

Food vs. Fuel

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Abstract

The aim of this paper is to measure the annual carbon footprint, when vegetables and grains travel from farms to consumers. The focus is on the food basket of Cuttack City, Odisha, India. Primarily, this is an exploratory research which includes research instruments namely interviews and survey through questionnaire with the transportation authority across the distribution channel. Additional data collected thorough secondary sources, existing literature. The major findings of this research are the amount of greenhouse gas emission, for the vegetable, rice, wheat, milk and pulses etc., which comprise the food basket, with comparative analysis of grains versus vegetables & milk products, when travels through the distribution network and reaches the consumers of Cuttack City. The study scope is limited to Cuttack City only and the product scope is limited to the vegetarian food and the milk products. This research will provide a better understanding to measure the environmental impact caused by the transportation of food items. Based on this research, distribution channels redesigning can done to make them environmental friendly and sustainable, to achieve food security.

Keywords: Food Miles, Food Basket, Carbon footprint, Distribution Network, Sustainability.

JEL code: M 31

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Introduction

In the last five decades, the methods of food production, storage, distribution and consumption have changed significantly. Most sophisticated distribution systems are being used to meet the demand, minimizing food wastages and maintaining quality of the food. But the vast distances that food travels 'from plough to plate' makes it vulnerable to oil supply, inefficient on a per calorie basis, and unsustainable in the long run. In accordance to the fair trade systems, many of these problems can be overcome by creating regional and local food systems which encourages the production and use of local produce. (sustainweb, 2002)

Few studies on the public understanding of sustainable food describes, seasonality in food production is gradually becoming a lost concept in the present situation, as consumers expect all produce to be available at any time of year regardless the availability in the local market. But there is serious concern for environment when food items travel long distance. Transportation and refrigeration rely mostly on fossil fuels to power them, which in turn emit various greenhouse gasses (GHG), which have a detrimental effect on the environment. Since in our country, such studies are very few. This paper will be helpful to gain better insight and understanding. The major objective of this research is to measure the annual carbon footprint, when vegetables and grains travel from the farms to the consumers. The focus is on the food basket of Cuttack City, Odisha, India. This study will help to assess the sustainability of the food distribution channel and addressing the complexity and challenges in effective distribution of food items along with addressing the major concerns for environment.

Background of the Study

'Food Basket' is described as a mixture of basic food products which prepares the usual diet of an individual for daily consumption (Flores, 1980). In another way food basket is defined as a customized basket of local agriculture products for daily consumption (Multitude, 2008). So, the term local produce is evident if we consider a food basket, but for loss of agricultural land due to rapid urbanization (Jiang, 2013) has changed the diet pattern of the indigenous people as they depend more upon the foreign food produces (Mohanty, 2012). The 'global food concept'

is another reason which created a categorical shift in the farmer community as nations become responsible for only one or two crops to sale it as major commodity, which directly impacted the variety of local food production. This type of food behavior, not only creates a socio-economic imbalance but also impacts the environment due to the massive movement of food products from foreign sites (Hodge & Gorelick, 2002).

The distance the food travels from the source point to the consumption point is termed as food miles. Timothy Lang first coined the term in 1990 to assess the distance travelled by the food and its impact on the environment to go towards sustainability (Lang, 1999). The process to calculate the environmental impact on each stage of transformation and distribution is known as the 'life cycle analyses' of that food product. Because of globalization it is now evident that the distribution of food impacts more to the environment rather than its production (Weber & Matthews, 2008).

Increasing population has increased the demand for fresh fruits and vegetables along with pulses. To meet demand and provide a food in proper quality and nutrition, Supply chain plays a very important role in this sector and becomes even more important because of perishability nature and very short shelf life. It helps to cut costs, and adds to maintain and improve the quality of produce delivered, which are perishable in nature (Veena, 2011).

