Chapter 6
Soil Degradation Under Irrigation

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Abstract Irrigation is a precondition for stable crop production in areas characterized by marked variability in rainfall distribution. Despite substantial investment in irrigation projects in the past decades, global irrigated cropland area has hardly grown. Here we discuss the factors related to the sustainability of irrigation and strategies to alleviate them. Water resources deterioration, diversion of water for other uses, and soil degradation are the major factors affecting the environmental sustainability of irrigated agriculture. Water logging results from the tendency to apply water in excess of irrigation requirements. It leads to reduced aeration, nutrient uptake, and crop yields. Salt buildup occurs through the process of capillary rise when the water table rises close to the surface. Salinity risks also increases when saline water is used for irrigation and when poor fertilizer and poor irrigation management are combined. Groundwater drainage is the ultimate precautionary measure against groundwater rise and salt accumulation, but its timely installation is essential for optimal result. Constant soil monitoring and the use of systematic diagnosis testing could also reveal the incipience of soil salinity. Future global warming would likely exacerbate water demand for irrigation with the implications that crops would grow in hotter, drier, and more saline conditions. The ability of irrigated agriculture to meet future challenges would therefore depend on the progress of new research to enhance adaptation to these changes.

Keywords Soil salinity, waterlogging, drainage, salt tolerance, climate change

6.1 Introduction

Irrigation, the supply of water to crops by artificial means is *sine qua non* for stable agricultural production both in arid regions and areas characterized by marked seasonal variability in rainfall. By supplementing the limited natural supply of water, irrigation helps to raise crop yields. It also aids land-use intensification and crop diversification in dryland areas by prolonging the effective growing period, thereby permitting multiple cropping (2–4 crops) per year. Lastly, irrigation provides synergy

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with other intensification inputs such as pesticides, fertilizers, and improved crop varieties whose efficiency depends on water availability. Therefore, irrigation provides incentives for farmers to invest in agricultural intensification inputs.

Water is a major constraint to food production in several parts of the world. With the exception of few areas, the rapid growth in food production during the green revolution occurred mainly on irrigated lands. Aggregate food supply in Asia more than doubled between 1970 and 1995, with only a 4% increase in the net cropland area (Rosegrant and Hazell, 1999). Average cereal yields under irrigation are typically twice those obtained under rainfed conditions, and irrigation continues to play a major role in feeding the world's growing population, contributing over 40% to total agricultural production.

Of all the major human activities, agriculture remains the largest user of water at the global level, accounting for about 70% of total freshwater withdrawal (Table 6.1). With the exception of Europe and North America that are relatively more industrialized, agricultural sector is the largest source of freshwater withdrawal in all regions of the world. In 2001, agricultural uses accounted for about 5%, 10%, and 17% of the internal renewable water resources of Africa, the Caribbean, and Asia, respectively. Asia has the largest proportion of global freshwater withdrawal for agriculture of about 73%.

In developing countries, a substantial proportion of investment in agriculture is usually from domestic sources, and irrigation is often the largest beneficiary of public agricultural investment. Table 6.2 shows that irrigated croplands increased in all the world regions between 1980 and 2003, suggesting significant investment in irrigation in the last 2 decades. Between 1980 and 1990, the amount of land equipped with

Table 6.1 Freshwater withdrawal by different sectors across world regions in 2001. (Based on FAO Aquastat database available at http://www.fao.org/ag/agl/aglw/aquastat/main/index.stm)

Continent/ Region	IRWR*	Total volume of freshwater utilization	Freshwater withdrawal by sector						Total withdrawal as % of IRWR
			Domestic		Industrial		Agricultural		
	km³/year	km³/year	km³/year	%	km³/year	%	Km³/year	%	
Africa	3 936	215	21	10	9	4	184	86	**5.5**
Asia	11 594	2 378	172	7	270	11	1 936	81	**20.5**
Latin America	13 477	252	47	19	26	10	178	71	**1.9**
Caribbean	93	13	3	23	1	9	9	68	**14.4**
North America	6 253	525	70	13	252	48	203	39	**8.4**
Oceania	1 703	26	5	18	3	10	19	72	**1.5**
Europe	6 603	418	63	15	223	53	132	32	**6.3**
World	**43 659**	**3 830**	**381**	**10**	**785**	**20**	**2 664**	**70**	**8.8**

*Internal Renewable Water Resources.