Food and sustainability: the water footprint assessment of the menus served in a university restaurant

Alimentação e sustentabilidade: avaliação da pegada hídrica em cardápios de um restaurante institucional

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ABSTRACT

The current agro-food system requires an intense exploitation of natural resources. “Sustainable diets” proposes a production model that considers both health and the preservation of natural resources. Given that university restaurants consume significant amounts of food in virtue of meal preparation, the use of indicators such as the Water Footprint (WF) is a vital tool for assessing the use of natural assets across these locals. This study aims to analyse the relationship between WP and the sustainability of the menus served in the Federal Institute of Piauí (IFPI), *São João do Piauí campus* restaurant. This is a quantitative, cross-sectional research which points out that animal-based foods, especially beef, present a high level of WF. In addition, the lack of vegetarian options on the menus was observed. These findings indicate the need to reformulate the menus under analysis so that they are more in line with the principles underlying sustainability.

Keywords: Agro-food System. Sustainability. Water footprint. Menus.

RESUMO

O atual sistema agroalimentar tem exigido uma intensa exploração dos recursos naturais. O conceito de "dietas sustentáveis" propõe um modelo de produção que considera não só a saúde como também a preservação dos recursos naturais. Considerando que os restaurantes institucionais utilizam quantidades significativas de alimentos para a produção de refeições, a Pegada Hídrica (PH) se torna uma ferramenta crucial para avaliar o uso dos recursos naturais nesses espaços. Com efeito, este estudo busca analisar a relação entre a PH e a sustentabilidade dos cardápios elaborados pelo restaurante institucional do Instituto Federal do Piauí, campus São João do Piauí. Trata-se de um estudo do tipo quantitativo, de análise transversal, por meio do qual se constatou que os produtos de origem animal, sobretudo a carne bovina, produzem elevadas quantidades de PH. Não obstante, verificou-se, ainda, *que não há opções de pratos vegetarianos nos cardápios. Esses achados indicam a necessidade de reformulação dos cardápios, de modo a estarem mais alinhados aos princípios da sustentabilidade.*

Palavras-chave: *Sistema Agroalimentar. Sustentabilidade. Pegada hídrica. Cardápios.*

1 INTRODUCTION

Contemporary societies have undergone significant changes that can be illustrated, but are not limited to, by substantive ways of producing and eating food. To earn a highly profitable amount of amenable productive resources, the agri-food system has applied innovative technologies favouring its efficiency on the supply side at the expense of negative outcomes on natural resources. This raises tricky questions about how to improve such a system in a distinctive manner (Lima; Paião; Triches, 2023).

In our current picture, a key aspect of food production stands out for its highly effortful consumption—not to mention striking environmental repercussions and the requirement to expand the area under production (Martinelli; Cavalli, 2019)—which raises growing concerns about the environment. Thus, the issue of sustainability has been discussed more and more, especially the one known as "sustainable diets."

This conceptual notion was first introduced in 1986 by Gussow and Clancy (Gussow; Clancy, 1986). They are based on discussions about guiding consumers to make food choices that favour their health and actually bring about natural capital maintenance. For Lang (2015), sustainable diets appeared as an alternative livelihood to traditional agri-food systems, where most production is clearly focused on generating food that meets consumption demands at the expense of its healthy features. In that respect, dietary habits and preferences are shifting over time, as can be exemplified by the rise of food away from home.

In rough terms, the "food away from home" phenomenon is driven at least in part by facts that have to do with fast urbanisation or the search for convenience (Queiroz; Coelho, 2017). In response to this expanding demand, there has been a notable growth of eating-out venues (commercial and\or institutional ones) designed to improve both food facilities and food production. The assumption is that those places (or, in this work's case, an institutional restaurant) form an interesting kind – a kind of activity or subject matter as local particularities (or maybe all two at once). The tempting idea of there being *some* sort of interesting, well-founded food procurement is a working hypothesis.

Broadly, institutional restaurants (IRs) stand out by providing a large number of meals to their clients daily, demanding the consumption of substantial quantities of food. Those establishments are commonly viewed as a means of recognising and addressing food safety tenets in their surroundings, to mention healthier eating practices, including food sustainability (Brasil, 2006). To such a degree, several polls have pointed out the prominent role played by IRs in encouraging, for instance, behaviours inclined to the consumption of environmentally friendly foods.

Given the complex relationship (shaped by tensions) that exists between human activity vis-à-vis natural assets, sustainability indicators, such as the water footprint devised in 2002 by Hoekstra and Hung, have been used to quantify the total amount of water used throughout the entire production process concerning goods and services (Hoekstra; Hung, 2002). Water footprint (WF hereafter) has been a remarkable device for estimating environmental pressures conflated with problems related to people's dietary patterns. Thus, the WF estimation tied to IR's menus may contribute to pursuing an effective food policy agenda committed to reducing food consumption's negative impact on the environment. In addition, this tool is crucial to providing enlightened advances to the current IR management strategies.

The previous literature has examined the WF level on menus of many distinct local dietary intakes (Hatjiathanassiadou *et al*., 2019; Kilian; Triches; Ruiz, 2021; Lima *et al*., 2023; Strasburg *et al*., 2021;

Strasburg *et al*., 2023). It recognises a couple of proposed improvements concerning food item choice, mainly the one related to the protein consumed, including those points necessary to make nutritional adequacy and food safety, and broadening the research scope along further implications, qualifying determinants, and more complex theoretical discussion. That said, for the purposes of this work, we follow these recommendations, as our hope is that they will help shape and promote what we take to be an important and underexplored part of the issue under analysis.