The environmental impact is calculated as the generation of the greenhouse gases or the carbon footprint. Carbon footprint is measured in tons of carbon dioxide equivalent (tCO₂e). The carbon dioxide equivalent (CO₂e) allows the different greenhouse gases to be compared on a like-for-like basis relative to one unit of CO₂. CO₂e is calculated by multiplying the emissions of each of the six greenhouse gases by its 100 year global warming potential (GWP). A carbon footprint considers all six of the Kyoto Protocol greenhouse gases: Carbon dioxide (CO₂), Methane (CH₄), Nitrous oxide (N₂O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF₆). So prior realizing the environmental impact we need to understand the food basket of Cuttack urban area.

In this study Cuttack city has been chosen to represent tier 3 and 4 city in the Odisha state in particular and country in general. The study highlights the difficulty in developing sustainable

food distribution channel owing to the fact the increasing income and availability of almost all varieties of vegetables and fruits throughout the year.

Objective of the study

- To calculate the annual carbon footprint (CO₂ Emission in grams), when the items of the food basket flows through the distribution network and reaches the consumers of Cuttack city.
- To evaluate the consumption pattern of food items of the food basket to understand the dependency on local food items to achieve sustainability.
- To identify the factors affecting sustainable food distribution network.

Research Methodology

In order to determine food mile for food basket of Cuttack city authors utilized multiphase research design incorporating both qualitative and quantitative research.

(a) Qualitative Research:

The first step of the qualitative research involves extant of literature review and techniques applicable to the specific problems. This embraces the works on existing literatures on food miles, carbon footprints, and different statistics to understand the food basket of Cuttack city. Other relevant research papers on food distribution channel of different food items, transportation system and sustainable distribution channel to have better understanding to measure the annual carbon footprint, when vegetables and grains travel from farms to fork.

Second step of the qualitative research involves semi structured questionnaire for in-depth interview. We have conducted around 20 in-depth interviews with various vendors. The purpose is to know how vendors of different food items source the products and make them available to the end user. Our motto is to have in-depth understanding of their role and challenges across distribution channel. This has helped us know the movement of different food items and develop the model of product movements. The collected data has been analyzed using qualitative content analysis. This is a research method for subjective interpretation of the content of text data through systematic classification process of coding and identifying

themes or patterns (Hsieh & Suannon, 2005).

Third step of the qualitative research involves experience surveys of different transporters, small vehicle owners, managers and drivers of heavy vehicles. We took responses from 20 vehicle owners, 20 heavy vehicle drivers and 5 managers of third party logistics to understand the complexity of transportation and variations among different food items while transporting them from source to end users. Keeping the purpose of study in mind summated content analysis has been used. This method starts with counting of words or manifest the content, then extends the analysis to include latent meaning and themes. (Marying, 2000).

(b) Quantitative Research:

The main thrust of the quantitative research is to determine food miles to assess sustainability of food distribution channel for Cuttack city. In order to do this, we need to have consumption data of different food items in our food basket. But, as of now no such data is available. Therefore, we have divided the quantitative research in two stages.

The stage one completely devoted to measure the consumption of food items in our food basket annually. We have collected the monthly consumption of family using closed ended questionnaire and converted that into annual consumption of different items. We have used proportionate stratified random sampling. This is a sampling technique that uses a two-step process to partition the population into subpopulations, or strata. Elements are selected from each stratum by a random procedure. (Malhotra & Dash, 2011). As per USDA (Economic Research Service, 2008) data published in Washington state magazine, Indians spend their 35.8% annual income on food. Since major portion of Indian family income spend on food we took this as classification criteria for strata. At present, there are 16,846 BPL (Below Poverty Line) families, 5,965 under the Antodaya and 1,38,063 APL (Above Poverty Line) families under the corporation limits.(Barik, 2014). We took 40 respondents from BPL and 80 from APL and as sampling frame we have used list of BPL from Cuttack Municipal Corporation and voter list.

