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Assessing Carbon Footprints of Students in University of Agriculture Makurdi, Benue State, Nigeria

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Authors' contributions

This work was carried out in collaboration between all authors. Authors ETT and AAO designed the study, wrote the protocol and wrote the first draft of the manuscript. Author SAS managed the literature searches, analyses and discussion of the study. All authors read and approved the final manuscript.

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ABSTRACT

The aim of the study was to assess the carbon footprints of students in the University of Agriculture, Makurdi, Nigeria, to determine the amount of carbon generated from unaccounted sources. The study was carried out in March, 2016, in 3 out of 10 Colleges in the University, purposively selected to involve students studying Forestry, Fisheries and Agricultural based disciplines within the North-Core of the University. The online carbon footprint calculator developed by World Wide Fund for nature (WWF), was used for the assessment. The calculator had well-structured questions to track carbon footprints generated by each student's activities through food consumption, home, travel and stuff. Results obtained were analyzed using simple descriptive statistics and compared with the planet global average of 3.06 tonnes. College of Forestry and Fisheries had the highest carbon footprints of 665.0 tonnes, representing 35% of carbon expenditure in the Colleges. College of Agricultural Economics and Extension had the lowest carbon footprints of 602.40 tonnes. Among the Departments, Animal production had the highest footprints of 339.60 tonnes while Department of Agricultural Extension recorded the lowest footprints of 293.6 tonnes. 400 level students generated the highest carbon footprints of 675.90

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tonnes while 300 level students produced the lowest footprint of 620.8 tonnes. The students surveyed in this study showed high carbon footprints in their food consumption, travel and home activities; requiring more planets to live if everyone else in the world adopted their lifestyles. It is therefore recommended that creation of awareness on the impacts of carbon footprints and its reduction strategies be carried out to enable them adopt lifestyles that could help them live within the limits of our only planet, the earth.

Keywords: Carbon footprints; carbon calculator; students; University of Agriculture; Makurdi.

1. INTRODUCTION

Daily human activities like driving, lighting of bulbs, eating of food, infrastructural development among others increase carbon dioxide emissions, which imply that man contributes to global warming from several unknown sources [1,2]. According to [3], humanity's well-being depends on nature's ability to provide food, fibre and timber, and to absorb waste, but the earth's ability to supply these ecological services, has limits. Fortunately, taking simple steps to cut man's energy use can help to reduce carbon footprints and protect the planet from the effects of greenhouse gases and climate change [4]. A carbon footprint can broadly be defined as a measure of the greenhouse gas emissions that are directly and indirectly caused by an activity or are accumulated over the life stages of a product or service, expressed in carbon dioxide equivalents [5]. According to [6], there are 18 greenhouse gases with different global warming potentials. But under the United Nations Framework Convention on Climate Change [7] and its Kyoto Protocol, only Carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O), Hydro-fluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6) are considered for the purposes of carbon accounting, with others being regulated elsewhere [8]. The term "carbon footprint" is usually used as shorthand for the amount of carbon (in tonnes) emitted by an activity or organization [9]. According to these authors, an ecological footprint on the other hand shows us how carbon emissions compare and interact with other elements of human demand, such as pressure on food sources, the quantity of living resources required to make the consumer goods and the amount of land converted to build cities and roads. In simple terms, the footprint can be described as a measure of demand on the biosphere [10]. Reducing humanity's carbon footprint is the most essential step to end overshoot and live within the means of our planet [11]. Citizens are responsible for more than 20 tonnes of heat-trapping atmospheric emissions annually, according to the Natural Resources Defense Council [12] but greener living can reduce this super-sized carbon footprints. [13] reported that the low-carbon issue, focused on emissions accounting and reduction, carbon emissions trading platforms, carbon tax and carbon emission policy, have made a lot of achievements. Research on the carbon footprint and assessment standard has become a hot topic for governments and researchers, in order to manage the footprints, reduce emissions over time and report the footprints accurately [14]. Individuals generate high carbon footprints in their daily activities which are not accounted for and this contributes to climate change with devastating consequences that are threatening human existence on earth. Tracking carbon forcings will enhance carbon accountability and reduce greenhouse gas emissions. According to [15], recycling paper for example saves trees and lets them continue to reduce climate change by removing carbon from the atmosphere. This study therefore assessed the footprints generated by students in the different Departments in three Colleges of University of Agriculture, Makurdi to ascertain their carbon footprints, whether they were living within the limits of our planet or they required more plants to live in if everyone lived their lifestyles.

