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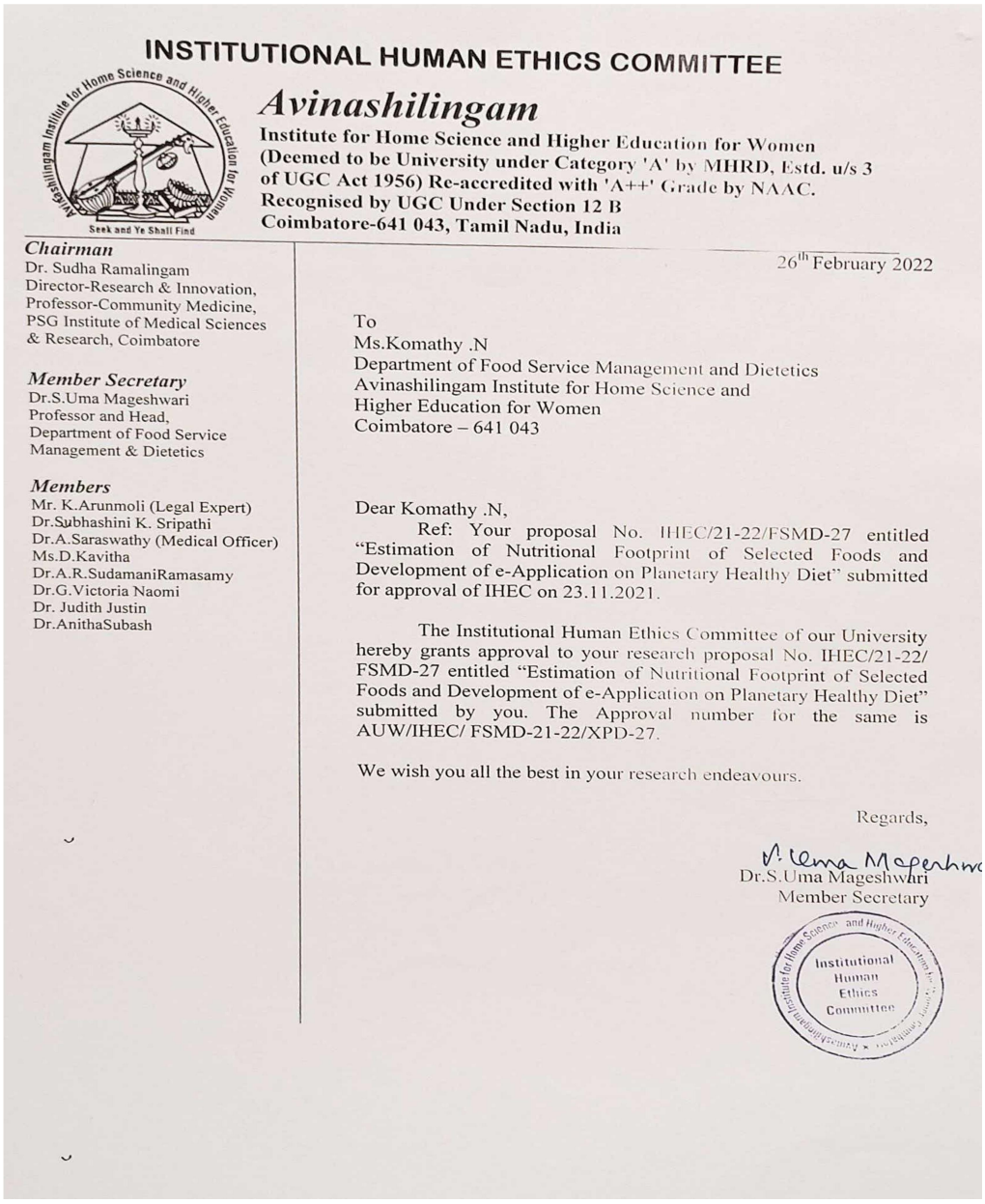
Annexures

Annexure - I

INSTITUTIONAL HUMAN ETHICS COMMITTEE CLEARANCE CERTIFICATE (AVINASHILINGAM INSTITUTE FOR HOME SCIENCE AND HIGHER EDUCATION FOR WOMEN)



INSTITUTIONAL HUMAN ETHICS COMMITTEE

Avinashilingam

Institute for Home Science and Higher Education for Women
(Deemed to be University under Category 'A' by MHRD, Estd. u/s 3 of UGC Act 1956) Re-accredited with 'A++' Grade by NAAC.
Recognised by UGC Under Section 12 B
Coimbatore-641 043, Tamil Nadu, India

Seek and Ye Shall Find

Chairman
Dr. Sudha Ramalingam
Director-Research & Innovation,
Professor-Community Medicine,
PSG Institute of Medical Sciences & Research, Coimbatore

Member Secretary
Dr.S.Uma Mageshwari
Professor and Head,
Department of Food Service Management & Dietetics

Members
Mr. K.Arunmoli (Legal Expert)
Dr.Subhashini K. Sripathi
Dr.A.Saraswathy (Medical Officer)
Ms.D.Kavitha
Dr.A.R.SudamaniRamasamy
Dr.G.Victoria Naomi
Dr. Judith Justin
Dr.AnithaSubash

26th February 2022

To
Ms.Komathy .N
Department of Food Service Management and Dietetics
Avinashilingam Institute for Home Science and
Higher Education for Women
Coimbatore – 641 043

Dear Komathy .N,

Ref: Your proposal No. IHEC/21-22/FSMD-27 entitled "Estimation of Nutritional Footprint of Selected Foods and Development of e-Application on Planetary Healthy Diet" submitted for approval of IHEC on 23.11.2021.

The Institutional Human Ethics Committee of our University hereby grants approval to your research proposal No. IHEC/21-22/FSMD-27 entitled "Estimation of Nutritional Footprint of Selected Foods and Development of e-Application on Planetary Healthy Diet" submitted by you. The Approval number for the same is AUW/IHEC/ FSMD-21-22/XPD-27.

We wish you all the best in your research endeavours.

