

Review Article

Regional food diversity and human health*

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Regions are significant for the way we understand and strategize food for health and economic development. They generally represent various food cultures and opportunities for food exchange based on proximity, historical linkages and *complementarities*. The example of North and West Africa represents an intersection of some of the most original of human eating experiences out of Africa and the enrichment of these by Arab traders, through the exchange of products, ideas, observations, beliefs and technologies. All of *these* will have encouraged *diversity in food intake*. However *food diversity* and, with it, *biodiversity* may not always have been recognized as important, and, therefore, secured and protected. Ultimately, food diversity cannot be sustained unless the food chain and the technologies to support it are environmentally appropriate. Cooking, without renewable energy sources, is a critical example. Additionally, human settlement has always required an adequate, a dependable and a safe *water supply*, although this same settlement tends to compromise these water characteristics. Water is a major factor in food diversity, whether as a source of aquatic food, or the basis of food production and preparation. The extent to which food diversity for human health is required will depend on the food component (essential nutrient and phytochemical) density of the foods represented. For example, fish, fresh lean meat, eggs and seed foods (grains, pulses, nuts) will reduce the requirement. Regional food diversity can support *food diversity at the community level* - where otherwise it might be fragile - by shared learning experiences, and by trade. Diversity can also be captured and enshrined in recipes with composite ingredients and by traditional emblematic foods - like soups and pies; and it provides the basis for food culture and cuisine. The evidence for *food diversity (or variety) as a major factor in health* has grown substantially over the last few years - as integrative indices of health like "maternal nutrition" and "successful pregnancy" (for example, through the inclusion of a variety of food sources of folate, increasing the bioavailability of iron, and the sustainable intakes of quality food protein and essential fatty acids); "adult mortality rates"; other "specific disease incidences" (like cancer, cardiovascular disease, diabetes and bone health) for "risk factors for disease" (like hypertension and abdominal fatness); and for "wellbeing" (palatable, enjoying and neurologically relevant food stuffs). Thus, there is an ongoing need to promote and maintain food diversity at the regional level and between communities.

Key Words: food diversity, biodiversity, regions, nutrition, health, water, community, Africa, literacy, women**Introduction**

The 20th State of the World (2003) report by the Washington-based Worldwatch Institute emphasizes the urgency with which remedial action needs to be taken about over-use of resources, pollution and destruction of natural areas which threaten planetary life.¹ Not to do so means committing more and more people to protracted misery and impoverishment. One reason for this is crop-land degradation. Already 420 million people do not have enough crop-land to grow their own food and must rely on imports. About 1.2 billion people survive on less than US\$1 per day, the definition of absolute poverty. But the greatest threat to people's well-being is water shortage.² This is likely to be exacerbated by conflict over water since more of the world's key confluences of water are emerging or actual "hotspots".³ The present 0.5 billion who live in regions prone to chronic drought is likely to increase to 2.4-3.4 billion by 2025 (World Watch Report).¹ The seriousness of this for the world food supply, and its quality, cannot be overstated. The argument of this paper is that, amongst other strategies, a regional focus, where there

are promotable inter-community alliances and a sense of ownership of the problem and its solution, with ecological relevance, is worthy of pursuit. Because biodiversity represents the strength and resilience of eco-systems, and because it can support a more diverse food intake (often reinforced by trade from areas with complementary diversity)⁴, it is regional theme that is considered here, as a legitimate concern of nutrition and health scientists and workers.

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The significance of regions

Before and beyond nation states, there were and are recognized regions of the world. Of course, they may be large or relatively small geographic areas, with vastly different population densities, but they generally represent a more evident relationship between peoples and their environment, and, if they do not, then risks of environmental degradation and of health disadvantage will be greater than necessary.

The reality is that the basis of regionality and regional difference is dynamic as well. This may occur through climate change, agricultural development, roads, railways, shipping, loss of fish stocks, migration, conflict or shifting national boundaries. Some nations (like France and China), or national alliances (the European Union, NEPAD (The New Partnership for Africa's Development), ASEAN (Association of South East Asian Nations) can also change regional significance. Perhaps the greatest stimuli to recent conceptual change about regions have been travel and the internet.

