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Managing Crop tradeoffs: A methodology for comparing the water footprint and nutrient density of crops for food system sustainability

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ABSTRACT

The relationship between human nutrition and the use of available resources to feed the planet's growing population demands greater attention from decision makers at all levels of governance. Indicators with dual environmental sustainability and food and nutrition security goals can encourage and measure progress towards a more sustainable food system. This article proposes a methodology that supports the development of an approach to assess the water footprint of nutrient-dense foods [m^3/kg]. It provides a clear explanation of the methodology, and the use of water footprint benchmark data and corresponding United States Department of Agriculture (USDA) nutrient composition data to apply the process. The study analyzed data for 17 grains, roots and tubers, 9 pulses, 10 nuts and seeds, 17 vegetables, and 27 fruits. Of these, fruits and vegetables are 85% of the bottom quartile for water footprint (i.e., highly water efficient) and 100% of the top quartile for nutrient-density (i.e., very nutrient dense). Spinach is a clear winner, with a very high nutrient-density and low water footprint. The article proposes that this approach can help to establish broad typologies to guide decision makers in distinguishing between win-win, win-lose, and lose-lose scenarios of natural resource use and nutrition security. This resource, if considered along with contributing social, environmental, and economic factors (e.g., local tastes, available water resources, soil fertility, local economies) can promote a food system that offers a diverse range of nutrient-dense foods more sustainably.

1. Introduction

The global community needs to urgently find ways to produce and consume healthier diets, while ensuring that food is produced in an environmentally and socially sustainable manner. Worldwide, over 795 million people are undernourished and many people face hidden hunger or micronutrient deficiencies (FAO, 2015). Further, 2.1 billion people are estimated to be overweight or obese (Ng et al., 2014). Re-thinking food systems becomes ever more important as the global population continues to grow in size and wealth, and by 2050 is expected to grow by over a third, or 2.3 billion people, thus further stressing the ecosystem services upon which agriculture relies (United Nations, 2015a). Of these ecosystem services, maintaining both quantity and quality of freshwater is an essential piece of the equation.

Rockström et al. (2009) define planetary boundaries, or thresholds, within which humans can operate safely, including global freshwater use. This research proposes a planetary boundary of less than 4000 $km^3\ yr^{-1}$ for the consumptive use of freshwater. As of 2010, the FAO estimated that the global water withdrawal, which includes use by agriculture, industries, and municipalities, already reached the planetary boundary of 4000 $km^3\ yr^{-1}$ (FAO, 2016). Agriculture is responsible for 70% of all water withdrawals from aquifers, streams, and lakes globally, even though most agricultural systems are rain-fed (FAO, 2011). Furthermore, agriculture accounts for approximately 85% of ground water and surface water consumption (Mekonnen and Hoekstra, 2011). Increasing food demands and dietary changes are raising global pressures on freshwater resources (Rockström et al., 2009). Globally, cereals, and meat are the agricultural products contributing the most to water footprint use at 27% and 22% (Hoekstra and Mekonnen, 2012). Due in part to these global pressures, the remaining safe operating space for freshwater may be already committed by this agricultural demand (Rockström et al., 2009). The demand for freshwater

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resources is expected to increase by 55% between 2000 and 2050, not considering rain-fed agriculture, and much of this increase will be from industries outside of the agricultural sector, creating competition for water resources (Whitmee et al., 2015). This future climate trajectory makes the case for understanding the water footprint of food grown even more essential. Much of the world is expected to experience increasingly arid soils, and some regions, such as California, will face persistent droughts (Dai, 2011). The adequate and timely supply of water resources is important for ensuring crop yields and agricultural efficiency, particularly in the face of future climate uncertainties (Gustafson et al., 2016).

The Sustainable Development Goals (SDGs) have put the sustainability of food systems for human and environmental health on the international agenda. The SDGs recognize the contribution of nutrition and freshwater resources to sustainable development, and their role in improving the wellbeing of individuals around the world (United Nations, 2015b). Yet, the SDGs fail to more closely and explicitly link health and environmental initiatives, such as food security and water resource sustainability, by establishing common goals and targets. The difficulties around 'generating simple yet representative indicators that combine elements of social and economic development with metrics of environmental health and sustainability' were highlighted by Oldekop et al. (2016) in a paper that identified 100 key research questions for the post-2015 development agenda. There is limited interaction among nutrition and water use goals (and their associated targets and indicators; Table 1). Targets 2.1 and 2.2 concern ending hunger and malnutrition, with limited consideration of the environmental impacts required to do so. Target 2.4 addresses the need to ensure a more sustainable food system, including resilient agriculture practices. The associated indicator tracks the proportion of agricultural area under productive and sustainable agriculture. In considering the complexity of the relationship between human nutrition and environmental sustainability, indicators that take into consideration interactions between the two factors can help map the tradeoffs and synergies between goals and targets (Nilsson et al., 2016; Stafford-Smith et al., 2016).

While there is international recognition for an integrated approach to addressing health and environmental issues, the policy, scientific, and business communities still lack a consensus and an in-depth understanding of the metrics required to assess multiple dimensions of sustainable diets and food systems (Gustafson et al., 2016). Allen et al. (2014) gathered expert knowledge to determine key indicators that jointly assess major interactions relevant to both environmental sustainability and food and nutrition security (Allen et al., 2014). One such interaction is the relationship between water depletion (environmental sustainability) and the nutritional quality of food (food and nutrition security). To assess these issues, experts proposed an indicator which measures the water footprint of nutrient-dense foods [m^3/kg]. This study proposes an initial framework to develop and test this approach.

This paper offers a method to measure and compare the water footprint of crops relative to their potential nutrient contribution to the human diet. This metric aims to compare information that is disparate from two distinct, but intersectional, fields. Some crops may better contribute to a location's environmental health, as well as human health, based on their water footprint and nutrient density. Scientific investigations have been made regarding trade-offs between multidimensional indicators (Stoessel et al., 2012; Tilman and Clark, 2017). Previous work includes assessments of the water footprint effects of different dietary patterns, such as comparing vegetarian diets to those diets that incorporate animal products (e.g., Ruini et al., 2015; Tilman and Clark, 2014; Tom et al., 2015). Yet little work has been done to compare the water footprint of individual foods. This research considers how to design and implement an approach to help guide program and policy decisions to support sustainable food systems. This analysis can serve as a resource, in tandem with knowledge of the local environmental, social, and economic factors, to help facilitate feasible and impactful changes in food systems that promote sustainable diets.

2. Methods

2.1. Water footprint analysis

For the purpose of this paper, the measure 'water footprint' describes the water demand of foods and the appropriation of the world's freshwater (Mekonnen and Hoekstra, 2011). According to the Water Footprint Network, water footprint is defined as the "measure of humanity's appropriation of fresh water in volumes of water

Table 1
Relevant SDG goals and their associated targets and indicators.

	Target	Indicator
Nutrition	**SDG 2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture**	
	2.1 By 2030, end hunger and ensure access by all people, in particular the poor and people in vulnerable situations, including infants, to safe, nutritious and sufficient food all year round	**2.1.1** Prevalence of undernourishment
		2.1.2 Prevalence of moderate or severe food insecurity in the population, based on the Food Insecurity Experience Scale
	2.2 By 2030, end all forms of malnutrition, including achieving, by 2025, the internationally agreed targets on stunting and wasting in children under 5 years of age, and address the nutritional needs of adolescent girls, pregnant and lactating women and older persons	**2.2.1** Prevalence of stunting (height for age < -2 standard deviation from the median of the World Health Organization (WHO) Child Growth Standards) among children under 5 years of age
		2.2.2 Prevalence of malnutrition (weight for height $>+2$ or < -2 standard deviation from the median of the WHO Child Growth Standards) among children under 5 years of age, by type (wasting and overweight)
	2.4 By 2030, ensure sustainable food production systems and implement resilient agricultural practices that increase productivity and production, that help maintain ecosystems, that strengthen capacity for adaptation to climate change, extreme weather, drought, flooding and other disasters and that progressively improve land and soil quality	**2.4.1** Proportion of agricultural area under productive and sustainable agriculture
Water Use	**SDG 6. Ensure availability and sustainable management of water and sanitation for all**	
	6.4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity	**6.4.1** Change in water-use efficiency over time
		6.4.2 Level of water stress: freshwater withdrawal as a proportion of available freshwater resources

consumed and/or polluted".[1] The analysis focused on blue and green water footprints, which reflect the freshwater planetary boundary as defined by Rockströ;m et al. (2009). The Water Footprint Network defines green water footprint as "water from precipitation that is stored in the root zone of the soil and evaporated, transpired or incorporated by plants" and blue water footprint as "water that has been sourced from surface or groundwater resources and is either evaporated, incorporated into a product or taken from one body of water and returned to another, or returned at a different time".

While food value chains include many uses of water, this research focuses on crop water requirements, particularly as irrigation is generally the greatest use of water in the system (Gustafson et al., 2016). Additionally, there are metrics that give greater weight to water consumed in areas where there is competition for water resources, but these methods have not received universal scientific consensus to date and thus were not incorporated into this research and analysis effort (Gustafson et al., 2016).

This analysis used the water footprint benchmark data published by Mekonnen and Hoekstra (2014). Mekonnen and Hoekstra established a set of global water footprint benchmark values for selected crops grown worldwide. The study used a spatial model, taking into consideration soil water balance to calculate crop water requirements, actual crop water use (both green and blue), and actual yields. The water footprints were then calculated taking into consideration evapotranspiration as well as the growing period and crop yield. Green-blue water footprints, which are considered simply 'water footprints' for the purposes of this paper, are calculated by dividing the evapotranspiration of green and blue water over the growing period by crop yield. Green-blue water footprints sum both rain and irrigated water consumption.

For this study, the water footprint benchmarks established in Mekonnen and Hoekstra (2014) were used for the comparison in part because of the ease of the data availability, unlike national water use accounts. For national water use accounts, data is often limited and, when available, is constrained to statistics on water withdrawals in the different sectors of the economy. Furthermore, these accounts often exclude green and grey water data (Bulsink et al., 2010). Whilst there are also limitations with benchmark approaches to 'virtual' water accounting (e.g., in policy setting – see Wichelns, 2010), the benchmarks established in Mekonnen and Hoekstra (2014) serve as a useful tool for establishing an approach and methodology to obtain a high-level understanding of the comparison between water footprint and nutrient density.

