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MAINTAINING NUTRITIONAL ADEQUACY DURING A PROLONGED FOOD CRISIS

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ENERGY DIVISION

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UNION CARBIDE CORPORATION
for the
DEPARTMENT OF ENERGY

Contents

Foreword

Large and well-dispersed food reserves are a recognized essential part of the preparations to survive a nuclear war. The largest food reserves in a long-term survival situation would be unprocessed grains, beans, and a few other elementary foods. There is need for a manual on the efficient use of basic foods, both to inform persons accumulating emergency stocks before a possible food crisis arises and to guide those having responsibilities for the postattack distribution and use of available foods.

Civil defense researchers at the Oak Ridge National Laboratory (ORNL) have worked intermittently for years developing and field-testing improved expedient means to process and cook whole grains, soybeans, and other foods not included in the normal American diet. They also have devised better expedient ways to carry and store water and to remove radioactive and other contaminants from water. However, ORNL does not employ a nutritionist with first-hand experience in combatting serious malnutrition or in making preparations to alleviate possible famines. Therefore, the Emergency Technology Program (of the ORNL Energy Division) sought the services of a nutritionist with the necessary background and a strong interest in survival problems.

Kay B. Franz, assistant professor in the Food Science and Nutrition Department of Brigham Young University, admirably met all of ORNL's requirements. Her background for the pioneering work of writing most of this report includes three years spent directing nutrition and health teams working with local resources to help seriously malnourished Indians in southern Mexico. She also has been involved in nutrition education programs in three countries. Kay Franz's academic training includes a B.S. in nutrition from the University of California at Berkeley, an M.S. in food and nutrition from Brigham Young University, and a Ph.D. in nutrition from the University of California at Berkeley.

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Summary

This handbook is the first to assemble nutritional information and make recommendations on the efficient use of unprocessed grains, beans, and other elemental foods during the aftermath of a nuclear war. These basic foods would constitute the main resources to combat famine after a major nuclear attack. Such an attack would reduce and probably eliminate most commercial food processing for many months.

To decision makers, this handbook should prove useful on basic aspects of nutrition in a long-term survival situation. These decision makers might range from the heads of families buying minimum-cost, long-lasting foods as insurance against possible shortages to government officials who, after a nuclear attack, would decide which foods should be transported to starving millions and would determine what instructions these hungry survivors should be given regarding expedient means for processing and cooking unfamiliar foods.

Recommendations for nutrition given by the Food and Nutrition Board of the National Academy of Sciences, the Food and Agriculture Organization of the United Nations, the U.S. Army, and other organizations experienced in crisis feeding are reviewed and compared. Based on the best nutritional information available, emergency dietary recommendations are made for minimum and intermediate goals.

The emergency dietary recommendations are applied to food for practical survival rations. After reviewing the principles developed by disaster specialists of the United Nations and other organizations regarding the introduction and use of unfamiliar foods to a population, long-term survival rations for Americans are evaluated. These rations are (1) ten single-food rations; (2) four cereal-legume rations, ratio 4:1; (3) four cereal-legume rations, ratio 8:1; and (4) four cereal-legume-dry milk rations.

The 22 different survival rations are detailed and summarized in 20 tables which list their nutritional adequacies and deficiencies.

Expedient procedures are given by which basic foods may be processed and cooked to provide a more healthful diet than most Americans believe possible from so few foods.

Special attention is given to the requirements of infants, children, and pregnant or lactating women. Expedient means by which their nutritional needs could best be met with austere foods, to be processed, prepared, and consumed under difficult conditions, are described in detail.

The eleven appendixes provide a wealth of specialized information. Among these appendixes is one that summarizes new and improved expedient methods for removing radioactive fallout and other contaminants from water. Another appendix is a comprehensive account of ways to sprout seeds to produce vitamins and improve palatability; also stated are many of the poorly understood limitations of sprouting.

1. Introduction

Americans are so accustomed to a full selection of food that many, if not most, would be at a loss to know how to plan and conduct feeding programs for their families, communities, or states in crisis situations which could create unprecedented food shortages. The most serious crisis situation would occur after a nuclear attack in which many parts of the country were targeted. Disruption of the normal transport of food would result in severe food shortages. Communications and sources of energy also would be very limited.

This report assembles nutritional information from many sources on the efficient use of basic foods during a time of serious shortages. It is written primarily to give decision makers, whether heads of families or officials responsible for transporting food to millions, practical information on aspects of nutrition in a long-term survival situation. The emphasis is on feeding the maximum number of people by using unprocessed grains and beans and other long-lasting foods likely to be available after a nuclear attack on the United States.

Ideally, nutritionally adequate survival foods should be stored by the family, community, or state prior to a crisis situation to prevent the possibility of rampant starvation in many parts of the United States.

A nuclear attack would also result in contamination of exposed people, animals, food, water, and the environment from radioactive fallout. Most individuals would not know how to cope with the problems of radioactive contamination. Appendix A contains a brief review of pertinent information about radioactive fallout and food.

The United Nations has classified problems of food and nutrition during crisis situations as short-, medium-, or long-term situations in *Food and Nutrition Procedures in Times of Disaster* (1). Long-term emergencies such as war are briefly discussed, but the focus is mainly on medium-term relief of famine in lesser-developed countries and on short-term natural disasters. The assumption is made that the international community would provide food to the stricken nation. Long-term food emergencies are discussed with regard to rationing systems, price and food controls, domestic food production, conservation, and more intensive use of land.

If a full-scale nuclear attack were made on the United States, features of all three types of food emergencies would be superimposed. Short-term disaster situations in every part of the country would follow the original blow. Depending on the season of the year, crops might or might not be destroyed in the fields. If they were, famine would be inevitable in some regions. The long-term food problems that would result from a full-scale nuclear attack would be enormous. Considering the current world food problems and the fact that the United States is the biggest supplier of food in times of disaster, it can be assumed that the international community would be unable to provide more than a token effort to help with the food problem, especially during a war. It would be up to the American people to survive by their own ingenuity.

A review of the experiences of people who have existed under various "survival" conditions has been made by Torrance (2). He has reviewed the stresses and food problems involved in survival. From studies such as Torrance's, it may be concluded that many people who would be uninjured by the weapons effects of a nuclear attack probably would die in the aftermath from starvation, malnutrition, and inability to cope with the stresses of postattack survival.

This report focuses on the minimum nutrient needs required to prevent nutritional deficiencies and evaluates different types of survival rations. Special attention is given to high-risk groups: infants, young children, and pregnant or lactating women.

2. Nutrient Needs

2.1 OVERVIEW

A well-nourished population, such as is found in the United States, will not become malnourished overnight. However, groups such as pregnant women, nursing mothers, infants, and young children require special considerations for nutrient needs that must be met for normal growth and development. Severe nutrient deficiencies during fetal development, infancy, or early childhood might result in retarded physical and mental development. Special foods for groups with chronic health conditions, such as diabetes, might be impossible to obtain.

Nutrient recommendations for the American people have been made by the Food and Nutrition Board of the National Academy of Sciences (3). These are known as recommended daily dietary allowances (RDA). (Also see Appendix B, "Comparison of Nutrient Recommendations Made by Various Groups.") The RDA are generally higher than the recommendations set by other countries or by the Food and Agriculture Organization/World Health Organization (FAO/WHO) (4). The RDA contain a higher safety factor to meet the known nutritional needs of practically all healthy people.

During a nuclear war emergency the RDA probably could not be met by many people because of limited food availability. Levels of nutrients needed to prevent deficiencies must be considered in planning food distribution. In 1962, the Food and Nutrition Board gave recommendations on nutrients for the general population following a nuclear war (5). These recommendations, presented in Table 1, assume a mixed population of adult men and women as well as children of various ages. The first 2-week period is the acute emergency stage when the shelter cannot be left, and total reliance must be placed on shelter stocks of water and food. The later planning periods are for the time immediately after the shelter confinement and during reconstruction.

These recommendations suggest that water, salt, and whatever food can be found might have to suffice for the first short period after an attack. As some semblance of order becomes established, attempts to balance the diet should be made. It would be difficult to meet nutrient needs for the population with normal means of food supply cut off. Transportation and energy supplies may be very limited, and populations may need to live on locally available foods. Because some areas of the country grow only one food crop of importance, the diet may be very unbalanced until transportation and energy supplies are reestablished.

Priorities need to be established for nutrients since some nutrients are more critical to survival than others; for example, water and salt need to be replaced daily to prevent dehydration. An adult can die from severe dehydration in less than a week. Infants, more vulnerable than adults, would die sooner.

Energy levels would next need to be met to prevent serious weight loss. A loss of 25% or more in body weight of the population would show a dangerous degree of starvation. Protein levels should be met at the same time energy levels are being met so that the body does not need to sacrifice its own protein tissues to maintain normal metabolism. The well-nourished adult usually has body stores of vitamins and minerals (except for sodium, potassium, and magnesium) which will last from several

Table 1. Recommended minimum allowances of nutrients for shelter survival of the general population

As consumed per person per day

Nutrients	Planning periods		
	I (up to 2 weeks)	II (up to 8 weeks)	III (over 8 weeks)
Water, quarts	2[a]	2[a]	4[a]
Energy, kcal	1500	1800	2000[b]
Protein, g	35	50	65[c]
Carbohydrate, g (minimum)	150	175	185
Fat, g (maximum)	83	100	110
Sodium chloride, g	3[a]	3.6[a]	4[a]
Calcium, g		0.3	0.4
Thiamin, mg		0.5	0.6
Vitamin C, mg		10	30
Niacin, mg		5	8
Riboflavin, mg		0.7	1.0
Vitamin A, IU[d]			

[a]Water and salt are not adequate for survival in hot weather or in hot, humid conditions under which 4 or 5 quarts of drinking water are essential. Five grams of salt should be made available to allow for possibly increased water needs.

[b]This level of energy will not support heavy physical work by adults.

[c]Since this recommendation was made it has been determined that less protein is needed to maintain health—see Table 2.

[d]Vitamin A should be provided to infants and young children within 4 to 8 weeks. Older children and adults should have Vitamin A sources in their diet by the sixth month.

Source: National Research Council, Food and Nutrition Board, *Minimal Allowances of Water and Food for Fallout Shelter Survival,* National Academy of Sciences, Washington, D.C., 1963. (*Footnotes added.*)

weeks to several months or longer, depending on the particular nutrient. Therefore, widespread vitamin and mineral deficiency diseases would not occur to an obvious degree for 2 or 3 months or longer, even if the population consumed a poorly balanced diet. Subclinical deficiencies probably would be developing.

Deficiency diseases might become widespread, especially in children, if the diet remained unbalanced. A balanced diet should be achieved as soon as possible after a nuclear attack in order to maintain the health and productivity of the population and to prevent lowered resistance to disease.

The following sections are discussions directed toward setting levels of nutrients to be used as minimum and intermediate goals until abundant food supplies again become available. These levels are called emergency recommendations.

2.2 WATER

Safe water supplies need to be established immediately to prevent serious dehydration and perhaps death. Minimum water, salt, and carbohydrate needs in survival settings have been carefully studied (6, 7, 8, 9, 10). Results show that a person can survive an initial period by drinking as little as 1 liter (about 1 quart) of fluid per day under the most ideal conditions, but 1.5 liters or more of fluid is preferable. At first, a minimum goal should be 2 liters of water for every person. If the climate is hot, the ration should be increased to 3 or 4 liters. If the weather is very hot or the living conditions are hot and humid such as may occur in shelter confinement, there may be considerable sweating. Under these conditions, 4 or 5 liters of water per person might be necessary to prevent dehydration. These water rations are only for drinking or cooking—water for personal hygienic needs is not included.

Infants, children, nursing mothers, and persons doing heavy physical work might need more fluids. Persons with illnesses resulting in greater than normal water losses would need extra fluids also. The Food and Agriculture Organization recommendation is 9 liters/day per person for drinking and hand washing (1). This amount could be the intermediate goal before plentiful water supplies are established.

Under emergency conditions, water supplies might be contaminated with disease organisms or radioactivity. The *Manual of Individual Water Supply Systems* recommends procedures for obtaining safe water under emergency conditions (11). These procedures are given in Appendix C, as are expedient methods for removing fallout particles and most dissolved radionuclides from water.

The locations of water sources must be considered when latrines are built. Poorly placed latrines can cause considerable water pollution. Mobile water purification equipment that can treat over 5000 liters/min has been used in international emergencies (1).

2.3 SALT

A minimum of 5 g/day (about 1/6 oz) of salt (sodium chloride) per person should be made available as soon as possible after the disaster. (This recommendation is greater than the daily salt allowances specified in Table 1. A larger amount of salt is needed to allow for those who have increased salt needs.) Without salt, the body cannot retain water effectively. The salt should be incorporated into food since salt is best assimilated this way. Excess salt is not recommended because the excess would be excreted in the urine and therefore increase the individual's water needs.

If a person requires more than 3 liters of water per day, an additional 1 g of salt should be allowed for every liter of fluid he drinks. Some or most of this salt should come from the food and beverages being consumed.

As water supplies become more plentiful, salt allowances can be expanded. A goal of 10 g per person should be established to allow for normal salt needs plus the extra salt needs of some individuals. Not all the salt may be used for immediate consumption: Some could be used for salting of meat or fish to help preserve needed food if refrigeration is limited or unavailable.

2.4 CARBOHYDRATE

In the initial survival period, some carbohydrate is recommended. Carbohydrate is needed to prevent ketosis, a condition in which the body burns primarily fat for energy, resulting in abnormal end products that must be excreted in the urine, thereby causing increased water loss from the body. A minimum of 75 to 100 g of carbohydrate is recommended to prevent ketosis and to help the body retain water to prevent dehydration. (An allowance of 150 g is preferable.)

2.5 ENERGY

During the initial shelter period when physical activity is lessened, 1500 kcal would be a reasonable goal, although more plentiful energy levels should be established as soon as possible. The 1500 kcal probably would not be adequate for most adults and adolescents, and there would probably be weight loss. [The kilocalorie (kcal) is the large calorie, usually called the calorie in popular articles on diet.]

The longer the delay in increasing energy levels after the initial disaster, the weaker the population will become, and the greater the chance will be for adverse effects on the growth and development of children. The effects of restricted energy levels will be determined by how long and how severely the energy intake is limited. Infants, of course, will be affected by restricted food supplies faster than will older children, and pregnant women and nursing mothers will need extra energy. If the energy level of the diet is not adequate, the body will use protein for energy instead of for tissue building.

During the reconstruction period following a nuclear disaster, fuel and machinery may be scarce or unavailable in some areas, resulting in a reliance on human labor. Therefore, dietary energy levels, ideally, should be kept high enough to enable people to perform physical work efficiently. The FAO/WHO recommend 3000 kcal for a man and 2200 kcal for a woman who is moderately active (4, 12). These levels are higher than the RDA (3), since the RDA are for a population with many labor-saving devices and one that is more sedentary than those of many lesser-developed countries. The population to be considered consists of adult men and women, infants, children, adolescents, pregnant women, and nursing mothers. The energy needs for the moderately active man and woman can be averaged to obtain a population goal. This averaging would provide for the greater energy needs of working adults and the smaller energy needs of children. The resulting initial goal of 2600 kcal for individuals would be low for a population consisting primarily of adults doing manual work or for a population that has lost weight from insufficient food.

Energy needs of children can be calculated as a percentage of the adult ration of 2600 kcal.

Age of child (years)	*Percentage of adult ration*
Less than 1	50
1–3	50
4–6	70
7–10	90
11+	100

Infants being nursed would share their ration with their mother. Children, because they are still growing, need more food in proportion to their sizes than do adults. By knowing the number of children and their ages, food needs in terms of the adult ration can be calculated for a family or community.

In planning food supplies, losses from shipping, spillage, and spoilage and from kitchen or table losses need to be taken into account. An increment above 2600 kcal is needed to ensure that 2600 kcal is available for consumption. It is recommended that this increment be 15% of the energy level to allow for shipping losses (1). When food is distributed to consumers, a 10% increment should be added to ensure that adequate energy levels remain after food preparation.

In practical terms, 15% of the energy level is the same as 15% of the weight of the food. If it were determined that a population needed 10,000 lb of grain, 11,500 lb should be shipped by whatever means are available. Small losses might occur from spillage, spoilage, and possibly pilfering, if food supplies were not well guarded. If a family is to receive 10 lb of grain as a ration to meet its energy needs, an increment of 10% of this weight should be added to help ensure that the family actually could consume the necessary food. This increment would allow for small losses that occur during food preparation from food remaining on utensils and for possible spillage or spoilage.

If there were no losses during shipping, 10% could be added. If shipping losses occurred, a minimum of 5% should be added. This means that the family should receive from 10.5 to 11 lb of grain as its ration. Small losses would occur during food preparation from food remaining on utensils and possibly from spillage or spoilage. By increasing the food ration by 5 to 10%, these losses would not decrease energy intake.

Food allowances for rehabilitation should be considered if the population has been subjected to starvation conditions and weight losses of 15 to 20% or more have occurred in normal-weight adults. Obese individuals would be able to tolerate starvation conditions longer than normal-weight individuals, because of the stored fat. In severely starved individuals the intestinal tract atrophies and becomes thin, and because large amounts of food in an atrophied intestine can cause hemorrhage and death, small amounts of food must be given at frequent intervals. After a few days the intestinal tract returns to normal and larger amounts of food can be provided. Dietary energy intakes of 5000 kcal or more might be needed to rehabilitate the semi-starved and starved.

2.6 PROTEIN

Estimates of minimum protein needs are difficult to make because of the factors involved: the age and size of a person, the protein quality or essential amino acid[a] balance of a food, and the digestibility of the food. Animal protein foods have a better protein quality and digestibility than do most plant protein sources. Therefore, recommendations for minimum protein needs will differ, depending on whether the protein comes from an animal source such as milk, meat, and eggs or from a plant source such as wheat, corn, and legumes.

Proteins were first evaluated on the basis of how well they would support growth in young animals. Proteins were divided into three groups.

1. *Complete proteins.* These proteins contain all the essential amino acids in sufficient amounts and support growth in young animals. Foods containing complete proteins include meat, milk, eggs, poultry, and fish. Soybeans are often included in this group even though they do not support growth in young animals quite as well as the other sources of complete proteins.
2. *Partially complete proteins.* These contain all the essential amino acids, but one or more of them are present in low amounts. These amino acids are said to be limiting. Although they are an adequate source of protein for adult animals, these proteins do not enable young animals to grow as well as they should. Foods containing partially complete proteins are all the cereal grains (including wheat, rice, corn, oats, and barley); legumes such as dried beans, peas, and lentils, with the exception of soybeans; and nuts and seeds.
3. *Incomplete proteins.* These proteins are lacking in an essential amino acid and are unable to support the maintenance of animal weight if used as the only source of protein. Gelatin is a protein in this category.

These groups have many gradations. For example, rice has a better quality of protein than corn, and egg has a better protein quality than meat.

Vegetables vary in protein quality from incomplete to nearly complete. Generally, the total quantity of protein in most vegetables is low, so they are not usually considered important sources of dietary protein in the Western diet. When the quantity of vegetables eaten provides a large percentage of the daily energy needs, they may make a substantial contribution to the total protein in the diet. Fruits contain less protein than do vegetables and have an incomplete protein quality, so they are not considered protein sources.

Supplementation of proteins is an important principle for improving protein quality in the diet and should be practiced to make the best possible use of available protein. Supplementation (also called complementation) is the combining of proteins from different foods to improve protein quality. For example, the limiting amino acid in corn is lysine, whereas in beans the limiting amino acid is methionine. If corn and beans are eaten *in the same meal*, the beans will supply lysine to improve the protein quality of the corn, and the corn will supply methionine to improve the protein quality of the beans. If these two foods are eaten *at the same meal* instead of at different times, a better quality protein will be provided.

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[a]Protein is composed of various combinations of amino acids. There are 20 amino acids needed by the body to make protein; 8 of them cannot be synthesized in the body and must be provided in the diet—these are called essential amino acids.

Cereal grains and legumes supplement each other since they have different limiting amino acids. Nuts and seeds supplement legumes. The peanut is botanically a legume and is low in the same amino acids as other legumes. In addition, it is low in the same amino acids as cereal grains. Therefore, peanuts should be supplemented both with other legumes and cereal grains.

A complete protein, such as is found in milk, meat, and eggs, can also supplement the partially complete protein in cereal grains, legumes, and nuts and seeds. For example, milk supplements the protein in bread and a small amount of meat or fish supplements the protein in rice. Generally, complete proteins will supplement the other proteins if eaten *in the same meal.*

Most cultures have traditional food combinations that are good examples of supplementation. The Mexican culture uses corn and beans together. In the Orient, small amounts of fish, poultry, meat, or soybean products are combined with rice. In Western society, milk is added to cereal, and casseroles are made with small amounts of meat, fish, poultry, milk, eggs, or cheese with macaroni, noodles, spaghetti, rice, beans, or potatoes. Vegetarian diets use beans instead of meat for supplementation. Vegetarians may also use animal products such as eggs, milk, or cheese.

In the survival situation being considered, animal protein sources may be very limited or unavailable. Under these circumstances, cereal grains and legumes may have to serve as protein sources.

Unfortunately, most Americans do not know the importance of supplementing the protein in grains by eating, *at every meal,* small quantities of beans or other foods having more complete proteins. Therefore, in a time of extreme food shortages, scarce fuel supplies, and widespread demoralization, it is important that unprocessed foods be distributed with accompanying brief explanations of how to best prepare and eat these basic foods to maintain health.

A more technical discussion of safe protein levels can be found in the FAO/WHO report on energy and protein requirements (12). This report gives the safe level of protein, based on the highest quality proteins known—milk and eggs. Table 2 gives these levels and shows the amount of protein increased according to the quality of the diet being considered. The diet quality is rated as 80, 70, or 60. A score of 80 means that the total protein in the diet is about 80% of the quality of milk or eggs. This is characteristic of the developed nations. A score of 70% is more characteristic of lesser-developed countries where less animal protein is used. A score of 60% is given if 70 to 80% of the protein in the diet comes from poor-quality plant sources such as corn, and there is essentially no animal protein in the diet.

If the safe levels of protein (based on milk or eggs) for the adult woman and man are averaged, 33 g/day is needed. If the protein score is 80, 41 g/day is needed; if 70, 47 g/day; and if 60, 55 g/day. Note the increased protein needs during the latter half of pregnancy and during the first 6 months of lactation. It is recommended that 7 g/day of protein per person come from animal sources (1) if possible.

When man is not restricted by food availability or economics, he generally chooses a diet that obtains about 11% of its energy value from protein (12). In the diets of healthy communities, 10% or more of the energy comes from protein.

In the initial survival setting, excessive amounts of protein (greater than 60 to 70 g) in the diet should be avoided unless abundant water supplies are available. Excess protein results in the production of urea, which must be excreted in the urine. Since water may be strictly rationed in a shelter situation, foods that would increase urine production should be avoided. Several investigators (7, 8, 9, 13) have recommended that only 7 to 8% of caloric intake be protein. Tate, Matthews, and Stone (14) developed a survival ration with 46 g of protein in 900 calories on the basis that caloric intake is not maintained in a survival setting. At first, survival rations with protein as low as 14 g/day were produced; this resulted in a negative nitrogen balance, illustrating that the body was losing protein from its tissues. Tate, Matthews, and Stone (14) recommended a higher protein level for greater nitrogen retention, less weight loss, and better physical condition.

Table 2. Safe levels of protein in terms of diets of protein qualities of 60%, 70%, and 80%, relative to milk or eggs

Age group	Body weight (kg)	Safe level of protein intake		Adjusted level for proteins of different quality (g/day per person)		
		g/day of protein per kg body weight	g/day of protein per person	Score[a] 80%	Score 70%	Score 60%
Infant						
6–11 months	9.0	1.53	14	17	20	23
Child						
1–3 years	13.4	1.19	16	20	23	27
4–6 years	20.2	1.01	20	26	29	34
7–9 years	28.1	0.88	25	31	35	41
Male adolescent						
10–12 years	36.9	0.81	30	37	43	50
13–15 years	51.3	0.72	37	46	53	62
16–19 years	62.9	0.60	38	47	54	63
Female adolescent						
10–12 years	38.0	0.76	29	36	41	48
13–15 years	49.9	0.63	31	39	45	52
16–19 years	54.4	0.55	30	37	43	50
Adults						
Men	65.0	0.57	37	46[b]	53[b]	62[b]
Women	55.0	0.52	29	36[b]	41[b]	48[b]
Pregnant woman, latter half of pregnancy			Add 9	Add 11	Add 13	Add 15
Lactating woman, first 6 months			Add 17	Add 21	Add 24	Add 28

[a]Scores are estimates of the quality of the protein usually consumed relative to that of egg or milk. The adjusted level of protein intake is determined by dividing the score of the food protein into 100 and multiplying the safe level by this number. For example, 100 ÷ 60 = 1.67, and for a child of 1 to 3 years the safe level of protein intake would be 16 g × 1.67, or 27 g of protein having a relative quality of 60%.

[b]The correction may overestimate adult protein requirements.

Source: Food and Agriculture Organization/World Health Organization, *Energy and Protein Requirements* (Report of a joint FAO/WHO ad hoc Expert Committee), WHO Tech. Rep. Ser. No. 552; FAO Nutrition Meetings Report Series 52, World Health Organization, Geneva, Switzerland, 1973, p. 74.

2.7 FAT

Usually, recommendations for fat are not given because, in most American diets, fat is high. In an emergency ration, fat must be considered. Fat is a concentrated source of energy which would help to reduce bulk in a survival diet. Reducing bulk in the diet will be especially important to children who, because their smaller size limits their food intake, may not be able to obtain enough energy from a diet high in whole grains. Infants being fed exclusively from a formula made from nonfat dry milk must have some fat in their diet. (This is discussed further in Chap. 6.) Fat would help to make a survival diet more palatable but would make the cleaning of utensils more difficult, especially if hot water and soap or boiling water were limited.

A diet containing 30 g of fat would provide 10.4% of the energy of a 2600-kcal diet. Survival rations have been formulated with less than half this amount. Very low fat diets would be considered unpalatable to an American public accustomed to a diet with energy levels of 40 to 45% fat. An initial goal could be to make 28 g (1 oz) of fat or oils available in survival rations. The remaining 2 g could come from staples in the diet. An intermediate goal is 60 g of fat.

Traditional concentrated fats in the American diet—vegetable oils, shortenings, lard, butter, margarines, and salad dressings—may be completely unavailable or severely limited in an emergency so it might be difficult to provide a fat ration. Sugar could be used to reduce bulk and increase palatability of the diet. If sugar were substituted for fat, hygienic conditions would be easier to maintain. A sugar ration of 65 g (2.3 oz) is equivalent in energy to 28 g fat (1 oz). Fat should be given if possible.

2.8 VITAMIN A

The first symptom of a vitamin A deficiency is an inability to see well in a dim light. Other symptoms are changes in the epithelial tissues, which are membranes that cover the body and line the digestive, respiratory, and genitourinary tracts (15). In children, the result may be stunted growth. Severe deficiencies damage the cornea of the eye and blindness may result; this occurs primarily in children.

Vitamin A (retinol) is found in foods of animal origin such as whole milk, eggs, liver, and fish liver oils. Carotene, a substance found in green and yellow plants, is converted to retinol in the body, although not very efficiently. For the most efficient digestion and absorption of carotene, fat must be in the diet.

Vitamin A is stored in the liver. As a result, vitamin A deficiencies should not occur in a well-nourished population for several months. Exceptions would be infants and young children because vitamin A stores in the body are low at birth and increase with age.

It has been found that as little as 390 μg/day of retinol will prevent night blindness in adults but that this dose does not maintain normal plasma concentrations (16). The Food and Nutrition Board has concluded that 500 to 600 μg retinol is the minimum requirement to maintain adequate plasma concentrations and to prevent all deficiency symptoms, but, with this amount, little storage of vitamin A occurs in the liver. The RDA is 1000 μg retinol for men and 800 μg retinol for women to meet daily vitamin A needs and to allow reserves to accumulate in the liver (3). The corresponding level for FAO/WHO is 750 μg retinol (16). In a long-term emergency, sources of both vitamin A and carotene would probably be in short supply; therefore, the emergency recommendation is 550 μg retinol. Infants and young children should receive about half of the emergency recommendation; pregnant or lactating women should receive 50% more. As more abundant food supplies become available, 750 μg retinol should be the goal.

Most nutrient tables still use the older term, international unit (IU), instead of the newer term, retinol equivalents (RE), for vitamin A, so it is necessary to know how to change IU to RE. One IU is equivalent to 0.3 μg retinol or 0.6 μg carotene. It was believed that twice as much carotene was needed because of the physiological inefficiency of its conversion to retinol. Later it was found that a further correction was needed since only one-third of the carotene could be absorbed in man. This means that six times as much carotene is needed in order to be equal to retinol. The use of retinol equivalents makes allowances for both the conversion and absorption of carotene to retinol (3).

1 retinol equivalent = 1 μg retinol
= 6 μg carotene
= 3.33 IU vitamin A activity from retinol
= 10 IU vitamin A activity for carotene.

For practical purposes, if the IU are from an animal source, divide by 3.33 to obtain retinol equivalents; if the IU are from plant sources, divide by 10.

If this vitamin cannot be supplied in the diet for several months, widespread deficiency symptoms might develop. Recent studies of liver levels of vitamin A in the United States and Canada have suggested that significant fractions of these populations have low liver reserves of vitamin A (3). Therefore, the diet should be balanced with respect to vitamin A as soon as possible, especially for children, pregnant women, and nursing mothers.

It is possible to eat a self-selected diet that is completely deficient in vitamin A. Sources such as liver, whole or vitamin A–fortified milk, butter, and margarine might be unavailable in a survival situation, and plant sources would have to be relied on. Yellow corn or yellow cornmeal might be an important source in some communities. Dried green peas would also provide some vitamin A. Small gardens of "greens" or carrots would be useful if seeds are available and environmental conditions permit. Edible weeds, such as dandelion greens, and the sprouting of whole grains may also be sources. The sprouts should be exposed to light until a green color develops, indicating that some carotene is present.

2.9 VITAMIN D

Vitamin D is needed to ensure the adequate absorption of calcium. Without it, a disease of defective bone mineralization (15) known as rickets occurs. Vitamin D is most important in infants, children, pregnant women, and nursing mothers: All these groups have an increased need for calcium.

The FAO/WHO recommend 10 μg vitamin D for children from birth through 6 years of age and for pregnant or lactating women. For all other persons over the age of 6 years, 2.5 μg is recommended (4, 17). The RDA for vitamin D is 10 μg for all persons below the age of 22 and for pregnant or lactating women (3). No RDA is given for persons 22 and older. The emergency recommendation is 10 μg vitamin D for children below the age of 7 years and for pregnant or lactating women. This is a compromise between the above recommendations. No recommendations are given for children over 7 years or for adults except as noted.

Vitamin D can also be expressed as IU:

2.5 μg = 100 IU

10.0 μg = 400 IU

In the American diet, the only consistent source of vitamin D is vitamin D–fortified milk. Liver and eggs contain only a smali amount. Fish liver oils were the primary source before fortification of milk became common and vitamin pills containing vitamin D became available. Plants are not a dietary source of vitamin D.

