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ENVIRONMENTAL IMPACT OF NON-VEGETARIAN DIET: AN OVERVIEW

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ABSTRACT

The food production and consumption pattern is very diverse and significantly changing due to the change in economic status, population pressures, urbanization, and lifestyle of people worldwide. The food system adopted by modern society has very serious environmental impacts. The main objective of this paper is to highlight the impacts of consuming non-vegetarian diet on the environment. The production of animal-based (livestock) foods is associated with high carbon footprint which contributes significantly to the acceleration of global climate change. Environmental issues such as global warming and climate change can be minimized by adopting vegetarianism or by lowering the consumption of meat and other animal based products.

KEYWORDS: Carbon footprint, Climate change, Environmental impact, Greenhouse gases, Livestock, Non-vegetarian diet

I. INTRODUCTION

There are so many environmental issues and problems i.e., deforestation, pollution, ozone layer depletion, acid rain, biodiversity loss, global warming, climate change etc., which resulted from anthropogenic activities caused by modern human civilization. Modern life style and day-to-day activities has significant environmental impacts. The food production and consumption pattern is significantly changing globally due to the change in economic status, population pressures, urbanization, and lifestyle of people [1-3]. The diet of an individual also influenced by several other factors such as personal preferences, cultural, geographical, and environmental factors. The tendency of eating non-vegetarian food (meat) has become a fashion which has boost up the non-vegetarian food market globally [4, 5]. In developing countries, the consumption and production of non-vegetarian food is growing rapidly as per capita income is growing [6]. The world's livestock sector is growing at an unprecedented rate to meet the demand of meat. Food production is responsible for environmental degradation mainly in developed countries [7-9]. The environmental consequences of food production have gained a lot of attention in recent years. Meat production contributes significantly to the acceleration of global climate change by adding a large quantity of greenhouse gases (GHG), i.e. mainly carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O), to the environment. The CO_2 generated by fossil fuels used to power farm machinery, transport, to store and cook foods; CH_4 from enteric fermentation in ruminant livestock and N_2O released from soils mainly after the addition of fertilizers [10, 11]. The total emission from global livestock is 7.1 gigatons (GT) of CO_2 equivalent per year which is about 14.5% of the world's GHG emissions [12]. The emission of GHG due to meat production contributes to global warming and climate change.

II. GLOBAL FOOD PRODUCTION AND CONSUMPTION

The world population is increasing exponentially (1.11% per year) and was estimated to have reached 7.5 billion in April, 2017. According to United Nations estimate, it will further increase to 9.7 billion in 2050 and 11.2 billion in the year 2100 [13]. This growth, along with rising incomes in developing countries is driving up global food consumption. The consumption of dairy products, eggs, and meat is increasing worldwide, and this will intensify the environmental impacts related to livestock production [14, 15]. On the basis of diet, world population can be classified into three categories i.e., vegans, vegetarians, and non-vegetarians. The proportion of vegetarians in different countries of the world is very low (≤10%) except India, Israel, Australia, Sweden, and Italy, where this value is 29-40% [16], 13% [17], 2-11.2% [18, 19], 10% [20], and 7.1-10% [21, 22], respectively, and it can be concluded that major proportion of population is consuming non-vegetarian diet.

In developing countries, the demand for livestock products has significantly increased since the early 1960s whereas share of cereals, roots and tubers, is declining. From 1966 to 1999, per capita meat consumption rose by 150% and that of milk and dairy products by 60%. By 2030, per capita consumption of livestock products could rise by a further 44% [23]. The most significant growth in per capita consumption of livestock products has occurred in East and Southeast Asia. In China, per capita meat consumption has quadrupled, consumption of milk has increased up to ten times, and egg consumption has increased eight times between 1980 and 2005 [24]. The diet in western countries is characterized by a high intake of livestock products (fat and meat) that is above dietary recommendations [25, 26]. Annual meat production is expected to increase from 218 million tons in 1999 to 376 million tons by 2030 which is about 1.7 times [23]. In 2008, meat production was estimated to 280 million tons [27] and by 2050 nearly twice as much meat will be required to meet out growing population needs [28]. In developing countries, demand is expected to grow faster than production which results in a growing trade deficit. An increasing share of livestock production will most likely come from industrial sector. In present scenario, production from this sector has grown twice as fast as that from traditional mixed farming systems and about six times faster than that from grazing systems [23]. According to the Food and Agriculture Organization (FAO), the world fisheries production was 93.2 million tons captured by commercial fishing in wild fisheries, including 48.1 million tons produced by fish farms in 2005. By 2030, annual fish consumption is expected to rise to 150-160 million tons per year [23].