Table 1. Regions and food diversity

Strengths	Weaknesses
Historical connectedness between food cultures with complementarity	Tribalism and rivalry
Sense of ownership, sustainability and advocacy	Monocultures
Various crops	Infrastructural limitations in transport and communication
Trade and food exchange	Competition about water
Collective decision about water	
Exchange of ideas, observations, beliefs and technologies	

Table 2. Biodiversity

Reasons for biodiversity

- (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 safe-guard against climatic and pestilent 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 to 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*'.

At the very least, a regional approach to problems of food and health may be more achievable, through worthwhile, yet manageable scale and commitment, than with a national or global approach. For regions and the food diversity they might represent or achieve, there are both strengths and weaknesses (Table 1).

Food diversity and biodiversity

Whilst biodiversity is essential for sustainable food diversity, it does not guarantee it.⁵ Indeed, as the extent and intensity of fishing, pastoral activity and agriculture increase, biodiversity is often threatened.⁶ Yet, on a more modest scale, these food production initiatives can, eventually lead to sustainable new eco-systems - as with farming and fishing communities. One of the concerns about monoculture is that it and the populations who depend on it for a staple are less food secure - as has happened with grain, potatoes and potentially, with bananas. The arguments for Biodiversity as a basis for food diversity are several (Table 2).⁵

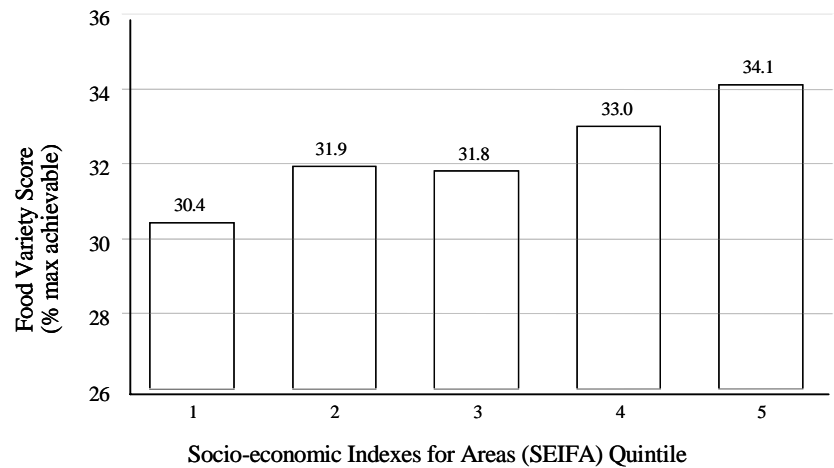
Food diversity and food security

Increasingly it is clear that the physical and chemical complexity of food represents a spectrum of human biological needs and these range from preferred levels of bioavailability of biologically active and useful food components, to the range and interaction of energy (calorie) sources, macronutrients (water, protein, carbohydrate, dietary fibre and fat), micronutrients (vitamins and minerals) and other phytonutrients (such as carotenoids, flavonoids, sulphur compounds, and terpenes).

Too often, food security is viewed in the short-to-medium term, representing the availability of energy, macro- and micronutrients. A *food-based approach* to food security recognizes the need for a sustainable, affordable and diverse food supply, in cultural context. The example of preferred *fat consumption* by humans is helpful, as it is characterised by varied sources of fat, meeting essential fatty acid (n-3 and n-6) requirements,

Table 3. Fat sources by culture

Unrefined vs refined
Plant vs animal
Animal type
- Evolutionary hierarchy
- Land vs water
- Monogastric vs ruminant
- Domestication, activity and feed
Food accompaniments
Frequency of consumption
- Small, frequent vs large, infrequent



but with cultural acceptability (Table 3). Fat intake can be quite different and varied in accordance with ethnicity (Table 4). It is worth considering which range of fat intake can be limited (Table 5). However, aside from food diversity, there may be *food commodity common denominators*, as evidenced by various longitudinal health and survival outcome studies.^{7,8} These indicate the particular value of regular inclusion of fish and seeds, mainly pulses, wholegrains, nuts and fruits.