The second step in quantitative research involves calculation of food mile and determination of greenhouse gas emission in the process of transportation of food item from farm to fork. A

Weighted Average Source Distance (WASD) is used to calculate a single distance figure that combines information on the distances from production to point of sale and the amount of food product transported. (Carlsson-Kanyama, 1997).

To calculate Carbon Footprint we found the following method has been used:

CO₂ Emission (in gms. w. r. t. vehicle used) = TV * TD * CO₂ emission factor

Where,

Transportation Volume (TV) measured in Tonne Transportation Distance (TD) measured in Kilometer CO₂e Factor is measured in gram/tonne-km

Avg. CO₂e ; Factor for Diesel trucks and vans are taken as 62g/tonne-km (ECTA, 2011) ; Avg. CO₂e Factor for Gasoline used vehicles are taken as 172g/tonne-km (DEFRA, 2013).

About the City:

As per Cuttack Municipal Corporation (Cuttack Municipal Corporation):

Cuttack, known as the cultural capital of Odisha is situated at the apex of the delta formed by the river Mahanadi and Kathajodi. The City experiences a hot and humid climate in summer characterized by temperatures going up as high as above 40° C and a dry and cold climate in winter with temperature as low as 10° C. Summer starts at the end of March and monsoon rains hit the city during September to middle October and supply most of the city's annual average rainfall.

Cuttack lies in the national high way No.5, connecting the metropolitan cities of Kolkata and Chennai. Well connected by rail, Cuttack is an important hub for most trains. The nearest airport is Biju Pattnaik Airport, 28 Kms away. It also has the largest bus terminus of the state.

The City is subdivided into a number of wards.

Area	:	192.5 Sq.Km.
Population	:	6,10,189 (as per 2011 census)
Total Nos. of Wards	:	59 Nos.
Identified Slums Under C.M.C.	:	264 Nos.
No. of Parks	:	29 Nos.
Males Population	:	3,16,242
Female Population	:	2,93,947

Food Basket Analysis of Cuttack City:

This research paper concentrates upon the distribution network and physical distribution of major food items included in the food basket of the population of Cuttack City, according to the consumption pattern and the environmental impact when the food follows through the distribution chain i.e. from the source to the consumption point. The major agenda behind determining the food basket is to know the actual amount of local crops used and the dependency on the foreign food items in daily consumption. The typical food basket of city people contains the food item on monthly basis is given in table no. 1

Table 1: Monthly consumption food items: Avg. family size is taken Family Size= (X=4)

Item	Consumption in kg or litre or in no.	Item	Consumption in kg or litre or in no.	Item	Consumption in kg or litre or in no.
Rice (Arwa)	16.2	Potato	11	Milk	30
Rice (Ushna)	8.12	Onion	6.5	Curd	10
Rice (Basmati)	2.7	Tomato	6	Paneer	3
Dal (moong)	3	Kakharu (Veg.) (pumpkin)	2.5	Cheese	1
Dal (Arhar)	2.5	Kaddu (Veg.)	2.2	Sugar	5
Dal (biri)	1.5	Bhendi (veg.)	2	Ghee	1
Dal (chana)	0.5	Cabbage	5	Aaata (Wheat flour)	20
Dal (Masoor)	0.5	Baingan (Brinjal)	5	Banana	5
Besan	1.5	Other Seasonal Vegetables	3	Coconut	3
Chura and chura powder	8.4	Saag (Leafy Veg.)	2	Other fruits	10