Because of its limited number of sources and the fact that traditional vitamin D–fortified foods might not be available, obtaining sufficient vitamin D might be of critical importance, especially for young children.

Evaporated and nonfat dry milks that are fortified with vitamin D should be kept in reserve for infants, young children, and pregnant or lactating women. Vitamin pills containing vitamin D could also be used.

Vitamin D can be formed in the body if the skin is exposed to the ultraviolet rays of the sun. The length of exposure time needed to get an adequate amount of vitamin D varies with the amount of skin exposed, the time of day, and the intensity of the sunlight available. The FAO recommends ½ hour in the open air during daylight for all persons over the age of 7 years (4). This might not be adequate for vulnerable groups, depending on the climate and the season of the year. Northern parts of the country in the winter would have more vitamin D deficiency problems than would southern, sunny climates. Infants would probably be the group most prone to a deficiency as they are often kept indoors even in good weather.

Exposure to the sun is an unreliable source of vitamin D, but may, of necessity, be the only method in many situations during an emergency.

2.10 THIAMIN

Thiamin deficiency results in a disease called beriberi (15). This has occurred primarily among people eating polished white rice as a large part of their diet. It has also occurred among people subsisting on unenriched, white wheat flour, since the refining process removes most of the thiamin. The most common symptoms are loss of appetite and general weakness, especially in the legs. If untreated, paralysis of the limbs and cardiovascular disturbances may develop. Death usually results from heart failure.

The FAO/WHO report 0.33 mg per 1000 kcal as the minimum thiamin requirement (16). They recommend 0.4 mg per 1000 kcal as the basis for dietary needs of thiamin. The Food and Nutrition Board recommends 0.5 mg per 1000 kcal on the basis of its calculations (3). For emergency purposes, the FAO/WHO recommendation would be followed, which, for 2500 kcal, would be 1.0 mg. This will be used even though the energy level will be 2600 kcal.

Since white rice is not a primary staple in this country and since very little could be processed soon after a nuclear attack, a thiamin deficiency is unlikely to occur as a result of eating rice. All white wheat flours and other refined cereal grains should be enriched with thiamin, if possible.

2.11 RIBOFLAVIN

Deficiency symptoms of riboflavin have been reported in extreme conditions, usually where people are already suffering from other nutritional problems (15). Symptoms are sores at the angles of the mouth; sore, chapped lips; swollen painful tongue and redness and congestion at the edges of the cornea of the eye. Serious diseases such as beriberi (thiamin deficiency) and pellagra (niacin deficiency), which have resulted in severe disability and death, are not known to occur as a result of riboflavin deficiency, but individuals with beriberi and pellagra may have riboflavin deficiency concurrently. Lack of several other nutrients has produced more serious deficiency problems than riboflavin.

The FAO/WHO report 0.44 mg per 1000 kcal as the minimum riboflavin level to prevent deficiency symptoms (16). The Food and Nutrition Board suggests 0.5 mg per 1000 kcal as the minimum level (3). The FAO/WHO recommend 0.55 mg per 1000 kcal, whereas the RDA is based on 0.6 mg per 1000 kcal. The emergency recommendation is 0.55 mg per 1000 kcal, which provides the suggested emergency intake of 1.4 mg per 2600 kcal.

The necessary level of riboflavin will be hard to meet on a survival diet using only grains and legumes as the basic staples. Since sprouting increases the riboflavin content of cereal grains and legumes, this may become an important supplementary source in an emergency.

Milk is one of the best sources of riboflavin, so small amounts of milk in a survival diet would help provide needed riboflavin. Refined cereal grains should be enriched with riboflavin, if possible.

2.12 NIACIN

Niacin deficiency causes pellagra (15). This disease occurred in epidemic proportions in the southern part of the United States during the first third of the 20th century. The symptoms are increasing weakness, a characteristic skin rash on surfaces of the body exposed to the sun, severe diarrhea, and mental deterioration. If untreated, it results in death. Pellagra has occurred when corn is the principal staple and few animal protein foods or legumes are eaten; it does not occur among populations having wheat or rice as the principal staple.

Niacin in dried corn, and possibly other cereals, is not readily available to the body since it occurs in a form that cannot be used by the body. The body can synthesize niacin from the amino acid tryptophan. It is estimated that the body synthesizes 1 mg niacin for every 60 mg tryptophan in the diet. This tryptophan conversion is a very important source of niacin. Among cereals, corn has the lowest tryptophan level. Since the niacin is not readily available from corn and the tryptophan level is low, the body can develop a niacin deficiency resulting in pellagra when corn intake is high. If a person had to eat primarily corn, the body would probably be depleted of niacin in about 5 to 6 months. Symptoms of pellagra would probably start to appear at this time.

Pellagra was once a serious disease in this country, but it is not a problem in Mexico, where more corn is used. This paradox can be explained by the Mexicans' method of processing. In Mexico and other countries where corn has been traditionally the staple food, the dried corn is processed with alkali (18). Lime (calcium oxide) or slaked lime (calcium hydroxide) is used in some cultures. Many cultures use wood ashes for their alkali. This treatment with alkali, in addition to making the corn easier to prepare for the traditional foods, makes the niacin available when the food is eaten (19). Therefore, people who eat alkali-treated corn do not develop pellagra.

In an emergency situation, niacin deficiency would only be a serious problem with corn-eating people. Soaking the dried corn for a few hours in water made alkaline with wood ashes or other alkali, prior to preparing the corn for food, would help to prevent pellagra. In Mexico, the dried corn is both soaked and boiled in a lime-water solution containing lime at a level of about 1% of the weight of the corn. Soaking may be from 4 hours to overnight; boiling may be from 20 minutes to 2 hours.

Both the FAO/WHO recommendation and the RDA are 6.6 mg niacin per 1000 kcal in the diet. This results in the emergency recommendation of 17.0 mg of niacin for 2600 kcal.

In tables giving the nutrient composition of food, only the preformed niacin that occurs in the food is given, whether available or not. Niacin available from the tryptophan contained in the food is not given. Therefore, tables showing the niacin content of food do not reflect the amount of niacin actually available to the body. Only preformed niacin is given in the tables in this report, so the data have severe limitations.

2.13 VITAMIN B-6

There are no areas in the world where a vitamin B-6 deficiency syndrome has been identified due to nutritional deficiency. Most information about dietary levels of this vitamin has come from carefully controlled laboratory studies. Vitamin B-6 is used by the body in the metabolism of protein. When the dietary protein level is high, more vitamin B-6 is needed in the diet than when the dietary protein level is low. One study showed that 1.25 mg vitamin B-6 is needed with a protein intake of 30 g and 1.5 mg is needed with an intake of 100 g protein (3). Another study found 0.6 mg/day sufficient for 54 g protein (3). The RDA has been set at 2 mg. There is no FAO recommendation for vitamin B-6. The emergency recommendation is 1.5 mg.

2.14 FOLACIN

Folacin is the name given to a group of compounds that have folic acid activity. These compounds are found in rich amounts in liver, leafy green vegetables, and yeast. They are found in lesser amounts in dried legumes, green vegetables, nuts, oranges, and whole wheat. Poor sources are meats, eggs, root vegetables, most fruits, white flour and other milled cereals. Since folacin is easily destroyed by normal cooking temperatures, fresh foods eaten raw or with little cooking are often important dietary sources (20).

During the latter half of pregnancy there is an increased need for this vitamin. A deficiency of folacin during pregnancy has resulted in megaloblastic anemia, a type of anemia where the red cells are sent into the bloodstream immature and large. This type of anemia is also seen in some medical problems such as malabsorption syndromes.

Dietary recommendations for folacin are difficult to determine since this vitamin occurs in both a free and a complex form. Experimental studies to determine the requirement of folacin have used the free form, which is believed to be more readily available. The minimum requirement is believed to be between 50 and 100 μg free folate since doses in this range can prevent and cure megaloblastic anemia caused by folacin deficiency. In many countries diets providing only 50 μg free folate are common (4). The RDA for folacin is 400 μg for adults, 800 μg during pregnancy, and 600 μg during lactation (3). Since the RDA is based on 25% of the folacin in the food being absorbed in a manner comparable to that of the free folate used in experimental studies, the RDA is equivalent to 100, 200, and 150 μg, respectively, of the free folate. The FAO/WHO recommend 200 μg free folate for adults and 400 μg free folate during pregnancy (17). These values are higher than the RDA when taken on a free folate basis. The emergency recommendation is 200 μg of food folacin, which is based on 25% absorption of the folacin. This would provide the equivalent of 50 μg of free folate. Pregnant or lactating women would need double this amount. The intermediate goal should be 300 μg of food folacin when more food supplies become available.

2.15 VITAMIN B-12

Vitamin B-12 is provided in the diet only from animal sources. Individuals have developed a deficiency of vitamin B-12 by eating a strictly vegetarian diet for a number of years. Normally, a person has a 2- to 4-year supply of vitamin B-12 stored in the liver. Therefore, a deficiency of this vitamin should not occur in the space of 1 year, even on a strictly vegetarian diet.

2.16 VITAMIN C

Ascorbic acid, or vitamin C, is needed to prevent the deficiency disease called scurvy (15). Scurvy has occurred where fresh fruits and vegetables were not available. Symptoms are associated with defective collagen, a protein that holds together the cells. With defective collagen, bleeding occurs easily. Swollen and bleeding gums around the teeth are one of the first symptoms. Large bruises and hemorrhages can occur any place in the body, and wounds do not heal. Sudden death occurs from severe hemorrhages and heart failure.

As little as 10 mg of ascorbic acid will prevent or cure scurvy but probably would not be sufficient to replenish depleted tissues. The FAO/WHO recommend 30 mg/day of ascorbic acid for an adult (17). The RDA is 45 mg/day (3).

Depending on the past intake of this vitamin, it would take healthy individuals from 4 weeks to 6 months to deplete the body of ascorbic acid and develop scurvy, if no ascorbic acid were in the diet. By the end of the first month, supplies are needed to provide 10 mg/day of ascorbic acid per person. The emergency recommendation is 15 mg of vitamin C as the lower limit in order to prevent scurvy. As more food becomes available, 30 mg should be a goal.

Potatoes and cabbage might be important vitamin C sources in an emergency when the traditional citrus fruits may be unavailable. Sprouting of seeds produces vitamin C (see Appendix D, "Nutritional Values of Germinated Seeds"). Cereal seeds or legumes can be used. Sprouted seeds were used to cure or prevent scurvy before synthetic vitamin C preparations were available. Rose hips, the seed receptacles of the rose, are high in vitamin C and could be a source of the vitamin.

Another unusual source of vitamin C is pine needles. There is about 25 mg per 100 g of needles (21). Early explorers in the new world were taught by the Indians to make a tea from pine needles to prevent or cure scurvy. The pine needles are to be crushed and steeped in hot water so that the water-soluble vitamin C will dissolve.

A breast-fed infant will receive enough vitamin C from the mother's milk to prevent scurvy. Cow's milk, either canned or dried, does not contain enough vitamin C to prevent scurvy. Fresh milk contains sufficient vitamin C to prevent scurvy, but after pasteurization it becomes an unreliable source. Special attention is needed to ensure infants against scurvy. If no other sources of vitamin C are available, some may be provided by feeding infants juice extracted from sprouts.

2.17 CALCIUM

Pure calcium deficiency is very rare. Calcium deficiency in the body is usually due (1) to a lack of vitamin D, which results in poor absorption of the dietary calcium, or (2) to factors in the food which decrease absorption.

Most of the people in the world live on a dietary calcium intake of 300 to 1000 mg/day (22). Calcium is a nutrient that is not completely absorbed from the diet. The amount absorbed depends partly on the need of the body. When dietary calcium is low, a larger percentage is absorbed than when dietary calcium is high.

For adults, the RDA is 800 mg/day, whereas FAO/WHO recommend an intake of 400 to 500 mg/day (22). FAO/WHO recommendations for children and adolescents are as follows:

Age	Suggested practical allowances (mg/day)
0–12 months (not breast fed)	500–600
1–9 years	400–500
10–15 years	600–700
16–19 years	500–600

The emergency recommendation for calcium is 400 mg.

A high percentage of the calcium in the American diet comes from milk and milk products. This gives the population a higher calcium intake than nonmilk-using populations. In a survival situation, milk products may not be available, causing a sharp decrease in the amount of calcium available in the diet. The population will gradually adjust to the lowered calcium intake by absorbing a larger percentage of the calcium available in the diet.

Since the body has large reserves of calcium, a deficiency of this mineral in adults is unlikely to occur in the space of 1 year (1). Stores of calcium should be reserved for pregnant or lactating women and young children because they have the greatest need. If the dietary calcium remains very low for several months or longer than a year, calcium supplements of some form are advised, especially for high-risk groups.

Phytic acid may cause a problem with calcium absorption. In whole grains such as wheat, phytic acid binds such divalent ions as calcium, zinc, and iron. Enough phytic acid is present in whole wheat to theoretically bind all the calcium and prevent absorption. Habitual consumers of diets high in whole wheat appear to adjust to this, and calcium deficiency is not often encountered (23).

During World War II in Great Britain, the government had flour milled to an extraction level of 85%. The extraction level is the percentage of the original kernel remaining after the flour is made.

An extraction level of 100% would be whole-wheat flour; about 72% is the extraction level of white flour. When Great Britain increased the extraction level to 85%, more phytic acid remained in the flour. Since milk was not plentiful during the war years, calcium carbonate was added to counteract the increased phytate in the flour and make more calcium available; it was added at the level of 166 mg/100 g, in the form of creta preparata or chalk (24). The 1972 level of calcium fortification in Britain was 400 g (14 oz) calcium carbonate to 127 kg (280 lb) flour (25). This is at the level of 315 mg/100 g flour. Finely pulverized limestone might also make more calcium available, but the amounts of typical limestones needed have not been determined, nor has the methodology to carry out this process been developed.

Rickets has been reported in Britain in children eating a diet high in unleavened bread made from flours of 85 to 95% extraction that had been fortified with calcium carbonate. Unleavened bread is bread that has not been lightened with yeast. Yeast contains an enzyme that destroys phytic acid. In unleavened breads made from high-extraction wheat flours, phytic acid binds the calcium. If the bread is leavened with yeast, a large percentage of the bonds are broken and more calcium is made available (24). This raises the question of what would happen to people on a diet with a high percentage of whole wheat, which would have a higher phytate content than the 85 to 90% extraction. If the wheat were made into leavened bread, there probably would be no problem. If the wheat were used as a porridge or unleavened bread, the calcium would be less available. Calcium deficiency due to phytate binding of the calcium would not cause a problem in the adult population for several months, if then. Children may need a calcium supplement.

In countries where corn is part of the traditional diet, the lime processing of the corn provides an important source of dietary calcium.

In areas where fish are available, well-cooked fish bones might be another source of calcium—for example, canned salmon with edible bones. Bones from animals such as poultry, after being well cooked and pulverized, might become a source of calcium. Egg shells might also be considered if they were available.

2.18 MAGNESIUM

Human magnesium deficiency is rare but has been reported in protein-calorie malnutrition, chronic malabsorption syndromes, acute diarrhea, chronic renal failure, and chronic alcoholism. Symptoms are emotional instability and irritability.

The FAO/WHO has estimated adult magnesium requirements to be between 200 and 300 mg (4, 26). The RDA is 350 mg for adult males and 300 mg for adult females (3). The FAO estimation is the emergency recommendation.

Whole grains, nuts, legumes, and green leafy vegetables are good sources of magnesium. Animal products, such as meat and milk, are poor to fair sources.

2.19 IRON

Iron deficiency results in anemia and is a prevalent problem in both developed and developing countries, primarily among infants, young children, pregnant women, and women during the reproductive years. Men usually do not develop iron deficiency problems unless they have some health problem which results in a chronic or acute blood loss. If a person becomes infested with hookworms, iron deficiency would probably develop. Hookworm infestation is not currently a problem in the United States but has been in parts of the South. If sanitation practices were to become very poor during a prolonged emergency, the dimensions of this problem might increase in the hot, humid parts of the country.

The RDA varies from 10 to 18 mg/day, depending on a person's age and sex (3). This recommended allowance assumes that a fair amount of foods of animal origin are in the diet, which is currently characteristic of the diet in the United States. Iron from meat is more readily absorbed than iron from plant foods. Only 5 to 10% of the iron in the diet is absorbed by the body. Up to 20% may be absorbed if the person has an iron deficiency anemia.

The FAO/WHO recommendations for iron (4, 17) take into consideration the percentage of animal foods in the diet. Table 3 lists these recommended daily intakes. Diets with over 25% of the calories from animal foods have the lowest recommendation; those diets with less than 10% of the calories from animal foods have the highest recommendation. In an emergency situation, the diet probably would contain less than 10% of the calories from animal food.

The emergency recommendation is set at 10 mg. This is not adequate for vulnerable groups. Iron deficiency among these groups may be a problem in a prolonged emergency. It would take varying lengths of time for anemia to develop, depending on the iron stores of the individual, the diet being eaten, and whether the individual has an increased iron need. In the American population there are some individuals with adequate stores of iron in the body, but there are others with completely inadequate stores. The groups most prone to inadequate iron stores are young children, adolescent girls, pregnant women, and women during the reproductive years. Considering the fact that there will be individuals with iron deficiency at the beginning of an emergency and the possibility that animal foods

Table 3. Food and Agriculture Organization/World Health Organization recommended daily intakes of iron

Age group	Animal foods contributing percentage of calories (mg)	
	Over 25%	Below 10%
Infants		
0–4 months	*a*	*a*
5–12 months	5	10
Children, 1–12 years	5	10
Boys, 13–15 years	9	18
Girls, 13–15 years	12	24
Adults		
Women	14	28
Men	5	9
Pregnancy – latter half	*b*	*b*
Lactation – first 6 months	*b*	*b*

[a]Breast feeding is assumed to be adequate.

[b]For women whose iron intake throughout life has been at the recommended level, the daily intake of iron during pregnancy and lactation should be the same as that recommended for nonpregnant, nonlactating women. For women whose iron status is not satisfactory at the beginning of pregnancy, the requirement is increased, and in the extreme situation of women with no iron stores, the requirement probably cannot be met without supplementation.

Source: Food and Agriculture Organization/World Health Organization, *Requirements of Ascorbic Acid, Vitamin D, Vitamin B_{12}, Folate and Iron, Report of a Joint FAO/WHO Expert Group,* WHO Technical Report Series No. 452, World Health Organization, Geneva, Switzerland, 1970, p. 54.

may be limited in the emergency diet, iron deficiency might gradually become a more widespread problem.

It is impossible to meet iron needs for most women and adolescents with the emergency recommendation of 10 mg. Children, because of their smaller size, might be unable to eat enough of the iron-containing foods to satisfy their iron needs. Iron supplements of some type would probably be needed by these groups. Pills containing iron could be used if they were available. The use of iron cooking utensils, especially with acid foods, will increase the iron content of the food considerably. For example, a 100-g serving of spaghetti sauce made with tomatoes, which contain acid, had 87.7 mg of iron when prepared in an iron skillet but only 3.0 mg when cooked in glassware (27). Iron nails could be placed in vinegar until small amounts of iron began to float on the surface (28). This may take from 2 to 4 weeks, depending on the number of nails and the amount of vinegar. A teaspoon of the iron-vinegar solution would contain about 30 to 60 mg iron and could be used as an iron supplement. Adding the teaspoon of iron-vinegar to a cup of water would make the supplement more palatable.

2.20 ZINC

Zinc has been identified as an important nutrient to man. Zinc deficiency symptoms have been reported to be poor appetite, growth failure, sexual immaturity, and delayed wound healing (29). The implications of marginal zinc deficiency are still unclear.

Zinc deficiency can develop from a low amount of zinc in the diet or an inability to absorb enough of that present in the diet. The second reason for zinc deficiency has been implicated in Iran, where many villagers eat a diet consisting of large amounts of unleavened bread made from high-extraction-level wheat flour. Zinc is present in the diet but it appears that phytic acid and other substances are binding the zinc and preventing most of it from being absorbed. Generally, zinc from animal foods is believed to be more available than zinc from whole grains and legumes.

A diet based on whole grains and legumes with few animal protein foods would be adequate in total quantity of zinc, but, since these foods are high in phytic acid, it is still unclear whether or not an adequate amount of zinc could be absorbed. Yeast leavening of wheat breads would make more zinc available and could possibly make the difference between whether or not a zinc deficiency occurred.

The RDA is 15 mg (3). The FAO/WHO have tentatively set the adult requirement at 5.5 mg when foods of high zinc availability are eaten, at 11 mg when foods of moderate availability are eaten, and at 22 mg when foods of low availability are eaten (4, 26). The emergency recommendation is 11 mg.

2.21 IODINE

Iodine might be involved in health problems in two different ways if a nuclear war occurred. Radioactive iodine would be a serious health hazard since it could be taken up by the thyroid gland and cause abnormal thyroid conditions (30). This problem and the prophylactic use of stable potassium iodide are discussed in Appendix E. A nutritional deficiency of iodine could occur in some parts of the country if the food supply were disrupted.

In some regions of the United States the soil does not contain adequate iodine. These places have been identified as the Northwest, intermountain West, Great Lakes region, and the Northeast. Foods grown in these areas would contain little iodine. People eating a diet consisting of only these iodine-poor foods would develop goiter, an enlargement of the thyroid gland (15). By using iodized salt, goiter caused by iodine deficiency has been eradicated from these areas. Modern transportation systems have also helped; the food being eaten now comes from many parts of the country and the world, not just from the local area.

In an emergency situation, iodized salt may not be available. Foods from iodine-rich parts of the country may or may not be available in iodine-poor parts of the country. It is possible that the locally grown food supply may again become a principal source of food for the diet. It would probably take several months and perhaps a year or more for an iodine deficiency to develop in a population that has been well nourished. Adolescents and pregnant or lactating women would be the first groups to develop an iodine deficiency.

If it is determined that there is not enough iodine available in the diet or from iodized salt, tincture of iodine can be used to provide the iodine needed. Tincture of iodine usually contains 2% elemental iodine and 2.4% sodium iodide. Since 85% of the sodium iodide can be considered as iodine, it is equivalent to 2.0% iodine. ("2% Tincture of Iodine" refers to the content of elemental iodine, which is effective as a disinfectant.) This means:

4.0 g iodine/100 ml, or 4000 mg/100 ml;
1 ml will contain 40 mg;
if there are 20 drops per milliliter, 1 drop contains 2.0 mg or 2000 μg.

The RDA for iodine varies from 100 to 150 μg/day per person for people over the age of 7 years (3). A little excess is not harmful. A week's need would therefore be 700 to 1050 μg. If 1 drop of 2% tincture of iodine were added to 1 cup of water, this would provide 2000 μg. This would be adequate to provide the iodine needed by an adult for 2 weeks. Infants and children under 7 years could use $^1/_8$ to $^1/_4$ of a cup of the iodine water to supply a week's need. Iodized salt, containing potassium iodide or iodate at the level of 0.01%, provides 382 μg iodine in 5 g salt.

2.22 POTASSIUM

This mineral is needed to maintain the normal acid-base balance of the body and is the principal cation within the cells. Potassium deficiencies occur when there is an inadequate intake in combination with a medical problem such as severe diarrhea or as a side effect of some medications. Since unprocessed foods of plant origin are high in potassium, a deficiency is unlikely to occur on survival diets. If milled grains are used, the potassium level would decrease considerably. Fruits and vegetables are good sources of potassium. It is estimated that healthy adults need about 2.5 g/day, but the body is capable of adapting to a wide range of intakes. The emergency recommendation is 1.5 g for the lower limit and 2.5 g as the goal in planning of food supplies.

2.23 SUMMARY OF EMERGENCY DIETARY RECOMMENDATIONS

Table 4 summarizes the emergency dietary recommendations for a long-term disaster feeding of 1 year or more. Short-term recommendations for emergencies of less than 2 months were given in Table 1. Table 4 gives a reasonable goal for the long-term nutrient intake needed during reconstruction, which could be used to calculate food needs for populations. Nutrients that have been evaluated in this report are those that have been associated with human deficiency conditions. There are other nutrients needed by the body, but human deficiency symptoms have not been well defined in populations or the information available is too limited to determine nutrient needs.

Table 4. Emergency dietary recommendations for long-term food needs that are compatible with a physically active population

Energy, kcal[a]	2600	Sodium chloride, g[f]	5
Fat, g[b]	30	Vitamin A, RE, μg[g]	550
Protein, g[c]	41–55	Vitamin D, μg[h]	
Calcium, mg	400	Thiamin, mg	1.0
Magnesium, mg	200–300	Riboflavin, mg	1.4
Iron, mg[d]	10	Niacin, mg	17.0
Zinc, mg	11	Vitamin B-6, mg	1.5
Iodine, μg[e]	100–150	Folacin, μg	200
Potassium, g	1.5–2.5	Vitamin C, mg[i]	15–30

[a]This is for a mixed population of men, women, and children. Higher needs of adults would be offset by lower needs of children.

[b]A fat level of 30 g will provide for 10.4% of the calories and will help to reduce bulk in the diet; more fat could be supplied if available.

[c]The safe protein level varies, depending on the protein quality of the diet.

[d]Iron needs of individuals prone to iron deficiency anemia cannot be met with food alone – an iron supplement will be required.

[e]Iodine may need to be provided to iodine-poor areas as iodized salt or tincture of iodine that can be diluted with safe water.

[f]Even though 5 g sodium chloride is theoretically adequate, a 10-g salt allowance would provide for possible increased needs.

[g]RE = retinol equivalents. 550 μg RE is equivalent to 1810 IU vitamin A from animal sources or 5500 IU from plant sources.

[h]Vitamin D is needed at the level of 10 μg/day by children less than 7 years old and pregnant or lactating women, especially during the months when little sunshine is available. This is equivalent to 400 IU.

[i]Scurvy can be prevented with 10 mg of vitamin C.

3. Application of Nutrient Recommendations to Practical Rations

3.1 BACKGROUND

Changing nutrient recommendations into practical rations presents many problems. Calculations can be made based on prevalent crops available in the United States. Final calculations would need to be made after the nuclear attack and after information about food reserves became available. If the disaster occurred before a harvest, more food would be lost and contaminated than if it were not the growing season. Because of the regional crop differences in the United States, emergency diets would need to be regionalized, depending on foods available. Special considerations would need to be given to infants, children, and pregnant or lactating women. These will be considered in later chapters.

In a disaster following a nuclear attack, some processed foods would be available from storage in various places around the country. These could be used if they were not damaged or contaminated by radioactive fallout. Food might be salvaged from damaged warehouses, homes, etc., if it is canned or if its fallout-contaminated portions could be removed. Eventually these processed rations would be used up. After a nuclear attack, agriculture would be disorganized by lack of manpower, lack of supplies of seeds, fertilizers, pesticides, machinery, oil and fuel for machines, and probably by radioactive contamination problems. Therefore, the agricultural productivity of the country would be sharply decreased. More manpower would be needed to replace mechanization. When the first crops were harvested after a large nuclear attack, industry probably would not be able to process most of them in the customary manner. These problems would result in the necessity to drastically change the food habits of the American people to improve their chances of survival.

During the early 1960s, survival rations were formulated (7, 8, 9, 10, 13). These survival rations were for short-term shelter conditions and were not well balanced. They were adequate for adults for only the initial weeks of the emergency and, for the most part, did not make allowances for infants and young children. The rations were usually stored in large-population areas.

Attempts have also been made to educate the public regarding what to do in times of an emergency (31, 32, 33). These publications have recommended that families maintain in their homes a 2-week emergency food supply and a 7-gallon water supply per person.

An emergency food supply could consist of nonperishable food used in the home or survival foods that would keep for months without refrigeration, require no cooking, yet provide a reasonably balanced diet. In the aftermath of a nuclear attack, many unprepared Americans would need special instructions to prepare and cook grains and other unprocessed foods. For example, they should be warned against cooking in galvanized containers to avoid zinc poisoning.

3.2 ACCEPTABILITY OF FOOD SUPPLIES

From the experiences that FAO disaster specialists have had in disaster situations around the world, they have gleaned three principles pertaining to introduced food supplies (1).

The first principle is that the food must be acceptable to the population that it is proposed to feed. This means that rice eaters will prefer rice and bread eaters will prefer bread. If people are starving, they will eat less familiar foods, but they might not want to try totally unfamiliar foods. The unfamiliar food might therefore be wasted. In the situation being considered—survival after a nuclear war—it might be necessary for populations to eat unpopular and/or unfamiliar foods if these are all that are available. Those people who would survive might be those who could adapt to unusual and unfamiliar foods.

The second principle is that any processing required by introduced foods must be locally possible. If wheat is being supplied, facilities should be available to mill the wheat into meal or flour. Existing facilities include the hammer mills and other grain mills on tens of thousands of American farms. However, since under postattack conditions many persons would be fortunate if they received only whole-kernel wheat, all issues of unprocessed grains should be accompanied by instructions for improvising means for pulverizing or grinding it. A forthcoming Oak Ridge National Laboratory report, *Nuclear War Survival Skills* (ORNL-5037) (34), will include instructions for using common household materials to expediently make equipment for processing grain and for cooking with only about 10% of the wood usually required. Summaries of some of these expedient techniques for processing and cooking grains and soybeans are given in Appendix F.

Whole-kernel corn is less familiar to the public than cornmeal or corn flour. For the average family, it would be difficult to prepare palatable food from staples such as whole-kernel wheat or whole-kernel corn. Priority should be given to the processing of grains or other foods that might be considered for use in survival rations.

The third principle of introduced food supplies is that they must be able to be cooked with local equipment. Methods of cooking with unfamiliar foods or with the limited number of foods available would need to be worked out and the information widely distributed. Since normal fuel sources might be limited or unavailable, information would need to be distributed on how to cook with the fuel supplies and equipment that would be available or could be improvised. Communal feeding centers might aid in distributing and popularizing acceptable methods, after the decay of fallout permits the operation of such centers.

The monotony of the survival diet might be a problem. Where survival rations have been used in long-term disasters around the world, the normal diet has often consisted of a limited number of foods. The people have often been accustomed to a sameness in the food they eat. In the United States, the people are accustomed to one of the most varied diets in the world. Psychologically, it would be very difficult to adjust to the monotony of survival rations. Variety should be provided in the diet as soon as possible.

4. Recommendations of the Food and Agriculture Organization

The FAO has published recommendations for emergency rations (1). These rations are suggested primarily for short- and medium-term disasters where the food would be furnished by the international community. Some of these foods may not be available. Table 5 gives these recommendations, along with calculated energy and protein levels.

Ration 1 was used in the Congo in 1960. This energy level of about 1500 kcal is inadequate for a long-term ration. The dried fish was imported; it probably would not be available in the United States unless individuals have dried their own fish.

Ration 2 was designed to supplement local foods but may also be regarded as a survival ration. The energy level is low so it could not be used very long without considerable weight loss in the population. The diet is based on cereals and legumes; dried skim milk, fats, and sugar are also used. These may or may not be available in substantial quantities in an emergency in this country.