In what follows, we will deal with the IR at the Federal Institute of Piauí (IFPI), São João do Piauí campus, in Brazil, where food is served to 220 students daily by using around two tons of food per month. Considering the large number of meals prepared, the potential significant environmental impact of the activity becomes uncontroversial. Then, this work aims to assess the WF concerned with the food consumed in the on-IFPI's *São João do Piauí* restaurant.

1.1 LITERATURE REVIEW

1.1.1 AGRO-FOOD SYSTEMS AND SUSTAINABLE DEVELOPMENT

As a result of the pernicious actions caused to natural resources by the agri-food system throughout the twentieth century and their painful social impacts, the United Nations held two conferences, in 1972 and 1982, from which the concept of sustainable development emerged. In 1987, its definition appeared in the Brundtland Report (Carmo, 2023) as follows: "development that seeks to meet the needs and aspirations of the present without compromising the possibility of meeting them in the future" (CMMAD, 1988, p. 44). Despite its relative vagueness, this definition unequivocally expresses a critical view of the development model previously devised. It overtly reinforces that economic and social progress cannot be based on the wildly off exploitation of natural resources (Ipiranga; Godoy; Brunstein, 2011).

However, it is worth highlighting that the current enlightened notion of sustainable development did not come from the Brundtland Report but stemmed from an early thought called "eco-development" long before disseminated by the Polish economist Ignacy Sachs. Eco-development means "endogenous development, driven by its own capacities, aiming at reconciling social and economic goals with an ecologically prudent resources management and the environment" (Montibeller-Filho, 1993).

Although the labelled sustainable development has represented a great conceptual leap, it nevertheless remains conceptually very wide, shifting constantly in perspective – its standard definition is nonetheless acknowledged in the Brundtland Report of the World Commission on Environment and Development (CMMAD, 1988). As conceived in it, sustainable development is a kind of embedding notion, as it is properly understood in terms of social, political, and cultural aspects, whose interrelated knowledge from one another is, in turn, crucial to mitigate the deleterious effects due to the overall human activities on natural resources (Barbieri, 2005).

Then, the challenge has traditionally centred on how to integrate successfully part of a progressive social vision towards nature preservation (Matias; Pinheiro, 2008). This ambivalence makes the point that we cannot meaningfully account for the issue *per si* unless we consider its underlying economic, social, and environmental dimensions. That suggests that a satisfying account will require a three-dimensional approach (at least) in line with the triple bottom line, as Elkington called it in his 1997 paper. In summary, the conditions present in the local, national – and even global economies that create a social scene dominated by consumer habits, practices and preferences – are conditions that profoundly influence the ways in which societies come to understand their commodity consumption (Dias; Silva; Gold, 2023). The implication is that, in practice, sustainability can be grounded in many ways, but not apart from the political and economic context and the productive milieu.

When running together food and sustainability, this setting up oftentimes different aspects along all production cycle, including the sale-supply and advertising of a product. In a nutshell, the sustainability notion is found to be pervasive in agri-food systems driven by policies and plans. Within that confine, food sustainability gets an undeniable cross-sectorial flavour. The ongoing loss of affordable and sustainable food environments was due to the so-called “Green Revolution”. In objection to the previous sub-optimal food system, it aimed to posit on principled grounds an agri-food model that could mitigate, as much as possible, world hunger via record harvests. And yet, this purpose would be achieved by strengthening the mechanisation of intensive agriculture, for example, allowing an extensive array of fertilisers, agrochemicals, and modified seeds (Fraga *et al*., 2022).

Liberal uses of biological and chemical farming methods have lowered the nutrient profiles of certain foods (Torrens, 2020), leading to serious health problems. Ribeiro, Jaime, and Ventura (2017) argue that persistent use of fertilisers and chemical pesticides is responsible for watercourse and soil contaminations and has affected biodiversity.

Furthermore, a word must be said about the process tied to the modernisation of agriculture, which has brought about the most in-depth change in the Brazilian rural setting. In particular, the effect of this has been to marginalise the small farmers since they are undoubtedly unable to take on the ‘novelties’ that came from this trend. The small farmers’ marginalisation had, in turn, a twofold impact: first, it caused an intense rural exodus; second, it made worse social inequalities (Fraga *et al*., 2022; Pessetti, 2021).

That said, it turns out that the model based on mechanisation is said to have several adverse consequences for the environment and public health, in addition to not fulfilling the goal of eradicating hunger. Since then, there has been a continued plea to devise another agri-food system equipped with both a sustainability agenda and nature preservation. Along these lines, in 1986, Gussow and Clancy introduced the term “sustainable diets” to mean dietary choices not just concerned with health but with placing the traditional food system in environmental sustainability roles (Gussow; Clancy, 1986). Its updated definition, such as we know it currently, was made up in 2010 by the Food and Agriculture Organization of the United Nations in the following terms:

Sustainable Diets are those diets with low environmental impacts which contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimising natural and human resources (FAO, 2010, p. 7).

Marchioni, Carvalho and Villar (2021) took sustainable diets to be a promising answer to the worrying implications attached to food consumption patterns currently in evidence while putting nutrition into perspective, allowing the preservation of natural resources plus the consequent quality of local people’s daily life. The food consumption pattern enormously influences the food-based dietary guidelines we follow. In other words, people's food decisions quickly impact modern food production, so the rise of sustainable food demands can remodel the entire food value chain, promptly reducing environmental impacts caused by traditional food systems (Martinelli; Cavalli, 2019).

1.1.2 FOOD AND NUTRITION SECURITY AND SUSTAINABILITY

It is well recognised that the label “Food and Nutrition Security” (FNS) expresses *prima facie* a fundamental human right. Granted, it is by itself one of the greatest challenges faced by contemporary societies, so in recent years, there have been warming debates built upon how to properly guarantee FNS for all people around the world while at the same time safeguarding the environment.

