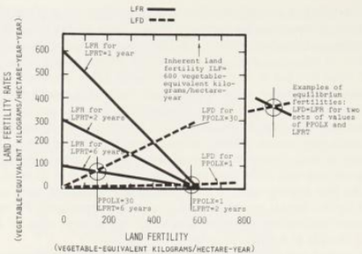

Figure 4-66 The adjustment of land fertility equilibria

ILF	= inherent land fertility (vegetable-equivalent kilograms per hectare-year)
LFD	= land fertility degradation (vegetable-equivalent kilograms per hectare-year-year)
LFERT	= land fertility (vegetable-equivalent kilograms per hectare-year)
LFR	= land fertility regeneration (vegetable-equivalent kilograms per hectare-year-year)
LFRT	= land fertility regeneration time (years)
PPOLX	= persistent pollution index (PPOL/PPOL70, dimensionless)

Even without active efforts (beyond leaving the land fallow) to speed up regeneration, traditional slash-and-burn societies could manage to maintain the land fertility because they were not faced with persistent pollution as defined in Chapter 6. When the persistent pollution index PPOLX is larger than zero, the equilibrium land fertility LFERT cannot be maintained close to the traditional, inherent value of 600 vegetable-equivalent kilograms per hectare-year unless the land fertility regeneration time LFRT is kept quite small—less than 4–6 years. In other words, constant fertility can be maintained in such situations only by enhancing the natural forces that tend to restore fertility. To achieve the relatively constant land fertility observed over the century before 1950, even in the face of some persistent pollution and population pressure, must have required sufficient allocations to land maintainance to make the land fertility regeneration time LFRT shorter than 5 years.

On this basis we assumed in World3 that farmers in the real world allocate some resources to land fertility maintenance. We hypothesized that the land fertility regeneration time LFRT is never decreased to less than 2 years by increased allocations to land maintenance. We also assumed that the regeneration time can be kept in this

general order of magnitude by allocating 5–10 percent of the agricultural inputs per hectare AIPH to regeneration. Figure 4-67 shows the assumed relationship between the land fertility regeneration time LFRT and the fraction of agricultural inputs allocated to land maintenance FALM. If no inputs are allocated to land maintenance, LFRT equals its average natural value of 20 years. As allocations to land maintenance increase, LFRT continuously decreases and reaches a minimum value of 2 years.

```
LFRT.K=TABHL(LFRTT,FALM.K,0,.10,.02)                    125, A
LFRTT=20/13/8/4/2/2                                     125.1, T
    LFRT   - LAND FERTILITY REGENERATION TIME (YEARS)
    TABHL  - A FUNCTION WITH VALUES SPECIFIED BY A TABLE
    LFRTT  - LFRT TABLE
    FALM   - FRACTION OF INPUTS ALLOCATED TO LAND
                 MAINTENANCE (DIMENSIONLESS)
```

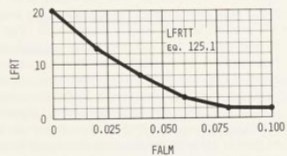

Figure 4-67 Land fertility regeneration time table

Thus in World3 the two ways of increasing the equilibrium land fertility LFERT are increasing land fertility regeneration through allocations to land maintenance, and lowering persistent pollution.

Loop 6: Discontinuing Land Maintenance

In the preceding subsection it was assumed that farmers under ordinary conditions allocate some resources to land fertility maintenance, although there are no immediate (say, within a year) benefits from such investments in terms of increased food output. On the other hand, if the same resources were spent on agricultural inputs, more food would result in the short run. Hence it is possible that land-maintaining activities are not kept up in times of extreme food shortages. Under famine conditions, would farmers still be farsighted and continue to allocate resources to land fertility maintenance or, to obtain the maximum amount of food in the short run, would they spend *all* their resources on productive activities?

Historically, extreme food shortages have seldom forced a clear-cut choice between land fertility maintenance and increased short-term productivity, perhaps because the hungry people were not usually the ones who owned the land. One possible example of this process is the hypothesis (see Harte and Socolow 1971) that the fall of the Mayan culture just before the year 1000 was due to widespread