavy Work	Adult Male	-	3800-4000	15.9-16.8
US Army Very Heavy Work	Adult male	-	4800-5000	20.1-30
Military exercise	Very Young Men	-	4066	17
Moderately active soldiers	Adult Male	-	3175	13.3
Heavy work	Adult Male	-	4340	18.2
Moderate Work	Adult Male	-	3430	14.4
Canadian army in Subarctic	Adult Male	-	3500	14.7
Canadian army in Arctic	Adult Male	-	4720	19.8
Military exercise in Arctic	Adult male	-	3900	16.4
Soldiers working hard and living in cold	Adult male	-	4500	18.9
Winter Military training in Sub Arctic	Adult male	-	3484	14.6
Winter military training	Adult Male	-	4375	18.3
Hot desert military Activity	Adult Male	-	4000	16.8
Active Men at Altitude				
373	Adult Male	-	3400	14.2
2,297	"	-	3500	14.7
3,100	"	-	3500	14.7
3,475	"	-	2700	11.3
3,500	"	-	4300	18.0
3,992	"	-	3600	15.1
4,500	"	-	3600	15.1
5,500	"	-	3800	15.9
6,000	"	-	3200-3800	13.4-15.9
Extensive thermal injuries				

APPENDIX 4: SUMMARY OF DEVELOPMENT WORK IN DIET PLANNING

YEAR	ORIGINAL DESIGNER & REFERENCE	DEVELOPMENT & PLANNING	OBJECTIVE FUNCTION, CONSTRAINTS & SELECTION CRITERIA	MATHEMATICAL PROGRAMMING & COMPUTER USED
1945	Stigler,G.J (Smith, 1959 & Baust, 1967)	Diet selection for moderate man 1 year. Six foods selected: wheat, flour, evaporated milk, cabbage, spinach dried mungbean.	Minimum cost 9 nutrients: cal prot, 2 minerals, 5 vitamins, 77 foods listed.	Linear programming with simplex method.
1949	Beckman, M. (Smith, 1963)	Diet selection for 45 year old man 4 foods selected lard, frozen orange juice, beef liver, soybean meal.	Minimum cost 9 nutrients: cal,prot, 2 minerals, 5 vitamins.	Linear programming.
1950	Brown, J.A.C. (Smith, 1963)	4 types of diets planned similar to actual diet of British working classes.	Fullfil nutritional requirements: cal, fat, calcium, thiamine and Vitamin A.	Descriptive models.
1958	Vajda, S. (Eckstein, 1973)	Diet model for British population, 8 foods selected: wheatmeal bread, cheese, roasted chicken, steamed fresh haddock, dried prune, walnut, bread & margarine.	Minimum cost 3 nutrients: prot, fat and CHO.	Linear programming.

Appendix 4: Contd

1958	Frankovic, V. Rismal, A. Kozak, V. (Hocevae, 1959)	One day diet planning of Slovenia family.	Minimum cost satisfied qualitative and quantitative physiological requirement.	Linear programming.
1959	Smith, V.C. (Smith, 1959 & 1963)	Diet planning by computer, 3 models: The Midget Model: 4 foods selected. The Small Model: 10 foods selected with cooking aid The Large Model: 57 foods selected with cooking aid.	Minium cost 12 nutrients: cal prot, fat, CHO 3 minerals, 5 vitamins, 73,83 and 572 food lists with minimum limit quantity of common food and maximum quantity of cheap food and including cooking aid, eg. baking powder.	Linear programming. Simplex method.
1961	Smith, P.E. (Smith, 1961)	Diet selection 4 foods selected haddock, lettuce, cooked turnip top and wheat germ.	Minimized calories.	Linear programming.
1964	Balintfy, J.L. (Balintfy, 1964)	Menu planning by computer. Non selective menu planning for a cycle of one day or one meal for a entire menu cycle.	Minimum cost 9 nutrients: cal prot, 2 mineral and 5 vitamins. Selection of one menu item of accepted recipes from each of menu components in a menu structure. Each menu item was in fixed portion size.	Zero-one integer programming algorithm used Fortran program for IBM 1410 30 sec. computation time for a daily menu.

Appendix 4: Contd

1966	Glue, R.L. Liggett, J.C. (Glue and Liggett, 1966)	Menu planning by computer, selective menu planning, daily menu for a cycle of 14 days - Multistage menu planning.	Minimum cost 9 nutrients: cal prot, 2 minerals, 5 vitamins. A choice of menu items selection probability was included in the model.	A stochastic zero-one programming for IBM 709 40 sec. computation time for a daily menu.
1966	Brown, R.M. (Eckstein, 1973)	Automated menu planning for individual non selective lunch and dinner menus	Factors included in model were texture, flavour, colour, shape and method of preparation.	Random selection-technique.
1967	Eckstein, E.F. (Eckstein, 1967 & 1973)	Menu planning by random approach planning selective dinner.	Selection criteria including cost, colour, texture shape, calorie, variety and acceptability.	Random approach computer programming 99 dinners in 1 1/2 min.
1969	Eckstein, E.F. (Eckstein, 1973)	Menu planning by random approach refinement of 1967 model planning breakfast and lunch menu for 21 days.	9 nutrients: cal, prot, fat, CHO, 2 minerals, five vitamins.	Random approach computer programme.
1969	Balintfy J.L. Blackburn C.R. (Balintfy 1975; Balintfy and Blackburn, 1969)	Menu planning by computer to non selective menu refinement of Multiple choice programming in Multi-stage menu planning.	Same as Balintfy (1964). A set of structural constraints added to become multi-choice constraints.	Zero-one integer programming using technique of truncated block pivoting.

Appendix 4: Contd

1969	Balintfy, J.L. (Balintfy, 1975)	System/360 Computer Assisted Menu Planning (CAMP) -a computerized food services information processing and menu planning programme package.	Minimum cost 10-20 nutrient constraints, 600-800 variables, 10-24 menu course per day.	Zero one interger programming solving by an additional block pivoting algorithm on IBM computer S/360 CAMP system.
1969	Glue, R.L. (Glue, 1969)	Reformulation of menu planning.	Addition to Glue & Liggett (1966) model constraints of colour, texture, variety, and other sensory attributes.	Chance constrained zero-one programming problem.
1970	Langier, J.D. (Eckstein, 1973)	Developing solution for use in Guatemala and less developed countries. Selection of common and acceptable foods to be added to improve nutritional status.	Minimum cost	Linear programming.
1970	Balintfy, J.L. (Balintfy, 1976)	Menu planning by computer-single stage menu planning of non selective menu planning length of menu cycle and only the frequency of the menu items and not their sequence in the meals is planned.	Minimum cost. Frequency of menu items serving in upper bound constraints. 800 variables. 100 constraints.	Linear programming with bounded variables.

Appendix 4: Contd

1970	Balintfy, J.L. Neter, J. Wasserman, W. (Balintfy et al, 1970)	Linear programming food price index based on the single stage menu planning and permits possibility of routine substitution in response to price change.	Minimized cost 5 nutrients:cal prot, iron, thiamine and niacin. 385 menu items serving frequency constraints planning for 31 day period.	Linear programming with bounded variables.
1971	Pinto, G.F. (Pinto, 1971)	Optimization of protein rich food mixtures.	Minimum cost adequate crude protein value & best amino acid pattern.	Linear programming.
1971	Patrick, G.F. Simoes MHR (Patrick & Simoes, 1971)	Diet selection for weekly food consumption of Cristalina family in Brazil.	Minimum cost. nutritionally adequate.	Linear programming.
1974	Armstrong, D.R. Sinha, P. (Armstrong & Sinha, 1974)	Menu planning by computer non-selective menu planning with variable portion size.	Minimum cost 10 nutrients: cal, prot, fat, 2 minerals, 5 vitamins. variation of portion size within specific limits.	Quasi-integer multiple-choice programming. run on CDC 3600
1974	Edwardson W. (Edwardson, 1974 & Edwardson et al 1980)	Raw material selection for nutritional food product formulation to supply 26 nutrients daily requirement at lowest cost for the Philippines average man.	Minimum cost 26 nutrients: cal prot, fat, fibre, 3 minerals, 9 vitamins, 10 amino acids. Quantitative constraints on nutrients relationship and amino acid pattern 170 lists of food raw materials for selection.	Linear programming on IBM LPS/1130

Appendix 4: Contd

1974	Balintfy, J.L. Duffy, W.J. Sinha, P. (Balintfy, et al. 1974)	Modeling food preferences over time:the measurement of preference for a menu item and the time history of its previous consumption.	Maxmized the total preference over a given time schedule. the estimation of preference time function obtained from questionnaires interviewing.	Finding the mathematical representation of preference time function is feasible.
1974	Sinha, P. (Balintfy, 1976, 1979 and Sinha, 1978)	Preference Maximising Models for Menu Planning and a prototype menu planning by computer.	Preference maximisation with cost, nutrients, menu structure, and service frequency constraints of a single stage, non-selective menu planning.	Non-linear programming and integer programming problem.
1974	Kansra, A.C. Srinivasan, N. Copaldas, T (Kansra et al. 1974)	Formulation of multimix supplement for preschool children in India.	Minimum cost calorie constraints. Four food raw materials.	Linear programming.
1974	Smith, V.E. (Smith, 1974)	Diet selection for 27 geographic areas in Nigeria. Protein quality was considered.	Minimum cost 9 nutrients: cal, prot, two minerals, 5 vitamins, 6 amino acids. Adding a non-linear constraint of protein variable to the model. 462 activities, 541 rows.	Linear programming using Control Data Corporation OPTIMA routine and CDC 3600 computer with computation time of 17 minutes.

Appendix 4: contd

1975	Anderson, A.M. (Anderson, 1975 Edwardson et al. 1980)	Raw material selection for nutritional food product formulation for Thai man aged 20-29 years.	Minimum cost 26 nutrients. As Edwardson(1974) with the addition of acceptability function obtained from information analysed by multidimensional scaling. 151 food raw materials for selection.	Linear programming and goal programming to minimise deviation of the nutrients.
1976	Balintfy, J.L. (Balintfy, 1976)	Multistage menu planning with chance constraints.	Minimum cost nutrients constraints to be considered as random variables.	Zero one integer programming and solved with either separate or joint chance constraints with a block pivoting algorithm.
1976	Harper, J.M. Jansen, G.R. Shigetomi, C.T. Freg, A.L. (Harper et al. 1976)	Planning weekly menu for the elderly.	10 nutrients: cal, prot, 3 minerals, 5 vitamins. Calculation of nutritional value using AOA menu monitor method from 1100 raw materials.	A Nutrient Standard Menu (NSM) planning method.
1976	Carmel, J. (Carmel, 1976)	Formulation of baby food of mixture of banana, milk powder and oil.	Minimum cost 3 food raw materials with limiting range of quantity. Adaption of equation to express NDp Cal%.	Linear programming on IBM 370.

Appendix 4: Contd

1977	Chittaporn, P. (Chittaporn, 1977)	Selection of raw materials for baby food formulations for Thailand.	Minimum cost 43 nutrients: cal, prot, fat, fibre, sugar, linoleic acid, CHO, 11 minerals, 14 vitamins, 11 amino acids with the nutritional loss during processing, colour and sweetness constraints.	Linear programming on IBM 1130.
1977	Moskowitz, H.R. Klarman, L. (Moskowitz and Klarman, 1977)	3 step approach evaluating compatibilities for menu planning.		Computer programmes for multidimensional scale, regression and cluster analysis.
1978	Unklesbay, N. Unklesbay, K. (Unklesbay and Unklesbay, 1978)	Menu planning for elderly in USA by automated menu planning system.	17 nutrients: cal, prot, 6 minerals, 9 vitamins. 608 menu items.	Heuristic algorithm.
1979	Balintfy, J.L. (Balintfy, 1972)	Menu planning with the Cost of Decent Subsistence (CDS)- planning a menu at minimum budget level where a nutritionally adequate diet is still not an unpleasant experience.	Maximised budget and optimised food purchases in income maintenance programme (where prices change).	Quadratic programming algorithm.

1981	Foytik, J	Very low cost nutritious diet. Plans designed by Linear Programming	Minimum cost 12 nutritents: cal, prot, 3 minerals, 7 vitamins	Linear Programming
1983	Ngarmsak, T	A system of meal planning for self improvement of the diet of villagers in Northeastern Thailand	Low cost and nutritionally balanced 7-day menu for a family unit	Mixed Integer Programming
1984	Makuna, K	Nutritionally adequate low-cost diets for the urban population of Kinshasa Zaire	Low cost and nutritionally adequate daily diet. Locally available foods	Linear Programming

NO LATER DEVELOPMENT IN DIET PLANNING HAS BEEN FOUND

APPENDIX 5. LIST OF FOODS USED IN SELECTING RATION PACKS.