Nutrient (food component) dense food items like lean meat, fish, and eggs, organ meats such as liver, yeast seeds and sprouts, can allow a reduction in the required range of foods⁹ (Table 6).

Also, more food diversity can be generated for a given level of biodiversity, when there is cross-cultural interaction, as with *migration*. Trade can combine different ecosystems into a more adequate level of biodiversity for food variety (Table 6 and 7). The Australian SEIFA report¹⁰, based on the 1995 National Nutrition Survey, shows a general positive relationship between a sense of personal food security and food intake variety (Fig. 1). Whilst there may be bi-directionality in this relationship, for cause and effect, the general phenomenon is important to acknowledge. The causal importance of food diversity in food security is seen in the Helen Keller Foundation Studies of Homestead Gardening in Bangladesh.¹¹

Table 4. Ethnicity and fat intake

	<25%	Fish	Meat	Dairy	Pulses	Grain	Other Seeds	Fruit
Indigenous	√	√	√	√	√	√		
Western Europe	X		√	√		√		
Southern Europe	X	√		√				√ (Olive)
Eastern Europe	X		√ (lard)	√				
Northern Europe	X	√		√		√		
East Asia	√	√	√		√ (soy)	√	√	
South Asia	√			√	√	√	√	
Middle East	√			√	√	√	√ (sesame, cotton)	
North Africa	√	√					√	√ (red palm)
West Africa	√	√					√ (red palm)	
Pacific Islands	√	√					√ (coconut)	
Latin America	√		√	√	√		√ (avocado)	

Figure 1. Socio-economic status and food variety (Australian 1995 National Nutrition Survey)**Table 5.** Cultural vulnerabilities for an excessive, refined and narrow range of fat intake

Refined fat available and affordable in liquid or solid form
Limited range of cooking techniques, with frying and baking amongst them
Little unrefined fat consumed at commodity source (legumes, grains, nuts, fish, milk, eggs)
Insufficient alternatives, like fruits and vegetables
Refined fat not consumed at same time as fruit, vegetables, herbs or spices

Food diversity and technology

Food Technology, at its best can confer food variety because it :

- may render potential food stuffs palatable (eg. wholegrains)
- reduce adverse factors in food (eg. anti-nutrient)
- increase bioavailability of nutrients (eg. lycopene in tomatoes)
- increase shelf-life (and reduce post-harvest loss) - canning, drying, freezing etc.

Distribution of food variety score in Melbourne women

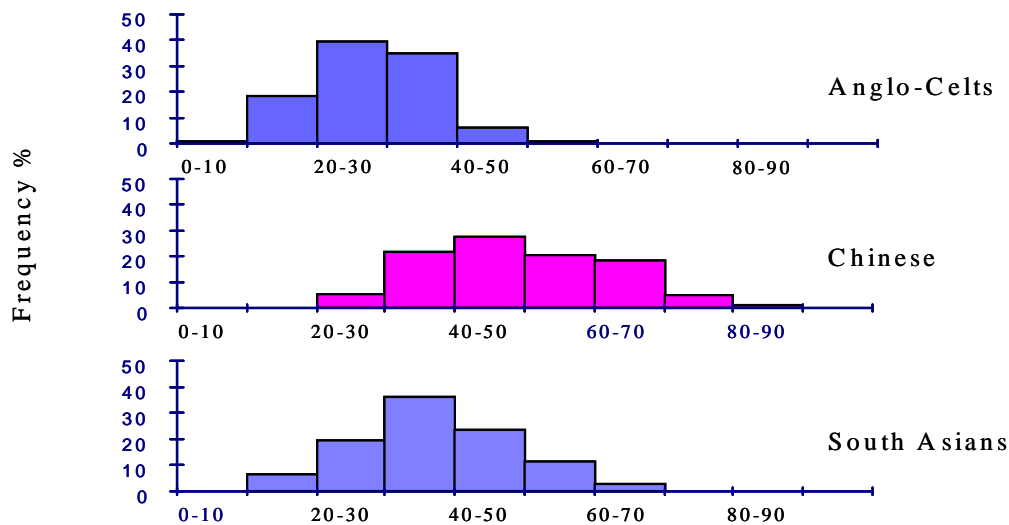


Figure 2. Food culture and variety²¹

Moreover, in a Chinese study, Hsu-hage and Wahlqvist¹², showed that food variety, aided by food processing conferred health advantage for cardiovascular risk factors.