Ration 3 is recommended where there is an abundant supply of one crop, but little else. The FAO has found the maximum amount of whole cereal grains that can be ingested by an adult unaccustomed to a bulky diet to be about 600 g ($1\frac{1}{3}$ lb) in 24 hours (1). The physical capacity of the individual prevents further consumption. More could be consumed as adjustment to a bulky diet occurs. The cereal-based diet is low in energy for an individual performing hard physical work. For individuals unaccustomed to a bulky diet, the physical limit for eating roots such as potatoes is about 1200 g/day ($2\frac{2}{3}$ lb) (1). Root diets are high-risk diets because of low energy and low protein levels. With ingenuity, foods could be prepared so that more could be consumed, especially if eaten more than three times a day. The Irish peasants during the 19th century were able to live on a potato-based diet, with few other foods. It has been estimated that they consumed 3400 g ($7\frac{1}{2}$ lb) of potatoes per day (35).

Ration 4 is considered an improved survival ration since it has more variety. Animal protein foods are available to replace the legumes. In an emergency in this country, these animal protein foods would be canned meats or fish or more milk powder if they are available. It is doubtful that these foods would be available in large quantities if most industries were shut down, either through destruction or due to lack of fuel or other essentials. The energy level is in the 2000+ calorie range; protein is adequate.

Ration 5 is for use in a situation where relief supplies are abundant and a reasonable variety of foods can be provided. Those foods requiring processing may or may not be available. The calorie level is about 2000+ and protein levels are adequate.

Table 5. Food and Agriculture Organization recommendations for emergency food

Food	Amount (g)	Energy (kcal)	Protein (g)
1. Survival ration of 1500 calories			
Rice or maize meal	300	1050	24
Dried fish	60	133	27.6
Oil	30	265	
Total		1448	45.2
2. Survival ration of 1200 calories to supplement local food supply			
Cereals	225	742–880	15.1–32
Legumes	50	171	11.2
Dried skim milk	15	54	5.4
Fats	15	132	
Sugar	15	58	
Total		1157–1295	31.7–48.6
3. Survival diet based on one crop			
Cereal grain	600	1998–2340	40–85
Root crop	1200	915–1360	20.4–25.2
4. Improved survival diet			
Cereals	500	1650–1950	33.5–71.0
Protein food (e.g., dried fish)	50	111	23
Milk powder	40	144	14.4
Sugar	10	38	
Fat	10–20	88–177	
Total		2031–2420	70.9–108.4
5. Abundant survival diet			
Cereals	500	1650–1950	33.5–71.0
Dried or canned fish or meat	50-70	135	15
Fat	20	177	
Milk powder	20	72	7.2
Sugar	20	77	
Salt	10		
Tea or coffee	2-5		
Some fruits and vegetables			
Total		2111–2411	55.7–93.2

Source: G. B. Masefield, *Food and Nutrition Procedures in Times of Disaster,* Food and Agriculture Organization, Rome, Italy, 1967, pp. 67–68. (Energy and protein levels added.)

5. Long-Term Survival Rations in the United States

Long-term survival rations would depend in large measure on what is available.

In many regions of the country only one important food crop is grown. In a long-term emergency, this crop might be needed to feed the population living in that region.

Unfortunately, all the nutrients needed by the body cannot be provided by one food. Therefore, single-food diets, although providing abundant amounts of some nutrients, may be totally inadequate in other necessary nutrients. These foods could be survival foods for a short period of time but must be supplemented with the missing nutrients to prevent deficiency diseases.

Both the energy and protein levels of survival rations should be considered first. After this, methods to balance the ration can be determined and changes made where possible.

Salt is needed with every diet—if possible, 10 g/day should be provided per person. The minimum should be 5 g. Those persons with increased salt need would suffer dehydration if restricted to 5 g.

It is recommended that a percentage factor be added to rations to allow for waste occurring from spoilage, diversions, spillage, and cooking and table wastes (1, 12). This has been discussed previously.

Appendix G gives the energy and nutrient levels in 100-g portions of some common foods. These data are used in nutrient calculations of the various survival diets. Data for local varieties of foods should be used if these data are available.

5.1 SINGLE-FOOD SURVIVAL RATIONS

Table 6 presents nutritive data based on single-food survival diets of 2600-kcal energy levels. The grains and red beans vary in quantity from 715 to 790 g, or about 1 1/2 to 1 3/4 lb. The soybeans are 645 g, which is slightly less than 1 1/2 lb; and the peanuts are 440 g, which is slightly less than 1 lb. The white potatoes are 3.4 kg (7 1/2 lb). Of these foods, peanuts provide the most energy in the lowest quantity of food, because of their high fat content. The large volume of white potatoes (7 1/2 lb) would be difficult to consume in 24 hours by populations unaccustomed to a bulky diet, although the Irish peasants were able to adjust to eating this amount. More nearly adequate quantities of bulky food can be eaten by average Americans if they eat 4 or 5 meals each day.

Table 7 presents data on diets with the grains, red beans, and soybeans reduced to 600 g (1 1/3 lb) and the white potatoes reduced to 1200 g (2 2/3 lb). The peanuts were already below 600 g, so they were not included in this table. The values of 600 g for grains and legumes and 1200 g for starchy roots are quantities recommended by FAO as about the maximum that the average person can conveniently eat (1). When the amounts of the cereals, red beans, and soybeans are reduced to 600 g and the white potatoes reduced to 1200 g, the energy levels drop below the emergency recommendations. The balance of the needed energy would have to come from any available source. Furthermore, the protein level is less than half the emergency recommendation when 1200 g of white potatoes is consumed. Since Americans are unaccustomed to a bulky diet, during the first critical months of crisis few would be able

Table 6. Nutrient levels of survival rations based on single foods provided at 2600-kcal energy levels

Numbers in parentheses denote values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount

	Emergency recommendation	Whole wheat	Enriched white flour	Unenriched white flour	Unenriched white rice (dry)	Brown rice (dry)	Field corn (dry)	Red beans (dry)	Soybeans (dry)	White potatoes (raw)
Amount, g		790	715	715	715	720	750	760	645	3,420
Energy, kcal	2600	2600	2600	2600	2600	2600	2600	2600	2,600	2,600
Protein, g	55[a]	102	75	75	48	54	61.5	171	220	72
Fat, g	30	15.8	7.1	7.1	2.9	13.7	29.1	11.4	114	34
Calcium, mg	400	324	114	114	172	231	164	835	1,460	240
Magnesium, mg	200–300	1260	178	178	200	635	1100	1230	1,710	1,165
Iron, mg	10	26	20.7	5.7	5.7	11.5	15.7	52.4	54.2	20.5
Zinc, mg	11	26.8	5.0	5.0	9.3	13.0	15.7	21.2		10.2
Potassium, mg	1500–2500	2920	675	675	660	1540	2120	7450	10,800	13,900
Vitamin A, RE[b]	550	0	0	0	0	0	366[c]	15	52	0
Thiamin, mg	1.0	4.3	3.1	0.4	0.5	2.4	2.8	3.9	7.1	3.4
Riboflavin, mg	1.4	1.0	1.9	0.4	0.2	0.4	0.9	1.5	2.0	1.4
Niacin, mg	17.0	34.0	25.0	6.4	11.4	34.0	16.4	17.5	14.2	51.4
Vitamin B-6, mg	1.5	2.6	0.4	0.4	1.2	3.9	1.8	3.3	5.2	8.5
Folacin, μg	200	(386)	57	57	114	144	(198)	1365	1,450	(231)
Vitamin C, mg	15–30	0	0	0	0	0	0	0	0	685
Vitamin D, μg	*d*	0	0	0	0	0	0	0	0	0

[a]This is the emergency recommendation if there is no animal protein in the diet.
[b]RE = retinol equivalents.
[c]This is based on yellow varieties of corn; if white corn is used, retinol equivalents would be only a trace.
[d]Although adults do not need vitamin D, infants, children, and pregnant or lactating women should receive 10 μg.

Table 7. Nutrient levels of survival rations based on single foods providing 600 g grains and legumes and 1200 g roots

Numbers in parentheses denote values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount

	Emergency recommendation	Whole wheat	Enriched white flour	Unenriched white flour	Unenriched white rice (dry)	Brown rice (dry)	Field corn (dry)	Red beans (dry)	Soybeans (dry)	Roasted peanuts (dry)	White potatoes (raw)
Amount, g		600	600	600	600	600	600	600	600	447	1200
Energy, kcal	2600	2000	2180	2180	2180	2160	2080	2060	2,410	2,600	910
Protein, g	55[a]	78	63	63	40	45	53	135	204	117	25
Fat, g	30	12.0	6.0	6.0	2.4	11.4	23.4	9.1	106.0	218	1.2
Calcium, mg	400	246	91	91	144	192	132	660	1,355	322	84
Magnesium, mg	200–300	960	150	150	168	528	882	978	1,590	782	408
Iron, mg	10	19.8	17.4	4.8	4.8	9.6	12.6	41.4	50.4	9.8	7.2
Zinc, mg	11	20.4	4.2	4.2	7.8	10.8	12.6	16.8		13.4	3.6
Potassium, mg	1500–2500	2220	570	570	552	1285	1710	5900	10,000	3132	4890
Vitamin A, RE[b]	550	0	0	0	0	0	294[c]	12	48	0	0
Thiamin, mg	1.0	3.3	2.6	0.4	0.4	2.0	2.2	3.0	6.6	1.34	1.2
Riboflavin, mg	1.4	0.7	1.6	0.3	0.2	0.3	0.7	1.2	1.9	0.6	0.5
Niacin, mg	17.0	25.8	21.0	5.4	9.6	28.2	22.2	13.8	13.2	76.4	18.0
Vitamin B-6, mg	1.5	2.0	0.5	0.5	1.0	3.3	(1.5)	2.6	4.8	1.8	3.0
Folacin, μg	200	(294)	48	48	96	120	(159)	1080	1,340	253	(81)
Vitamin C, mg	15–30	0	0	0	0	0	0	0	0	0	240
Vitamin D, μg	*d*	0	0	0	0	0	0	0	0	0	0

[a] This is the emergency recommendation if there is no animal protein in the diet.
[b] RE = retinol equivalents.
[c] This is based on yellow varieties of corn; if white corn is used, retinol equivalents would be only a trace.
[d] Although adults do not need vitamin D, infants, children, and pregnant or lactating women should receive 10 μg.

to eat more than about 1200 g of potatoes. Children, especially, would not be able to consume enough to meet their energy needs.

The protein levels of grains are adequate, except for rice and corn, but the protein quality is poor. The protein in corn is close to the adequate level. The quantity of protein in red beans and soybeans is excessive, but the quantity in peanuts is tolerable if sufficient fluid for drinking is available. Thus, in a survival situation, diets with high or excessive levels of protein would result in a great amount of urea, which must be excreted in the urine. An increase in fluid intake would be required to prevent dehydration and kidney damage. Because of the poor protein quality of cereal grains, beans, peanuts, and potatoes, children would not grow well if they had to subsist on one-food diets.

Vitamins A and C are inadequate in most of the diets. Yellow field corn has carotene and thus can provide retinol equivalents. If the corn were white, only a trace of retinol equivalents would be provided. Vitamin C is adequate only in the potato diet; all other diets contain no vitamin C. If no other sources of vitamin C are available, whole grains and/or legumes can be sprouted and the sprouts eaten. Potato sprouts are poisonous and should not be eaten. Sprouted seeds from 30 g (1 oz) of dry grains or legumes would contain enough vitamin C, about 10 mg, to prevent or cure scurvy, if eaten daily. The grains and/or legumes should be sprouted for 2 to 5 days.

Grain sprouts can be eaten raw, but sprouted legumes should be cooked briefly to inactivate growth-inhibiting substances that occur in all legumes. Sprouted legumes can be cooked by boiling in a small amount of water for about 2 minutes. Prolonged cooking will destroy the vitamin C; therefore, cooking time should be long enough to inactive the growth inhibitors but short enough to prevent destruction of the vitamin C.

If the sprouts were exposed to sunlight and allowed to develop a green color before being eaten, small amounts of carotene would be present; the amount of carotene formed depends on the grain or legume. This is not an adequate source of vitamin A in the diet. A more complete discussion of sprouted seeds is given in Appendix D.

Vitamin D is not present in any of the survival diets. This vitamin must be provided to vulnerable groups from supplemental sources or by adequate exposure to the ultraviolet rays of the sun.

Only in unenriched white flour and unenriched white rice is thiamin inadequate. Milling of whole wheat to white flour removes many nutrients. Enrichment adds thiamin, riboflavin, niacin, and iron to white flour. Deficiencies of thiamin have occurred in populations eating high proportions of these foods.

Riboflavin is adequate only in the enriched white flour, red bean, and soybean diets. Grains have a tendency to be low in riboflavin. If thiamin and niacin are adequate, these low riboflavin levels will not be critical.

The niacin figures that appear in the tables show only the amount of preformed niacin that occurs in the food. Niacin that can be synthesized in the body from the amino acid tryptophan is not included in the tables. The preformed niacin is quite low in the diets based on unenriched white flour and unenriched white rice. Tryptophan would probably provide enough niacin to prevent serious niacin deficiencies but niacin should be supplied if possible. Widespread pellagra is not associated with unenriched white flour or white rice diets. The legume diets are adequate in niacin when the niacin from tryptophan is included. The niacin in corn shown in the tables appears adequate but pellagra has been associated with diets high in corn. Therefore, the niacin shown in the tables does not always reflect that available to the body.

In white flour and white rice, vitamin B-6 is inadequate. This vitamin is not added when flour is enriched, so enrichment does not improve the diet in regard to this vitamin. Vitamin B-6 is adequate in the other diets.

Folacin is lowest with the white flour diet, about 1/4 of the emergency recommendation. The white rice and potato diets have less than half of the emergency recommendation. The brown rice and corn diets are also low in the vitamin.

Multivitamin pills would be the easiest method to supplement dietary vitamin deficiencies. If vitamin pills are to be used, note the vitamin content of the pills, which is usually given on the bottle. Not all the needed vitamins may be contained in the pills. If vitamin pills are available, they should be given first to vulnerable groups such as infants, young children, and pregnant or lactating women.

Calcium is low in all except the legume diets. Legumes, however, especially soybeans, have high amounts of phytic acid; thus, it is not clear how much of the calcium is really available. Calcium supplementation should be considered to bring the grain diets up to 400 mg if they must be used for several months.

Magnesium is low in the white flour and white rice diets.

Iron is below the emergency recommendation in the unenriched white flour and white rice diets. Supplements would be needed to make these diets adequate. Supplementation above the emergency recommendation would be needed for high-risk individuals. In those diets composed of whole grains or legumes (including peanuts), phytic acid is present and can prevent dietary iron from being absorbed; therefore, the iron may not be adequate in these diets.

Zinc is adequate only with whole wheat, brown rice, and legume (including peanut) diets. The potato diet provides less than 1/3 the emergency recommendation. The white rice and white flour diets are also quite low in zinc.

Potassium levels are exceeded in the legume (including peanut) and potato diets. Whole wheat and corn diets meet the emergency level; brown rice is slightly low. The milled cereal grains supply about 1/3 the emergency recommendation.

Diets based on whole grains would provide more of the necessary nutrients than would diets of milled grains. The legume (including peanut) diets provide high amounts of several nutrients. It would be better to use the legumes to supplement the protein in the grain diets and to provide additional vitamins and minerals. A diet of legumes only is not recommended because of the excessive protein. Because of their amino acid composition, peanuts should be used with grains and beans.

The FAO has also found that unprocessed soybeans are so difficult to prepare in a palatable form by people unaccustomed to preparing them that they do not recommend including soybeans in relief supplies unless detailed instructions are given on how they should be prepared. Appendix F gives some expedient ways to utilize soybeans.

The potato diet is deficient in energy and several nutrients. It would need high quality protein and more energy, plus the other deficient nutrients if it were to be used as the base of a long-term diet. Potatoes could be used to advantage by adding them to the other diets to provide vitamin C, potassium, and variety in the diet.

Besides the nutritional value of foods that may be considered for survival diets, many of the foods have unique factors that must be considered. One of the most important factors is how the different foods could be prepared for consumption. Whole grains such as whole wheat, corn, and sorghum can be eaten only in small, inadequate quantities unless they are cracked, ground, etc., before or after cooking. In the United States, such processing is now done by commercial mills. In a long-term emergency, home or community milling of grains might, of necessity, become commonplace. This means turning the clock back a long way to find milling methods that used to be carried out in survival settings, or devising new methods. Also, it would be important to use methods of food preparation that take the minimum of energy, since fuel probably would be a very scarce resource in many areas.

5.2 WHEAT

Different ways in which wheat has been used around the world are described in the FAO publication, *Wheat in Human Nutrition* (24). Some suggestions for using wheat under crisis conditions are found in Appendix F.

Because the American diet is usually very low in fiber, the use of whole wheat as a large part of the diet will result in increased stool frequency and volume. This is a result of both the fiber content and the particle size of the bran. Large bran particles, such as result from merely chewing whole kernels, would have more effect in increasing stool frequency and volume than would small bran particles, such as those in whole wheat flour. Children and elderly people may have some trouble adjusting to a high-fiber diet. Increased stool frequency would be a problem if sanitary facilities are limited, as is likely to be the situation in a survival shelter. A low-fiber diet would be desirable under shelter conditions. However, if low-fiber foods are unavailable, grinding grains as fine as practical would be helpful.

When it is possible to mill flour commercially, whole wheat flour or high-extraction flours, above 85%, should be the products. The FAO recommends using extraction rates of 85 to 95% in conditions of acute grain shortages (1). Flour from these extraction rates would keep better than would flour from 100% extraction and also would produce a bread normally preferred by consumers. The removed bran could be used to feed livestock. Whenever possible, enrichment of milled flours with thiamin, riboflavin, niacin, iron, and possibly other nutrients should be mandatory for flours less than 100% whole wheat.

5.3 RICE

In a long-term emergency, it might not be possible to mill most rice to a white rice or to enrich it. A thiamin deficiency associated with diets of unenriched white rice is the primary nutritional problem associated with rice. Although it will take longer to cook, brown rice will be more adequate in thiamin and iron than will unenriched white rice.

5.4 CORN

Most corn in the United States is used as a feed for livestock. In an emergency, corn might have to be used to feed people. Methods of using the dry field corn would present a problem. During the Irish famine of the past century, whole-kernel corn was shipped from the United States for use in famine relief (35). The Irish did not have milling facilities so they boiled the kernels and attempted to chew them. This use was very unsatisfactory. Later, when cornmeal was shipped, it was used as a porridge and to thicken soups. These uses were satisfactory. This famine experience shows that milling corn into meal or flour would increase acceptability. When corn is milled, the product should be a whole meal or whole flour. The germ should not be removed since it is rich in nutrients.

If corn constitutes a large percentage of the diet for many months, with few other foods, pellagra might become a serious nutritional problem. In this situation, adaptations of the alkali treatment of the corn, as done in many Latin American countries, should be considered (18). The alkali treatment would increase the availability of niacin and help to prevent pellagra.

Some suggestions for using corn in a survival diet are given in Appendix F.

5.5 LEGUMES

Dry beans should be cooked before being eaten to destroy growth-inhibiting substances which prevent much of the protein in the beans from being digested and absorbed by the body. Beans that are eaten after being sprouted to increase their vitamin content still contain growth inhibitors and should be cooked to use the protein most efficiently. If fuel sources are limited, less fuel would be required to cook beans if they were softened by letting them germinate for 24 to 48 hours before cooking. Precautions need to be taken to prevent mold growth during the germination.

Freshly harvested dried legumes can be cooked in a short period of time. When beans with high moisture content are stored, the cooking time increases dramatically (36). Beans stored with a moisture content below 10% do not have the increased cooking time. Beans harvested in dry climates have a lower moisture content than those harvested in wet climates.

"Hardshell" may be another problem with some dry beans. In the "hardshell" condition, their seedcoats do not absorb water during the soaking period; as a result, the beans are uncookable. This can be overcome if the beans are first blanched by steam or boiling water for 2 minutes and allowed to cool in the soaking water (37, 38).

Legumes cause flatulence in most people because of the presence of certain indigestible carbohydrates. These carbohydrates are fermented in the colon by a variety of microörganisms, resulting in the production of flatus (gas). Many methods have been proposed to reduce flatulence from legumes, but none has been found to be completely satisfactory (39, 40).

Soybeans have received special attention in the United States in recent years because of the high quality and quantity of the protein. The use of whole soybeans in the home is rare because they do not cook in the same manner as other dry beans. Soybeans are different in composition from the standard legume, being lower in carbohydrate and higher in protein and fat. When a normal bean "cooks up," the starch becomes gelatinized and the bean softens. Soybeans do not soften this way; more cooking time is required to soften them. When soybeans become soft, the protein has been somewhat broken down and degraded. New techniques are needed to cook soybeans alone and in combination with other foods.

The experts in soybean cookery are in the Orient. There, soybeans are a staple in the diet but only after special processing. Bean sprouts, bean curd, and fermented products are the basic categories of traditional soybean processing. These methods may need to be adopted in the United States if soybeans are used in large amounts. Descriptions of the principles of soybean cookery from the Orient are found in the FAO publication, *Legumes in Human Nutrition* (41). Principles for traditional soybean processing are also described. Information on sprouted soybeans is probably the most applicable to this country. Appendix F gives methods of soybean preparation.

Legumes would be important in a survival diet to provide for amino acid supplementation of the protein in cereal grains. Cereal grains would be the base of the diet, but they must be supplemented by legumes to improve the protein quality.

Soybeans might be used in survival diets to replace the common dry bean. Since soybeans are about 34% protein and other dry beans are about 22% protein, soybeans can provide the same quantity of protein in only $^2/_3$ of the weight. Therefore, if a diet requires 100 g of dry beans, the same amount of protein could be provided by about 67 g of soybeans. The protein in the soybeans would also be of better quality. Since soybeans are also higher in calcium, iron, thiamin, and riboflavin than are other common beans, substituting soybeans at $^2/_3$ of the weight would provide about the same quantity of protein, minerals, and vitamins. In the list on the following page, mature dry soybeans are compared with dry white beans. Note that the soybeans are $^2/_3$ the weight of the white beans, a typical dry bean.

	Common white bean	Soybean	Peanuts
Weight, g	63	42	63
Energy, kcal	214	169	367
Protein, g	14.0	14.3	16.5
Fat, g	1.0	7.4	30.7
Calcium, mg	91	95	45
Iron, mg	4.9	3.5	1.4
Thiamin, mg	0.41	0.46	0.20
Riboflavin, mg	0.13	0.13	0.08
Niacin, mg	1.2	0.9	10.8

In many parts of the country, peanuts are the major crop and would be considered in a survival situation. Before eating, the peanuts should be roasted or heated. One major advantage of peanuts and other types of nuts is their high fat content. This allows more energy to be present with a smaller bulk and would be especially important in providing adequate calories to children. As can be seen in the list above, peanuts are lower in thiamin and riboflavin than are white beans, but peanuts are much higher in niacin.

Unfortunately, peanuts are low in both lysine and methionine, which are the limiting amino acids in grains and beans, respectively. Therefore, peanuts need to be supplemented with grains to provide methionine and with beans to provide lysine. If possible, in a survival ration, peanuts should be used with both grains and beans.

5.6 CEREAL-LEGUME RATIONS

Since single-food rations have nutritional inadequacies, combinations of various foods would better meet nutritional needs, besides reducing the monotony of the diet.

Cereal grains and legumes are a natural combination since the protein in legumes and cereal grains supplement each other and the legumes increase the total protein. It has been found that the best protein intake ratio is obtained when 60 to 70% by weight of the total intake is derived from cereals and 30 to 40% from legume foods (42). This is a cereal grain–legume ratio of about 1.8:1. This combination of cereals and legumes would be most important with young children who need high quality protein for growth. Weaning foods based on this ratio have been prepared for young children in many places in the world. This high quality protein is not needed as much by older children who are not growing as rapidly, nor by adults. It would also be an unusual situation if legumes were available in large enough quantities so that they could be supplied at this high a level for everyone.

In 1971, India fed the Bangladesh refugees a ration consisting of rice or wheat [400 g (14 oz)], legumes [100 g (3.5 oz)], vegetables, salt, and oil (35). Here the grain-legume ratio is 4:1. This is a practical ration which makes good use of limited foods. The wheat and legumes would provide about 1650 kcal and 75 g of protein. Rice and legumes would provide about 1800 kcal and 48 g of protein. The vegetables and oil probably brought the energy level of these diets close to 2000 kcal.

In the long-term survival situation being considered, 2600 kcal is the energy goal. The emergency recommendation is 55 g of protein if no animal protein is included in the diet. On this basis, rations have been calculated using grains, legumes, salt, and fat, and recommendations are given for other foods to be included. The grain-legume ratio is 4:1. The quantities of food needed are as follows:

	Per day	Per week	Per year
Cereal grains	450 g (1 lb)	7 lb	365 lb
Legumes	112 g (4 oz)	1.75 lb	91 lb
Fat	28 g (1 oz)	7.0 oz	22.5 lb
Salt	10 g (1/3 oz)	2.5 oz	8.1 lb
Other foods	To provide 340 to 490 kcal/day		

Fat improves the palatability of the diet considerably and helps to reduce its bulk, since fat is a concentrated energy source. A minimum of 1 oz should be added to the diet daily, if possible. More fat could be used if available. Sugar could also be used to increase palatability and reduce bulk. If 1 oz (28 g) of fat is not available, 65 g of sugar would provide an equal amount of energy and would also improve the palatability of the ration, but some fat should be provided. A combination of fat and sugar would be desirable; 15 g of fat and 30 g of sugar would provide the same energy as 28 g (1 oz) of fat.

Salt is included at the level of 10 g but this would be consumed only as needed. This amount is equivalent to 2.5 oz of salt per week.

Other foods are needed to bring the energy level up to 2600 kcal. These might be fruits, vegetables, sugar, more fat, etc. If possible, fruits and vegetables that would provide vitamins A and C should be used. In most parts of the country, minor crops are grown that would help to provide these other foods. Every region would need to be considered separately. If these other foods were not available, more grains or legumes would be needed to meet energy recommendations.

Tables 8 through 11 present nutritive data for grain-legume diets having a 4:1 ratio, based on 450 g of whole wheat, enriched white flour, unenriched white rice, or yellow field corn.

The energy levels are met if the other foods are provided. These other foods would probably also contribute some protein, fat, vitamins, and minerals but these would have to be added to the calculations when the specific foods are known. The protein level of all the diets exceeds the emergency recommendation.

Vitamins A and C are the most glaring deficiencies. Vitamin D is not present in any of the diets. Thiamin is adequate in all the diets. Legumes make an important contribution to thiamin in the rice diet. Riboflavin meets the emergency recommendation only with the diet based on enriched white flour. Grains are low in riboflavin, especially milled rice. Enrichment increases riboflavin to a higher level than was in the original wheat. Both the rice and corn diets are low in preformed niacin. The conversion of tryptophan to niacin would provide more niacin, but the corn-based diet would probably still be low in niacin. Vitamin B-6 is slightly low in the rice diet, but the white-flour-based diet provides only 3/5 of the emergency recommendation. Folacin is low in the diet based on white flour.

Calcium is below 400 mg in all the diets. Magnesium is adequate in all the diets but is lowest in the white-flour- and rice-based diets. Zinc exceeds 11 mg only in the whole wheat and corn rations. The diets based on white flour and rice are quite low in zinc. Potassium is adequate, but lowest in the white-flour- and rice-based diets.

Table 8. Nutrient levels of a survival ration based on whole wheat and legumes – 4:1 ratio[a]

	Whole wheat[b]	Legumes[c]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	450	112	28	10			
Energy, kcal	1480	380	250	0	490	2600	2600
Protein, g	58.5	25.0	0	0		83.5	55
Fat, g	9	2	28	0		39	30
Calcium, mg	184	161	0	0		345	400
Magnesium, mg	720	190	0	0		910	200–300
Iron, mg	14.8	8.7	0	0		23.5	10
Zinc, mg	15.3	3.1	0	0		18.4	11
Potassium, mg	1670	1340	0	0		3010	1500–2500
Vitamin A, RE[d]	0	0		0			550
Thiamin, mg	2.5	0.7	0	0		3.2	1.0
Riboflavin, mg	0.5	0.2	0	0		0.7	1.4
Niacin, mg	19.3	2.7	0	0		22.0	17.0
Vitamin B-6, mg	1.5	0.6	0	0		2.1	1.5
Folacin, μg	(220)	140	0	0		360	200
Vitamin C, mg	0	0	0	0			15–30

[a]Number in parentheses denotes values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as hard wheat; if soft wheat were used, the protein would be lower.

[c]Calculated as 112 g of raw, dry, white beans; may be replaced by 75 g of dry soybeans.

[d]RE = retinol equivalents.

Table 9. Nutrient levels of a survival ration based on enriched white flour and legumes – 4:1 ratio[a]

	Enriched white flour	Legumes[b]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	450	112	28	10			
Energy, kcal	1630	380	250	0	340	2600	2600
Protein, g	47.2	25.0	0	0		72.2	55
Fat, g	4	2	28	0		34	30
Calcium, mg	72	161	0	0		233	400
Magnesium, mg	112	190	0	0		302	200–300
Iron, mg	13	8.7	0	0		21.7	10
Zinc, mg	3.2	3.1	0	0		6.3	15
Potassium, mg	425	1340	0	0		1765	1500–2500
Vitamin A, RE[c]	0	0		0			550
Thiamin, mg	1.9	0.7	0	0		2.6	1.0
Riboflavin, mg	1.2	0.2	0	0		1.4	1.4
Niacin, mg	15.7	2.7	0	0		18.4	17.0
Vitamin B-6, mg	0.3	0.6	0	0		0.9	1.5
Folacin, μg	36	140	0	0		176	200
Vitamin C, mg	0	0	0	0			15–30

[a]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as 112 g of raw, dry, white beans; may be replaced by 75 g of dry soybeans.

[c]RE = retinol equivalents.

Table 10. Nutrient levels of a survival ration based on unenriched white rice and legumes – 4:1 ratio[a]

	Unenriched white rice	Legumes[b]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	450	112	28	10			
Energy, kcal	1630	380	250	0	340	2600	2600
Protein, g	30.1	25.0	0	0		55.1	55
Fat, g	2	2	28	0		32	30
Calcium, mg	108	161	0	0		269	400
Magnesium, mg	126	190	0	0		316	200–300
Iron, mg	3.6	8.7	0	0		12.3	10
Zinc, mg	5.8	3.1	0	0		8.9	11
Potassium, mg	410	1340	0	0		1650	1500–2500
Vitamin A, RE[c]	0	0		0			550
Thiamin, mg	0.3	0.7	0	0		1.0	1.0
Riboflavin, mg	0.1	0.2	0	0		0.3	1.4
Niacin, mg	7.2	2.7	0	0		9.9	17.0
Vitamin B-6, mg	0.8	0.6	0	0		1.4	1.5
Folacin, μg	72	140	0	0		212	200
Vitamin C, mg	0	0	0	0			15–30

[a]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.
[b]Calculated as 112 g of raw, dry, white beans; may be replaced by 75 g of dry soybeans.
[c]RE = retinol equivalents.

