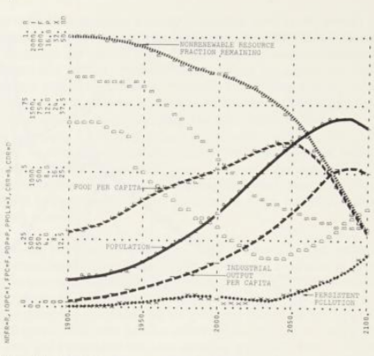

Figure 7-20 Run 7-15: resource and pollution technologies

Note: The scale for IOPC has been increased from 1,000 to 2,000 dollars per person-year

The resource and air pollution control technologies of the previous run are augmented in 1975 by a technological policy that reduces by a factor of 10 the index of persistent pollution PPOLX generated by each unit of agricultural and industrial output. The lower level of pollution allows population and industrial output to continue to grow until the amount of available food becomes the constraining factor. The decline in food per capita FPC eventually causes a reduction in both population POP and industrial output per capita IOPC.

IOPC reaches a level of 1,000 dollars per person-year in the year 2080 and then declines. (Note that the scale for IOPC has been changed in this run). The removal of the resource and pollution constraints to growth has allowed the system to continue to grow until limited by the third constraint in the system—the limits to food production assumed in the agriculture sector. In Run 7-15, growth is halted by the decline in food per capita FPC after the year 2040.

The decline in FPC stops the growth in population POP through the effect of the lifetime multiplier from food on the life expectancy of the population. As food per capita FPC declines toward the assumed subsistence food per capita of 230 vegetable-equivalent kilograms per person-year, the life expectancy of the population begins to decrease. The crude death rate CDR rises after 2050, and after 2075 exceeds the crude birth rate CBR, causing the population to decrease. The decline in food per capita also causes more industrial output to be allocated to the agriculture sector, for the discrepancy between the indicated food per capita (a function of

industrial output per capita IOPC) and actual food per capita FPC rises after 2050. This reallocation of industrial output eventually forces the level of industrial capital (and thus industrial output) to decline after the year 2080 because less output is reinvested in the industrial capital stock.

Resource, Pollution, and Land Yield Technologies In Run 7-15, developments in resource and pollution control technologies succeeded in eliminating these two factors as limitations to growth, but continued growth was eventually halted by a decline in food per capita FPC. The amount of available food in the model was assumed to be equal to the product of the amount of arable land under cultivation and the average yield per hectare of that land. To increase the level of food, Run 7-16 (Figure 7-21) assumes that the resource and pollution technologies of the previous run are combined with technological advances in the agriculture sector that double the effectiveness of all agricultural inputs employed to increase land yield after 1975.

Run 7-16 shows that the rise in land yield in 1975 increases the available food and thus food per capita FPC in the short run (1975–2030). In the long run, however, the intensive use of the cultivated land results in faster land erosion, which decreases the amount of arable land available for food production. Although land yields are high, food per capita begins to decrease after the year 2030, for the amount of arable land cultivated begins to decline. The policy of increasing land yields is effective in the short run but could be counterproductive in the long run if not combined with other policies to avoid land deterioration. After the year 2050 the land erosion rate is so high that food per capita FPC is actually lower than in the previous run, even though land yields are considerably higher.

The long-term behavior mode resulting from new land yield technologies is actually quite similar to the behavior shown in the previous run, where land yields increased gradually because of increased agricultural inputs per hectare. The growth in population POP and industrial output per capita IOPC is again halted by a decline in food per capita FPC. However, the doubling of land yields in 1975 reduces the negative pressures from the agriculture sector that hinder growth after 1975. Thus both population POP and industrial output per capita IOPC grow faster from 1975 to 2050 in Run 7-16 than in the previous run; population POP reaches a level of 10.5 billion people by 2050; and industrial output per capita IOPC reaches a level of almost 1,500 dollars per person-year by the year 2065 (note the change in scale for IOPC). Both population POP and industrial output per capita IOPC decline earlier than in the previous run, for the decline in food per capita FPC is more severe in Run 7-16 than in Run 7-15, where no additional land yield technologies were assumed.

Resource, Pollution, and Agricultural Technologies Runs 7-12 through 7-15 show that discrete increases in resource and pollution control technologies implemented in 1975 tend to move the limitation to growth to the agricultural sector. An increase in land yields in Run 7-16 increases food in the short run but causes excessive erosion in the long run, which again reduces food production. Run 7-17 (Figure 7-22) shows the behavior of the model if additional land maintenance tech-