Environmental degradation caused by current agricultural production can reduce future productivity. The generation and disposal of irrigation drainwater is an important example of this phenomenon. In this chapter, the authors model the environment’s ability to absorb the polluting drainwater as exhaustible and argue that competitive farmers have every incentive to treat it like a common property resource. If such is the case, then competitive farmers use more irrigation water and generate more drainage than is socially optimal, causing production to end sooner than is optimal. A tax on drainage may be used to encourage adoption of efficient irrigation technologies, reduce drainage, and maintain a relatively high rate of production for a longer period. Whenever feasible, the development of costly drainage disposal schemes may also be used to prolong production; but this should not be expected to overcome the problem of exhaustibility or the need for policy intervention. Data from the San Joaquin Valley of California is used to show that the losses due to competitive inefficiency may be considerable, and a water-pricing strategy for correcting the problem is computed.

INTRODUCTION

Agricultural production often generates byproducts, or has side effects, that can be a serious threat to agricultural productivity in the future. Loss of land fertility through soil erosion is one example of this phenomenon. Waterlogging of productive lands through underground accumulation of irrigation wastewater is another important example of the harm which can result over time from the cumulative effect of undesirable byproducts generated in the
production process. In such cases, the basic problem is that the capacity of the productive environment to sustain damage or to absorb wastes is limited. Even when this capacity can be renewed or augmented, the associated cost may be high and substantial gains may be realized through adoption of agricultural practices which cause less damage to the environment. From a policy viewpoint, it would be highly desirable to determine the extent to which market forces may be expected to provide appropriate incentives for the adoption of conservationist agricultural practices. If the free market mechanism is likely to result in significantly inefficient outcomes, it may be worthwhile to devise interventionist measures to improve the intertemporal allocation of scarce environmental resources. This chapter presents a general framework of analysis to address the preceding issues in situations where production may cause environmental degradation. For the sake of concreteness, however, the analysis is conducted in terms of the specific problem of waterlogging, which is currently a threat to the survival of agriculture in many parts of the world.

Waterlogging occurs mainly when irrigation is practiced in regions with poorly drained soils and inadequate drainage facilities. In such circumstances, salt-laden drainwater tends to accumulate underground and has a debilitating effect on crop yields as the saline water level encroaches on the crop-root zone. In most of these situations, the development of drainage outlets is considered either too expensive or unacceptable for political or environmental reasons. This is the case, for example, in the San Joaquin Valley, where transporting drainwater to the Pacific Ocean is currently deemed infeasible and disposal in large-scale evaporation ponds has been restricted following the discovery of toxic selenium concentrations in evaporation ponds at Kesterson. Under circumstances of this type, a region's subsurface capacity for storage of drainwater may be viewed as an exhaustible resource. Some expert observers believe that if the current trends persist, more than a million acres in the Valley will become unproductive in the next century (see, for example, Frederick, 1982). Given that the storage capacity is used jointly by a large number of competitive farmers, there is every reason to suspect that the current rates of its depletion are excessive from a social point of view. In the second section of this chapter, this hypothesis is developed more formally. Regional subsurface capacity to store drainwater is modeled as a "common-property" exhaustible resource; socially optimal and competitive rates of depletion are compared; and some policy measures are suggested to correct the inefficiency due to the common pool problem.

The literature on the economics of exhaustible resources is quite extensive. The seminal paper in this area is by Hotelling (1931). The model in the next section basically extends the Hotelling model to incorporate the possibility of resource conserving technological change which may be triggered over time by increasing resource scarcity. Following earlier work by Caswell and Zilberman