2.2. Nutrient density analysis

Previously, the focus of food security efforts was to ensure people gain an adequate number of calories. This approach does not consider the full complexity of food security, which, as defined by the 1996 World Food Summit, is "when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO, 1996). This definition not only calls for the sufficiency of food (or an adequate supply of calories), but 'safe' and 'nutritious' food as well, thus requiring more complex approaches and measurements that address all forms of malnutrition (Development Initiatives, 2017). Poor quality diets, characterized by low intakes of fruit, vegetables, nuts and seeds, and whole grains and high intakes of processed meat, sodium, and sugar-sweetened beverages are the number one risk factor in the global burden of disease and affect about three billion people worldwide (Forouzanfar et al., 2015). Focusing on the nutrient density of plant crops helps to assess the contribution of these foods to diet quality.

For this analysis, all selected crops were analyzed in their raw form, as preparation methods can alter the nutrient content of the food. Additionally, crops chosen had established water footprint baselines and associated data present in the USDA Food Composition Database (Mekonnen and Hoekstra, 2011; USDA, 2015). This database was selected, as it contains the most comprehensive food composition data to date. As both datasets used different crop coding systems, an effort was made (by use of averages and exclusions, as needed) to match food items in both databases. Ultimately, the study analyzed data for 17 grains, roots and tubers, 9 pulses, 10 nuts and seeds, 17 vegetables, and 27 fruits (see Appendix B). Culinary, rather than botanical definitions, were used to assign a food crop to a food group. Based on the selected crops, the nutrient information for 10 key nutrients, along with the energy density, was gathered based on 100 g of food.

The study used nutrient profiling to quantify and compare the nutrient density of plant crops with an important role in improving diet quality. Nutrient profiling is defined as "the science of classifying or ranking foods according to their nutritional composition for reasons related to preventing disease and promoting health" (WHO, 2010). While many current nutrient profiling methods consider nutrients to limit in a diet, such as saturated fat, added sugars, and sodium (Arambepola et al., 2008; Darmon et al., 2009; Fulgoni et al., 2009), because these limiting factors were not relevant to the crops analyzed the analysis only considered beneficial nutrients. This analysis used the nutrient density score (NDS) methodology defined in Darmon et al. (2005), which established a nutrient density standard for fruits and vegetables. The study built on Darmon et al. (2009) by weighting the NDSs according to the bioavailability of the nutrients Di Noia (2014).

The nutrient profiling model used nutrient requirements established by the World Health Organization (WHO) and Food and Agriculture Organization (FAO) (WHO and FAO, 2004). The analysis uses recommended nutrient intakes (RNIs) for males between the ages of 19 and 65 years (unless otherwise noted in Table 2; WHO and FAO, 2004). Micronutrients chosen are essential nutrients important for public health nutrition internationally. Food groups not analyzed in this study, such as animal source foods, contribute different components to the diet that are not reflected in the nutrients selected for this analysis.

The nutrient profiling calculations for each crop occurred in the following stages (Di Noia, 2014; Darmon et al., 2005):

1. The nutrient adequacy score was calculated. This score is the mean of percent RNIs (or mean requirement, in the case of vitamin A) per day for the nutrients listed in Table 2 per 100 g of the selected crop (based on the USDA data). The RNI/mean requirement established by WHO/FAO takes into account bioavailability, where applicable. The nutrient adequacy score = $(\Sigma\ [\text{nutrient}_i/\text{RNI}_i] \times 100)/10$, where: nutrient_i = amount of one of the 10 nutrients in 100 g of food (based on USDA data), RNI_i = the recommended nutrient intake per day for the same nutrient for adult males (see Table 2 to see specific details regarding the RNI).
2. For each nutrient, percent RNIs were capped at 100% daily value, as some foods are excellent sources of a particular nutrient but contain few other nutrients. This approach prevents against inflated score values for crops containing high levels of a single nutrient (Di Noia, 2014; Gustafson et al., 2016).
3. The nutrient adequacy score was then divided by the energy density of the food (kilocalories per 100 g): The nutrient density score (expressed per 100 kcal) = (nutrient adequacy score/energy density) x 100.

[1] Water Footprint Network. Available at: http://waterfootprint.org/en/water-footprint/what-is-water-footprint/. Accessed July 16, 2017.

Table 2
Recommended nutrient intake (RNI) per day for selected nutrients.

Nutrient	Units (Per Day)	RNI Per Day[a]	Notes on Applicability of the RNI
Vitamin A	μg RE (Retinol Equivalents)	300	Vitamin A value is the 'mean requirement' instead of the RNI.
Vitamin C	mg	45	RNI reflects the amount required to half saturate body tissue with vitamin C in 97.5% of the population.
Thiamin	mg	1.2	Applies to males 19 years and older
Riboflavin	mg	1.3	Applies to males 19 years and older
Niacin	mgNEs (Niacin Equivalents)	16	Applies to males 19 years and older
Vitamin B_6	mg	1.5	RNI is an average of the following: - Males 19–50 years - 1.3 mg/day - Males 51 + years - 1.7 mg/day
Folate	μg	400	Applies to all adults
Calcium	mg	1000	–
Zinc	mg	7	Considers moderate bioavailability
Iron	mg	19.4	Based on the average of 5% bioavailability (27.4 mg) and 12% bioavailability (11.4 mg)

[a] Unless otherwise noted, RNI is based on the WHO/FAO recommendation for males between 19 and 65 years old.

The final nutrient density score (NDS) represents the mean of the percent RNIs per 100 kcal of food. The nutrient profiling values calculated can then be compared to the water footprint benchmarks, as established in Mekonnen and Hoekstra (2014). See Appendix B for a table with results from the nutrient density calculation.

3. Results

The analysis sheds light on the tradeoffs and synergies between a crop's water footprint and its nutrient density. See Appendix A for a table containing a side-by-side comparison between the NDSs and water footprint benchmarks, which permits a comparison of these tradeoffs and synergies.

Fig. 1 through 6, below, provide a visual comparison of the water footprint and nutrient density for the selected crops, where Fig. 1 represents all crops and Fig. 2 through 6 represent crops by food group. The figures include lines to demarcate the median water footprints and NDSs to facilitate the consideration of tradeoffs (see Table 3 for medians). The top left quadrant includes crops that are relatively water inefficient and nutrient poor and the bottom right quadrant represents crops that are water efficient and nutrient dense. These results demonstrate how this new interdisciplinary approach can be analyzed. The figures use different scales to better demonstrate distinctions among crops within each food group. The median water footprints and NDSs help to compare between the food groups analyzed (Table 3).

Fig. 1 includes all 80 individual crops included in the analysis, where the median water footprint is approximately 818 m^3/ton and the median NDS is 9.00. Crops in the most water efficient quartile have a water footprint of less than or equal to 345 m^3/ton, of which 85% are fruits and vegetables. Crops in the most nutrient dense quartile have a NDS of greater than or equal to 21.4, of which 100% are fruits and vegetables. This does not come as a surprise, due to the overwhelming evidence in the literature of the importance of fruit and vegetable consumption, and the harms of low consumption. According to the 2013 Global Burden of Disease Study, low fruit and vegetable consumption is among the top risk factors for mortality worldwide (Forouzanfar et al., 2015). Additionally, as demonstrated by the density of crops in the bottom left portion of the graph, most crops are not nutrient dense but relatively water efficient.

Fig. 2 represents the 17 vegetables analyzed, where the median water footprint is approximately 249 m^3/ton and the median NDS is 36.94. One crop that stands out is spinach, which has the highest possible NDS of 100 and a low water footprint of 132 m^3/ton, though green-leafed lettuce and cauliflower are also highly nutritious and water efficient. Spinach has high levels of Vitamin A (RAE), 156% of RNI, which was capped at 100% when calculating the NDS as to not inflate the score, and 49% of RNI for folate (DFE) and 62% of RNI for Vitamin C (including total ascorbic acid), which contributes to the vegetable's high NDS. Spinach's energy density value is 23 kcal per 100 g, which is relatively low in comparison to grains, which often have energy density values above 300 kcal per 100 g.

Fig. 3 represents 27 fruits analyzed, where the median water

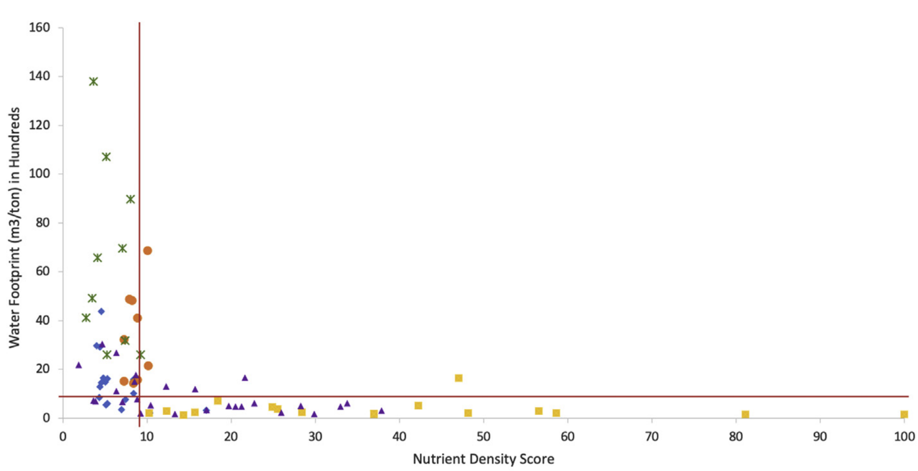

Fig. 1. Water footprint and nutrient density comparison: All crops.

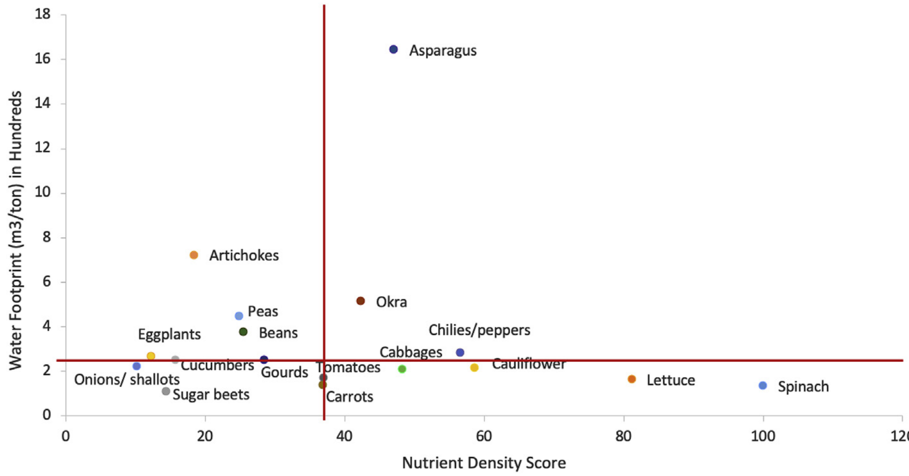

Fig. 2. Water footprint and nutrient density comparison: Vegetables.