For some, food practices set up a long, not linear, and complex way from soil to the dining room, in which various factors mixed with sustainability need to be continuously (re)evaluated (Ribeiro; Jaime; Ventura, 2017). Food, food security, and sustainability are notions strongly intertwined; thereby, they must be addressed in an integrated way, i.e., without leaving relevant elements from different domains outside the scope. Incidentally, as expressed by Organic Law 11.346, in its third article, FNS intends to single out:

> The right of all to regular and permanent access to good quality food, in enough quantity, without compromising access to other essential needs, based on health-promoting food practices that respect cultural diversity and are environmentally, culturally, economically and socially sustainable (Brasil, 2006).

By catching a glimpse at the passage above, we note the explanatory value of FNS to the food sustainability issue (Rahal; Gentil; Magalhães, 2020). Everyone's diet impacts both the environment and healthfulness: on the one hand, people's dietary intakes have a direct influence on public health, as do indirectly; their excesses have the potential to impact natural assets on the other hand. Consequently, there has been the need to rethink\reorient certain common procedures since the traditional food system has not been primarily designed to take seriously all "food practices that respect cultural diversity and are environmentally, culturally, economically and socially sustainable".

Given their prices are not inflated, Triches (2020) pointed out that insofar as ultra-processed food products have become habitually accessible to all kinds of consumers, even to disadvantaged ones, this contemporary product consumption has been viewed as creating false needs: it effectively replaced form for substance, and pushed persons into illusory satisfactions, while present to some degree, avoiding them to enjoy amenable products instead of pathological ones. It also claimed as well that that all-too-common situation misrepresents the social impact and genesis of the willpower to acquire mass-produced items even at the cost of someone else's health and\or well-being, shaping misperceptions about the epidemic rates of diet-related chronic not-so-subtle (non-communicable) diseases.

In virtue of these worsening problems and the like, Marchioni, Carvalho, and Villar (2021) observed that the tangle of pathology does not take place in a vacuum but rather in a disorganised material world where other processes, carried from without as well as experienced from within, are equally at work. The authors also argue that instruments are needed to indicate whether we are on the right track or away from the context-defined sustainability goals. At present, devised by the Ministry of Health, Brazil has the official food-based dietary guidelines, named Brazilian Food Guide, a document which sets targets and drives policy for sustainability by giving attention to FNS, including ecological footprint (Brasil, 2014).

1.1.3 WATER FOOTPRINT

According to the United Nations Food and Agriculture Fund (FAO), agriculture and livestock are the economic sectors that consume the most freshwater worldwide, around 70% of total water consumption (FAO, 2020). As water plays a key role in practically every economic activity, its high and increased usage will contribute to further demand for this limited resource by different sectors. The significance of assessing the WF of food processes, attached to a wide range of activities, lies (i) in its particular capability to afford a helpful grasp into the environmental impact of the IR's, (ii) while allowing their food processors to identify water wasted at each stage, and optimise their WF (Carmo *et al*., 2007; Montoya, 2020).

Framed by Hoekstra and Hung during the Internation Expert Meeting on Virtual Water Trade at the end of 2002 in the Netherlands, the very idea behind the WF can be grasped from the fact that "producing goods and services generally requires water. The water used in the production process of an agricultural or industrial product is called the 'virtual water' contained in the product" (Hoekstra; Hung, 2002, p.

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13). To wrap up that presentation, here are a couple of final observations about the WF devising: it is traced back to “embedded water”, as Allan (1988) came to call it in the early nineties; the food-water nexus means that when operating substantial changes in populace consumption this can reduce water demand as well (Strasburg; Jahno, 2015).

1.1.4 INSTITUTIONAL/UNIVERSITY RESTAURANTS

Viewed as an important means to offer healthy meals, university restaurants were specifically designed to support all students’ needs in relation to their nutritional adequacy patterns, allowing them to develop their knowledge and skills (Paula; Bifano, 2019). In the most generalised sense, those establishments can be understood as satisfiers and enablers of students' fundamental needs of permanence. Within those places students are pushed into thinking on diets unconstrained by the one-dimensional understanding of nutritional adequacy, but to that of personal and environmental well-being, incorporating aspect of food literacy and environmental sustainability. In summary, it is worth noting that most university restaurants produce a large amount of meals. Consequently, this inevitably requires greater volumes of food, so as more food to care about, more water to be used. For this reason, it is crucial to assess the WF thereof.

2 METHODOLOGY

This is a cross-sectional study conducted on quantitative terms in the on-IFPI’s *São João do Piauí* restaurant. After the Institutional Authorization signature, the quantitative sample included lunch menus served to the average consumption of 220 students throughout November 2023. Twenty diversified menus were identified. The campus dining staff provided the composition and per capita values of each food category by means of technical preparation sheets.

2.1 WF MEASURE

The WF of meals was calculated by means of the following equation:

$$WFn = \Sigma(WF\mathit{i} \times \mathit{qi})/100$$

Where:
WFn: WF of meal n\liters;
WFi: WF of food i\water liters per 100g of food;
qi: quantity of food i served per meal\g;
Note: n runs from 1 to 20 (20 menus as the total amount)

The WF of meals derives from the WF sum of all foods involved in the menu of the day. This value comes in multiplying WFi of each food product by its amount consumed. Our WFi has been inspired by Garzillo 2019 joint paper, who provided originally the WF values of an array of foods and culinary options consumed in Brazil – expressed in liters\water sufficient to produce 100g of each food, as can be checked on https://osf.io/gs4cy/, where data are designed-table available in Microsoft® Excel format.