Table 11. Nutrient levels of a survival ration based on yellow field corn and legumes – 4:1 ratio[a]

	Yellow field corn (dry)	Legumes[b]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	450	112	28	10			
Energy, kcal	1560	380	250	0	410	2600	2600
Protein, g	40.0	25.0	0	0		65.0	55
Fat, g	17	2	28	0		47	30
Calcium, mg	99	161	0	0		260	400
Magnesium, mg	660	190	0	0		850	200–300
Iron, mg	9.4	8.7	0	0		18.1	10
Zinc, mg	9.4	3.1	0	0		12.5	11
Potassium, mg	1280	1340	0	0		2620	1500–2500
Vitamin A, RE[c]	220	0		0		220	550
Thiamin, mg	1.6	0.7	0	0		2.3	1.0
Riboflavin, mg	0.5	0.2	0	0		0.7	1.4
Niacin, mg	9.9	2.7	0	0		12.6	17.0
Vitamin B-6, mg	(1.1)	0.6	0	0		1.7	1.5
Folacin, μg	(119)	140	0	0		259	200
Vitamin C, mg	0	0	0	0			15–30

[a]Number in parentheses denotes values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.
[b]Calculated as 112 g of raw, dry, white beans; may be replaced by 75 g of dry soybeans.
[c]RE = retinol equivalents.

From these data it can be seen that whole grains are better sources of most nutrients than are the milled grains. The legumes add significant amounts of many nutrients, especially to the white-flour- and rice-based rations.

Sufficient legumes might not be available to provide a 4:1 ratio of grains to legumes for everyone. For healthy adults a ratio of 8:1 would be adequate. The other foods provided would probably become very important in providing variety to a rather monotonous diet. The quantities of food needed are as follows:

	Per day	Per week	Per year
Cereal grains	500 g (1.1 lb)	7.7 lb	400 lb
Common legumes	63 g (2¼ oz)	0.97 lb	50 lb
Fat	28 g (1 oz)	7.0 oz	22.5 lb
Salt	10 g (⅓ oz)	2.5 oz	8.1 lb
Other foods	To provide 310 to 490 kcal/day		

The recommendations that were given for fat, salt, and other foods still apply.

Tables 12 through 15 present nutritive data for grain-legume diets having an 8:1 ratio, using the same four cereals previously used. The nutritive analysis is similar to that of the 4:1 grain-legume ratio. The smaller quantity of legumes results in decreased values for many nutrients. This becomes most important in the diets based on milled grains.

The energy level of the diets is met if sufficient amounts of other foods are provided. Protein has become low in the rice-based diet because rice has a low quantity of protein; more legumes are needed to make the protein level adequate. A grain-legume ratio of 5:1 would be better for rice than 8:1.

Vitamins A, C, and D are as given previously with the 4:1 rations. Thiamin has become low in the rice-based diet. Riboflavin is essentially unchanged and is still very low in the rice-based diet. Niacin is much the same as before. Vitamin B-6 has dropped to ⅖ of the emergency recommendation in the white-flour-based diet and is about ⅘ in the rice-based diet. Folacin is quite low in both the white-flour- and rice-based diets.

Calcium is below the emergency recommendation in all these diets. Magnesium is adequate in all the diets but is lowest in the white-flour- and rice-based diets. Iron is now low in the rice-based diet. Zinc continues to be quite low in the white-flour- and rice-based diets, and only the whole wheat and corn diets are adequate in potassium.

These data show that legumes add important quantities of protein, thiamin, vitamin B-6, folacin, calcium, magnesium, iron, zinc, and potassium to a survival diet.

When food is given to families, it does not ensure that vulnerable individuals will receive the necessary nutrients. The distribution within the family may not be on the basis of nutritional need. Because of this it would be desirable to make the grain-legume ratio 4:1 for adults, if possible, to try to ensure that vulnerable individuals receive adequate nutrients.

Table 12. Nutrient levels of a survival ration based on whole wheat and legumes – 8:1 ratio[a]

	Whole wheat[b]	Legumes[c]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	63	28	10			
Energy, kcal	1650	214	250	0	486	2600	2600
Protein, g	65.0	14.0	0	0		79.0	55
Fat, g	10	1	28	0		39	30
Calcium, mg	310	91	0	0		301	400
Magnesium, mg	750	107	0	0		857	200–300
Iron, mg	16.5	4.0	0	0		21.4	10
Zinc, mg	17.0	1.7	0	0		18.7	11
Potassium, mg	1850	750	0	0		2600	1500–2500
Vitamin A, RE[d]	0	0		0			550
Thiamin, mg	2.7	0.4	0	0		3.1	1.0
Riboflavin, mg	0.6	0.1	0	0		0.7	1.4
Niacin, mg	21.5	1.2	0	0		22.7	17.0
Vitamin B-6, mg	1.7	0.3	0	0		2.0	1.5
Folacin, μg	(245)	78	0	0		323	200
Vitamin C, mg	0	0	0	0			15–30

[a]Number in parentheses denotes values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.
[b]Calculated as hard wheat; if soft wheat were used, the protein would be lower.
[c]Calculated as 63 g of raw, dry, white beans; may be replaced by 42 g of dry soybeans.
[d]RE = retinol equivalents.

Table 13. Nutrient levels of a survival ration based on enriched white flour and legumes – 8:1 ratio[a]

	Enriched white flour	Legumes[b]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	63	28	10			
Energy, kcal	1820	214	250	0	316	2600	2600
Protein, g	52.5	14.0	0	0		66.5	55
Fat, g	5	1	28	0		34	30
Calcium, mg	80	91	0	0		171	400
Magnesium, mg	125	107	0	0		232	200–300
Iron, mg	14.5	4.9	0	0		19.4	10
Zinc, mg	3.5	1.7	0	0		5.2	11
Potassium, mg	475	750	0	0		1225	1500–2500
Vitamin A, RE[c]	0	0		0			550
Thiamin, mg	2.2	0.4	0	0		2.6	1.0
Riboflavin, mg	1.3	0.1	0	0		1.4	1.4
Niacin, mg	17.5	1.2	0	0		18.7	17.0
Vitamin B-6, mg	0.3	0.3	0	0		0.6	1.5
Folacin, μg	40	78	0	0		118	200
Vitamin C, mg	0	0	0	0			15–30

[a]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.
[b]Calculated as 63 g of raw, dry, white beans; may be replaced by 42 g of dry soybeans.
[c]RE = retinol equivalents.

Table 14. Nutrient levels of a survival ration based on unenriched white rice and legumes – 8:1 ratio[a]

	Unenriched white rice	Legumes[b]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	63	28	10			
Energy, kcal	1810	214	250	0	326	2600	2600
Protein, g	33.5	14.0	0	0		47.5	55
Fat, g	2	1	28	0		31	30
Calcium, mg	120	91	0	0		211	400
Magnesium, mg	140	107	0	0		247	200–300
Iron, mg	4.0	4.9	0	0		8.9	10
Zinc, mg	6.5	1.7	0	0		8.2	11
Potassium, mg	460	750	0	0		1210	1500–2500
Vitamin A, RE[c]	0	0		0			550
Thiamin, mg	0.4	0.4	0	0		0.8	1.0
Riboflavin, mg	0.2	0.1	0	0		0.3	1.4
Niacin, mg	8.0	1.2	0	0		9.2	17.0
Vitamin B-6, mg	0.8	0.3	0	0		1.1	1.5
Folacin, μg	80	78	0	0		158	200
Vitamin C, mg	0	0	0	0			15–30

[a]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as 63 g of raw, dry, white beans; may be replaced by 42 g of dry soybeans.

[c]RE = retinol equivalents.

Table 15. Nutrient levels of a survival ration based on yellow field corn and legumes – 8:1 ratio[a]

	Yellow field corn (dry)	Legumes[b]	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	63	28	10			
Energy, kcal	1740	214	250	0	396	2600	2600
Protein, g	44.5	14.0	0	0		58.9	55
Fat, g	20	1	28	0		49	30
Calcium, mg	110	91	0	0		201	400
Magnesium, mg	735	107	0	0		842	200–300
Iron, mg	10.5	4.9	0	0		15.4	10
Zinc, mg	10.5	1.7	0	0		12.2	11
Potassium, mg	1240	750	0	0		1990	1500–2500
Vitamin A, RE[c]	240	0		0		240	550
Thiamin, mg	1.8	0.4	0	0		2.2	1.0
Riboflavin, mg	0.6	0.1	0	0		0.7	1.4
Niacin, mg	11.0	1.2	0	0		12.2	17.0
Vitamin B-6, mg	(1.2)	0.3	0	0		1.5	1.5
Folacin, μg	(132)	78	0	0		210	200
Vitamin C, mg	0	0	0	0			15–30

[a]Number in parentheses denotes values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as 63 g of raw, dry, white beans; may be replaced by 42 g of dry soybeans.

[c]RE = retinol equivalents.

5.7 CEREAL–LEGUME–DRY MILK RATIONS

If both legumes and dry milk are available, both can be used to supplement the cereal grains. This would increase the variety in the diet and improve the protein quality. Diets have been calculated with grains in an 8:1 ratio with the supplementary foods. Calculations could easily be made for a 4:1 ratio of grain to supplementary food. Dry milk has been added at a level to provide 7 g of protein, the recommendation of the FAO (1). This is equivalent to 7 oz of fluid milk. Small amounts of animal protein would increase the protein quality of the diet.

The quantities of food needed to provide an 8:1 ratio of grains to legumes and nonfat dry milk are as follows:

	Per day	Per week	Per year
Cereal grains	500 g (1.1 lb)	7.7 lb	400 lb
Legumes	43 g (1 ½ oz)	10.5 oz	34.1 lb
Nonfat dry milk	20 g (⅔ oz)	5.0 oz	16.2 lb
Fat	28 g (1 oz)	7.0 oz	22.5 lb
Salt	10 g (⅓ oz)	2.5 oz	8.1 lb
Other foods	To provide 312 to 482 kcal/day		

Substitutions for fat and suggestions for other foods have been given previously.

Tables 16 through 19 give the nutritive data on these grain–legume–nonfat dry milk diets.

The protein score of the diet is set at 70, since there is animal protein in the diet. This establishes the safe level of protein as 47 g. All four diets exceed the recommended level.

The yellow-corn-based diet is the only diet having vitamin A. If the nonfat dry milk were fortified with vitamin A, nearly ¼ of the emergency recommendation would be met. Other sources of vitamin A are needed.

Vitamins C and D are still inadequate. If the nonfat dry milk were fortified with vitamin D, 20 g would provide 2.2 μg, which is nearly ¼ of the amount needed for vulnerable groups.

Thiamin is inadequate in the unenriched-rice-based diet; the other diets have adequate thiamin. Riboflavin content is improved because of the contribution made by the dry milk; it is lowest in the rice-based diet. Preformed niacin is low in the rice- and corn-based diets. Vitamin B-6 is low in the flour- and rice-based diets. The whole-wheat-based diet is the only diet that exceeds the emergency recommendation for folacin.

Calcium is adequate in all four diets because of the contribution made by the milk. Magnesium is low but adequate in the white-flour- and rice-based diets, and zinc and potassium are quite low in these two diets.

In summary, vitamins A, C, and D continue to be deficient in survival diets using nonfat dry milk and legumes to supplement the cereal grains. In addition, the whole wheat diet is low in riboflavin. The enriched flour diet is low in vitamin B-6, folacin, zinc, and potassium. The unenriched white rice diet is low in thiamin, riboflavin, niacin, vitamin B-6, folacin, iron, zinc, and potassium. The yellow-corn-based diet is low in riboflavin and folacin.

The addition of milk to the diets provides high quality protein, brings the calcium above the recommended level, and increases the riboflavin slightly. If the nonfat dry milk were fortified with vitamins A and D, it would be helpful even though it would not make the diets entirely adequate in these nutrients. If more milk could be used, the riboflavin, and possibly vitamins A and D, would meet the recommended levels. If milk supplies are scarce, all milk should be reserved for infants, children, and pregnant or lactating women. Milk fortified with vitamins A and D should be used whenever possible.

Table 16. Nutrient levels of a survival ration based on whole wheat, using legumes and dry milk[a]

	Whole wheat	Legumes[b]	Nonfat dry milk	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	43	20	28	10			
Energy, kcal	1650	146	72	250	0	482	2600	2600
Protein, g	65.0	9.6	7.1	0	0		81.7	47[c]
Fat, g	10.0	0.7	0.1	28.0	0		38.8	30
Calcium, mg	210	62	258	0	0		530	400
Magnesium, mg	750	73	28	0	0		851	200–300
Iron, mg	16.5	3.3	0.1	0	0		19.9	10
Zinc, mg	17.0	1.2	0.9	0	0		19.1	11
Potassium, mg	1850	515	345	0	0		2710	1500–2500
Vitamin A, RE[d]	0	0	0[e]		0			550
Thiamin, mg	2.7	0.3	0.1	0	0		3.1	1.0
Riboflavin, mg	0.6	0.1	0.4	0	0		1.1	1.4
Niacin, mg	21.5	1.0	0.2	0	0		22.7	17.0
Vitamin B-6, mg	1.7	0.2	0.1	0	0		2.0	1.5
Folacin, μg	(245)	53	1	0	0		298	200
Vitamin C, mg	0	0	1	0	0		1	15–30

[a]Numbers in parentheses denote values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as 43 g of raw, dry, white beans; may be replaced by 29 g of dry soybeans.

[c]The protein score of the diet is set at 70 since some animal protein is included.

[d]RE = retinol equivalents.

[e]If the nonfat dry milk were fortified with vitamins A and D, the RE would be 135 μg (446 IU) and the vitamin D would be 2.2 μg (88 IU).

Table 17. Nutrient levels of a survival ration based on enriched white flour, using legumes and dry milk[a]

	Enriched white flour	Legumes[b]	Nonfat dry milk	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	43	20	28	10			
Energy, kcal	1820	146	72	250	0	312	2600	2600
Protein, g	52.5	9.6	7.1	0	0		69.2	47[c]
Fat, g	5.0	0.7	0.1	28.0	0		33.8	30
Calcium, mg	80	62	258	0	0		400	400
Magnesium, mg	125	73	28	0	0		226	200–300
Iron, mg	14.5	3.3	0.1	0	0		17.9	10
Zinc, mg	3.5	1.2	0.9	0	0		5.6	11
Potassium, mg	475	515	345	0	0		1335	1500–2500
Vitamin A, RE[d]	0	0	0[e]		0			550
Thiamin, mg	2.2	0.3	0.1	0	0		2.6	1.0
Riboflavin, mg	1.3	0.1	0.4	0	0		1.8	1.4
Niacin, mg	17.5	1.0	0.2	0	0		18.7	17.0
Vitamin B-6, mg	0.3	0.2	0.1	0	0		0.6	1.5
Folacin, μg	40	53	1	0	0		94	200
Vitamin C, mg	0	0	1	0	0		1	15–30

[a]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as 43 g of raw, dry, white beans; may be replaced by 29 g of dry soybeans.

[c]The protein score of the diet is set at 70 since some animal protein is included.

[d]RE = retinol equivalents.

[e]If the nonfat dry milk were fortified with vitamins A and D, the RE would be 135 μg (446 IU) and the vitamin D would be 2.2 μg (88 IU).

Table 18. Nutrient levels of a survival ration based on white rice, using legumes and dry milk[a]

	Unenriched white rice	Legumes[b]	Nonfat dry milk	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	43	20	28	10			
Energy, kcal	1810	146	72	250	0	322	2600	2600
Protein, g	33.5	9.6	7.1	0	0		50.2	47[c]
Fat, g	2.0	0.7	0.1	28.0	0		30.8	30
Calcium, mg	120	62	258	0	0		440	400
Magnesium, mg	140	73	28	0	0		241	200–300
Iron, mg	4.0	3.3	0.1	0	0		7.4	10
Zinc, mg	6.5	1.2	0.9	0	0		8.6	11
Potassium, mg	460	515	345	0	0		1320	1500–2500
Vitamin A, RE[d]	0	0	0[e]		0			550
Thiamin, mg	0.4	0.3	0.1	0	0		0.8	1.0
Riboflavin, mg	0.2	0.1	0.4	0	0		0.7	1.4
Niacin, mg	8.0	1.0	0.2	0	0		9.2	17.0
Vitamin B-6, mg	0.8	0.2	0.1	0	0		1.1	1.5
Folacin, μg	80	53	1	0	0		134	200
Vitamin C, mg	0	0	1	0	0		1	15–30

[a]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as 43 g of raw, dry, white beans; may be replaced by 29 g of dry soybeans.

[c]The protein score of the diet is set at 70 since some animal protein is included.

[d]RE = retinol equivalents.

[e]If the nonfat dry milk were fortified with vitamins A and D, the RE would be 135 μg (446 IU) and the vitamin D would be 2.2 μg (88 IU).

Table 19. Nutrient levels of a survival ration based on yellow field corn, using legumes and dry milk[a]

	Yellow field corn (dry)	Legumes[b]	Nonfat dry milk	Fat	Salt	Other foods	Total	Emergency recommendation
Amount, g	500	43	20	28	10			
Energy, kcal	1740	146	72	250	0	392	2600	2600
Protein, g	44.5	9.6	7.1	0	0		61.2	47[c]
Fat, g	19.5	0.7	0.1	28.0	0		48.3	30
Calcium, mg	110	62	258	0	0		430	400
Magnesium, mg	735	73	28	0	0		836	200–300
Iron, mg	10.5	3.3	0.1	0	0		13.9	10
Zinc, mg	10.5	1.2	0.9	0	0		12.6	11
Potassium, mg	1240	515	345	0	0		2100	1500–2500
Vitamin A, RE[d]	240[e]	0	0[f]		0		240	550
Thiamin, mg	1.8	0.3	0.1	0	0		2.2	1.0
Riboflavin, mg	0.6	0.1	0.4	0	0		1.1	1.4
Niacin, mg	11.0	1.0	0.2	0	0		12.2	17.0
Vitamin B-6, mg	(1.2)	0.2	0.1	0	0		1.5	1.5
Folacin, μg	(132)	53	1	0	0		186	200
Vitamin C, mg	0	0	1	0	0		1	15–30

[a]Numbers in parentheses denote values imputed – usually from another form of the food; zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[b]Calculated as 43 g of raw, dry, white beans; may be replaced by 29 g of dry soybeans.

[c]The protein score of the diet is set at 70 since some animal protein is included.

[d]RE = retinol equivalents.

[e]If white corn were used, there would be only a trace of vitamin A.

[f]If the nonfat dry milk were fortified with vitamins A and D, the RE would be 135 μg (446 IU) and the vitamin D would be 2.2 μg (88 IU).

5.8 SUMMARY

Tables 20 through 22 present a summary of the rations that have been previously evaluated: grain-legume at a 4:1 ratio, grain-legume at an 8:1 ratio, and grain–legume–dry milk as a variation of the 8:1 ratio.

The protein level of the diets is adequate except for the 8:1 rice-legume diet. The protein quality of the grain-legume diets is best when the ratio is 4:1 rather than 8:1. Although the 8:1 ratio is adequate for healthy adults, the 4:1 ratio provides a better protein quality for children. This would be the ratio of choice if sufficient legumes were available. The addition of the nonfat dry milk provides a high quality protein to supplement the protein in the grains and legumes. If milk supplies are limited, milk should be reserved for infants, children, and pregnant or lactating women.

Calcium is adequate in the diets only where milk is used. Lime treatment of corn could also provide calcium. Other calcium sources might need to be found for vulnerable groups if calcium sources are limited for several months.

The most obvious deficiencies in these diets are in vitamins A, C, and D. The only diet with any vitamin A value uses yellow corn. If white corn were used, the vitamin A contribution of the corn would be essentially zero. If fortified nonfat dry milk were used, vitamin A would be increased by 135 μg retinol equivalents and vitamin D would be increased by 2.2 μg. There are no other sources of vitamin D in the diets.

Table 20. Summary of cereal grain–legume survival rations – 4:1 ratio[a, b]

	Whole wheat	Enriched white flour	Unenriched white rice	Yellow field corn	Emergency recommendation
Energy, kcal[c]	2600	2600	2600	2600	2600
Protein, g	83.5	72.2	55.1	65.0	55[d]
Fat, g	39	34	32	47	30
Calcium, mg	345	233	269	260	400
Magnesium, mg	910	302	316	850	200–300
Iron, mg	23.5	21.7	12.3	18.1	10
Zinc, mg	18.4	6.3	8.9	12.5	11
Potassium, mg	3010	1765	1650	2620	1500–2500
Vitamin A, RE[e]				220[f]	550
Thiamin, mg	3.2	2.6	1.0	2.3	1.0
Riboflavin, mg	0.7	1.4	0.3	0.7	1.4
Niacin, mg	22.0	18.4	9.9	12.6	17.0
Vitamin B-6, mg	2.1	0.9	1.4	1.7	1.5
Folacin, μg	360	176	212	259	200
Vitamin C, mg					15–30
Vitamin D, μg[g]	0	0	0	0	0

[a]These rations are based on 450 g of cereal grains and 112 g of legumes (other than soybeans) per day. If soybeans are used, only 75 g/day are needed.

[b]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[c]If other foods are not supplied to meet this energy level, the energy levels would be: whole wheat, 2110 kcal; white flour, 2260 kcal; white rice, 2260 kcal; and field corn, 2190 kcal.

[d]The protein score is set at 60 since there is no animal protein in the diets.

[e]RE = retinol equivalents.

[f]If white corn were used, there would be only a trace of vitamin A.

[g]The emergency recommendation for infants, children less than 7 years, and pregnant or lactating women is 10 μg.

Table 21. Summary of cereal grain–legume survival rations – 8:1 ratio[a,b]

	Whole wheat	Enriched white flour	Unenriched white rice	Yellow field corn	Emergency recommendation
Energy, kcal[c]	2600	2600	2600	2600	2600
Protein, g	79.0	66.5	47.5	58.9	55[d]
Fat, g	39	34	31	49	30
Calcium, mg	301	171	211	201	400
Magnesium, mg	857	232	247	842	200–300
Iron, mg	21.4	19.4	8.9	15.4	10
Zinc, mg	18.7	5.2	8.2	12.2	11
Potassium, mg	2600	1225	1210	1990	1500–2500
Vitamin A, RE[e]				240	550
Thiamin, mg	3.1	2.6	0.8	2.2	1.0
Riboflavin, mg	0.7	1.4	0.3	0.7	1.4
Niacin, mg	22.7	18.7	9.2	12.2	17.0
Vitamin B-6, mg	2.0	0.6	1.1	1.5	1.5
Folacin, μg	323	118	158	210	200
Vitamin C, mg					15–30
Vitamin D, μg[f]	0	0	0	0	0

[a]These rations are based on 500 g of cereal grains and 63 g of legumes (other than soybeans) per day. If soybeans are used, only 42 g/day are needed.

[b]Zero indicates that the amount of nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[c]If other foods are not supplied to meet this energy level, the energy levels would be: whole wheat, 2114 kcal; white flour, 2284 kcal; white rice, 2274 kcal; and field corn, 2204 kcal.

[d]The protein score is set at 60 since there is no animal protein in the diets.

[e]RE = retinol equivalents.

[f]The emergency recommendation for infants, children less than 7 years, and pregnant or lactating women is 10 μg.

The only source of vitamin C in the diets is the inadequate trace in the nonfat dry milk. Whole grains and legumes may be sprouted and used for their vitamin C content (see Appendix D). Sprouted legume seeds should be boiled for about 2 minutes since the protein is not well utilized if they are eaten raw. Whole small grains, such as wheat, that could be used for sprouting should be included in the refined cereal grain rations as a vitamin C source if other sources are not available. Sprouts derived from 30 g (about 1 oz) of dry grain or legumes would be sufficient to prevent a vitamin C deficiency if they were eaten daily.

Thiamin is inadequate only in the ration consisting of the unenriched white rice when the legumes are provided at the level of 63 g or less. If enriched white or brown rice were used instead of the unenriched white rice, thiamin levels would be adequate. Milled, parboiled rice would also improve the thiamin content of the diet.

Riboflavin is adequate only in the diets based on enriched white flour. Milk contributes some riboflavin but not enough to make the diets adequate. The diets based on unenriched white rice have the lowest riboflavin level. Preformed niacin is low in the corn- and rice-based diets. Corn-based diets might cause pellagra unless niacin is supplemented, more high quality protein is included, or the corn is treated with alkali to make the niacin more available.

Vitamin B-6 is low in all the white-flour- and rice-based diets.

Folacin is low in all the white-flour-based diets and in the rice-based diets when the legumes are provided at the level of 63 g or less. Folacin becomes low in the corn-based diet when the legumes are at the level of 40 g. Folacin is adequate in all the whole-wheat-based diets.

Table 22. Summary of the cereal grain–legume–dry milk[a] survival rations[b,c]

	Whole wheat	Enriched white flour	Unenriched white rice	Yellow field corn	Emergency recommendation
Energy, kcal[d]	2600	2600	2600	2600	2600
Protein, g	81.7	69.2	50.2	61.2	47[e]
Fat, g	38.8	33.8	30.8	48.3	30
Calcium, mg	530	400	440	430	400
Magnesium, mg	851	226	241	836	200–300
Iron, mg	19.9	17.9	7.4	13.9	10
Zinc, mg	19.1	5.6	8.6	12.6	11
Potassium, mg	2710	1335	1320	2100	1500–2500
Vitamin A, RE[f]				240[g]	550
Thiamin, mg	3.1	2.6	0.8	2.2	1.0
Riboflavin, mg	1.1	1.8	0.7	1.1	1.4
Niacin, mg	22.7	18.7	9.2	12.2	17.0
Vitamin B-6, mg	2.0	0.6	1.1	1.5	1.5
Folacin, μg	298	94	134	186	200
Vitamin C, mg	1	1	1	1	15–30
Vitamin D, μg[h]	0	0	0	0	0

[a]If the nonfat dry milk were fortified with vitamins A and D, the RE would be 135 μg (446 IU) and the vitamin D would be 2.2 μg (88 IU).

[b]These rations are based on 500 g of cereal grains, 43 g of legumes (other than soybeans), and 20 g of nonfat dry milk per day. If soybeans are used, only 29 g/day are needed. The ratio of cereal grains to supplementing foods is 8:1.

[c]Zero indicates that the amount of a nutrient probably is none or is too small to measure; no entry denotes lack of reliable data for a nutrient believed to be present in measurable amount.

[d]If other foods are not supplied to meet this energy level, the energy levels would be: whole wheat, 2118 kcal; white flour, 2288 kcal; white rice, 2278 kcal; and field corn, 2208 kcal.

[e]The protein score is set at 70 since some animal protein is included.

[f]RE = retinol equivalents.

[g]If white corn were used, there would only be a trace of vitamin A.

[h]The emergency recommendation for infants, children less than 7 years, and pregnant or lactating women is 10 μg.

Magnesium is adequate in all the diets but is lowest in the white-flour- and rice-based diets when the grain-legume ratio is 8:1 or more.

Iron is low in the rice-based diet when the grain-legume ratio is 8:1 or more. The recommended level of iron is not adequate for vulnerable groups so supplementary iron might be needed by women and children prone to iron deficiency anemia.

Zinc is adequate only in the whole-wheat- and corn-based diets. The white-flour-based diets have the lowest zinc levels.

Potassium is adequate in all the whole-wheat-based and corn-based diets. The white-flour-based and rice-based diets are low in potassium when they are in an 8:1 ratio with legumes.

Combinations of grains could be used to increase some of the low nutrient values. If they are available, whole wheat and rice or white enriched flour and corn would be good combinations. Grain combinations would also help relieve the monotony of the survival rations.

If they were available, multivitamin pills would eliminate vitamin deficiencies, and for those individuals prone to iron deficiency, a multivitamin pill with iron is recommended.

Energy levels in the diet should be met by other foods that may be available. Otherwise, more staple foods should be distributed. Fruits, vegetables, fats and oils, and sugar could be used. Fruits and vegetables should be selected to provide vitamins A and C, if possible.

Slightly different combinations of cereal grains, legumes, and/or dry milk and other foods might be used, depending on the supplies available. Other good protein sources, such as meat, fish, poultry, and eggs, might be used if they are available. Protein levels of the diets should meet the emergency level.

If changes occurred in the selection of the foods, some major nutritional changes might occur in the diet. If plain instead of iodized salt is used, iodine might become deficient in the diet. If unenriched white flour is used, the iron, thiamin, and riboflavin content of the diet would drop sharply. Careful attention must be given to the nutrient content of the foods so that the right combinations are selected.

Since it probably would not be possible to provide adequate quantities of all nutrients immediately, nutrient priorities should be determined. Priorities based on physiological needs would be water, salt, energy needs, protein, vitamin C, and, finally, other nutrients as soon as possible. The other nutrients would be determined by those nutrients most critical in particular survival diets. Infants and young children, in addition, would need vitamins A and D. During the last half of pregnancy, women would need additional energy foods, protein, folacin, vitamin A, and perhaps iron. Lactating women would need extra fluids, energy foods, protein, vitamins, and calcium.

A percentage factor of 10 should be added to energy and protein foods to allow for shipping losses from spoilage and spillage. When the food is distributed to the consumer, a percentage factor of 5 to 10 should be added to allow for small losses that occur in food preparation and wastes remaining on plates and utensils.

Would people eat these survival rations? This is an important question since survival rations might be vastly different from the traditional diet. Methods of using the foods might be new and many, if not most, people would not know how to prepare them. Mass education on how to prepare the foods would be needed but would be difficult to provide in a survival setting. Complaints would be frequent because of the monotony of the diet and the limited number of available foods. Many people might prefer to lose weight than to eat the food. In addition to providing food for populations, encouragement and special instructions would probably be needed to get modern Americans to eat enough of the survival rations to remain healthy.

6. Infants and Young Children

6.1 DIETARY NEEDS OF INFANTS

Survival rations are usually established to provide for the majority of the population, that is, adults and older children. In developing countries, where a majority of the women nurse their babies, rations for infants are often ignored. In the United States, most mothers nurse their babies for no more than a few weeks, if at all, whereas mothers in the lesser-developed countries may nurse their babies for more than a year. Special provisions are needed for infants in an emergency.

Rations provided by the government during short-term emergencies usually include commercial baby formula. In a national emergency of great magnitude, especially a nuclear war and its aftermath, baby formula supplies would soon be exhausted, thus forcing mothers to feed their babies with formulas made from evaporated or nonfat dry milk, if available. The nonfat dry milk formula would require the addition of fat to give it an adequate energy level, without providing excess protein. The added fat would also provide essential fatty acids in the diet, which are necessary for normal growth and development of the infant.

An evaporated milk formula can be made by mixing one 13½-oz can of evaporated milk with 2 tablespoons of sugar or corn syrup and diluting it to 1 quart with safe water. A nonfat dry milk formula can be made by combining 1 cup plus 2 tablespoons of instant nonfat dry milk [79 g (2¾ oz, or ¾ cup) of noninstant nonfat dry milk], 3 tablespoons vegetable oil (28 g), and 2 tablespoons of sugar or corn syrup and diluting it to 1 quart with safe water. Both of these formulas will provide 29 g protein and 640 to 680 kcal. If milk supplies are limited, milk should be fed to infants only.