2. MATERIALS AND METHODS

2.1 Study Area

The study was conducted in the University of Agriculture, Makurdi (UAM) which was established in 1988, following the recommendations of a 1987 Federal Government white paper on higher education curriculum development in Nigeria. The University is located on Latitude 7° 44N and Longitude 8° 33E in Benue State, North-Central Nigeria. The wet or rainy season begins in April and ends in October with total annual rainfall ranging between 1,200-1,800 mm while the dry season starts in November and ends in March [16,17]. According to [16], temperatures are constantly high,

averaging between 28-32℃ and sometimes rising to 37℃.

2.2 Sampling Strategy

The study was carried out in 3 out of 10 Colleges in the University, purposively selected to involve students studying Forestry, Fisheries and Agricultural based disciplines within the North-Core of the University. In each of the 3 Colleges, 2 Departments representing 50% of Departments in the Colleges were randomly selected for the study. In every Department, 5 male and 5 female students from 300-500 levels were engaged, giving a total of 180 students.

2.3 Data Collection

The study data was collected using a well-structured on-line Carbon Footprint Calculator developed by World Wide Fund for Nature [18] in March, 2016. The on-line Carbon Calculator had well-structured questions to track carbon footprints generated by the students' activities through food consumption, home, travel and stuff and at the end of each assessment, the calculator displayed the amount of carbon footprints generated by the students. The results showed carbon footprints by category and the total footprints generated for each student and gave the number of planets needed to sustain the respondent's lifestyle. Categories covered were 'Food'-covering diet, food waste and buying habits; 'Home' covering energy type and usage in the house and the presence of energy saving measures; 'Travel' personal and public transport usage for leisure and work; and 'Stuff' covering the purchase of consumable items. The average time taken for the on-line assessment was between 5-10 minutes per student and data obtained was analyzed using simple descriptive statistics.

3. RESULTS

3.1 Carbon Footprints of Selected Colleges in the University

College of Forestry and Fisheries had the highest carbon footprints of 665tonnes, representing 35% of carbon expenditure in the Colleges (Table 1). The food category had the highest carbon footprint of 250.70 tonnes (37.70%) and stuff had the lowest footprints of 69.82 tonnes (10.50%). The College required 8.02 planets to exist based on the lifestyles of its respondents. The College of Animal Science had total footprints of 635 tonnes requiring 7.54 planets to maintain its lifestyle. The College of Agricultural Economics and Extension had the lowest carbon footprints of 602.4 tonnes, requiring 6.99planets. Again, food had the highest footprints of 303.60 tonnes (46.0%) while stuff had the lowest footprints of 54.20 tonnes (9.0%). The College required 10.05 planets to maintain its lifestyle.

3.2 Footprints of Departments in Selected Colleges of the University

The Department of Animal Production had the highest Carbon Footprints of 339.6 tonnes (Table 2). Food had the highest carbon footprints of

Table 1. Carbon footprints of Colleges in the University

College	Category	No of respondents	Total carbon footprints (tonnes)	Percentage footprints (%)	Carbon footprints per respondent (tonnes)	No of planets required per college
Agricultural	Food	60	303.60	50.40	5.06	
economics &	Home	60	142.80	23.70	2.38	
Ext.	Travel	60	102.40	17.0	1.71	6.99
	Stuff	60	54.20	9.0	0.90	
	Total	**60**	**602.40**	**100.0**	**10.05**	
Animal science	Food	60	292.1	46.0	4.86	
	Home	60	137.8	21.70	2.31	7.54
	Travel	60	151.1	23.80	2.52	
	Stuff	60	53.98	8.50	0.91	
	Total	**60**	**635.0**	**100.0**	**10.60**	
Forestry &	Food	60	250.7 0	37.70	4.18	
fisheries	Home	60	153.10	23.0	2.55	
	Travel	60	191.50	28.80	3.19	8.02
	Stuff	60	69.82	10.50	1.16	
	Total	**60**	**665.0**	**100.0**	**11.08**	**22.55**

155.54 tonnes (45.80%) and stuff had the lowest footprints of 31.58 tonnes (9.30%), while the lowest carbon footprints of 293.60tonnes came from the Department of Agricultural Extension. The food category had the highest footprints of 145.95 tonnes (49.71%) while stuff had the lowest footprint of 26.63 tonnes (9.07%), with the Department requiring 9.71 planets for its current lifestyle in everyone lived their lifestyle.

3.3 Carbon Footprints of Different Study Levels in the University

Four hundred (400) Level students had the highest carbon footprints of 675.9tonnes in all the levels of study investigated as shown in Table 3. The food category had the highest carbon footprint of 279.96% tonnes (41.42%) and the stuff category had the lowest footprints of 69.96 tonnes (10.35%) and requiring 11.28 planets to maintain their lifestyles. The 300 level students had the lowest carbon footprint of 620.80 tonnes. Again, the food category had the highest footprint of 280.60 tonnes (45.20%) while stuff had the lowest footprint of 60.84tonnes (9.80%).

