DBN Review N° 35
A resource about dairy-based nutrition
A product of the Consumer Education Project of Milk SA
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This review explains what sustainable healthy diets mean in context of nutrition goals and environmental responsibility, and highlights the role of dairy in such diets.

A publication for health professionals

Why dairy has a significant place *in sustainable diets*

Sustainable healthy diets consist mostly of unprocessed or minimally processed plant-based foods, with moderate amounts of animal-sourced foods. Consuming more plant-based foods and less animal-sourced foods could potentially reduce environmental impact and increase health benefits. However, animal-based foods such as dairy play a vital role in sustainable diets because of their unmatched nutritional quality. Strategies for dietary change need to consider nutritional quality, environmental impacts, and environmental-nutritional trade-offs of composite diets, rather than individual food items, alongside social and income constraints and sociocultural influences on food practices. The environmental-nutritional trade-offs will depend on the current food system, food security and nutritional status within a population. There is no one, diet fits all. Plant-based foods, particularly fruits and vegetables that are highly perishable and shifts to a plant-based diet may result in higher household food waste. Context-specific and realistic dietary shifts, together with a reduction in household food waste, are needed to reduce environmental impact and improve health.

What is a sustainable healthy diet?

Sustainable healthy diets have a favourable effect on both the environment and the well-being of the population. The environmental impact of food production is among the lowest for wholesome plant-based foods (e.g. wholegrain cereals, vegetables and fruit), and the highest for animal-source foods, particularly meat (unprocessed and processed).[1] Dietary shifts away from animal-source foods towards a more plant-based diet can significantly reduce agricultural land use, greenhouse gas emissions, acidification, eutrophication and freshwater withdrawals, and therefore have significant environmental benefits.[2] Besides having a low environmental impact, sustainable diets should be nutritionally adequate; optimise health with regard to physical, mental and social well-being, and prevent disease; and be safe, equitable and culturally acceptable. Enough nutritious food of appropriate quality must therefore be available, accessible and affordable.[3] Although dietary shifts to plant-based diets will improve environmental sustainability,[1] not all diets that are considered sustainable are healthy.[4] For example, the environmental impact of sugar-sweetened beverages is relatively low, but their frequent consumption increases the risk of diet-related non-communicable diseases.[1]

A healthy diet consists mostly of plant-based foods such as fruits, vegetables, whole grains, legumes and nuts, moderate amounts of eggs, dairy, poultry and fish and lean meat. Foods in a healthy diet are mostly unprocessed or minimally processed, while highly processed foods and sugar-sweetened beverages are restricted.[3] Health benefits associated with healthy plant-based diets include lower blood cholesterol concentrations,[5] lower incidence of type 2 diabetes,[6] lower risk of cardiovascular morbidity and mortality,[7] and all-cause mortality.[8] Mente et al.[9] reported that, based on a newly developed healthy diet score and dietary intake data for 80 countries across all continents, a diet with higher amounts of fruit, vegetables, nuts, legumes, fish and full-cream dairy products is associated with lower cardiovascular disease and mortality in all regions. The association was, however, strongest in lower-income countries, where consumption of these foods is generally low and the diet consists mostly of refined carbo-hydrates.[9] Furthermore, according to a recent systematic review and meta-analysis, adherence to sustainable healthy diets is associated with lower risk of overweight and obesity.[10] Dietary shifts to plant-based diets will therefore have health benefits, and consequently economic benefits owing to a reduction in healthcare cost.[11]

However, predominantly plant-based diets with low amounts of animal-source foods may be deficient in multiple micronutrients, particularly for vitamin B12, iron, calcium and zinc. Animal-source foods not only are rich in these nutrients but also have a higher bioavailability of these nutrients than plant-sourced foods.[12]