The FAO/WHO Expert Committee on Energy and Protein Requirements suggests 17 g protein, equivalent in quality to milk protein, for 6- to 11-month-old infants (12). This recommendation is equivalent to 8 oz of evaporated milk or 48 g of nonfat dry milk. Other food would be needed in the diet to meet energy needs. The FAO/WHO committee assumes that infants younger than 6 months would be nursed (12); however, this may not be so. The RDA (3) is 2.2 g protein per kilogram of body weight for infants from birth to 6 months of age, and 2.0 g/kg for those from 6 months to 1 year. Thus, the RDA for protein for a 20-lb (9.1-kg) infant would be 18.2 g, which is similar to the FAO/WHO recommendation of 17 g.

Women who give birth during a time of dire national emergency must nurse their infants, whether they want to or not. Therefore, customs must change so that nursing infants will be as accepted and as natural in the United States as in lesser-developed countries. Women, while still pregnant, must learn how to prepare for nursing their infants. Wet nurses will be needed for infants whose mothers are not able to nurse them.

Many mothers must be taught how to make infant formula from whatever milk supplies (whole, dry, or evaporated) are available. If baby bottles are not available, infants must be fed by spoon from a cup. If soap, water, and boiling facilities are limited, methods using chlorine water should be used to keep the utensils safe for the infant (43). (See Appendix H for directions.)

Many women in the United States depend on commercial baby food for feeding infants less than I year old. Since, in a national disaster, these foods may not be available, mothers must be taught the basic principles of how to feed their infants from the foods that are available.

If the infant is breast-fed and if the amount of the mother's milk is adequate, there is no need to provide solid food until the child is about 6 months old. If inadequate in amount, the breast milk must be supplemented by another milk source. If another milk source is not available, solid foods must be started earlier to provide the necessary nutrients.

Depending on the source of milk for the infant, vitamins A, D, and C may or may not be needed. (See Table 23 for an evaluation of infant milk sources.) These vitamins should be provided from the time of birth, in the milk or by supplement. If the infant does not receive adequate amounts of vitamins A, D, and C, he will develop deficiency symptoms in 1 to 3 months, depending on his extent of body stores. The following methods of providing supplements are recommended in a survival setting.

1. If vitamin pills are available, a standard daily vitamin pill providing 5000 IU (1500 RE) of vitamin A, 400 IU (10 μg) of vitamin D, and 50 to 100 mg of vitamin C is required. Other vitamins in the pill would not harm the infant. The infant should receive ¼ to ½ of a pill each day. The pill should be crushed to a fine powder between two spoons and dissolved in a small amount of fluid that the baby can easily swallow.
2. The infant should receive 15 mg or more of vitamin C per day, from either a crushed pill containing vitamin C or traditional foods containing vitamin C. If these options are not available, the juice from sprouted grains or legumes can be used.
3. Vitamin A will be difficult to provide in a survival setting if no traditional vitamin A foods are available. Green sprouts from germinated seeds can be crushed to provide a greenish water. This source would provide some carotene, but it would not supply all the vitamin A needed.
4. Vitamin D is present in adequate amounts in certain foods only if those foods have been fortified with it. Fish liver oils are the only naturally occurring source of vitamin D that has been used regularly; fish liver oils are also a good source of vitamin A. If no food sources or vitamin pills containing vitamin D are available, the infant's skin should be exposed to sunlight every day if possible. This procedure will initiate vitamin D production. A delay of up to about 30 days before beginning exposures would not be harmful to the infant. After 30 days, only in areas of extremely heavy fallout would the radiation dangers outdoors make short exposures to sunlight impractical. Initial exposures should be very short, no more than 10 minutes.

Table 23. Supplements needed for infants being fed various milk sources

Type of milk	Vitamin A	Vitamin D	Vitamin C
Breast	Present if mother's diet is adequate	Supplement needed[a]	Present
Evaporated	Present	Present	Supplement needed
Nonfat, dry	Present if fortified	Present if fortified	Supplement needed
Fresh, whole	Present	Present if fortified; otherwise, supplement needed	Supplement needed[b]
Commercial infant formula	Present	Present	Present

[a]Breast milk theoretically has adequate amounts of vitamin D, but rickets has been reported in breast-fed infants; therefore, a supplement is recommended.

[b]Although fresh milk theoretically has adequate amounts of vitamin C, by the time it has been prepared for infant formula, it has become a marginal source; therefore, a supplement is recommended.

6.2 SOLID FOODS

Solid foods should be supplied to the infant by the sixth month if the milk supply has been adequate, or earlier if the milk supply has not been adequate. If commercial baby foods are not available, foods must be made by the family. The order in which the foods are provided is not important as long as the infant gradually learns to eat a variety of whatever foods are available. The food must be finely pureed for the young infant. As the child acquires his teeth and grows older, the food can become coarser in texture. There are several methods for making pureed baby food: (1) Food can be pressed through a sieve; (2) food can be mashed with a fork or spoon; or (3) crushed food can be squeezed through a porous piece of cloth. Good sanitation must be maintained while preparing baby foods. All foods should be heated to a boil after pureeing to ensure that the food is safe from bacteria.

One recommendation for solid food is to use a combination of cereal grains and legumes in a ratio of 3 parts to 1 part (44). The cereals and legumes should be boiled together until they are soft and mashed through a sieve. The sieve catches the fiber from the grain and the skin from the legumes as the puree is prepared. Flours made from cereal grains could also be used in place of the whole-kernel grains. The grain-legume combination will provide needed calories and a well-supplemented protein. The legumes also provide the additional iron that is needed by the infant by the time he is 6 months old.

Some grains are preferable to others. It is easier to mash a cooked corn kernel through a sieve than a cooked wheat kernel. Likewise, a wheat flour would be easier to use than whole-kernel wheat. Since wheat is the most allergenic of the cereal grains, it should not be fed to an infant until he is 6 or 7 months old if other grains, such as rice or corn, are available.

Available fruits or vegetables should be similarly prepared. Safe fresh foods can be scraped with a spoon to provide a pureed fresh food. By applying these principles with ingenuity, a mother can provide her infant with solid food.

6.3 CHILDREN OLDER THAN 1 YEAR

By the time the infant is 1 year old, he should be eating nearly the same foods as the other members of the family. To avoid the serious malnutrition problems that are encountered in some countries, the mother should provide her infant with sufficient energy and protein in addition to the nutrients mentioned. (See Table B.1 in Appendix B for the suggested RDA for energy and protein levels for children.) Because the child has a high protein requirement for his size, a complete protein pattern must be provided several times a day, either from a complete protein food or from a supplemented source, if normal growth is to occur.

If milk supplies are uncertain for children, it is important that they receive an adequate amount of protein from other sources, such as the legume-cereal combination previously described.

Young children need fat in their diet so that they can meet their energy needs, which are high for their size. If the diet is lacking a concentrated energy source such as fat or sugar, it may not be physically possible for the child to eat enough food to supply his energy needs. A diet of 10 to 20% fat should be adequate.

If only very low fat foods are available, the child's feedings should be increased to 4 or 5 or more per day. This would reduce the amount of food in each feeding and allow the young child to better consume the total amount of food necessary.

If milk cannot be provided to young children, another calcium source should be found, if possible. Vitamins A, C, and D must continue to be supplied to the young child.

7. Pregnancy and Lactation

7.1 INTRODUCTION

Pregnancy and lactation are times of stress in a woman's life because of increased nutrient demands on her body. These demands must be met, even during an emergency, to keep both the mother and infant healthy.

All women should be encouraged to breast-feed their infants. During times of food shortage, especially if milk is in short supply, a lactating mother becomes a natural resource. Since nursing is no longer traditional among many women in the United States, pregnant women must be taught how to prepare for nursing and how to nurse. Many healthy women in the United States have a more difficult time nursing than do malnourished women in lesser-developed countries. Good nutrition is not the only factor for nursing success; psychological factors and stress also play an important role.

7.2 ENERGY

Studies have shown that a low weight gain of the mother is associated with low birth weight in infants (45). Low birth weight is associated with greater risk to the infant. One way to prevent the low weight gain of the mother is to provide her with an adequate energy intake. The recommended RDA is 300 kcal above normal, nonpregnant needs for a women during pregnancy. This energy intake should provide a weight gain of about 24 lb. It has been shown that large calorie supplements given to undernourished pregnant women cause an appreciable improvement in birth weight and that the calorie value of the supplement is more important than its protein content (46). An adequate weight gain of the mother during her pregnancy increases body fat stores, which provide an energy reserve for lactation. An additional 500 kcal above nonpregnant energy needs is recommended for lactating women (3).

A recent study reports the effect of prenatal exposure of fetuses to the Dutch famine of 1944–1945 on later mental performance (47). The subjects, who were tested when 19 years old, were in utero during part or the whole of the famine. Records show that (1) poor rations provided a mean of 450 kcal at their lowest point; (2) for 6 months, rations were below 750 kcal per head per day; (3) birth weights of infants were lower in the famine areas. However, there was no effect on the frequency of severe or mild mental retardation nor on intelligence of the subjects tested. It is believed that the mothers went into the famine relatively well nourished and were able to draw on their body nutrient reserves during pregnancy. If the mother had entered the famine with poor nutrient stores, the outcome might have been different.

Hopefully, in the event of a national emergency in this country, the mothers would, likewise, not have experienced a previous starvation period. If food supplies are critical, women in their last trimester of pregnancy should be fed before others since this is the time when maternal undernutrition will most affect the fetus (45).

7.3 PROTEIN

The FAO/WHO recommends an additional 11 and 17 g protein for pregnancy and lactation, respectively, if the protein score of the diet is 80 or above (12). (See Table B.2 in Appendix B.) Note that the recommended amount of the additional protein increases as the protein score of the diet decreases. These amounts of protein should be met if at all possible.

7.4 VITAMIN A

A woman who enters her pregnancy with adequate vitamin A stores would have sufficient vitamin A for the pregnancy; however, there is no way to determine the extent of vitamin A reserves. It is prudent to assume that vitamin A levels might be borderline and to provide for minimum needs. The FAO/WHO recommends 750 μg/day of retinol for both pregnant and lactating women. If vitamin A food supplies are limited, available supplies should be given to children and pregnant or lactating women first.

The milk of lactating women should supply adequate amounts of vitamin A to the infant during the first few months of his life. If the mother's vitamin A stores are inadequate, her milk will contain little vitamin A and the infant may develop deficiency symptoms. Among children, vitamin A deficiency is second only to protein-calorie malnutrition as a problem in the world. Most victims are children born to vitamin A–deficient mothers, who cannot provide adequate amounts of vitamin A in their milk.

7.5 VITAMIN D

A pregnant or lactating woman should receive 10 μg/day (400 IU) of vitamin D or expose her skin to sunlight each day. (See Sect. 6.1 for pertinent cautions.) The exposure to sunlight would enable her to better absorb calcium from her diet.

7.6 IRON

If a woman has good iron stores at the time of conception, FAO/WHO recommendations for daily intakes of iron during pregnancy (Table 3) should be adequate. If prepregnancy iron stores are not adequate, an additional iron supplement will be necessary.

7.7 CALCIUM

If supplies of milk, which is the most important source of calcium in the American diet, are limited, it may not be possible to provide additional calcium during pregnancy. If the mother has had enough calcium in her diet in the past, a deprivation of calcium at this time can be tolerated for one pregnancy. Such deprivation is, however, undesirable since the mother's body will sacrifice about 30 g calcium for the baby. Her body will partly balance the lowered calcium in the diet by absorbing a larger percentage of the dietary calcium. Most women in developing countries do not have the calcium intake that is considered normal in the United States, but they are able to produce normal infants. Some milk or calcium should be provided if possible, especially during lactation.

7.8 THIAMIN, RIBOFLAVIN, AND NIACIN

Increased amounts of thiamin, riboflavin, and niacin are needed during pregnancy and lactation. Demand for these vitamins should be met by increasing the calories in the diet. This assumes that the additional calories are not coming from unenriched white rice or white flour, sugar, or fat.

7.9 FOLACIN

There is an increased need for folacin, which is found in whole grains, legumes, and green leaves, during pregnancy. Since whole grains and legumes may be major parts of the diet, folacin supplies should be adequate, but eating green leaves will help provide increased amounts of folic acid and carotene. Sprouted seeds may be eaten to increase the folic acid content of the diet if other sources are not available.

7.10 VITAMIN C

The FAO/WHO recommends 50 mg/day of vitamin C for all pregnant and lactating women. Since vitamin C is secreted in human milk, a vitamin C source must be included in the mother's diet. If no other sources are available, sprouted seeds can be used to provide vitamin C. Since the vitamin C concentration of sprouted seeds and sprouts is not high, it might not be possible to provide 50 mg/day from such sources unless large quantities are eaten. (See Appendix D.)

7.11 SUMMARY

Energy needs for pregnancy and lactation should be the first considerations in times of extreme stress. An additional 300 kcal above the nonpregnant needs are necessary for pregnant women, and 500 kcal or more are needed during lactation. There is an increased need for all nutrients during pregnancy and lactation. Protein, vitamins A, C, and D, iron, and folic acid are nutrients that may be critical during this time unless additional food sources or supplements are given.

References

1. G. B. Masefield, *Food and Nutrition Procedures in Times of Disaster,* Food and Agriculture Organization, Rome, Italy, 1967, 96 pp.

2. E. P. Torrance, "Survival Stresses and Food Problems," paper presented at Symposium on Stress As Applied to Food Problems, at the Quartermaster Research and Development Command. Natick, Mass., May 21–22, 1957 (unpublished paper).

3. National Research Council, Food and Nutrition Board, *Recommended Dietary Allowances, 8th Edition,* National Academy of Sciences, Washington, D.C., 1974, 128 pp.

4. R. Passmore et al., *Handbook on Human Nutritional Requirements,* Food and Agriculture Organization, Rome, Italy, 1974, 66 pp.

5. National Research Council, Food and Nutrition Board, *Minimal Allowances of Water and Food for Fallout Shelter Survival,* National Academy of Sciences, Washington, D.C., 1963, 5 pp.

6. J. L. Gamble, "Physiological Information from Studies on the Life Raft Ration," *Harvey Lecture Series,* vol. 42, 1946–47, p. 247, as reported by J. H. Browe, "Survival Rations and Water," *Health News,* New York State Department of Health, Albany, vol. 39, No. 2, 1962, pp. 4–13.

7. D. H. Calloway, "Nutritional Aspects of the All-Purpose Survival Ration," *U.S. Armed Forces Med. J.* **11,** 403–17 (1960).

8. J. H. Browe, "Survival Rations and Water," *Health News,* New York State Department of Health, Albany, vol. 39, No. 2, 1962, pp. 4–13.

9. R. Van Reen et al., "Nutrition of Recruits During a Summer Habitability Study," *J. Am. Diet. Assoc.* **45,** 117–23 (1964).

10. R. E. Davenport, J. K. Spaide, and R. E. Hodges, "An Evaluation of Various Survival Rations," *Am. J. Clin. Nutr.* **24,** 513–23 (1971).

11. Environmental Protection Agency, Water Supply Division, *Manual of Individual Water Supply Systems,* Washington, D.C., 1973, pp. 139–41.

12. Food and Agriculture Organization/World Health Organization, *Energy and Protein Requirements,* report of a Joint FAO/WHO ad hoc Expert Committee, WHO Technical Report Series 522, FAO Nutrition Meetings Report Series 52, World Health Organization, Geneva, Switzerland, 1973, 118 pp.

13. R. Van Reen et al., "Nutrition of 96 Naval Recruits During a Shelter Habitability Study," *J. Am. Diet. Assoc.* **42,** 117–24 (1963).

14. J. N. Tate, R. D. Matthews, and H. Stone, "Development of a New Product for the Civil Defense Program," *J. Food Sci.* **35,** 831–33 (1970).

15. W. R. Aykroyd, *Conquest of Deficiency Diseases,* World Health Organization, Geneva, Switzerland, 1970, 98 pp.

16. Food and Agriculture Organization/World Health Organization, *Requirements of Vitamin A, Thiamin, Riboflavin, and Niacin,* report of a Joint FAO/WHO Expert Committee, FAO Nutrition Meetings Report Series 41, WHO Technical Report Series 362, World Health Organization, Geneva, Switzerland, 1967, 86 pp.

17. Food and Agriculture Organization/World Health Organization, *Requirements of Ascorbic Acid, Vitamin D, Vitamin B_{12}, Folate and Iron,* report of a Joint FAO/WHO Expert Group, WHO Technical Report Series 452, World Health Organization, Geneva, Switzerland, 1970, 75 pp.

18. S. H. Katz, M. L. Hediger, and L. A. Velleroy, "Traditional Maize Processing Techniques in the New World," *Science* **184,** 765–73 (1974).

19. A. E. Harper, B. D. Punekar, and C. A. Elvehjem, "Effect of Alkali Treatment on the Availability of Niacin and Amino Acids in Maize," *J. Nutr.* **66,** 163–72 (1958).

20. L. J. Bogert, G. M. Briggs, and D. H. Calloway, *Nutrition and Physical Fitness,* W. B. Saunders Co., Philadelphia, Pa., 1973, pp. 156–57.

21. E. L. R. Stokstad, Department of Nutritional Sciences, University of California, Berkeley, Calif., unpublished data.

22. Food and Agriculture Organization/World Health Organization, *Calcium Requirements,* report of an FAO/WHO Expert Committee on Calcium Requirements, WHO Technical Report Series 230, Food and Agriculture Organization, Rome, Italy, 1962, 54 pp.

23. D. M. Hegsted, "Calcium and Phosphorus," pp. 273–74 in R. S. Goodhart and M. E. Shils, eds., *Modern Nutrition in Health and Disease,* 5th ed., Lea and Febiger, Philadelphia, Pa., 1973.

24. W. R. Aykroyd and J. Doughty, *Wheat in Human Nutrition,* Food and Agriculture Organization, Rome, Italy, 1970, 163 pp.

25. J. A. Ford et al., "Biochemical Response of Late Rickets and Osteomalacia in a Chupatty-free Diet," *British Med. J.* **3,** 446–47 (1972).

26. World Health Organization, *Trace Elements in Human Nutrition,* report of a WHO Expert Committee, WHO Technical Report Series 532, World Health Organization, Geneva, Switzerland, 1973, pp. 13, 33.

27. C. V. Moore, "Iron," p. 300 in R. S. Goodhart and M. E. Shils, eds., *Modern Nutrition in Health and Disease,* 5th ed., Lea and Febiger, Philadelphia, Pa., 1973.

28. K. B. Franz and B. M. Kennedy, "Iron Concentration in Folk Remedies for Anemia," *New Eng. J. Med.* **293,** 1265–66 (1975).

29. J. A. Halsted, J. C. Smith, Jr., and M. Isabel Irwin, "A Conspectus of Research on Zinc Requirements of Man," *J. Nutr.* **104,** 345–78 (1974).

30. R. A. Conard, B. M. Dobyns, and W. W. Sutow, "Thyroid Neoplasia As Late Effect of Exposure to Radio-Active Iodine in Fallout," *J. Am. Med. Assoc.* **214,** 316–24 (1972).

31. U.S. Department of Agriculture, *Family Food Stockpile for Survival,* Home and Garden Bulletin 77, Washington, D.C., 1971, 16 pp.

32. M. J. Babcock, *Fallout Shelters and Nutrition Education,* Nutrition Committee News, U.S. Department of Agriculture, Jan.–Feb. 1962, 4 pp.

33. D. L. Bovee, "Food and Water for Survival in Emergencies," *J. Home Ec.* **54,** 751–54 (1962).

34. Cresson H. Kearny, *Nuclear War Survival Skills,* ORNL-5037, Oak Ridge National Laboratory, Oak Ridge, Tenn., 1979.

35. W. R. Aykroyd, *The Conquest of Famine,* Reader's Digest Press, New York, 1975, 203 pp.

36. H. K. Burr, S. Kon, and H. J. Morris, "Cooking Rates of Dry Beans as Influenced by Moisture Content and Temperature and Time of Storage," *Food Technol.* **22,** 88–90 (1968).

37. W. O. Gloyer, "Hardshell of Beans: Its Production and Prevention Under Storage Conditions," *Proc. Assoc. Off. Seed Anal.* **20,** 52–55 (1928).

38. H. K. Burr, "Effect of Storage On Cooking Qualities, Processing, and Nutritive Value of Beans," pp. 81–91 in W. G. Jaffe, ed., *Nutritional Aspects of Common Beans and Other Legume Seeds as Animal and Human Foods,* Archivos Latinoamericanos de Nutricion, Caracas, Venezuela, 1975.

39. D. H. Calloway, C. A. Hickey, and E. L. Murphy, "Reduction of Intestinal Gas Forming Properties of Legumes by Traditional and Experimental Food Processing Methods," *J. Food Sci.* **36,** 251–55 (1971).

40. K. S. Shurpalekar, O. E. Sundaravalli, and B. L. M. Desai, "Effect of Cooking and Germination on the Flatus Inducing Capacity of Some Legumes," pp. 134–37 in W. G. Jaffe, ed., *Nutritional Aspects of Common Beans and Other Legume Seeds as Animal and Human Foods.* Archivos Latinoamericanos de Nutricion, Caracas, Venezuela, 1975.

41. W. R. Aykroyd and J. Doughty, *Legumes in Human Nutrition,* Food and Agriculture Organization, Rome, Italy, 1964, 138 pp.

42. R. Bressani and L. G. Elias, "Legume Foods," p. 234 in A. M. Altschul, ed., *New Protein Foods,* Academic Press, New York, 1974.

43. D. B. Jelliffe, *Child Nutrition in Developing Countries,* Office of War on Hunger, Agency for International Development, U.S. Department of State, Washington, D.C., 1968, pp. 181, 189–90.

44. Personal communication with A. Chavez, Institute Nacional de Nutricion, Mexico 22, D.F., 1974.

45. "Mom's Diet: Key to Child's Growth," *Med. World News,* 28–36 (Jan. 5, 1973).

46. "Maternal Nutrition and Fetal Growth," *Nutr. Rev.* **32,** 241–43 (1974).

47. "Effect of Famine on Later Mental Performance," *Nutr. Rev.* **31,** 140–42 (1973).

Appendix A
Radioactive Fallout and Food

A brief review of radioactive fallout and food has been given in a booklet of the Food and Agriculture Organization, World Health Organization, *Food and Nutrition Procedures in Times of Disaster* (1). The following excerpt is taken from the FAO/WHO booklet.

Contamination of food supplies by radioactive fallout may arise from the use of nuclear weapons in war or from industrial accidents in a nuclear power plant.... If any warning at all is available before the danger arises, livestock and especially dairy cows should be brought under shelter, if possible, together with supplies of water and fodder for them. If this has not been done, milk from cows grazing on pastures subject to fallout should be regarded as dangerous for human consumption. Green vegetables will also be dangerous owing to their exposure to fallout, with the exception of peas and beans which are protected by their pods. Fruits should be avoided unless they have a thick skin which is removed before eating. Root crops would be relatively safe to use, especially if harvested soon after the explosion. Crops stored in weatherproof buildings should be safe as food; crops exposed to fallout while growing should not be consumed until tested for radioactivity. The flesh of animals affected by radiation sickness would be edible if they were killed before they were very sick, but the bones and offals should not be used as food. Eggs would be a fairly safe food. Packaged, canned and bottled foods in storage would be the safest of all to use.

These facts suggest that the most urgent food relief needs of affected areas will be milk and vegetables. Further needs can be assessed later, when examinations are made of stocks available and tests for radioactivity are conducted.

If the danger of fallout has been anticipated, householders may have been advised to store a reserve of water and foodstuffs in their homes, packaged or canned and bottled foods being the most suitable to withstand storage and escape contamination.

REFERENCES FOR APPENDIX A

1. G. B. Masefield, *Food and Nutrition Procedures in Times of Disaster,* Food and Agriculture Organization, Rome, Italy, 1967, pp. 73–74.

Appendix B

Comparison of Nutrient Recommendations Made by Various Groups

The recommended dietary allowances (RDA), which are the most widely used nutrient recommendations in the United States, were first published in 1943 with the objective of "providing standards to serve as a goal for good nutrition." Since that time they have been revised at intervals in accordance with newer information; the eighth edition was published in 1974 (1) (see Table B.1). The RDA are "the levels of intake of essential nutrients considered, in the judgment of the Food and Nutrition Board (National Academy of Sciences), on the basis of available scientific knowledge, to be adequate to meet the known nutritional needs of practically all healthy persons."

The RDA should be provided from as varied a selection of foods as is practicable to ensure that possibly unrecognized nutritional needs are met. Since, of course, food has no nutritional value unless it is eaten, the RDA should be provided from a selection of foods that are acceptable and palatable. The RDA are the levels of nutrients that should be consumed daily. They do not provide for extra nutrient needs that may arise from infections, metabolic disorders, chronic disease, or other abnormalities.

The Food and Agriculture Organization/World Health Organization (FAO/WHO) of the United Nations has published *Handbook on Human Nutritional Requirements* (2), which summarizes the results of studies by several expert groups. The aim of the handbook is "to provide a commentary written in a language that is intended to be more readily understandable to food administrators, agricultural planners and applied nutritionists." These data are presented in Table B.2. The recommendations are for food that reaches the stomach; that is, allowances for waste are not included. The FAO/WHO recommendations are used extensively in lesser-developed countries.

The RDA are generally higher than standards set for other countries or by the FAO/WHO of the United Nations since other countries do not have the food available to set optimum standards for all their people. Table B.3 presents a comparison of the RDA and the FAO/WHO standards.

In comparing these data (Table B.3), we note that energy levels are generally higher in the FAO/WHO recommendations since people in less industrialized countries do more physical work. The FAO/WHO protein allowances and other nutrients, with the exception of riboflavin and niacin, are not as generous as the RDA for the same nutrients. Recommendations for riboflavin and niacin are based on energy intake and are therefore higher for the FAO/WHO. Iron in the FAO/WHO recommendations varies, depending on the food sources in the diet. If animal protein foods are abundant in the diet, the lower value is used. If the diet is essentially devoid of animal protein foods, the higher figure is used.

In times of food emergencies the allowances of the RDA probably could not be met by many people because of limited food availability. Levels of nutrients needed to prevent nutrient deficiencies must be considered.

Table B.1 Food and Nutrition Board, National Academy of Sciences–National Research Council, recommended daily dietary allowances[a] (revised 1974)

Designed for the maintenance of good nutrition of practically all healthy people in the United States

	Age (years)	Weight		Height		Energy (kcal)[b]	Protein (g)	Fat-soluble vitamins: Vitamin A activity		Fat-soluble vitamins: Vitamin D (IU)	Fat-soluble vitamins: Vitamin E activity[d] (IU)	Water-soluble vitamins: Ascorbic acid (mg)	Water-soluble vitamins: Folacin[e] (μg)	Water-soluble vitamins: Niacin[f] (mg)	Water-soluble vitamins: Riboflavin (mg)	Water-soluble vitamins: Thiamin (mg)	Water-soluble vitamins: Vitamin B-6 (mg)	Water-soluble vitamins: Vitamin B-12 (μg)	Minerals: Calcium (mg)	Minerals: Phosphorus (mg)	Minerals: Iodine (μg)	Minerals: Iron (mg)	Minerals: Magnesium (mg)	Minerals: Zinc (mg)
		kg	lb	cm	in.			RE[c]	IU															
Infants	0.0–0.5	6	14	60	24	kg × 117	kg × 2.2	420[g]	1400	400	4	35	50	5	0.4	0.3	0.3	0.3	360	240	35	10	60	3
	0.5–1.0	9	20	71	28	kg × 108	kg × 2.0	400	2000	400	5	35	50	8	0.6	0.5	0.4	0.3	540	400	45	15	70	5
Children	1–3	13	28	86	34	1300	23	400	2000	400	7	40	100	9	0.8	0.7	0.6	1.0	800	800	60	15	150	10
	4–6	20	44	110	44	1800	30	500	2500	400	9	40	200	12	1.1	0.9	0.9	1.5	800	800	80	10	200	10
	7–10	30	66	135	54	2400	36	700	3300	400	10	40	300	16	1.2	1.2	1.2	2.0	800	800	110	10	250	10
Males	11–14	44	97	158	63	2800	44	1000	5000	400	12	45	400	18	1.5	1.4	1.6	3.0	1200	1200	130	18	350	15
	15–18	61	134	172	69	3000	54	1000	5000	400	15	45	400	20	1.8	1.5	2.0	3.0	1200	1200	150	18	400	15
	19–22	67	147	172	69	3000	54	1000	5000	400	15	45	400	20	1.8	1.5	2.0	3.0	800	800	140	10	350	15
	23–50	70	154	172	69	2700	56	1000	5000		15	45	400	18	1.6	1.4	2.0	3.0	800	800	130	10	350	15
	51+	70	154	172	69	2400	56	1000	5000		15	45	400	16	1.5	1.2	2.0	3.0	800	800	110	10	350	15
Females	11–14	44	97	155	62	2400	44	800	4000	400	12	45	400	16	1.3	1.2	1.6	3.0	1200	1200	115	18	300	15
	15–18	54	119	162	65	2100	48	800	4000	400	12	45	400	14	1.4	1.1	2.0	3.0	1200	1200	115	18	300	15
	19–22	58	128	162	65	2100	46	800	4000	400	12	45	400	14	1.4	1.1	2.0	3.0	800	800	100	18	300	15
	23–50	58	128	162	65	2000	46	800	4000		12	45	400	13	1.2	1.0	2.0	3.0	800	800	100	18	300	15
	51+	58	128	162	65	1800	46	800	4000		12	45	400	12	1.1	1.0	2.0	3.0	800	800	80	10	300	15
Pregnant						+300	+30	1000	5000	400	15	60	800	+2	+0.3	+0.3	2.5	4.0	1200	1200	125	18+[h]	450	20
Lactating						+500	+20	1200	6000	400	15	80	600	+4	+0.5	+0.3	2.5	4.0	1200	1200	150	18	450	25

[a]The allowances are intended to provide for individual variations among most normal persons as they live in the United States under usual environmental stresses. Diets should be based on a variety of common foods in order to provide other nutrients for which human requirements have been less well defined.

[b]Kilojoules (kJ) = 4.2 × kcal.

[c]Retinol equivalents.

[d]Total vitamin E activity, estimated to be 80% as α-tocopherol and 20% other tocopherols.

[e]The folacin allowances refer to dietary sources as determined by *Lactobacillus casei* assay. Pure forms of folacin may be effective in doses less than one-fourth of the recommended dietary allowance.

[f]Although allowances are expressed as niacin, it is recognized that on the average 1 mg of niacin is derived from each 60 mg of dietary tryptophan.

[g]Assumed to be all as retinol in milk during the first six months of life. All subsequent intakes are assumed to be half as retinol and half as β-carotene when calculated from international units. As retinol equivalents, three-fourths are as retinol and one-fourth as β-carotene.

[h]This increased requirement cannot be met by ordinary diets; therefore, the use of supplemental iron is recommended.

Source: National Research Council, Food and Nutrition Board, *Recommended Dietary Allowances*, 8th ed., National Academy of Sciences, Washington, D.C., 1974.