2.2 AVERAGE WF OF MEALS

The average WF of meals derived from the following equation:

$$WF_M = \Sigma\, WF_n/n$$

Such as:
WF_M: average WF of meals\liters;
WF_n: WF of meals;
Note: n = 20 (20 meals as the total amount)

2.3 THE BEARINGS ON THE MEAT GROUP ON THE WF

The contribution (%) of the meat group on the WF of a meal is figured out by considering the following equation:

$$\%\ WF\ carne = \frac{WF_n - WF(S+DM+A+D)}{WF_n} \times 100$$

Where:
WF_n: WF of meal n\liters;
WF (S+DM+A+D): salad, main dish, accompaniments, dessert\liters.

2.4 WF – SAMPLED GROUPS

As a way of reporting the kind of protein that most contributed to total WF, protein-based foods weekly served in the on-IFPI's *São João do Piauí* restaurant were classified into 3 groups: chicken meat (G1), beef (G2), pork (G3) – G1 and G2 are offered twice a week, while G3 once. G2 components include lizard, duckling, soft drumstick, rump, ground muscle, and liver; G1 ones cover thigh and thigh-breast; G3 contemplates ham, steak, ribs, and loin.

2.5 STATISTICAL ANALYSIS

The WF tied to G1, G2 and G3 will be analysed by means of the PAST software. Shapiro-Wilk test will be applied to verify data normality under $p < 0.05$. A non-parametric Mann-Whitney test was taken to compare the average water footprint of those menus ($p < 0.05$ significance level chosen).

3 RESULTS AND DISCUSSION

The lunch menus daily offered to students in the on-IFPI's *São João do Piauí* restaurant run in the following terms: entrees (raw or cooked salad); main dishes (chicken meat, beef, and pork variations portioned by a local staff member); base dishes (rice and beans); accompaniments (tubers, vegetables and pasta), and an over-table (fruit). The sampled groups under analysis revealed to have shaped significantly different average of WF ($p < 0.05$).

Table 1 – Mann-Whitney test (p – values)

Groups	*G1*	*G2*	*G3*
Chicken meat (G1)		0,000891	0,0078
Beef (G2)	0,000891		0,008022
Pork (G3)	0,0078	0,008022	

Source: Work by authors (2024).

Table 2 summarises that the menus analysed present an average consumption of 2,969.67 litres of water per person. This result is similar to other studies that have considered the WF of omnivorous meals (Hatjiathanassiadou *et al*., 2019; Kilian; Triches; Ruiz, 2021; Lima; Paião; Triches, 2023).

Table 2 – WF of menus

Day	*WF of meal*	*WF (S+DM+A+D)*	WF of protein	%WF of meat
1	1681,89	477,15	1204,74	71,63
2	3211,02	568,45	2642,57	82,30
3	3023,92	625,86	2398,06	79,30
4	1532,00	499,72	1032,28	67,38
5	5073,63	493,16	4580,46	90,28
6	1263,64	508,16	755,48	59,79
7	5243,73	441,92	4801,81	91,57
8	2610,11	571,76	2038,35	78,09
9	1758,85	526,84	1232,01	70,05
10	3933,08	486,29	3446,78	87,64
11	5241,36	543,63	4697,73	89,63
12	1838,33	633,59	1204,74	65,53
13	2843,04	444,98	2398,06	84,35
14	4661,83	467,14	4194,69	89,98
15	1267,96	512,48	755,48	59,58
16	1472,17	439,89	1032,28	70,12
17	3246,42	603,86	2642,57	81,40
18	2662,45	624,09	2038,35	76,56
19	1767,41	535,41	1232,01	69,71
20	5060,65	480,18	4580,46	90,51
TOTAL	59393,48	10484,59	48908,89	
Average	2969,67	524,23	2445,44	77,77
Deviation	1437,57	62,54	1450,00	10,54

WF (S+DM+A+D): WF of salad, main dish, accompaniments, dessert\liters.

Source: Work by authors (2024).

Table 3 refers to the average weight of the meal by using the preparation technical sheets, along with the per capita values of each item used. It also shows that animal-based food comprises only 20.9% of the global weight of meal, nonetheless, on average, it counts 77.7% of global WF of the meal (as shown in Table 2). Ferraz *et al*. (2020) took animal-based foods to be the ones among an array of food production systems with the lowest sustainability level, besides their high consumption of energy and water throughout the production.

Table 3 – Bearings on the origin of foodstuff purchased to compose the menus *(grams per capita)*

Day	*Meal weight*	*Animal-based food weight*	Plant-based food weightn
1	970	185	785
2	780	170	610
3	850	200	650
4	815	160	655
5	745	170	575
6	905	170	735
7	795	160	635
8	830	170	660
9	825	190	635
10	720	170	550
11	885	100	785
12	820	185	635
13	810	200	610
14	770	160	610
15	765	170	595
16	920	160	760
17	760	170	590
18	785	170	615
19	850	190	660
20	730	170	560
Average weight of meal	816,5		
Average weight of animal-based food	171		
Average weight of plant-based food	645,5		

Source: Work by authors (2024).

When comparing the sampled groups, G2 gets the highest average of WF (4,458.96 l), followed by G3 (2,784.88 l) and G1 (1,572.78 l). In other words, G2 is 2.83 times higher than G1 and 1.6 times higher than G3 (Table 4).

