

Loop 1: Food from Investment in Land Development

Arable land AL The world land area, which comprises about one-third of the total surface of the earth, amounts to about 13.1 billion hectares (excluding ice-covered areas). This total area can be divided into three major categories (Figure 4-17). As shown, only 24 percent of the world's total land area, or 3.2 billion hectares, is suitable for cultivation. We call this upper limit to the amount of cultivable land the potentially arable land total PALT. Then the fraction of land actually cultivated LFC at any time equals the arable land AL divided by the total potentially arable land area (PALT).

$$\begin{aligned} LFC &= AL/E/PALT \\ PALT &= 3.2E9 \\ &= \text{LAND FRACTION CULTIVATED (DIMENSIONLESS)} \\ AL &= \text{ARABLE LAND (HECTARES)} \\ PALT &= \text{POTENTIALLY ARABLE LAND TOTAL (HECTARES)} \end{aligned}$$

Several inconsistent statistics can be found in the literature with regard to arable and potentially arable land and to annual crop production totals. Presumably, the differences arise from differing definitions of "crop" and "arable." Since the concept of "food" used in World3 is quite inclusive, we chose to use the broadly defined estimate of potentially arable land total PALT made by the President's Science Advisory Committee (PSAC 1967). Differing assumptions about prices and technology will also alter this estimate, but probably by only a small factor.

In World3, land is considered to be arable when it is used from time to time or full time to grow crops. This land "includes soils considered to be cultivated and acceptably productive of food crops adapted to the environment" (PSAC 1967). But not all of this land is highly productive. Its agricultural capability varies widely and depends on

1. the physical, chemical, and biological composition of the soil;
2. the range and the seasonality of temperature;
3. the annual amount and seasonal distribution of precipitation relative to evapotranspiration.

Land Category	Area (billion hectares)	Percentage of Total
Land suitable for cultivation ¹ (potentially arable land total)	3.2	24.2
Nonarable land with grazing potential	3.6	27.8
Nonarable land with no grazing potential	6.3	48.0
Total	13.1	100.0

¹In the original table appearing in PSAC (1967), this category was termed "potentially arable land." We chose to reserve that term for land that is suitable for cultivation but not yet cultivated.

Figure 4-17 World land area in different agricultural categories
Source: PSAC 1967, vol. 2, p. 428.

The arable land level in the world model embodies the average characteristics of all land under cultivation around the world.

$$\begin{aligned} AL &= AL.J + (DT) (LDR.JK - LER.JK - LRUI.JK) & 85, L \\ AL &= ALI & 85.1, H \\ ALI &= .9E9 & 85.2, C \\ AL &= \text{ARABLE LAND (HECTARES)} \\ DT &= \text{TIME INTERVAL BETWEEN CONSECUTIVE} \\ &\quad \text{CALCULATIONS (YEARS)} \\ LDR &= \text{LAND DEVELOPMENT RATE (HECTARES/YEAR)} \\ LER &= \text{LAND EROSION RATE (HECTARES/YEAR)} \\ LRUI &= \text{LAND REMOVAL FOR URBAN-INDUSTRIAL USE} \\ &\quad \text{(HECTARES/YEAR)} \\ ALI &= \text{ARABLE LAND INITIAL (HECTARES)} \end{aligned}$$

The amount of arable land AL at any time equals the amount at a previous time, plus the amount of new land that has been developed through the land development rate LDR, minus the land that has been lost through the land erosion rate LER and land removal for urban-industrial use LRUI. It is estimated that the area of arable land in the year 1900 (ALI, the initial value of AL) was about 0.9 billion hectares (Doane 1957).

$$\begin{aligned} PALT &= PALT.J + (DT) (-LDR.JK) & 86, L \\ PALT &= PALT & 86.1, H \\ PALT &= 2.3E9 & 86.2, C \\ PALT &= \text{POTENTIALLY ARABLE LAND (HECTARES)} \\ DT &= \text{TIME INTERVAL BETWEEN CONSECUTIVE} \\ &\quad \text{CALCULATIONS (YEARS)} \\ LDR &= \text{LAND DEVELOPMENT RATE (HECTARES/YEAR)} \\ PALT &= \text{POTENTIALLY ARABLE LAND INITIAL (HECTARES)} \end{aligned}$$

The amount of potentially arable land (land that could be but has not yet been brought under cultivation) is steadily decreased as the land development rate LDR moves land from the potentially arable to the arable category. Since the area of arable land was about 0.9 billion hectares in 1900, and since the total cultivable area is estimated to be about 3.2 billion hectares, we may assume that the potentially arable but undeveloped land in 1900 must have totaled 2.3 billion hectares (neglecting losses to erosion and urban-industrial use).

The geographic distribution of arable land shown in Figure 4-18 indicates that approximately half the potentially arable land total PALT had been moved into the arable category by 1967. Thus the total world acreage of arable land can still be increased by a factor of two, but the potentially arable land left undeveloped is generally assumed to be less productive than the land already in use. In developed as well as in developing regions, good land is becoming a scarcer resource. The *Provisional Indicative World Plan for Agricultural Development* published by the FAO states:

In Southern Asia, which contains a very large part of the population of the developing regions, some countries in Eastern Asia, in the Near East and North Africa and in certain parts of Latin America and Africa (e.g., the Andean highlands and the Savannah Zone of West Africa) there is almost no scope for expanding the arable land. [FAO 1970a, vol. 1, p. 41]