

# 1E: FOOD SUSTAINABILITY AND HEALTH THROUGH FOOD VARIETY

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## **Environmental integrity and eco-nutrition**

Environmental integrity, where *Homo sapiens* can live with an adequate, healthful and sustainable food supply, where other forms of life are valued and respected, where population density, housing and recreation do not irreversibly degrade or render unsafe that environment, and where natural surroundings and development are harmonious and inoffensive, is becoming increasingly difficult to achieve. The problems for food and health with uncertain environmental integrity are ones of food insecurity, in quantity, quality, safety, and variety; lack of realization of the socio-behavioural roles of food; and food component (essential and otherwise) inadequacies and energy (calorie) imbalance, compounded by restraints and disincentives for physical activity. The fundamental eco-nutritional issue for health is that biodiversity is retained for food sufficiency and variety and that environments are safe and conducive to social, mental and physical activity.

## **Biodiversity**

At present, there are countless, possibly 10 million (excluding microbes), species of plants and animals, both vertebrate and invertebrate, with an animal extinction rate measured in at least thousands each year. The biomass and its diversity depends principally on the evaporative power of the atmosphere, along with solar radiation, carbon dioxide level, ambient temperature, and the availability of water and inorganic nutrients. The plant biomass in turn determines the animal biomass.

The human species, *Homo sapiens*, emerged in its present form as recently as approximately 200,000 years ago, and ventured out of Africa as a group of about 500 individuals around 137,000 years ago. Technology, by way of traps, nets and spears, allowed it to be successfully competitive. The ecological niches of the species broadened, and has continued to do so, threatening biodiversity. Although human-centred values have hitherto been dominant, these are undergoing a shift, with a decline in the utilitarian and a rise in ecological-scientific values. This may provide some optimism for an arrest in the decline of biodiversity, although population pressures and political factors may supervene. It may represent a return to traditional ecological knowledge and wisdom.

## **Human diversity**

The development of human diversity has been a wonderful, risky and troublesome journey for our species from its beginnings in Africa. Human diversity is unique amongst species for grafting on to genetic diversity non-genetically based behavioural, cultural, technological and residential diversities. With this has gone a remarkable range of eating patterns typified by the broad categories of: forager (until technological advances which facilitated hunting); hunter-gatherer; pastoralist; subsistence agriculturalist; agri-business-urban dweller; and the beginning of a new era of information technology directed eating, underpinned by biotechnology.

The omnivorous capacity of the human species has been a biological advantage in withstanding climate change and its effects on food supply, as well as enabling migration

and re-settlement in vastly different ecological niches (e.g. the water's edge, the littoral, plains and savannah; bushland; island; and desert with its oases). In turn, this has required environmental understanding, co-operation or management unless environmental degradation and forced migration were to be accepted: the latter undoubtedly happened at times and may have led to desertification, as with early and more recent pastoralists.

One question is how obligatory human omnivorous behaviour has been, and how much is elective, convenient, economic or nutritionally advantageous. What is certain is that human life is not sustainable beyond days without water and beyond weeks without certain essential nutrients. However, they can be obtained from a range of foods (e.g. magnesium from seeds, chlorophyll containing plants and milk; vitamin C from various fruits, vegetables and even animal tissues; essential fatty acids from selected land plants, sea plants, structural lipids in animals and, especially depot fat in fish, shellfish and crustaceans and in monogastric animals). Thus, human diversity, food diversity and cultural diversity are achievable despite metabolic pathway limitations of the species.

Indeed, it may be argued that, because of an unusually large repertoire of essential nutrients (macronutrients, micronutrients, vitamins and minerals, and certain phyto-chemicals and zoo-chemicals whose essentiality is yet to be defined), the human species is peculiarly destined to be at once highly ecologically dependent and with a specific requirement to locate various ecological niches for its survival. The completion of the Human Genome project in the near future and the advent of molecular, especially mitochondrial (maternal) genealogy as a companion to molecular evolutionary studies will allow these ideas to be rigorously tested from a genetic point of view.