Table 4 – WF per group

Day	*WF of meal*	*WF (S+DM+A+D)*	WF of protein	%WF of meat
		G1\liters		
1	1681,89	477,15	1204,74	71,63
4	1532,00	499,72	1032,28	67,38
6	1263,64	508,16	755,48	59,79
9	1758,85	526,84	1232,01	70,05

Day	WF of meal	WF (S+DM+A+D)	WF of protein	%WF of meat
12	1838,33	633,59	1204,74	65,53
15	1267,96	512,48	755,48	59,58
16	1472,17	439,89	1032,28	70,12
19	1767,41	535,41	1232,01	69,71
Average	*1572,78*	*516,66*	*1056,13*	*66,72*
Deviation	*225,26*	*56,01*	*202,82*	*4,73*
		G2\liters		
2	3211,02	568,45	2642,57	82,30
5	5073,63	493,16	4580,46	90,28
7	5243,73	441,92	4801,81	91,57
10	3933,08	486,29	3446,78	87,64
11	5241,36	543,63	4697,73	89,63
14	4661,83	467,14	4194,69	89,98
17	3246,42	603,86	2642,57	81,40
20	5060,65	480,18	4580,46	90,51
Average	*4458,96*	*510,58*	*3948,38*	*87,91*
Deviation	*871,22*	*55,50*	*911,16*	*3,91*
		G3\liters		
3	3023,92	625,86	2398,06	79,30
8	2610,11	571,76	2038,35	78,09
13	2843,04	444,98	2398,06	84,35
18	2662,45	624,09	2038,35	76,56
Average	*2784,88*	*566,67*	*2218,21*	*79,58*
Deviation	*188,02*	*84,92*	*207,68*	*3,37*

Source: Work by authors (2024).

The current work is in line with several studies, including a comprehensive global study on the WF related to animal-based foods and their derivations carried out by Mekonnen and Hoekstra (2012). On average, the ongoing increase of WF as for meat runs in the following bottom-up way: from chicken meat (4,300 l/kg), goat meat (5,521 l/kg), pork (6,000 l/kg) and sheep meat (10,412 l/kg) to beef (15,400 l/kg). Those differences can be partially explained by considering the production process of feed consumed by the animals, around 98% of global WF – bovine average consumption of feed (1,300 kg) and fodder (7,200 kg); porcine average consumption of feed (385 kg), while chicken consumes 3.3 kg of feed (Ferraz *et al*., 2020).

Given the feed conversion, i.e, the effective way in which the animal converts feed into meat, it is reasonably expected that bovine meat to show the highest impact in terms of WF, since bovine meat production requires 8 times more feed per kg when compared to porcine meat, and 11 times in relation to chicken meat (Mekonnen; Hoekstra, 2012). Thus, we can infer that changing eating behaviours by seeking alternative sources of protein other than beef offers the potential to positively impact both food security and environmental sustainability. However, the first to say is that there is an element of deception in this scenario, making things look simpler than they really are: Brazil is an international player beef supplier, and even possible advances in terms of sustainability seem to be at present unthinkable at expense of Brazilian export opportunities (Garzillo *et al*., 2022).

With respect the menus, there is no vegetarian option within the university restaurant at IFPI. The existing literature shows that in relation to WF, lower environmental impacts are found in the plant-based dietary profile. Alves (2022) observed that omnivorous menus had a WF 2.85 times higher than vegetarian ones. This is in line with Hatjiathanassiadou 2019 joint paper, as the authors highlighted that the presence of meat renders a WF value 2.47 times higher. Similarly, in Kilian, Triches and Ruiz (2021) study, the water demand was low vis-à-vis a plant-based menu as opposed to animal-based one.

In fact, the menus prepared in the restaurant are not so different from those found in the literature. Still, they can be improved in terms of sustainability. As an average of 220 meals are daily offered, therefore, it is estimated that to execute its daily menu one needs about 653,327.40 liters of water. However, given that the WF of a vegetarian menu is, on average, 3 times lower than an omnivorous one (Alves, 2022; Lima; Paião, Triches, 2023), then the inclusion, in just one day, of plant-based food would represent a reduction of 435,551.6 litres of water.

The benefits associated to the reduction of meat out of the diets are relatively consensual among scholars. Even so, it is worth carefully evaluating this move. Although the specialised literature adopted here has shown that plant-based dietary patterns do not cause protein deficit by combining foods with different amino acids, vegetarian menus have a low amount of vitamin B12 compared to omnivorous menus (Lima; Paião; Triches, 2023). B12 is an essential cofactor for several metabolic processes, so its deficiency can origin injurious health conditions, such as megaloblastic anaemia and neuropathy (Moreira, 2023), which is why vegetarian menus should receive B12 supplementation (Fernandes *et al*., 2024). In view of this, for the recommendations to reduce meat consumption to be consistent with the goals of mitigating environmental impacts, nutritional labelling should not be neglected in any way, so it is essential to observe the nutritional quality of food in the face of the composition of environmentally sustainable diets.

Obviously, the findings tied to the present work were not limited to pointing out the nutritional aspects of the menus nor the magnitude of their water footprint. On the contrary, the findings even highlighted the role both played by State and public policies upon the process of building a sustainable society. In fact, the State’s responsibility goes beyond the mere affordance of policies, norms and regulations aimed at managing natural resources. Rather, its ability encompasses the integration of environmental protection strategies into its institutional practices while implementing educational-environmental awareness actions.

In this regard, launched in 1999 and elaborated by the Ministry of Environment, the Environmental Agenda for Public Administration (A3P in Portuguese) constitutes a device containing guidelines for implementing environmental management across the public sector, by encouraging public managers to incorporate sustainable principles and attitudes as part of their routinely activities (Araújo; Ludewigs; Carmo, 2015). A3P aims to motivate reflection and reinforce change of practices on the part of civil servants, embodying actions that boost natural resources savings and reduce institutional expenses by means of 6 thematic axes: rational use of public goods; waste management adequacy; sustainable bidding; sustainable constructions; civil servants awareness-training, and quality of life promotion (Silva; Da Silva; Cavalcanti, 2024).