CODE NO.	WEIGHT.	NAME.
1268	454.0000	CHICKEN CASSEROLE WITH VEGETABLES
427	454.0000	BEEF STEW
428	454.0000	BOLOGNESE SAUCE
429	454.0000	CURRIED MEAT
430	454.0000	HOT POT
1250	454.0000	CHILI CON CARNE
1251	454.0000	LASAGNA
1260	454.0000	PORK, LEAN STEWED WITH VEGETABLES
1261	454.0000	PORK, LEAN AND FAT, STEWED WITH VEGETABLES
1255	454.0000	MINCED BEEF, LEAN, STEWED WITH VEGETABLES
1258	454.0000	MINCED BEEF, LEAN AND FAT, STEWED WITH VEGETABLES
1264	454.0000	STEAK AND KIDNEY, STEWED WITH ONION
1266	454.0000	STEWING STEAK, STEWED WITH ONION
397	454.0000	STEWED STEAK WITH GRAVY CANNED
650	100.0000	POTATOES INSTANT POWDER
	55.0000	INSTANT RICE
2036	100.0000	PARBOILED RICE
2027	100.0000	INSTANT NOODLES
1268	300.0000	CHICKEN CASSEROLE WITH VEGETABLES
427	300.0000	BEEF STEW
428	300.0000	BOLOGNESE SAUCE
429	300.0000	CURRIED MEAT
430	300.0000	HOT POT
1250	300.0000	CHILI CON CARNE
1251	300.0000	LASAGNA

1260	300.0000	PORK, LEAN STEWED WITH VEGETABLES
1261	300.0000	PORK, LEAN AND FAT, STEWED WITH VEGETABLES
1255	300.0000	MINCED BEEF, LEAN, STEWED WITH VEGETABLES
1258	300.0000	MINCED BEEF, LEAN AND FAT, STEWED WITH VEGETABLES
1264	300.0000	STEAK AND KIDNEY, STEWED WITH ONION
1266	300.0000	STEWING STEAK, STEWED WITH ONION
397	300.0000	STEWED STEAK WITH GRAVY CANNED
508	185.0000	TUNA CANNED IN OIL
498	220.0000	SALMON CANNED
500	125.0000	SARDINES CANNED IN OIL FISH ONLY
502	125.0000	SARDINES CANNED IN TOMATO SAUCE
784	310.0000	PEACHES CANNED
790	310.0000	PEARS CANNED
792	340.0000	PINEAPPLE CANNED
28	300.0000	SPAGHETTI CANNED IN TOMATO SAUCE
28	258.0000	SPAGHETTI CANNED IN TOMATO SAUCE] Included together
409	42.0000	SAUSAGES BEEF FRIED]
569	300.0000	BEANS BAKED CANNED IN TOMATO SAUCE
569	258.0000	BEANS BAKED CANNED IN TOMATO SAUCE] Included together
409	42.0000	SAUSAGES BEEF FRIED]
393	340.0000	BEEF CORNED CANNED
58	100.0000	BISCUITS CHOCOLATE - FULL COATED
60	100.0000	BISCUITS - CRISPBREAD RYE
62	100.0000	BISCUITS DIGESTIVE PLAIN
64	100.0000	BISCUITS GINGER NUTS
66	100.0000	BISCUITS MATZO
67	100.0000	BISCUITS OATCAKES

69	100.0000	BISCUITS SEMI-SWEET
70	100.0000	BISCUITS SHORT-SWEET
71	100.0000	BISCUITS SHORTBREAD
	100.0000	FOODBAR - MUESLI
1394	100.0000	BISCUITS - SULTANA
159	100.0000	PROCESSED CHEESE
861	60.0000	CHOCOLATE MARS BAR
857	55.0000	CHOCOLATE MILK
858	55.0000	CHOCOLATE PLAIN
688	100.0000	APRICOTS DRIED RAW
809	100.0000	RAISINS DRIED
819	100.0000	SULTANAS DRIED
837	100.0000	PEANUTS ROASTED
856	100.0000	BOILED SWEETS
872	5.0000	COFFEE INSTANT
876	5.0000	TEA INDIAN
1039	5.0000	MILO
132	55.0000	MILK CONDENSED WHOLE SWEETENED
1305	100.0000	RISE AND SHINE - BLACKCURRANT (POWDER)
1306	100.0000	RISE AND SHINE - ORANGE, GRAPEFRUIT, PINEAPPLE (POWDER)
1307	100.0000	RISE AND SHINE LEMON (POWDER)
941	25.0000	CHICKEN NOODLE SOUP DRIED
953	25.0000	TOMATO SOUP DRIED
944	25.0000	MINESTRONE SOUP DRIED
948	25.0000	OXTAIL SOUP
SOUP1	25.0000	CREAM OF VEGETABLE SOUP

SOUP2	25.0000	BEEF NOODLE SOUP
SOUP3	25.0000	ONION SOUP
SOUP4	25.0000	MUSHROOM SOUP
SOUP5	25.0000	CHICKEN AND VEGETABLE SOUP
SOUP6	25.0000	CHICKEN AND RICE SOUP
SOUP8	25.0000	CREAM OF CHICKEN SOUP
SOUP9	25.0000	ASPARAGUS SOUP
SOUP10	25.0000	PEA AND HAM SOUP
958	3.5000	CURRY POWDER
2028	100.0000	POTATO AND ONION POWDER
626	100.0000	PEAS DRIED RAW
966	14.0000	SALT TABLE
843	84.0000	SUGAR WHITE
848	55.0000	HONEY IN JARS
849	55.0000	JAM FRUIT WITH EDIBLE SEEDS
	5.0000	ONION POWDER
	1.0000	CHILI POWDER

Food Technology Research Centre

Combat Ration Pack Field Trial Survey

February 1986

Questionnaire Number 1A - Foods not taken on Exercise.

Introduction

In this questionnaire we would like you to first answer some questions about yourself. Secondly, we would like you to record the type and quantity of food that you have not taken on this exercise. (All information will be kept strictly confidential).

We would appreciate you help by carefully filling out this survey form. Your opinions and comments will be important for the development work of new ration packs. Feel free to make comments where there are points you would like to make.

Please place the completed questionnaire in the plastic bag with the foods left behind.

Thank you for your co-operation.

Bing D. Soo

Appendix 6a: Contd

For Office Use

1 ☐☐☐ 6 ☐☐ ☐☐ 10 ☐☐ 14 ☐☐

Name:

Rank:

Age:

Height:

Weight:

Platoon:

Months in Army:

1. Foods and beverages left behind

Please indicate the number of food and beverage items that you have left behind, and the reasons for leaving them behind by circling a number or letter.

Example only

	Quantity left behind			Main Reason					
				Don't like	Too heavy	Too bulky	Too much	Not necessary	Other (specify)
Baked Beans (can)	1	(2)	3 4	(D)	H	B	M	N	_____

In this example, it has been indicated that 2 cans of baked beans were left behind because they were not liked.

Food/beverage	Quantity left behind	Main Reason						For Office Use
		Don't like	Too heavy	Too bulky	Too much	Not necessary	Other (specify)	
Meatballs in T/S	1 2	D	H	B	M	N		17
Savory Mince	1 2	D	H	B	M	N		
Vege & Beef Casserole	1 2	D	H	B	M	N		
Ravioli	1 2	D	H	B	M	N		23

Food/beverage	Quantity left behind	Main Reason: Don't like	Too heavy	Too bulky	Too much	Not necessary	Other (specify)	For Office Use
Sardines	1 2 3 4	D	H	B	M	N		25
Chicken Pieces	1 2	D	H	B	M	N		
[illegible] PEARS	1 2	D	H	B	M	N		
Fruit Salad	1 2	D	H	B	M	N		31
Instant Noodles	1 2	D	H	B	M	N		33
Rice - Risone	1 2	D	H	B	M	N		
Rice - Freeze Dried	1 2	D	H	B	M	N		
Quick Cooking Macaroni	1 2	D	H	B	M	N		39
Biscuits - Fruit	1 2 3 4	D	H	B	M	N		41
Biscuits - High Fibre	1 2 3 4	D	H	B	M	N		
Biscuits - Cabin Bread	1 2 3 4	D	H	B	M	N		
Muesli Food Bar	1 2 3 4	D	H	B	M	N		47
Chocolate - Moro	1 2	D	H	B	M	N		49
Chocolate - Rich & Dark	1 2	D	H	B	M	N		
Chocolate - Peanut Extra	1 2	D	H	B	M	N		
Chocolate - Full Creme	1 2	D	H	B	M	N		55
Sultanas	1 2 3 4 5 6 7	D	H	B	M	N		57
	8 9 10 11 12	D	H	B	M	N		
Roasted Nuts	1 2 3 4 5 6 7 8	D	H	B	M	N		
Chewing Gum	1 2	D	H	B	M	N		
Lifesavers - peppermint	1 2	D	H	B	M	N		
Lifesavers - five fruits	1 2	D	H	B	M	N		
Life Savers - mixed berry	1 2	D	H	B	M	N		68

Food/beverage	Quantity left behind	Main Reason						For Office Use	
		Don't like	Too heavy	Too bulky	Too much	Not necessary	Other (specify)		
Coffee	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	D	H	B	M	N			70
Tea (pack of 2 bags)	1 2 3 4 5 6 7 8	D	H	B	M	N			1*
Milo	1 2 3 4	D	H	B	M	N			
Soup - Mushroom	1 2	D	H	B	M	N			
Soup - Chicken Noodle	1 2	D	H	B	M	N			
Condensed Milk - Sweetened	1 2 3 4 5 6 7 8	D	H	B	M	N			
Fruit Drink - Lime	1 2 3 4	D	H	B	M	N			
Fruit Drink - Lemon	1 2 3 4	D	H	B	M	N			13
Salt	1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16	D	H	B	M	N			15
Sugar	1 2 3 4 5 6 7 8	D	H	B	M	N			
Honey	1 2 3 4	D	H	B	M	N			
Jam - Apricot	1 2	D	H	B	M	N			
Jam - B/currant	1 2	D	H	B	M	N			
Butter Spread	1 2 3 4	D	H	B	M	N			26
Curry	1 2 3 4 5 6 7 8	D	H	B	M	N			28
Pepper	1 2	D	H	B	M	N			
Onion Flakes	1 2	D	H	B	M	N			
Chilli Powder	1 2	D	H	B	M	N			
Tomato Sauce	1 2	D	H	B	M	N			
Dried Peas	1 2 3 4	D	H	B	M	N			38
Steel Cleaning Cloth	1 2 3 4 5 6 7 8	D	H	B	M	N			40
Toilet Paper	1 2 3 4 5 6 7 8	D	H	B	M	N			
Matches	1 2 3 4 5 6 7 8	D	H	B	M	N			44

Appendix 3b: Consumer Questionnaire Used in Preliminary Test

FOOD TECHNOLOGY RESEARCH CENTRE

COMBAT RATION PACK FIELD TRIAL SURVEY

FEBRUARY 1986

QUESTIONNAIRE NUMBER 2A - DIARY OF FOOD EATEN EACH DAY.

This questionnaire asks questions concerning the foods and beverages that you have consumed this day only. We ask that you would help us by carefully answering all the questions. You are free to make any comments that you think maybe helpful. It should not take you more than 10-15minutes of your time to complete it. ALL ANSWERS WILL BE KEPT STRICTLY CONFIDENTIAL.

FOR OFFICE USE

1. NAME:_____ 1 ☐☐☐

2. Date:_____ 4 ☐☐

3. HOW MUCH DID YOU LIKE EATING/DRINKING EACH TYPE OF FOOD OR BEVERAGE?

Please indicate the number of items consumed, and whether you consumed them hot or cold.
Also circle one number in each row on how you liked the particular food/beverage item.

EXAMPLE ONLY

FOOD/BEVERAGE	QUANTITY CONSUMED	HOW EATEN	HOW LIKED						
			TERRIBLE	DISLIKE VERY MUCH	DISLIKE MODER-ATELY	NEITHER LIKE NOR DISLIKE	LIKE MODER-ATELY	LIKE VERY MUCH	EXCELLENT
		HOT COLD							
Baked Beans(can)	(1) 2 3 4	(H) C	1	2	3	4	(5)	6	7

In this example, one can of baked beans was consumed hot during the day. The food was moderately liked.