III. FOOD CONSUMPTION IN INDIA

In India about 30-40% of population consumes vegetarian diet. Since last decade, globalization has played an important role in the transformation of food consumption patterns in India. There has been a significant increase in imports of fruits such as apple, dry fruits and processed food products. However, income-induced diet diversification has resulted in consumers moving away from inferior cereals such as bajra and jowar to superior grains such as wheat and rice and more recently from cereals to high value food products such as milk, vegetables, egg, fruits, and meat. According to report published by National Council of Applied Economic Research, New Delhi [29], per capita rice consumption in rural households has declined from about 83 kg in 1987-1988 to 73 kg in 2009-2010. A similar trend was noticed in the urban households where per capita rice consumption declined from 64 kg in 1987-1988 to 55 kg in 2009-2010. The trend in wheat consumption shows a similar pattern as that of rice and has declined from 54 kg per year during 1997-1998 to below 52 kg in 2009-2010. In urban households, the decline was more significant from around 54 kg to 50 kg. On the other hand, consumption of pulses has declined due to limited availability in the global market. Per capita consumption in urban households declined from 12 kg in 1999-2000 to 9.6 kg in 2009-2010 and from 10 kg to 8 kg in rural households. While the consumption of edible oils has increased significantly (during 1987-88 to 2009-10) both in rural and urban households with 4 kg to 7.7 kg and 6.6 kg to 10 kg per capita per year in rural and urban households, respectively. The milk consumption in rural households increased about 28% from 39 kg in 1987-1988 to 50 kg per capita per year in 2009-2010, whereas in urban households per capita consumption increased about 25% from 52 kg to 65 kg during the same period. During 1987-1988 to 2009-2010, average per capita poultry meat consumption registered an exponential growth of about 525% i.e., from 0.240 kg to 1.5 kg in rural households and about 816% from 0.240 kg to 2.2 kg in urban areas. The higher poultry meat consumption is attributed to larger supplies and its relatively lower prices than other categories of meat such as mutton. Per capita consumption of eggs also registered a significant growth from 17 eggs to 32 eggs in urban households and from 6 eggs per year in 1987-1988 to 21 eggs in 2009-1010 in rural households. This significant growth in poultry sector is due to the larger availability of feed stocks (such as maize and soybean meal) and better infrastructure.

According to data from the central government's sample registration system baseline survey (SRSBS) (2014) [30], Telangana tops the list of 21 big states in the country in non-vegetarianism (98.8% men and 98.6% women) followed by West Bengal (98.7% men and 98.4% women) and Andhra Pradesh (98.4% men and 98.1% women). These two states (Andhra Pradesh and Telangana) are also the largest producers of egg and meat. Andhra Pradesh stands second in egg production in the country with 1309.58 crore eggs whereas Telangana stands third with 1006 crore eggs. In meat production, Andhra Pradesh is at fourth with 5.27 lakh metric tons and Telangana stands at sixth with 4.46 lakh metric tons. Andhra Pradesh also tops the country in exporting buffalo meat and is well known for its shrimp exports. Among the South Indian states, Karnataka has the lowest number of non-vegetarians. On the other hand, Rajasthan has the highest number of vegetarians with 73.3% men and 76.6% women followed by Haryana with 68.5% men and 70% women. [31]