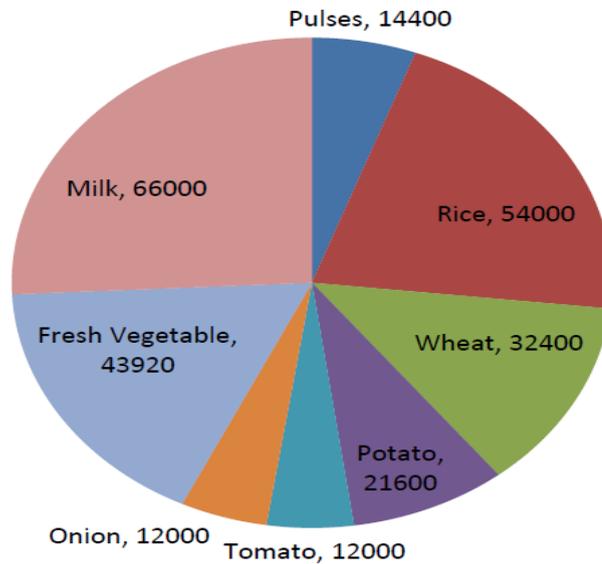
Source: Based on Pilot study conducted for understanding food basket of the city by authors

Authors classified the food basket in the following manner on the basis of product

characteristics and their distribution channel:

Food Basket of Cuttack City: Pulses, Rice, Wheat, Potato, Tomato, Onion, Fresh Vegetables, Milk and Milk Products

Figure 1: Total Annual Consumption of Food in Cuttack city

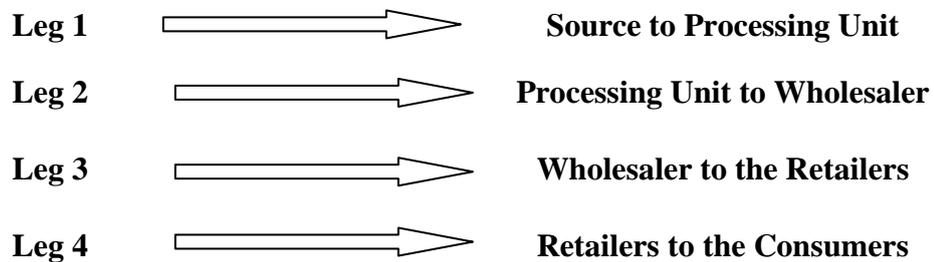


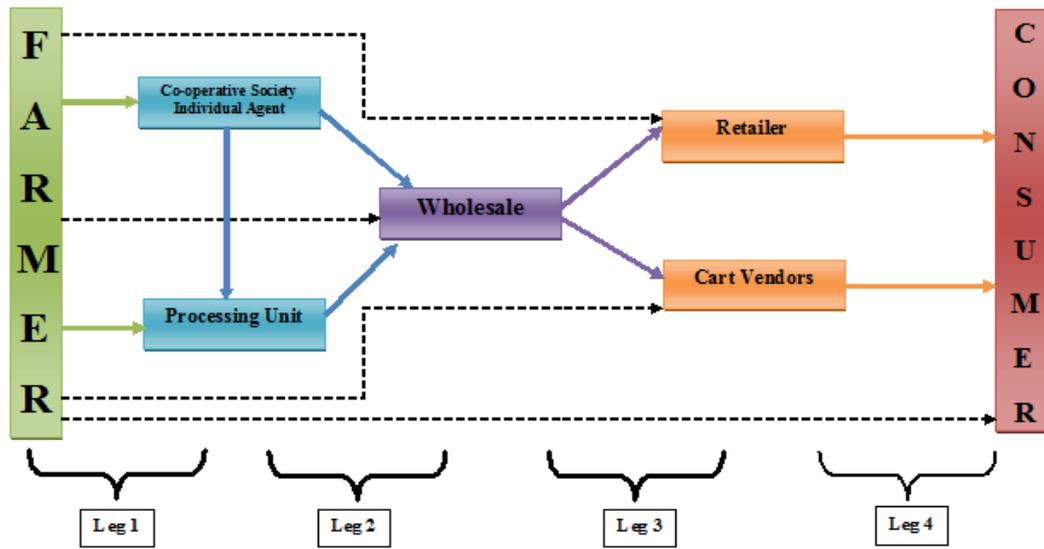
Source: Based on Primary Data Collection