### **Food variety, biodiversity and human health**

The most internationally agreed upon dietary guidelines specify the promotion of breast feeding and the enjoyment of food variety. The combination of social activity, physical activity and food variety is the most likely lifestyle profile to maximise health, reflected in longevity and healthy ageing. It is an approach which is also likely to reduce substance abuse. But it is predicated on biodiversity for food variety and environments in which it is a pleasure to be active, both socially and physically.

There are several ways in which biodiversity confers health:

1. A varied food supply is essential to maintain the health of the omnivorous human species.
2. A range of diverse food sources is necessary to safeguard against climatic and pestilential disasters which may affect one or more of the food sources.
3. A diversity of plants and animals may provide a rich source of medicinal material, essential for the extraction of undiscovered therapeutic compounds.
4. Intact ecosystems of indigenous plants and animals appear to act as a buffer against the spread of invasive plants and animals, and of pathogens and toxins, thus contributing to the health of populations nearby.
5. The 'spiritual' values of exploring the diversity of plants, animals and ecosystems in an area appear to have a beneficial effect on mental health, strengthening the feeling of 'belonging to the landscape'.

Seasons and the added diversity they bring also appear to confer vigour. Even where seasons have been regarded as simply 'dry' and 'wet', as in the tropics, the reality is great change through the solar and lunar years.

## Applications of eco-nutrition

The concept of eco-nutrition requires food variety to be linked to sustainable food production which maintains bio-diversity. The following are some examples of how the food supply may not meet nutritional expectations on account of environmental constraints:

1. Water - One of the most limiting factors in food production and in human habitation is an adequate and safe water supply. In the past, reticulation and separation of water from human and animal waste have played a huge role in human health. Now, whole waterways like the Murray-Darling, the most important river system in Australia, are being damaged by salination, excess fertilizer and pesticide residue run-offs, with algal bloom and their toxins producing unsafe water for stock and humans. In China, 60 million people cannot get enough water for their daily needs, and, in 1996, 50,000 people were affected by water-pollution related disease. China may have insufficient water for its population, with potentially adverse consequences for global food security.
2. Fish - There is growing evidence that a regular intake of fish, principally as a source of long-chain fatty acids is protective against a number of health problems, including cardiovascular disease, certain cancers, and mood disturbance. At the same time, world fish stocks are in decline through overfishing and pollution of waterways. A partial solution may be found in aquaculture, although this can itself significantly damage ecosystems, with actual losses of fish stocks. It may be possible to develop more sustainable ecosystems for aquaculture, with, for example, the introduction of genetically modified fish feeds containing omega-3 fatty acids.
3. Meat - Food obtained higher up the food chain, like meat and dairy products, requires a higher overall biomass for its production. But, when it is low in fat, it has a high nutrient density (nutrients per unit of energy), a measure of nutritional quality. Thus, such foods can add significantly to the nutritional safety of a cuisine, and do so in small quantities. One reasonable deduction would be that small quantities of meat for most of the world's population would be more environmentally sustainable than the large quantities currently consumed by a few affluent nations. It will be difficult, ultimately to escape these questions of nutritional equity in relation to sustainability of the food supply.
4. Soy - Another way to approach some of the nutritional needs met by fish and meat, insofar as omega-3 fatty acids and high quality protein are concerned, is to consume certain plant foods like soy (and in the case of omega-3 fatty acid linseed, purslane, and certain sea plants). Soy also has other health protective properties because of its phytochemical profile of isoflavones like daidzien and genistein. This may account for its apparent heart-protective and cancer-protective role in Chinese, Indonesian and Japanese populations.

Combining nutritious plant-derived foods with small quantities of fish (as little as 1 or 2 servings a week) and meat is nutritionally and environmentally attractive. The question is then how to produce and fill the growing need for plant foods like soy. GMF (genetically modified food) could be helpful here, since greater yields can be obtained where soy, for example, is pest or pesticide resistant. For such approaches to be environmentally successful, the monocultures will need to be not so extensive as to reduce overall biodiversity. This is a matter of environmental governance and requires the agreement of a number of parties and organisations, locally, nationally and internationally.