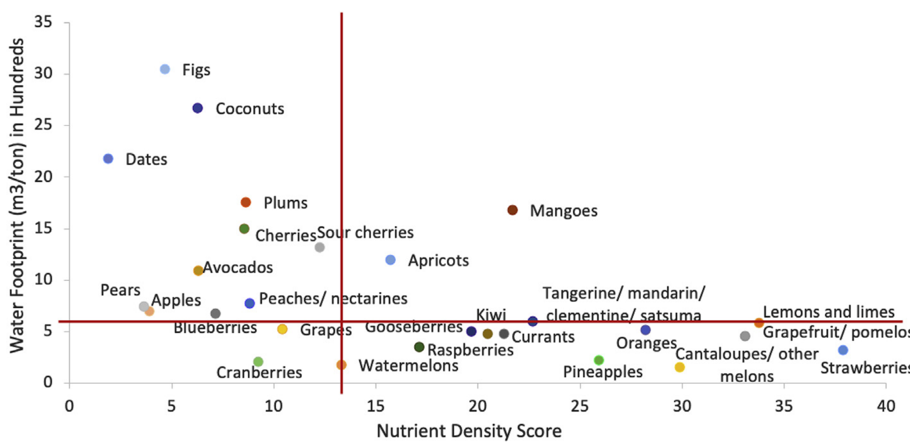

Fig. 3. Water footprint and nutrient density comparison: Fruits.

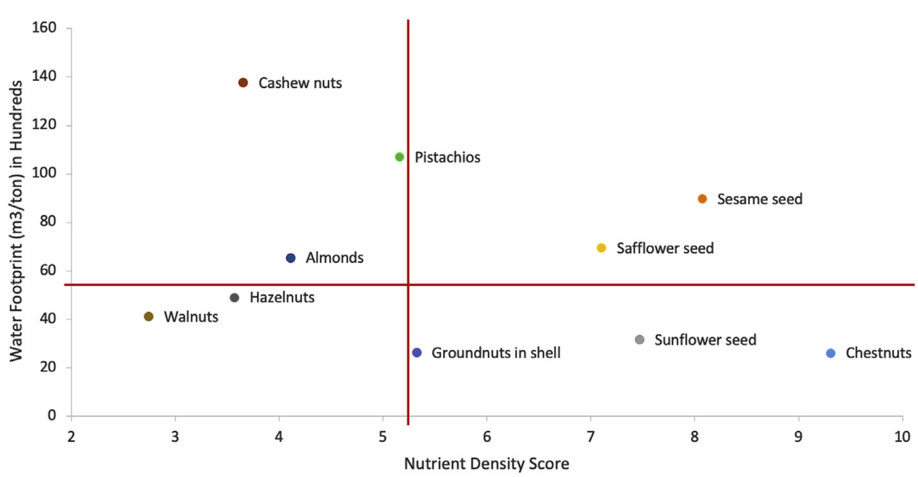

Fig. 4. Water footprint and nutrient density comparison: Nuts and seeds.

footprint is 597 m^3/ton and median NDS is 13.31. Citrus fruits, such as oranges, lemons, limes, grapefruits, and pomelos, are both nutrient dense and water efficient. Some fruits, such as coconuts and avocados, are energy dense with high levels of healthy dietary fats. They are valuable additions to the diet, but do not contribute a significant proportion of micronutrients identified as critical for this analysis. Figs, coconuts, and dates have a low nutrient density and high water footprint among fruits.

Fig. 4 represents 10 nuts and seeds analyzed, where the median water footprint is 5721.5 m^3/ton and median NDS is 5.24. Overall,

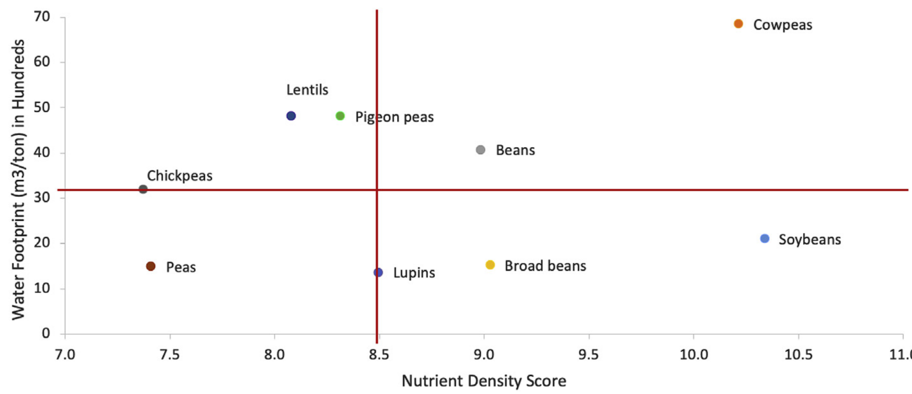

Fig. 5. Water footprint and nutrient density comparison: Pulses.

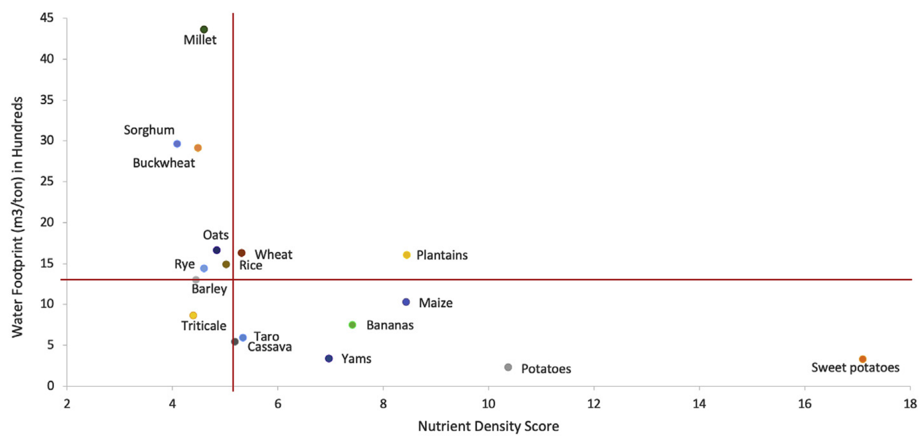

Fig. 6. Water footprint and nutrient density comparison: Grains/roots/tubers/plantains.

Table 3
Median water footprint and nutrient density score (NDS) by food group.

Food Group (Including All Crops)	Median NDS	Median Water Footprint (m^3/ton)
All Crops	*9.00*	*818*
Nuts/Seeds	5.24	5721.5
Grains/Roots/Tubers/Plantains	5.18	1292
Pulses	8.49	3196
Vegetables	36.94	249
Fruits	13.31	597

nutrient density is low for nuts and seeds, as compared to other food groups, with the highest NDS at 9.31 for chestnuts. The selected nuts and seeds are more energy dense, many having high concentrations of important macronutrients (protein and fat). A consideration for interpretation is the relative lower energy density of chestnuts (197 kcal per 100 g on average), compared to other nuts and seeds (greater than 440 kcal per 100 g). This food group is also generally water inefficient, which is seen clearly in Fig. 1 that compares all crops analyzed, where most nuts and seeds fall in the upper left quadrant, representing crops with low nutrient density and water efficiency.

Fig. 5 represents 9 pulses analyzed, where the median water footprint is 3196 m^3/ton and median NDS is 8.49. Like the nuts and seeds food group, the NDSs for pulses are generally low, ranging from 6 to 10, as compared to vegetables with a median NDS of 36.94. Cowpeas and soybeans are both relatively nutrient dense, as they fall well above the median when comparing the pulses analyzed. This figure demonstrates that some tradeoffs are difficult to judge, where the water footprint and nutrient density measures are disparate. For example, cowpeas have a higher NDS than broad beans, 10.21 versus 9.03. Cowpeas have a more significant impact on the water resources than broad beans, 6850 m^3/ton versus 1521 m^3/ton. For this reason, criteria must be established based on the needs of the local population and environment to make decisions based on these tradeoffs.

Fig. 6 represents 17 grains, roots, tubers, and plantains analyzed, where the median water footprint is 1292 m^3/ton and median NDS is 5.18. These crops are generally clustered with NDSs falling between 1 and 10. Demonstrated most clearly by Fig. 1, these crops, which fall in the bottom left portion of the graph, generally have lower water footprints and NDSs as compared to other food groups analyzed. When comparing these grains, roots, tubers, and plantains, sweet potato stands out as being both nutrient dense and having a low water footprint.

Lessons learned from these tradeoffs, along with careful consideration of the social, environmental, and economic contexts, can help decision makers build a sustainable food system meeting human and environmental health needs.

4. Discussion

This paper assesses the nexus between water footprint and nutrient density from a bird's eye view. This perspective aims to foster an understanding of how these two areas can be conceptualized and compared to contribute to designing a more effective, more sustainable food system—in essence, a food system that produces nutritious foods and has a limited water footprint impact that aims to help keep freshwater appropriation by humans within planetary boundaries. Measuring the water footprint of nutrient-dense foods can serve as a framework to develop broad typologies. Using global precipitation and soil maps, along with nutrition surveys, decision makers responsible for agriculture, food policy, natural resource management, and environmental conservation can develop broad typologies for water footprint and nutrient density situations. The aim of developing typologies is that areas and regions can be classified and grouped according to a particular combination of characteristics that pertain directly to food production (e.g., soil type and land capability), nutritional/dietary requirements (e.g., human health characteristics), and water use (e.g., precipitation patterns, water body cover, soil type, aquifer presence, and population densities). By doing this, areas with similar characteristics can be grouped on the basis of likely similar water availability issues and similar nutrition issues. This can help guide policy and decision makers in terms of giving due consideration to both water use and nutritional attributes of different crop types. The groupings may also allow similar strategies to be adopted in terms of the crops that are a) required on a nutritional basis, b) able to flourish given the water availability in a given region, and c) suited to the agroecological conditions (e.g. soil type, altitude, climatic variables) in a region. This means that general principles of response can be prescribed (although there will likely always be a need to tailor responses to each location to some extent), without the necessity of treating each region as exhibiting a completely unique set of threats, issues, and potential responses.

This analysis is an early and unique attempt to combine two distinct but cross-disciplinary indicators related to the food system. There are limitations to the indicators and methodology used, as discussed in the following sections. Thus, further research and analysis (particularly where this dual approach is trialed in actual locations and communities) will be required to test and refine metrics for this methodology.