Distribution network of the food items in the Cuttack Urban Area: Traditional Method:

The food items follow an as usual source to consumer distribution network pattern. According to previous researches and understanding the distribution network is divided in to four regions. (Rajkumar, 2010)

Figure 2: Traditional Food Distribution Network



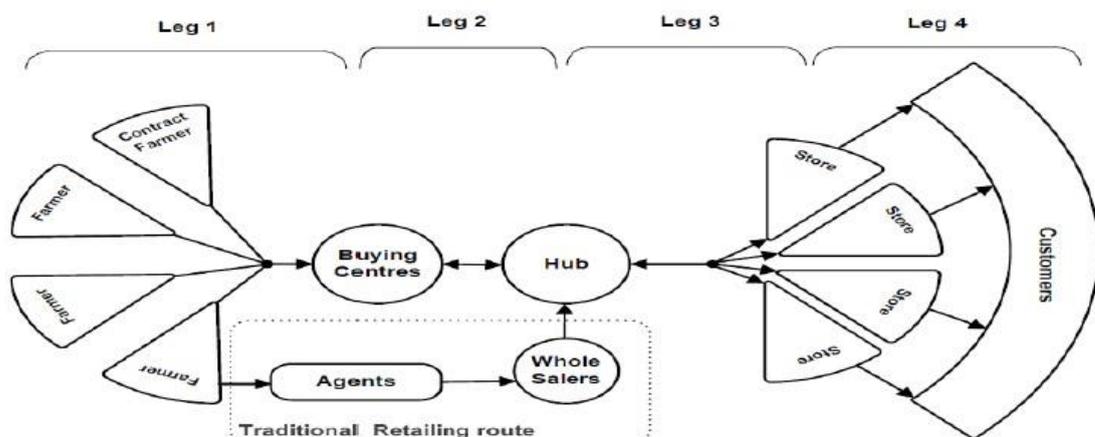


Source: Rajkumar, 2010

Hub and Spoke Model:

Various organized retailers like reliance fresh, food bazar (future Group), Udyaan Fresh have adopted ‘Hub & Spoke’ model for the supply chain of F&V, and Figure 3 explains the model. Important members in the model are Farmers, Buying Centers, Agents, Wholesalers, and organized retail stores along with customers. This model has buying centers; hub and stores (retail outlets) are operational units of the organized retailers. Small farmers and Contract farmers are the major source of supply of F&V in this model.

Figure 3: Supply Chain of Hub & Spoke

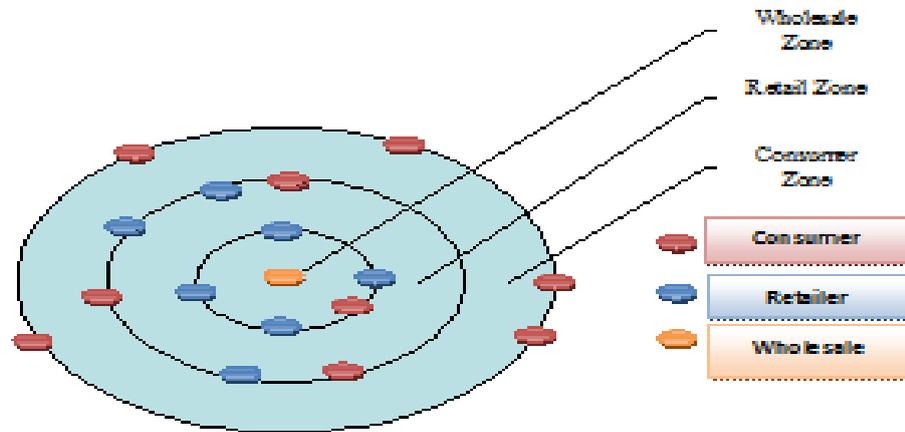


Source: Halder, 2011

Wholesale Zone, Retailer Zone of Cuttack City:

To make the research simple the city is divided in to three zones i.e. wholesale zone, retail zone, consumer zone.