FOOD/BEVERAGE	QUANTITY CONSUMED	HOW EATEN	HOW LIKED							
			TERRIBLE	DISLIKE VERY MUCH	DISLIKE MODER-ATELY	NEITHER LIKE NOR DISLIKE	LIKE MODER-ATELY	LIKE VERY MUCH	EXCELLENT	
		HOT COLD								
Meatballs in t/s	1 2	H C	1	2	3	4	5	6	7	6 ☐☐☐
Savoury mince	1 2	H C	1	2	3	4	5	6	7	☐☐☐
Vege & Beef Cass.	1 2	H C	1	2	3	4	5	6	7	☐☐☐
Ravioli	1 2	H C	1	2	3	4	5	6	7	15 ☐☐☐
Sardines	1 2 3 4	H C	1	2	3	4	5	6	7	18 ☐☐☐
Chicken pieces	1 2	H C	1	2	3	4	5	6	7	☐☐☐
Canned pears	1 2	H C	1	2	3	4	5	6	7	☐☐☐
Canned Fruit salad	1 2	H C	1	2	3	4	5	6	7	27 ☐☐☐

Appendix 6b: Contd

FOOD/BEVERAGE	QUANTITY CONSUMED	HOW LIKED						FOR OFFICE USE
		TERRIBLE	DISLIKE VERY MUCH	DISLIKE MODER-ATELY	NEITHER LIKE NOR DISLIKE	LIKE MODER-ATELY	LIKE VERY MUCH	EXCELLENT	
Instant Noodles	1 2	1	2	3	4	5	6	7	30
Rice - Risone	1 2	1	2	3	4	5	6	7	
Rice - F/dried	1 2	1	2	3	4	5	6	7	
Macaroni	1 2	1	2	3	4	5	6	7	36
Biscuits - Fruit	1 2 3 4	1	2	3	4	5	6	7	38
Biscuits - Fibre	1 2 3 4	1	2	3	4	5	6	7	
Biscuits - Cabin	1 2 3 4	1	2	3	4	5	6	7	
Muesli Foodbar	1 2 3 4	1	2	3	4	5	6	7	44
Choc. - Moro	1 2	1	2	3	4	5	6	7	45
Choc. - Rich&dark	1 2	1	2	3	4	5	6	7	
Choc. - Peanut	1 2	1	2	3	4	5	6	7	
Choc. - F/creme	1 2	1	2	3	4	5	6	7	
Sultanas	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	
Peanuts	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	
Chewing gum	1 2	1	2	3	4	5	6	7	58
Lifesavers									
- peppermints	1 2	1	2	3	4	5	6	7	60
- five fruits	1 2	1	2	3	4	5	6	7	
- mixed berry	1 2	1	2	3	4	5	6	7	64
Coffee	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	65
Tea	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	
Milo	1 2 3 4	1	2	3	4	5	6	7	
Soup - Mushroom	1 2	1	2	3	4	5	6	7	
Soup - C/noodle	1 2	1	2	3	4	5	6	7	72
Condensed milk	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	1*
Lime Drink	1 2 3 4	1	2	3	4	5	6	7	
Lemon Drink	1 2 3 4	1	2	3	4	5	6	7	
Salt	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	7
Sugar	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	9
Honey	1 2 3 4	1	2	3	4	5	6	7	
Jam - Apricot	1 2	1	2	3	4	5	6	7	
Jam - Apricot	1 2	1	2	3	4	5	6	7	
Butter spread	1 2 3 4	1	2	3	4	5	6	7	19
Curry	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	21
Pepper	1 2	1	2	3	4	5	6	7	
Onion flakes	1 2	1	2	3	4	5	6	7	
Dried peas	1 2 3 4	1	2	3	4	5	6	7	
Chilli powder	1 2	1	2	3	4	5	6	7	
Tomato sauce	1 2	1	2	3	4	5	6	7	
Steel cloth	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	
Toilet paper	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	
Matches	1 2 3 4 5 6 7 8	1	2	3	4	5	6	7	37

Appendix 6b: Contd

4. HOW DID YOU FIND THE SIZES OF THE FOOD AND BEVERAGE ITEMS?

FOOD/BEVERAGE	SIZE ACCEPTANCE					FOR OFFICE USE
	MUCH TOO SMALL	SLIGHTLY TOO SMALL	JUST RIGHT	SLIGHTLY TOO BIG	MUCH TOO BIG	
Meatballs in t/s	1	2	3	4	5	39
Savoury mince	1	2	3	4	5	
Vege & Beef Cass.	1	2	3	4	5	
Ravioli	1	2	3	4	5	42
Sardines	1	2	3	4	5	43
Chicken pieces	1	2	3	4	5	
Canned pears	1	2	3	4	5	
Canned Fruit salad	1	2	3	4	5	
Instant Noodles	1	2	3	4	5	47
Rice - Risone	1	2	3	4	5	48
Rice - F/dried	1	2	3	4	5	
Macaroni	1	2	3	4	5	50
Biscuits - Fruit	1	2	3	4	5	51
Biscuits - Fibre	1	2	3	4	5	
Biscuits - Cabin	1	2	3	4	5	
Muesli Foodbar	1	2	3	4	5	54
Choc. - Moro	1	2	3	4	5	55
Choc. - Rich&dark	1	2	3	4	5	
Choc. - Peanut	1	2	3	4	5	
Choc. - F/creme	1	2	3	4	5	
Sultanas	1	2	3	4	5	
Peanuts	1	2	3	4	5	
Chewing gum	1	2	3	4	5	61
Lifesavers						
- peppermints	1	2	3	4	5	62
- five fruits	1	2	3	4	5	
- mixed berry	1	2	3	4	5	64
Coffee	1	2	3	4	5	65
Tea	1	2	3	4	5	
Milo	1	2	3	4	5	
Soup - Mushroom	1	2	3	4	5	
Soup - C/noodle	1	2	3	4	5	
Condensed milk	1	2	3	4	5	
Lime Drink	1	2	3	4	5	
Lemon Drink	1	2	3	4	5	72
Salt	1	2	3	4	5	73
Sugar	1	2	3	4	5	1*
Honey	1	2	3	4	5	
Jam - Apricot	1	2	3	4	5	
Jam - B/currant	1	2	3	4	5	
Butter spread	1	2	3	4	5	5

Appendix 6b: Contd

FOOD/BEVERAGE	SIZE ACCEPTABILITY					FOR OFFICE USE
	MUCH TOO SMALL	SLIGHTLY TOO SMALL	JUST RIGHT	SLIGHTLY TOO BIG	MUCH TOO BIG	
Curry	1	2	3	4	5	3
Pepper	1	2	3	4	5	
Onion flakes	1	2	3	4	5	
Dried peas	1	2	3	4	5	
Chilli powder	1	2	3	4	5	
Tomato sauce	1	2	3	4	5	
Steel cloth	1	2	3	4	5	
Toilet paper	1	2	3	4	5	
Matches	1	2	3	4	5	14

5. WHAT TIME WAS REQUIRED TO PREPARE FOOD AND HOW CONVENIENT WAS IT TO PREPARE?

FOOD/BEVERAGE	APPROXIMATE TIME FOR PREPARATION (MINUTES).	HOW CONVENIENT TO PREPARE					
		VERY CONVEN IENT	MODER ATELY CONVEN IENT	JUST RIGHT	MODER ATELY INCON VENIENT	VERY INCON VENIENT	
Meatballs in t/s	5 10 15 20 20+	1	2	3	4	5	15
Savoury mince	5 10 15 20 20+	1	2	3	4	5	
Vege & Beef Cass.	5 10 15 20 20+	1	2	3	4	5	
Ravioli	5 10 15 20 20+	1	2	3	4	5	21
Sardines	5 10 15 20 20+	1	2	3	4	5	23
Chicken pieces	5 10 15 20 20+	1	2	3	4	5	
Canned pears	5 10 15 20 20+	1	2	3	4	5	
Canned Fruit salad	5 10 15 20 20+	1	2	3	4	5	29
Instant Noodles	5 10 15 20 20+	1	2	3	4	5	31
Rice - Risone	5 10 15 20 20+	1	2	3	4	5	
Rice - F/dried	5 10 15 20 20+	1	2	3	4	5	
Macaroni	5 10 15 20 20+	1	2	3	4	5	37
Coffee	5 10 15 20 20+	1	2	3	4	5	39
Tea	5 10 15 20 20+	1	2	3	4	5	
Milo	5 10 15 20 20+	1	2	3	4	5	
Soup - Mushroom	5 10 15 20 20+	1	2	3	4	5	
Soup - C/noodle	5 10 15 20 20+	1	2	3	4	5	
Lime Drink	5 10 15 20 20+	1	2	3	4	5	
Lemon Drink	5 10 15 20 20+	1	2	3	4	5	51

Comment on any other problems encountered in food preparation.

Appendix 6b: Contd

FOR OFFICE USE

6. HOW MUCH WATER DID YOU USE TODAY?

							Other, please specify
NUMBER OF CANTEENS (circle one number)	1	2	3	4	5	6	----------

53 ☐

7. HOW DIFFICULT WAS IT TO OBTAIN WATER?

NO WATER AVAILABLE	NOT QUITE ENOUGH WATER	ENOUGH WATER	PLENTY OF WATER
1	2	3	4

54 ☐

8. WHAT WAS YOUR MAIN SOURCE OF WATER SUPPLY. CIRCLE ONLY ONE NUMBER.

CREEKS	1
RIVERS	2
SUPPLIED BY ARMY	3
RAIN	4
OTHER, PLEASE SPECIFY	

55 ☐

9. OTHER COMMENTS YOU WOULD LIKE TO MAKE?

THANKYOU

APPENDIX 6c: CONSUMER QUESTIONNAIRE USED IN PRELIMINARY TEST

FOOD TECHNOLOGY RESEARCH CENTRE

COMBAT RATION PACK FIELD TRIAL SURVEY

1986

QUESTIONNAIRE 3A - OVERALL LIKING OF THE NEW RATION PACKS.

Your overall opinion of the ration pack wil be helpful for its improvement in the future. Feel free to make any comments.
ALL ANSWERS WILL BE KEPT STRICTLY CONFIDENTIAL

Circle the numbers and comment where required.

1. NAME:_____

2. Were there enough Main meals (that is the cans) for the period of the exercise.

NO	YES	TOO MANY
1	2	3

If too many, which meals would you leave out?

3. Were there enough snacks for the period of the exercise (biscuits, sweets, chocolate).

NO	YES	TOO MANY
1	2	3

If too many, which would you reduce in size or leave out?

4. Overall, was there enough food for the period of the exercise.

NO	YES	TOO MUCH
1	2	3

If too much, what foods would you reduce in size or leave out?

APPENDIX 6c: continued.

5. Were there enough drinks for the period of the exercise (i.e. coffee, tea, soup)

NO	YES	TOO MANY
1	2	3

If too many, what would you reduce in size or leave out?

6. Overall was there enough water available to make-up the beverages for the period of the exercise.

PLENTY	JUST ENOUGH	SLIGHTLY TOO LITTLE	FAR TOO LITTLE
1	2	3	4

7. Were there enough spices for the period of the exercise.

NO	YES	TOO MANY
1	2	3

If not, write down the spices you would like more of or other types you would like.

8. Were the non-food items adequate (e.g cleaning cloth, toilet paper, matches, can opener).

NO	YES
1	2

If not, what was not adequate.

9. Overall, how would you rate this pack.

TERRIBLE	VERY MUCH DISLIKE	MODERATELY DISLIKE	NEITHER LIKE NOR DISLIKE	MODERATELY LIKE	VERY MUCH LIKE	EXCELLENT
1	2	3	4	5	6	7

10. Write down any additional comments you would like to make.

Food Technology Research Centre

Combat Ration Pack Field Trial Survey

February 1986

Questionnaire Number 4A - Foods left over from Field Exercise.

Introduction

In this questionnaire we would like you to record the quantity and the type of food or beverage that you have left over from your field exercise. Record only whole quantities and disregard foods partially consumed.

All information will be kept strictly confidential.

Please place the completed questionnaire in the plastic bag with the foods left over.

Thank you for your co-operation.

Bing D. Soo

1. Foods and beverages left over

Please indicate the number of food and beverage items that you have left over by circling the appropriate number for each of the food and beverages listed. Also indicate why you did not consume the food or beverage

Example only

	Quantity left over				Main Reason		
					Didn't like	Too much	Other (specify)
Baked Beans (can)	(1)	2	3	4	D	(M)	_____

In this example, one can baked beans was left over because there was too much other food.