The A3P guidelines have been widely disseminated across various sectors of Brazilian public management, such as schools, institutes and universities, which are being encouraged to take responsibility for fostering educational, social and environmentally sustainable practices. Furthermore, these environments are identified by their high consumption of natural resources during their activities (Ferraz *et al*., 2023). Of paramount importance are the IRs, in which environmental impact is significant due to the very nature of their operations.

Within the institutional restaurants, menus are created by a nutritionist, who, by embodying the knowledge about WF, can develop ones aimed at preserving water resources. In this way, there is an opportunity to influence consistent changes as for consumers’ eating habits, since it is feasible to transmit this knowledge by means of the meals offered therein. In light of this, the implementation of public environmental policies that encourage the redesign of menus and align them with the principles of sustainability are fundamental and urgent.

4 CONCLUSION

InWhile being plant-based, the foodstuff used to create the restaurant's menus, the survey findings indicated nonetheless that the main animal-based protein accounts for an average of 77% of the total water footprint. When comparing the three sampled groups, it was observed that those containing beef had the largest water footprints. The lack of vegetarian options on the menus was uncontroversial. Specialised studies show the positive environmental benefits of rising plant-based food consumption. Promoting the adoption of more balanced diets is crucial to mitigate environmental impacts due to the diets, but modifying eating habits rooted and driven by globalisation is equally a complex challenge, which involves several dimensions and requires the cooperation of several sectors.

Regarding the limitations of the current study, it is relevant to point out that the WF levels may not faithfully reflect the Brazilian setting, as these parameters are based on an average of global living standards. Additionally, it is crucial to conduct further research on group dining sites, identifying critical areas that affect the availability of more sustainable menus. To conclude, studies similar to this one are essential for institutional and people's dietary changes getting impact on the environment in a positive vein, by encouraging conscious food choices and guidelines, in order to highlight the importance of a sustainable diet attachment, especially considering the scarcity of water resources.

REFERENCES

ALLAN, J. A. **Virtual water**: a strategic resource global solutions to regional deficits. Ground Water, v. 36, p. 545-546, 1998. DOI: 10.1111/j.1745-6584.1998.tb02825.x

ALVES, L. **Sustentabilidade e alimentação escolar**: análise nutricional e ambiental dos cardápios de um município catarinense. 2022. Trabalho de Conclusão de Curso (Bacharelado em Nutrição) – Universidade Federal da Fronteira do Sul, Realeza, PR, 2022.

ARAÚJO, C. L.; LUDEWIGS, T.; CARMO, E. A. do. A Agenda Ambiental na Administração Pública: desafios operacionais e estratégicos. **Desenvolvimento em Questão**, Ijuí, v. 13, n. 32, p. 21-47, 2015. DOI: 10.21527/2237-6453.2015.32.21-47

BARBIERI, J. C. **Desenvolvimento e meio ambiente**: as estratégias da agenda 21. 7. ed. Petrópolis: Vozes, 2005.

BRASIL. Ministério da Saúde. **Guia alimentar para a população brasileira**. 2nd ed. Brasília, DF: Ministério da Saúde, 2014. Available at: https://www.gov.br/saude/pt-br/assuntos/saude-brasil/publicacoes-para-promocao-a-saude/guia_alimentar_populacao_brasileira_2ed.pdf. Access at: 12 jul. 2023.

BRASIL. Lei nº 11.346, de 15 de setembro de 2006. Lei Orgânica de Segurança Alimentar e Nutricional (Losan). Cria o Sistema Nacional de Segurança Alimentar e Nutricional – Sisan com vistas a assegurar o direito humano à alimentação adequada e dá outras providências. **Diário Oficial da União**. 18 de sept. 2006.

CARMO, R. L. *et al*. Água virtual, escassez e gestão: o Brasil como grande "exportador" de água. **Revista Ambiente & Sociedade**, v. 10, n. 1, p. 83-96, 2007. DOI: https://doi.org/10.1590/S1414-753X2007000200006

CARMO, W. M. F. do. Ser ou Não Ser Sustentável? O Papel da Educação Ambiental para um Futuro mais Equilibrado. **Revista Científica FESA**, [S. l.], v. 3, n. 4, p. 80-92, 2023. DOI: 10.56069/2676-0428.2023.272. Available at: https://revistafesa.com/index.php/fesa/article/view/272. Access at: 24 jul. 2024.

COMISSÃO MUNDIAL SOBRE MEIO AMBIENTE E DESENVOLVIMENTO (CMMAD). **Nosso futuro comum**. Rio de Janeiro: Fundação Getúlio Vargas, 1988.

DIAS, G. P.; SILVA, M. E.; GOLD, S. Microfoundations of supply chain sustainability practices: a social capital perspective. **International Journal of Production Economics**, v. 263, 108947, 2023. Available at: https://www.sciencedirect.com/science/article/pii/S0925527323001792. Access at: 13 nov. 2023. DOI: https://doi.org/10.1016/j.ijpe.2023.108947

ELKINGTON, J. **The triple bottom line**. Environmental management: readings and cases, v. 2, p. 49-66, 1997.