Figure 4: Wholesale Zone, Retailer Zone of Cuttack City



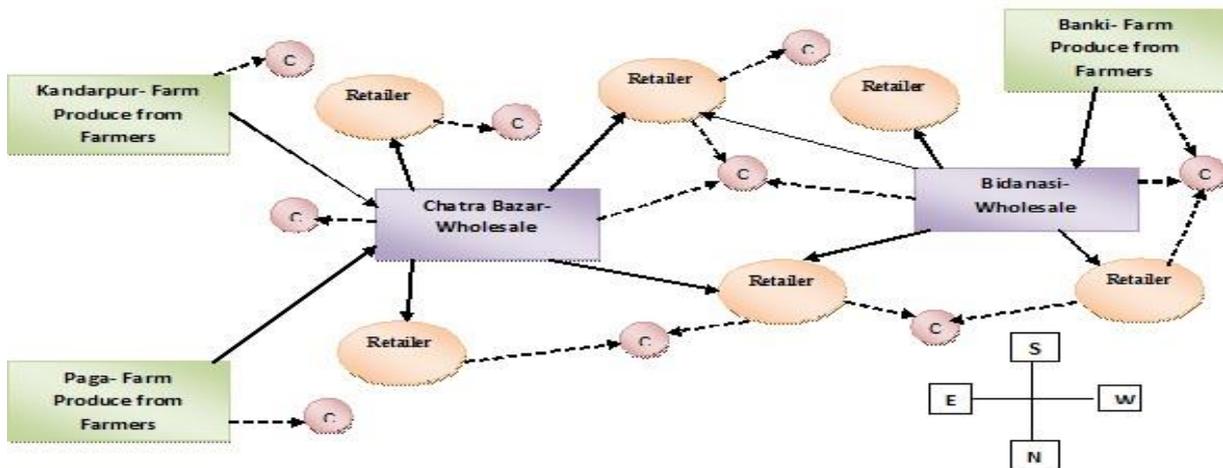
Source: Developed by the Authors based on experience survey

In accordance to the food basket milk and fresh vegetable distribution network follow a different path than the distribution of pulses, rice, wheat, potato, tomato and onion in the city. The zonal distribution of consumers, retailers and the wholesale area is demonstrated keeping the geography of Cuttack city in mind. As per the trend the wholesale area i.e. Malgoldown, is centrally located and the radius of the city is of 9 km. The retail stores are located in between the city perimeter, and the consumers follow a maximum travel distance of 1 km to complete the distribution network.

Distribution of fresh vegetable:

As per the observation, the distribution of fresh vegetable follows slightly different path than the other items in the food basket. The farmers sale their produces in Paga, Kandarpur and Banki areas which are located in the north- eastern, eastern and western part of the city with distance from the wholesale areas 17 km, 17 km and 50 km respectively. The city is having two Mandi (wholesale for the fresh vegetable), which are located in the central part and the western part of the city, within its perimeter and the retailers follow a balanced procurement policy according to their accessibility to the wholesale area and availability of the products. Here the consumers follow a distance of 1 km from the retail area.