4.1. Nutrient density score

The NDS serves as an effective indicator to measure the contribution of a selected crop to the human diet. When designing this indicator, critical micronutrients were chosen with the nutrient composition of fruits and vegetables in mind as the analysis was limited to plant crops. There could be a different set of water footprint/nutrient density tradeoffs if looking, for example, at fish and different types of aquaculture. For example, small indigenous fish have higher nutrient density than many larger species of farmed fish such as carp and tilapia (Thilsted et al., 2016). Therefore, this analysis is most robust in its understanding of the water footprint and nutrient density tradeoffs regarding fruits and vegetables, and plant foods more broadly. While this paper presents data for other food groups, additional work is required at a more localized level to tailor the NDS to the important nutritional contributions of these food groups to the diet based on typical dietary patterns and socio-economic conditions. Future region and country-specific analysis using the specific staple foods (e.g., maize, rice, or cassava) and the most commonly consumed fruits and vegetables is needed. These further analyses could include protein and amino acid, and fat and fatty acid profile of crops as well as an attempt to include neglected and underutilized species to ensure the approach reflects the full complexity of nutrient density/water trade-offs at a more granular level of analysis.

In addition to modifications to the scoring methodology, additional analyses can be performed on different foods, including different methods of preparation. Because this study analyzed crops in their raw form, additional analysis is required to assess crops in their commonly consumed form(s) to more accurately reflect their contribution to diets. Furthermore, additional research may include animal source foods (e.g., aquaculture), which typically have a larger water footprint than crop products (Mekonnen and Hoekstra, 2010). There may be options to better integrate crop production and animal source foods, such as aquaculture, through use of pond water to irrigate and fertilize crops (Attwood et al., 2015), that would help manage the overall water footprint of the production system.

A huge challenge for developing food composition datasets, upon which to base policies and programs, is that the nutrient content of foods can vary significantly among different ecological and climatic conditions, and among the many different varieties that exist within a species. In a study by Barikmo et al. (2007) of the differences in micronutrient contents found in cereals in different ecological zones of Mali, the micronutrient content of the same cereal species varied among different regions (Barikmo et al., 2007). Large variations in nutrient content within varieties of the same crop have also been demonstrated (Kennedy and Burlingame, 2003). Scientists around the world are working to develop comprehensive food composition databases in an effort to better contribute to the food security of regions, with much of this data stored in the FAO/INFOODS Composition Databases.[2] This data can then be applied to the proposed methodology to better understand the water footprint and nutrient density dichotomy across various regions, including which crop varieties better contribute to high nutrient density and low water footprint values.

4.2. Water footprint

Mekonnen and Hoekstra's spatial model serves as an effective way to compare water footprints for selected crops grown worldwide. When comparing crop water footprint data from Mekonnen and Hoekstra (2014), it is important to keep in mind the impact of crop yields on water footprint. Because of the role of yields in determining water footprints, these values are influenced by the various factors that impact yields apart from water availability, including nutrient supply, crop varieties, farmer access to agricultural inputs (e.g., agrochemicals, labor), seasonality and severity of rainfall, soil type and condition, pest and disease incidence, and pollinator densities and activity. Mekonnen and Hoekstra explain, for example, that green-blue water footprint is typically lower for irrigated as opposed to rain-fed crops because irrigated yields are larger than rain-fed yields. Higher water productivity is not just determined by whether irrigation is used or not, or due to climatic and soil factors determining evapotranspiration. Instead, water footprint is largely determined by agricultural management practices (Mekonnen and Hoekstra, 2014). In fact, farmers can achieve a large increase in their yields without impacting evapotranspiration with effective nutrient, water, and soil management (Mueller et al., 2012). For example, agricultural management approaches such as mulching (Leaky et al., 2009), adding manure (Tilman et al., 2002), or conservation tillage (Chartzoulakis and Bertaki, 2015; Leaky et al., 2009; Tilman et al., 2002) can retain or increase the soil's organic matter, thus increasing its capacity to hold water and decrease evapotranspiration (Leaky et al., 2009). Technological tools, such as the Commonwealth Scientific and Industrial Research Organization's (CSIRO) Agricultural Production Systems Simulator

[2] FAO/INFOODS website is available at: http://www.fao.org/infoods/infoods/tables-and-databases/faoinfoods-databases/en/.

(APSIM™) offers crop management strategies for farmers, including optimal plant density, sowing period, and nitrogen quantities to maximize crop water use efficiency and improve crop production (Botwright Acuña et al., 2015; Moore et al., 2011).

In determining sustainable crops for a region (i.e., crops that reduce natural resource use and increase nutrition security), decision makers must not only consider water-use efficiency, but tradeoffs between a whole host of environmental, social, and economic factors (Rohmer et al., 2018). They should consider the supply chain configuration in a common framework with dietary consumption (Rohmer et al., 2018), including where and how land-use change and related impacts will occur as a result of modifications to the food system (Chaplin-Kramer et al., 2017). Many well-known dryland crops (e.g., sorghum, millet, dates, and figs) that are often sustainable crop solutions in arid regions have higher water footprint values in this analysis, likely in part due to their lower crop yields (and the inclusion of yield in the calculations). Sorghum and millet are such crops widely known to be dryland cereals that provide nutritious and resilient sources of food for communities prone to low or erratic rainfall (ICRISAT and ICARDA, 2012). Several factors impact crop resilience (e.g., chlorophyll stability and leaf mass), where water use is just one component (Gholami et al., 2012). Certain varieties of crops are more drought-tolerant than others, and thus are more sustainable options in dryland regions, as seen in the case of *Kalanchoe claigremontiana* for dates (Djibril et al., 2005) and Deyme Ahvaz and Sabz Estahban fig varieties (Gholami et al., 2012). For millets, barnyard millet is known as a drought-tolerant variety due in part to its short growing period, using less water and escaping the seasonal drought period (Tadele, 2016; Zegada-Lizarazu and Iijima, 2005).

Millet and sorghum are characterized as neglected and underutilized species (NUS), which are species that often have not been sufficiently studied to understand their potential, particularly under changing climate conditions (Padulosi et al., 2013). NUS crops offer an opportunity to improve diets, strengthen income generation across the supply chain, and empower indigenous communities (particularly women, who are often custodians of traditional knowledge) (Padulosi et al., 2013). Millet varieties may offer climate-smart crops, as their adaptations to challenging environments are better than the current major crops of the world. Millet is often grown in low fertility, sandy upland soils, where poor environmental, management, and plant-related factors are applied (Sadras et al., no date). These factors contribute to the low water productivity of millet, particularly in arid regions such as the Sahel (Sadras et al., no date; Tadele, 2016). Agronomy and inputs, not limited to water, are often the principal factors limiting the productivity of millet (Sadras et al., no date). Adjusting these factors, such as applying more fertilizer to millet crops, must be considered in relation to its costs and benefits in the region of interest. Further research can help to understand the benefits conventional and modern improvement techniques can have on the productivity of these varieties under varying conditions (Tadele, 2016). Enhancing the productivity of NUS crops, such as millets, requires the collaborative efforts of diverse stakeholders, including breeders, agronomists, policy makers, and donors and their associated institutions (Tadele, 2016).

When considering tradeoffs for water use efficiency and nutrient density, it is important to consider the multitude of factors impacting the sustainability of a crop for a region. These factors include not only water use and nutrient profile, but crop hardiness, food access in drought-prone regions, income generation, and gender empowerment. Additional analysis of crops, and their associated cultivars, is required to better understand the water footprint of different crops based on the agricultural management practices applied. Further research must also consider social and economic factors that impact this interaction; for example, rainwater collection systems can help grow thirstier crops like asparagus. To support sustainably-focused, evidence-based food and agriculture policies, researchers must work to collect, manage, and evaluate all available quantitative and qualitative data on the regional or national food system conditions, and assess which particular management interventions may be suitable, effective, and feasible.

When designing tailored guidelines and recommendations at regional, national, or local levels, researchers and policy makers will likely want to take into account the unique agroecological factors of their region when performing analyses. There currently are barriers for conducting this analysis at regional and national levels due to the limited availability of water footprint and nutrient density data at those scales. Water footprint can differ for the same crop species based on the unique local conditions, such as climate, soil characteristics, local to catchment scale hydrology, and water management practices (Mekonnen and Hoekstra, 2014). When analyzing water footprint in field or modelling studies, it is also important to take into consideration constraining factors, such as pests, diseases, and weeds, which could affect the water footprint analysis (Grassini et al., 2009). Field studies and modelling studies can have limitations based on the location or the quality of the data set. The water footprint data from Mekonnen and Hoekstra (2014) represents spatial variations of the water productivity using remote sensing studies. This method allows researchers to analyze large land areas, may lose the fine-grain detail of specific ecological and management conditions. Thus, when implementing this analysis for a nation, researchers must carefully consider the water footprint data available, as well as the surrounding conditions, to determine what water footprint data should be considered for analysis.

A final factor to keep in mind is that this analysis includes data from two distinct datasets, where crops have different names, codes, and groupings across each dataset. The study addresses these differences by aggregating and excluding food groups, as necessary. Further work must be done to improve these comparisons. As more scientists and practitioners recognize the need to work on intersectional, interdisciplinary issues, improved data management approaches and techniques will be necessary to align data across subject matters and geographic regions.

4.3. Implications for future users

Decision makers must take into account social, environmental, and economic factors and the trade-offs and synergies among them when designing and implementing policies or developing programs to deliver on policy intent. Decision makers should also consider historical, present, and future scenarios, including marginal changes, in order to build dynamic, prospective, and innovative solutions aligned with the on-the-ground reality (Yang and Campbell, 2017). In addition to broad directives and guiding principles, it is important—if possible—for policy makers to develop these initiatives through participatory approaches, rather than top-down efforts, to fully understand the challenges and constraints communities face, and opportunities available, in their particular context. Policy makers may determine synergies that benefit both environmental and nutritional outcomes, or identify and seek to address tradeoffs between outcomes where they are likely to occur. Whilst the aim of this paper was to provide a broad overview of water use and nutritional attributes, context-specific, on-the-ground circumstances must also be considered when developing policies or guidelines that are informed by general, broad scale principles. For example, the community may have: limited access to clean drinking water impacting the choice of crops that can be safely prepared (e.g., leafy greens that required more water for washing as compared to other vegetables); well-established and hard-to-change dietary patterns; or financial constraints that make producing or consuming a particular product difficult.