FERNANDES, S. *et al*. Exploring Vitamin B12 Supplementation in the Vegan Population: a scoping review of the evidence. **Nutrients,** n. 16, p. 1442, 2024. Available at: https://doi.org/10.3390/ nu16101442

FERRAZ, A. S. S. *et al*. Água: a pegada hídrica no setor alimentar e as potenciais consequências futuras. **Acta Portuguesa de Nutrição**, n. 22, p. 42-47, 2020. Available at: https://scielo.pt/pdf/apn/n22/n22a08.pdf. Access at: 11 mar. 2024. DOI: http://dx.doi.org/10.21011/apn.2020.2208

FERRAZ, T. V. *et al*. Práticas sustentáveis em restaurantes universitários de universidades federais brasileiras. **Cuadernos de Educación y Desarrollo**, v. 15, n. 8, p. 7089-7114, 2023. Available at: https://ojs.europubpublications.com/ojs/index.php/ced/article/view/1616. Access at: 12 dec. 2023. DOI: https://doi.org/10.55905/cuadv15n8-015

FOOD AND AGRICULTURE ORGANIZATION. **International Scientific Symposium**: biodiversity and sustainable diets – United Against Hunger. Rome: FAO, 2010.

FRAGA, L. K. *et al*. Sistemas agroalimentares sustentáveis e saudáveis: reflexões a partir da perspectiva agroecológica. **Colóquio – Revista do Desenvolvimento Regional**. Faccat - Taquara/RS, v. 19, Ed. especial (Sober), 2022. DOI: https://doi.org/10.26767/coloquio.v19iesp1.2437

GARZILLO, J. *et al*. Consumo alimentar no Brasil: influência da carne bovina no impacto ambiental e na qualidade nutricional da dieta. **Rev. Saúde Pública**, v. 56, n. 102. 2022. Available at: https://www.scielosp.org/article/rsp/2022.v56/102/pt/#. Access at: 11 feb. 2024. DOI: https://doi.org/10.11606/s1518-8787.2022056004830

GARZILLO, J. *et al*. **Pegadas dos alimentos e das preparações culinárias consumidos no Brasil**. São Paulo: Faculdade de Saúde Pública da USP, 2019.

GUSSOW, J. D.; CLANCY, K. Dietary guidelines for sustainability. **Journal of Nutrition Education**, v. 18, n. 1, p. 1-5, 1986. DOI: https://doi.org/10.1016/S0022-3182(86)80255-2

HATJIATHANASSIADOU, M. *et al*. Environmental impacts of university restaurant menus: a case study in Brazil. **Sustainability**, v. 11, n. 19, p. 5157, 2019. Available at: https://lume.ufrgs.br/bitstream/handle/10183/200459/001103358.pdf. Access at: 26 jun. 2023. DOI: https://doi.org/10.3390/su11195157.

HOEKSTRA, A.; HUNG, P. Q. Virtual water trade: a quantification of virtual water flows between nations in relation to international crop trade. **Water Science and Technology**, v. 49, p. 203-209, 2002.

IPIRANGA, A. S. R.; GODOY, A. S.; BRUNSTEIN, J. Introdução. **RAM. Revista de Administração Mackenzie**, v. 12, n. 3, p. 13-20, jun. 2011. Available at: https://www.scielo.br/j/ram/a/Xv3r9ypsxNsjLtTqtPCBnJP/?format=pdf. Access at: 3 mar. 2024.

KILIAN, L.; TRICHES, R. M.; RUIZ, E. N. F. Food and sustainability at university restaurants: analysis of water footprint and consumer opinion. **Sustainability in Debate**, [S. l.], v. 12, n. 2, p. 79-89, 2021. Available at: https://www.periodicos.unb.br/index.php/sust/article/view/37939. Access at: 11 mar. 2024. DOI: https://doi.org/10.18472/SustDeb.v12n2.2021.37939

LANG, T. Sustainable Diets: another hurdle or a better food future? **Development**, v. 57, n. 2, p. 240-256. London, 2015. Available at: https://openaccess.city.ac.uk/id/eprint/12769/. Access at: 11 mar. 2024. DOI: 10.1057/dev.2014.73

LIMA, F. A. A.; PAIÃO, A. F.; TRICHES, R. M. Conciliando cardápios saudáveis e sustentáveis com menor custo em restaurante universitário. I**nterfaces Científicas – Saúde e Ambiente**, v. 9, n. 2, p. 245-260. 2023. Available at: https://periodicos.set.edu.br/saude/article/view/11353. Access at: 8 jul. 2023. DOI: https://doi.org/10.17564/2316-3798.2023v9n2p245-260

MARCHIONI, D. M.; CARVALHO, A. M. de; VILLAR, B. S. Dietas sustentáveis e sistemas alimentares: novos desafios da nutrição em saúde pública. **Revista USP**, [S. l.], v. 1, n. 128, p. 61-76, 2021. Available at: https://www.revistas.usp.br/revusp/article/view/185411. Access at: 13 aug. 2023. DOI: https://doi.org/10.11606/issn.2316-9036.i128p61-76

MARTINELLI, S. S.; CAVALLI, S. B. Alimentação saudável e sustentável: uma revisão narrativa sobre desafios e perspectivas. **Ciência & Saúde Coletiva**, v. 24, n. 11, p. 4251-4262, nov. 2019. Available at: https://www.scielo.br/j/csc/a/z76hs5QXmyTVZDdBDJXHTwz/?format=pdf. Access at: 11 mar. 2024. DOI: 10.1590/1413-812320182411.30572017

MATIAS, H. J. D.; PINHEIRO, J. de Q. Desenvolvimento sustentável: um discurso sobre a relação entre desenvolvimento e natureza. **Psicologia & Sociedade**, Porto Alegre, v. 20, n. 1, p. 132-143, 2008. Available at: https://www.scielo.br/j/psoc/a/q6Wq37WVV886mYtDzFDZ8mj/?format=pdf. Access at: 11 mar. 2024. DOI: https://doi.org/10.1590/S0102-71822008000100015

MEKONNEN, M. M.; HOEKSTRA, A. Y. Uma avaliação global da pegada hídrica de produtos de origem animal. **Ecossistemas**, v. 15, p. 401-415, 2012. Available at: https://link.springer.com/content/pdf/10.1007/s10021-011-9517-8.pdf. Access at: 11 mar. 2024. DOI: 10.1007/s10021-011-9517-8

MONTIBELLER FILHO, G. Ecodesenvolvimento e desenvolvimento sustentável: conceitos e princípios. **Textos de Economia**, Florianópolis, v. 4, n. 1, p.131-142. 1993. Available at: https://periodicos.ufsc.br/index.php/economia/article/view/6645. Access at: 10 mar. 2024.

