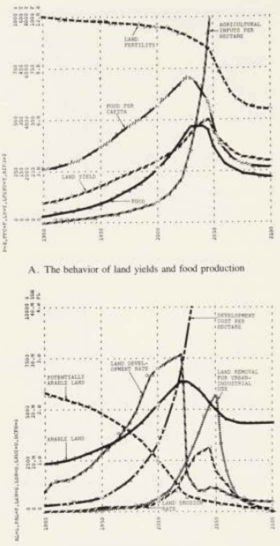

A. The behavior of land yields and food production

B. The behavior of arable land

Figure 4-88 Run 4-16: equilibrium run in which the exogenous inputs level off in the year 2050

standard run. The resulting dynamic behavior is shown in Run 4-16 (Figure 4-88), where both total food production F and food per capita FPC still overshoot and decline. This decline is caused by a continued decrease in both arable land AL and land fertility LFERT after 2050. Arable land AL continues to decrease due to the high levels of land

erosion LER and land removal for urban and industrial use LRUI. Continued high rates of land erosion LER are caused by high land yield LY. Land removal for urban-industrial use LRUI continues to decrease the arable land AL till about the year 2070. Land fertility LFERT declines gradually after 2050, and eventually levels off at its equilibrium value of 320 vegetable-equivalent kilograms per hectare-year. This equilibrium value of land fertility is lower than the maximum land fertility because of the significant amount of persistent pollution present at equilibrium.

Run 4-17 (Figure 4-89) shows a simulation in which the exponentially growing exogenous inputs level off in the year 2025. The slight decline in food production F and food per capita FPC is again caused by a gradual reduction in arable land AL due to erosion. The rate of land erosion LER continues to increase in this run since land yields LY continue to increase slightly. The agricultural system as a whole very nearly reaches equilibrium in this run, and the amount of food per capita is maintained at about 700 vegetable-equivalent kilograms per person-year, which is about 150 percent of the 1970 value.

The final simulation, Run 4-18 (Figure 4-90), assumes that the growth in population POP, industrial output IO, and the index of persistent pollution PPOLX is halted in the year 2000. Here food production F and food per capita FPC achieve high sustainable levels. Food per capita FPC reaches an equilibrium level that is only slightly lower than its peak value in the standard run. This equilibrium level of food per capita FPC is about 50 percent higher than the 1970 level. Since both land development and land erosion are maintained at low rates in this run, the total stock of arable land is maintained at a constant level.

The stable behavior shown in Run 4-18 is made possible by the fact that none of the factors that tend to erode the carrying capacity of the agriculture sector are allowed to reach a high value. Land removal for urban-industrial use LRUI approaches zero around the year 2020 because the amount of urban-industrial land UIL is finally brought into equilibrium with the amount of urban-industrial land required UILR. A small amount of land erosion LER continues, but it is balanced by an equally low rate of land development LDR. This balance can continue only if a reserve amount of potentially arable land PAL still exists. A comparison of Runs 4-17 land and 4-18 indicates that the extra 25 years of high rates of land development LDR in Run 4-17 use up the reserve of potentially arable land PAL necessary to maintain the equilibrium of Run 4-18. Another way of maintaining this equilibrium would be to implement new policies for sufficient investment in land erosion control.

The last three runs show that it is possible for the agriculture sector to exhibit equilibrium behavior rather than overshoot and decline if the exogenous driving functions of population POP, industrial output IO, and the index of persistent pollution PPOLX are not allowed to grow exponentially and indefinitely. Runs 4-16, 4-17, and 4-18 illustrate the trade-off between short-term and long-term behavior in the sector. Physical growth ensures high food production in the short term but causes