Added to food technology, can be *agricultural technology and biotechnology*. Information, provided by established and newer technologies (like mobile phones, the internet) has the prospect of exposing and encouraging people to expand their taste and food variety horizons. The same is true of *transport and travel*. In these respects, recognition of the contribution of women and the need for *maternal literacy* is crucial as illustrated by the role that women have played in the development of basic human technologies (Table 8).

Table 6. Caveats for biodiversity to allow for food diversity

Depends on
- Cultivars (agricultural sustainability & edibility)
- Access (transport)

Table 7. Food categories associated with human development in relation to biodiversity, people movement and trade

	People Movement and Trade	
	NO	YES
HIGH	- Local - Intact ecosystem/ mixed farming - Limited food availability - Degraded ecosystem	- Migration - Active food trade - Sustainable ecosystem - Migration may be necessary - Food trade essential - Degraded ecosystem
LOW		

Technologies can address *basic human needs* (Table 9) and improve nutritional status in various ways, but are often ones which can increase food variety (eg. water supply, gardening, food storage, transport). *Renewable Energy Technologies* may yet be amongst the most important in ensuring biodiversity and food variety. The critical state of cooking fuel, with de-afforestation and desertification is a pressing example. Yet solar energy, cooking devices and, depending on location, geothermal¹³ and wind power are possibilities.

Food diversity and culture

Not all food cultures achieve the same level of food variety.¹⁴ Asian cultures tend to exceed European ones (Fig. 2)¹⁴ and tend to be associated with exceptional health indices (both Japan and Cantonese Hong Kong in the top 5 life expectancies) in recent years. Thus, there is potential for some developing economies to confer health advantage beyond that already seen in developed regions. The maximum required food variety may be somewhat around 30 biologically distinct food per week.^{15,16} But this will be affected by other considerations (Table 10).

Food diversity and health

The body of evidence for food diversity¹⁷ and health¹⁶ survival, disease specific and risk factor) is now substantial from longitudinal studies.^{9,18,19}

Table 8. The importance of maternal literacy and informed women in development

Women have been founders of technology related to basic human needs:

1. Food-gathering, processing, cooking, storing, feeding
2. Clothing - textiles, manufacturer, design
3. Information - purveyors 'communication'

Table 9. Technologies to address basic needs

Very Basic	Essential
Food & water	Fuel
Hygiene	Health Care
Housing	Transport
Clothing	Information management (organisational-living, apparel, systems)
	Time

Table 10. How much food diversity is required?

Modulated by

- Food component density⁺
- Trade

⁺Food components include essential nutrients (macro- and micro-nutrients) and other biologically active factors which confer health advantage (eg. phytonutrients).

Conclusions

To be practical about regions, biodiversity, and food and health, they (regions) should probably redefine themselves:

- Where it is natural, logical and desirable to work together
- Where newer technologies can enable people to work together eg. geography giving way to IT and transport
- Growing strength through a new economy based on development (eg. inter-community, "south-south-south" "south-north")
- Taking account of ecological "hotspots" eg. buying them out over loggers as with "Conservation International"²⁰ which indicates that 60% of land species can be found in 25 "biodiversity hotspots" covering only 1.4% of land on earth.