Some nations have already taken actions to incorporate features of sustainable diets into their dietary guidelines, for example suggesting food choices that limit the use of freshwater resources. A study by Fischer and Garnett (2015) reviews and assesses the role of sustainability in national food-based dietary guidelines (Fischer and Garnett, 2015). Brazil and the United Kingdom suggest reducing the consumption and production of animal-based foods, in part due to the water use associated with animal production systems (Fischer and Garnett, 2015). The Brazil guidelines also highlight the high levels of water use required by intensive production systems, such as soybean and corn monocultures (Fischer and Garnett, 2015). Swedish guidelines provide more specific guidance on specific types of vegetables, suggesting high fiber vegetables (e.g., root vegetables) over salad greens due to their environmental impact (Fischer and Garnett, 2015). These examples are small ways considerations regarding the water footprints of nutrient-dense foods can be incorporated into national guidance.

Overall, this analysis serves as a starting point to understand how multi-disciplinary concepts relating to sustainable food systems can be constructed and tested. This research provides a useful entry point for researchers, programmers, and policy makers interested in trade-offs and synergies between planetary and human health. The initiative is also in line with ambitions of the SDGs, as it demonstrates one way to analyze potential win-win options to achieve multiple SDG targets. A more comprehensive understanding of the environmental, health, social, and economic areas of a nation and its regions and communities is required to develop effectives policies and interventions, and to ensure the policies or programs are meeting the needs of the intended audience.

5. Conclusions

Global sustainability challenges, including challenges facing human and environmental health, are highly intertwined in a complex system. A holistic, systems integration approach involving diverse disciplines can help to integrate human and environmental issues in an attempt to identify efficient, effective solutions to these challenges. Researchers and policy makers must engage in this process through the analysis of a diverse range of food system metrics that monitor and track both environmental and human health issues. Researchers should also continue to develop high quality datasets and effective, clear analysis methods to track issues pertaining to sustainable food systems. These metrics and methods should support multi-sector initiatives that cross environmental, agriculture, and nutrition sectors to best address these unique challenges.

This study frames a cross-disciplinary analytical approach to measure water footprint of nutrient-dense foods. This methodology is an important contribution to a decision makers' 'sustainable food system dashboard' to track progress towards the SDGs. Further research and analysis can refine the metrics and methods for this approach based on unique and timely information relevant to local conditions. This method can help to establish broad typologies to guide decision makers in distinguishing between win-win, win-lose, and lose-lose scenarios of natural resource use and nutrition security.

Policies should continue to recognize and consider the unique socio-cultural and socio-economic conditions which impact the sustainability of food systems within context. Of these conditions, a community's unique tastes and preferences for different foods and cuisines may inhibit efforts to promote specific food tradeoffs that benefit humans and their environment. Programs promoting positive behavior change, including school programs on nutrition and sustainability, can be an effective bottom-up approach contributing to the sustainability of food systems. Due to the time it takes for the impact of these behavior changes to be seen, more immediate measures must be taken through the work of front-line technical assistance. Agricultural extension workers should be equipped with the best materials and resources as they are able, including seeds for crop species that better contribute to a nutritious diet and sustainable ecosystem and training resources on effective water management and nutrient education. These tools can better support the agricultural management of farmers, giving them the resources needed to be effective stewards of the land and contributors to a more sustainable food system.

The concept of a sustainable food system is one of the most complex issues of the time, as the global community must work to feed the world's growing population in a time of rapid environmental change. Now, more than ever, it is important for researchers and policy makers to holistically consider integrated food system metrics that help to conceptualize and improve upon the current system. This is an effort that will require enormous support from diverse stakeholders worldwide, but with the 2030 SDGs in sight, now is the time to work collectively to meet the global goals, and to improve the wellbeing of individuals worldwide and the health of the planet.

6. Significance statement

The water footprint of nutrient-dense foods can help decision makers concurrently track progress towards Sustainable Development Goals (SDGs) focused on food and nutrition security, human health, natural resource use, and environmental sustainability. The methodology proposed in this article supports the development of an approach that tracks interactions between multiple, interdisciplinary SDGs and their Targets, and supports innovative solutions and collaborations across disciplines. This analysis has the potential to encourage more sustainable and healthier diets across the globe. Further research can build off this methodology to create typologies for water footprint and nutrient density situations regionally to help guide food system decision makers.

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Appendix A. Nutrient Density and Water Footprint Tradeoffs of Selected Crop

The following table organizes the crop(s), using the FAO naming conventions used in Mekonnen and Hoekstra (2014), into food groups. For the purpose of this table, vitamin A-rich fruits and vegetables and vitamin-A rich dark leafy greens were combined under the fruit and vegetable categories, as few of these crops were available in the Mekonnen and Hoekstra (2014) dataset. Within each category, crops were filtered first by nutrient density score, or NDS, (with scores ranked high to low) to bring to light the most nutrient-dense crops, then by water footprint (with scores ranked low to high). The reference numbers by food group are not intended to be a ranking system but aim to facilitate the citation of crops.

Reference Number (By Food Group)	Crop Name	Nutrient Density Score (NDS)	Green-Blue Global Water Footprint Average (m_3/ton)	Notes on Averages and Food Groupings
Grains, white roots and tubers, and plantains				
1	Sweet potatoes	17.11	330	
2	Potatoes	10.37	224	NDS is an average of varieties
3	Plantains	8.46	1597	
4	Maize	8.43	1028	
5	Bananas	7.43	756	
6	Yams	6.96	342	NDS is an average of varieties
7	Taro (coco yam)	5.33	591	
8	Wheat	5.31	1620	NDS is an average of varieties
9	Cassava	5.18	550	
10	Rice, paddy	5.02	1486	NDS is an average of varieties
11	Oats	4.85	1660	
12	Rye	4.60	1445	
13	Millet	4.60	4363	
14	Buckwheat	4.49	2913	
15	Barley	4.46	1292	NDS is an average of varieties
16	Triticale	4.39	866	
17	Sorghum	4.11	2960	
Pulses (beans, peas, and lentils)				
1	Soybeans	10.33	2107	
1	Cowpeas, dry	10.21	6850	NDS is an average of varieties
2	Beans, dry	8.98	4070	NDS is an average of varieties
3	Broad beans, dry	9.03	1521	
4	Lupins	8.49	1371	
5	Pigeon peas	8.31	4811	
6	Lentils	8.08	4814	NDS is an average of varieties
7	Peas, dry	7.41	1486	
8	Chickpeas	7.37	3196	
Nuts and Seeds				
1	Chestnuts	9.31	2606	NDS is an average of varieties
2	Sesame seed	8.07	8969	
3	Sunflower seed	7.47	3165	
4	Safflower seed	7.10	6938	
5	Groundnuts	5.32	2618	
6	Pistachios	5.16	10697	
7	Almonds	4.11	6540	
8	Cashew nuts	3.66	13774	
9	Hazelnuts (filberts)	3.57	4903	
10	Walnuts	2.74	4105	
Vegetables (Including Vitamin-A Rich and Dark Leafy Greens)				
1	Spinach	100.00	132	Considered dark leafy green
2	Lettuce	81.14	161	NDS is an average of varieties
3	Sugar beets	14.36	108	
4	Cauliflower	58.68	211	
5	Chilies and peppers, green	56.56	282	NDS is an average of varieties
6	Cabbages	48.25	208	
7	Asparagus	47.10	1643	
8	Okra	42.32	511	
9	Tomatoes	37.00	171	
10	Carrots	36.94	134	Vitamin-A rich
11	Pumpkins, squash, gourds	28.41	252	NDS is an average of varieties; Orange or dark yellowed-flesh, vitamin-A rich
12	Beans, green	25.50	374	Assumed to be eaten as pods; Average of varieties
13	Peas, green	24.97	446	Assumed to be eaten as pods
14	Artichokes	18.44	720	
15	Cucumbers and gherkins	15.74	249	
16	Eggplants	12.34	267	
17	Onions and shallots, green	10.25	221	NDS is an average of onions and shallots
Fruits (Including Vitamin-A Rich)				
1	Strawberries	37.90	311	
2	Lemons and limes	33.79	584	NDS is an average of lemons and limes
3	Grapefruit and pomelos	33.08	453	
4	Cantaloupes and other melons	29.90	154	NDS is an average of varieties; Cantaloupe (ripe) and musk melon considered vitamin-A rich
5	Oranges	28.25	510	
6	Pineapples	25.93	224	
7	Tangerines, mandarins, clementines, satsumas	22.72	597	NDS is an average of tangerines and clementines only
8	Mangoes	21.70	1676	Vitamin-A rich
9	Currants	21.30	477	NDS is an average of varieties
10	Kiwi Fruit	20.51	475	
11	Gooseberries	19.71	495	
12	Raspberries	17.15	346	

(*continued*)

13	Apricots	15.74	1195	Vitamin-A rich
14	Watermelons	13.31	175	
15	Sour cherries	12.25	1312	
16	Grapes	10.45	522	NDS is an average of varieties
17	Dates	1.90	2180	NDS is an average of varieties
18	Cranberries	9.26	199	
19	Peaches and nectarines	8.87	770	NDS is an average of peaches and nectarines
20	Plums	8.65	1758	
21	Blueberries	7.14	675	
22	Avocados	6.35	1087	
23	Coconuts	6.32	2671	NDS includes coconut meat and water
24	Cherries	8.56	1493	
25	Figs	4.69	3049	
26	Apples	3.94	695	
27	Pears	3.66	739	

Appendix B. Nutrient Density Scores

The following nutrient composition data includes corresponding nutrient adequacy and nutrient density scores and energy density for selected crops. The selected crops were chosen based on the availability of the water footprint benchmark. Calculated averages match calculated nutrient density scores (NDSs) to water footprint benchmark data.

