

CHAPTER 1

Introduction to Land Transformation in Agriculture

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Whether couched in Malthusian terms or more current style, concern for the adequacy of land resources for agriculture in the future continues to be expressed by individuals all over the world. These concerns relate to the availability of land for agriculture and to the quality of the land that will be needed forever to produce food and fibre. Increasing numbers of people, and the encroachment of urban, industrial and transportation activities on the agricultural landscape, and the modern techniques of agriculture, are all properly viewed as exerting real or potential pressure on the availability of good land required for future agricultural production. The word 'forever' is not an exaggeration. Trends which show increasing pressures on agricultural land can be projected to demonstrate that the potential to provide food for future world populations is imperiled.

The present volume was stimulated by this worldwide concern for the way in which land used in agriculture is being transformed throughout the world. This concern is a response to increasing reports of damage to the environment and to the ecosystems which comprise it as a result of the changing nature and intensity of a number of human activities. Such reactions, however, may be based on observations of some unusual facts or on environmental changes, the causes of which are often arbitrarily identified in the absence of data or careful analysis. Rational analysis of the factors influencing transformation of the land requires objective data characterizing the transformation, a tie between these observations and their apparent causes, and an understanding of the processes or mechanisms involved in the changes. The emphasis here is upon the land itself, not upon the complex web of social, economic and political factors which may determine what happens to land. Rather, an attempt is made to focus upon how such factors influence or transform the land. The approach is not exhaustive, but illustrative. The intent is to illustrate

the kinds of changes taking place on the land, some impacts of significant factors affecting the land, and the nature of the scientific evidence which might permit us to evaluate such impacts, or to determine their extent and potential influence.

The initial overview in Chapter 2 provides a picture of current land use, agricultural production, and the relationship between land availability and potential productivity. Subsequent chapters fall within this initial framework.

While the book deals with the present and the future, historical perspective is essential in considering land transformation and agriculture. First, a historical perspective provides the best possible illustration of the way in which land is transformed, both spatially and qualitatively, through the influence of factors wholly external to agriculture itself. Population change, war, technological revolutions, and a variety of social changes throughout history have resulted in profound transformations of the land. The magnitude of the changes, as well as the rates of transformation, are clearly demonstrated in the history of agricultural development from earliest man through the industrial revolution. Whether one refers to these as lessons or not, history provides superb examples of continuing change, changes mirroring those of today and certain to occur tomorrow. This does not imply that future transformations will be like those of the past or present, but that a myriad of influences will alter how the land is used, what it is used for, and the imprint that such uses will have on the land and soil.

The 'lessons' vantage point is a second contribution of the historical perspective. The same kinds of influences clearly dominate land transformations in agriculture today as they did in the past. Rates of transformation are often accelerated, and analogues from the past may not match precisely those of the present or the future. Nevertheless, without an appreciation of the breadth of factors which influence change today, one can well be misled by assuming that the transformations which take place in and on the land are somehow controlled solely by those who till the land or build upon it. In the last analysis this may be so; yet those who till the land are not always, and are perhaps rarely, independent agents of the world and society in which they live. Historical examples coupled with illustrations throughout the volume from the present scene clearly demonstrate this.

Major technological factors today have a direct influence on the transformation of the land. After clearing the land to make it suitable for producing food and fibre for human beings and feed for domestic animals, improvement of the infrastructure influences land transformation as agricultural products can be more easily transported. In agriculture itself, irrigation, mechanization, conservation practices and wetland reclamation are used, in Chapters 5.I–5.VI, to illustrate the kinds of transformations that are taking place today. Irrigation, while satisfying the need for water, also produces deleterious effects such as waterlogging and salinization. Mechanization has contributed

significantly to land transformation. It not only increases the rate at which work can be performed, but also allows various kinds of work to be carried out at appropriate times, thus improving the quality of the work and increasing yields; it also allows new lands to be opened to agriculture. At the same time, mechanization has introduced changes in the physical properties of the soil. Mismanagement of land and cultivation of marginal land have caused severe soil erosion by both water and wind. Thus various soil conservation practices have been developed during the last half century, not only to stop erosion, but also to avoid damaging the land and to improve degraded lands.