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IV. CARBON FOOTPRINT OF NON-VEGETARIAN DIET

In general, the accurate calculation of total carbon footprint by any activity such as land clearance, production and consumption of food, fuels, manufactured goods, materials, roads, buildings, transportation and other services, is not possible because of insufficient knowledge and data about the complex interactions between contributing processes. Livestock production is a major anthropogenic source of pollutants such as CO_2, CH_4, NH_3, and N_2O, which affects soil characteristics and cause global warming [32]. Livestock production affects the natural environment in two ways i.e., directly and indirectly. Direct impact caused by the emissions directly produced by the animal from enteric fermentation of fiber by ruminants, manure and urine excretion while indirect impact caused by indirect emissions from feed crops used for animal feed, emissions from manure application, CO_2 emissions from fertilizer production, emissions from processing and transportation of refrigerated livestock products [33]. A vegetarian's food print is about half that of a non-vegetarian and for a vegan it is even lower. An average American's diet has a carbon food print of around 2.5 ton CO_2 equivalent (CO_2e) per person each year but for a meat lover this is about 3.3 ton CO_2e, and for those who don't consume beef, it is 1.9 ton CO_2e, for vegetarian it is 1.7 ton CO_2e and for the vegan it is 1.5 ton CO_2e [33]. In 2002, Gerbens-Leenes and Nonhebel [34] have developed a model to measure the CO_2e and land required for production of 1 kg meat. According to this model, CO_2e for beef and pig is 14.8 kg and 0.9 kg, respectively, where as land requirement is about 20.9 m^2 for beef and 7.3 m^2 for pig. As a comparison, 1 gallon of gasoline emits approximately 2.4 kg of CO_2 [35]. It means that consumption of 1 kg beef thus has a similar environment impact as 6.2 gallons of gasoline, or driving 160 highway miles in the average American mid-size car. In 2002, CO_2e produced from livestock and poultry farming was around 982 million metric tons whereas it is going to be approximately three times (2753 million metric tons) by 2050. Such a large amount of emissions undoubtedly affects the global climate. Scarborough et al., (2014) reported GHG emissions in kg of CO_2e per day (d) which were 7.19 for high meat-eaters (>=100 g/d), 5.63 for medium meat-eaters (50- 99 g/d), 4.67 for low meat-eaters (<50 g/d), 3.91for fish-eaters, 3.81for vegetarians and 2.89 for vegans [36]. This data shows that GHG emissions in high meat-eaters are approximately twice as high as those in vegans.

V. ENVIRONMENTAL IMPACT

The environmental impacts of the human diet are mainly depends on the type of diet consumed, its quantity, and origin. Dairy products, eggs, fish, and meat have the higher environmental impacts, while starchy products, vegetables, legumes, and fruits have the lower impacts [37, 38]. Global warming is directly related to the concentration of GHG in the atmosphere and global warming further leads to climate change. As the demand of livestock products and meat will grow in future the production of CO_2e responsible for climate change will also increase. Livestock products are associated with higher GHG emissions than plant-based products (such as vegetables, cereals, and legumes) with the exception of those transported by airplanes [39]. Currently, the global food system is estimated to contribute to 30% of global GHG emissions. With the rise in global population, the consumption of most resource-intensive food products (dairy and meat) will increase and further accelerate the environmental losses [1]. According to different studies carried out in UK [40], Netherlands [41] and Sweden [42], dairy and meat products account for over 50% of the GHG emissions associated with food in each country. In UK, drinks and sugary foods contribute around 20% of emissions. The other dietary components vary by country while bread, pastry and flour account for around 10% of emissions as do potatoes, fruit and vegetables. Latin America has the highest regional GHG emissions (per capita) mainly due to large cattle populations in the beef exporting countries [43]. Cattles produce a large amount of CH_4, a potential global-warming gas, into the atmosphere. A dairy cow produces about 75 kg of CH_4 per year, equivalent to over 1.5 metric tons of CO_2. CH_4 is about 28 times more accountable for global warming than CO_2. Globally, CH_4 emission from livestock contributes around 6% of GHG [44]. Cow, sheep and goat emit CH_4 through the digestive process. That is why atmospheric concentrations of CH_4 increased by 150% over the past 250 years, while CO_2 concentrations increased by 30%. As meat and dairy products consumption increase, CH_4 emission is predicted to raise by up to 60% by 2030 [45] which is would be the serious environmental impacts in near future.

Figure 1 shows inter-relationship of human diet with carbon footprints and climate change. The carbon footprint associated to non-vegetarian's diet is about twice the vegetarian's and vegan's diet. It means that non-vegetarians are contributing more for climate change which further leads to ecological imbalance, natural disasters, global food insecurity, biodiversity loss and social & economical issues.

