Continent	1 Total Land	2 Total Potentially Arable Land	3 Arable Land	4 Land Fraction Cultivated
		(billion hectares)		(3/2)
Africa	3.02	0.73	0.16	.22
Asia	2.74	0.63	0.52	.83
Australia and New Zealand	0.81	0.15	0.02	.13
Europe	0.48	0.17	0.15	.88
North America	2.11	0.47	0.22	.47
South America	1.75	0.68	0.09	.13
USSR[1]	2.24	0.36	0.23	.64
Total	13.15	3.19 =PALT	1.39 =AL (1967)	.44 =LFC (1967)

[1]The USSR is treated here as its own continent, and China is not included in the figures for Asia.

Figure 4-18 The geographic distribution of the potential for expansion of agricultural land
Source: PSAC 1967, vol. 2, p. 434.

Food Output F "Food" in World3 is the total direct output of the world's arable land. The relatively small output from the oceans and from grazing land, as noted earlier, is neglected. Food is measured in vegetable-equivalent kilograms per year. Some of this total crop is fed to animals before the animals are consumed by man. We measure the "food content" of meat in vegetable equivalents—the amount of (fodder) crops needed to produce the meat. The conversion factor from fodder to meat is roughly 7:1 (CRAM 1969, p. 78), so the world's meat output can be multiplied by 7 for an approximate measure of the crop output it represents.

In World3 the total annual food output was assumed to be a function of land and agricultural inputs. Labor is not included as an explicit factor in the production function because we assumed there will be a surplus of labor over the period studied. Thus the food output is calculated simply as the output per hectare of harvested land times the total cultivated land area.

```
F.K=LY.K*AL.K*LFH*(1-PL)                                    87, A
LFH=.7                                                      87.1, C
PL=.1                                                       87.2, C
    F     - FOOD (VEGETABLE-EQUIVALENT KILOGRAMS/YEAR)
    LY    - LAND YIELD (VEGETABLE-EQUIVALENT KILOGRAMS/
              HECTARE-YEAR)
    AL    - ARABLE LAND (HECTARES)
    LFH   - LAND FRACTION HARVESTED (DIMENSIONLESS)
    PL    - PROCESSING LOSS (DIMENSIONLESS)
```

The land yield LY is the average amount of crops produced per hectare of arable land AL in the year when it is harvested. Typically, LY varies from 600 vegetable-equivalent kilograms per hectare-year in a traditional agricultural society to 5,000 vegetable-equivalent kilograms per hectare-year in highly intensive and mechanized modern agriculture (see the discussion of land yield later in this section).

Region	Arable Land (billion hectares)	Area Harvested Annually[1] (billion hectares)	Cropping Intensity[2] (percent)
Africa south of the Sahara	0.152	0.064	42
Asia and the Far East	0.211	0.211	100
Latin America	0.130	0.071	54
Near East and Northwest Africa	0.070	0.039	56
Total or average	0.563	0.385	68

[1]Figures for area actually planted are not available for many countries; thus those for the area harvested give closest approximation. In some countries a significant proportion of cereal crops may be grazed off, or flood and other damage may reduce the harvested area compared with the planted area.
[2]Cropping intensity is calculated by dividing the harvested area by arable area and expressing it as a percentage. Both arable land and harvested area include permanent crops.

Figure 4-19 Average cropping intensities in developing countries, 1961–1963
Source: FAO 1970*a*, p. 44.

All arable land AL is not harvested every year; typically, one-third of the land is left fallow for lack of irrigation or as a consequence of established cropping practices. The cropping intensity (= land fraction harvested LFH) can also surpass 100 percent under circumstances where double-cropping is possible. On the basis of the data in Figure 4-19, we set LFH as a constant equal to 0.7.

The effective edible food output F was also assumed to be somewhat smaller than the total agricultural production because some areas are used for the cultivation of nonedible crops (e.g., cotton, and because loss and spoilage are inevitable in the processing and storage of the food product. In the real world the loss factor is small—of the order of 1 percent (U.N. 1970*a*, p. xxxi). The spoilage factor however, is more important since large amounts of grain can spoil. We took these effects into account by choosing the processing loss PL as a constant equal to 0.1.

Food per Capita FPC The total annual food output F divided by the total population POP gives the average food per capita FPC.

```
FPC.K=F.K/POP.K                                             88, A
    FPC   - FOOD PER CAPITA (VEGETABLE-EQUIVALENT
              KILOGRAMS/PERSON-YEAR)
    F     - FOOD (VEGETABLE-EQUIVALENT KILOGRAMS/YEAR)
    POP   - POPULATION (PERSONS)
```

Since world food output is expressed in World3 in units of vegetable-equivalent kilograms per year, food per capita must be expressed in vegetable-equivalent kilograms per person-year. A more common measure of human nutritional requirements is in terms of energy—kilocalories per person-day—with a minimum requirement for normal health of about 2,200 kilocalories per person-day (see Chapter 2 for further discussion and references). The conversion factor between kilocalories and vegetable-equivalent kilograms is roughly 3,500 kilocalories per kilogram for grain crops, as illustrated in Figure 4-20. This number varies widely for different crops and is particularly high for low-protein crops such as potatoes and sugar beets. However,