

Figure 4.1.3: Malawian foods

Food	Protein (g)	Ca (mg)	Fe (mg)	Vit. B ₉ (μg)	Vit. B ₁₂ (μg)	Vit. C (mg)	Vit. B ₁ (mg)	Vit. B ₂ (mg)	Vit. B ₃ (mg)	Vit. A (μg)
Maize flour	0.08120	0.0612	0.03450	0.2450	0	0	0.00385	0.00201	0.03630	0.112
Tangerines	0.00805	0.3640	0.00156	0.1560	0	0.268	0.00058	0.00036	0.00377	0.338
Pigeon peas	0.06760	0.4290	0.10000	1.1000	0	0	0.00148	0.00571	0.00781	0
Matemba	0.20100	0.1000	0.00556	0.2440	0.0158	0	0.00041	0.00063	0.03900	0
Potatoes	0.01960	0.0507	0.00350	0.0922	0	0.128	0.00105	0.00021	0.01390	0
Chinese cabbage	0.01500	1.0500	0.00800	0.6630	0	0.450	0.00040	0.00070	0.00500	2.230

Table 4.1.2: Nutritional content per gram of foods

Food	Energy content (cal/g)
Maize flour	3.620
Tangerines	0.532
Pigeon peas	1.190
Matemba	0.956
Potatoes	0.931
Chinese cabbage	0.131

Table 4.1.3: Energy content of foods

Dr. Corr uses linear programming to design a diet that meets all nutritional requirements while keeping the intake of calories at a minimum. In this case, each nutrient under consideration acts as a constraint. The total number of calories is the objective function. Note that the objective is to *minimize* the number of calories. Therefore, the method used to solve this problem must be different from the previous chapters, where the objective was maximization.

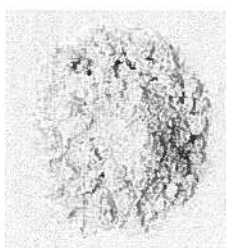
- Q1. How do you think this minimization problem differs from the maximization problems in the previous two chapters?

Malawi is an impoverished nation, so the financial aspect of any food program is a vital concern. For that reason, Dr. Corr, an administrator at the World Health Organization, needs to determine an optimal food program for this country. In particular, he needs to minimize the total number of calories while meeting the minimum requirements for key nutrients, using the highest nutrient concentrated food combinations. This will be the most efficient way to meet the children's minimum nutritional requirements. A common problem in poor regions is that their diet is dominated by low cost high caloric foods with little other nutritional value. All of the foods under consideration are readily available in Malawi at low cost.

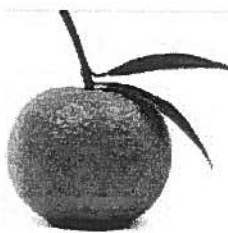
The key nutrients Dr. Corr takes into account and the minimum daily requirements recommended by the World Health Organization are listed in Table 4.1.1. The foods available to the Malawians are shown in Figure 4.1.3. Notice that the units of measurement are not all the same in Table 4.1.1. For example, protein is measured in grams. Calcium and iron are measured in milligrams. Vitamins B₉ and B₁₂ are measured in micrograms. Nutritional facts per gram for these foods appear in Table 4.1.2. These nutrients are all scaled based on the same units of measurement in Table 4.1.1. For example, let's look at a gram of maize flour. Each gram of maize flour contains 0.08120 grams of protein. It also contains 0.0612 milligrams of calcium and 0.03450 milligrams of iron. Each gram of maize flour contains 0.2450 micrograms of vitamin B₉ and so forth. The caloric content per gram of each of the food sources is given in Table 4.1.3.

Nutrient	Minimum daily requirement
Protein	20 grams (g)
Calcium (Ca)	400 milligrams (mg)
Iron (Fe)	7 mg
Folate (Vitamin B ₉)	50 micrograms (μg)
Cyanocobalamin (Vitamin B ₁₂)	0.5 μg
Ascorbic acid (Vitamin C)	20 mg
Thiamine (Vitamin B ₁)	0.7 mg
Riboflavin (Vitamin B ₂)	1.1 mg
Niacin (Vitamin B ₃)	12.1 mg
Retinol (Vitamin A)	400 μg

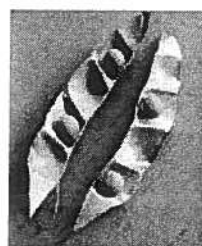
Table 4.1.1: Nutrients and minimum daily requirements



Maize flour



Tangerines



Pigeon peas