Regards,

Dr.S.Uma Mageshwari
Member Secretary

Institutional Human Ethics Committee

Annexure - II

INTERVIEW SCHEDULE TO ELICIT INFORMATION ON KNOWLEDGE, ATTITUDE AND PRACTICE ABOUT PLANETARY HEALTH DIET

I. General Information

1. Name :
2. Age :
3. Gender :
4. Mobile Number :
5. Address :
6. Email.ID :
7. Religion : ☐Hindu ☐Christian ☐Muslim ☐others

II. Socio Economic Status

1. Family Income per annum **(Modified Kupusamy, 2019)**

☐≤2,640 ☐ 2,641-7,886 ☐13,161-19,758

☐19,759-26,354 ☐26,355-52,733 ☐≥52,734

2. Type of Family

☐Nuclear ☐Joint

3. Size of family

☐ Less than 3 ☐ 4-7 ☐ More than 7

4. Details of the family Members

S. No	Name	Relationship	Age	Sex	Educational Status	Marital status	Employment status	Income

Food expenses:

S. No	Food	Daily	Weekly	Monthly
1	Cereals and grains			
2	Pulses and legumes			
3	Fruits and vegetables			
4	Milk and milk products			
5	Meat and meat products			
6	Fats, oils and Sweets			
7	Spices and condiments			
8	Ready to eat foods			
9	Ready to cook foods			
10	Snacks			
11	Fast foods			
12	Hotel foods			

4. Health Status of the Respondent and their family members

A. Do you have any health problem?

1)Yes 2) No

B. If so, state the nature of the health problem that you have **(Emilie Reber *et al.*,, 2019, Srilakshmi, 2015)**

S. No	Symptoms	Yes	No
1	**Skin** Petechial Purpura Pigmentation Edema		

	Scaly rashes at sun exposed areas Easy bruising Dry, flaky skin Yellow or orange discoloration		
2	**Nails** Pallor or white colouring Clubbing Spoon shaped. Excessive dryness Darkness in nails Curved nail ends Discoloured and thickened nails		
3	**Head/Hair** Dull/lack luster. Sparse Alopecia Depigmentation of hair Scaly/flacky scalp Easy pluckability Swan neck deformity Flag sign. Brittle hair		
4	**Eyes** Pallor conjunctiva Night vision impairmrnt Photophobia Xeropthalmia Bitot's spots Corneal ulceration Diplopia Nystagmus Lateral gaze		

	Optic nerve atrophy Retinitis pigmentosa Visual deficits KayserFleischer ring Sunflower cataract Xanthelasma		
5	**Oral cavity** Glossitis Gingivitis Fissures/stomatitis Cheilosis Pale tongue Atrophied papillae Dental erosions Dental caries Dental fluorosis		
6	**Nervous system** Mental confusion Depression Lethargy Weakness Leg paralysis. Peripheral neuropathy Ataxia Hyporeflexia Muscle cramps Fatigue		
7	**Neck** Goitre Parotid enlargement		
8	**Heart** High output failure		

9	**Chest** Respiratory muscle weakness		
10	**Abdomen** Ascites Hepatomegaly		
11	**Extremities** Edema Atoxia Bone tenderness Bone/joint pain Muscle pain Hyporeflexia Muscle wasting and weakness		
12	**Thorax muscles** Joint swelling Thoracic roasary Atrophic muscles Decreased grip strength		
13	**General appearance** Loss of subcutaneous fat Sunken or hollow cheeks		

C. How long you / your family members suffer from diseases/disorders (---years / ---month)

D. What is the frequency of the health problems?

1) Regularly 2) Weekly 3) Monthly 4) Rarely

E. Are you / your family members on medications?

1) Yes 2) No

F. If so, which type of medications are preferred the most for the health complications mentioned,

1) Allopathy 2) Siddha 3) Homeopathy 4) Ayurveda 5) Unani

	Weekly	Monthly	Yearly
Medical expenses of your family			

5. Anthropometric details

A. Height (in cm):

B. Weight (in kg):

C. Body Mass Index (BMI):

D. Waist (in cm):

E. Hip (in cm):

F. Waist Hip Ratio (WHR):

G. MUAC:

H. Skin fold thickness:

I. BAI:

J. WHtR:

K. ABSI:

III. Diet Pattern

	Yes	No
Vegetarian		
Non vegetarian		
Ova vegetarian		
Lactovegetarian		
Lacto ova vegetarian		
Pescatarian		
Flexitarian		
Paleo diet		
Keto diet		
Mediterranean diet		
HCG diet		
Atkins diet		
Ultra low-fat diet		
Low carbohydrate diet		

Zone diet		
Dukan diet		

IV. Food and nutrition related knowledge (Macias *et al.*,, 2019)

1. Are you willing to learn more knowledge about healthy food and nutrition?
   a) Yes b) No
2. Do you know eating nutritious food can live a healthy life?
   a) Yes b) No
3. Why is a balanced diet important?

   a) Keeps healthy b) Protects from chronic disease c) Helps to maintain blood circulation

4. What foods are healthy?
   a) Plant based foods b) Animal based foods

5. How well do you think it is to have different types of foods at meals?
   a) Its tasty b) Appetising c) Healthy
6. Which food is high fat?
   A) Plant based foods b) Animal based foods
7. Which food is rich in iron?
   a) Organ meat b) greensC) Fruitsd) Milletse) Nuts
8. Which foods that contained high fibre?
   a) Milletsb) Vegetables c) Chicken d) Fruitse) Greens
9. Why is protein important for humans?

   a) Improves bone health b) maintain and repairs tissue c) helps to lose weight

V. Sociocultural Reasons on diet (Fresan*et al.*,, 2020)

1. Do you eat the same diet that rest of your family eat (parents, partner, children)? Why?
   a) Yes b) No
2. If not, what diet is followed by most of your family members?

Vegetarian	
Non vegetarian	

Ova vegetarian	
Lactovegetarian	
Lacto ova vegetarian	
Pescatarian	
Flexitarian	
Paleo diet	
Keto diet	
Mediterranean diet	
HCG diet	
Atkins diet	
Ultra low-fat diet	
Low carbohydrate diet	
Zone diet	
Dukan diet	

3. Do you follow the same diet as the most of your friends do?

   a) Yes b) No

   4. Are you influenced by the diet followed by your friends?

   a) Yes b) No

4. Do you ever give in to peer pressure and compromise your diet?

   a) Very often b) sometimes c) No

5. Is there a link between eating a more plant-based diet and your family's religious or spiritual beliefs?

   a) Yes b) No

6. According to you, which of the following statements do you think suits best with how plant-based diet is perceived in your city?

A health promoting lifestyle.	
A lifestyle for women.	
A weight loss lifestyle.	

A lifestyle for those who are highly concerned about their health.	
A lifestyle for low-income families.	
A higher income family's lifestyle.	
A lifestyle for those who follow particular religious or spiritual ideas.	
A lifestyle for those who are passionate about animal welfare.	
A way of living that recognises and reduces climate change.	
I'm not sure.	