Table B.2. Food and Agriculture Organization, World Health Organization, recommended intakes of nutrients

Age (years)	Body weight [kilograms (kg)]	Energy[a] [kilocalories (kcal)]	[megajoules (MJ)]	Protein[a,b] [grams (g)]	Vitamin A[c,d] [micrograms (μg)]	Vitamin D[e,f] [micrograms (μg)]	Thiamin[c] [milligrams (mg)]	Riboflavin[c] [milligrams (mg)]	Niacin[c] [milligrams (mg)]	Folic acid[e] [micrograms (μg)]	Vitamin B-12[c] [micrograms (μg)]	Ascorbic acid[e] [milligrams (mg)]	Calcium[g] [grams (g)]	Iron[e,h] [milligrams (mg)]
Children														
<1	7.3	820	3.4	14	300	10.0	0.3	0.5	5.4	60	0.3	20	0.5–0.6	5–10
1–3	13.4	1360	5.7	16	250	10.0	0.5	0.8	9.0	100	0.9	20	0.4–0.5	5–10
4–6	20.2	1830	7.6	20	300	10.0	0.7	1.1	12.1	100	1.5	20	0.4–0.5	5–10
7–9	28.1	2190	9.2	25	400	2.5	0.9	1.3	14.5	100	1.5	20	0.4–0.5	5–10
Male adolescents														
10–12	36.9	2600	10.9	30	575	2.5	1.0	1.6	17.2	100	2.0	20	0.6–0.7	5–10
13–15	51.3	2900	12.1	37	725	2.5	1.2	1.7	19.1	200	2.0	30	0.6–0.7	9–18
16–19	62.9	3070	12.8	38	750	2.5	1.2	1.8	20.3	200	2.0	30	0.5–0.6	5–9
Female adolescents														
10–12	38.0	2350	9.8	29	575	2.5	0.9	1.4	15.5	100	2.0	20	0.6–0.7	5–10
13–15	49.9	2490	10.4	31	725	2.5	1.0	1.5	16.4	200	2.0	30	0.6–0.7	12–24
16–19	54.4	2310	9.7	30	750	2.5	0.9	1.4	15.2	200	2.0	30	0.5–0.6	14–28
Adults (moderately active)														
Men	65.0	3000	12.6	37	750	2.5	1.2	1.8	19.8	200	2.0	30	0.4–0.5	5–9
Women	55.0	2200	9.2	29	750	2.5	0.9	1.3	14.5	200	2.0	30	0.4–0.5	14–28
Pregnancy (latter half)		+350	+1.5	38	750	10.0	+0.1	+0.2	+2.3	400	3.0	30	1.0–1.2	*i*
Lactation (first 6 months)		+550	+2.3	46	1200	10.0	+0.2	+0.4	+3.7	300	2.5	30	1.0–1.2	*i*

[a] *Energy and Protein Requirements. Report of a Joint FAO/WHO Expert Group,* FAO, Rome, 1972.
[b] As egg or milk protein.
[c] *Requirements of Vitamin A, Thiamine, Riboflavin and Niacin. Report of a Joint FAO/WHO Expert Group,* FAO, Rome, 1965.
[d] As retinol.
[e] *Requirement of Ascorbic Acid, Vitamin D, Vitamin B_{12}, Folate and Iron. Report of a Joint FAO/WHO Expert Group,* FAO, Rome, 1970.
[f] As cholecalciferol.
[g] *Calcium Requirements. Report of a FAO/WHO Expert Group,* FAO, Rome, 1961.
[h] On each line the lower value applies when over 25% of calories in the diet come from animal foods, and the higher value applies when animal foods represent less than 10% of calories.
[i] For women whose iron intake throughout life has been at the level recommended in this table, the daily intake of iron during pregnancy and lactation should be the same as that recommended for nonpregnant, nonlactating women of childbearing age. For women whose iron status is not satisfactory at the beginning of pregnancy, the requirement is increased, and in the extreme situation of women with no iron stores, the requirement can probably not be met without supplementation.

Source: R. Passmore et al., *Handbook on Human Nutritional Requirements,* Food and Agriculture Organization, World Health Organization, Rome, Italy, 1974.

The U.S. Army has defined the minimal nutritional allowances for planning survival and disaster rations for populations in an occupied war zone (3). These values are presented in Table B.4. These allowances are to serve as a guideline in planning for feeding population groups to ensure that rations will at least meet minimal levels. Rations do not need to be this restricted if additional food

Table B.3. Comparison of dietary standards of the United States (1974) and FAO/WHO

	United States		FAO/WHO	
	Male	Female	Male	Female
Age, years	23–50	23–50	20–39	20–39
Weight, kg	70	58	65	55
Energy, kcal	2700	2100	3000	2200
Protein, g	56	46	46[a]	36[a]
Calcium, mg	800	800	400–500	400–500
Iron, mg	10	18	5–9	14–28
Vitamin A, retinol equivalents, μg	1000	800	750	750
Thiamin, mg	1.4	1.0	1.2	0.9
Riboflavin, mg	1.6	1.2	1.8	1.3
Niacin equivalents, mg	18	13	19.8	14.5
Vitamin C, mg	45	45	30	30
Vitamin D, μg			2.5	2.5

[a]Protein adjusted to a diet with the protein score of 80, which is the protein score of the diet normally consumed in the United States.

Table B.4. Minimal nutritional allowances[a] for planning rations for survival and disaster (May 1959)

As consumed per capita per day[b]

	Phase I (survival)		Phase II (austere)–8 weeks	Phase III (near normal)–8 weeks	Phase IV–indefinite
	2 weeks	2–4 weeks			
Water, quarts	2	2	4	4[c]	4
Energy, kcal	1500	1500	1800	2000	2400
Protein, g		35	50	65	65
Thiamin, mg			0.4	0.6	0.7
Vitamin C, mg			10	30	30
Niacin, mg			5	8	10
Riboflavin, mg			0.7	1.0	1.2
Calcium, g			0.3	0.4	0.4
Vitamin A, IU					3500

[a]The OCDM Interdepartmental Ad Hoc Advisory Group on Research and Development for Food for Shelters recommends the following nutritional allowances for planning rations for shelters for phases I and II. These allowances also represent the opinions of the Food and Nutrition Board, consultants to and staff members of the Interdepartmental Committee on Nutrition for National Defense, and representatives of the Department of Health, Education, and Welfare.

[b]To meet physiological needs; based on the population, age, distribution in the United States, July 1959.

[c]Includes water for cooking and drinking.

Source: Department of the Army, *Nutrition*, Army Technical Manual TM 8-501, Washington, D.C., 1961, pp 82–86.

is available. The allowances have been divided into four phases depending on the duration of the emergency and the food available. The phase I survival requirement for water, 2 quarts/day, would be dangerously inadequate for the occupants of a shelter in hot weather. The phases for which allowances have been indicated are defined as follows (3).

1. *Phase I.* This is the bare existence level for a nonactive, sedentary population [but not a population living in the hot, humid conditions of many fallout shelters] and indicates the minimum food necessary to meet the physiological needs. Little or no productive labor may be expected from the population. It is anticipated that the food supply would be increased after one month at this level.

2. *Phase II.* This level should prevent serious undernutrition or potentially serious civil unrest due solely to food deficiencies. Some productive work may be expected, but over a period of more than 2 months a significant loss of body weight may occur and production may be expected to fall off.

3. *Phase III.* At this level the population may be expected to remain in good health and be productive for many months. This level, however, will not allow maximum production or reconstruction.

4. *Phase IV.* This is the goal which should be attained in helping a population "get back on its feet." It is not the optimum or rehabilitation level but is the level beyond which the military authorities should not divert further effort from their primary military missions.

In 1962, the Food and Nutrition Board of the National Academy of Sciences gave nutrient recommendations for populations following a nuclear war (4). These recommendations are divided into three plans, depending on the length of time since the disaster. (See Table B.5.) These recommendations are very similar to those recommended by the Army.

Recommendations listed in column I of Table B.5 are for an acute period of 2 weeks or more during which strict confinement in a fallout shelter is necessary.

Column II recommendations are for a period of up to 8 weeks with initial confinement and an intermediate period of some weeks during which movement is limited by lack of power, transportation, and supplies.

Column III recommendations are for confinement and an intermediate period, followed by a prolonged period of readjustment and reconstruction.

The two plans for disasters (Tables B.4 and B.5) suggest that water, salt, and whatever food can be found might have to do for the first few weeks. Water and salt recommendations are low for hot climates or the hot, humid conditions that might occur in a shelter situation. Water and salt would be the most critical nutrients during the first few days until sources are established.

Protein recommendations were made according to the best available knowledge when these plans were formulated. Since that time, it has been found that good health can be maintained on lower amounts of protein. Currently, both the RDA and FAO/WHO recommendations give lower amounts of protein.

Table B.5. Recommended minimum allowances of nutrients for shelter survival of the general population

As consumed per person per day [a]

Nutrients	Planning periods[b]		
	I (up to 2 weeks)	II (up to 8 weeks)	III (over 8 weeks)
Water, quarts[c]	2	2	4
Energy, kcal	1500	1800	2000
Protein, g[d]	35	50	65
Carbohydrate, g[c] (minimum)	150	175	185
Fat, g[e] (maximum)	83	100	110
Sodium chloride, g[f]	3	3.6	4
Calcium, g		0.3	0.4
Thiamin, mg[d]		0.5	0.6
Vitamin C, mg		10	30
Niacin, mg		5	8
Riboflavin, mg[d]		0.7	1.0
Vitamin A, IU			
Fiber[g]			

[a]It is assumed that the population will be mixed, including adult men and women, adolescents and children, and that most will be sedentary. The recommendations are on a population basis.

[b]These periods are taken from estimates by various planning agencies. Plan I is for the acute emergency, when the shelter cannot be left and total reliance must be placed on shelter stocks of water and food. Plan II envisages an intermediate period after shelter confinement when some constructive activity is possible, but other supplies are assumed to be available outside the shelter. Plan III would provide for a prolonged period after shelter confinement in which constructive activities must go on and some resupply of local stockpiles will be necessary. Plans of stockpiling may consider all three situations separately or in combination.

[c]Water is exclusively for drinking. None is allowed for personal hygiene during Phases I and II.

[d]Protein quality should be equivalent to that in common whole or enriched American cereal grains. Such products will also provide the minimal allowance of B vitamins.

[e]Fat should provide no more than 50 per cent of the total calories, and may provide for less without harm. A diet low in calories but high in fat may induce ketosis. This may be deleterious to function, and will increase the requirement for water. Ketosis is prevented by an adequate amount of carbohydrate.

[f]Salt should be incorporated in the food. The recommended amounts should not be exceeded. An excess will increase the water requirement.

[g]Typically a diet low in calories and without bulk (i.e., undigestible fiber) will cause a diminution or even cessation of normal bowel movements for many days. This is not harmful and no cause for concern.

Source: National Research Council, Food and Nutrition Board, *Minimal Allowances of Water and Food for Fallout Shelter Survival,* National Academy of Sciences, Washington, D.C., 1963.

REFERENCES FOR APPENDIX B

1. National Research Council, Food and Nutrition Board, *Recommended Dietary Allowances,* 8th ed., National Academy of Sciences, Washington, D.C., 1974, 128 pp.

2. R. Passmore et al., *Handbook on Human Nutritional Requirements,* Food and Agriculture Organization, Rome, Italy, 1974, 66 pp.

3. Department of the Army, *Nutrition,* Army Technical Manual TM 8-501, Washington, D.C., 1961, pp. 82–86.

4. National Research Council, Food and Nutrition Board, *Minimal Allowances of Water and Food for Fallout Shelter Survival,* National Academy of Sciences, Washington, D.C., 1963, 5 pp.

Appendix C
Nutritional Value of Germinated Seeds

After a heavy nuclear attack on the United States, the normal sources of some vitamins probably would be in short supply for a long time. Since sprouted seeds are a reliable source of some essential vitamins and since much misinformation is prevalent concerning the food value of "sprouts," information on the nutritional value of germinated seeds is presented.

The sprouting or germination of seeds has been used to prevent and cure the vitamin C deficiency disease, scurvy. Captain James Cook, the English explorer, used germinated grains during a 3-year voyage (1752 to 1755) and did not lose a single man from scurvy. More recently, in 1940, germinated legumes were used to control scurvy during a famine in Punjab (1).

Research data on the nutritive value of sprouted grains and legumes show considerable variation because the methods of germinating the seeds varied. Seeds were soaked for varying lengths of time and germinated for a different number of days. During germination, variations in humidity, the number of times the seeds were rinsed, and the amount of light would have affected the growth rate. The seeds might also have had different viabilities. Thus it is difficult to make exact statements about the nutritive content of germinated seeds. Where exact figures are given, they apply only to a specific set of conditions used in determining that data. Other data generated from slightly different conditions might vary by as much as 50% or more.

C.1 VITAMIN C

The U.S. Department of Agriculture's Handbook 8 (2) gives values for ascorbic acid in 100 g of raw bean sprouts as 19 mg for mung bean sprouts and 13 mg for soybean sprouts. Values for cooked sprouts would be lower. The Home and Garden Bulletin 72 (3) gives 1 cup of cooked, drained mung bean sprouts as weighing 125 g and having 8 mg of ascorbic acid.

The vitamin C content of germinated legumes has been reviewed by Aykroyd and Doughty in the FAO publication, *Legumes in Human Nutrition* (4). Table C.1 gives the vitamin C content of legumes. The legumes were not specified (4). Akyroyd and Doughty report that higher values have been recorded in soybeans sprouted for 4 days, but that no great increase occurs after 48 hours. After 24 hours, germinating legumes become useful sources of vitamin C. Table C.2 lists the total ascorbic acid content of several legumes reported in more recent work (5, 6, 7).

One unpublished report (8) gives 23 mg vitamin C in 100 g of raw germinated wheat between the fifth to eighth day of the sprouting and 34 mg vitamin C in 100 g of raw germinated mung beans on the fifth day. On the eighth day, when the wheat grass sprouts were separated from the root and kernel, they contained 53 mg vitamin C per 100 g of the raw wheat grass.

It would be useful to be able to convert grams of germinated seeds to a volume measure. This is difficult to do since the weight of a specific volume of germinated seeds (such as 1 cup) varies

Table C.1. Vitamin C (mg) in 100 g of germinated legumes

Dry seeds	Trace or none
After 24 hours	7–8
After 48 hours	10–12
After 72 hours	12–14

Source: W. R. Aykroyd and J. Doughty, *Legumes in Human Nutrition,* Food and Agriculture Organization, Rome, Italy, 1964, p. 57.

Table C.2. Total vitamin C in raw germinated legumes[a] and sprouts[b]

	Germinated seeds (mg per 100 g)	Sprouts (mg per 100 g)
Alfalfa	16[c]	
Lentils	24[c]	
Mung	20[c]	38.3[d]
Soybeans	12[c]	21.1[e]
Peas	17.3–26.2[e]	18.8–50.0[f]
Beans	14.8–15.2[g]	12.6–42.2[h]

[a]Germinated legumes refer to both the seed and the attached sprout.
[b]Sprouts refer to the sprout after separation from the seed.
[c]Seeds were soaked overnight and germinated for 3 days (6).
[d]Seeds were soaked for 6 hours and germinated for 4 to 6 days (5).
[e]Seeds were soaked overnight and germinated for 4 to 6 days; these data come from 5 varieties of peas (7).
[f]Seeds were soaked for 6 hours or overnight and germinated for 4 to 6 days; data come from 6 varieties of peas (5).
[g]Pinto beans and white navy beans were soaked for 6 hours or overnight and germinated for 4 to 6 days (7).
[h]Seeds were soaked for 6 hours or overnight and germinated for 4 to 6 days; sprout data come from 12 varieties of beans (5).

according to the length of germination and the variety of seed. Table C.3 gives unpublished data (9) on the weight and volume of four types of seeds when germination has been carried out for varying lengths of time. The weight and volume refer to the germinated seeds. Sprout length refers to the length of the sprout that is attached to the seed. Because of the great variability in the methods of germinating the seeds, sprout length may be a better index than time of the maturity of the germinating seeds.

It has been found that about 30 g (a little over 1 oz) of dry legume seeds must be sprouted to provide 10 to 15 mg of vitamin C (10). It was not stated if these sprouted legume seeds were used raw or cooked, but because of growth-inhibiting substances present in legumes, they should be cooked for at least 2 minutes if they are to be used as protein sources in the diet. Cooking may be by

Table C.3. Volume, weight, and size of sprouts[a] from germinated seeds

Changes during germination	Alfalfa	Mung bean	Pinto bean	Wheat
Seed weight, g	186	186	180	188
Volume, cup	1	1	1	1
Weight after 24-hour soak, g	469	339	371	297
Volume, cups	3.4	2.2	2.0	1.9
Weight after 24-hour soak and 48-hour germination, g	532	350	319	311
Volume, cups	9.3	3.3	2.4	6.3
Sprout length, inches	1/6–1/2	1/4–1 1/4	1/8–1	1/4–1/2
Weight after 24-hour soak and 96-hour germination, g	842	427	354	366
Volume, cups	22.6	5.1	3.4	6.3
Sprout length, inches	1/4–1	1/2–1 1/4	1/4–1 1/4	1/4–1/2
Weight after 24-hour soak and 192-hour germination, g	1583	603	451	569
Volume, cups	47.1	15.3	5.6	14.6
Sprout length, inches	1 1/4–1 1/2	1–2	1–1 1/2	1 1/2–2

[a]All seeds were sprouted in the dark at a temperature of 21 to 24°C. Germinating seeds were rinsed automatically every 4 hours following the 24-hour soak.

Source: D. J. Eliason, P. Liu, and J. M. Hill, "Vitamin A Content of Green Sprouts," Dept. of Food Science and Nutrition, Brigham Young University, Provo, Utah, 1975, unpublished data.

blanching in boiling water or by lightly frying as in the stir-fry method of Oriental cookery. Sprouted wheat is in the same range. No data are available for other cereals but they are probably similar.

C.2 B VITAMINS

Amounts of thiamin, riboflavin, and niacin in germinated seeds and dormant seeds have been given (6, 7, 11, 12). In both legumes and cereals, riboflavin was generally increased by germination. This has been noted in alfalfa, mung beans, soybeans, black-eyed peas, lima beans, cotton seed, oats, wheat, barley, and corn but not in lentils. Niacin usually also increased on germination, but not to a great extent. Thiamin either increased or decreased but the change was only slight. Folacin increased severalfold in oats, wheat, barley, corn, and cotton seeds but decreased in black-eyed peas and lima beans (11, 12). In summary, germinating seeds generally increased in content of riboflavin, niacin, and folic acid.

C.3 CAROTENE AND VITAMIN A

Data for the carotene content of sprouts and germinated seeds have been reported when the sprouts were grown in the dark (5, 7). The carotene content of 100 g of germinated peas or beans was equivalent to less than 1 RE. Carotene is increased in germinating seeds when they are exposed to light. Table C.4 gives data on the retinol equivalents of germinated seeds on the fifth day of

Table C.4. Retinol equivalents[a,b] from seed germinated[c] in light

	Water (%)	RE per 100 g wet weight	RE per cup	Cups per 500 μg RE	Dry seeds to produce 500 μg RE (g)	Dry seeds to produce 500 μg RE (volume)
Wheat	89	610	415	1.2	17.5	1.5 tbsp
Barley	90	397	270	1.9	100	8 tbsp
Corn	87	208	195	2.6		8 tbsp
Alfalfa	89	156	91	5.5	81	7 tbsp
Mung beans	85	83	60	8.3	186	1.0 cup
Pinto beans	82	23	28	18.1	740	4.1 cups

[a]Retinol equivalents (RE) calculated on the basis of 6 μg carotene being equivalent to 1 μg retinol.

[b]550 μg RE is the emergency dietary recommendation for vitamin A; see Table 4.

[c]Seeds soaked for 24 hours and then germinated for 5 days. Germinating seeds were rinsed automatically every 4 hours following the 24-hour soak.

Source: D. J. Eliason, P. Liu, and J. M. Hill, "Vitamin A Content of Green Sprouts," Dept. of Food Science and Nutrition, Brigham Young University, Provo, Utah, 1975, unpublished data.

germination in light (9). The data show that wheat, barley, corn, and alfalfa might contribute retinol equivalents to a survival diet if germination occurred in the light. Fairly large quantities, more than 1 cup, of the sprouts would be required.

Palatability of the sprouts should also be considered. The sprouts are more palatable on the third day than they are on the fifth day of germination. Of the four sprouts, wheat and alfalfa were preferred. If sprouts were consumed on the third day, the retinol equivalents in wheat would be reduced by about 67%, but would increase in mung beans by about 30% and in alfalfa by nearly 60%. It is concluded that wheat and alfalfa sprouts grown in the light for 3 days are marginal sources of retinol equivalents which might be considered in a survival setting.

C.4 PROTEIN

Some claims have been made that the protein content of sprouts is increased. Data appear to substantiate this (6, 13, 14, 15, 16) with reports of an increased percentage of protein in the germinated seed. Error has been introduced by not evaluating the situation carefully. If a germinating seed is grown under laboratory conditions, it usually has access only to water. There is no place it can get more nitrogen to make an increased amount of protein. While the seed is germinating, some organic components, such as carbohydrate and fat, are used to provide energy for the germinating process. The decrease in these components in the germinating seed thus causes the protein present to be a larger percentage of the germinated seed. Seeds growing in a field present a different situation. Eliason (17) determined the protein content of sprouted and unsprouted wheat under laboratory conditions. The protein content of the sprouted wheat was calculated back to the original wheat. The unsprouted wheat had a protein content of 13.5%. Wheat sprouted for 5 days had a protein level equal to 12.3% of the original wheat. Therefore, the actual protein level had dropped. Bartlett (13), working with oats that were sprouted for 6 to 8 days, reported a 3.5% loss of the crude protein.

Does the protein quality change in sprouted legumes? Raw legumes cannot support adequate growth in young animals because of the growth-inhibiting substances the legumes contain. Cooking inactivates these inhibiting substances, allowing the legumes to support growth (14, 18). When raw sprouted legumes are fed to rats and the growth inhibition is found to be reduced, is the sprouting reducing the amount of growth-inhibiting substances, improving the quality of the protein, or both?

Everson et al. (19) fed raw-ungerminated, raw-germinated, and autoclaved-ungerminated soybeans to rats. The rats fed the raw-ungerminated soybeans reached a weight of 72.8 g; those fed the raw-germinated soybeans reached a weight of 127.3 g; and those fed the autoclaved-ungerminated soybeans reached a weight of 164.8 g. Mattingly and Bird (20) confirmed the work of Everson et al. (19): The rats reached weights of 84, 121, and 181 g, respectively, at the end of 8 weeks. In contrast, Kakade and Evans (14) fed raw-ungerminated and raw-germinated navy beans to rats for 4 days: All the rats died. An analysis of the raw-germinated beans showed that growth-inhibiting substances were present. Cooked navy beans, however, supported growth.

Palmer, McIntosh, and Pusztai (16) studied the effect of the germination of kidney beans on rat growth. They concluded that germination brought about a gradual improvement in nutritive value, probably through the elimination of some growth-inhibiting constituents of the seed. Germination of 8 days was necessary for the nutritional improvement. Chen, Wells, and Fordham (7) fed rats both raw-germinated seeds and blanched-germinated seeds. Five pea varieties were used and two bean varieties (pinto and white navy). All the raw-germinated seeds except the pintos and one variety of peas depressed growth significantly, but the blanched-germinated seeds supported normal growth. This shows that growth-inhibiting substances were present in most of the raw-germinated seeds.

It appears that growth-inhibiting substances interfere with the complete utilization of the protein in germinated legumes. Germination decreases these growth-inhibiting substances but does not completely eliminate them except in specific varieties. Sprouting, for most legumes, is not a satisfactory substitute for cooking.

If germinated legumes were cooked, would there be any improvement in protein quality over cooked ungerminated legumes? Palmer, McIntosh, and Pusztai (16) found no substantial changes in the amino acid pattern of kidney beans germinated 4 and 8 days when compared with raw kidney beans. This suggests that there is no change in nutritive quality. Everson et al. (19) compared autoclaved, mature soybeans with autoclaved soybeans germinated for 2½ days. The rats eating the mature soybeans reached a weight of 164.8 g, and those eating the germinated soybeans reached a weight of 185.0 g. The germinated soybeans appeared to have a better nutritional value.

Elias et al. (21) studied the effect of germination on the nutritive value of common beans. The beans were germinated for 0, 3, 6, and 9 days. They found that the growth-inhibiting substances decreased as germination progressed. Beans were autoclaved to destroy growth inhibitors, the protein level was adjusted to 10%, and the beans were fed to rats. As the time of the germination increased from 0 to 9 days, the protein efficiency ratio (PER)[a] decreased from 0.99 to 0.86, 0.59, and 0.26. This shows that the protein quality of the germinated legumes decreased.

Jaya, Krishnamurthy, and Benkataraman (22) studied the effects of germination and cooking on the PER of greengram, cowpea, and chickpea. These are legumes commonly eaten in India after sprouting. Germination was carried out for 24, 48, and 72 hours; the data are presented in Table C.5. After 24 hours germination, the cooked greengram and chickpea had PER values slightly higher than the ungerminated, cooked legumes. After 48 hours, only the germinated, cooked greengram was higher in PER. After 72 hours, all the germinated, cooked legumes had lower PER values than their respective ungerminated, cooked legumes.

From the studies indicating that protein quality is improved, it does not appear that the protein quality of germinated, cooked legumes is greatly improved over that of the ungerminated, cooked legumes. Generally, studies show that protein quality is decreased during germination.

[a]PER (protein efficiency ratio) is a measure of protein quality. The ratio is determined by feeding protein to 3-week-old rats for 4 weeks at the level of 10% of the diet, after which time the weight gain is divided by the total amount of protein eaten.

Table C.5. Effect of germination and cooking on the protein efficiency ratio (PER) of greengram, cowpea, and chickpea

Treatment	PER		
	Greengram	Cowpea	Chickpea
Ungerminated, cooked	1.25	1.55	2.41
Germinated 24 hours, cooked	1.37	1.33	2.56
Germinated 48 hours, cooked	1.35	1.45	1.72
Germinated 72 hours, cooked	1.18	1.20	2.28

Source: T. V. Jaya, K. S. Krishnamurthy, and L. V. Benkataraman, "Effect of Germination and Cooking on the Protein Efficiency Ratio of Some Legumes," *Nutr. Rep. Int.* 12, 175–83 (1975).

Two studies have been reported in which sprouted wheat was used as feed for animals. Sibbald, Slinger, and Pepper (23) fed wheat that had been sprouted for $2^1/_2$ days to chickens as 50% of the ration. The other half of the ration was the basal diet. After 2 weeks, they concluded that the sprouting of the wheat did not change its nutritive value as regards weight gain and feed efficiency, when compared with unsprouted wheat. Farlin, Dahmen, and Bell (15) fed sprouted wheat to cattle. The wheat had sprouted in the field because of wet weather, and the sprouts were less than 2 mm long, so this sprouted wheat cannot be readily compared with wheat having sprouts 1 cm or more in length. This study also concluded that sprouting did not change the nutritive value of the wheat.

C.5 CAUTION

A caution should be given about choosing seeds for sprouting for human consumption. Field seed that has been treated with pesticides must never be used for any human food or animal feed. These seeds usually differ in color from normal seeds and are labeled as treated seeds. Use of these treated seeds may result in fatal food poisoning. Potato sprouts, too, are poisonous, treated or untreated.

REFERENCES FOR APPENDIX C

1. W. R. Aykroyd, *Conquest of Deficiency Diseases,* World Health Organization, Geneva, Switzerland, 1970, 98 pp.

2. B. K. Watt and A. L. Merrill, *Composition of Foods: Raw, Processed, Prepared,* Agriculture Handbook 8, Agriculture Research Service, U.S. Department of Agriculture, Washington, D.C., 1963, 190 pp.

3. U.S. Department of Agriculture, Agriculture Research Service, *Nutritive Value of Foods,* Home and Garden Bulletin 72, Washington, D.C., 1971, p. 14.

4. W. R. Aykroyd and J. Doughty, *Legumes in Human Nutrition,* Food and Agriculture Organization, Rome, Italy, 1964, pp. 56–58.

5. J. R. Fordham, C. E. Wells, and L. H. Chen, "Sprouting of Seeds and Nutrient Composition of Seeds and Sprouts," *J. Food Sci.* **40,** 552–56 (1975).

6. A. M. Kylen and R. M. McCready, "Nutrients in Seeds and Sprouts of Alfalfa, Lentils, Mung Beans and Soybeans," *J. Food Sci.* **40,** 1008–9 (1975).

7. L. H. Chen, C. E. Wells, and J. R. Fordham, "Germinated Seeds for Human Consumption," *J. Food Sci.* **40,** 1290–94 (1975).

8. I. G. Berg, "Determination of Ascorbic Acid in Sprouted Wheat," Dept. of Food Science and Nutrition, Brigham Young University, Provo, Utah, 1969, unpublished data.

9. D. J. Eliason, P. Liu, and J. M. Hill, "Vitamin A Content of Green Sprouts," Dept. of Food Science and Nutrition, Brigham Young University, Provo, Utah, 1975, unpublished data.

10. G. B. Masefield, *Food and Nutrition Procedures in Times of Disaster,* Food and Agriculture Organization, Rome, Italy, 1967, p. 85.

11. P. R. Burkholder, "Vitamins in Dehydrated Seeds and Sprouts," *Science* **97,** 562–64 (1943).

12. V. H. Cheldelin and R. L. Lane, "B Vitamins in Germinating Seeds," *Proc. Soc. Expl. Biol. Med.* **54,** 53–55 (1944).

13. J. M. Bartlett, "The Chemical Composition of Green Sprouted Oats," *Maine Agric. Exp. Stn. Bull.* **266,** 1–6 (1917).

14. M. L. Kakade and R. J. Evans, "Effect of Soaking and Germinating on the Nutritive Value of Navy Beans," *J. Food Sci.* **31,** 781–83 (1966).

15. S. D. Farlin, J. J. Dahmen, and T. D. Bell, "Effect of Sprouting on Nutritional Value of Wheat in Cattle Diets," *Can. J. Anim. Sci.* **51,** 147–51 (1971).

16. R. Palmer, A. McIntosh, and A. Pusztai, "The Nutritional Evaluation of Kidney Beans (*Phaseolus vulgaris*), the Effect of Nutritional Value of Seed Germination and Changes in Trypsin Inhibitor Content," *J. Sci. Food Agric.* **24,** 937–44 (1973).

17. D. J. Eliason, "Protein Analysis of Sprouted and Unsprouted Wheat," Dept. of Food Science and Nutrition, Brigham Young University, Provo, Utah, 1973, unpublished data.

18. G. Everson and A. Heckert, "The Biological Value of Some Leguminous Sources of Protein," *J. Am. Diet. Assoc.* **20,** 81–82 (1944).

19. G. J. Everson et al., "The Effect of Germination, the Stage of Maturity, and the Variety upon the Nutritive Value of Soybean Protein," *J. Nutr.* **27,** 225–29 (1944).

20. J. P. Mattingly and H. R. Bird, "Effect of Heating Under Various Conditions and Sprouting on the Nutritive Value of Soybean Oil, Meal and Soybeans," *Poultry Sci.* **24,** 344–52 (1945).