Indirect influences of major importance in transforming the land in agriculture, such as the use of fertilizers and plant protection techniques, are described in Chapters 5.I–5.VI. Introduction of inorganic fertilizers, for example, is an important factor causing land transformation as the application of these fertilizers not only increases crop yields, but also affects land use. Intensive application of fertilizers can cause nutrient imbalances in soils, and pollution of soil or groundwater. The control of crop pests and diseases directed toward reducing animal food crop losses currently estimated at \$300 billion introduces many changes in land use. Insecticides, fungicides and herbicides have transformed agriculture and land for agriculture. Traditional crop rotation systems could be altered allowing the introduction of monocropping and reduced tillage. Although pesticides have many advantages, there are again shortcomings in side-effects such as the emergence of pesticide-resistant strains of pest organisms, the disturbance of agroecosystems, and pollution of the environment.

These direct and indirect factors influencing land transformation are of fundamental importance throughout the world, and illustrate not only the nature of change, but the kinds of changes associated with such practices. Not every conceivable change is addressed. Thus, forestry and pastoral activities are touched upon indirectly. Primary emphasis is given to major factors affecting cropland agriculture.

* Last, a key issue in the discussion of transformation of land in agriculture is the establishment of criteria, observable and preferably measurable, that can be used to chart the course of such transformation and to suggest mechanisms for mitigating or reversing long-term deleterious changes. An attempt is made in Chapter 6, using illustrative examples, to describe mechanisms or processes that are associated with changes in land use and that impact the land itself. Knowledge of these processes is fundamental, not only to an understanding of the kinds of changes likely to take place under a given set of conditions, but to the prescription of measures that might be taken to recognize such changes and to alter or reverse them where society wishes to do so. Some processes in the soil, for example, are not well understood. Others are well described and techniques exist for monitoring change. In some cases, scientific and technological information needed to reverse the effects of earlier impacts becomes

available after a lapse of years or decades. For others, recognition of incipient and unwanted changes provides a basis for immediate changes in management.

The case studies in Section II of this volume, rather than being separate, form an integral part of the design of the project. The original and current orientation of the study of land transformation under the sponsorship of SCOPE involved the establishment of case studies in diverse regions of the world. These provide a basis for evaluating what is known about land transformation processes and some measure of the potential significance of such processes in different regions of the world. Thus, the case studies, along with the discussion of direct and indirect influences of various practices on the land, provide illustrative examples of criteria which can be established to measure land transformation under different agricultural and other pressures. The case studies reported here are among 30 or 40 such studies from 20 countries identified or prepared for the broader SCOPE Land Transformation Project. Not all of the original studies deal with transformations related to agriculture, and many have been published elsewhere. A list of these studies is available from SCOPE. In addition, the Ministry of Environment of the French Government published a collection of case studies of Land Transformation des Terres (1982), and SCOPE cooperated with COSPAR in a symposium resulting in publication of a volume entitled *Study of Land Transformation Processes from Space and Ground Observations* (Pergamon Press, Vol. 2, No. 8, 1982).

This introduction would be incomplete without several important disclaimers. First, under ideal circumstances it would be desirable to have a complete description of the varied land uses, and their areal extent throughout the world. Thus, it would be desirable to know precisely how much land is in various uses, and the ways in which these uses, and the land devoted to them, are changing in different regions throughout the world. In addition, one would like to know how the quality of the land in each use was changing, as well as the areal extent of such changes in quality. Chapter 2 summarizes some of this information. However, no attempt was made to do a detailed evaluation of the spatial and qualitative changes in lands in all parts of the world. Existing data are insufficient to accomplish this task as data on the spatial distribution of various land uses at relevant scales do not exist for many parts of the world. Even less information is known in detail about the quality of lands associated with these uses. Thus Chapter 2 includes information for relatively large areas within broad classifications of land use and land characteristics.

As the historical discussion suggests, major changes in the land are brought about from distant causes involving social changes in the world, as well as on the local scene. The complex system involving land resources, and cultural, social and political factors, influences what happens to the land. The overview

in Chapter 2, as well as the historical perspective, and the conclusions of this volume, address the influence of these complex factors on transformation of the land. However, the focus in this volume is upon the land itself. Thus the emphasis is upon the natural sciences rather than the social sciences. This orientation, or emphasis, is not intended to suggest that the system of resources and man is dominated by processes characterized by the natural sciences. Rather, the emphasis here is simply upon that phase of the complex system involving processes occurring in and on the land itself.

