Nutrition ecology: the contribution of vegetarian diets[1–3]

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ABSTRACT Nutrition ecology is an interdisciplinary scientific discipline that encompasses the entire nutrition system, with special consideration of the effects of nutrition on health, the environment, society, and the economy. Nutrition ecology involves all components of the food chain, including production, harvesting, preservation, storage, transport, processing, packaging, trade, distribution, preparation, composition, and consumption of food, as well as disposal of waste materials. Nutrition ecology has numerous origins, some of which go back to antiquity. The introduction of industrialized agriculture and mass animal production gave rise to various negative influences on the environment and health. Food quality is determined in part by the quality of the environment. The environment, in turn, is influenced by food consumption habits. Research shows that vegetarian diets are well suited to protect the environment, to reduce pollution, and to minimize global climate changes. To maximize the ecologic and health benefits of vegetarian diets, food should be regionally produced, seasonally consumed, and organically grown. Vegetarian diets built on these conditions are scientifically based, socially acceptable, economically feasible, culturally desired, sufficiently practicable, and quite sustainable. *Am J Clin Nutr* 2003;78(suppl):657S–9S.

KEY WORDS Nutrition ecology, vegetarian diets, nutrition system, health, environment, sustainability

INTRODUCTION

Nutrition ecology is an interdisciplinary scientific discipline that incorporates the entire food chain as well as its interactions with health, the environment, society, and the economy. The food chain includes production, harvesting, preservation, storage, transport, processing, packaging, trade, distribution, preparation, composition, and consumption of food, as well as disposal of all waste materials along the food path.

Nutrition ecology has many roots, some of which go back to antiquity. The introduction of systematic agriculture (slash and burn cultivation) and domestication of animals (food rivals) has markedly affected our environment. One early example of the consequences of systematic agriculture is the Greek invasions of other countries as a consequence of their increasing meat consumption, which required them to acquire more farmland for fodder production. Another example is the deforestation for farmland and for building purposes, which began thousands of years ago and has continued to this day. Both the Torah and the Bible mention environmental issues numerous times. The impact of systematic agriculture on the environment was discussed by Thomas Aquinas (1224–1274), Jean-Jacques Rousseau (1712–1778), and Henry David Thoreau (1817–1862). At the end of the 19th century, Jacob von Uexkuell (1864–1944) founded the science of ecology.

Industrialized agriculture was introduced in the 19th century and rapidly took command of all aspects of life, with striking social, economic, and environmental consequences. Reactions to these developments led to the formation of the Sierra Club in North America and to the Reform Movement in Central Europe in the second half of the 19th century. People migrated from urban to rural areas to dwell in unpolluted regions and to grow their own food. Economic and social reforms were proposed and practiced. Some of these included a vegetarian lifestyle. Another reaction to industrialized agriculture was organic farming, which was initiated by the anthroposophists in 1924 and started to flourish in the 1970s. At that time, a number of organizations were established that raised concerns about the environment and food quality [eg, the Club of Rome (1968), Greenpeace (1971), World Watch Institute (1975), the Green Party (1980)]. At the same time, literature on the negative influence of industrialized agriculture appeared by Rachel Carson (1), Frances Moore-Lappé (2), Dennis Meadows (3), Joan Gussow (4), and Ralph Nader (5). These authors discussed the dramatic effects of industrialization and industrialized agriculture on the environment, health, society, and the economy.

NUTRITION ECOLOGY

The term *nutrition ecology* was coined in 1986 by a group of nutritionists at the University of Giessen, Germany (6). Nutrition ecology as an interdisciplinary scientific discipline is a holistic concept that considers all links in the nutrition system, with the aim of sustainability. Thus, nutrition ecology describes a new field of nutrition sciences that deals with the local and global consequences of food production, processing, trade, and consumption. Nutrition ecology goes beyond *econutrition*, which is limited to the interactions of nutrition and environment. Nutrition ecology goes further than the older concept of *ecology of food and nutrition*, which is limited to the eating patterns of indigenous and aboriginal populations.

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At present, nutrition sciences are dominated by health aspects of food and, in part, by food quality. Recommendations are based primarily on physiologic and toxicologic considerations (7). The implications of our current nutrition system are more complex and go beyond nutrient content and contamination with pathogens and contaminants. To avoid ecologic damage caused by the nutrition system and to attain nutrition security for the world population, additional aspects need to be incorporated (8–10). The necessity of taking a more holistic view for a sustainable development is underlined by the current crises in the nutrition system, as discussed at the World Food Summit in June 2002 (11).

Dimensions of nutrition ecology

As is typical for an interdisciplinary discipline, nutrition ecology deals with a wide range of issues, including research, teaching, and public actions. A broad view of the entire nutrition system covers subject matters such as total food quality, ecologic balances, and life cycle assessments; the influences of nutrition systems on climate, world nutrition, and food prices; and a comparison of different diets and agricultural, environmental, and consumer policies. Basically, there are 4 dimensions of nutrition ecology: health, the environment, society, and the economy.

To maintain or retain good health, the consumption of an individually optimal diet is recommended. The term *preventative diet* has been used recently to underline the possibility of avoiding nutrition-based diseases (12, 13). The aggregate of most studies suggests that the consumption of plant-derived foods (grains, vegetables, fruits, legumes, nuts) should be increased and that the intake of animal-derived foods (meat products, dairy products, and eggs) should be reduced. This principle applies particularly to sedentary individuals. Plant foods should be consumed when they are as fresh as possible, should be minimally processed, and should be eaten partly as raw food (14–16).