Figure 5: Model for Fresh Vegetable Distribution in Cuttack

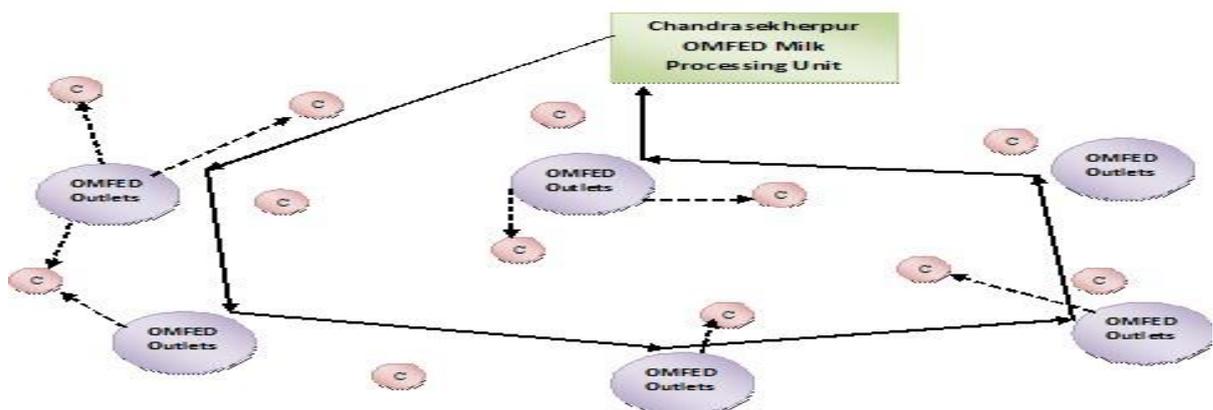


Source: Developed by the Authors based on experience survey

The distribution model for milk:

The city depends upon the government of Odisha milk processing and distribution unit (OMFED- Odisha Milk Federation), to compensate the demand of milk. Major dependency is upon the Chandrasekherpur OMFED milk processing unit, which is 40 km away of the city. It is observed that OMFED has got its numerous outlets in the city where packaged milk and other milk products are distributed every day morning and evening. The consumers follow a pattern of buying milk from nearest outlet which ranges from 1-2 Km.

Figure 6: Model for Milk Distribution (Milk-Van Method) in Cuttack



Source: Developed by the Authors based on experience survey

Findings & Conclusions

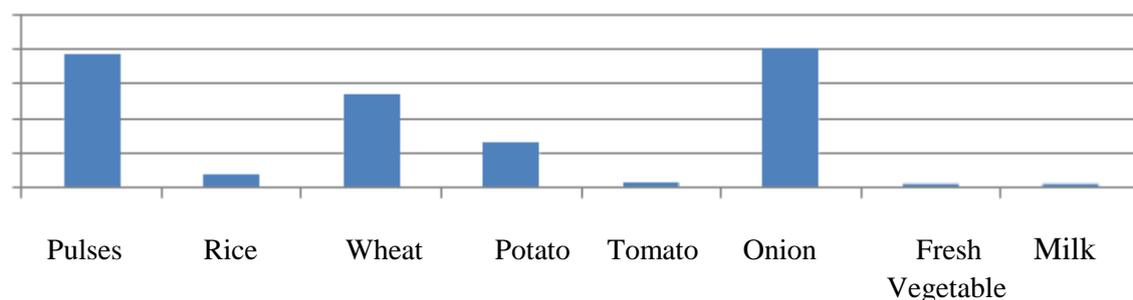
Keeping the total consumption in mind with respect to the total population of the city the CO₂e in gram is calculated for each of the food items when it travels from the source to the consumer in a yearly basis. The data suggest that grains which is around 39% of total consumption contributes 64% emission of CO₂ whereas reverse is true in case of vegetables, milk and milk products. So we can see the difference is 29% between grains and vegetables & milk for yearly emission of CO₂.

Table 2: Annual Consumption and yearly CO₂ Emission

Categories	Food Items	Yearly CO ₂ Emission in Gram	Total Annual Consumption in 1000 kgs	Contribution of food item in CO ₂ emission in %	Total annual consumption in percentage	Ratio of total annual consumption to yearly CO ₂
Grains	Pulses	1131.24281	14400	21.65381523	5.617977528	3.854379111
	Rice	423.6900232	54000	8.110111636	21.06741573	0.384959966
	Wheat	1793.834131	32400	34.33688372	12.64044944	2.716429023
	Subtotal grains	3348.766964	100800	64.10081059	39.3258427	6.9557681
Vegetables, Milk and Milk Products	Potato	569.9931452	21600	10.91058979	8.426966292	1.294723321
	Tomato	41.65925248	12000	0.797425405	4.68164794	0.170330066
	Onion	989.3168525	12000	18.93712308	4.68164794	4.04496949
	Fresh Vegetable	108.5939704	43920	2.078664058	17.13483146	0.121312197
	Milk	165.8891872	66000	3.175387084	25.74906367	0.123320487
	Sub Total	1875.452408	155520	35.89918942	60.6741573	5.754655561
Grand Total	5224.219372	256320	100	100	12.71042366	