The role of dairy in healthy, sustainable diets

Calcium intake is low across all age groups in South Africa,[13,14] which can be attributed to the low intake of milk and milk products.[15] Mente et al.[9] argue that limiting dairy consumption in certain parts of the world may not be warranted. In low- and middle-income countries where dairy consumption is low, consumption of dairy products should be encouraged.[16] In South Africa, increased consumption of milk and maas is promoted through the South African food-based dietary guidelines.[17] The high nutrient density of milk and milk products will likely outweigh[18] the higher environmental impact associated with including dairy products in the diet.[19]

In the United Kingdom, diets with the highest dairy content were shown to have higher nutrient content and better overall diet quality than diets with lower dairy content.[20] In the multinational PURE prospective cohort study, higher dairy consumption was shown to be associated with a lower risk of mortality and major cardiovascular disease,[16] and higher intake of full-cream (but not low-fat) dairy was associated with a lower prevalence of metabolic syndrome and with a lower incidence of hypertension and diabetes.[21] Based on results from Mente et al.,[9] the authors suggest that increasing the consumption of whole-fat dairy, together with fruits, vegetables, nuts, legumes and fish, would most likely result in lower cardiovascular disease and mortality in lower-income countries. Furthermore, increased milk consumption has been shown to be associated with a reduction in the prevalence of stunting over time.[22]

Context-specific sustainable healthy diets

The impact of dietary shifts on health and the environment is context specific owing to diverse food systems and differences in food security and nutritional status across and within countries.[4] In high-income countries with excessive intakes of protein and animal-source food, consumption of animal-source foods should be limited because of a high risk of non-communicable diseases and high environmental footprints,[23] and shifts towards a more plant-based diet will simultaneously reduce health risks and environmental impact.[11] In contrast, in low- and middle-income countries with a high prevalence of nutrient deficiencies and undernutrition, diversifying the diets and increasing the intake of animal-source foods will be needed to meet dietary requirements and nutrition targets, with a higher environmental impact as a trade-off.[4]

It therefore follows that sustainable healthy diets should not be implemented based solely on decisions around environmental impact.[19]

Modelling studies have shown the importance of considering both the environmental and nutritional impacts of dietary shifts to more sustainable diets. Furthermore, shifts to sustainable healthy diets should consider the nutritional quality, environmental impacts, and environmental-nutritional trade-offs of composite diets, rather than individual food items.[24] Using data from 150 counties,[25] researchers studied sustainable diets motivated by environmental (partial replacement of animal-source food with plant-based foods), food security (adequate energy intake) and public health (aligned with healthy eating guidelines) objectives. They illustrated that dietary shifts to predominantly plant-based diets that are energy balanced and aligned with healthy eating guidelines perform better in reducing environmental impact, potential nutrient deficiencies and diet-related mortality than dietary changes driven only by either environmental or food security objectives. Reynolds et al.[26] indicated that the degree of possible dietary changes across income groups in the United Kingdom differed because of affordability of different foods and different dietary habits, pointing towards the need for a tailored approach that is informed by social and income constraints. These modelling studies showed that there were large differences in the impact of dietary changes between regions and dietary change approaches.

The four domains of sustainable diets (nutrition, economics, environment and society) are context specific and interconnected, and the trade-offs between these domains need to be considered.[27] For example, in countries where food production drives the rural economy, dietary shifts may have adverse effects on the income and livelihoods of smallholder farmers.[4] Furthermore, sustainable healthy diets generally cost more and a large part of the population in low- and middle-income countries cannot afford nutrient-rich healthy diets. In more remote areas, availability of a variety of healthy foods may be a challenge. Taste and food preferences, cultural practices, social norms and religious beliefs are context specific and vary across countries and regions.[28]