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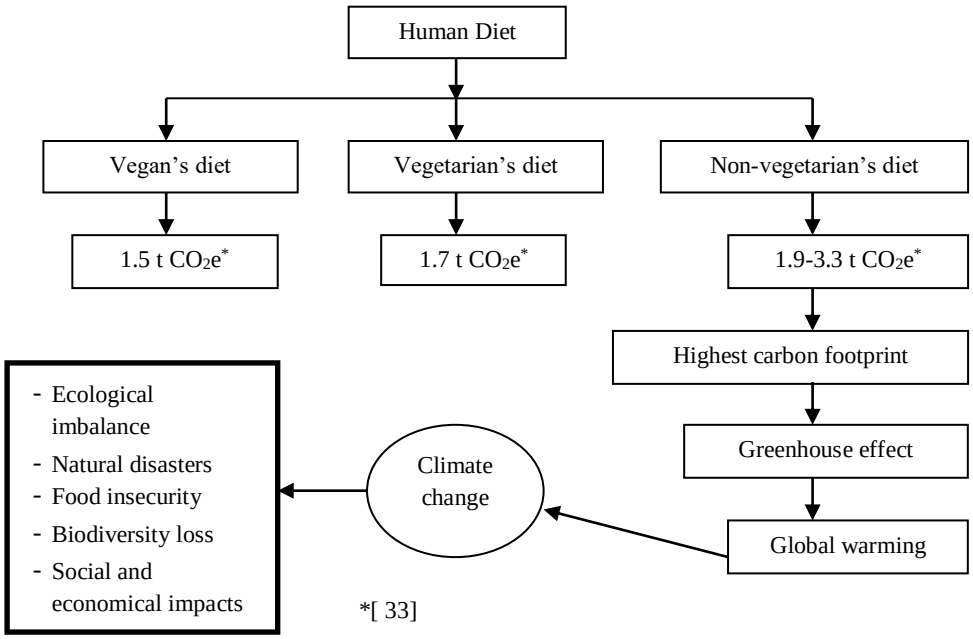

Figure 1: Inter-relationship between human diet, carbon footprint and climate change

Raising and feeding of livestock introduce an additional trophic level in the food chain, and each trophic level leads to loss of energy and matter, thus reduce the efficiency of the production. [46]. Figure 2 show the two pathways (a & b) for the transfer of food energy from producers (plants) to man. In first case 'a', food energy is directly transferred from plants to man i.e., no intermediate trophic level (stage) is there but in case 'b', first of all plant's food energy is transferred to livestock (animals) after that it get transferred to man. This can be better explained by the '10% rule'. In an ecosystem, plants capture and transform light energy from the sun and transfer this energy throughout the system subject only to the consequences of the second law of thermodynamics. The second law states that entropy (disorder) in the universe is constantly increasing and that during energy conversions, energy changes to less organized and useful forms. During each conversion stage, some energy is lost as heat. Therefore, the more conversions taking place between the capture of light energy by plants and the trophic (feeding) level being considered, the less the energy available to that level. In general, efficiency of the transfer along food chains is less than 10% because 90% of the available energy is lost to surrounding environment. At each trophic level within the system, only a small fraction of the available energy is used for the production of new biomass, most is used for respiration and body maintenance. A common ecological measure of efficiency is the trophic-level efficiency, the ratio of production at one trophic level to that of next lower trophic level. This is never very high and rarely exceeds 10%, more typical values being only 1-3% [47]. To meet out the growing demand of meat (as in case 'b'), additionally more crop, food grains, cereals, water, land, and energy are required for the growth and reproduction of livestock which further lead to emission of GHG. This additional GHG emission significantly increases global warming and climate change.

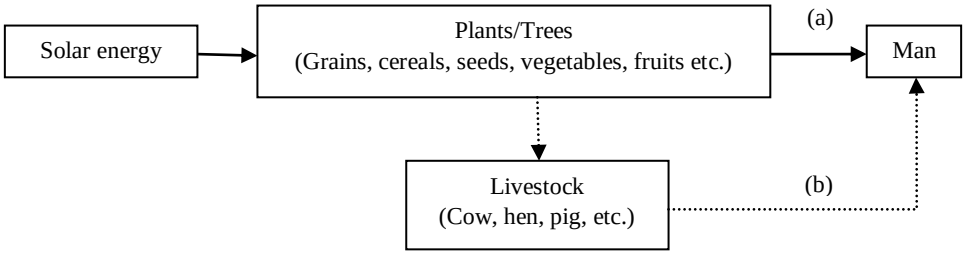

Figure 2: Trophic level(s) in vegetarian's ('a') and non-vegetarian's ('b') diet

Furthermore meat production requires up to 10 times the quantity of resources (land, energy, and water) relative to equivalent amounts of vegetarian food [48, 49]. The rearing of livestock for meat, eggs and milk utilizes 70% of agricultural land [50]. Over the next 50 years, this projected growth in meat production will cause a serious