21. L. G. Elias et al., "Effect of Germination on the Nutritive Value of Common Beans (*Phaseolus vulgaris*)," pp. 139–52 in W. G. Jaffe, ed., *Nutritional Aspects of Common Beans and Other Legume Seeds as Animal and Human Foods,* Archivos Latinoamericanos de Nutricion, Caracas, Venezuela, 1975.

22. T. V. Jaya, K. S. Krishnamurthy, and L. V. Benkataraman, "Effect of Germination and Cooking on the Protein Efficiency Ratio of Some Legumes," *Nutr. Rep. Int.* **12,** 175–83 (1975).

23. I. R. Sibbald, S. J. Slinger, and W. R. Pepper, "Spouted, Frozen and Mouldy Wheat as Sources of Nutrients for Chicks," *Poultry Sci.* **31,** 1003–4 (1962).

Appendix D

Some Suggestions for Using Wheat, Corn, and Other Grains and Legumes

D.1 NEED FOR DISSEMINATING SUGGESTIONS FOR USING UNPROCESSED SURVIVAL FOODS

In a long-term survival situation, the consumption of unpopular or unfamiliar foods would probably be necessary. Suggested methods for preparing these foods should be given to the population. Since fuel supplies might also be limited, preparation methods should be those that would use the least amount of fuel. Methods of food preparation from less-developed countries would need to be adapted, depending on the available foods, fuel, and cooking facilities. Many citizens, away from home and lacking kitchen utensils, would need to be warned not to cook in galvanized containers because of the hazard of zinc poisoning. Suggestions are not given for using rice because most populations are familiar with rice cookery. Salt and/or other ingredients such as sugar and oil could be added as desired.

D.2 WHEAT (1, 2)

D.2.1 Expedient Processing

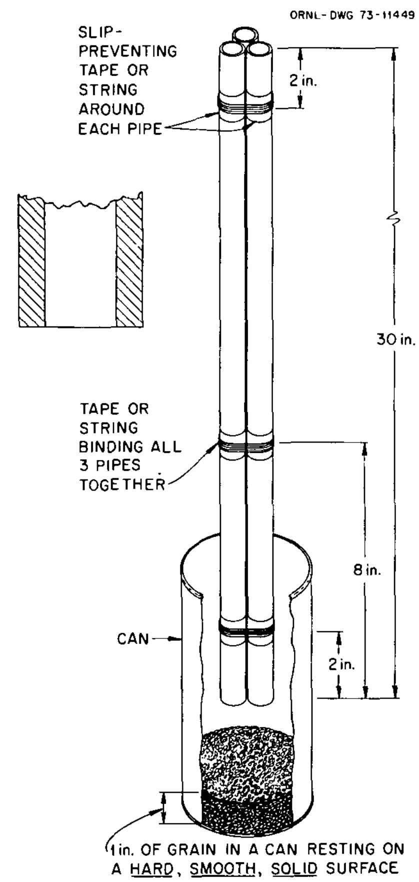
Traditional milling of wheat into flour might not be possible in a long-term survival situation. Even machines used on the farm for grinding livestock feeds might be unavailable, or might be unusable for lack of power or fuel. The population would need to devise methods to prepare whole-kernel wheat in a palatable form. It is most desirable to make wheat meal and coarse flour by expedient means and then to use this to make porridge and bread. The whole-kernel wheat can also be boiled or parched. A combination of methods of preparing wheat is recommended for long-term use.

An emergency means of making meal and coarse flour uses three 30-inch lengths of ordinary ³/₄-inch pipe and a large fruit-juice can; the best size is about 4 in. in diameter (1) (see figure on next page). If pipe-cutting equipment is available, the ends of the pipe may be cut off square to preserve full wall thickness. The three pipes are then taped or tied to form a bundle that is used to pound grain into meal and flour. The pipes are not capped because the increased air pressure would cause more of the grain to be blown away from the ends of the pipes during pounding.

The can is placed on a smooth, solid surface such as a concrete floor, and the wheat or other grain about 1 inch deep is placed in the bottom of the can. The bundle of pipes is "bounced" on the grain with an approximately 2-inch vertical stroke. One pound of wheat or corn can be pounded into a meal-flour mixture in about 12 minutes. By sifting through a coarse cloth or flour sifter, the flour can be separated from the meal. The meal can be used to make porridge or soup. The flour can be used to feed babies and small children and to make bread.

In contrast, simpler expedient means for pounding or grinding grains are much less efficient. For example, if a flat-ended hard rock is used to pound wheat in a heavy frying pan, about an hour is required to produce a pound of a meal-flour mixture, which is more coarse than that produced by the pipe method.

Whole-kernel wheat, corn, and rice can be parched by heating a little at a time in a pan, a skillet, or a tin can while shaking it over a flame or hot coals. They also can be parched on hot stones (2). The kernels brown and puff slightly when parched. They can be eaten as is and are not difficult to chew. These parched grains can be pounded to a meal more easily than can the raw kernels and can be used in making porridge and soup. Parched grain stores well if kept dry and free of insects.



D.2.2 Expedient Cooking

Fine meal can be cooked easily and quickly; boiling for 30 minutes is sufficient. A ratio of 1 part wheat to 3 or 4 parts salted water is recommended.

Whole-kernel wheat is best prepared by soaking it for several hours before boiling it for at least 1 hour. Or, soak it, bring it to a brisk boil, and then cook it for at least 4 hours in a "fireless cooker," as described below. However, even well-cooked whole-kernel wheat is so chewy and fibrous that it is very difficult to eat enough to satisfy all or most of a person's energy needs. A wheat meal is much to be preferred.

Four methods that can be used to make a porridge are described below. The first two methods are useful when fuel is in short supply.

1. Use an available insulated container, such as a thermos jug, to make porridge. First put the meal and salt into the thermos. Then pour in boiling water, shake, and close the thermos tightly. Since the retained heat maintains a high temperature, after several hours the meal is thoroughly cooked.
2. Improvise an insulated container—a "fireless cooker"—if a thermos jug is not available or is too small. To make a "fireless cooker" and use it to cook porridge:
   a. Line the bottom and inner sides of a box or basket with 3 or more inches of newspaper, blankets, etc., so that the cooking pot to be used will fit snugly into the insulated cavity. A towel used as the innermost lining helps prevent hot air circulation.

b. Pour into the pot 3 parts of water to 1 part of the grain to be cooked.
c. Salt the water and bring it to a brisk boil.
d. Remove the pot of boiling water from the fire and promptly stir the meal into the water. (Home-ground or expediently pounded meal contains flour, which tends to lump, stick or scorch worse if the meal and water are brought to a boil together, or if the meal is stirred into boiling water.)
e. Bring the pot to a boil again while stirring constantly.
f. Continue to stir until the porridge is no longer thin and watery and appears quite uniform.
g. Put a lid on the pot and promptly place it in the insulated container.
h. Cover the pot with at least 3 inches of newspapers and/or other insulating material and let stand for 4 hours or more.

This type of improvised "fireless cooker" can be used to cook not only large quantities of porridge with minimum fuel, but also slow-cooking beans, tough meat, etc.

3. To shorten cooking time, use a pressure cooker.

4. If there is ample fuel and a double boiler is available or can be improvised, bring porridge briefly to a boil as described above and then cook it in a double boiler for an additional 45 minutes.

If flour is available, various types of bread would be desirable. If ovens are scarce or unavailable, leavened or unleavened flat breads might have to replace the breads more traditional in the American diet.

Unleavened bread is made by mixing flour with water and salt to make a dough. The dough is then shaped, usually in a flat circle less than 1/4-inch thick, and heated. Hot stones or ashes were the heat sources in early times; later, a heavy pan or griddle was used. Flat bread can be cooked by placing the shaped dough on a hot griddle until it is heated on one side and then turning it over, much like a pancake.

Leavened bread is made with baking powder or yeast; however, these might not be available. Wild yeast could be used since it occurs everywhere. The flavor would be different from the traditional yeast commonly used. Wild yeast can be developed by making a soft dough and letting it stand in a large covered container in a warm place for 2 or 3 days until it becomes bubbly and expands. The dough is made from equal parts of flour and water. When the dough is bubbly, active yeast is present. This is called a starter. One volume of starter can be used to raise a dough made from 2 to 4 volumes of flour. Yeast-leavened dough can be used to make flat bread or more traditional breads. Since yeast starters are easily contaminated with molds and other microorganisms, they are difficult to keep, especially under conditions of no refrigeration and limited facilities for keeping the starter in sterile containers.

D.3 CORN

In a long-term survival situation, dry field corn might have to be used as food for people. Such use would present some problems. Even if dry field corn is boiled in water until tender, it is still extremely difficult to eat and to digest. Dry corn must be processed in some manner.

A coarse meal or flour can be made by using the pipe method to pound the corn, as previously described for wheat. By sifting the resultant meal-flour mixture, the coarse meal can be removed from the flour. The meal and flour can be used to thicken soups or to make porridge.

Plain cornmeal porridge is not an appealing food. Acceptability experiments have shown that average Americans will eat a more nearly adequate amount of cornmeal or wheat porridge if it is sweetened, and that they will eat even more if both sugar and oil are added.

The corn flour can be used to make baby food and corn breads. If it is not possible to make traditional corn breads, unleavened flat breads, such as tortillas, can be made. The corn flour is mixed with water to form a soft dough. Portions of the dough are flattened into a circle less than $^{1}/_{4}$-inch thick and then cooked on a hot griddle, as previously described for wheat flat breads.

In cultures in which corn is treated with alkali, the dry corn is soaked for several hours in an alkali water. Then it is wet-ground to a dough and used to make bread, a flat bread such as tortillas being the most common. The alkali water is made by adding lime, quicklime, or wood ashes to the soak water at the level of about $^{1}/_{2}$ to 1% of the weight of the corn to be soaked. The alkali water softens the corn and makes it easier to wet-grind into a dough. While in the soak water the corn can be boiled for about 30 minutes to 1 hour at the beginning of the soak or at the end, or, in some methods, not at all. When the corn is not boiled, usually the soak begins with hot water that has been brought to a boil. As previously mentioned, alkali treatment of corn helps prevent pellagra and provides calcium in the diet.

It would be difficult to wet-grind the corn to a smooth dough without the special equipment that has evolved in corn-eating countries. In these countries, corn is traditionally ground on a slightly rough stone surface with an instrument resembling a stone rolling pin, but having flat sides to prevent it from rolling. Such an instrument would be difficult to improvise in the American culture.

An adaptation of the traditional alkali-corn methods must be used if alkali treatment is carried out. This would be desirable to make niacin more available and prevent pellagra, especially if the diet consisted primarily of corn. One of the simplest adaptations would be to make a flour from dry corn by the pipe method previously described or by other expedient means and then mix it with alkali water (made as previously described) to form a dough. This dough could be used to make a flat bread.

D.4 OTHER GRAINS

Most of the other unprocessed grains likely to be important survival foods have coarse husks covering their kernels. These very rough materials, such as the husks of barley, grain sorghums, and oats, must be removed to make human consumption practical. The best expedient method of removal is first to grind or pound the grain into a coarse meal and then to put the meal in water. After being stirred, the husks and chaff will float to or toward the top and can be removed. Oat husks cannot be removed by this method.

Enough of the husks of most varieties of rough grains can be removed more easily if the husks of the dry grain are first toughened by dampening them with a little water. Sprinkle the water—only about 2% of the weight of oats to be ground—over the grain. Use 2 teaspoons of water to dampen 1 lb of grain. Next, stir and mix for 5 to 10 minutes—long enough for the water to be absorbed by the husks and the oats to appear dry again. Then, grind or pound into a mixture of edible meal and much larger pieces of toughened husks. The meal can be separated from the husks by sieving through a piece of window screen and/or by flotation. Regrinding and sieving through a finer-mesh sieve or cloth will produce a flour suitable for babies.

D.5 LEGUMES

The traditional method of cooking dry beans is first to soak the beans for several hours and then to boil them until tender. Soaking time can be shortened considerably by bringing the beans and soak water to a boil for 2 minutes at the beginning of the soak time. This brief boiling causes the dry beans to take up water more quickly. The soak time can be shortened to 1 hour by following this procedure.

Varying lengths of time are needed to cook beans, depending on the variety of the bean, its moisture content, storage conditions, and length of time in storage. When preparing a very limited number of basic foods, one should realize that cooked beans can be used in soup, mashed to a paste and fried, mixed with vegetables, and used in casseroles with many other ingredients.

Soybeans should be treated as a special category of legumes. They do not cook up as easily as traditional dry beans and take much longer to soften. If fuel is limited, this would be a problem. The following are suggestions on soybean preparation.

One of the simplest ways to cook soybeans is to soak them for about 3 hours and then to boil them for 20 minutes in salted water. The beans still will be quite firm. Unfortunately, soybeans cooked this way require so much chewing as to make eating more than a very small amount generally impractical. Digestibility would also be a problem (3).

To cook soybeans with minimum fuel and in such a way as to enable an average American to eat enough of them, probably the best expedient method is to:

1. Grind or pound dry soybeans into a meal.
2. Mix about 2½ oz of the dry soybean meal (equivalent in nutritional value to 112 g (4 oz) of ordinary beans) with each pound of corn meal or flour to be cooked.
3. Bring to a brisk boil a volume of salted water about 3 times the volume of the mixed meals.
4. Add the mixed meals to the boiling water, keeping the pot boiling briskly and stirring constantly.
5. Boil for an additional 10 to 15 minutes, while continually stirring and adding other foods that may be available, especially sugar and/or oil.
6. Cook for several hours in an improvised fireless cooker, as previously described (see Sect. D.2.2).

Unexpectedly, this corn-soybean porridge tastes rather sweet, even without sugar (4). The typical taste of boiled soybeans, which most persons find unappealing, is disguised. Meals made from other grains can be cooked with soybean meal in a similar manner.

Other legumes can be ground or pounded and cooked with cereal grains in the same manner as described for soybeans and corn.

Germinated soybeans should be considered since germination considerably shortens cooking time. To start germination, the soybeans should be soaked for several hours in cool, safe water and placed on a clean, well-drained surface such as a towel. (If the soybeans were brought to a boil during soaking, they could not be sprouted later.) The beans must be kept moist and protected from dust and mold for about 48 hours. For maximum nutritional value, the sprouted soybeans should be cooked for 2 minutes either by frying in a small amount of oil or boiling in a little water. Longer cooking reduces the vitamin C content.

REFERENCES FOR APPENDIX D

1. C. H. Kearny, Emergency Technology Section, Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., unpublished data, 1975 and 1976.

2. W. R. Aykroyd and J. Doughty, *Wheat in Human Nutrition,* Food and Agriculture Organization, Rome, Italy, 1970, pp. 52–66.

3. W. R. Aykroyd and J. Doughty, *Legumes in Human Nutrition,* Food and Agriculture Organization, Rome, Italy, 1964, p. 48.

4. K. Franz, "Tortillas Fortified with Whole Soybeans Prepared by Different Methods," *J. Food Sci.* **40,** 1275–77 (1975).

Appendix E

Radioactive Iodine and the Prophylactic Use of Stable Potassium Iodide

Americans could ingest or inhale radioactive iodine in hazardous quantities during the following several different types of possible emergencies.

1. By eating or drinking fallout-contaminated food or drink after a nuclear attack on this country. Because of the rapid decay of their radioactivity, radioactive iodines would continue to be a serious health hazard for only a few weeks after the last nuclear explosions.
2. By inhalation in areas of very heavy fresh fallout under certain unusual meteorological conditions.
3. By inhalation in a relatively small area a few miles downwind of a catastrophic nuclear reactor accident. To a less hazardous extent, harmful amounts of radioiodines could be ingested by drinking milk or eating leafy vegetables or fruit produced in considerably further downwind areas during the first few weeks after the accident.
4. By eating or drinking food or drink contaminated by fallout carried into this country by winds from across the Pacific (1, 2).

When taken into the body, radioactive iodine will be absorbed by the thyroid gland, thus causing eventual thyroid damage. If the radiation damage is enough to destroy the thyroid, the individual becomes hypothyroid, that is, loses thyroid function. Doses to the thyroid that are insufficient to destroy the thyroid have resulted in thyroid nodules and thyroid cancer, especially in persons less than 10 years old when exposed (3). Sixty-four Marshall Islanders were accidentally exposed in 1954 to radioactive fallout produced by a large test explosion 100 miles away on Bikini Atoll and received whole-body doses of about 175 R. Absorption of radioactive iodine, principally from ingestion of fallout-contaminated water and food by these uninformed natives, years later resulted in thyroid abnormalities in 22 of these 64 people (4, 5).

If the thyroid gland is saturated with nonradioactive iodine before exposure to radioiodine, the subsequent thyroid absorption of radioiodine is only about 1% of what the absorption would have been without prior prophylactic saturation (6, 7, 8). In this condition the uptake of radioiodine by the thyroid gland is said to be blocked.

Experiments with adult volunteers indicate that 130 mg of nonradioactive potassium iodide (supplying 100 mg of nonradioactive iodine) taken $^1/_2$ hour to 1 day before exposure to radioiodine produces thyroid blocking (6, 7, 8). If prior prophylactic saturation has not occurred, 130 mg of stable (nonradioactive) iodide should be administered as soon as possible after exposure. The U.S. Food and Drug Administration plans "... to establish requirements for the manufacture of 130 mg potassium iodide tablets that can be stockpiled for emergency use." (6) Recommendations (6) on doses are given: "Only one tablet daily is needed and more will not be helpful... A half tablet [65 mg of potassium iodide] may be given to children under one year of age ... For infants, the KI [potassium iodide] tablets should be dissolved in milk or orange juice."

In March 1979, no 130-mg potassium iodide tablets were available. Therefore, when the April 1979 accident occurred at the Three Mile Island Nuclear Power Plant in Pennsylvania, 259,000 small bottles of a saturated aqueous solution of potassium iodide were produced and rushed to the vicinity of the accident. An equal number of medicine droppers also were supplied (9). Fortunately, the accident did not result in the discharge of hazardous quantities of radioiodines, so this prophylactic medicine was not distributed.

Authorities are in agreement that 130-mg daily doses are safe for the majority of people. The USP dose is 300 mg daily, and adverse reactions at this level, even for long-continuing use, are uncommon. For example, one pharmaceutical manufacturer reported that his firm supplies about 43,200,000 therapeutic doses of 300 mg of USP potassium iodide saturated solution per year and that his company had not received any reports of adverse reactions to iodine in the past 5 years (6). Expectorant cough medicines supplying much more than 100 mg per day of iodine are commonly given for long periods, and rarely cause toxic side effects (10, 11). One study (11) concludes that daily doses of 510 mg of potassium iodide for adults and 210 mg for children "... can be prescribed to unselected groups of individuals without fear of any untoward side effects."

The following information and warnings concerning the use of potassium iodide were prepared by the U.S. Food and Drug Administration. This official advice would have been distributed along with small bottles of potassium iodide solution if the 1979 accident at the Three Mile Island Nuclear Power Plant had resulted in dangerous discharges of radioactive iodine.

PATIENT INFORMATION USE OF SATURATED SOLUTION OF POTASSIUM IODIDE (SSKI) FOR THYROID BLOCKING

Directions for Use: See label on bottle.

Background: This product is available solely for public health protection in the event of a nuclear accident which releases into the environment radioactive iodine which may be inhaled or swallowed. Use of potassium iodide as directed reduces the accumulation of radioactive iodine in the thyroid gland. This is important because radiation may damage the cells of the thyroid gland in such a way that changes in the function or structure of the gland may occur even many years after exposure. You should take this product as soon as possible after being told to do so by your public health authority. While the length of time you will take this product will depend upon the directions from your public health authority, it is not expected to exceed about 10 days unless specifically directed otherwise.

Facts about Potassium Iodide: Potassium iodide has been used for many years in large doses (2 to 10 times the dose recommended here) to treat persons with asthma and other lung conditions. It is a relatively safe drug when taken as directed, but as with any drug, side effects may occur. Although side effects are unlikely because of the low dose and the short time you will be taking the drug, they are listed in this insert along with advice on what to do if they occur. It is important to emphasize that larger doses are not necessary for the drug to work properly. The larger the dose, the greater the risk of side effects; therefore, do not exceed the recommended dose.

Who Can Take Potassium Iodide? Unless you are allergic to iodide, you may take potassium iodide as directed. Even if you are taking a thyroid hormone drug product for an underactive thyroid gland, or taking an anti-thyroid drug for an overactive thyroid gland, you may still take potassium iodide. Pregnant women may also take it.

Side Effects: In general, the side effects of potassium iodide have been seen when higher doses of potassium iodide have been taken for a long time. You should be especially cautious not to exceed the recommended dose or take potassium iodide longer than instructed. There are two kinds of side effects: those not involving the thyroid gland and those involving the thyroid gland.

Side effects not involving the thyroid gland. The taking of iodide has been associated with skin rashes, swelling of the salivary glands ("iodide mumps"), and iodism (metallic taste, burning in the mouth and throat, soreness of the teeth and gums, skin rashes, symptoms of a head cold, and sometimes a gastric upset and diarrhea). Also, allergic reactions may produce symptoms such as fever and pains in the joints or, on rare occasions, swelling of various parts of the face and body with at times severe shortness of breath requiring immediate medical attention.

Side effects involving the thyroid gland: The taking of iodide has been associated with overactivity of the thyroid gland, underactivity of the thyroid gland, and enlargement of the thyroid gland (goiter). Goiter may occur also in infants born to mothers who took large doses of potassium iodide throughout pregnancy.

What To Do If Side Effects Occur:

For side effects not involving the thyroid gland: If any of these side effects occur, call your physician or public health authority for instructions. If the symptoms are minor, you may be advised to continue taking potassium iodide. If you have an allergic reaction, discontinue taking potassium iodide and seek immediate medical attention.

For side effects involving the thyroid gland: Because these side effects are very unlikely, with short term use, they pose no immediate problem. However, the taking of iodide has been associated with overactivity of the thyroid gland in elderly persons with heart disease. The symptoms of an overactive thyroid gland are very similar to those associated with anxiety and include nervousness, sweating, and rapid heartbeat. Because in an emergency some anxiety is likely, it is difficult to determine whether these symptoms are caused by anxiety or an overactive thyroid gland. An overactive thyroid, however, would only occur after you had taken potassium iodide for several days. Thus, if these symptoms are persistent and severe, and particularly if the heartbeat is not only rapid but irregular, you should call your physician or public health authority because medical attention is probably required.

Uninformed persons lacking potassium iodide during a crisis should be warned not to try to use tincture of iodine for thyroid blocking. Elemental (free) iodine is ineffective as a blocking agent and is poisonous if taken in more than the very small amounts consumed in drinking water that has been disinfected with iodine. Also, they should be warned against making futile, harmful attempts to eat enough iodized salt to result in thyroid blocking.

E.1 PROPHYLACTIC DOSES OF POTASSIUM IODIDE

If the iodine is administered in the form of the preferred iodide, potassium iodide (KI), the recommended doses are:

For adults and children, 130 mg per day of KI.
For infants less than 12 months old, 65 mg per day of KI.

If these doses were being taken in an America at peace, as a prophylactic against fallout from an overseas war or against radioiodines released in a domestic accident, usually they should be continued for 7 to 10 days, or for shorter or longer periods as directed by public health authorities or other competent officials (6). If the United States were subjected to a nuclear attack, many survivors would not be able to get expert advice concerning the fallout and the perhaps repeated radioactive dangers in their localities. Such uninformed survivors would do well to take these daily doses for 80 days.

Of the dangerous radioisotopes of iodine produced by a nuclear explosion, iodine-131 has the longest half-life. Since iodine-131 decays with a half-life of about 8 days, it takes 80 days for its activity to decay to only about $^1/_{1000}$ of what its activity was 1 hour after the detonation producing radioisotopes of iodine. Therefore, an 80-day supply of stable iodine should prove adequate, even for use in a massive nuclear attack on the United States lasting several weeks, followed by continuing dangers from radioiodines lasting for 40 days or more after the last nuclear explosions. In the very unlikely event that nuclear attacks continued for several months, an 80-day supply would be inadequate.

These doses of stable iodine rarely would have adverse side effects if used for the full 80 days. Hypothyroidism might occur in a very few individuals (12), but this condition usually reverses itself when the iodides are removed. A more serious complication is the possible formation of a goiter in the fetus of pregnant women who are taking high doses of iodides (300 mg per day or more) (13).

Certain trade-offs would occur during a nuclear war. Thyroid damage from radioactive iodine from fallout would be much more serious than the possible adverse effects of blocking doses of potassium iodine in a very few individuals.

Potassium iodide can be taken in tablet form or in solution. To find practical ways for average Americans to take the right amounts of a saturated aqueous solution of KI to provide the recommended daily doses, experiments were conducted at the Oak Ridge National Laboratory. By using a variety of ordinary household medicine droppers, it was found that 1 drop of a saturated aqueous solution of KI contains from 28 to 36 mg of KI. Therefore, the recommended daily doses of a saturated solution of KI are:

For adults and children, 4 drops per day of the saturated solution.
For infants less than 12 months old, 2 drops per day of the saturated solution.

E.2 WAYS TO OBTAIN POTASSIUM IODIDE FOR PROPHYLACTIC USE

With a prescription from a doctor, a USP saturated solution of KI can be purchased at most pharmacies. This solution contains a very small amount of a compound that prevents significant deterioration for a few years. The solution is best stored in a dark glass bottle having a solid cap that screws on liquid-tight and is not made of metal. A separate medicine dropper should be kept in the same place. ["Supplies of potassium iodide can be stored in a variety of places, including homes . . ." (6)]

In April 1979, a 2-oz bottle, containing about 2000 drops of this 99%-effective prophylactic solution, sold for $2.35 in an economy drug store.

If it is to be stored for years, the crystalline or granular form of KI is better than the solution. The solid forms of KI may also be purchased from pharmacies by doctor's prescription. Chemical-reagent-grade KI, which is purer than the pharmaceutical grade, can be purchased from many chemical supply firms without a prescription or other authorization. In 1979 1 lb of chemical-reagent-grade KI, enough for about 3500 doses of 130 mg each, retailed for about $20. Dry KI should be stored in a dark bottle having a solid, gasketted, screw-top lid.

E.3 PRACTICAL EXPEDIENT WAYS TO PREPARE AND TAKE A SATURATED AQUEOUS SOLUTION OF POTASSIUM IODIDE

To prepare a saturated solution of KI, fill a bottle about 60% full of crystalline or granular KI. (A 2 fl oz bottle, made of dark glass and having a solid, screw-cap top, is a good size for a family. About 2 oz of crystalline or granular KI is needed to fill a 2 fl oz bottle about 60% full.) Next, pour safe, room-temperature water into the bottle until it is about 90% full. Then close the bottle tightly and shake it vigorously for at least 2 minutes. Some of the solid KI should remain permanently undissolved at the bottom of the bottle; this is proof that the solution is saturated.

Potassium iodide has a very bad taste, so bad that a single crystal or 1 drop of the saturated solution in a small child's mouth would make him cry. Since many persons will not take a bad-tasting medication, especially if no short-term health hazards are likely to result from not taking it, the following two methods of taking a saturated solution of KI are recommended.

1. Put 4 drops of the solution into a glass of milk or other beverage, stir, and drink quickly. Then drink some of the beverage with nothing added. If only water is available, use it in the same manner.

2. If there is bread or thick grain mush, place 4 drops of the solution on a piece of it; dampen and mold it into a firm ball the size of a large pea, about $^{3}/_{8}$ inch in diameter. There is almost no taste if this "pill" is swallowed quickly with water. (If the pill is coated with margarine, there is no taste.)

As stated before, 4 drops of the saturated solution provide a dose approximately equal to 130 mg of KI.

REFERENCES FOR APPENDIX E

1. C. H. Kearny, *Trans-Pacific Fallout and Protective Countermeasures,* ORNL-4900, Oak Ridge National Laboratory, Oak Ridge, Tenn., November 1973.

2. H. Lee and W. E. Strope, *Assessment and Control of the Transoceanic Fallout Threat,* SRI Project EGU (830) 2981, Stanford Research Institute, Menlo Park, Calif., August 1974.

3. National Council on Radiation Protection and Measurements, *Radiological Factors Affecting Decision-Making in a Nuclear Attack,* NCRP Report 42, Washington, D.C., 1974, pp. 29–30.

4. R. A. Conard, B. M. Dobyns, and W. W. Sutow, "Thyroid Neoplasia as Late Effect of Exposure to Radio-active Iodine in Fallout," *J. Am. Med. Assoc.* **214**, 316–24 (1972).

5. R. A. Conard et al., *A Twenty-Year Review of Medical Findings in a Marshallese Population Accidentally Exposed to Radioactive Fallout,* Brookhaven National Laboratory Report 50424, Brookhaven National Laboratory, Upton, N.Y., September 1975.

6. National Council on Radiation Protection and Measurements, *Protection of the Thyroid Gland in the Event of Releases of Radioiodine,* NCRP Report 55, Washington, D.C., Aug. 1, 1977.

7. J. A. Auxier and R. O. Chester, *Report of the Clinch Valley Study,* ORNL-4835, June 1972, pp. 34–37.

8. D. Ramsden et al., "Radioiodine Uptakes in the Thyroid Studies of the Blocking and Subsequent Recovery of the Gland Following the Administration of Stable Iodine," *Health Phys.* 13, 633–46 (1967).

9. Robert Reinhold, "Frantic Team Efforts Brought Vital Chemical to Stricken Plant," *New York Times,* Apr. 4, 1979, p. A16.

10. E. E. Pochin and C. F. Barnaby, "The Effect of Pharmacological Doses of Non-Radioactive Iodine on the Course of Radioiodine Uptake by the Thyroid" *Health Phys.* 7, 125–26 (1962).

11. C. A. Adams and J. A. Bonnell, "Administration of Stable Iodine as a Means of Reducing Thyroid Irradiation Resulting from Inhalation of Radioactive Iodine," *Health Phys.* 7, 127–49 (1962).

12. R. R. Cavalieri, "Iodine," pp. 365–66 in R. S. Goodhert and M. E. Shils, eds., *Modern Nutrition in Health and Disease,* 5th ed., Lea and Febiger, Philadelphia, Pa., 1973.

13. F. Carswell, M. M. Kerr, and J. H. Hutchison, "Congenital Goiter and Hypothyroidism Produced by Material Ingestion of Iodides," *Lancet* 1, 1241–42 (1970).

Appendix F

Procedures for Obtaining Safe Water Under Emergency Conditions

Under emergency conditions, water supplies may be contaminated with disease organisms and/or radioactivity. Since even after a massive nuclear attack the casualties due to drinking water contaminated by organisms probably would greatly exceed casualties due to drinking water contaminated by radioactive fallout, the former will be discussed first.

F.1 DISEASE ORGANISMS

An Environmental Protection Agency publication, *Manual of Individual Water Supply Systems* (1), gives procedures to follow for obtaining safe water under emergency conditions when no radioactivity is involved:

When ground water is not available and surface must be used, avoid sources containing floating material or water with a dark color or an odor. The water from a surface source should be taken from a point upsteam from any inhabited area and dipped, if possible, from below the surface.

When the home water supply system is interrupted by natural or other forms of disaster, limited amounts of water may be obtained by draining the hot water tank or melting ice cubes.