VI. Psychopathology of planetary health diet (Georgois*et al.*,, 2020)

1. Which food is completely healthy and harmless?

   a) Animal based foods b) Plant based foods

2. A planetary health diet can lead to nutritional deficiency.

   a) True b) False

3. People who only eat plant-based food are _____

   a) Healthy b) Overweight c) Undernourished

4. The person who follows a vegetarian diet have higher level of protection.

   a) Agree b) Disagree

5. A planetary health diet can prevent disease.

   a) Agree b) Disagree

6. A planetary health diet is good for the environment.

   a) Agree b) Disagree

7. A planetary health diet is less cruel to animals.

   a) Agree b) Disagree

8. Why is it being difficult to follow planetary health diet?

   a) Not tasty b) Nutritional Deficiency c) Expensive

   d) preference of family members

9. People who eat a planetary health diet do so out of ethical motivation.

   a) True b) False

VII. Availability of plant-based diet (Fresan*et al.*,, 2020)

1. Do you find it is convenient in your region to get plant-based foods?

a) Yes, there is no difficulty in supermarket to find plant-based foods

b) Most of the time, yes, although I can't always get what I need from one store.

c) No, at supermarkets I find it is hard to find essential plant-based foods

2. Do you think it is easily possible to purchase ready-to-eat foods for plant-based diet in your region?

a) Yes, it is no problem to find in the supermarkets here

b) Sometimes, I find it difficult to find either

c)No, I find it difficult to find either.

d)I haven't looked for it.

3. Do you think that plant-based foods are costlier than animal-based foods?

a) Yes, plant-based foods are costlier than animal-based ones.

b) I think they are about the same.

c)No, plant-based foods are cheaper than animal-based ones.

d)I do not know.

4. Does your work, school or location that you spend most of your day have no choices for meals only based on plants?

a) Yes, there is no choices.

b) The choices are accessible for sometimes.

c) No, there is alternatives but not good food.

5. When you dine out, is there an absence of plant-based foods?

a) Yes, there is no choices.

b) The choices are accessible for sometimes.

c) No, there is alternatives but not good food.

VIII. Knowledge on Planetary Health Diet (Angela,2020)

1. Do you know the following concepts?

	I know very well	**I know partly**	**I don't know**
Ecological footprint			

Carbon footprint			
Food sustainability			
Environmental impact			
Biodiversity			
Local food			
Greenhouse gas emissions			
Green water–Blue water			

2. Do you think that a healthy diet and a sustainable diet are synonymous with?
    a) Yes
    b) Are similar concepts, but not the same?
    c) No
    d) Don't know.
3. Please comment on the contribution to the sustainability of the world of the following foods (less damage)
    a) Vegetables/fruits
    b) Meat
    c) Egg
    d) Milk
    e) Processed food
4. Provide the extent to which you agree with the following declarations on water and its usage in food production.

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
The natural cycle of water is sufficient for the planet.					
The foodstuffs with higher water cost are animal origins					
Foods which consumes higher water is vegetables.					

5. Do you think that the ecological health of the earth is adversely affected by meat consumption?

    a) Strongly disagree b) disagree c) neutral d) agree e) strongly agree.

6. Do you believe that intake of meat has a bad effect on the human health?

    a) Strongly disagree b) disagree c) neutral d) agree e) strongly agree

7. How does the current global level of meat consumption have the most significant adverse effect?

    a) Natural resources depletion b) pollutionc) others

    e) There are no serious negative impacts of current global levels of meat consumption

IX. Attitude towards Planetary Health diet (BEUC,2019)

1. Which of the following assertion do you agree with the most?

    a) My eating habits harm the environment.

    b) When compared to automobile usage, eating habits have minor environmental impact?

    c) In relative terms, the environmental impact of eating habits and food production

    d) No view

2. How much consideration do you give to the environmental effect of your dietary choices?

    a) I do not care about whether my food choices have an impact on environment.

    b) I pay few attention.

    c) I pay some attention.

    d) I pay a lot of attention.

3. When you think of "sustainable" food, what comes to mind?

    a) Low environmental impact

    b) Food availability and cost effectiveness

    c) To prevent the application of pesticides and GMOs

    d) Local distribution chains

    e) Fair farmer's income

    f) High standard for animal welfare

    g) Agricultural food economic growth

h) Minimally processed, traditional.

i) Healthy

4. To what extent do you believe that environmental concerns influence the eating habits?

a) There is no single influence.

b) There is minor influence.

c) There are some influences.

d) There is significant influence.

e) I don't know.

5. What are the primary barriers to eat (more) sustainably? Tick maximum 3 reasons

a) Misinformation on how to accomplish this.

b) Mislabelling

c) I'm not concerned with sustainability.

d) Lack of sustainable food products in my typical shop/ eating places

e) Too costly

f) I'm not willing to change my eating habits.

6. How much do you agree to each of the statement?

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
I'm open to purchase seasonal fruit and vegetables					
I'm willing to pay extra money on food that is sustainable					
I'm prepared to spend more money on food if I know farmers will get a fair price in return					
I'm willing to eat less red meat (beef, lamb, and pork).					
I'm willing to eat less dairy.					
I'm willing to throw away less food at home					

I'm willing to consume more vegetables/plant-based food					
Even if my eating habits are not environmentally friendly, I am unwilling to modify them.					
No point of view					

7. Did you cut (or plan to limit) your intake of red meat for the sake of environment?
   a) Because I'm vegetarian/vegan, I don't eat meat.
   b) Yes, for the environmental concern, I've stopped eating red meat (although I'm not vegetarian/vegan)
   c) Yes, I decreased the intake of redmeat (but still consume it)
   d) No for environmental concern, I do not limit the intake of red meat.
   e) No, I do not want to do so.

7. In the future, would you be willing to replace meat with plant-based foods?

   a) No b) Yes c) I don't know / I'm not sure

9. To what degree do you agree that meat-related terms like "sausage" and "burger" are used to describe meat-free vegetarian goods (for example, a veggie "burger")?

   a) Vegetarian goods should never be authorised.
   b) It should only be permitted if the product is clearly labelled as vegetarian.
   c) I don't see why such names shouldn't be used.
   d) I don't have an opinion.

10. How much do you agree with each of the statements below?

	Strongly agree	**Agree**	**Neutral**	**Disagree**	**Strongly disagree**
Food labels should include mandatory sustainability information.					
Food that isn't as sustainable should be taxed more (and be more expensive)					

Food products that aren't sustainable should be removed off store shelves (e.g. no 22strawberries in winter, supermarkets should only sell fish sourced sustainably, etc.)					
I don't want someone to tell me or make decisions for me about what I should or should not eat.					
Farmers and food producers should be forced to fulfil more severe sustainability requirements through regulations (in terms of greenhouse gas emissions, water use, biodiversity impact, etc.)					
Farmers should be rewarded for producing (for example, through subsidies).					