Crop Code	Crop Description	Calcium, Ca	Iron, Fe	Zinc, Zn	Vitamin C, total ascorbic acid	Thiamin	Riboflavin	Niacin	Vitamin B-6	Folate, DFE	Vitamin A, RAE	NDS (RNIs per 100 g)	Energy Density (kcal per 100g)	NDS (RNIs per 100 kcal)
20071	WHEAT, HARD RED SPRING	25.00	3.60	2.78	0.00	0.50	0.11	5.71	0.34	43.00	0.00	18.01	329.00	5.47
20072	WHEAT, HARD RED WINTER	29.00	3.19	2.65	0.00	0.38	0.12	5.46	0.30	38.00	0.00	16.16	327.00	4.94
20073	WHEAT, SOFT RED WINTER	27.00	3.21	2.63	0.00	0.39	0.10	4.80	0.27	41.00	0.00	15.54	331.00	4.70
20074	WHEAT, HARD WHITE	32.00	4.56	3.33	0.00	0.39	0.11	4.38	0.37	38.00	0.00	17.62	342.00	5.15
20075	WHEAT, SOFT WHITE	34.00	5.37	3.46	0.00	0.41	0.11	4.77	0.38	41.00	0.00	18.81	340.00	5.53
20076	WHEAT, DURUM	34.00	3.52	4.16	0.00	0.42	0.12	6.74	0.42	43.00	0.00	20.60	339.00	6.08
AVERAGE	**Wheat (Average)**	**31.20**	**3.97**	**3.25**	**0.00**	**0.40**	**0.11**	**5.23**	**0.35**	**40.20**	**0.00**	**17.79**	**335.80**	**5.31**
20088	WILD RICE,RAW	21.00	1.96	5.96	0.00	0.12	0.26	6.73	0.39	95.00	1.00	21.93	357.00	6.14
20036	RICE, BROWN,LONG-GRAIN,RAW	9.00	1.29	2.13	0.00	0.54	0.10	6.49	0.48	23.00	0.00	16.85	367.00	4.59
20040	RICE, BROWN,MEDIUM-GRAIN,RAW	33.00	1.80	2.02	0.00	0.41	0.04	4.31	0.51	20.00	0.00	14.17	362.00	3.91
20044	RICE, WHITE,LONG-GRAIN,REG,RAW,ENR	28.00	4.31	1.09	0.00	0.58	0.05	4.19	0.16	231.00	0.00	18.72	365.00	5.13
20050	RICE, WHITE,MEDIUM-GRAIN,RAW,ENR	9.00	4.36	1.16	0.00	0.58	0.05	5.09	0.15	231.00	0.00	19.11	360.00	5.31
AVERAGE	**Rice (Average)**	**20.00**	**2.74**	**2.47**	**0.00**	**0.44**	**0.10**	**5.36**	**0.34**	**120.00**	**0.20**	**18.16**	**362.20**	**5.02**
20004	BARLEY, HULLED	33.00	3.60	2.77	0.00	0.65	0.29	4.60	0.32	19.00	1.00	19.22	354.00	5.43
20005	BARLEY, PEARLED, RAW	29.00	2.50	2.13	0.00	0.19	0.11	4.60	0.26	23.00	1.00	12.31	352.00	3.50
AVERAGE	**Barley (Average)**	**31.00**	**3.05**	**2.45**	**0.00**	**0.42**	**0.20**	**4.60**	**0.29**	**21.00**	**1.00**	**15.77**	**353.00**	**4.46**
20062	RYE GRAIN	24.00	2.63	2.65	0.00	0.32	0.25	4.27	0.29	38.00	1.00	15.56	338.00	4.60
20038	OATS	54.00	4.72	3.97	0.00	0.76	0.14	0.96	0.12	56.00	0.00	18.87	389.00	4.85
20031	MILLET,RAW	8.00	3.01	1.68	0.00	0.42	0.29	4.72	0.38	85.00	0.00	17.41	378.00	4.60
20067	SORGHUM GRAIN	13.00	3.36	1.67	0.00	0.33	0.10	3.69	0.44	20.00	0.00	13.51	329.00	4.11
20008	BUCKWHEAT	18.00	2.20	2.40	0.00	0.10	0.43	7.02	0.21	30.00	0.00	15.39	343.00	4.49
20069	TRITICALE	37.00	2.57	3.45	0.00	0.42	0.13	1.43	0.14	73.00	0.00	14.76	336.00	4.39
11362	POTATOES,RAW,SKIN	30.00	3.24	0.35	11.40	0.02	0.04	1.03	0.24	17.00	0.00	8.13	58.00	14.03
11352	POTATOES, FLESH & SKN,RAW	12.00	0.81	0.30	19.70	0.08	0.03	1.06	0.30	15.00	0.00	9.29	77.00	12.06
11353	POTATOES, RUSSET,FLESH & SKN,RAW	13.00	0.86	0.29	5.70	0.08	0.03	1.04	0.35	14.00	0.00	6.49	79.00	8.21
11354	POTATOES, WHITE,FLESH & SKN,RAW	9.00	0.52	0.29	9.10	0.07	0.03	1.07	0.20	18.00	0.00	6.12	69.00	8.87
11355	POTATOES,RED,FLESH & SKN,RAW	10.00	0.73	0.33	8.60	0.08	0.03	1.15	0.17	18.00	0.00	6.07	70.00	8.68
AVERAGE	**Potatoes (Average)**	**14.80**	**1.23**	**0.31**	**10.90**	**0.07**	**0.03**	**1.07**	**0.25**	**16.40**	**0.00**	**7.22**	**70.60**	**10.37**
11507	SWEET POTATO,RAW,UNPREP	30.00	0.61	0.30	2.40	0.08	0.06	0.56	0.21	11.00	709.00	14.71	86.00	17.11
11134	CASSAVA,RAW	16.00	0.27	0.34	20.60	0.09	0.05	0.85	0.09	27.00	1.00	8.29	160.00	5.18
11518	TARO,RAW	43.00	0.55	0.23	4.50	0.10	0.03	0.60	0.28	22.00	4.00	5.97	112.00	5.33
11601	YAM,RAW	17.00	0.54	0.24	17.10	0.11	0.03	0.55	0.29	23.00	7.00	8.88	118.00	7.52
11258	MOUNTAIN YAM,HAWAII,RAW	26.00	0.44	0.27	2.60	0.10	0.02	0.48	0.18	14.00	0.00	4.29	67.00	6.40
AVERAGE	**Yams, not including Jicama (Average)**	**21.50**	**0.49**	**0.26**	**9.85**	**0.11**	**0.03**	**0.52**	**0.24**	**18.50**	**3.50**	**6.58**	**92.50**	**6.96**
11080	BEETS,RAW	16.00	0.80	0.35	4.90	0.03	0.04	0.33	0.07	109.00	2.00	6.17	43.00	14.36
16001	BEANS, ADZUKI, MATURE SEEDS,RAW	66.00	4.98	5.04	0.00	0.46	0.22	2.63	0.35	622.00	1.00	29.93	329.00	9.10
16014	BEANS, BLACK, MATURE SEEDS,RAW	123.00	5.02	3.65	0.00	0.90	0.19	1.96	0.29	444.00	0.00	31.15	341.00	9.13
16016	BEANS, BLACK TURTLE, MATURE SEEDS,RAW	160.00	8.70	2.20	0.00	0.90	0.19	1.96	0.29	444.00	0.00	31.34	339.00	9.25
16019	BEANS, CRANBERRY (ROMAN),MATURE SEEDS,RAW	127.00	5.00	3.63	0.00	0.75	0.21	1.46	0.31	604.00	0.00	29.87	335.00	8.92
16022	BEANS, FRENCH,MATURE SEEDS,RAW	186.00	3.40	1.90	4.60	0.54	0.22	2.08	0.40	399.00	0.00	27.46	343.00	8.01