There are two general methods by which small quantities of water can be effectively disinfected. One method is by boiling. It is the most positive method by which water can be made bacterially safe to drink. Another method is chemical treatment. If applied with care, certain chemicals will make most waters free of harmful or pathogenic organisms.

When emergency disinfection is necessary, the physical condition of the water must be considered. The degree of disinfection will be reduced in water that is turbid. Turbid or colored water should be filtered through clean cloths or allowed to settle, and the clean water drawn off before disinfection. Water prepared for disinfection should be stored only in clean, tightly covered, noncorrodible containers.

Methods of emergency disinfection

1. *Boiling*. Vigorous boiling for 1 *full* minute will kill any disease-causing bacteria present in water. The flat taste of boiled water can be improved by pouring it back and forth from one container into another, by allowing it to stand for a few hours, or by adding a small pinch of salt for each quart of water boiled.

2. *Chemical treatment*. When boiling is not practical, chemical disinfection should be used. The two chemicals commonly used are chlorine and iodine.

a. *Chlorine*

(1) *Chlorine bleach*. Common household bleach contains a chlorine compound that will disinfect water. The procedure to be followed is usually written on the label. When the necessary procedure is not given, one should find

the percentage of available chlorine on the label and use the information in the following tabulation as a guide:

Available chlorine[a]	Drops per quart of clear water[b]
1%	10
4–6%	2
7–10%	1

[a]If strength is unknown, add 10 drops per quart to purify.
[b]Double amount for turbid or colored water.

[*Author's addition*: If a dropper is not available, use a spoon and a square-ended strip of paper or thin cloth about $^1/_4$ inch wide by 2 inches long. Put the strip in the spoon with an end hanging down about $^1/_2$ inch beyond the end of the spoon. Then, when bleach is placed in the spoon and the spoon is carefully tipped, drops the size of those from a medicine dropper will drip off the end of the strip.

To disinfect large volumes of water, use 1 scant teaspoon of bleach containing 5.25% sodium hypochlorite for each 10 gallons of clear water; use 2 scant teaspoons for muddy or colored water.]

The treated water should be mixed thoroughly and allowed to stand for 30 minutes. The water should have a slight chlorine odor; if not, repeat the dosage and allow the water to stand for an additional 15 minutes. If the treated water has too strong a chlorine taste, it can be made more palatable by allowing the water to stand exposed to the air for a few hours or by pouring it from one clean container to another several times.

(2) *Granular Calcium Hypochlorite.* Add and dissolve one heaping teaspoon of high-test granular calcium hypochlorite (approximately $^1/_4$ ounce) for each 2 gallons of water. This mixture will produce a stock chlorine solution of approximately 500 mg/*l*, since the calcium hypochlorite has an available chlorine equal to 70 percent of its weight. To disinfect water, add the chlorine solution in the ratio of one part of chlorine solution to each 100 parts of water to be treated. This is roughly equal to adding 1 pint (16 oz.) of stock chlorine solution to each 12.5 gallons of water to be disinfected. To remove any objectionable chlorine odor, aerate the water as described above.

(3) *Chlorine tablets.* Chlorine tablets containing the necessary dosage for drinking water disinfection can be purchased in a commercially prepared form. These tablets are available from drug and sporting goods stores and should be used as stated in the instructions. When instructions are not available, use one tablet for each quart of clear water to be purified [and two tablets for each quart of turbid water].

b. *Iodine*

(1) *Tincture of Iodine.* Common household iodine from the medicine chest or first aid package may be used to disinfect water. Add five drops of 2 percent United States Pharmacopeia (U.S.P.) tincture of iodine to each quart of clear water. For turbid water add 10 drops and let the solution stand for at least 30 minutes.

(2) *Iodine tablets.* Commercially prepared iodine tablets containing the necessary dosage for drinking water disinfection can be purchased at drug and sporting goods stores. They should be used as stated in the instructions. When instructions are not available, use one tablet for each quart of clear water to be purified [and two tablets for each quart of turbid water].

Water to be used for drinking, cooking, making any prepared drink, or brushing the teeth should be properly disinfected.

F.2 RADIOACTIVITY IN WATER (2)

Suspended fallout particles or dissolved radioisotopes cannot be removed from water by the methods most frequently used to eliminate disease organisms, such as chemical disinfection or boiling. Therefore, water should be obtained from the least radioactive sources available. Before stored potable water has been exhausted, other water sources should be located. Possible water sources are listed below in the order of probable increasing radioactive contamination and, therefore, in decreasing order of safety. Contaminated water should first be treated to reduce radioactivity levels and then treated to destroy disease organisms.

Possible Water Sources

1. Water from deep wells and from water tanks and covered reservoirs into which no fallout particles or fallout-contaminated water has been introduced.
2. Water from shallow, hand-dug wells or seepage pits into which fallout or fallout-contaminated surface water has been prevented from entering by waterproof coverings and by waterproofing the ground around the hole to keep water from running down outside the well casing. This water is usually safe.
3. Contaminated water from deep lakes. Water from deep lakes would be much less contaminated by both dissolved radioisotopes and fallout particles than would water from shallow ponds if both were exposed to the same amount of fallout per unit of surface area. Water from postattack runoff usually would constitute a smaller fraction of the total volume in deep lakes since particles settle to the bottom more rapidly in deep lakes than in shallow ponds, which are agitated more by wind.
4. Contaminated water from shallow ponds and other shallow, still water.
5. Contaminated water from streams, which would be especially dangerous if the stream is muddy. If runoff results from the first rain after deposition of fallout, this runoff will contain most of the radionuclides that can go into solution from fallout particles that have been deposited on the drainage area (3). Runoff, after the first few rains following the deposition of fallout, is unlikely to have high amounts of dissolved radionuclides.
6. Badly contaminated water collected from fallout-contaminated roofs would contain more fallout particles than would runoff from the ground.
7. Water obtained by melting snow that has fallen through air containing fallout-particles, or onto which fallout has fallen. Avoid using for drinking or cooking, if possible.

The dangers from drinking fallout-contaminated water could be greatly lessened by using expedient filtration methods to remove almost all the fallout particles and most of the dissolved radionuclides. Fortunately, in areas of heavy fallout, less than 2% of the radioactivity of the fallout particles would become dissolved in water (3). If almost all the radioactive fallout particles were to be removed by filtering or by settling methods, few casualties would be likely to result from drinking and cooking with most fallout-contaminated water.

Removing Radioactive Particles and Dissolved Radionuclides (2)

1. *Boiling-water still.* A boiling-water still would remove almost all radioactivity from water except that due to radioiodines. However, equipment to build a still would be available only to a small fraction of the population, and the dissolved radioiodines could be a serious hazard during the first few weeks after fallout deposition.

2. *Expedient filters.* In areas subject to heavy fallout, about 99% of the radioactivity in water could be removed by using an expedient filter with ordinary soil for the filter medium. Only materials found in and around most American homes would be required to make an effective filter.

a. Perforate the bottom of a 5-gallon can, a large bucket, a watertight wastebasket, or a similar container with about a dozen large nail holes. Punch the holes from the bottom upward, within about 2 inches of the center.
b. Place a layer of washed pebbles or smaller stones about $1^1/_2$ inches thick on the bottom of the can. If pebbles are not available, twisted coat-hanger wires could be used.

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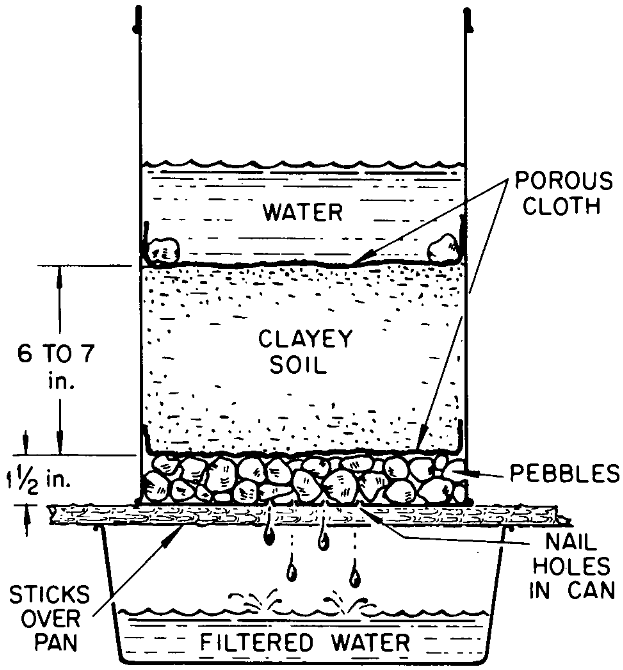

EXPEDIENT FILTRATION

c. Cover the pebbles with one thickness of terrycloth towel, burlap sackcloth, or other quite porous cloth. Cut the cloth roughly circular and about 3 inches larger in diameter than the diameter of the can.
d. Take soil containing some clay (almost all soils do) from at least 6 inches below the surface. (Almost all fallout particles remain near the surface.) Pulverize the soil and gently press it in layers over the cloth that covers the pebbles so that the cloth is held snugly against the sides of the can. Do not use pure clay (not porous enough) or sand (too porous). The soil layer should be 6 to 7 inches thick.
e. Completely cover the surface of the soil layer with one thickness of fabric that is as porous as a bath towel. This is to keep the soil from being eroded as water is poured into the filtering can. The cloth will also remove some of the particles from the water. A dozen small washed stones placed on the cloth near its edges will secure it adequately.
f. Support the filter can on rods or sticks placed across the top of a container such as a dishpan, that is larger in diameter than the filter can.

Contaminated water should be poured into the filter can, preferably after allowing it to settle, as described below. The filtered water should then be disinfected by one of the previously described methods.

If the 6 or 7 inches of filtering soil is a sandy clay loam, the filter initially will deliver about 6 quarts of clear water per hour. (If the filtration rate is faster than about 1 quart in 10 minutes, remove the upper fabric and recompress the soil.) After several hours, the rate will be reduced to about 2 quarts per hour.

When the filtering rate becomes too slow, it can be increased by removing and rinsing the surface fabric, removing about $^1/_2$ inch of soil, then replacing the fabric. The life of a filter is extended and its efficiency increased if muddy water is first allowed to settle for several hours in a separate container, as described below.

Tests of this filter design at Oak Ridge National Laboratory, using 5 inches of sandy clay soil (about 70% clay minerals and about 30% sand) for the filter medium, have included the filtration of water containing 21.8 μg/ml of dissolved elemental iodine and 24.5 μg/ml of dissolved sodium iodide. The filtered water (filtered at a rate of 1 liter every 10 to 15 minutes) contained less than 0.3 μg/ml of elemental iodine (0.3 μg/ml is the minimum concentration detectable by the analytical procedure used) and 6 to 7 μg/ml of sodium iodide. Since elemental iodine would be the major hazard from dissolved radioiodines, filtering through clayey earth is a practical method of removing radioiodines from water—an effectiveness not possessed by ordinary ion-exchange water softeners, nor by charcoal filters using ordinary (not activated) charcoal.

Experiments by the U.S. Army Mobility Equipment R&D Center (4) have established the fact that filtration of fallout-contaminated water through clayey soil also is effective in removing strontium and cesium (the most dangerous long-lived radionuclides in fallout) and other contaminants.

A less effective type of expedient filter was made and tested by U.S. Army engineers. It can be made by using a flower pot, screen, toilet tissue, and a column of subsoil (i.e., soil taken from several inches below the surface) (5):

a. Cut a circular piece of metal screen to cover the bottom of a flower pot or similar container.
b. Lay two sheets of toilet tissue over the screen.
c. Carefully add subsoil to a minimum depth of 2 inches.
d. Cover soil with a layer of small stones.

Contaminated water is gently poured on top of the filter. The filtration rate depends on the type of subsoil used. This filter was found to remove from 92 to 98% of the radioactivity from water contaminated mostly by fallout particles.

3. *Settling and filtering.* Settling is one of the easiest methods to remove most fallout particles from water. The procedure for settling is as follows:

a. Fill a bucket or other deep container three-fourths full with the contaminated water.
b. Take pulverized clay or clayey soil from a depth of 6 inches or more below ground surface and stir it into the water. Use about 1 inch of dry clay or dry clayey soil for every 4 inches of water in the container. Stir until practically all the clay particles are suspended in the water.
c. Let the clay settle for at least 6 hours. The settling clay particles will carry most of the suspended fallout particles to the bottom and cover them.
d. Carefully dip out or siphon the clear water.

To remove most of the dissolved radionuclides (usually a minor danger in untreated water, compared to the fallout particles), the clear water should be filtered through a clayey soil and then disinfected.

4. *Letting contaminated water stand.* During the first 3 days after a nuclear explosion, most of the danger to the thyroid would be due to 4 radioiodines having half-lives shorter than that of iodine-131. The most dangerous thyroid doses of radioiodines would result from fallout-contaminated water consumed 1 to 3 hours after the explosion, when the 4 shorter-lived radioisotopes of iodine would cause about 95% of the radiation dose to the thyroid (6, 7). In contrast, 1 week after the explosion, over 90% of the thyroid dose would be caused by iodine-131. After 1 week, this danger would be halved every 8 days, primarily due to the natural decay of iodine-131.

Before the arrival of the first fallout, shelter occupants should strive to store at least a 2-week supply of water—a minimum of 7 gallons per person (14 gallons is preferable, and more if possible). After the arrival of fallout, if they expect additional fallout from later nuclear attacks, they may find it advantageous to obtain and store fallout-contaminated water and to allow it to stand for as long as practical before use. To justify such storage, the whole-body radiation doses resulting from going outside the shelter to get the contaminated water must be small. Furthermore, even after days of storage, the fallout particles and dissolved radionuclides in the stored water would still need to be removed by filtration, or by settling and filtration, and the water should be disinfected by boiling or chemical treatment.

Adequate supplies of safe water can be stored or carried at minimum cost by using large polyethylene bags of the untreated types that are widely sold in 20- and 30-gallon sizes. A waterproof bag is placed inside a fabric bag having a smaller diameter. To minimize the possibility of a leak, it is better to use two plastic bags, one inside the other. During and after filling, the tightly tied mouths of these improvised water containers are kept above the water level. One such container holds 10 to 20 gallons. Blast tests have shown that such water containers will even withstand severe ground shocks, as will pits dug in the earth, lined with thin plastic, filled with water, and covered. These and other expedient means to store and carry the most essential nutrient—water—will be described in a forthcoming Oak Ridge National Laboratory report, *Nuclear War Survival Skills.*

REFERENCES FOR APPENDIX F

1. Environmental Protection Agency, Water Supply Division, *Manual of Individual Water Supply Systems*, Washington, D.C., 1973, pp. 139–41.

2. C. H. Kearny, Emergency Technology Section, Health Physics Division, Oak Ridge National Laboratory, Oak Ridge, Tenn., unpublished data, 1975 and 1976.

3. D. C. Lindsten et al., "Solubility of Radioactive Bomb Debris," *J. Am. Water Works Assoc.* 53, 256–62 (1961).

4. U.S. Army MERDC Reports 1396, 1404, 1406, and 1451 RR, Mobility Equipment R&D Center, Fort Belvoir, Va.

5. D. C. Lindsten and M. Pressman, *Field Experiments for Decontaminating Water Containing Nuclear Bomb Debris,* Report 1904, U.S. Army Engineer Research and Development Laboratories, Fort Belvoir, Va.

6. R. A. Conard et al., *A Twenty-Year Review of Medical Findings in a Marshallese Population Accidentally Exposed to Radioactive Fallout,* Brookhaven National Laboratory Report 50424, Brookhaven National Laboratory, Upton, N.Y., September 1975.

7. R. O. Chester, *Biological Dose and Radiological Activity from Nuclear Reactor or Nuclear Weapon Fission Products,* ORNL-4996, Oak Ridge National Laboratory, Oak Ridge, Tenn., December 1974.

Appendix G

Method for Sterilizing Infant Feeding Utensils Without Boiling

In an emergency setting it may not always be possible to boil infant feeding utensils (1). It is still possible to make these safe by using chlorine. The most common source of chlorine would be household bleach. The chlorine bleach solution can be added to water and the necessary utensils soaked in this solution. Directions follow.

The Utensils

1. Immediately after feeding, wash the inside and outside of all utensils used to prepare the formula and to feed the infant.
2. Fill a covered container with clean, cold water and add the appropriate amount of chlorine solution (2), which can be determined from the following:

Available chlorine[a] (%)	Amount per quart of clear water[b] (teaspoon)
1	3
4–6	½
7–10	⅓

[a]If strength is unknown, add 3 teaspoons per quart. [% available chlorine is about equal to % sodium hypochlorite in a bleach solution in which sodium hypochlorite is the only active ingredient.]

[b]Double amount for turbid or colored water.

Commercial household bleach as used in the United States is usually 5.25% hypochlorite (chlorine).

3. Totally immerse all utensils until the next feeding (3 to 4 hours). Be sure that the bottle, if used, is filled with solution. Keep container covered.

Feeding Time

1. Before preparing food, wash hands.
2. Remove utensils from the disinfectant solution and drain, but do not rinse.
3. Prepare formula; feed infant.
4. Immediately after feeding, wash utensils in clean water and immerse again in the disinfectant solution.
5. Prepare fresh solution each day.

REFERENCES FOR APPENDIX G

1. D. B. Jelliffe, *Child Nutrition in Developing Countries,* Office of War on Hunger, Agency for International Development, U.S. Department of State, Washington, D.C., 1968, pp. 189–90.

2. Environmental Protection Agency, Water Supply Division, *Manual of Individual Water Supply Systems,* Washington, D.C., 1973, pp. 139–41.

Appendix H

Nutrient Composition of Some Common Foods in 100-g Edible Portions

Appendix H

Nutrient Composition of Some Common Foods in 100-g Edible Portions[a,b]

	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Magnesium (mg)	Iron (mg)	Zinc (mg)	Potassium (mg)	Vitamin A (RE)[c]	Thiamin (mg)	Ribo-flavin (mg)	Niacin (mg)	Vitamin B-6 (mg)	Folacin (μg)	Vitamin C (mg)
Cereals															
Barley, pearled, light	349	8.2	1.0	16	37	2.0		160	0	0.12	0.05	3.1		(50.0)	0
Corn, field, dry	348	8.9	3.9	22	147	2.1	2.1	284	49[d]	0.37	0.12	2.2	(0.25)	(26.5)	0
Oatmeal	390	14.2	7.4	53	144	4.5	3.4	352	0	0.60	0.14	1.0	0.14	(33.0)	0
Rice, brown	360	7.5	1.9	32	88	1.6	1.8	214	0	0.34	0.05	4.7	0.55	20.0	0
Rice, milled, white, unenriched	363	6.7	0.4	24	28	0.8	1.3	92	0	0.07	0.03	1.6	0.17	16.0	0
Sorghum	332	11.0	3.3	28		4.4		350	0	0.38	0.15	3.9			0
Wheat flour, all purpose, enriched	364	10.5	1.0	16	25	2.9	0.7	95	0	0.44	0.26	3.5	0.06	8.0	0
Wheat flour, all purpose, unenriched	364	10.5	1.0	16	25	0.8	0.7	95	0	0.06	0.05	0.9	0.06	8.0	0
Wheat, hard	330	13.0	2.0	41	160	3.3	3.4	370	0	0.55	0.12	4.3	0.34	(49.0)	0
Wheat, soft	326	10.2	2.0	42	160	3.5	2.7	376	0	0.43	0.11	3.6	0.34	(49.0)	0
Legumes															
Beans, dry, red	343	22.5	1.5	110	163	6.9	2.8	984	2	0.51	0.20	2.3	0.44	180	0
Benas, dry, white	340	22.3	1.6	144	170	7.8	2.8	1196	0	0.65	0.22	2.4	0.56	125	0
Beans, lima, dry	345	20.4	1.6	72	180	7.8	2.8	1529	0	0.48	0.17	1.9		128	0
Peanuts, shelled, raw	564	26.0	47.5	69	206	2.1	2.9	674	0	1.14	0.13	17.2	(0.40)	(56.5)	0
Peas, dry, whole	340	24.1	1.3	64	180	5.1	3.2	1005	12	0.74	0.29	3.0	0.13	(201)	0
Soybeans, dry	403	34.1	17.7	226	265	8.4		1677	8	1.10	0.31	2.2	0.81	224	0
Animal foods															
Beef carcass, total edible, trimmed to retail level, raw, good grade	263	18.5	20.4	11	18	2.8	4.2	355	12	0.08	0.16	4.4	0.33	(6.9)	0
Beef, canned	224	25.0	13.0	16	(21)	2.4		259	0	0.02	0.23	4.2			0
Chicken, roaster, total edible	239	18.2	17.9	10	(23)	1.6	(1.5)		276	0.08	0.19	6.7	(0.50)	(2.8)	0
Hen's egg, not in shell	163	12.9	11.5	54	11	2.3	1.0	129	354	0.11	0.30	0.1	0.11	5.1	0

	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Magnesium (mg)	Iron (mg)	Zinc (mg)	Potassium (mg)	Vitamin A (RE)[c]	Thiamin (mg)	Ribo-flavin (mg)	Niacin (mg)	Vitamin B-6 (mg)	Folacin (μg)	Vitamin C (mg)
Milk, cow's fresh whole	65	3.5	3.5	118	13	trace	0.4	144	42	0.03	0.17	0.1	0.04	0.6	1
Milk, nonfat dry, fortified[e]	359	35.8	0.7	1293	142	0.6	4.5	1725	667[f]	0.35	1.78	0.9	0.38	6.6	7
Roots															
Potatoes, white, raw	76	2.1	0.1	7	34	0.6	0.3	407	trace	0.10	0.04	1.5	0.25	(6.8)	20[g]
Sweet potatoes, raw	114	1.7	0.4	32	31	0.7		243	880	0.10	0.06	0.6	0.22	12.0	21[g]
Other															
Sugar, refined	385	0	0	0	0	0.1	0.06	3	0	0	0	0	0	0	0
Oils, salad or cooking	884	0	100.0	0	0	0	0	0	0	0	0	0	0	0	0

[a]Data come from (1) except for zinc (2), vitamin B-6 (3), and folacin (4).

[b]Numbers in parentheses denote values imputed – usually from another form of the food; zero indicates that the amount of a constituent probably is zero or is too small to measure; no entry denotes lack of reliable data for a constituent believed to be present in measurable amount.

[c]RE = retinol equivalents. Retinol units can be changed to international units (IU) by multiplying animal sources of RE by 3.33 and plant sources of RE by 10. This will result in the same IU as reported in the Department of Agriculture Handbook 8 (1).

[d]Based on yellow varieties, white varieties contain only a trace of cryptoxanthin and carotenes, the pigments in corn that have biological activity.

[e]Fortified nonfat dry milk will provide 11 μg (440 IU) of vitamin D.

[f]If the nonfat dry milk is not fortified, the vitamin A level is 9 RE.

[g]Year-round average. Recently dug potatoes contain about 26 mg of vitamin C per 100 g. After 3 months' storage the value is only half as high; after 6 months, about ⅓ as much.

Sources:

1. B. K. Watt and A. L. Merrill, *Composition of Foods: Raw, Processed, Prepared*, Agriculture Handbook 8, Agriculture Research Service, U.S. Department of Agriculture, Washington, D.C., 1963, 190 pp.
2. E. W. Murphy, B. W. Willis, and B. K. Watt, "Provisional Tables on the Zinc Content of Foods," *J. Am. Diet. Assoc.* **66**, 345–55 (1975).
3. M. L. Orr, *Pantothenic Acid, Vitamin B-6 and Vitamin B-12 in Foods*, Home Economics Research Report 36, Agriculture Research Division, U.S. Department of Agriculture, Washington, D.C., 1969, 53 pp.
4. M. G. Hardinge and H. Crooks, "Lesser Known Vitamins in Foods," *J. Am. Diet. Assoc.* 38, 240–45 (1961).

Appendix I

Conversion Tables

Weight

1 United States short ton = 2000 pounds
1 metric ton (1000 kilograms) = 2205 pounds

1 pound = 454 grams
1 ounce = 28.4 grams
1 kilogram = 2.2 pounds

1000 grams = 1 kilogram
1000 milligrams = 1 gram
1000 micrograms = 1 milligram

16 ounces = 1 pound
28 grams = 1 ounce

Volume

8 fluid ounces = 1 cup
1 cup = 16 tablespoons
2 cups = 1 pint
4 cups = 1 liquid quart
1 liquid quart = 0.95 liter
1 liter = 1.06 liquid quarts

1 tablespoon = ½ fluid ounce
= ¼ grams water
1 teaspoon = ⅙ fluid ounce
= 5 grams water

Symbols

lb = pound
kg = kilogram
g = gram
kcal = kilocalorie
= the large calorie, usually called the calorie in popular articles on diets

mg = milligram
μg = microgram
c = cup

tbsp = tablespoon
tsp = teaspoon
l = liter
qt = quart
kcal = kilocalorie
oz = ounce

Appendix J

Weight-Volume Conversion Tables for Foods

Appendix J

Weight-Volume Conversion Tables for Foods

	Volume	Weight [g (oz)]	Conversion
Cereals			
Barley, pearled, light, uncooked	1 cup	200 (7.0)	$2\frac{1}{4}$ c = 1 lb
Corn, field, whole kernel, dry	1 cup	200 (7.0)	$2\frac{1}{4}$ c = 1 lb
Cornmeal, whole ground, unbolted, dry	1 cup	122 (4.35)	4 c = 1 lb
Oatmeal, dry, old fashioned	1 cup	80 (2.85)	$4\frac{3}{4}$ c = 1 lb
Rice, milled	1 cup	185 (6.60)	3 c = 1 lb
Wheat			
Whole kernels	1 cup	212 (7.50)	2 c = 1 lb
Flour, all purpose, sifted	1 cup	125 (4.45)	4 c = 1 lb
Flour, whole wheat, stirred	1 cup	120 (4.30)	$3\frac{3}{4}$ c = 1 lb
Meal, whole wheat, coarse-ground or coarse-pounded	1 cup	162 (5.75)	$2\frac{3}{4}$ c = 1 lb
Legumes			
Beans, common, white, dry	1 cup	190 (6.75)	$2\frac{1}{4}$ c = 1 lb
Beans, common, red, dry	1 cup	197 (7.00)	$2\frac{1}{4}$ c = 1 lb
Beans, lima, dry	1 cup	190 (6.75)	$2\frac{1}{4}$ c = 1 lb
Beans, pinto, dry		205 (7.25)	$2\frac{1}{4}$ c = 1 lb
Peanuts, roasted, jumbo, shelled	1 cup	144 (5.15)	3 c = 1 lb
Peas, split, dry	1 cup	210 (7.5)	$2\frac{1}{2}$ c = 1 lb
Soybeans	1 cup	214 (7.50)	$2\frac{1}{2}$ c = 1 lb
Whole beans, dry			
Meal, whole beans, coarse-ground or coarse-pounded	1 cup	170 (6.00)	$2\frac{3}{4}$ c = 1 lb
Milk			
Fluid, whole, 3.5% fat	1 cup	244 (8.70)	
Dry, low density ($1\frac{1}{3}$ cups needed for reconstitution to 1 qt)	1 cup	68 (2.42)	1 lb = 5 qt
Dry, high density ($\frac{7}{8}$ cup needed for reconstitution to 1 qt)	1 cup	104 (4.30)	1 lb = 5 qt
Roots			
Potatoes, white, medium (about 3 per pound, raw)	1	150 (5.35)	
Sweet potatoes, medium, raw (5 by 2 inches)	1	168 (6)	
Other			
Sugar, granulated	1 cup	200 (7.15)	$2\frac{1}{4}$ c = 1 lb
	1 tbsp	11 (0.4)	
Oil	1 cup	220 (7.85)	2 c = 1 lb
	1 tbsp	14 (0.5)	
Salt	1 cup	190 (7.15)	$2\frac{3}{8}$ c = 1 lb $2\frac{1}{8}$ tbsp = 1 oz $\frac{3}{4}$ tbsp = 10 g

Appendix K

Glossary

amino acid—one of a group of about 20 organic compounds containing nitrogen which are used to synthesize protein.

anemia—a condition in which there is a reduction in the total number of red blood cells or hemoglobin in the blood.

autoclave—a container for sterilizing or cooking by superheated steam under pressure.

beriberi—a disease associated with a deficiency of thiamin in the diet.

blanch—to apply boiling water or steam for a few minutes.

carbohydrate—a class of nutrients which includes sugar and starch.

carotene—an organic compound formed in some plants, which can be converted into vitamin A by the body.

cereals—any grain used for food, such as wheat, oats, rice, corn, etc.

dehydration—removal of water.

digestibility—the fitness of food for conversion into assimilable form.

enrichment—the process of adding specific nutrients to a food, usually products of cereal grains; for example, thiamin, riboflavin, niacin, and iron are added to white four.

essential amino acid—an amino acid that cannot be synthesized by the body and thus must be supplied in the diet.

extraction level of flour—the percentage of the wheat kernel left after being milled into flour: 100% extraction is whole wheat; 72% extraction is the white flour normally consumed in the United States.

FAO—Food and Agriculture Organization, United Nations.

fat—a term that includes fats and oils.

flatulence—condition of having gas in the stomach or intestine.

fortification—the process of adding 1 or more nutrients to a food for a specific dietary purpose; for example, iodine is added to salt and vitamin D to milk.

germinate—to start developing or growing.

goiter—a swelling of the thyroid gland.

gram—a unit of weight measurement equal to $^1/_{1000}$ of a kilogram (about $^1/_{28}$ of an ounce).

kcal—kilocalorie, Calorie, unit used in measuring the energy value of food and in the study of metabolism.

ketosis—a condition in which ketones are present in the body in excessive amounts. (Ketosis can be produced by a diet containing less than 60 to 100 g of carbohydrate per day.)

legumes—the name given to beans and other related plants.

limiting amino acid—the amino acid present in the smallest amount when protein is being synthesized.

maize—corn.

megaloblastic anemia—a type of anemia that can be caused by a deficiency of either folacin or vitamin B-12.

microgram—one-millionth of a gram; symbol, μg.

parboiled rice—brown rice that is partially cooked, dried, and then milled to white rice, resulting in higher levels of vitamins and minerals.

pellagra—a disease associated with a deficiency of niacin in the diet.

PER—see protein efficiency ratio.

phytic acid—an organic compound occurring naturally in whole grains and legumes, which has been implicated in decreased absorption of some minerals.

protein efficiency ratio—protein quality expressed as weight gained divided by total protein eaten.

protein quality—relative usefulness of a food protein to support tissue formation in the body.

RDA—recommended dietary allowance; the daily allowance recommended by the Food and Nutrition Board, National Academy of Sciences, on the basis of current scientific information.

RE—see retinol equivalent.

rickets—a disease caused by lack of vitamin D.

retinol equivalent—a term used to express the vitamin A value of foods.

supplementation of protein—process of combining foods to improve the protein quality.

tryptophan—an essential amino acid which can be used by the body to synthesize niacin.

vitamins—complex organic compounds which are needed in small amounts for metabolism regulation and the normal growth and functioning of the body.

weaning foods—foods given to an infant or young child to bridge the food intake between an all-milk diet and an adult's diet.

WHO—World Health Organization, United Nations.

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