

FOOD, ENERGY, AND SOCIETY

THIRD EDITION

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DAVID PIMENTEL
MARCIA H. PIMENTEL



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Preface

In the more than 25 years since the publication of the first edition of *Food, Energy, and Society*, the world's natural resources have become more stressed in the face of rapid expansion of the world population. In less than 50 years the world population has doubled, world food supplies have dwindled, and supporting energy, water, land, and biological resources have come under great pressure. Now in the twenty-first century, the ecological integrity of world resources is threatened with many species facing extinction. In the face of these major changes, this third edition presents an updated and expanded perspective and analysis of the interdependency of food, energy, water, land, and biological resources.

Large numbers of humans throughout the world are facing hunger and malnutrition because of political struggles and the overwhelming increase in population. The World Health Organization reports there are 3.7 billion who are malnourished. This is the largest number ever in history, and signals a serious food problem now and certainly for the future. Since 1984, food production, especially cereal grain production, has been declining per capita because of growing numbers of people, shortages of energy in agricultural crop production (e.g., fertilizers), and shortages of freshwater.

Humans use energy from many sources to grow food, provide shelter, maintain health, and improve their well-being. The energy source, whether from the sun, human energy, animal power, or fossil fuels, and its abundance influence all human activities and personal security. As society has evolved, so have energy needs and uses. Early humans who hunted and gathered their food in the wild depended primarily on their own energies. Even now many people in developing countries augment personal energy with animal and human power, firewood, and other resources.

In contrast, ample affordable fossil energy supplies have supported intensive agriculture, industry, and transport in developed nations. However, along with increased population numbers, the per capita availability of fossil energy has been declining worldwide. This is because reserves of these finite energy resources are decreasing. The United States now imports 63% of its oil at a cost of \$120 billion per year. The imports are projected to increase to 95% by 2020 and the possibility is \$10 per gallon gasoline at that time. Petroleum geologists project about 40 years of oil and natural gas resources for the world. The United States has 50–100 years of coal reserves. Societies that now rely 97% or more on fossil fuels need to develop sustainable, renewable energy sources. Of course, renewable energy depends on water, land, and biological resources and at substantial environmental and economic costs.

Along with energy, fertile land is a critical resource for food production. The Food and Agricultural Organization (FAO) reports that 99.9% of all food (calories) comes from the land. At a time when more cropland is needed, valued fertile soil is being lost because of erosion that is 10–30 times faster than sustainability. With this environmental impact, crop yields decline, or more fertilizers and pesticides (fossil energy dependent) are used. Obviously on a per capita basis, cropland resources are

declining and now are less than one-half of what is needed for a diverse diet for the world population.

Freshwater is vital to all plants, animals, and humans. For cereal grains, for example, about 1000 L (265 gal) of freshwater are required on average to produce 1 kg (2.2 pounds) of these grains. Approximately 17% of all crops are irrigated and this irrigation provides the world with 40% of its food. World agriculture consumes from 70% to 80% of the freshwater and currently serious shortages exist in many regions. This is one of the major limits to world food production.

David Pimentel and Marcia H. Pimentel

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