Name: _____

For Office Use

1 ☐☐☐

Food/beverage	Quantity left over	Main Reason: Didn't like	Main Reason: Too much	Main Reason: Other (specify)	For Office Use
Meatballs in T/S	1 2	D	M	___	4
Savory Mince	1 2	D	M	___	
Vege & Beef Casserole	1 2	D	M	___	
Ravioli	1 2	D	M	___	10
Sardines	1 2 3 4	D	M	___	12
Chicken Pieces	1 2	D	M	___	
[illegible] PEARS	1 2	D	M	___	
Fruit Salad	1 2	D	M	___	18
Instant Noodles	1 2	D	M	___	20
Rice - Risone	1 2	D	M	___	
Rice - Freeze Dried	1 2	D	M	___	
Quick Cooking Macaroni	1 2	D	M	___	26
Biscuits - Fruit	1 2 3 4	D	M	___	28
Biscuits - High Fibre	1 2 3 4	D	M	___	
Biscuits - Cabin Bread	1 2 3 4	D	M	___	
Muesli Foodbar	1 2 3 4	D	M	___	34
Chocolate - Moro	1 2	D	M	___	36
Chocolate - Rich & Dark	1 2	D	M	___	
Chocolate - Peanut Extra	1 2	D	M	___	
Chocolate - Full cream	1 2	D	M	___	42
Sultanas	1 2 3 4 5 6 7	D	M	___	44
	8 9 10 11 12	D	M	___	
Roasted Nuts	1 2 3 4 5 6 7 8	D	M	___	47
Chewing Gum	1 2	D	M	___	
Lifesavers - peppermint	1 2	D	M	___	
Lifesavers - five fruits	1 2	D	M	___	
Lifesavers - Mixed berry	1 2	D	M	___	55

Food/beverage	Quantity left over	Main Reason: Don't like	Main Reason: Too much	Main Reason: Other (specify)	For Office Use
Coffee	1 2 3 4 5 6 7 8 9 10	D	M	___	57
	11 12 13 14 15 16	D	M	___	
Tea (pack of 2 bags)	1 2 3 4 5 6 7 8	D	M	___	60
Milo	1 2 3 4	D	M	___	
Soup - Mushroom	1 2	D	M	___	
Soup - Chicken Noodle	1 2	D	M	___	
Condensed Milk - Sweetened	1 2 3 4 5 6 7 8	D	M	___	
Fruit Drink - Lime	1 2 3 4	D	M	___	
Fruit Drink - Lemon	1 2 3 4	D	M	___	72
Salt	1 2 3 4 5 6 7 8 9 10	D	M	___	1*
	11 12 13 14 15 16	D	M	___	
Sugar	1 2 3 4 5 6 7 8	D	M	___	4
Honey	1 2 3 4	D	M	___	
Jam - Apricot	1 2	D	M	___	
Jam - B/currant	1 2	D	M	___	
Butter Spread	1 2 3 4	D	M	___	12
Curry	1 2 3 4 5 6 7 8	D	M	___	14
Pepper	1 2	D	M	___	
Onion Flakes	1 2	D	M	___	
Chilli Powder	1 2	D	M	___	
Tomato Sauce	1 2	D	M	___	
Dried Peas	1 2 3 4	D	M	___	24
Steel Cleaning Cloth	1 2 3 4 5 6 7 8	D	M	___	26
Toilet Paper	1 2 3 4 5 6 7 8	D	M	___	
Matches	1 2 3 4 5 6 7 8	D	M	___	30

APPENDIX 6e: Consumer Questionnaire Used in Preliminary Test

FOOD TECHNOLOGY RESEARCH CENTRE

COMBAT RATION PACK FIELD TRIAL SURVEY FEBRUARY 1986

Questionnaire No. 5

Name: _____

Over the period of the field trial you have tasted two different ration packs - the existing ration pack and a new ration pack.

Please answer the following questions by ticking the boxes.

1. Which pack did you prefer?

☐ I preferred the old ration pack

☐ I preferred the new ration pack

☐ I liked both packs equally

☐ I did not like either pack

2. Overall how acceptable did you find the packs?

2a. Overall the old ration pack was

☐ extremely acceptable

☐ moderately acceptable

☐ slightly acceptable

☐ slightly unacceptable

☐ moderately unacceptable

☐ extremely unacceptable

Appendix 6e: Contd

2. Overall the new ration pack was

- ☐ extremely acceptable
- ☐ moderately acceptable
- ☐ slightly acceptable
- ☐ slightly unacceptable
- ☐ moderately unacceptable
- ☐ extremely unacceptable

Appendix 7a: Selection of a Commercially Available Muesli Bar

a7.1 Screening

In total, seven different muesli bars (with different flavours) were selected for consideration. Sequential screening was then carried out on the seven bars. The factors used for this were:

* the shelf life of the bar must be at least two years;
* the bar must be robust enough to withstand Army personnel treatment (evaluated subjectively);
* product cost must be less than 122 cents per 100 g, retail.

Table a7.1 shows the results of the sequential screening.

Table a7.1: Sequential Screening of Food Bars

Bar Name	Shelf Life	Solidity	Product Cost 122¢	Overall
Flemings Muesli Bar	F	P	P	F
Tasti Snak Log	P	P	P	P
Nutoata Bar	F	P	P	F
Mother Natures Muesli Slice	F	P	P	F
Real Foods Bar	P	P	P	P
Marthas Energy Bar	F	F	P	F
Canterbury Oaty Bar	F	F	F	F

P = Pass
F = Fail

Appendix 7a: Contd

Two bars passed the screening test. These were the Tasti Snak Log and the Real Foods bar. Most of the other bars did not have an adequate shelf life due to the ingredients susceptible to rancidity, e.g. coconut, oil, wheatgerm and sesame seeds.

a7.2 Consumer Test

Three bars were tested using ten army personnel from Linton Military Camp, Palmerston North, New Zealand as a taste panel. The three bars tested were:

Real Foods Apricot Bar	36 g
Real Foods Fig Bar	36 g
Tasti Foods Apricot Snak Log	40 g

a7.3 Panel Procedure

A questionnaire was filled out by the panelists during tasting. Appendix 7b is a copy of this, with summary results also listed. An informal focus group discussion was held after tasting. During the taste panel session, panelists were given water with which to cleanse their palates. All samples were identified with random three digit code numbers so as not to bias the results of the soldiers in any way.

a7.4 Results

The colour of all bars was judged as just right by the majority of the respondents. Respondents preferred the Real Foods Bars shape as they looked less like 'birdseed' bars and they looked like fruit biscuits. The Real Foods Bars also had a larger surface area available on which to spread honey. Some soldiers saw the Real Foods Bars as biscuits than as bars, due to the

Appendix 7a: Contd

shape and eating qualities of the bar.

The texture of the Tasti Bar was described as just right for hardness when the bar was bitten into and just right for chewiness. Although the Real Foods Bars contained the same outer biscuit coating, the texture of the bars was described very differently. The Apricot bar was just right for hardness but moderately too chewy. The fig bar was described as moderately too hard but just right for chewiness. It is important to the soldiers that the texture of a food bar is not too dry due to limited amount of water available.

The flavour of the bars showed a wide range of opinions. Averaging this, opinions showed that the flavour of the Real Foods Bars were liked more than the Tasti Bar. Some respondents felt that one or other of the bars should have a weaker or stronger flavour. For the Tasti bar, four respondents felt it should have a weaker flavour and three felt it should have a stronger flavour.

The Apricot and Fig Real Food Bars were liked more overall than the Tasti Bar. A preference was shown for the apricot flavouring although the fig flavouring was a close second. Overall, the Real Food Bars were liked moderately and the Tasti Bar was neither liked nor disliked.

APPENDIX 7D: FOOD BARS QUESTIONNAIRE AND RESULTS

MASSEY UNIVERSITY

FOOD TECHNOLOGY RESEARCH CENTRE

FOOD BARS

Today you will taste three food bars. The bars are intended to be part of the ration pack. Each bar will be identified by a number. Please taste the bars in the following order.

Apricot Real Foods 672 | Tasti Apricot 358 | Fig Real Foods 221

PLEASE LOOK AT AND TASTE EACH BAR AND ANSWER ALL OF THE QUESTIONS. RINSE YOUR MOUTH WITH WATER AND TASTE THE NEXT BAR.
PLEASE LOOK AT THE BAR AND FILL IN THE FOLLOWING QUESTIONS.

	672	358	221
Colour			
Too light	3	1	3
Just right	6	7	6
Too dark		1	

Appendix 7b: Contd

NOW TASTE THE BARS AND FILL IN THE FOLLOWING QUESTIONS:

Texture (when you first bite into the bar)

	672	358	221
Far too hard			
Moderately too hard	1	3	6
Just right	9	6	4
Moderately too soft		1	
Far too soft			

Chewiness (as you were chewing the bar)

Far too chewy	1	1	
Moderately too chewy	9	3	3
Just right		5	6
Moderately too soft		1	1
Far too soft			

For bars 672 and 221, would you like:

	672	221
More filling	3	3
The same amount of filling	5	6
Less filling	2	1

For bars 672 and 221, would you like:

	672	221
More biscuit		1
The same amount of biscuit	10	9
Less biscuit		

Appendix 7b: Contd

For bars 672 and 221, what flavour do you think the filling is:

672 Apricot 5 Date or Raisin 3 Mixed Fruit 1
221 Fig 4 Date 2 Raisin 3 Raisin & Date 1
Date or Raisin 1

Are there any other flavours you would like in a bar of this kind? Date
Plum, Peach, Raisin, Apricot

What do you think about the flavour?	672	358	221
Like extremely	1		1
Like moderately	3	4	3
Like slightly	3	1	3
Neither like or dislike	3	1	2
Dislike slightly		2	1
Dislike moderately		2	
Dislike extremely			

Do you think any of the bars should have a stronger flavour?

672 No 9 Yes 1
358 Yes 3 No 7
221 No 10 Yes

Do you think any of the bars should have a weaker flavour?

672 No 9 Yes 1
358 No 6 Yes 4
221 No 9 Yes 1

Appendix 7b: Contd

ONCE YOU HAVE TASTED ALL THREE BARS, PLEASE ANSWER THESE QUESTIONS.

Rank the bars, giving a 1 for the bar you like the most, a 2 for the bar you like second best and a 3 for the bar you like third best. Give each bar only one number. Do not give two bars the same number.

672 ____
358 ____
221 ____

Why did you give a 1 to that bar? _____

_____

_____

Overall, how do you rate these bars as an Army Ration Snack Bar?

	672	358	221
Excellent			
Like very much	3	2	4
Like moderately	5	4	4
Neither like or dislike	2	1	1
Dislike moderately		1	1
Dislike very much		2	
Terrible			

Thank you. Once everyone has finished tasting, we will have a short discussion.

Appendix 8a: Development of Canned Foods

a8.1 Product Characteristics

General product characteristics were first specified for the five canned products to be developed (Sweet and Sour Pork, Chicken Casserole, Beans and Bacon in Tomato Sauce, Beef Casserole, and Mutton Curry). These were:

* the product must be of an acceptable quality so that it can be eaten hot or cold;
* the consistency of the sauce in the food must be such that no water is required when it is being prepared by the soldiers;
* the size of the majority of meat pieces should be between 1.5 and 2.5 cubic centimetres;
* a minimum amount of gristle and visible fat should be present;
* frozen and fresh vegetables are to be used;
* the can size will be large enough to hold 310 g of product.

a8.2 Initial Formulation

Initial formulations of the canned products being developed were made. These were based on the product characteristics already mentioned and in some cases, adaptions of known recipes.

a8.3 Panel Procedure

The evaluation of the initial formulations was done by soldiers stationed at Linton Military Camp, Palmerston North. Each product was heated to an acceptable temperature and then sensory evaluated by between eight and ten soldiers (all soldiers had previously used the present combat ration pack).

Appendix 8a: Contd

The soldiers were required to complete a questionnaire that was aimed at determining the acceptability of the product characteristics outlined previously (hedonic scales were used). The overall acceptability of the product as an army ration pack item was also asked (Appendix 8b gives an example of the questionnaire that was used).

After the completion of taste panelling, soldiers were involved in a focus group discussion.

a8.4 Results

From the taste panel results and the focus group discussions, areas of unacceptability were identified within each of the products. The reformulation that followed concentrated on these areas of unacceptability. Further sensory evaluation and reformulation continued in the same form until the overall acceptance was reached.

Appendix 8b: Example of Questionnaire Used to Evaluate Developed Canned Foods

MASSEY UNIVERSITY

FOOD TECHNOLOGY RESEARCH CENTRE

CANNED MEALS

Today you will taste a canned chicken casserole. The meal is intended to be part of the Ration Pack.

Colour

Too light
Just right
Too dark

Meat Amount

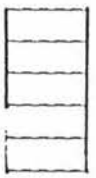
Far too much meat
Moderately too much meat
Just right
Moderately too little meat
Far too little meat

Size Of Meat Pieces

Far too large pieces
Moderately too large pieces
Just right sized pieces
Moderately too small pieces
Far too small pieces

Amount Of Vegetables

Far too many vegetables
Moderately too many vegetables
Just right amount of vegetables
Moderately too few vegetables
Far too few vegetables



Amount Of Gravy or Sauce

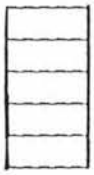
Far too much sauce
Moderately too much sauce
Just right amount of sauce
Moderately too little sauce
Far too little sauce

Appendix 8b: Contd

NOW TASTE THE FOOD AND FILL IN THE FOLLOWING QUESTIONS

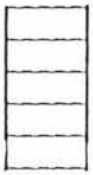
Meat Texture

Far too chewy
Moderately too chewy
Just right
Moderately too soft
Far too soft



Gravy or Sauce

Far too thick
Moderately too thick
Just right
Moderately too thin
Far too thin



Spiciness/Flavouring (for this type of dish)

Far too strong
Moderately too strong
Just right
Moderately too weak
Far too weak

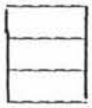
Are there any vegetables you would like in this meal that are not already there?