5. Fruit - Fruit has an increasingly well substantiated place in human health, based not only on its provision of the macronutrients, water and carbohydrate (glycaemic and

non-glycaemic), and micronutrients (vitamins and minerals), but also protective phytochemicals of which polyphenolic flavinoids, anthocyanins and a wide range of carotenoids are characteristic. Fruits and vegetables are consistently protective against cardiovascular and neoplastic disease. They also contribute to much of the potential variety in the human diet. Curiously, men more than women have difficulty in eating adequate quantities of fruit, but, if they did, global fruit consumption and production would rise markedly. Fruit is a convenient food, which has its own 'packaging', as a skin, keeps usually for days, or even weeks, and can be preserved in many different ways. The environmental advantages of fruit are that the trees that produce it provide canopy with atmospheric improvement, add to biodiversity, and that it can often be grown locally and eaten without transport and packaging. The problems with fruit production come with the demands for pesticides, although FAO now has 'Integrated Pesticide Management' strategies (<http://www.fao.org>) to help minimise residue contamination. As with other horticultural products, safety in fruit produced for human consumption applies through the whole chain, from orchard to mouth. Recent outbreaks of salmonellosis and rotavirus infection in Australia attest to this.

6. Rice - Rice is one of the world's oldest crops and staples, having probably been first grown in Henudu in about 5500 BC. Higher yielding rice was the hallmark of the 'Green Revolution' of the 1970s, controversial for what its net impact on the environment has been, and per capita, given the number of people now fed. Improvements in nutritional qualities of rice, notably protein, were also made at a time when protein nutrition in its own right was a focus of nutrition research. It could be argued that improvements in rice production and quality were spurred by the food-health concepts of the day, located around staples (and monocultures) and selected nutrients. Today we have a bigger picture, and a variety of cereals, amongst an even greater variety of foods, is seen to be more scientifically desirable, as long as it is culturally acceptable and capable of being implemented. Moreover, we now know that rice yields have begun to fall with greater pesticide usage. More attention should be given to growing rice which has less environmental impact, by international agreement and with trade benefits. For example, more cultivation with natural rainfall and less where water supply is marginal.
7. Herbs and spices - Herbs and spices have been a major feature of world food trade since its beginnings. Ten per cent of the value of food imports into Australia are herbs and spices. They have, for herbs especially, been accorded a place in the health promoting properties of food and, for spices, regarded principally for their flavour enhancement of food and the pleasure so derived. But, for both, the new wave of food phytochemical science and the explanation of health effects of these food components is giving renewed importance to them in the human diet. Many phytochemicals are multifunction compounds covering biological attributes like being anti-oxidant, anti-inflammatory, anti-microbial, immuno-modulatory, anti-mutagenic, anti-angiogenic, anti-neoplastic, oestrogenic, anti-oestrogenic, hypolipidaemic, carminative, laxative, analgesic, and mood-altering. In the past, the spice trade has stimulated local cash economies, sometimes with environmental detriment, and adverse colonial arrangements. However, since small quantities of a range of herbs and spices have commercial value and health benefit, it is possible to grow them in a way that supports biodiversity. For example, they may be grown amongst other crops or by subsistence agriculturalists, or in greenhouse conditions. Another possible benefit of these crops is that they have potential to restore contaminated environments. This is because they respond to environmental stressors by producing many of the compounds that characterise them. The microbiological safety of herbs and spices is more guaranteed where they are treated by irradiation. This has been a prototype for the introduction of this technology into a major area of food trade. The production, trade and consumption

of herbs and spices can be expected to grow in response to food cultural diversification and perceived health need. It can do so with environmental benefit.

