SECTION 5

Conclusions

5.1. Framework of the Scenarios

Though there is no established definition of drought in NEB (Northeast Brazil or the "Nordeste"), at least 10 extreme droughts and 33 partial droughts, including multi-year events, have apparently occurred in the past 400 years (*see* Section 1). Although information is not complete, there is ample evidence to show that droughts have caused great impacts upon the NEB economy and society.

There is also an apparent, but perhaps not real, tendency for these events to occur with increasing frequency. While five extreme events occurred over approximately 300 years (1603–1898), the other five occurred between 1900 and 1983 (*Table 1.5*). However, one cannot conclude that a change in climate is occurring, because some early events may not have been recorded. Also, population growth and the modification in the environment due to human occupation have increased the vulnerability of society to drought events. Thus, climatic conditions that would constitute an extreme drought event in 1983 might not have had such an extreme effect in the eighteenth century.

Based on the history of droughts, selected scenarios of drought were chosen for use in this case study. Fortunately (or unfortunately), the very recent period, 1979–1984, provided plenty of examples of extreme drought events (*see* Section 2). The year 1983 was chosen as a typical extreme event, while 1979–1980 provided the example of a back-to-back drought. However, due to lack of data or to special situations in some localities, and to the particular requirements of the impact models, other years have been alternatively used as drought scenarios (*see* Section 3).

5.2. Limitations of the Study

Some limitations of this case study must be considered. The first is the problem of the availability of data. There is a great volume of meteorological data, but they are not organized in a way to facilitate their use for such research. At present the National Institute for Meteorology (INEMET) is engaged in a project to improve the quality and availability of meteorological information in Brazil.

M. L. Parry et al. (eds.), *The Impact of Climatic Variations on Agriculture*

Also, there are no widely available agricultural productivity data. These data problems restricted the number of places that could be included in this study.

The second limitation relates to the validation of the models. Validation was attempted in Section 3, but results were not conclusive, primarily owing to the lack of data. Much work on this subject is still needed.

It was also beyond the scope of this case study to undertake any thorough investigation where the need was indicated. For example, in the multivariate regression analysis (Section 4), the distinction between the contributions of precipitation and of other factors could not be clarified, and more investigation is clearly needed on the apparent unimportance of weather in explaining yield variations.

5.3. Summary of the Results

The main results of this work are summarized in *Table 5.1.* It shows that the 1979–1983 droughts affected an average of 75% of NEB and involved the equivalent of US$1778 million of federal government expenditures in emergency programs. In 1983, a year of extreme drought, 88% of the area and 12 million people were affected, although only 2.5 million were directly assisted (Section 1).

Those droughts were not the severest in the history of NEB. However, in 1983, the deviation of rainfall in relation to the average was −57%. During 1979–1980, the deviation was −31% (Section 2). Such events greatly reduce the probability of farmers obtaining acceptable harvests. Although this probability is typically rather low in the semi-arid zone, it becomes still lower in a drought period, when the risk in agriculture considerably increases. Estimates for six municipalities (Section 3) have shown that, even with 10% less precipitation and more moisture demand, the probability of obtaining an acceptable bean harvest would still be at least 80% in Ceará (Icó municipality); for three of the municipalities the probability would range from 26% to 35%, and for another it would be 63%.

The results also showed that the droughts have a large impact on crop yields. Estimates made using a soil–water–plant type model indicated very low yields in extreme drought periods. It also appears that yield reductions of more than 60% in relation to the yield trend are likely in such periods (Section 3).

Among economic activities, food production is the most affected by drought. Beans and manioc are the most vulnerable crops. In the states of Ceará and Bahia, the main beans and manioc producers of NEB, the production of those crops was almost totally destroyed by drought during the 1979–1980 period. Among raw materials, cotton rather than sugarcane is the most affected because it is cultivated in the most drought-prone areas. For example, in the Borborema Potiguar area of the State of Rio Grande do Norte, bean production was reduced in 1979–1980 by almost 80% (Section 4). On the other hand, for sugarcane, which is cultivated in the Zona da Mata, a less drought-prone area, that period did not significantly disturb the trend toward increasing production in all the municipalities analyzed (Section 4).