Appendix 8b: Contd

What improvements would you like to see made to this meal?

Do you think this meal would be acceptable cold?

Yes
No
Maybe



Comments: _____

_____

_____

_____

Overall, how do you rate these meals as an Army Ration Food?

Excellent
Like very much
Like moderately
Neither like or dislike
Dislike moderately
Dislike very much
Terrible

Thank you. Once everyone has finished tasting, we will have a short discussion.

APPENDIX 9a MASTER FILE OF FOODS AND THEIR NUTRITIONAL COMPOSITION

FOODTYPE	WEIGET (x 100g)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
CHICKEN CASSEROLE	3.100	273	21.36	10.17	23.50	37.36	51.21	2.98	0.409	2.53	0.00	1235.38	205.90	0.00	0.158	0.248	13.206	31.37	1.736	0.549	0.000
LUNCHEON	3.100	970	39.06	83.39	17.05	46.50	24.80	3.41	1.023	6.82	0.00	0.00	0.00	0.00	0.217	0.372	5.580	0.00	0.341	0.062	3.100
BEEF CASSEROLE	3.100	412	35.50	22.85	16.09	44.95	43.12	5.64	0.428	10.04	0.00	1331.82	221.97	0.00	0.080	0.409	12.248	14.08	1.079	0.450	2.229
BEANS & BACON	3.100	357	24.12	7.60	47.40	95.42	82.46	4.74	0.400	3.50	0.00	328.04	54.67	0.00	0.428	0.167	8.460	11.47	0.849	0.279	0.310
MUTTON CURRY	3.100	437	32.83	19.56	32.52	43.37	58.06	5.10	0.468	5.30	0.00	335.95	55.99	0.00	0.158	0.388	13.051	8.86	0.388	0.329	2.229
SWEET & SOUR PORK	3.100	198	14.97	6.32	20.46	40.58	37.50	1.98	0.400	2.59	0.00	97.00	16.17	0.00	0.589	0.288	9.229	13.67	0.310	0.350	0.837
CORNBEEF	3.400	738	76.16	62.83	0.00	47.60	51.00	9.86	0.816	19.04	0.00	0.00	0.00	0.00	0.000	0.782	30.600	0.00	2.652	0.204	6.800
TUNA IN OIL	1.850	535	35.15	37.00	0.00	12.95	51.80	2.04	0.167	1.48	0.00	0.00	0.00	5.80	0.074	0.204	31.820	0.00	11.655	0.814	9.250
SPAGHETTI&SAUSAGES	3.000	265	9.81	9.37	37.73	81.06	35.10	1.70	0.489	1.45	0.00	0.00	0.00	0.00	0.030	0.080	3.669	0.00	0.120	0.060	0.420
CHEESE	0.500	156	10.75	12.50	0.00	350.00	12.00	0.25	0.250	1.60	120.00	60.00	130.00	0.07	0.010	0.145	2.565	0.00	0.000	0.000	0.000
PEACHES	3.100	270	1.24	0.00	70.99	12.40	18.60	1.24	0.186	0.00	0.00	775.00	129.17	0.00	0.031	0.062	1.860	12.40	0.000	0.062	0.000
PEARS	3.100	245	1.24	0.00	62.00	15.50	18.60	0.93	0.124	0.00	0.00	31.00	5.17	0.00	0.031	0.031	1.860	3.10	0.000	0.031	0.000
FRUIT SALAD	3.100	295	0.93	0.00	77.50	24.80	24.80	3.10	0.093	0.00	0.00	930.00	155.00	0.00	0.062	0.031	0.930	9.30	0.000	0.031	0.000
PINEAPPLE	2.250	173	0.68	0.00	45.45	29.25	18.00	0.90	0.113	0.00	0.00	90.00	15.00	0.00	0.113	0.045	0.450	27.00	0.000	0.158	0.000
MACARONI	0.750	277	9.95	0.71	61.62	16.59	26.07	0.95	0.190	0.71	0.00	0.00	0.00	0.00	0.024	0.000	2.844	0.00	0.000	0.024	0.000
INSTANT NOODLES	0.850	314	11.26	0.80	69.68	18.76	29.48	1.07	0.214	0.80	0.00	0.00	0.00	0.00	0.027	0.000	3.216	0.00	0.000	0.027	0.000
BISCUITS-FRUITDIGE.	0.500	200	2.10	5.10	35.80	0.00	0.00	0.00	0.000	0.00	0.00	7.50	1.25	0.00	0.081	0.000	0.000	0.00	0.000	0.000	0.000
-CABINBREAD	0.600	213	6.00	1.44	43.50	9.00	0.00	0.42	0.000	0.00	0.00	0.00	0.00	0.00	0.044	0.042	0.060	0.00	0.000	0.000	0.000
-SUPERWINE	0.320	146	2.14	5.31	23.94	38.40	5.44	0.67	0.026	0.19	0.00	0.00	0.00	0.00	0.042	0.026	0.928	0.00	0.448	0.019	0.000
-SHORTBREAD	0.400	202	2.48	10.40	26.20	38.80	5.20	0.60	0.048	0.20	92.00	56.00	101.33	0.09	0.060	0.004	0.960	0.00	0.240	0.028	0.000
-CHOCOCHIP	0.400	197	2.72	9.64	26.60	33.60	16.40	0.84	0.096	0.40	0.00	0.00	0.00	0.00	0.032	0.044	1.080	0.00	0.400	0.032	0.000
-PEANUTCRU.	0.400	183	2.68	6.64	29.92	48.00	6.80	0.84	0.032	0.24	0.00	0.00	0.00	0.00	0.052	0.032	1.160	0.00	0.560	0.024	0.000
FRUITBAR-FIG&APRICOT	0.720	229	3.64	3.33	47.69	22.33	41.05	1.48	0.144	0.71	31.86	284.59	79.29	0.03	0.108	0.043	2.297	0.00	0.353	0.151	0.000
CHOCOLATE	0.500	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
SWEETS - ALL TYPES	0.350	114	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
CHEWING GUM	0.150	48	0.00	0.00	14.28	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.042	4	0.61	0.00	0.46	6.72	16.38	0.18	0.002	0.02	0.00	0.00	0.00	0.00	0.000	0.005	1.046	0.00	0.000	0.001	0.000
MILO	0.220	94	2.79	2.57	14.96	108.46	0.00	4.40	0.000	0.00	20.24	17.38	23.14	0.00	0.424	0.000	0.000	0.00	0.000	0.000	0.000
TEA BAGS	0.025	2	0.20	0.00	0.00	0.00	2.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.020	0.200	0.00	0.000	0.000	0.000
TOMATO SOUP	0.200	74	1.60	1.40	13.50	28.00	8.00	0.40	0.060	0.20	0.00	0.00	0.00	0.00	0.040	0.040	0.600	0.00	0.000	0.000	0.000
MUSHROOM SOUP	0.200	71	2.80	1.40	12.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
CHICKEN SOUP	0.170	56	2.35	0.85	10.35	7.65	7.48	0.46	0.044	0.20	0.00	0.00	0.00	0.00	0.039	0.014	0.816	0.00	0.000	0.000	0.000
BEEF SOUP	0.200	71	2.80	1.40	12.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
ORANGE DRINK	0.100	18	0.00	0.00	31.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	18.00	0.000	0.000	0.000
CONDENSED MILK	0.650	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	69.66	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
JAM - ALL TYPES	0.550	144	0.22	0.00	38.12	6.60	2.75	0.55	0.066	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
HONEY	0.550	288	0.22	0.00	42.02	2.75	1.10	0.22	0.028	0.00	0.00	0.00	0.00	0.00	0.000	0.028	0.110	0.00	0.000	0.000	0.000
BUTTER CONCENTRATE	0.400	296	0.16	32.80	0.00	6.00	0.80	0.06	0.012	0.06	300.00	188.00	331.33	0.30	0.000	0.000	0.044	0.00	0.800	0.000	0.000
MARMITE	0.150	27	6.21	0.11	0.27	14.25	27.00	0.56	0.045	0.32	0.00	0.00	0.00	0.00	0.465	1.650	10.050	0.00	0.000	0.195	0.075
OXO -CHICK&BEEF	0.060	14	2.30	0.20	0.72	10.80	3.54	1.47	0.043	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
CURRY	0.035	8	0.33	0.38	0.91	22.40	9.80	2.63	0.036	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
PEPPER	0.010	3	0.09	0.07	0.68	1.30	0.45	0.10	0.011	0.02	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
CHILI	0.050	12	0.53	0.35	1.93	8.75	0.00	0.53	0.000	0.00	0.00	0.00	455.00	0.00	0.000	0.035	0.350	0.00	0.000	0.000	0.000
CHILI SAUCE	0.050	1	0.05	0.03	0.20	0.45	0.00	0.03	0.000	0.00	0.00	286.80	47.80	0.00	0.000	0.005	0.030	1.50	0.000	0.000	0.000
TOMATO SAUCE	0.150	13	0.36	0.77	1.22	4.20	2.10	0.11	0.018	0.06	4.50	184.50	35.25	0.04	0.012	0.008	0.150	1.50	0.210	0.017	0.000
SOYA SAUCE	0.100	7	0.56	0.13	0.95	8.20	0.00	0.48	0.000	0.00	0.00	0.00	0.00	0.00	0.002	0.025	0.040	0.00	0.000	0.000	0.000
WORCESTER SAUCE	0.100	8	0.10	0.00	1.80	10.00	0.00	0.60	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
PEAS-DRIED	0.430	44	2.97	0.17	8.21	10.32	12.90	0.60	0.073	0.43	0.00	34.40	5.73	0.00	0.047	0.030	0.903	0.00	0.000	0.000	0.000
ONIONFLAKES	0.070	35	1.01	0.11	8.07	36.30	12.20	0.26	0.000	0.23	0.00	0.00	0.00	0.00	0.042	0.056	0.065	1.47	0.000	0.000	0.000

APPENDIX 9b NUTRITIONAL COMPOSITION OF MENU A OF THE SECOND PROTOTYPE RATION PACK

FOODTYPE	WEIGHT (x 100g)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
BEEFCASSER.	3.100	412	35.50	22.85	16.09	44.95	43.12	5.64	0.428	10.04	0.00	1331.82	221.97	0.00	0.080	0.409	12.248	14.08	1.079	0.450	2.229
TUNA IN OIL	1.850	535	35.15	37.00	0.00	12.95	51.80	2.04	0.167	1.48	0.00	0.00	0.00	5.80	0.074	0.204	31.820	0.00	11.655	0.814	9.250
CHEESE	0.500	156	10.75	12.50	0.00	350.00	12.00	0.25	0.250	1.60	120.00	60.00	130.00	0.07	0.010	0.145	2.565	0.00	0.000	0.000	0.000
PEACHES	3.100	270	1.24	0.00	70.99	12.40	18.60	1.24	0.186	0.00	0.00	775.00	129.17	0.00	0.031	0.062	1.860	12.40	0.000	0.062	0.000
INSTANT NOODLES	0.850	314	11.26	0.80	69.68	18.76	29.48	1.07	0.214	0.80	0.00	0.00	0.00	0.00	0.027	0.000	3.216	0.00	0.000	0.027	0.000
BISCUITS: SUPERWINE FRUIT	0.320	146	2.14	5.31	23.94	38.40	5.44	0.67	0.026	0.19	0.00	0.00	0.00	0.00	0.042	0.026	0.928	0.00	0.448	0.019	0.000
DIGESTIVE	0.500	200	2.10	5.10	35.80	0.00	0.00	0.00	0.000	0.00	0.00	7.50	1.25	0.00	0.081	0.000	0.000	0.00	0.000	0.000	0.000
FRUITBAR: FIG	0.700	223	3.54	3.24	46.36	21.71	39.91	1.44	0.140	0.69	30.98	276.69	77.09	0.03	0.105	0.042	2.233	0.00	0.343	0.147	0.000
CHOCOLATE	0.500	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
BARLEY SUGAR	0.350	114	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.042	4	0.61	0.00	0.46	6.72	16.38	0.18	0.002	0.02	0.00	0.00	0.00	0.00	0.000	0.005	1.046	0.00	0.000	0.001	0.000
MILO	0.220	94	2.79	2.57	14.96	108.46	0.00	4.40	0.000	0.00	20.24	17.38	23.14	0.00	0.424	0.000	0.000	0.00	0.000	0.000	0.000
TEABAGS	0.050	4	0.40	0.00	0.00	0.00	4.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.040	0.040	0.00	0.000	0.000	0.000
ORANGE DRINK	0.100	30	0.00	0.00	5.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.03	0.000	0.000	0.000
COND.MILK	0.650	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	69.66	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SOUP-CHICKEN	0.170	56	2.35	0.85	10.35	7.65	7.48	0.46	0.044	0.20	0.00	0.00	0.00	0.00	0.039	0.014	0.816	0.00	0.000	0.000	0.000
SALT	0.140	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
APRICOT JAM	0.350	91	0.14	0.00	24.26	4.20	1.75	0.35	0.042	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BUTTER CONC.	0.400	296	0.16	32.80	0.00	6.00	0.80	0.06	0.012	0.06	300.00	188.00	331.33	0.30	0.000	0.000	0.044	0.00	0.800	0.000	0.000
OXO-CHICKEN	0.060	14	2.30	0.20	0.72	10.80	3.54	1.47	0.043	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
CURRY POWDER	0.035	8	0.33	0.38	0.91	22.40	9.80	2.63	0.036	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
PEAS-DRIED	0.430	44	2.97	0.17	8.21	10.32	12.90	0.60	0.073	0.43	0.00	34.40	5.73	0.00	0.047	0.030	0.903	0.00	0.000	0.000	0.000
STEEL CLOTH																					
TOILETPAPER																					
MATCHES																					
CAN OPENER																					
TOTAL:	15.257	3813	121.47	144.23	515.16	912.35	365.85	24.00	2.101	16.27	535.57	2742.64	992.67	6.26	1.046	1.328	59.729	27.81	14.848	1.543	11.804
RDA		3900	65.00			600.00	350.00	10.00	2.500	15.00			900.00	12.00	1.440	2.040	21.600	72.00	16.200	2.400	3.600
SHORTFALL		87	-56.47	-144.23	-515.16	-312.35	-15.85	-14.00	0.399	-1.27	-535.57	-2742.64	-92.67	5.74	0.394	0.712	-38.129	44.19	1.352	0.857	-8.204
% RDA		97.77	186.88			152.06	104.53	239.99	84.04	108.48			110.30	52.18	72.66	65.08	276.53	38.62	91.65	64.28	327.89