challenge to the environment. More meat production means more land resources (for housing and crop production) will be required for additional livestock which further cause increased soil erosion, water pollution, wildlife habitat degradation, and increased use of pesticide and fertilizer inputs. According to the United Nations, raising animals for food production (including land used for grazing and to grow feed crops) uses about 30% of the available land. It is obvious that livestock farming has excessive pressure on land. In Netherlands, 20.9, 8.9, and 7.3 m^2 of land is required to produce 1 kg of beef, pork and broiler, respectively [34]. If same model is followed, the total land used for meat production was 2.53 million km^2 in 2002 whereas it is estimated to be 6.59 million km^2 by 2050, which is more than 2.5 times. More than 20% of all water consumed is used to grow grain to feed livestock [50]. According to Mishra (2012), it takes more than 2,400 gallons of water to produce 1 pound of meat, while to grow 1 pound of wheat, 25 gallons of water is required. A vegan diet requires around 300 gallons of water per day, while a typical meat-eating diet requires more than 4,000 gallons of water per day [51]. The production of 1 kg of animal protein requires about 100 times more water than 1 kg of grain protein production [52]. Livestock directly requires only 1.3% of the total water used in agriculture but when the water required for forage and grain production is included, the water requirements for livestock production significantly increase. [53]. But the environmental impact of consuming sea food may either relatively low or very high, depending on whether it originate from aquaculture or wild catch, species, production efficiency etc. [9]

VI. CONCLUSION

On the basis of above discussion, it is clear that the current scenario of food production and consumption, mainly non-vegetarian, is not environmentally sustainable. Hence, there is an urgent need to consume low carbon footprint diet (vegan or vegetarian) that have lower environmental impacts. Environmental issues such as global warming and climate change can be minimized by adopting vegetarianism or by lowering the consumption of meat and other animal based products. It should be mandatory on the part of government to label carbon footprint value on food products that would further helpful for consumers to choose low impact food products. In this context, environmental educationist can play a vital role by awaring the children/students through environmental education.

REFERENCES

[1] Foresight, The future of food and farming. Final Project Report, London: Government Office for Science (2011).
[2] Fanzo, J., & Mattei F., Ensuring agricultural biodiversity and nutrition remain central to addressing the MDG1 hunger target. In: Burlingame, B., & Dernini, S. (editors), Sustainable diets and biodiversity: directions and solutions for policy, research and action. Rome: Food and Agriculture Organization, 44-53 (2012).
[3] Jessica, L. J., Jessica, C. F., & Bruce, C., Understanding sustainable diets: A descriptive analysis of the determinants and processes that influence diets and their impact on health, food security, and environmental sustainability. *Advances in Nutrition*, 5, 418-429 (2014).
[4] Brown, L. R., Who Will Feed China? Wake-Up Call for a Small Planet. Norton, New York (1995).
[5] Rosegrant, M. W., Paisner, M. S., Meijer, S. & Witcover, J., Global food projections to 2020: Emerging trends and alternative futures. International Food Policy Research Institute, Washington, DC (2001).
[6] Steinfeld, H. & Chilonda, P., Old players, new players in FAO. Livestock Report (2006).
[7] Tukker, A., Goldbohm, R. A., Koning, A. de, Verheijden, M., Kleijn, R., Wolf O., Pérez-Domínguez, I., & Rueda-Cantuche, J., Environmental impacts of changes to healthier diets in Europe. *Ecological Economics*, 70 (10), 1776-1788 (2011).
[8] Tukker, A., Huppes, G., Guinée, J. B., Heijungs, R., Koning, A. de, Oers, L. van, Suh, S., Geerken, T., Holderbeke, van M., Jansen, B., Nielsen, P., Environmental impact of products Analysis of the life cycle environmental impacts related to the final consumption of the EU-25, Technical report, p. 139 (2006).
[9] Nemecek, T., Jungbluth, N., Canals, L. M. & Schenck, R., Environmental impacts of food consumption and nutrition: where are we and what is next? *International Journal of Life Cycle Assessment*, 21, 607-620 (2016).
[10] Audsley, E., Brander, M., Chatterton, J., Murphy-Bokern, D., Webster, C., & Williams, A., How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope to reduce them by 2050. Food Climate Research Network & WWF, London, UK (2009).
[11] Garnett, T., Where are the best opportunities for reducing greenhouse gas emissions in the food system (including the food chain)? *Food Policy*, 36, S23–S32 (2011).