11.How do you feel about Planetary Health Diet? (Brielle Stark Gay, 2018)

S. No		**Yes**	**No**
1	Eating a handful of nuts every day is beneficial to your health.		
2	The Planetary Diet is an extreme way of living.		
3	The major argument for adopting a planetary diet lifestyle is that killing animals is unethical.		
4	In today's world, being a vegetarian is just too difficult.		
5	The fact that vegetarians live longer and are less sick is the major argument for choosing a vegetarian diet.		

6	Omega-3 fatty acids may be found in flax seeds and fish.		
7	Vitamin B-12 is exclusively found in animal-based foods.		
8	Milk intake is linked to a number of severe illnesses.		
9	The major benefit of adopting a planetary diet lifestyle is that it is considerably more environmentally friendly.		
10	Vegetable proteins are inadequate supplies of necessary amino acids;therefore, vegetarians must combine proteins from a variety of sources with caution.		
11	Global warming is caused by excessive meat eating.		

X. Health and wellness tool (Ryan Bart, 2018)

Physical health	**Rarely, if ever**	**Sometimes**	**Most of the Time**	**Always**
I keep a healthy body weight.				
I exercise vigorously, such as by fast walking.				
I engage in muscle and joint strengthening activities.				
Before and after strenuous activity, I stretch to warm up and chill down.				
I'm pleased with the state of my body.				
Every night, I sleep for 7-8 hours.				
My immune system is robust, and I am immune to most infectious illnesses.				

When I'm sick or wounded, my body recovers rapidly.				
I'm a high-energy person who can go through the day without being exhausted.				
I pay attention to my body, and if anything isn't right, I seek expert help.				

Social health	**Rarely, if ever**	**Sometimes**	**Most of the Time**	**Always**
When I meet new people, I am pleased with the impression I make.				
I am a person that is open, honest, and gets along well with others.				
I like being among individuals who are different from me and participate in a range of social activities.				
I attempt to be a "better person" and work on behaviours that have produced issues in my interpersonal interactions.				
My family members and I g*et al*ong swimmingly.				
I am an excellent listener.				
I am available and willing to be in a loving and responsible relationship.				
I have someone with whom I				

can share my intimate sentiments.				
I am considerate of others' sentiments and do not act in a selfish or cruel manner.				
Before I say anything, I think about how others could interpret what I'm saying.				

Emotional health	**Rarely, if ever**	**Sometimes**	**Most of the Time**	**Always**
It's simple for me to laugh at things that occur in my life.				
I try to stay away from drinking as a way to forget about my issues.				
I am able to communicate my emotions without feeling foolish.				
When I'm upset, I attempt to communicate with others in a non-aggressive and non-harmful manner.				
I'm a worrier by nature.				
When I feel stressed, I realise it and take efforts to de-stress through exercise, quiet time, or other activities.				
I am confident in myself and believe that others appreciate me for who I am.				
When I'm unhappy, I talk to				

other people and try to solve my problems.				
I am adaptable and adjust to change in a constructive manner.				
My friends think of me as a solid, emotionally balanced individual.				

Spiritual health	**Rarely, if ever**	**Sometimes**	**Most of the Time**	**Always**
It's simple for me to chuckle at things that occur in my life.				
I take time to appreciate the natural world and the beauty that surrounds me.				
I set aside time to reflect on what matters most in life: who I am, what I value, where I fit in, and where I'm headed.				
I believe in the significance of things other than myself.				
I perform acts of kindness and generosity without expecting anything in return. I am saddened by people who are suffering and attempt to assist them in their distress.				
I am certain that I have made a good impact on the lives of others.				

In my personal connections, my community, and the globe at large, I strive for peace.				
I'm happy with who I am. I go for the thrill of it and the experience in life.				

Intellectual health	**Rarely, if ever**	**Sometimes**	**Most of the Time**	**Always**
I have a tendency to behave rashly without considering the repercussions.				
I attempt to learn from my errors and act differently in the future.				
I behave in ways that are likely to keep others and myself safe by following directives or recommended recommendations.				
Before making a decision, I evaluate the options.				
I am attentive and prepared to respond to life's difficulties in thoughtful and prudent ways.				
I have a tendency to let my emotions control me and act without thinking.				
Before making a choice, I make an active effort to understand everything I can about a topic.				

Rather than time managing me, I manage my time wisely.				
My family and friends have faith in my judgement.				
I consider my self-talk (the things I tell myself) and then examine the real evidence for my perceptions and feelings.				

XI. Eating behaviour tool (Hunot,2016)

S. No	Behaviours	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
1	I love food					
2	I often decide that I don't like a food, before tasting it					
3	I enjoy eating					
4	I look forward to mealtimes					
5	I eat more when I'm annoyed					
6	I often notice my stomach rumbling					
7	I refuse new foods at first					
8	I eat more when I'm worried					
9	If I miss a meal, I get irritable					
10	I eat more when I'm upset					
11	I often leave food on my plate at the end of a meal					

12	I enjoy tasting new foods					
13	I often feel hungry when I am with someone who is eating					
14	I often finish my meals quickly					
15	I eat less when I'm worried					
16	I eat more when I´m anxious					
17	Given the choice, I would eat most of the time					
18	I eat less when I'm angry					
19	I am interested in tasting new food I haven't tasted before					
20	I eat less when I'm upset					
21	I eat more when I'm angry					
22	I am always thinking about food					
23	I often get full before my meal is finished					
24	I enjoy a wide variety of foods					
25	I am often last at finishing a meal					
26	I eat more and more slowly during a meal					
27	I eat less when I'm annoyed					

28	I often feel so hungry that I must eat something right away					
29	I eat slowly					
30	I cannot eat a meal if I have had a snack just before					
31	I get full up easily					
32	I often feel hungry					
33	When I see or smell food that I like, it makes me want to eat					
34	If my meals are delayed, I get light-headed					
35	I eat less when I'm anxious					

XII. Diet diversity (FAO,2013)

	YES	**No**
Cereals: rice, wheat, sorghum, millet or any other grain foods made from these (eg., idly, dosai, bread, noodles, porridge or other grain products) upma, pongal, paniyaram		
White roots and tubers **White potatoes, white yarn, white cassava, or other foods made from roots**		
Vitamin A rich Vegetables and tubers: Pumpkin, carrot, squash or sweet potato that are orange inside plus locally available vitamin A rich vegetables eg., red sweet pepper		
Dark green leafy vegetables Amaranth, cassava leaves, spinach		
Other Vegetables		