APPENDIX 9c NUTRITIONAL COMPOSITION OF MENU B OF THE SECOND PROTOTYPE RATION PACK

FOODTYPE	WEIGHT (x 100g)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
CHICKENCAS	3.100	273	21.36	10.17	23.50	37.36	51.21	2.98	0.409	2.53	0.00	1235.38	205.90	0.00	0.158	0.248	13.206	31.37	1.736	0.549	0.000
SWEET&SOUR	3.100	198	14.97	6.32	20.46	40.58	37.50	1.98	0.400	2.59	0.00	97.00	16.17	0.00	0.589	0.288	9.229	13.67	0.310	0.350	0.837
CHEESE	0.500	156	10.75	12.50	0.00	350.00	12.00	0.25	0.250	1.60	120.00	60.00	130.00	0.07	0.010	0.145	2.565	0.00	0.000	0.000	0.000
PEARS	3.100	245	1.24	0.00	62.00	15.50	18.60	0.93	0.124	0.00	0.00	31.00	5.17	0.00	0.031	0.031	1.860	3.10	0.000	0.031	0.000
INSTANT NOODLES	0.850	314	11.26	0.80	69.68	18.76	29.48	1.07	0.214	0.80	0.00	0.00	0.00	0.00	0.027	0.000	3.216	0.00	0.000	0.027	0.000
BISCUITS:																					
FRUIT																					
DIGESTIVE	0.500	200	2.10	5.10	35.80	0.00	0.00	0.00	0.000	0.00	0.00	7.50	1.25	0.00	0.081	0.000	0.000	0.00	0.000	0.000	0.000
SHORTBREAD	0.400	202	2.48	10.40	26.20	38.80	5.20	0.60	0.048	0.20	92.00	56.00	101.33	0.09	0.060	0.004	0.960	0.00	0.240	0.028	0.000
FRUITBAR:																					
FIG	0.720	229	3.64	3.33	47.69	22.33	41.05	1.48	0.144	0.71	31.86	284.59	79.29	0.03	0.108	0.043	2.297	0.00	0.353	0.151	0.000
CHOCOLATE	0.500	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
BUTTERSCOTCH	0.350	114	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.042	4	0.61	0.00	0.46	6.72	16.38	0.18	0.002	0.02	0.00	0.00	0.00	0.00	0.000	0.005	1.046	0.00	0.000	0.001	0.000
MILO	0.220	94	2.79	2.57	14.96	108.46	0.00	4.40	0.000	0.00	20.24	17.38	23.14	0.00	0.424	0.000	0.000	0.00	0.000	0.000	0.000
TEABAGS	0.050	4	0.40	0.00	0.00	0.00	4.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.040	0.400	0.00	0.000	0.000	0.000
TOMATO SOUP	0.200	74	1.60	1.40	13.50	28.00	8.00	0.40	0.060	0.20	0.00	0.00	0.00	0.00	0.040	0.040	0.600	0.00	0.000	0.000	0.000
ORANGEDRINK	0.100	30	0.00	0.00	5.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.03	0.000	0.000	0.000
COND.MILK	0.650	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	69.66	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
PLUM JAM	0.550	144	0.22	0.00	38.12	6.60	2.75	0.55	0.066	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BUTTER CONC.	0.400	296	0.16	32.80	0.00	6.00	0.80	0.06	0.012	0.06	300.00	188.00	331.33	0.30	0.000	0.000	0.044	0.00	0.800	0.000	0.000
OXO-CHICKEN	0.060	14	2.30	0.20	0.72	10.80	3.54	1.47	0.043	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
CAYENNE PEP.	0.050	18	0.75	0.50	2.75	12.50	0.00	0.75	0.000	0.00	0.00	0.00	650.00	0.00	0.000	0.500	5.000	0.00	0.000	0.000	0.000
PEAS-DRIED	0.430	44	2.97	0.17	8.21	10.32	12.90	0.60	0.073	0.43	0.00	34.40	5.73	0.00	0.047	0.030	0.903	0.00	0.000	0.000	0.000
STEEL CLOTH																					
TOILETPAPER																					
MATCHES																					
CAN OPENER																					
TOTAL:	16.852	3454	87.35	106.73	556.47	949.36	352.26	19.20	2.284	9.90	628.45	2063.10	1622.30	0.55	1.662	1.726	43.336	49.47	3.962	1.160	1.162
RDA		3900	65.00			600.00	350.00	10.00	2.500	15.00			900.00	12.00	1.440	2.040	21.600	72.00	16.200	2.400	3.600
SHORTFALL		446	-22.35	-106.73	-556.47	-349.36	-2.26	-9.20	0.216	5.10	-628.45	-2063.10	-722.30	11.45	-0.222	0.314	-21.736	22.53	12.238	1.240	2.438
% RDA		88.57	134.38			158.23	100.64	192.01	91.34	65.97			180.26	4.62	115.40	84.62	200.63	68.71	24.46	48.34	32.28

APPENDIX 9d NUTRITIONAL COMPOSITION OF MENU C OF THE SECOND PROTOTYPE RATION PACK

FOODTYPE	WEIGHT (x 100g)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
CORNBEEF	3.400	738	76.16	62.83	0.00	47.60	51.00	9.86	0.816	19.04	0.00	0.00	0.00	0.00	0.000	0.782	30.600	0.00	2.652	0.204	6.800
SPAG&SAU.	3.000	265	9.81	9.37	37.73	81.06	35.10	1.70	0.489	1.45	0.00	0.00	0.00	0.00	0.030	0.080	3.669	0.00	0.120	0.060	0.420
CHEESE	0.550	171	11.83	13.75	0.00	385.00	13.20	0.28	0.275	1.76	132.00	66.00	143.00	0.08	0.011	0.160	2.822	0.00	0.000	0.000	0.000
FRUIT SALAD	3.100	295	0.93	0.00	77.50	24.80	24.80	3.10	0.093	0.00	0.00	930.00	155.00	0.00	0.062	0.031	0.930	9.30	0.000	0.031	0.000
MACARONI	0.750	277	9.95	0.71	61.62	16.59	26.07	0.95	0.190	0.71	0.00	0.00	0.00	0.00	0.024	0.000	2.844	0.00	0.000	0.024	0.000
BISCUITS:																					
CHOCOCHIP	0.400	197	2.72	9.64	26.60	33.60	16.40	0.84	0.096	0.40	0.00	0.00	0.00	0.00	0.032	0.044	1.080	0.00	0.400	0.032	0.000
CABINBREAD	0.600	213	6.00	1.44	43.50	9.00	0.00	0.42	0.000	0.00	0.00	0.00	0.00	0.00	0.044	0.042	0.060	0.00	0.000	0.000	0.000
FRUITBAR:																					
FIG	0.720	229	3.64	3.33	47.69	22.33	41.05	1.48	0.144	0.71	31.86	284.59	79.29	0.03	0.108	0.043	2.297	0.00	0.353	0.151	0.000
CHOCOLATE	0.500	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
CRYSTALMINTS	0.350	114	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.042	4	0.61	0.00	0.46	6.72	16.38	0.18	0.002	0.02	0.00	0.00	0.00	0.00	0.000	0.005	1.046	0.00	0.000	0.001	0.000
MILO	0.220	94	2.79	2.57	14.96	108.46	0.00	4.40	0.000	0.00	20.24	17.38	23.14	0.00	0.424	0.000	0.000	0.00	0.000	0.000	0.000
TEABAGS	0.050	2	0.20	0.00	0.00	0.00	2.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.020	0.200	0.00	0.000	0.000	0.000
BEEF.SOUP	0.200	71	2.80	1.40	12.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
ORANGE DRINK	0.100	30	0.00	0.00	5.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.03	0.000	0.000	0.000
COND.MILK	0.650	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	69.66	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
STRAW. JAM	0.550	144	0.22	0.00	38.12	6.60	2.75	0.55	0.066	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BUTTER CONC.	0.400	296	0.16	32.80	0.00	6.00	0.80	0.06	0.012	0.06	300.00	188.00	331.33	0.30	0.000	0.000	0.044	0.00	0.800	0.000	0.000
OXO-BEEF	0.060	14	2.30	0.20	0.72	10.80	3.54	1.47	0.043	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
PEPPER	0.010	3	0.09	0.07	0.68	1.30	0.45	0.10	0.011	0.02	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
PEAS-DRIED	0.430	44	2.97	0.17	8.21	10.32	12.90	0.60	0.073	0.43	0.00	34.40	5.73	0.00	0.047	0.030	0.903	0.00	0.000	0.000	0.000
STEEL CLOTH																					
TOILETPAPER																					
MATCHES																					
CAN OPENER																					
TOTAL:	17.062	4004	140.93	158.74	562.22	1006.81	355.29	27.49	2.748	25.35	548.45	1572.22	810.49	0.47	0.868	1.589	48.505	10.63	4.848	0.526	7.545
RDA		3900	65.00			600.00	350.00	10.00	2.500	15.00			900.00	12.00	1.440	2.040	21.600	72.00	16.200	2.400	3.600
SHORTFALL		-104	-75.93	-158.74	-562.22	-406.81	-5.29	-17.49	-0.248	-10.35	-548.45	-1572.22	89.51	11.53	0.572	0.451	-26.905	61.37	11.352	1.874	-3.945
% RDA		102.66	216.81			167.80	101.51	274.91	109.92	169.01			90.05	3.91	60.30	77.87	224.56	14.76	29.92	21.92	209.58