3.4 Carbon Footprints of Male and Female Students in Selected Colleges of the University

Female and male students had the same carbon footprints of 914tonnes as shown in Table 4. The food category had the highest carbon footprint of 415.22 tonnes (45.40) and 411.60 tonnes (45.0%) for male and female students respectively. It was observed that the home, stuff and travel categories had a similar trend with their total carbon footprints per respondent being less than the planet's (earth) global average of 3.06 tonnes.

Table 2. Carbon footprints of Departments in selected Colleges of the University

College	Department	Category	No of respondents	Total carbon footprints (tonnes)	Percentage footprints (%)	Carbon footprints per respondent (tonnes)	No of planets required per department
Agricultural economics & extension	Agricultural economics	Food	30	146.37	47.40	4.88	
		Home	30	74.11	24.0	2.47	7.22
		Travel	30	60.22	19.50	2.0	
		Stuff	30	28.10	9.10	0.93	
		Total	**30**	**308.8**	**100**	**10.28**	
	Agricultural extension	Food	30	134.92	45.58	4.51	
		Home	30	68.26	23.06	2.28	6.81
		Travel	30	66.87	22.59	2.23	
		Stuff	30	25.95	8.77	0.87	
		Total	**30**	**296.0**	**100**	**9.87**	
Animal science	Animal nutrition	Food	30	155.54	45.58	4.51	
		Home	30	67.92	23.06	2.28	8.26
		Travel	30	84.56	22.59	2.23	
		Stuff	30	31.58	8.77	0.87	
		Total	**30**	**339.60**	**100**	**11.32**	
	Animal production	Food	30	155.54	45.80	5.19	
		Home	30	67.92	20.00	2.26	
		Travel	30	84.56	24.90	2.82	8.26
		Stuff	30	31.58	9.30	1.05	
		Total	**30**	**339.60**	**100**	**11.32**	
Forestry and fisheries	Fisheries	Food	30	126.0	37.39	4.20	
		Home	30	84.79	25.16	2.83	
		Travel	30	93.38	27.71	3.11	8.17
		Stuff	30	32.83	9.74	1.09	
		Total	**30**	**337.0**	**100**	**11.23**	
	Forestry	Food	30	124.77	38.04	4.16	
		Home	30	68.72	20.95	2.29	7.87
		Travel	30	97.87	29.84	3.26	
		Stuff	30	36.64	11.17	1.22	
		Total	**30**	**328.0**	**100**	**10.93**	**46.59**

Table 3. Carbon footprints of study levels in the University

Study level	Category	No of respondents	Total carbon footprints (tonnes)	Percentage footprints (%)	Carbon footprints per respondent (tonnes)	No of planets required per level of study
300	Food	60	280.60	45.20	4.68	
	Home	60	142.78	23.0	2.38	
	Travel	60	136.58	22.0	2.28	7.29
	Stuff	60	60.84	9.80	1.01	
	Total	**60**	**620.80**	**100.0**	**10.35**	
400	Food	60	279.96	41.42	4.67	
	Home	60	149.31	22.09	2.49	8.21
	Travel	60	176.68	26.14	2.95	
	Stuff	60	69.96	10.35	1.17	
	Total	**60**	**675.9**	**100.0**	**11.27**	
500	Food	60	287.99	47.5	4.71	
	Home	60	143.09	23.60	2.39	7.05
	Travel	60	127.32	21.0	2.12	
	Stuff	60	47.90	7.90	0.81	
	Total	**60**	**606.3**	**100.0**	**10.11**	**22.31**

Table 4. Footprints of male and female students in selected Colleges of the University

Gender	Category	No of respondents	Total carbon footprints (tonnes)	Percentage footprints (%)	Carbon footprints per respondent (tonnes)	No of planets required per gender
Male	Food	90	415.22	45.40	4.61	
	Home	90	208.53	22.80	2.32	
	Travel	90	210.34	23.0	2.32	7.1
	Stuff	90	80.49	8.80	0.89	
	Total	**90**	**914.40**	**100.0**	**10.16**	
Female	Food	90	411.60	45.0	4.57	
	Home	90	203.96	22.30	2.27	7.1
	Travel	90	214.02	23.40	2.38	
	Stuff	90	87.80	9.60	0.98	
	Total	**90**	**914.60**	**100.0**	**10.20**	**14.2**

4. DISCUSSION

4.1 Carbon Footprints of Colleges

The College of Forestry and Fisheries had the highest carbon footprints of 665 tonnes, requiring 11.08 planets, with 8.02 tonnes above the planet global average of 3.06 tonnes. This implies that the College students require 11.08 planets to maintain their lifestyle if everyone had the same carbon expenditure with them. Alternatively, appropriate decisions including awareness and relevant policies could help the students reduce their footprints to bring their lifestyle demands within the limits of our planet [2]. According to this source, if this lifestyle continues, the overshoot will make it more and more difficult to meet the needs of the growing population as well as space for other species. Their food consumption patterns recorded the highest carbon footprints of 250.70 tonnes (37.7%), food alone required 1.12 tonnes above the planet global average. This may be attributed to the students eating more meat in most meals, cooking more than required quantity of food or wasting of excess food with little or no preservation facilities etc. Stuff had the lowest carbon footprints of 69.82 tonnes (10.50%) and required 1.16 planets, this means that the students prioritized food and spent less on stuff like jewelries, pets and pet's food, perfumes, phones, etc perhaps due to the prevailing economic constraints especially among low income parents and guardians in Nigeria.