Tomatoes, onion, eggplant other vegetables		
Vitamin A rich Fruits: ripe mango, cantaloupe, apricot (fresh or dried) ripe papaya, dried peach and 100 % fresh juice from these fruits		
Other fruits including wild fruits and 100 % fruit juices made from these		
Organ meat: liver, kidney, heart or other organ meats or blood-based foods		
Flesh meats lamb, goat, chicken, rabbit, beef, duck other birds,		
Eggs: eggs from chicken, or any other birds' egg		
Fish and Sea food: Fresh or dried fish or shellfish		
Legumes, nuts and seeds: dried beans, dried peas, lentils, nuts, seeds or foods made from these (eg peanut butter)		
Milk and milk products: Milk, Cheese, yogurt or other milk products		
Oils and Fats: Oil, fat or butter added to food or used for cooking		
Sweets: Sugar,honey, sweetened soda or sweetened juice drinks, sugary foods such as chocolates, candies, cookies and cakes		
Spices Condiments Beverages: Spices (black pepper, salt) Condiments (coy sauce, hot sauce), coffee, tea, other beverages		
Do you eat anything (meal or snack) outside the home yesterday?		

XIII. 24 hrs Diet recall (3 days)

Day: 1

Timings	Menu	Quantity
Early Morning		
Breakfast		

Brunch		
Lunch		
Snacks		
Dinner		
Bed time		

Day: 2

Timings	Menu	Quantity
Early Morning		
Breakfast		
Brunch		
Lunch		
Snacks		
Dinner		
Bed time		

Day: 3

Timings	Menu	Quantity
Early Morning		
Breakfast		
Brunch		
Lunch		
Snacks		
Dinner		
Bed time		

Annexure – III

MARKET SURVEY ON SOURCING PATTERN OF FOOD INGREDIENTS

XIV. General Information

8. Name :
9. Age :
10. Gender :
11. Mobile Number :

XV. Perishable foods

	Place I	**Place II**	**Place III**	**Quantity**	**Amount**
Green Leafy vegetables					
Amaranth					
Caudatus					
Gangeticus (tender)					
Gangeticus (stem)					
Paniculatus					
Polygonoides					
Spinosus					
Chakravarthikeerai					
Koyakeerai					
Tristis					
Viridis					
Caudatus					
Bathua leaves					
Beet greens					
Bengalgram leaves					
Betel leaves					
Bottlegourd leaves					

Broad bean leaves					
Brussels sprouts					
Cabbage					
Carrot leaves					
Cauliflower leaves					
Celery leaves					
Celery stalk					
Colocasia leaves					
Black					
Green					
Dried					
Coriander leaves					
Cow pea leaves					
Curry leaves					
Drumstick leaves					
Fenugreek leaves					
Fetid cassia, fresh					
Dried					
Garden cress					
Garden sorrel, sepals					
Gogu					
Ipomea stems					
Ipomea leaves					
Knol-khol greens					
Kuppameni					

Lettuce					
Lettuce tree leaves					
Mature					
Tender					
Manathakkali leaves					
Mayalu					
Mint					
Modakathankeerai					
Mukarratekeerai					
Mustard leaves					
Nerringi					
Parsely					
Paruppukeerai					
Ponnanganni					
Pumpkin leaves					
Radish leaves					
Radish leaves, table					
Rape, stem					
Rape leaves					
Rape leaves, dried					
Safflower leaves					
Shepu					
Spinach					
SPINACH, stalks					
Susni sag					

Tamarind leaves					
Turnip greens					
Roots and tubers					
Arrow root					
Flour					
Banana rhizome					
Beet root					
Carrot					
Colocasia					
Khamalu					
Mang0 ginger					
Onion big					
Onion small					
Parsnip					
Potato					
Radish pink					
Radish rat-tailed					
Radish table					
Radish white					
Sweet potato					
Tapioca					
Turnip					
Yam, elephant					
Yam, ordinary					
Yam, wild					

Other vegetables					
Ash gourd					
Beans, scarlet runner					
Bitter gourd					
Bitter gourd					
Small					
Bottle gourd					
Brinjal					
Broad beans					
Cauliflower					
Cho-cho-marrow					
Cluster beans					
Colocasia stem					
Cowpea pods					
Cucumber					
Double beans					
Drumstick					
Drumstick flowers					
Field beans. Tender					
Figs. Red (ficuscunia)					
French beans					
Ghosala					
Giant chillies					
(Capsicum)					
Jack. Tender					

Jack fruit, seeds					
Kovai					
Knol-khol					
Ladies' fingers					
Leeks					
Lotus stem, dry					
Mango, green					
Onion stalks					
Papaya, green					
Parwar					
Pink beans					
Plantain flower					
Plantain green					
Plantain stem					
Pumpkin fruit					
Pumpkin flowers					
Ridge gourd					
Snake gourd					
Sundakkai, dry					
Sword beans					
Tinda, tender					
Tomato, green					
Vegetable marrow					
Water chestnut					

Fresh					
Dry					
Fruits					
Ambada					
Amla					
Apple					
Apricot fresh					
Apricot dry					
Avocado pear					
Bael fruit					
Banana, ripe					
Banyan tree figs					
Bilimbi					
Bread fruit					
Bullocks heart					
Cape gooseberry					
Cashew fruit					
Cherries, red					
Currants, black					
Dates dried					
Dates fresh					
Figs (Ficuscarcia)					
Grapes blue variety					
Pale green variety					
Grapefruit					

Marsh's seedless					
Triumph					
Guava, country					
Guava, hill					
Harfarowrie					
Jack fruit					
Jamb, safed					
Jambu fruit					
Korukkapalli					
Lakuch					
Lemon					
Lemon sweet					
Lichi					
Lichies, bastard					
Lime					
Sweet malta					
Sweet musambi					
Loquat					
Mahua, ripe					
Mango. Ripe					
Mangosteen					
Melon, musk					
Me lon. Water					
Mulberry					
Orange					

Orange juice					
Palmyra fruit					
Ripe (mesocarp)					
Tender					
Papaya. Ripe					
Passion fruit					
Passion fruit juice					
Peaches					
Pears					
Persimmon					
Phalsa					
Pineapple					
Plum					
Pomegranate					
Prunes					
Pummelo					
Quince					
Raisins					
Raspherry					
Rose apple					
Sapota					
Seethaphal					
Strawberry					
Tomato, ripe					
Tomatillo					