South Africa carries a triple burden of malnutrition, with the co-existence of undernutrition, micronutrient malnutrition, and a high prevalence of overweight/obesity and diet-related non-communicable diseases.[29] Dietary shifts to sustainable diets should therefore be sensitive to all forms of malnutrition, with different trade-offs between the various aspects of sustainable diets. Overconsumption (overweight and obesity) not only has a negative impact on health, but it is also considered an avoidable environmental burden.[30] Overconsumption should thus be reduced to improve energy balance.[25] At the same time, energy balance of the diet should be improved for those who are undernourished.[25] South Africa is a diverse country with diverse cultures, religions and cuisine. Initiatives to encourage shifts to sustainable diets should therefore be sensitive to the various sociocultural influences on food practices. Changing dietary practices related to core foods (foods that are used universally, regularly and consistently by the population, e.g. maize meal as staple food) may be

challenging. People are usually less emotionally invested in non-core foods, and it may be easier to modify consumption of these foods.[31]

Nutrient density, environmental impact and cost per portion of different food items

Figure 1 illustrates the nutrient density, environmental impact and cost per portion for specific foods. According to Figure 1, animal products, legumes and fortified brown bread have the highest nutrient density per portion. Foods with lower nutrient density, indicated in the yellow box in Figure 1A, are enlarged in Figure 1A (the size of the bubbles cannot be compared between Figure 1 and Figure 1A).

The complexity of dietary shifts to more sustainable diets is evident from Figure 1A. Fish (hake and pilchards) has a lower environmental impact and slightly higher nutrient density compared with beef mince. Substituting meat with fish may therefore have a favourable effect on the environment. However, a 135 g portion of hake costs nearly three times more than a 100 g portion of beef mince, whereas the cost of a 100 g portion of pilchards is approximately half the cost of beef mince. For lower-income households, pilchards, but not hake, may therefore be an affordable substitute for beef mince.

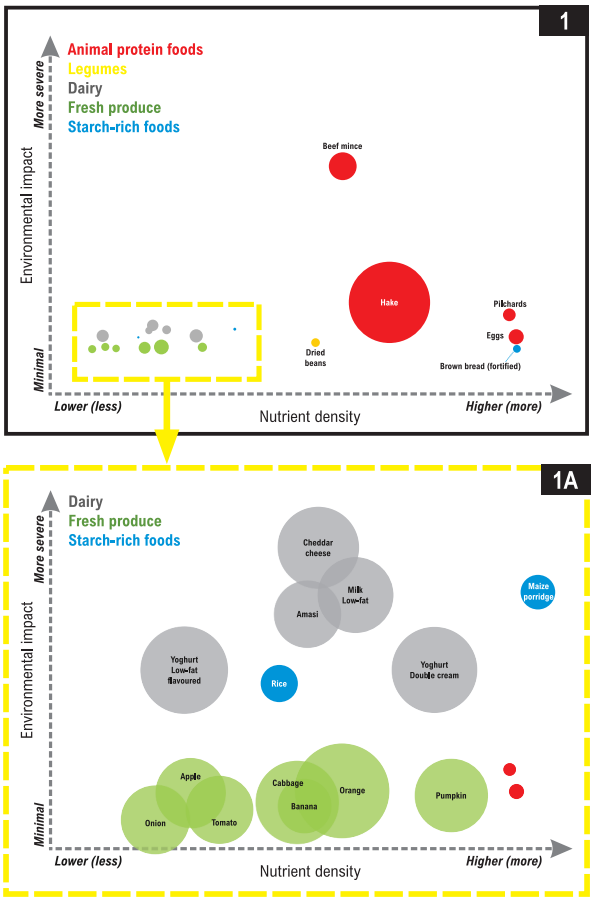

Figure 1: Nutrient density (*x*-axis), environmental impact (*y*-axis) and cost per portion (bubble size) for selected foods

In South Africa, fortification of maize meal and wheat flour (used to make bread) with eight micronutrients is mandatory as part of the National Food Fortification Programme.

*** Sources used for calculations:**

Nutrient density values are based on the NRF9.3 values published by Madlala et al.[32] The nine nutrients of which intake should be encouraged are protein, fibre, vitamin A, vitamin B6, vitamin D, folate, calcium, zinc and iron; the three nutrients of which intake should be limited are saturated fat, added sugar and sodium.