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Crop Code	Crop Description	Calcium, Ca	Iron, Fe	Zinc, Zn	Vitamin C, total ascorbic acid	Thiamin	Riboflavin	Niacin	Vitamin B-6	Folate, DFE	Vitamin A, RAE	NDS (RNIs per 100 g)	Energy Density (kcal per 100g)	NDS (RNIs per 100 kcal)
16024	BEANS, GREAT NORTHERN, MATURE SEEDS,RAW	175.00	5.47	2.31	5.30	0.65	0.24	1.96	0.45	482.00	0.00	30.51	339.00	9.00
16027	BEANS, KIDNEY,ALL TYPES, MATURE SEEDS,RAW	143.00	8.20	2.79	4.50	0.53	0.22	2.06	0.40	394.00	0.00	30.52	333.00	9.17
16030	BEANS, KIDNEY,CALIFORNIA RED,MATURE SEEDS,RAW	195.00	9.35	2.55	4.50	0.53	0.22	2.06	0.40	394.00	0.00	31.29	330.00	9.48
16032	BEANS, KIDNEY,RED,MATURE SEEDS,RAW	83.00	6.69	2.79	4.50	0.61	0.22	2.11	0.40	394.00	0.00	29.80	337.00	8.84
16035	BEANS, KIDNEY,ROYAL RED,MATURE SEEDS,RAW	131.00	8.70	2.66	4.50	0.39	0.24	2.11	0.40	393.00	0.00	29.47	329.00	8.96
16037	BEANS, NAVY,MATURE SEEDS,RAW	147.00	5.49	3.65	0.00	0.78	0.16	2.19	0.43	364.00	0.00	30.55	337.00	9.07
16040	BEANS, PINK,MATURE SEEDS,RAW	130.00	6.77	2.55	0.00	0.77	0.19	1.89	0.53	463.00	0.00	31.04	343.00	9.05
16042	BEANS, PINTO,MATURE SEEDS,RAW	113.00	5.07	2.28	6.30	0.71	0.21	1.17	0.47	525.00	0.00	29.87	347.00	8.61
16045	BEANS,SML WHITE, MATURE SEEDS,RAW	173.00	7.73	2.81	0.00	0.74	0.21	1.34	0.44	386.00	0.00	30.93	336.00	9.20
16047	BEANS,YEL,MATURE SEEDS,RAW	166.00	7.01	2.83	0.00	0.69	0.33	2.43	0.44	389.00	0.00	31.80	345.00	9.22
16049	BEANS, WHITE,MATURE SEEDS,RAW	240.00	10.44	3.67	0.00	0.44	0.15	0.48	0.32	388.00	0.00	29.91	333.00	8.98
16078	MOTHBEANS, MATURE SEEDS,RAW	150.00	10.85	1.92	4.00	0.56	0.09	2.80	0.37	649.00	2.00	30.36	343.00	8.85
16080	MUNG BNS,MATURE SEEDS,RAW	132.00	6.74	2.68	4.80	0.62	0.23	2.25	0.38	625.00	6.00	30.81	347.00	8.88
AVERAGE	**Beans, Only Mature Seeds Not Including Broadbeans (Average)**	**146.67**	**6.98**	**2.88**	**2.39**	**0.64**	**0.21**	**1.94**	**0.39**	**464.39**	**0.50**	**30.37**	**338.11**	**8.98**
16052	BROADBEANS (FAVA BEANS),MATURE SEEDS,RAW	103.00	6.70	3.14	1.40	0.56	0.33	2.83	0.37	423.00	3.00	30.78	341.00	9.03
16085	PEAS,GRN,SPLIT, MATURE SEEDS,RAW	37.00	4.82	3.55	1.80	0.73	0.22	2.89	0.17	274.00	7.00	26.08	352.00	7.41
16056	CHICKPEAS (GARBANZO BNS,BENGAL GM),MATURE SEEDS,RAW	57.00	4.31	2.76	4.00	0.48	0.21	1.54	0.54	557.00	3.00	27.86	378.00	7.37
16060	COWPEAS, CATJANG,MATURE SEEDS,RAW	85.00	9.95	6.11	1.50	0.68	0.17	2.80	0.36	639.00	2.00	36.24	343.00	10.56
16062	COWPEAS, COMMON (BLACKEYES, CROWDER,SOUTHERN),MATURE SEEDS,RAW	110.00	8.27	3.37	1.50	0.85	0.23	2.08	0.36	633.00	3.00	33.13	336.00	9.86
AVERAGE	**Cowpeas (Average)**	**97.50**	**9.11**	**4.74**	**1.50**	**0.77**	**0.20**	**2.44**	**0.36**	**636.00**	**2.50**	**34.68**	**339.50**	**10.21**
16101	PIGEON PEAS (RED GM),MATURE SEEDS,RAW	130.00	5.23	2.76	0.00	0.64	0.19	2.97	0.28	456.00	1.00	28.51	343.00	8.31
16069	LENTILS,RAW	35.00	6.51	3.27	4.50	0.87	0.21	2.61	0.54	479.00	2.00	33.57	352.00	9.54
16144	LENTILS, PINK OR RED,RAW	48.00	7.39	3.60	1.70	0.51	0.11	1.50	0.40	204.00	3.00	23.70	358.00	6.62
AVERAGE	**Lentils (Average)**	**41.50**	**6.95**	**3.44**	**3.10**	**0.69**	**0.16**	**2.05**	**0.47**	**341.50**	**2.50**	**28.63**	**355.00**	**8.08**
16076	LUPINS, MATURE SEEDS,RAW	176.00	4.36	4.75	4.80	0.64	0.22	2.19	0.36	355.00	0.00	31.51	371.00	8.49
12087	NUTS, CASHEW NUTS,RAW	37.00	6.68	5.78	0.50	0.42	0.06	1.06	0.42	25.00	0.00	20.22	553.00	3.66
12093	CHESTNUTS, CHINESE, RAW	18.00	1.41	0.87	36.00	0.16	0.18	0.80	0.41	68.00	10.00	18.13	224.00	8.10
12097	CHESTNUTS, EUROPEAN,RAW, UNPEELED	27.00	1.01	0.52	43.00	0.24	0.17	1.18	0.38	62.00	1.00	19.19	213.00	9.01
12202	CHESTNUTS, JAPANESE,RAW	31.00	1.45	1.10	26.30	0.34	0.16	1.50	0.28	47.00	2.00	16.66	154.00	10.82
AVERAGE	**Chestnuts (Average)**	**25.33**	**1.29**	**0.83**	**35.10**	**0.25**	**0.17**	**1.16**	**0.36**	**59.00**	**4.33**	**18.00**	**197.00**	**9.31**
12061	ALMONDS	269.00	3.71	3.12	0.00	0.21	1.14	3.62	0.14	44.00	0.00	23.80	579.00	4.11
12155	WALNUTS, ENGLISH	98.00	2.91	3.09	1.30	0.34	0.15	1.13	0.54	98.00	1.00	17.95	654.00	2.74
12151	PISTACHIO NUTS,RAW	105.00	3.92	2.20	5.60	0.87	0.16	1.30	1.70	51.00	26.00	28.89	560.00	5.16
12120	HAZELNUTS OR FILBERTS	114.00	4.70	2.45	6.30	0.64	0.11	1.80	0.56	113.00	1.00	22.43	628.00	3.57
16108	SOYBEANS, MATURE SEEDS,RAW	277.00	15.70	4.89	6.00	0.87	0.87	1.62	0.38	375.00	1.00	46.09	446.00	10.33
16087	PEANUTS,ALL TYPES,RAW	92.00	4.58	3.27	0.00	0.64	0.14	12.07	0.35	240.00	0.00	30.19	567.00	5.32
12036	SUNFLOWER SD KRNLS, DRIED	78.00	5.25	5.00	1.40	1.48	0.36	8.34	1.35	227.00	3.00	43.62	584.00	7.47
12021	SAFFLOWER SD KRNLS, DRIED	78.00	4.90	5.05	0.00	1.16	0.42	2.28	1.17	160.00	3.00	36.73	517.00	7.10
12023	SESAME SEEDS, WHOLE,DRIED	975.00	14.55	7.75	0.00	0.79	0.25	4.52	0.79	97.00	0.00	46.26	573.00	8.07
11109	CABBAGE,RAW	40.00	0.47	0.18	36.60	0.06	0.04	0.23	0.12	43.00	5.00	12.06	25.00	48.25
11007	ARTICHOKES, (GLOBE OR FRENCH),RAW	44.00	1.28	0.49	11.70	0.07	0.07	1.05	0.12	68.00	1.00	8.67	47.00	18.44
11011	ASPARAGUS,RAW	24.00	2.14	0.54	5.60	0.14	0.14	0.98	0.09	52.00	38.00	9.42	20.00	47.10
11250	LETTUCE, BUTTERHEAD (INCL BOSTON&BIBB TYPES),RAW	35.00	1.24	0.20	3.70	0.06	0.06	0.36	0.08	73.00	166.00	11.18	13.00	85.98
11251	LETTUCE,COS OR ROMAINE,RAW	33.00	0.97	0.23	4.00	0.07	0.07	0.31	0.07	136.00	436.00	17.25	17.00	100.00
11252	LETTUCE, ICEBERG (INCL CRISPHEAD TYPES),RAW	18.00	0.41	0.15	2.80	0.04	0.03	0.12	0.04	29.00	25.00	3.68	14.00	26.26
11253	LETTUCE,GRN LEAF,RAW	36.00	0.86	0.18	9.20	0.07	0.08	0.38	0.09	38.00	370.00	16.09	15.00	100.00
11257	LETTUCE,RED LEAF,RAW	33.00	1.20	0.20	3.70	0.06	0.08	0.32	0.10	36.00	375.00	14.95	16.00	93.43
AVERAGE	**Lettuce (Average)**	**31.00**	**0.94**	**0.19**	**4.68**	**0.06**	**0.06**	**0.30**	**0.08**	**62.40**	**274.40**	**12.63**	**15.00**	**81.14**
11457	SPINACH,RAW	99.00	2.71	0.53	28.10	0.08	0.19	0.72	0.20	194.0	469.00	28.09	23.00	100.00
11529	TOMATOES,RED,RIPE,RAW,YEAR RND AVERAGE	10.00	0.27	0.17	13.70	0.04	0.02	0.59	0.08	15.00	42.00	6.66	18.00	37.00
11135	CAULIFLOWER,RAW	22.00	0.42	0.27	48.20	0.05	0.06	0.51	0.18	57.00	0.00	14.67	25.00	58.68
11167	CORN,SWT,YEL,RAW	2.00	0.52	0.46	6.80	0.16	0.06	1.77	0.09	42.00	9.00	7.25	86.00	8.43
11422	PUMPKIN,RAW	21.00	0.80	0.32	9.00	0.05	0.11	0.60	0.06	16.00	426.00	15.52	26.00	59.71
11641	SQUASH, SMMR,ALL VAR,RAW	15.00	0.35	0.29	17.00	0.05	0.14	0.49	0.22	29.00	10.00	8.83	16.00	55.19
11643	SQUASH, WNTR,ALL VAR,RAW	28.00	0.58	0.21	12.30	0.03	0.06	0.50	0.16	24.00	68.00	8.56	34.00	25.17

(*continued*)