Tree tomato					
Wood apple					
Zizyphus					
Fishes and other sea foods					
Air					
Anchovy					
Bacha					
Bam					
Baspatamachli					
Bata. Small varieties					
Beley					
Bhagon fresh					
Bhagon dried					
Bhanganbata					
Bhekti fresh					
Bhekti dried					
Bhola					
Big jawed jumper					
B0al					
Bombay duck					
Dried					
Blue mussel					
Catfish					
Chela					
Chela dried					

Chingri small dried					
Chingrigoda, dried					
Chital					
Crab muscle					
Crab small					
Folui					
Ghol					
Goggler					
Herring, Indian					
Herring ox-eyed					
Hilsa					
Horse mackerel					
Indian whiting					
Jew fish (kora)					
Jew fish (pallikora)					
Kalabasu					
Katla					
Khorsula					
Khoyra fresh					
Khoyra dried					
Koi					
Koochamachli					
Lata					
Lobster					
Mackerel					

Magur					
Mahasole					
Mandeli, dried					
Mrigal					
Mullet					
Mushi dried					
Mussel, fresh water					
Mutijella, dried					
0il sardine					
Pabda					
Pangas					
Parsey fresh					
Parsey dried					
Pomfrets, black					
Pomfrets, white					
Prawn					
Puti					
Ravas					
Ray					
Ribbon fish fresh					
Ribbon fish dried					
Rohu					
Sardine					
Sarputi					
Shark					

Shrimp (small. Dried)					
Seer					
Silver belly					
Singhala					
Singhi					
Sole					
Sole (malahar)					
Surmai fresh					
Surmai dried					
Tapra (dried)					
Tapsi (dried)					
Tartoor					
Tengra fresh					
Tengra dried					
Tunny					
White bait					
Meat and poultry					
Beef meal					
Beef muscle					
Buffalo meat					
Duck					
Egg. Duck					
Egg, hen					
Egg turtle					
Finch					

Fowl					
Goat meat lean					
Grey quail					
Livfr goat					
Liver sheep					
Mutton. Muscle					
Pigeon					
Pork, muscle					
Ruff and reeve					
Snail, small					
Snail, big					
Turtle's meat					
Milk and milk products					
Milk ass's					
Milk buffalo*s					
Milk cow's					
Milk goat's					
Milk human					
Curds (cow's milk)					
Butter milk					
Skimmed milk, liquid					
Channa, cow's milk					
Buffalo's milk					
Cheese					
Khoa whole buffalo					

milk					
Skimmed buffalo milk					
Whole cow milk					
Skimmed milk powder cow's milk					
Whole milk powder cow's milk					

XVI. Non-Perishable foods

	Place I	**Place II**	**Place III**	**Quantity**	**Amount**
Cereals					
Bajra					
Barley					
Italian millet					
Jowar					
Maize, dry					
Maize, tender					
Panivaragu					
Ragi					
Rice Parboiled,					
handpounded					
Parboiled, milled					
Raw, handpounded					
Raw, milled					
Bran					
Flakes					
Puffed					

Samai					
Varagu					
Wheat,					
Bulgar (parboiled)					
Whole					
Flour whole					
Flour refined					
Germ					
Semolina					
Vermicelli					
Bread (brown)					
Bread (white)					
Pulses					
Bengal gram					
Whole					
Dhal					
Roasted					
Black gram, dhal					
Cow pea					
Field bean, dry					
Green gram, whole					
Green gram, dhal					
Horse gram, whole					
Khesar, dhal					
Lentil					

Moth beans					
Peas, green					
Peas, dry					
Peas, roasted					
Rajmah					
Redgram, dhal					
Redgram, tender					
Soyabean					
Nuts and oilseeds					
Almond					
Arecanut					
Avocado pear (nut)					
Cashewnut					
Chilgoza					
Coconut dry					
Coconut fresh					
Coconut tender					
Coconut milk					
Coconut water					
Coconut meal. Deoiled					
Garden cress seeds					
Gingelly seeds					
Groundnut					
Groundnut roasted					

Groundnut cake					
Linseed seeds					
Mustard seeds					
Niger seeds					
Pistachio nut					
Piyal seeds					
Safflower seeds					
Sunflower seeds					
Walnut					
Watermelon seeds					
(Kernal)					
Condiments and spices					
Arisithippilli					
Asafoetida					
Cardamom					
Chillies dry					
Chillies, green					
Cloves dry					
Cloves green					
Coriander					
Cumin seeds					
Fenugreek seeds					
Garlic dries					
Ginger fresh					
Lime peel					

Mace					
Mango powder					
Nutmeg fruit					
Nutmeg rind					
Omum					
Pepper dry					
Pepper green					
Pippali					
Poppy seeds					
Tamarind pulp					
Turmeric					
Milk and milk products					
Milk ass's					
Milk buffalo*s					
Milk cow's					
Milk goat's					
Milk human					
Curds (cow's milk)					
Butter milk					
Skimmed milk, liquid					
Channa, cow’s milk					
Buffalo's milk					
Cheese					
Khoa whole buffalo milk					
Skimmed buffalo milk					

Whole cow milk					
Skimmed milk powder cow's milk					
Whole milk powder cow's milk					
Fats and edible oils					
Butter					
Ghee cow					
Ghee buffalo					
Hydrogenated oil fortified					
Cooking oil					
Sugars					
Sugar cane					
Honey					
Jaggery cane					
Jaggery coconut palm					
Jaggery date palm					
Jaggery fan palm					
Jaggery sago palm					
Sago					

Annexure – IV

INTERVIEW SCHEDULE TO EVALUATE THE DEVELOPED e-APPLICATION

General Information

Name :
Age :
Gender :
Mobile Number :
Address :
Email.ID :
Occupation :☐Computer professional ☐ Dietician ☐Household women