(1) United Nations. Date not specified. Food and Climate Change: Healthy diets for a healthier planet. Available at: https://www.un.org/en/climatechange/science/climate-issues/food

(2) Carbon Cloud: https://apps.carboncloud.com/climatehub/product-reports/id/78947255193#:~:text=Milk%203%25%20fat%20%C2%B7%201.46%20kg,CO%E2%82%82e%2Fkg%2 0%7C%20Verified%20by%20CarbonCloud ; https://apps.carboncloud.com/climatehub/product-reports/id/118245018106#:~:text=Yoghurt%2C%203%25%20fat%20%C2%B7%203.08,CO%E2%82%82e%2Fkg%20%7C%20Verified%20by%20CarbonCloud

Food prices are as published by Stats SA (CPI related) for February 2024, except for double-cream yoghurt (obtained online).

Dietary changes to healthy, sustainable diets

In 2019, the EAT-Lancet Commission report described a planetary health diet, which is predominantly plant based, with small amounts of animal-source foods, as a global reference diet to improve health and reduce the environmental impact of food production.[33] In their review paper, Alexandropoulou et al.[34] highlight numerous concerns raised on the limitations of the EAT-Lancet reference diet, which is based solely on nutritional and environmental impacts. They highlight the need for local and regional recommendations to be appropriate for specific cultures, populations, patients and geographic locations, while considering all aspects of sustainability.

Whereas the EAT-Lancet Commission planetary diet will require major dietary shifts, promoting drastic dietary changes at the population level may not be feasible. A moderate reduction in animal-source foods with a simultaneous increase in plant foods is a more realistic approach that can still significantly contribute to lowering greenhouse emissions and land use. In addition, cutting back on discretionary products such as oils, sugar and alcohol can significantly reduce land use, further contributing to environmental sustainability.[2] Cutting back on these products will also have a beneficial effect on health. Using fats (including oil) and sugar-sweetened foods and beverages sparingly, and, if consumed, drinking alcohol sensibly are included in the South African food-based dietary guidelines.[35]

Partially replacing meat with legumes and improving dietary quality and energy balance may be a more feasible and sustainable approach.[24] A high-quality diet is characterised by: (i) nutrient adequacy, meaning that all essential nutrients are consumed in adequate amounts to support overall health and well-being; (ii) moderation, therefore avoiding excessive intake of any particular food or nutrient, particularly high-calorie, high-fat, high-sugar and salty foods; (iii) balance, meaning consuming the right proportions of different food groups and macronutrients (carbohydrates, proteins, fats); and (iv) variety, meaning consuming a wide range of foods within and across food groups.[4]

- Dietary changes to achieve a sustainable healthy diet: Small, targeted, food-level substitutions can have nutritional benefits and reduce environmental impacts.[36,37] For example:
  - Red meat has the highest environmental impact, and therefore eating smaller portions of meat can contribute to sustainable diets.
  - Other animal-source foods, such as fish, poultry and dairy, have lower environmental impacts and are healthy alternatives to red and processed meats.
  - Animal protein can be substituted or partially replaced with plant protein, such as beans, nuts and seeds.

- Legumes and pulses are rich sources of high-quality plant protein. Legumes and pulses have a lower cost per serving and longer shelf life than most animal-source foods and are therefore a more affordable source of protein. Regular consumption is recommended by the South African food-based dietary guidelines.[38]

- Consuming a diet that exceeds a person's energy requirement is considered an avoidable environmental burden.[30] Reducing overconsumption and improving the energy balance of the diet will have both environmental and health benefits.

- Consuming less discretionary foods, which are energy dense and highly processed and packaged, reduces both the risk of dietary imbalances and the use of environmental resources.[30]

At the consumer end, environmental impact will be reduced not only by shifting to plant-based diets with less meat and processed food, but also by reducing household food waste.