Crop Code	Crop Description	Calcium, Ca	Iron, Fe	Zinc, Zn	Vitamin C, total ascorbic acid	Thiamin	Riboflavin	Niacin	Vitamin B-6	Folate, DFE	Vitamin A, RAE	NDS (RNIs per 100 g)	Energy Density (kcal per 100g)	NDS (RNIs per 100 kcal)
11218	GOURD,WHITE-FLOWERED (CALABASH),RAW	26.00	0.20	0.70	10.10	0.03	0.02	0.32	0.04	6.00	0.00	4.64	14.00	33.11
11220	GOURD, DISHCLOTH (TOWELGOURD),RAW	20.00	0.36	0.07	12.00	0.05	0.06	0.40	0.04	7.00	0.00	4.74	20.00	23.71
AVERAGE	**Pumpkin, Squash, Gourd (Average)**	**23.00**	**0.28**	**0.39**	**11.05**	**0.04**	**0.04**	**0.36**	**0.04**	**6.50**	**0.00**	**4.69**	**17.00**	**28.41**
11205	CUCUMBER, WITH PEEL,RAW	16.00	0.28	0.20	2.80	0.03	0.03	0.10	0.04	7.00	5.00	2.36	15.00	15.74
11209	EGGPLANT,RAW	9.00	0.23	0.16	2.20	0.04	0.04	0.65	0.08	22.00	1.00	3.08	25.00	12.34
11333	PEPPERS,SWT,GRN, RAW	10.00	0.34	0.13	80.40	0.06	0.03	0.48	0.22	10.00	18.00	13.79	20.00	68.97
11670	PEPPERS,HOT CHILI,GRN,RAW	18.00	1.20	0.30	242.50	0.09	0.09	0.95	0.28	23.00	59.00	17.66	40.00	44.15
AVERAGE	**Peppers, Sweet and Hot, Green (Average)**	**14.00**	**0.77**	**0.22**	**161.45**	**0.07**	**0.06**	**0.72**	**0.25**	**16.50**	**38.50**	**15.73**	**30.00**	**56.56**
11282	ONIONS,RAW	23.00	0.21	0.17	7.40	0.05	0.03	0.12	0.12	19.00	0.00	4.16	40.00	10.41
11677	SHALLOTS,RAW	37.00	1.20	0.40	8.00	0.06	0.02	0.20	0.35	34.00	0.00	7.27	72.00	10.09
AVERAGE	**Onions and Shallots (Average)**	**30.00**	**0.71**	**0.29**	**7.70**	**0.05**	**0.02**	**0.16**	**0.23**	**26.50**	**0.00**	**5.72**	**56.00**	**10.25**
11199	YARDLONG BEAN,RAW	50.00	0.47	0.37	18.80	0.11	0.11	0.41	0.02	62.00	43.00	10.59	47.00	22.52
11052	BEANS, SNAP,GREEN, RAW	37.00	1.03	0.24	12.20	0.08	0.10	0.73	0.14	33.00	35.00	8.83	31.00	28.48
AVERAGE	**Beans, Green (Average)**	**43.50**	**0.75**	**0.31**	**15.50**	**0.09**	**0.11**	**0.57**	**0.08**	**47.50**	**39.00**	**9.71**	**39.00**	**25.50**
11304	PEAS, GREEN,RAW	25.00	1.47	1.24	40.00	0.27	0.13	2.09	0.17	65.00	38.00	20.22	81.00	24.97
11124	CARROTS,RAW	33.00	0.30	0.24	5.90	0.07	0.06	0.98	0.14	19.00	835.00	15.14	41.00	36.94
11278	OKRA,RAW	82.00	0.62	0.58	23.00	0.20	0.06	1.00	0.22	60.00	36.00	13.97	33.00	42.32
9040	BANANAS,RAW	5.00	0.26	0.15	8.70	0.03	0.07	0.67	0.37	20.00	3.00	6.61	89.00	7.43
9277	PLANTAINS,RAW	3.00	0.60	0.14	18.40	0.05	0.05	0.69	0.30	22.00	56.00	10.32	122.00	8.46
9200	ORANGES,RAW,ALL COMM VAR	40.00	0.10	0.07	53.20	0.09	0.04	0.28	0.06	30.00	11.00	13.28	47.00	28.25
9218	TANGERINES, (MANDARIN ORANGES),RAW	37.00	0.15	0.07	26.70	0.06	0.04	0.38	0.08	16.00	34.00	9.53	53.00	17.98
9433	CLEMENTINES,RAW	30.00	0.14	0.06	48.80	0.09	0.03	0.64	0.08	24.00	0.00	12.90	47.00	27.45
AVERAGE	**Tangerine and Clementine (Average)**	**33.50**	**0.15**	**0.07**	**37.75**	**0.07**	**0.03**	**0.51**	**0.08**	**20.00**	**17.00**	**11.22**	**50.00**	**22.72**
9150	LEMONS,RAW, WITHOUT PEEL	26.00	0.60	0.06	53.00	0.04	0.02	0.10	0.08	11.00	1.00	12.05	29.00	41.54
9156	LEMON PEEL,RAW	134.00	0.80	0.25	129.00	0.06	0.08	0.40	0.17	13.00	3.00	15.05	47.00	32.01
9159	LIMES,RAW	33.00	0.60	0.11	29.10	0.03	0.02	0.20	0.04	8.00	2.00	8.35	30.00	27.82
AVERAGE	**Lemons and Limes (Average)**	**64.33**	**0.67**	**0.14**	**70.37**	**0.04**	**0.04**	**0.23**	**0.10**	**10.67**	**2.00**	**11.81**	**35.33**	**33.79**
9111	GRAPEFRUIT,RAW,PINK&RED&WHITE,ALL AREAS	12.00	0.09	0.07	34.40	0.04	0.02	0.25	0.04	10.00	46.00	10.58	32.00	33.08
9003	APPLES,RAW,WITH SKIN	6.00	0.12	0.04	4.60	0.02	0.03	0.09	0.04	3.00	3.00	2.05	52.00	3.94
9252	PEARS,RAW	9.00	0.18	0.10	4.30	0.01	0.03	0.16	0.03	7.00	1.00	2.08	57.00	3.66
9021	APRICOTS,RAW	13.00	0.39	0.20	10.00	0.03	0.04	0.60	0.05	9.00	96.00	7.56	48.00	15.74
9063	CHERRIES, SOUR,RED, RAW	16.00	0.32	0.10	10.00	0.03	0.04	0.40	0.04	8.00	64.00	6.12	50.00	12.25
9070	CHERRIES, SWEET,RAW	13.00	0.36	0.07	7.00	0.03	0.03	0.15	0.05	4.00	3.00	3.07	63.00	4.88
AVERAGE	**Cherries (Average)**	**14.50**	**0.34**	**0.09**	**8.50**	**0.03**	**0.04**	**0.28**	**0.05**	**6.00**	**33.50**	**4.60**	**56.50**	**8.56**
9236	PEACHES,YEL,RAW	6.00	0.25	0.17	6.60	0.02	0.03	0.81	0.03	4.00	16.00	3.64	39.00	9.33
9191	NECTARINES,RAW	6.00	0.28	0.17	5.40	0.03	0.03	1.13	0.03	5.00	17.00	3.70	44.00	8.41
AVERAGE	**Peaches and Nectarines (Average)**	**6.00**	**0.27**	**0.17**	**6.00**	**0.03**	**0.03**	**0.97**	**0.03**	**4.50**	**16.50**	**3.67**	**41.50**	**8.87**
9279	PLUMS,RAW	6.00	0.17	0.10	9.50	0.03	0.03	0.42	0.03	5.00	17.00	3.98	46.00	8.65
9316	STRAWBERRIES,RAW	16.00	0.41	0.14	58.80	0.02	0.02	0.39	0.05	24.00	1.00	12.13	32.00	37.90
9302	RASPBERRIES,RAW	25.00	0.69	0.42	26.20	0.03	0.04	0.60	0.06	21.00	2.00	8.92	52.00	17.15
9107	GOOSEBERRIES,RAW	25.00	0.31	0.12	27.70	0.04	0.03	0.30	0.08	6.00	15.00	8.67	44.00	19.71
9083	CURRANTS, EUROPEAN BLACK,RAW	55.00	1.54	0.27	181.00	0.05	0.05	0.30	0.07	0.00	12.00	13.56	63.00	21.52
9084	CURRANTS,RED& WHITE,RAW	33.00	1.00	0.23	41.00	0.04	0.05	0.10	0.07	8.00	2.00	11.80	56.00	21.07
AVERAGE	**Currants (Average)**	**44.00**	**1.27**	**0.25**	**111.00**	**0.05**	**0.05**	**0.20**	**0.07**	**4.00**	**7.00**	**12.68**	**59.50**	**21.30**
9050	BLUEBERRIES,RAW	6.00	0.28	0.16	9.70	0.04	0.04	0.42	0.05	6.00	3.00	4.07	57.00	7.14
9078	CRANBERRIES,RAW	8.00	0.23	0.09	14.00	0.01	0.02	0.10	0.06	1.00	3.00	4.26	46.00	9.26
9129	Grapes, muscadine, raw	37.00	0.26	0.11	6.50	0.00	1.50	0.00	0.00	2.00	3.00	12.26	57.00	21.50
9131	GRAPES, AMERICAN TYPE (SLIP SKN),RAW	14.00	0.29	0.04	4.00	0.09	0.06	0.30	0.11	4.00	5.00	3.63	67.00	5.42
9132	GRAPES,RED OR GRN (EURO TYPE, SUCH AS THOMPSON SEEDLESS),RAW	10.00	0.36	0.07	3.20	0.07	0.07	0.19	0.09	2.00	3.00	3.05	69.00	4.42
AVERAGE	**Grapes (Average)**	**20.33**	**0.30**	**0.07**	**4.57**	**0.05**	**0.54**	**0.16**	**0.07**	**2.67**	**3.67**	**6.31**	**64.33**	**10.45**
9326	WATERMELON,RAW	7.00	0.24	0.10	8.10	0.03	0.02	0.18	0.05	3.00	28.00	3.99	30.00	13.31
9181	MELONS, CANTALOUPE, RAW	9.00	0.21	0.18	36.70	0.04	0.02	0.73	0.07	21.00	169.00	16.20	34.00	47.63
9183	MELONS, CASABA,RAW	11.00	0.34	0.07	21.80	0.02	0.03	0.23	0.16	8.00	0.00	7.02	28.00	25.09
9184	MELONS, HONEYDEW, RAW	6.00	0.17	0.09	18.00	0.04	0.01	0.42	0.09	19.00	3.00	6.11	36.00	16.97
AVERAGE	**Melons (Average)**	**8.67**	**0.24**	**0.11**	**25.50**	**0.03**	**0.02**	**0.46**	**0.11**	**16.00**	**57.33**	**9.78**	**32.67**	**29.90**
9089	FIGS,RAW	35.00	0.37	0.15	2.00	0.06	0.05	0.40	0.11	6.00	7.00	3.47	74.00	4.69
9176	MANGOS,RAW	11.00	0.16	0.09	36.40	0.03	0.04	0.67	0.12	43.00	54.00	13.02	60.00	21.70
9037	AVOCADOS,RAW,ALL COMM VAR	12.00	0.55	0.64	10.00	0.07	0.13	1.74	0.26	81.00	7.00	10.16	160.00	6.35
9266	PINEAPPLE,RAW,ALL VAR	13.00	0.29	0.12	47.80	0.08	0.03	0.50	0.11	18.00	3.00	12.96	50.00	25.93
9421	DATES, MEDJOOL	64.00	0.90	0.44	0.00	0.05	0.06	1.61	0.25	15.00	7.00	5.89	277.00	2.12
9087	DATES, DEGLET NOOR	39.00	1.02	0.29	0.40	0.05	0.07	1.27	0.17	19.00	0.00	4.73	282.00	1.68

(*continued on next page*)

(*continued*)

Crop Code	Crop Description	Calcium, Ca	Iron, Fe	Zinc, Zn	Vitamin C, total ascorbic acid	Thiamin	Riboflavin	Niacin	Vitamin B-6	Folate, DFE	Vitamin A, RAE	NDS (RNIs per 100 g)	Energy Density (kcal per 100g)	NDS (RNIs per 100 kcal)
AVERAGE	**Dates (Average)**	**38.67**	**0.74**	**0.28**	**16.07**	**0.06**	**0.05**	**1.13**	**0.18**	**17.33**	**3.33**	**5.31**	**203.00**	**1.90**
9148	KIWIFRUIT,GRN,RAW	34.00	0.31	0.14	92.70	0.03	0.03	0.34	0.06	25.00	4.00	12.51	61.00	20.51
12104	COCONUT MEAT,RAW	14.00	2.43	1.10	3.30	0.07	0.02	0.54	0.05	26.00	0.00	5.75	354.00	1.62
12119	COCONUT H2O (LIQ FROM COCONUTS)	24.00	0.29	0.10	2.40	0.03	0.06	0.08	0.03	3.00	0.00	2.09	19.00	11.01
AVERAGE	**Coconuts, Meat and H20 (Average)**	**19.00**	**1.36**	**0.60**	**2.85**	**0.05**	**0.04**	**0.31**	**0.04**	**14.50**	**0.00**	**3.92**	**186.50**	**6.32**

Appendix C. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2019.03.056.

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