MONTOYA, M. A. A pegada hídrica da economia brasileira e a balança comercial de água virtual: uma análise insumo-produto. **Economia Aplicada**, [S. l.], v. 24, n. 2, p. 215-248, 2020. Available at: https://www.revistas.usp.br/ecoa/article/view/167721. Access at: 2 sept. 2022. DOI: https://doi.org/10.11606/1980-5330/ea167721

MOREIRA, L. M.; LYON, J. P.; TEIXEIRA, A. de O. A relação estrutura-atividade da Vitamina B12 e das cobalaminas e suas correlações nutricionais. **Pesquisa, Sociedade e Desenvolvimento,** [S. l.], v. 12, n. 11, p. e05121143658, 2023. Available at: https://rsdjournal.org/index.php/rsd/article/view/43658. Access at: 11 jul. 2024. DOI: 10.33448/rsd-v12i11.43658.

PAULA, A. H. de; BIFANO, A. C. S. Modos de gestão em Restaurantes Universitários. **Brazilian Journal of Development**, [S. l.], v. 5, n. 12, p. 32478-32493, 2019. Available at: https://ojs.brazilianjournals.com.br/ojs/index.php/BRJD/article/view/5667. Access at: 13 mar. 2023. DOI: https://doi.org/10.34117/bjdv5n12-313

PESSETTI, M. Modernização da agricultura e seus desdobramentos no espaço agrário. **Revista Geografia em Atos** (Online), [S. l.], v. 5, p. 1-26, 2021. Available at: https://revista.fct.unesp.br/index.php/geografiaematos/article/view/8050. Access at: 11 jun. 2023. DOI: https://doi.org/10.35416/geoatos.2021.8050

QUEIROZ, P. W. V. de; COELHO, A. B. Alimentação fora de casa: uma investigação sobre os determinantes da decisão de consumo dos domicílios brasileiros. **Análise Econômica,** [S. l.], v. 35, n. 67, 2017. Available at: https://seer.ufrgs.br/index.php/AnaliseEconomica/article/view/57132. Access at: 7 jul. 2023. DOI: https://doi.org/10.22456/2176-5456.57132

RAHAL, L. S.; GENTIL, P. C.; MAGALHÃES, E. S. A política de Segurança Alimentar e Nutricional no Brasil. In: PREISS, P. V.; SCHNEIDER, S.; COELHO-DE-SOUZA, G. (org.). **A Contribuição brasileira à segurança alimentar e nutricional sustentável.** Porto Alegre: Editora da UFRGS, 2020. p. 17-26.

RIBEIRO, H.; JAIME, P. C.; VENTURA, D. Alimentação e sustentabilidade. **Estudos Avançados,** v. 31, n. 89, p. 185-198, jan. 2017. DOI: https://doi.org/10.1590/s0103-40142017.31890016

SILVA, A. C. de L.; DA SILVA, C. M.; CAVALCANTI, P. N. M. Percepção ambiental em instituições públicas do Brasil. **Cuadernos de Educación y Desarrollo**, [S. l.], v. 2, pág. e3044, 2024. Available at: https://ojs.europubpublications.com/ojs/index.php/ced/article/view/3044. Access at: 1 mar. 2024. DOI: 10.55905/cuadv16n2-076.

STRASBURG, V. *et al*. Calidad nutricional e impacto en medio ambiente por los insumos de un comedor universitario en Uruguay. **Archivos Latinoamericanos de Nutrición**, v. 73, n. 2; p. 90-101, apr-jun 2023. DOI: https://10.37527/2023.73.2.001

STRASBURG, V. *et al*. Environmental impacts of the water footprint and waste generation from inputs used in the meals of workers in a Brazilian public hospital. **Research, Society and Development**, v. 10, n. 3, e22510313129, 2021 (CC BY 4.0). ISSN 2525-3409. DOI: http://dx.doi.org/10.33448/rsd-v10i3.13129

STRASBURG, V. J.; JAHNO, V. D. Sustentabilidade de cardápio: avaliação da pegada hídrica nas refeições de um restaurante universitário. **Revista Ambiente & Água**, v. 10, n. 4, p. 903–914, oct. 2015. Available at: https://www.scielo.br/j/ambiagua/a/HbhPjLz6zkHyQx6T8DzcPjN/. Access at: 20 jul. 2023. DOI: https://doi.org/10.4136/ambi-agua.1664.

TORRENS, J. C. S. Sistemas Agroalimentares: impactos e desafios num cenário pós-pandemia. **P2P e inovação**, Rio de Janeiro, v. 7, n. 1, p. 192–211, 2020. Available at: https://revista.ibict.br/p2p/article/view/5406. Access at: 27 may 2023.

TRICHES, R. M. Dietas saudáveis e sustentáveis no âmbito do sistema alimentar no século XXI. **Saúde em Debate**. Rio de Janeiro, v. 44, n. 126, p. 881-894, jul-sept, 2020. Available at: https://doi.org/10.1590/0103-1104202012622. Access at: 12 jun. 2023. DOI: https://doi.org/10.1590/0103-1104202012622