The nutrition system influences the environment (17), which in turn determines the quality of food. The environmental impact of food production is determined by the agricultural method used. Conventional farming methods rely on extensive use of natural resources and result in higher levels of food contamination. In contrast, the environmental impact of organic farming is lower. Organic farming practices include controlling pests naturally, rotating crops, and applying legume plants as manure, in contrast to the use of synthetic pesticides and fertilizers in conventional farming. In integrated farming, organic and conventional methods are combined, resulting in an intermediate environmental impact (18, 19). To reduce the environmental impact of the nutrition system, organic farming needs to be supported globally. In addition, foods should be minimally processed, packaged, and transported.

The nutrition system is closely related to society, including the responsibility for food purchasing and meal preparation, as well as the social implications of the family meal. Furthermore, the interactions between food consumption habits and lifestyle, as well as the social conditions and the wages of people working in the nutrition system, need to be considered. Additional social aspects include the import and export of agricultural and other products and the influence of this trade on people in developing countries (20).

On a worldwide basis, the major factor driving food consumption patterns is the financial situation of countries, different population groups, and influential individuals. Transportation and processing of food are carried out under the premise that money can be earned. In private households, the food budget is a determining factor in the choice of foods. From a holistic point of view, the food price should include all costs caused by the nutrition system, especially environmental damage (internalization of external costs) (9).

These 4 dimensions of nutrition ecology are of equal importance for achieving a sustainable nutrition system. On this basis, the various aspects of food and nutrition are taken into account. What eating pattern best serves the holistic and sustainable aspects of nutrition ecology? From all we know, a vegetarian diet comes closest to fulfilling the demands and to minimizing damage to the 4 dimensions.

Contribution of vegetarian diets

Vegetarians have many reasons not to eat the flesh of animals. In addition to religious beliefs, there are health-based, ecologic, ethical, and philosophical reasons (14, 21–23). When the ecologic damage caused by industrial animal production is examined (24), certain aspects need to be considered. On average, land requirements for meat-protein production are 10 times greater than for plant-protein production. About 40% of the world's grain harvest is fed to animals. Half of this grain would be more than enough to feed all hungry people of our planet. Animal manure, which is produced in huge amounts by industrial agriculture, causes high levels of potentially carcinogenic nitrates in drinking water and vegetables. Animal production requires considerable energy and water resources and leads to deforestation, overgrazing, and overfishing (8, 25–27).

One solution to the problems caused by industrial animal production is a vegetarian lifestyle (23, 28–32). The positive ecologic effects achieved by vegetarianism can be enhanced by avoiding processed and packaged foods and by choosing seasonally available and locally produced organic foods. In this way, support is given to subsistence and family farming, the securing of employment, and global food security. In addition to these socioeconomic benefits, the caging of animals as well as their transportation over long distances and finally slaughtering them can be avoided, thus fulfilling ethical concerns.

Sustainability

The 4 dimensions of nutrition ecology are the basis for sustainable nutrition behavior (6). The term *sustainability* was introduced in the 17th century by forestry experts in Germany to call attention to the fact that only the amount of trees that would grow back in a given time should be harvested. Presently, *sustainability* describes development that fulfills current global needs without diminishing the possibility of future generations to meet their own needs (33).

From a nutritional point of view, sustainability also deals with the fair distribution of food through ecologic and preventive eating behavior. To achieve sustainability, a comprehensive rethinking of common values is needed to attain a new understanding of the quality of life. The question as to the adequate amount of food needs to be addressed at all social levels with the goal of achieving nutrition security for all. To fulfill the demands concerning ecologic, economic, social, and health compatibility, the following 7 principles have been formulated: *1*) food should be predominantly plant derived, *2*) food should originate from organic farming, *3*) food should be produced regionally and seasonally, *4*) food should be minimally processed, *5*) food should be ecologically packaged, *6*) food trade should be fair, and *7*) food should be tastefully prepared. These principles have been derived from

guidelines of wholesome nutrition described elsewhere (34). A diet based on these principles has a scientific basis, is socially acceptable, is economically feasible, is culturally desired, is practicable, and has a high degree of sustainability.

There are only a limited number of long-term trials on sustainability. In one project, 3 apple production systems—organic farming, integrated farming, and conventional farming—were compared (19). The yields were nearly equal, but the organic production system showed not only the best apple quality but also the best soil quality and the least detrimental environmental impact. Therefore, the organic production system had the best environmental sustainability. The economic sustainability is given, since the market price was highest for the organic apples. The authors of this report question the sustainability of conventional farming systems because of escalating production costs, heavy reliance on nonrenewable resources, reduced biodiversity, water contamination, soil erosion, and health risks to farmworkers caused by pesticide use.

Another study carried out over 21 y showed that although the crop yield was 20% lower in the organic systems, the input of fertilizer and energy was reduced by 34–53% and the pesticide input by 97%. Enhanced soil fertility and higher biodiversity found in organic plots were due to compost- and legume-based crop rotations (35).

Biodiversity is also the basis of food variety. Apart from the promotion of breast-feeding, the recommendation to eat a variety of foods is the most internationally agreed-upon dietary guideline. Biodiversity also protects against climate and pestilence disasters. In addition, biodiversity serves increasingly as the basis for new pharmaceuticals.

CONCLUSIONS

Nutrition ecology has the goal of attaining sustainability of food and nutrition security worldwide. To achieve this goal, professionals involved in the nutrition system must inform the public about the principles of nutrition ecology. In this manner, people can be motivated to practice sustainable eating behavior (36).

Nutrition ecology is also a question of personal priorities. Interested and well-informed consumers will be able to weigh the arguments and make the necessary decisions. The vision of a sustainable future depends upon individuals who feel responsible for the environment and health. One of the most effective ways to achieve the goals of nutrition ecology, including healthy and sustainable food choices, is a vegetarian lifestyle (37).

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