[12] Food and Agriculture Organization (FAO), Key facts and findings. http://www.fao.org/news/story/en/item/197623/icode/
[13] World Population Prospects, Population Division, United Nations. http://www.esa.un.org.
[14] Bouwman, L. , Goldewijk, K. K., Hoek, K. W. V. D. , Beusen, A. H. W., Van Vuuren, D. P., Willems, J., Rufino M. C. &, Stehfest, E., Exploring global changes in nitrogen and phosphorus cycles in agriculture induced by livestock production over the 1900–2050 period. In Proc. of National Academy of Science of the United States of America, 110 (52), 20882–20887, Nov. (2013).
[15] Godfray, H. C. J., Beddington, J. R. Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Pretty, J., Robinson, S., Thomas, S. M. & Toulmin, C., Food Security: The Challenge of Feeding 9 Billion People. *Science*, 327(5967) 812-81812 (2010).
[16] *"This Survey Found Out How Many Indians Are Non-Vegetarians And Which State Is The Least Vegetarian*" June (2016). https://www.scoopwhoop.com/This-Survey-Found-Out-How-Many-Indians-Are-NonVegetarians-And-Which-State-Is-The-Least-Vegetarian/
[17] https://www.reuters.com/article/2015/07/21/us-israel-food-vegan-idUSKCN0PV1H020150721
[18] *"The slow but steady rise of vegetarianism in Australia".* August (2016). http://www.roymorgan.com/findings/vegetarianisms-slow-but-steady-rise-in-australia-201608151105
[19] *"Vegetarians, vegans 'hated and bullied in Australia', author says". ABC.* August (2016). http://www.abc.net.au/news/2016-08-02/vegetarians-vegans-hated-bullied-australia-richard cornish/7680900
[20] *"One in ten Swedes is vegetarian: survey"* March (2014). http://www.thelocal.se/20140321/one-in-ten-swedes-is-vegetarian-survey
[21] *"Il popolo dei vegetariani e vegani in Italia: l'infografica".* http://www.repubblica.it/cronaca/2015/09 /17/news/il_popolo_dei_vegetariani_e_vegani_in_italia_l_infografica-123063811/
[22] *"Un bébé sous régime vegan retiré à ses parents pour malnutrition".* July (2016). *https://www.rtbf.be/info/societe/detail_un-bebe-sous-regime-vegan-retire-a-ses-parents-pour-malnutrition?id=9350722*
[23] "*Global and regional food consumption patterns and trends*". http://www.fao.org/docrep/005/ac911e/ ac911e05.htm
[24] Food and Agriculture Organization, The state of food and agriculture-Livestock in the balance. Rome (2009).
[25] Linseisen, J., Welch, A. A., Ocke, M., Amiano, P., Agnoli, C., Ferrari, P., Sonestedt, E., Chajes, V., Bueno-de-Mesquita, H. B., Kaaks, R., Weikert, C., Dorronsoro, M., Rodrıguez, L., Ermini, I., Mattiello, A., van der Schouw, Y. T., Manjer, J., Nilsson, S., Jenab, M., Lund, E., Brustad, M., Halkjær, J., Jakobsen, M. U., Khaw, K. T., Crowe, F., Georgila, C., Misirli, G., Niravong, M., Touvier, M., Bingham, S., Riboli, E. & Slimani, N., Dietary fat intake in the European prospective into cancer and nutrition: results from the 24-h dietary recalls. *European Journal of Clinical Nutrition*, 63, S61–S80 (2009).
[26] Pan, A., Sun, Q., Bernstein, A. M., Schulze, M. B., Manson, J. E., Stampfer, M. J., Willett, W. C., Hu, F. B., Red meat consumption and mortality: results from 2 prospective cohort studies. *Archives of Internal Medicine*, 172, 555-563 (2012).
[27] Food and Agriculture Organization, Meat and meat products. Food Outlook, June (2008).
[28] Food and Agriculture Organization, Livestock's long shadow, environmental issues and options (2007).
[29] "*An Analysis of Changing Food Consumption Pattern in India"*, National Council of Applied Economic Research, New Delhi. http://nfsm.gov.in/
[30] Sample registration system baseline survey (SRSBS) (2014). www.censusindia.gov.in/vital_statistics/BASELINE%20TABLES07062016.pdf
[31] http://www.deccanchronicle.com/lifestyle/food-and-recipes/110616/telangana-is-india-s-most-non-veg-state.html
[32] Wathes, C. M., Holden, M. R., Sneath, R. W., White R. P. & Phillips, V. R., Concentrations and emission rates of aerial ammonia, nitrous oxide, methane, carbon dioxide, dust and endotoxin in UK broiler and layer houses. *British Poultry Sciences*, 38(1), 14-28 (1997).
[33] IPCC, The regional impacts of climate change: An assessment of vulnerability. Cambridge University Press, U.K. (1997).
[34] Gerbens-Leenes, P. W. & Nonhebel, S., Consumption patterns and their effects on land required for food. *Ecological Economics*, 42(1-2) 185-199 (2002).
[35] United States Environmental Protection Agency. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