APPENDIX 9e NUTRITIONAL COMPOSITION OF MENU D OF THE SECOND PROTOTYPE RATION PACK

FOODTYPE	WEIGHT (x 100g)	ENERGY (KCAL.)	PROTEIN (g)	FAT (g)	CARBOHY (g)	CALCIUM (mg)	MAGNESIUM (mg)	IRON (mg)	COPPER (mg)	ZINC (mg)	RETINOL (ug)	CAROTENE (ug)	VIT. A (ug)	VIT. D (ug)	THIAMIN (mg)	RIBOFLAVIN (mg)	NIACIN (mg)	VIT. C (mg)	VIT. E (mg)	VIT. B6 (mg)	VIT. B12 (ug)
BEANS&BACON	3.100	357	24.12	7.60	47.40	95.42	82.46	4.74	0.400	3.50	0.00	328.04	54.67	0.00	0.428	0.167	8.460	11.47	0.849	0.279	0.310
MUTTON CURRY	3.100	437	32.83	19.56	32.52	43.37	58.06	5.10	0.468	5.30	0.00	335.95	55.99	0.00	0.158	0.388	13.051	8.86	0.388	0.329	2.229
CHEESE	0.500	156	10.75	12.50	0.00	350.00	12.00	0.25	0.250	1.60	120.00	60.00	130.00	0.07	0.010	0.145	2.565	0.00	0.000	0.000	0.000
PEACHES	3.100	270	1.24	0.00	70.99	12.40	18.60	1.24	0.186	0.00	0.00	775.00	129.17	0.00	0.031	0.062	1.860	12.40	0.000	0.062	0.000
MACARONI	0.750	277	9.95	0.71	61.62	16.59	26.07	0.95	0.190	0.71	0.00	0.00	0.00	0.00	0.024	0.000	2.844	0.00	0.000	0.024	0.000
BISCUITS:																					
PEANUTCRUN	0.400	183	2.68	6.64	29.92	48.00	6.80	0.84	0.032	0.24	0.00	0.00	0.00	0.00	0.052	0.032	1.160	0.00	0.560	0.024	0.000
CABINBREAD	0.600	213	6.00	1.44	43.50	9.00	0.00	0.42	0.000	0.00	0.00	0.00	0.00	0.00	0.044	0.042	0.060	0.00	0.000	0.000	0.000
FRUITBAR:																					
APRICOT	0.720	229	3.64	3.33	47.69	22.33	41.05	1.48	0.144	0.71	31.86	284.59	79.29	0.03	0.108	0.043	2.297	0.00	0.353	0.151	0.000
CHOCOLATE	0.500	263	2.35	14.60	32.40	19.00	50.00	1.20	0.350	0.10	0.00	20.00	3.33	0.00	0.035	0.040	0.600	0.00	0.250	0.010	0.000
FRUITREFRE	0.350	114	0.00	0.00	30.56	1.75	0.70	0.14	0.032	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
COFFEE	0.042	4	0.61	0.00	0.46	6.72	16.38	0.18	0.002	0.02	0.00	0.00	0.00	0.00	0.000	0.005	1.046	0.00	0.000	0.001	0.000
MILO	0.220	94	2.79	2.57	14.96	108.46	0.00	4.40	0.000	0.00	20.24	17.38	23.14	0.00	0.424	0.000	0.000	0.00	0.000	0.000	0.000
TEA BAGS	0.050	2	0.20	0.00	0.00	0.00	2.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.020	0.200	0.00	0.000	0.000	0.000
MUSH.SOUP	0.200	71	2.80	1.40	12.00	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
ORANGE DRINK	0.100	30	0.00	0.00	5.20	0.00	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.03	0.000	0.000	0.000
COND.MILK	0.650	209	5.40	5.85	36.08	182.00	17.55	0.13	0.026	0.65	64.35	31.85	69.66	0.06	0.052	0.312	1.411	1.30	0.273	0.013	0.325
SALT	0.140	0	0.00	0.00	0.00	32.20	40.60	0.03	0.014	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
SUGAR	0.840	331	0.00	0.00	88.20	1.68	0.00	0.00	0.017	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BLACKC. JAM	0.550	144	0.22	0.00	38.12	6.60	2.75	0.55	0.066	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
BUTTER CONC.	0.400	296	0.16	32.80	0.00	6.00	0.80	0.06	0.012	0.06	300.00	188.00	331.33	0.30	0.000	0.000	0.044	0.00	0.800	0.000	0.000
OXO-BEEF	0.060	14	2.30	0.20	0.72	10.80	3.54	1.47	0.043	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.00	0.000	0.000	0.000
PEAS-DRIED	0.430	44	2.97	0.17	8.21	10.32	12.90	0.60	0.073	0.43	0.00	34.40	5.73	0.00	0.047	0.030	0.903	0.00	0.000	0.000	0.000
ONION FLAKES	0.070	24	0.71	0.07	5.65	25.41	8.54	0.18	0.000	0.16	0.00	0.00	0.00	0.00	0.029	0.039	0.046	1.03	0.000	0.000	0.000
STEEL CLOTH																					
TOILETPAPER																					
MATCHES																					
CAN OPENER																					
TOTAL:	16.872	3761	111.72	109.45	606.18	1008.05	400.80	23.96	2.304	13.49	536.45	2075.21	882.32	0.46	1.441	1.325	36.546	35.09	3.473	0.893	2.864
RDA		3900	65.00			600.00	350.00	10.00	2.500	15.00			900.00	12.00	1.440	2.040	21.600	72.00	16.200	2.400	3.600
SHORTFALL		139	-46.72	-109.45	-606.18	-408.05	-50.80	-13.96	0.196	1.52	-536.45	-2075.21	17.68	11.54	-0.001	0.715	-14.946	36.91	12.727	1.507	0.736
% RDA		96.43	171.88			168.01	114.51	239.61	92.15	89.90			98.04	3.85	100.10	64.95	169.19	48.73	21.44	37.20	79.55

Appendix 10a Questionnaire in Malaysian Field Trial for the Second Prototype Ration Pack

FOOD TECHNOLOGY RESEARCH CENTRE

COMBAT RATION PACK FIELD TRIAL SURVEY

OCTOBER 1986

NAME: _____

QUESTIONNAIRE NUMBER 1A: Foods not taken on exercise.

1. Foods and Beverages Left Behind.
   Please write in the number of food and beverage items that you have left behind, and circling the letter representing the reason for doing so.

Example only:

	WRITE IN QUANTITY LEFT BEHIND	DON'T LIKE	TOO HEAVY	TOO BULKY	TOO MUCH	NOT NECESSARY	OTHER (Specify)
Baked Beans	2	(D)	H	B	M	N	_____

In this example, it has been indicated that 2 cans of baked beans were left behind because they were not liked.

FOOD/ BEVERAGE	WRITE IN QUANTITY LEFT BEHIND	MAIN REASON DON'T LIKE	TOO HEAVY	TOO BULKY	TOO MUCH	NOT NECESSARY	OTHER (specify)
Beef Casserole	____	D	H	B	M	N	_____
Tuna in Oil	____	D	H	B	M	N	_____
Chicken Casserole	____	D	H	B	M	N	_____
Sweet & Sour Pork	____	D	H	B	M	N	_____
Spaghetti & Saus.	____	D	H	B	M	N	_____
Beans & Bacon	____	D	H	B	M	N	_____
Mutton Curry	____	D	H	B	M	N	_____
Peaches	____	D	H	B	M	N	_____

For Office Use

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continued ...

FOOD/ BEVERAGE	WRITE IN QUANTITY LEFT BEHIND	DON'T LIKE	TOO HEAVY	MAIN REASON TOO BULKY	TOO MUCH	NOT NECESSARY	OTHER (specify)	For Office Use
Pears	____	D	H	B	M	N		17
Fruit Salad	____	D	H	B	M	N		
Instant Noodles	____	D	H	B	M	N		
Macaroni	____	D	H	B	M	N		23
Biscuits								
-Fruit Digestives	____	D	H	B	M	N		25
-Superwine	____	D	H	B	M	N		
-Shortbread	____	D	H	B	M	N		
-Choc. O Chic	____	D	H	B	M	N		
-Cabin Bread	____	D	H	B	M	N		
-Peanut Crunch	____	D	H	B	M	N		35
Fruit Bars								
-Fig	____	D	H	B	M	N		37
-Apricot	____	D	H	B	M	N		
Chocolate	____	D	H	B	M	N		41
Sweets								
-Barley Sugar	____	D	H	B	M	N		43
-Butterscotch	____	D	H	B	M	N		
-Crystal Mints	____	D	H	B	M	N		
-Fruit Refreshers	____	D	H	B	M	N		
Condensed Milk	____	D	H	B	M	N		
Cheese	____	D	H	B	M	N		
Jam								
-Apricot	____	D	H	B	M	N		55

continued ...

FOOD/ BEVERAGE	WRITE IN QUANTITY LEFT BEHIND	DON'T LIKE	TOO HEAVY	MAIN REASON TOO BULKY	TOO MUCH	NOT NECESSARY	OTHER (specify)
-Plum	____	D	H	B	M	N	_____
-Strawberry	____	D	H	B	M	N	_____
-Blackcurrant	____	D	H	B	M	N	_____
Butter Concentrate	____	D	H	B	M	N	_____
Coffee	____	D	H	B	M	N	_____
Tea	____	D	H	B	M	N	_____
Milo	____	D	H	B	M	N	_____
Soup							
-Chicken	____	D	H	B	M	N	_____
-Tomato	____	D	H	B	M	N	_____
-Beef	____	D	H	B	M	N	_____
-Mushroom	____	D	H	B	M	N	_____
Fruit Drink	____	D	H	B	M	N	_____
Salt	____	D	H	B	M	N	_____
Sugar	____	D	H	B	M	N	_____
Curry	____	D	H	B	M	N	_____
Pepper	____	D	H	B	M	N	_____
Cayenne Pepper	____	D	H	B	M	N	_____
Onion Flakes	____	D	H	B	M	N	_____
Dried Peas	____	D	H	B	M	N	_____
Oxo Cube	____	D	H	B	M	N	_____
-Chicken	____	D	H	B	M	N	_____
-Beef	____	D	H	B	M	N	_____

For Office Use

67 ☐☐

69 ☐☐

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29 ☐☐

continued ...

Appendix 10a: Contd

FOOD/ BEVERAGE	WRITE IN QUANTITY LEFT BEHIND	MAIN REASON DON'T LIKE	TOO HEAVY	TOO BULKY	TOO MUCH	NOT NECESSARY	OTHER (specify)	For Office Use
Steel Cleaning Cloth	____	D	H	B	M	N	_____	31
Toilet Paper	____	D	H	B	M	N	_____	
Matches	____	D	H	B	M	N	_____	
Can Opener	____	D	H	B	M	N	_____	37

Appendix 10b Questionnaire Used in Both Field Trials for the Second Prototype Ration Pack

FOOD TECHNOLOGY RESEARCH CENTRE

MASSEY UNIVERSITY

Survey on how you found the items
in the developed ration pack

1986

Appendix 10b: Contd

1. What you are required to do, is to circle the appropriate number that relates to how you found the taste and the size of the food.

Food Type	How Liked			Size			For Office Use
Example:	Disliked	Neither liked nor Disliked	Liked	Too Small	Just Right	Too Large	
Baked Beans	1	2	(3)	1	(2)	3	
Beef Casserole	1	2	3	1	2	3	1
Tuna in Oil	1	2	3	1	2	3	
Chicken Casserole	1	2	3	1	2	3	
Sweet & Sour Pork	1	2	3	1	2	3	
Spaghetti and Sausages	1	2	3	1	2	3	
Corn Beef	1	2	3	1	2	3	
Beans and Bacon	1	2	3	1	2	3	
Mutton Curry	1	2	3	1	2	3	
Pears	1	2	3	1	2	3	
Peaches	1	2	3	1	2	3	
Fruit Salad	1	2	3	1	2	3	
Instant Noodles	1	2	3	1	2	3	
Macaroni	1	2	3	1	2	3	25
Biscuits							27
Fruit Digestive	1	2	3	1	2	3	
Superwine	1	2	3	1	2	3	
Shortbread	1	2	3	1	2	3	
Choc O Chip	1	2	3	1	2	3	
Cabin Bread	1	2	3	1	2	3	
Peanut Crunch	1	2	3	1	2	3	
Fruit Bar							
Fig	1	2	3	1	2	3	
Apricot	1	2	3	1	2	3	
Chocolate							
Dairy Milk	1	2	3	1	2	3	
Energy	1	2	3	1	2	3	45
Sweets							47
Barley Sugar	1	2	3	1	2	3	
Butterscotch	1	2	3	1	2	3	
Crystal Mints	1	2	3	1	2	3	
Fruit Refreshers	1	2	3	1	2	3	
Condensed Milk	1	2	3	1	2	3	
Cheese	1	2	3	1	2	3	57

continued ...

Appendix 10b: Contd

(1) continued ...

Food Type	How Liked: Disliked	Neither Liked nor Disliked	Liked	Size: Too Small	Just Right	Too Large	For Office Use
Jam							
Apricot	1	2	3	1	2	3	59
Strawberry	1	2	3	1	2	3	
Plum	1	2	3	1	2	3	
Blackcurrant	1	2	3	1	2	3	
Butter Concentrate	1	2	3	1	2	3	
Coffee	1	2	3	1	2	3	
Tea	1	2	3	1	2	3	
Milo	1	2	3	1	2	3	73
Instant Soup							
Chicken	1	2	3	1	2	3	1*
Tomato	1	2	3	1	2	3	
Beef	1	2	3	1	2	3	
Mushroom	1	2	3	1	2	3	
Salt	1	2	3	1	2	3	
Sugar	1	2	3	1	2	3	
Curry Powder	1	2	3	1	2	3	
Cayenne Pepper	1	2	3	1	2	3	
Onion Flakes	1	2	3	1	2	3	
Dried Peas	1	2	3	1	2	3	19
Oxo Cube							
Chicken	1	2	3	1	2	3	21
Beef	1	2	3	1	2	3	
Steel Cleaning Cloth	1	2	3	1	2	3	
Toilet Paper	1	2	3	1	2	3	
Matches	1	2	3	1	2	3	
Can Opener	1	2	3	1	2	3	31

Continued over page

Appendix 10b: Contd

For Office Use

2. Were there enough Main meals (that is the cans) for the period of the exercise? 33

NO	YES	TOO MANY
1	2	3

If too many, which meals would you leave out? 34

3. Were there enough snacks for the period of the exercise? (Biscuits, sweets, chocolate). 42

NO	YES	TOO MANY
1	2	3

If too many, which would you leave out?