References

1. Worldwatch Institute. State of the World 2003. www.worldwatch.org.
2. Wahlqvist ML. The impact of changing world resources on food security. Proceedings of Nutrition Society of Australia 2001, Vol. 25. Asia Pac J Clin Nutr 2001; 10 (4): S95.
3. Klare MT. The new geography of conflict. Foreign Affairs 2001; 80 (3): 49-61.
4. Folke C, Carpenter S, Elmqvist T, Gunderson L, Holling CS, Walker B, Bengtsson J, Berkes F, Colding J, Danell K, et al. Resilience and sustainable development. ICSU series on Science for Sustainable Development No.3, Paris: International Council for Science, 2002.
5. Wahlqvist ML, Specht RL. Food variety and biodiversity: Ecnutrition. Asia Pac J Clin Nutr 1998; 7 (3/4): 314-319.
6. Wahlqvist ML. Prospects for the Future: Nutrition, Environment and Sustainable Food Production. Proceedings of the FAO Conference on International Food Trade Beyond 2000: Science-Based Decisions, Harmonisation, Equivalence and Mutual Recognition. Melbourne, 11-15 Oct 1999. w.fao.org/docrep/meeting/2638e.htm
7. Haveman-Nies A, de Groot LPGM, Burema J, Cruz JAA, Osler M, van Staveren WA for the SENECA Investigators. Dietary Quality and lifestyle factors in relation to 10-year mortality in older Europeans. Am J Epidemiol 2002; 156 (10): 962-968.
8. de Lorgeril M, Salen P, Martin J-L, Monjaud I, Delaye J, Mamelle N. Mediterranean diet, traditional risk factors, and the rate of cardiovascular complications after myocardial infarction. Final report of the Lyon Diet Heart Study. Circulation 1999; 99:779-785.
9. Michels KB, Wolk A. A prospective study of variety of healthy foods and mortality in women. Int J Epidemiol 2002; 31:847-854.
10. Wood B, Wattanapenpaiboon N, Ross K, Kouris-Blazos A. 1995 National Nutrition Survey: Data for persons 16 years and over grouped by socio-economic disadvantaged area. The SEIFA Report. I Coles-Rutishauser (ed). Clayton, Victoria: Monash University, Healthy Eating Healthy Living Program, 2001.
11. Talukder A, de Pee S, Taher A, Hall A, Moench-Pfanner R, Bloem MW. Improving food and nutrition security through homestead gardening in rural, urban and peri-urban areas in Bangladesh. Leusden: Resource Centre in Urban Agriculture & Forestry, UA-Magazine, Dec 2001; 45-46.
12. Hsu-Hage B, Wahlqvist ML. Food variety of adult Melbourne Chinese: A case study of a population in transition. In: Dietary patterns of selected countries, tea and coffee: Metabolic consequences. World Review of Nutrition and Dietetics, Basel, Karger, 1996; 79: 53-69.
13. Treadgold T. Deep heat. Business Review Weekly 2003; Jan 16-22, p36 (www.geodynamics.com.au).
14. Wahlqvist ML. Asian migration to Australia: Its food and health consequences. Asia Pac J Clin Nutr 2002; 11 (supplement): 562-568.
15. Savige GS, Hsu-Hage B, Wahlqvist ML. Food variety as nutritional therapy. Current Therapeutics March 1997; 57-67.
16. Wahlqvist ML, Lo CS, Myers KA. Food variety is associated with less macrovascular disease in those with Type II diabetes and their healthy controls. J Am Coll Nutr 1989; 8 (6): 515-523.
17. Hodgson JM, Hsu-Hage BH-H, Wahlqvist ML. Food variety as a quantitative descriptor of food intake. Ecology of food and nutrition 1994; 32:137-148.
18. Kant AK, Schatzkin A, Harris TB, Ziegler RG, Block G. Dietary diversity and subsequent mortality in the First National Health and Nutrition Examination Survey Epidemiologic Follow-up Study. Am J Clin Nutr 1993; 57: 434-440.
19. Kant AK, Schatzkin A, Ziegler RG. Dietary diversity and subsequent cause-specific mortality in the NHANES I epidemiologic follow-up study. J Am Coll Nutr 1995; 14: 233-238.
20. Ness J. The green land grab. Newsweek, 27 January 2003; 3.
21. Wahlqvist ML. Nutritionally-related risk factors for cancer and heart disease in Anglo-Celtic, Chinese and South Asian Melbournians. In: Nutrition, Cancer and Cardiovascular Disease. Melbourne: Human Services, 30 May-1 June 1996; 25-8.