General information about e- application

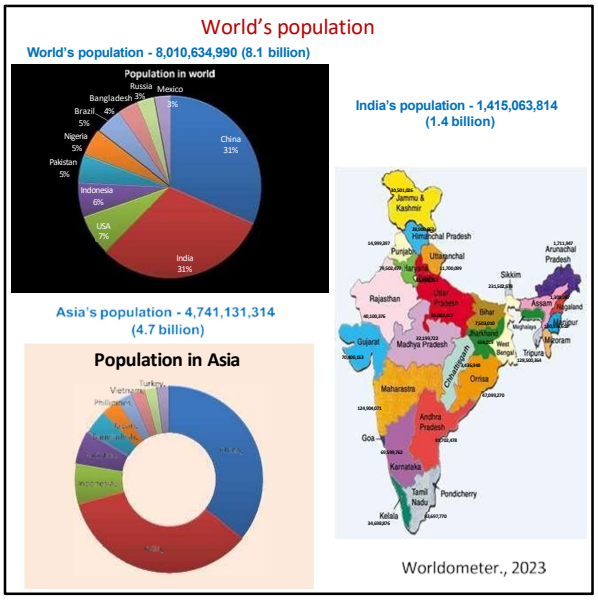
S. No	QUESTIONS	YES	NO
1.	Are you using smart phones?		
2.	Are you using any diet, nutrition or food related apps?		
3.	Were there any specific features or functionalities that you found particularly useful or lacking?		
4.	Did you encounter any bugs or crashes while using this app?		
5.	Did the app provide motivation or support features?		
6.	Do you intend to use this app in future?		
7.	Would you recommend this app to others?		
8.	Did the app effectively track your diet?		
9.	Is it time consuming?		
10.	Are the fonts easy to read and understand?		

S. No	QUESTIONS	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
11.	Do you feel this app provides all required data that you needed?					
12.	Do you feel comfortable to calculate your BMI and WHR using this app?					
13.	Is the food exchange list being easy to understand?					
14.	Is the information in this app is clear and detail?					
15.	Are the contents and presentation of the app being appropriate?					
16.	Is this app being user friendly?					
17.	Did the app provide motivation or support features?					
18.	Do you feel this app is informative and beneficial for users?					
19.	Were the app's layout and navigation intuitive?					
20.	Did the app perform the tasks you expected it to perform?					
21.	Did the app respond quickly to your inputs and commands?					
22.	Whether the screen designing is good?					
23.	Did you find the content within the app valuable and relevant to your needs?					
24.	Do you feel this app would bring any behavioural change?					
25.	Do you think dieticians would be benefitted with this app?					

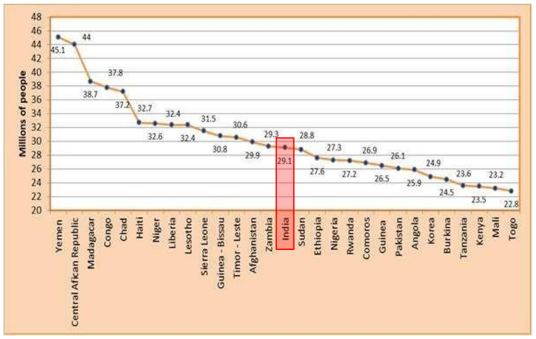
How would you rate the overall design of the app? (1-10)

Annexure V

AWARENESS MATERIAL TO CREATE AWARENESS



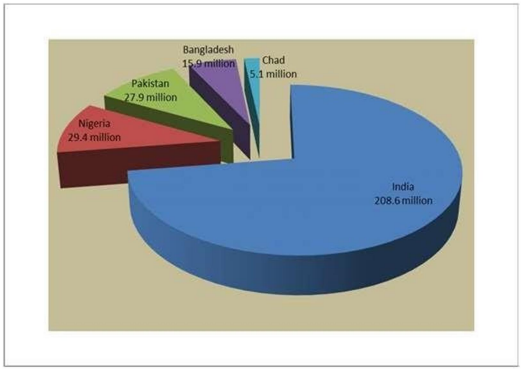
Countries that are most affected by hunger and malnutrition according to the Global Hunger Index 2022



Statista., 2022

Number of people - Undernourished

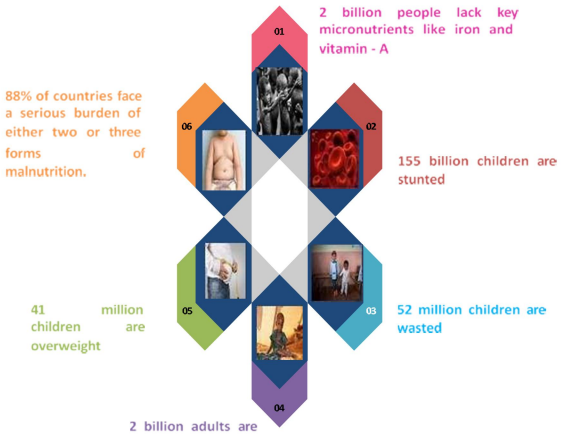
768 million people - undernourished



FAO., 2020

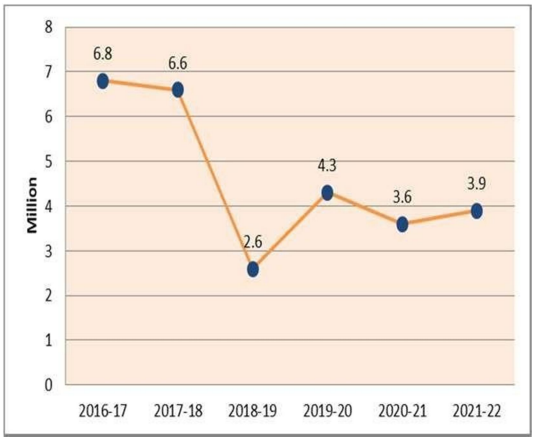
The scale of the challenge

And the world is off track to meet all global nutrition targets.



EAT Lancet., 2019

Growth of agriculture by 2022 in India

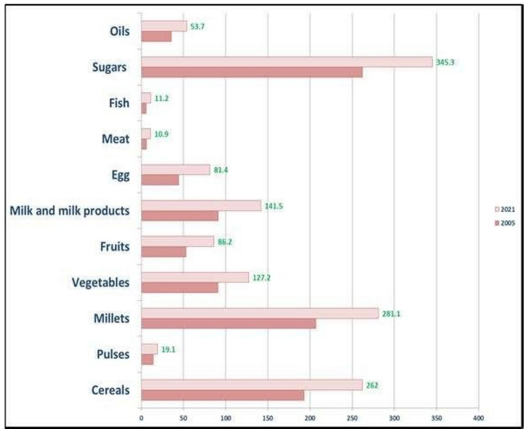


(First advance estimates of National Income., 2021-2022)

