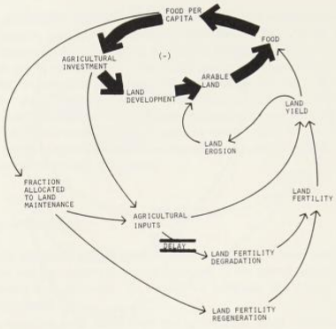

Figure 4-10 Loop 1: food from investment in land development

current techniques) land is developed first. Therefore, the amount of arable land arising from a given investment in land development, or the marginal return on land investment, will steadily decline. However, throughout the operation of the model, investment will continue to increase the stock of land, resulting finally in more food and thus more food per capita—assuming that everything else remains constant.

This land development loop is a negative loop that attempts to adjust the food available from the current arable land area to equal the food output judged desirable by the population.

Loop 2: Food from Investment in Agricultural Inputs

The output of food can also be raised in World3 by increasing the intensity at which arable land is used, or the land yield (measured in vegetable-equivalent kilograms per hectare-year). Loop 2 (Figure 4-11) indicates the process of increasing land yield through the use of modern agricultural inputs such as improved seed, fertilizer, pesticides, and farm machinery.

As pressures for more food rise and more resources are invested in agriculture, investment in agricultural inputs will also increase. Again—ceteris paribus—this investment is assumed to lead to increased land yield and hence more food and food per capita.

Loop 2 is also a negative feedback loop. It attempts to adjust the actual food per capita to the level desired by the population. Together, loops 1 and 2 (Figures 4-10 and 4-11) represent the basic behavioral assumption that man tries to keep food

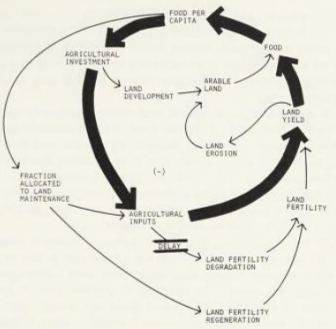

Figure 4-11 Loop 2: food from investment in agricultural inputs

availability at a level he judges desirable, a level that is a function of both total population and the desired or indicated food per capita determined by his level of income. He does so by increasing agricultural investment when food is scarce and by decreasing investment when the food supply is ample.

Loop 3: Land Erosion

If loops 1 and 2 were the only ones affecting the adjustment of food output to the demand for food in World3, it would be relatively simple to achieve a balance between food supply and demand in the long run, although the inevitable short-run reallocation problems would still exist. However, other factors make it more difficult to achieve an allocation of agricultural investment that is optimal in the long run. As mentioned in the basic concepts section (4.3), we assumed two processes by which the productive capacity of arable land can be reduced. Both arise from the assumption that the intensive use of land, and in fact any human use of land, disturbs the ecological balance that naturally sustains the soil and its fertility. The first process, which we termed fertility degradation, occurs when the soil is not restored—through fertilization, drainage, periods of fallow, and other means—to its original quality between growing seasons. It is assumed that under normal circumstances such restoration is usually performed, because fertility would otherwise decline catastrophically even within the lifespan of a farmer. It is also assumed that the damage incurred through occasional negligence is reversible, if action is taken to undo it.