Household food waste

Although dietary shifts to plant-based diets will have environmental benefits, they may result in higher household food waste, as vegetables and fruits are highly perishable and therefore prone to spoilage.[39] Buying packaged food may reduce household food waste, but the packaging contributes to environmental pollution.[40] Recycling, reusing or repurposing of waste materials (packaging) can effectively reduce resource waste and environmental pollution.[41]

Some level of household food waste is unavoidable (inedible parts of food such as bones, apple cores,

egg shells, etc.). However, a large part of household food waste is avoidable (i.e. discarding food that is still edible), and preventing and reducing food waste should be centred around preventing avoidable food waste.[42] The target for the Sustainable Development Goal (SDG) 12.3 is to 'by 2030, halve per capita global food waste at the retail and consumer levels'.[39]

Generating household food waste is complex and multifaceted[42] and varies across different food commodities.[43] Routine household practices such as planning, shopping, storing, cooking, eating and managing leftovers have a key role not only in providing food but also in generating household food waste. Purchased or cooked food items may be assessed with regard to their edibility and consequently either be wasted or redistributed.[44] Practices to reduce household food wastage are summarised in Table 1.

Table 1. Practices to reduce household food waste

Planning Inadequate meal planning and food budgeting, and going to the store without a shopping list may lead to unnecessary food purchases and, consequently, food waste. Unnecessary food purchases can be avoided by planning meals and writing a shopping list. When writing the shopping list, check inventories to avoid unnecessary purchasing of items already stored at home, and communicate with other household members to avoid buying the same food items twice.
Shopping Buying more food than needed often results in unnecessary waste. Consumers often buy more than needed because of stockpiling food for unexpected occasions, promotional deals such as "Buy one, get one free" offers and the availability of bulk packages. Often, the large package sizes of certain products may not be suitable for smaller households or for people who live alone. Buying an excessive amount of food can be avoided by buying only the items on the shopping list and in the amount needed. For more affordable food, buy local food products and fruit and vegetables that are in season. Homegrown vegetables and fruit are less likely to be thrown away.
Storing Proper storage will keep perishable items fresh for longer and reduce food waste. Organising and categorising food items systematically, along with stacking newer items behind older ones or prioritising based on the frequency of use, can improve visibility and help prevent food tucked away in the back of the refrigerator or cupboard being forgotten. Freezing will extend the shelf-life of certain foods and leftovers. Foods should be stored at the correct temperature. Food spoilage can be accelerated if the temperature of the fridge is higher than reccomended recommended.
Cooking Often too much food is prepared, which ends up being thrown away. Not cooking meals for which ingredients have already been bought may also lead to food waste. To avoid waste, cooking should be need based. Cook meals based on what is stored at home. Be creative and improvise with ingredients left in the fridge or cupboards.
Eating Larger plates lead people to eat more and increase the amount of food wasted. Reducing portion sizes and adjusting the plate size will help prevent overeating and reduce plate waste.
Managing leftovers To avoid leftovers going to waste, they should be systematically stored in appropriate containers, kept in a fridge or frozen to extend shelf-life, and be used in other dishes.
Assessing edibility Edibility of food can be assessed through smelling or tasting, checking the 'best before' date, and, less commonly, tracking how long food items have been opened or stored. The best-before date is the suggested date before which the full quality of the product, as marketed, can be enjoyed. The sell-by date refers to a product's shelf life in-store – the recommended time for which it should be sold to retain marketed quality. The use-by/expiry date is the date after which food will perish and no longer retain the marketed quality.
Disposal/redistribution How food is disposed of may influence the amount of food wasted. Recycling or composting may undermine people's motivation for waste prevention. Giving leftover cooked food to others may reduce waste, but this may not be acceptable to all.

Sources: Lisciani et al., 2024;[42] Schanes et al., 2018;[44] Some et al., 2022.[45]

Conclusion

Dietary shifts to plant-based diets should consider nutritional quality, environmental impacts and environmental-nutritional trade-offs, along with social and income constraints and sociocultural influences on food practices. The environmental-nutritional trade-offs will depend on the current food system, food security and nutritional status within a population. Context-specific and realistic dietary shifts, together with a reduction in household food waste, are needed to reduce environmental impact and improve health.

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