4. Overall, was there enough food for the period of the exercise. 49

NO	YES	TOO MUCH
1	2	3

If too much, what foods would you leave out?

5. Were there enough drinks for the period of the exercise (i.e. coffee, tea, soup)? 56

NO	YES	TOO MANY
1	2	3

If too many, what would you leave out?

6. Overall was there enough water available to make-up the beverages for the period of the exercise? 61

PLENTY	JUST ENOUGH	SLIGHTLY TOO LITTLE	FAR TOO LITTLE
1	2	3	4

7. Were there enough spices for the period of the exercise?

NO	YES	TOO MANY
1	2	3

If not, write down the spices you would like more of or other types you would like.

8. Were the non-food items adequate (e.g. cleaning cloth, toilet paper, matches, can opener)?

NO	YES
1	2

If not, what was not adequate.

9. Overall, how would you rate this pack? 74

TERRIBLE	DISLIKE VERY MUCH	MODERATELY DISLIKE	NEITHER LIKE NOR DISLIKE	MODERATELY LIKE	LIKE VERY MUCH	EXCELLENT
1	2	3	4	5	6	7

10. Write down any additional comments you would like to make.

Appendix 10c: Questionnaire Used in Both Field Trials for the Second Prototype Ration Pack

FOOD TECHNOLOGY RESEARCH CENTRE

MASSEY UNIVERSITY

Daily Survey Form

You will keep this form for the entire period that you use the developed Ration Pack (i.e. 10 days). You will be required to fill in part of the form each day, which should take you no more than a few minutes.

1. You are required to circle a number which represents how you liked the Ration Pack for the day you used it. Also write down any foods you ate which you did not like.

DAY	OVERALL LIKING FOR PACK							DID YOU DISLIKE ANYTHING	For Office Use
	Terrible	Dislike Very Much	Dislike Moderately	Neither Like Nor Dislike	Like Moderately	Like Very Much	Excellent		
0(Example)	1	2	3	4	(5)	6	7	Chocolate, Condensed Milk	
1	1	2	3	4	5	6	7		
2	1	2	3	4	5	6	7		
3	1	2	3	4	5	6	7		
4	1	2	3	4	5	6	7		
5	1	2	3	4	5	6	7		
6	1	2	3	4	5	6	7		
7	1	2	3	4	5	6	7		
8	1	2	3	4	5	6	7		
9	1	2	3	4	5	6	7		
10	1	2	3	4	5	6	7		

2. Fill this part in at the end of day 10

(a) Did you use everything? YES/NO (Circle one) ☐

(b) If NO, what did you not use?

_____

_____

Appendix 11: Overall Rating of Ration Pack Items Evaluated in Malyasia

Food Type	No Response %	Disliked %	Neither Liked or Disliked %	Liked %
Beef Casserole	0.0	0.0	7.6	92.3
Milo	0.0	0.0	7.6	92.3
Peaches	3.8	3.8	3.8	88.5
Fruit Salad	3.8	3.8	3.8	88.5
Cabin Bread	0.0	0.0	11.5	88.5
Steel Cleaning Cloth	0.0	0.0	15.4	88.5
Condensed Milk	0.0	0.0	15.4	88.5
Instant Noodles	3.8	0.0	11.5	88.5
Pears	3.8	3.8	11.5	80.7
Jam Strawberry	0.0	15.4	11.5	73.1
Fruit Digestive	0.0	19.2	7.6	73.1
Chocolate	0.0	26.9	3.8	69.2
Sugar	0.0	0.0	30.8	69.2
Jam Apricot	3.8	15.4	15.4	65.4
Coffee	0.0	11.5	23.1	65.4
Tuna in Oil	0.0	26.9	7.6	65.4
Shortbread	3.8	7.6	23.1	65.4
Choc-o-chip	0.0	11.5	23.1	65.4
Fruit Refresher	3.8	15.4	15.4	65.4
Corn Beef	0.0	19.2	19.2	61.5
Peanut Crunch	0.0	23.1	15.4	61.5
Onion Flakes	3.8	19.2	15.4	61.5
Superwine	0.0	19.2	23.1	57.7
Fruit Bar Apricot	3.8	26.9	11.5	57.7
Jam Plum	3.8	11.5	26.9	57.7
Butter Concentrate	0.0	11.5	30.8	57.7
Spaghetti & Sausages	3.8	19.2	23.1	53.8
Fruit Bar Fig	7.6	23.1	15.4	53.8
Butterscotch	0.0	15.4	30.8	53.8
Mushrooms	7.6	15.4	23.1	53.8
Cheese	0.0	23.1	23.1	53.8
Sweet & Sour Pork	0.0	7.6	42.3	50.0

Food Type	No Response %	Disliked %	Neither Liked or Disliked %	Liked %
Barley Sugars	10.0	7.6	42.3	50.0
Curry Powder	3.8	23.1	23.1	50.0
Dried Peas	3.8	26.9	19.2	50.0
Toilet Paper	3.8	19.2	26.9	50.0
Mutton Curry	0.0	11.5	42.3	46.2
Macaroni	0.0	26.9	26.9	46.2
Blackcurrant Jam	7.6	26.9	19.2	46.2
Tea	0.0	7.6	46.2	46.2
Chicken Soup	3.8	19.2	30.8	46.2
Tomao Soup	3.8	23.1	26.9	46.2
Can Opener	0.0	23.1	30.8	46.2
Beef Soup	7.6	23.1	26.9	46.2
Salt	3.8	3.8	53.8	36.5
Cayenne Pepper	7.6	34.6	19.2	36.5
Chicken Casserole	7.6	34.6	23.1	34.6
Crystal Mints	0.0	30.8	34.6	34.6
Beans & Bacon	0.0	42.3	26.9	30.8
Oxo Cube Chicken	3.8	46.2	30.8	19.2
Oxo Cube Beef	3.8	50.0	30.8	15.4
Matches	7.6	36.5	42.3	11.5

Appendix 12: Overall Rating of Ration Pack Items Evaluated in New Zealand

Food Type	No Response %	Disliked %	Neither Liked or Disliked %	Liked %
Peaches	0.0	0.0	0.0	100.0
Fruit Salad	0.0	0.0	0.0	100.0
Pears	0.0	1.4	4.1	94.5
Milo	1.4	4.1	1.4	93.2
Steel Cleaning Cloth	1.4	0.0	6.8	91.8
Dairy Milk	1.4	1.4	9.5	87.7
Cabin Bread	1.4	0.0	12.3	86.3
Instant Noodles	1.4	2.7	10.9	84.9
Beef Casserole	4.1	2.7	12.3	80.8
Corn Beef	1.4	9.5	12.3	76.7
Chco-o-chip	4.1	15.1	13.7	76.7
Fruit Digestive	4.1	5.5	6.8	74.0
Butterscotch	4.1	5.5	178	72.6
Sugar	4.1	1.4	21.9	72.6
Shortbread	6.8	8.2	15.1	69.9
Peanut Crunch	8.2	9.5	13.7	68.5
Tuna in Oil	2.7	16.4	15.1	65.8
Vita Plus	2.7	10.9	20.5	65.8
Can Opener	0.0	12.3	23.3	64.6
Superwine	8.2	10.9	17.8	63.0
Sweet & Sour Pork	0.0	24.7	13.7	61.6
Strawberry Jam	11.0	5.5	23.3	60.3
Coffee	9.6	9.5	20.5	60.3
Energy Chocolate	1.4	26.0	15.1	57.5
Condensed Milk	2.7	21.9	19.1	56.2
Plum Jam	12.3	6.8	26.0	54.8
Spaghetti & Sausages	1.4	17.8	27.4	53.4
Barley Sugar	8.2	4.1	34.2	53.4
Fruit Refreshers	17.8	5.5	24.6	52.1
Tea	13.7	13.7	20.5	52.1
Cheese	4.1	17.8	27.4	50.7
Apricot Bar	12.3	13.7	23.3	50.7

Food Type	No Response %	Disliked %	Neither Liked or Disliked %	Liked %
Onion Flakes	13.7	13.7	23.3	49.3
Chicken Soup	21.9	8.2	21.9	47.9
Mushroom Soup	23.3	12.3	17.8	46.6
Salt	11.0	6.8	38.4	43.8
Matches	6.8	26.0	23.3	43.8
Toilet poaper	15.1	17.8	24.7	42.5
Blackcurrant Jam	16.4	19.1	21.9	42.5
Fig Bar	6.8	27.7	26.0	42.5
Curry Powder	13.7	30.1	15.1	41.1
Chicken Oxo	19.2	13.7	26.0	41.1
Beef Oxo	16.4	13.7	28.8	41.1
Butter Concentrate	12.3	24.7	23.3	39.7
Tomato Soup	17.8	21.9	20.5	39.7
Beef Soup	21.9	15.1	23.3	39.7
Mutton Curry	12.3	28.8	19.1	39.7
Apricot Jam	17.8	13.7	30.1	38.4
Cayenne Pepper	26.0	31.5	9.5	32.9
Crystal Mints	4.1	34.2	30.1	31.5
Beans and Bacon	11.0	35.6	23.3	30.1
Macaroni	6.8	31.5	31.5	30.1
Chicken Casserole	2.7	49.3	19.1	28.8
Dried Peas	15.1	41.1	27.4	16.4

Appendix 13: **Unused Ration Pack Items**

Ration Pack Item	Percentage of Soldiers
Apricot Jam	28.8
Blackcurrant Jam	28.8
Plum Jam	27.4
Strawberry Jam	26.0
Butter Concentrate	24.7
Dried Peas	24.7
Macaroni	20.5
Chicken Oxo Cube	20.5
Beef Oxo Cube	20.5
Tea	20.5
Cheese	17.8
Coffee	17.8
Tomato Soup	16.4
Chicken Soup	15.1
Beef Soup	15.1
Mushroom Soup	15.1
Condensed Milk - Sweetened	12.3
Salt	12.3
Cayenne Pepper	12.3
Apricot Fruit Bar	9.5
Fig Fruit Bar	8.2
Butterscotch	8.2
Onion Flakes	8.2
Beans and Bacon	6.8
Fruit Digestive	6.8
Tuna in Oil	5.5
Milo	5.5
Vita Plus	5.5
Toilet Paper	5.5
Chicken Casserole	4.1
Sweet and Sour Pork	4.1
Instant Noodles	4.1
Superwine	4.1
Shortbread	4.1

APPENDIX 14: RECOMMENDATIONS FOR CHANGES IN THE PRESENT RATION PACK

The following is a summary list of final recommendations to changes in the present combat ration pack:

* The canned foods should be replaced with more acceptable quality foods. A variety of meats should be included, e.g., beef, lamb, pork, chicken and fish. The can size will remain the same.

* Canned fruit should be introduced in place of one of the three cans. These will be commercially available and will weigh 310 grams.

* The rice should be deleted and replaced with instant noodles and quick cooking macaroni. Special and robust packaging will be required for both these foods.

* The service biscuits should be replaced with cabin bread and a variety of non-fragile sweet biscuits, e.g., gingernuts, shortbread.

* A fruit food bar to be introduced.

* A variety of jams to be used instead of just honey, e.g., apricot, strawberry, plum and marmalade. The quantity would be 35 grams in a metal tube. Other spreads such as marmite and peanut butter could also be considered.

* Cheese and butter introduced in quantities of 35 grams and 25 grams respectively, in a metal tube.

* Sparkles to be replaced with other sweets such as butterscotch, barley sugar, glucose fruits and chewing gum.

* Military chocolate to be replaced with dark and milk chocolate varieties. In the case of ration packs being used in the tropics, a high temperature resistant chocolate should be used (this is now dependent on the frequency of tropical exercises, now that the Battalion in Singapore is being called back).

* Delete sultanas.

* Milk powder replaced with sweetened condensed milk in a metal tube - weight 65 grams).

* The tea sachets should be replaced with one tea bag. This should be packed to ensure water proofing.

* A chocolate drink such as milo enough for a canteen cup to be made-up, should be introduced.

* A variety of instant fruit drinks which contain an artificial, non-thirsting sweetener should be introduced, e.g., orange, lime, etc.

* Instant soups to be included in alternate ration packs.

* The use of condiments such as tomato, soya, chili sauces and chili powder instead of just curry.

* Replace the box of waterproof matches with a booklet of matches. The striker should be waterproof and the booklet placed in a waterproof container.

* Replace the steel wool pad with a non-rusting steel cloth.

* Replace the can opener with one similar to that issued by the Australian Army.

* Increase the amount of toilet paper to 10 sheets per ration pack.

* Redesign the outer plastic bag so that it is able to be resealed.

* Investigate ways of ensuring the issuing of a mixture of menus when supplying ration packs to soldiers.