### **The role of trade in health advancement through food**

Various nutrition policies have placed emphasis on *local food production* for food security and health. The rationale for this is that, in times of food trade difficulty, there continues to be a local food supply; that knowledge about food and skill in its production are not lost; that local food culture, with its beliefs, habits and checks and balances on intake continues to play a role, even in the evolution towards a contemporary food culture. We can hope that cultural changes in food consumption will be brought about through scientific, health and environmental considerations.

Such emphasis on local foods and cuisine is not exclusive of *food trade*, which in any case, *can be complementary to the local food supply*. Even though humans have migrated far from their original roots, from or around the rift valley of Africa, to successfully occupy various environmental niches, many communities and nations are now dependent, to a lesser or greater extent, on trade for their food security. This is especially so where local population size has outstripped local food production capacity and/or water supply, sometimes because food imports have become affordable. Examples of *heavy dependence on food trade for survival are island states, desert economies, remote mountainous and icy regions*. In the past, communities in these areas were small and seafaring, or nomadic, with highly developed hunting and gathering skills.

There are some geographical locations where there are *endemic nutrient deficits*, like iodine or selenium because of soil deficits; or away from safe water so that nutrients like omega-3 fatty acids are hard to come by; or where certain plants grow with difficulty and their components are not available. Clearly, imported food helps to resolve these problems without fortification or supplementation, generally a less satisfactory option as it oversimplifies the basic food inadequacy as a nutrient or food component inadequacy. Food trade is often stimulated as *people migrate with their food cultures*. This is particularly evident in culturally pluralistic advanced economies like those of North America and Australasia. There is good circumstantial evidence that the injection of new foods into these locations has contributed to health advancement. Greater emphasis on food trade might have spared some of the new precarious ecosystems in these locations, like the rice growing areas of Australia.

### **Future foods and future health**

Technological innovation through biotechnology, designer foods, changing demography (through ageing – to about 20% of the world population over the age of 60 by 2020), and changing health patterns all present a challenge to applied nutritional science. There should be a cohesive approach between international agencies, the corporate sector, NGOs and communities to sustainability of the world food supply.

\*This contribution is condensed from two publications:

- 1) Food variety and biodiversity: Econutrition, published in co-operation with Professor Emeritus Raymond Specht, University of Queensland, in *Asia Pacific J Clin Nutr* (1998)7 (314): 314-319.
- 2) Prospects for the Future: Nutrition, Environment and Sustainable Food Production, in *Conference on International Food Trade Beyond 2000: Science-Based Decisions, Harmonisation, Equivalence and Mutual Recognition*. Prepared for the Food and

## Discussion notes

- There are clearly important links between food variety, biodiversity and optimum health. Yet modern industrial agricultural practice tends towards monocultures, with or without GM crops. The emphasis on locally grown food, and rational food trade and processing, will provide for greater diversity. We need concepts and practices beyond those presently contained in “organic” food production. For example, local food production will diminish dependence on fossil fuels for transport.
- Although all the reasons for retaining biodiversity are valid, unfortunately it seems that much biodiversity is already doomed. Some researchers talk of manufacturing food from microorganisms cultured in large vats. While this might prove useful for producing deficient micronutrients such as omega-3 fatty acids and iodine, the wider application of this type of genetic engineering would take us one step further away from nature and we would lose more touch with our roots. This in turn would give us less incentive to care for the environment, thereby causing further loss of biodiversity and impairing our relationship with nature, which is essential for optimal health and wellbeing.
- Food safety “from orchard to mouth” is essential to avoid infections such as salmonellosis and rotavirus. The problems with microbiological contamination of fruit and vegetables are largely ones of handling and process – cooking, pasteurisation etc. Although microbiological safety of herbs and spices is more guaranteed where they are treated by irradiation, there remain some community concerns about the long-term effects of this process on human health.
- Central to long-term food security internationally will be the recognition that the ideal of food variety for health is dependent on environmental sustainability and biodiversity. With the exception of food supplements such as iodine in locations with nutrient-deficient soils, the highly lucrative industry of micronutrient additives comes a poor second to the principle of econutrition.

## Further reading

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