4.2 Carbon Footprints of Departments

The Department of Animal Production recorded the highest carbon footprint of 339.60tonnes.

Food consumption had the highest footprints of 155.54 tonnes representing 45.8% and required 5.19 planets. Travel had 84.56 tonnes representing 24.90% and required 2.82 planets as a result of the students travelling by bus or motor cycle to lectures due to use of automobiles as the major means of transport and the long distance between hostels and lecture venues and travel outside the campus. The home category had 67.92 tonnes (20.0%) and required 2.26 planets, as a lot of home appliances were not energy efficient, increasing their rate of carbon footprints at home. Their stuff had the lowest footprints of 31.58 tonnes (9.30%), requiring 1.05 planets. This indicates that the students prioritized food and their movement within and outside the campus which were the most relevant categories to their success as students in times of scarce resources. The students in the Department required a total of 11.32 planets to maintain their lifestyles. This confirms the assertion by [12] that citizens are responsible for atleast 20 tonnes of heat-trapping atmospheric emissions.

4.3 Carbon Footprints of Students at Different Study Levels

This study revealed that 400 level students recorded the highest carbon footprint (675.9 tonnes) generated in the University, requiring 8.21 planets other than the earth. Their food consumption had the highest footprints of 279.96 tonnes and required 4.67 planets, implying that students fed on high carbon footprint foods, encouraged wastage and had weak food storage facilities. Their stuff had the lowest footprints of 69.96tonnes (10.35%) and required 1.17 planets, this means that the students spend less on stuff. The students of the Department required the highest number of planets among all the study levels to accommodate their lifestyle and this could be due to their involvement in the Students Industrial Work Experience Scheme (SIWES) which required more physical activities in field practicals and travel to other Forestry establishments in the country.

300 level students followed with 620.08 tonnes requiring 7.2 planets to maintain their lifestyles. From all the categories considered for students at this study level, the food category had the highest carbon footprints of 280.60 tonnes (45.20%) and required 4.68 planets while the home category had 142.78 tonnes (23.0%) and required 2.38 planets to accommodate their lifestyle. The stuff category had the lowest carbon footprints of 60.84 tonnes (9.8%) and required 1.01 planets, which means they could maintain their current lifestyle and still not cause harm to the earth.

500 level students had the lowest carbon footprints generated in the study (606.3 tonnes), requiring 7.05 planets to exist. This may be attributed to the level of awareness having covered more courses in the school curriculum. This could be the likely reason why the 300 level generated more footprints, having spent only 3 years on the curriculum. A deviation from this reason was observed from the 400 level students due to their additional travel on the Students Industrial Work Experience Scheme (SIWES) program which required movement to different Forestry establishments in the country, engaging in more practical activities leading to more demand for food and increased footprints.

4.4 Gender Carbon Footprints

This study revealed that female students and male students had similar lifestyles, generating the same carbon footprints of 914 tonnes in the University. Their food consumption had the highest footprints of atleast 411 tonnes, followed by travel and stuff having the least generation of footprints. This indicates that the students had a lot in common and gender had no effect on carbon footprint generation among the students in the University.

Their lifestyles required atleast 10 planets, 7.1 tonnes above the planet global average of 3.06 tonnes. They both need adjustments in their lifestyles by understanding lifestyles that generate more carbon footprints and adopting less carbon generating options for sustainable living on the single planet that we all share.

5. CONCLUSION

Lifestyle choices or living habits determine the state of our environmental carbon footprint and for a future where people and nature will thrive; there is need for an understanding of every individual's contribution to the world's carbon expenditure. The students surveyed in this study showed high carbon footprints in their food consumption, travel and home activities; requiring more planets to live if everyone else in the world adopted their lifestyle. This can be attributed to low level of awareness on the causes and impacts of high carbon footprint generating activities among the students. Therefore sensitization of the students and

indeed the general populace on the need to check their lifestyle implications on carbon footprint generation and appropriate actions on the ways to reduce their footprints is necessary. Appropriate policies and programs by Government and other agencies that can support carbon footprint reduction will be essential to enable us adopt lifestyles that help us to live within the only planet we have on a sustained basis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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