Source: Based on Primary Data Collection

Figure 7: Ratio of total annual consumption to yearly CO₂ emission



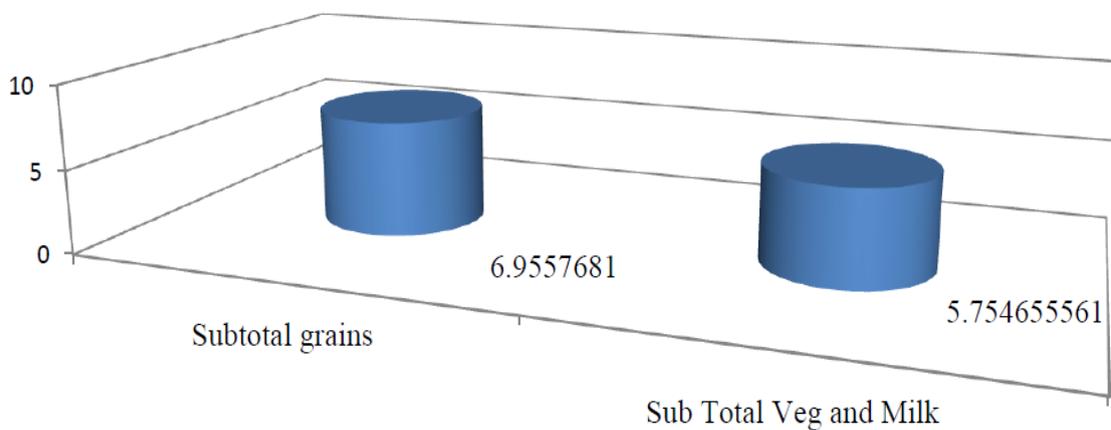
Source: Based on Primary Data Collection

Figure 8: Total annual consumption in percentage



Source: Based on Primary Data Collection

Figure 9: Ratio of total annual consumption to yearly CO₂ emission



Source: Based on Primary Data Collection

We can see the difference is in real terms just around 10% when we consider ratio of total annual consumption to yearly emission of CO₂. This clearly explains that rather the quantity of food consumption than distance and kind of transportation vehicle affects the carbon footprint. The various distribution channel used at local level further increase the carbon footprint because of smaller vehicle to reach different nook and corner of the city. It is quite evident if proper support and initiative will be taken by local authorities and people more organized distribution network with lesser GHG emission can be achieved. Wastage of vegetable because of poor infrastructure and refrigeration facility further increases dependency on foreign goods which further increase carbon footprints.

According to the research the major objective to calculate the CO₂ emission is achieved, which will provide a firm understanding to analyze the present distribution practices to redesign a sustainable model in future. Moreover, the local items generate comparatively less CO₂ emission than the foreign food items like pulses, wheat and onion.

The factors and aspects addressed in paper may further be empirically tested and validated on the grains and F&V distribution network. Cuttack city is a 3 tier city and has similar characteristics of tier 3 and 4 cities. Eventually, the study will help to study and develop sustainable distribution channel for food across Odisha in particular and across country in general.

Limitations of the study

In our study we are limited to vegetarian food items only. There are various processed food, ready to eat items, tea, coffee, packaged cold drink, fruit juice, oil, spices etc. along with non-vegetarian items are not part of our food basket. Since, no proper data on floating population and their consumption pattern is available we took the permanent residents of Cuttack city only.

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