[36] Scarborough, P., Appleby, P. N., Mizdrak, A., Briggs, A. D. M., Travis, R. C., Bradbury, K. E., & Key, T. J., Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the U.K. *Climatic Change*, 125, 179-192 (2014).
[37] Pelletier, N., Audsley, E., Brodt, S., Garnett, T., Henriksson, P., Kendall, A., Kramer, K. J., Murphy, D., Nemecek, T. & Troell, M., Energy intensity of agriculture and food systems. *Annual Review of Environment and Resources* 36: 223–246 (2011).
[38] Tilman, D., & Clark, M., Global diets link environmental sustainability and human health. *Nature*, 515, 518-522 (2014).
[39] Kanyama, A. C. & Gonzalez, A. D., Potential contributions of food consumption patterns to climate change. *American Journal of Clinical Nutrition*, 89(suppl.), 1704S–1709S (2009).
[40] Barrett, J., Vallack, H., Jones, A. & Haq, G., A material flow analysis and ecological footprint of York: Technical report (2002).
[41] Kramer, K. J., Moll, H. C. & Nonhebel, S., Greenhouse gas emissions related to Dutch food consumption. *Energy Policy*, 27**,** 203-216 (1999).
[42] Wallen, A., Brandt, N. & Wennersten, R., Does the Swedish consumer's choice of food influence greenhouse gas emissions? *Environmental Science and Policy*, 7**,** 525-535 (2004).
[43] "Now, It's Not Personal!", *World Watch Magazine*, July/August (2004).
[44] Food and Agriculture Organization, World agriculture towards 2015/2030. www.fao.org/3/a-y4252e.pdf
[45] Food and Agriculture Organization, Livestock's long shadow: Environmental issues and options, November (2006).
[46] Alig, M., Grand, F., Mieleitner, J., Nemecek, T., & Gaillard, G., Ökobilanz von Rind-, Schweine- und Geflügelfleisch. Agroscope Reckenholz-Tänikon ART, Zürich, p. 151 (2012).
[47] Santra, S. C., *Environmental Science*, Third edition, New Central Book Agency, Kolkata, India, p. 79-80 (2016).
[48] Durning, A. T. & Brough, H. B., Taking Stock: Animal Farming and the Environment. World Watch Institute, Washington, DC, *World Watch Paper*, 103 (1991).
[49] Dutilh, C. E. & Kramer, K. J., Energy consumption in the food chain: comparing alternative options in food production and consumption. *Ambio*, 29 (2), 98-101 (2000).
[50] *"Tim Zimmermann,* Who can't rally behind that?" June (2015). https://www.outsideonline.com/2046606/eating-right-can-save-world
[51] Mishra, M. K., Modern lifestyle, non veg food and its impact on environmental aspects. *Global Journal of Human Social Science*, 12(7), Version 1.0 (2012).
[52] Pimentel, D. & Pimentel, M., Food, energy and society. Colorado University Press, Niwot, CO (1996).
[53] Pimentel, D. & Pimentel, M., Sustainability of meat-based and plant-based diets and the environment, *American Journal of Clinical Nutrition*, 78(suppl), 660S-663S (2003).

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