Yield of crops and livestock in India in 2020-2021

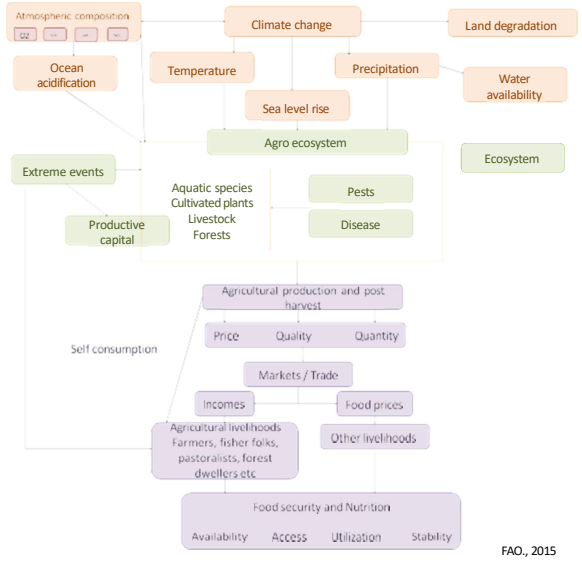
ICAR., 2022

Agri food consumption in India (in Billion tones)



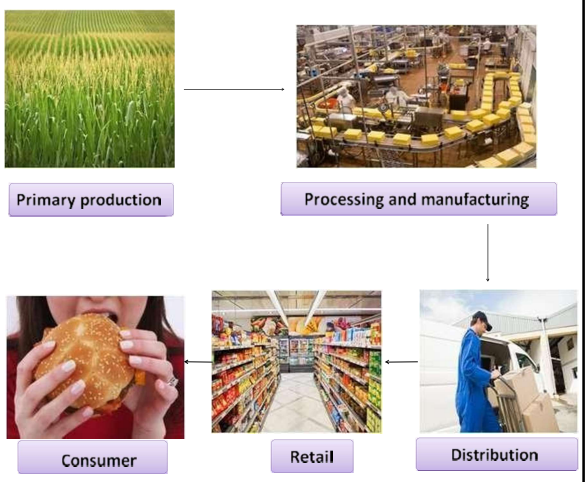
Srinivas Rao *et al.*, 2022

Systematic representation of the cascading effects on food security and nutrition



FAO., 2015

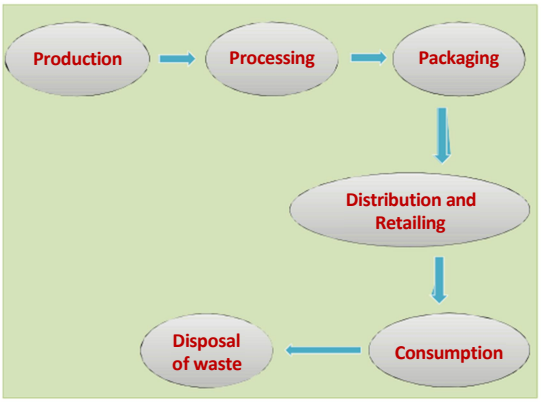
The food supply chain



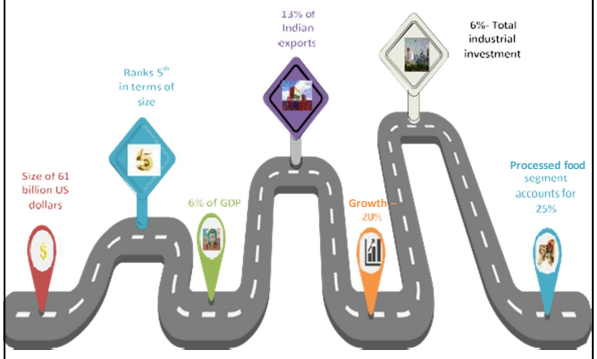
Poore *et al.*, 2018

Food processing

Food processing is the set of methods and techniques used to transform raw ingredients into finished and semi-finished products.

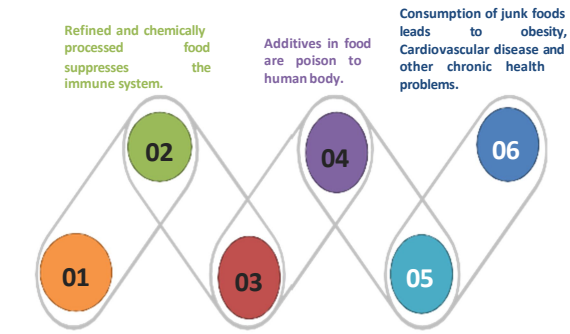


Processed food market



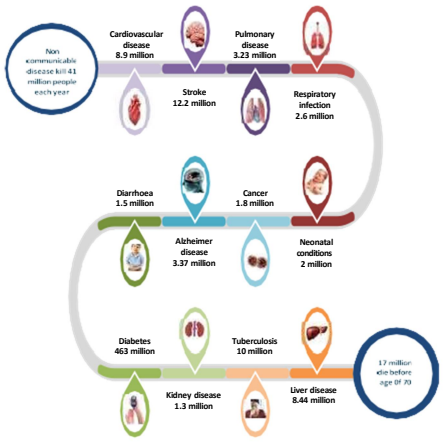
NCERT., 2022

Effects of processing foods



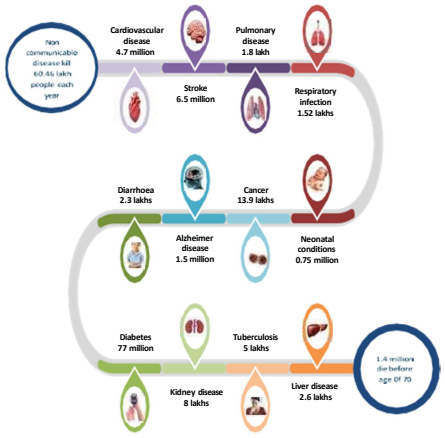
NDTV., 2017

Diseases and Disorders - World



WHO., 2020

Diseases and Disorders -India



ICMR., 2020

Environmental Impact of food

- At the global level, agriculture contributes to climate change through emission of green house gases and reduction of carbon storage in vegetation and soil.
- Locally, agriculture reduces biodiversity and affects natural habitats through land conversion, eutrophication, pesticides inputs, irrigation and drainage.

ICAR., 2022

Environmental Impact of food

Soil degradation – Compaction, pesticide contamination, salting, water logging, loss of fertility, alkalinity, erosion (Awuchi and Igwe., 2017)

Irrigation – depletion of underground water, accumulation of toxic salt and water pollution (Chinaza *et al.*, 2020)

Climate change – global warming, radioactive forcing (Machado et al., 2015)

Wastes – plastics (50-70%) in soil (Plasticulture) (Chinaza et al., 2019)

Environmental Impact of food

Deforestation – farming (48%), cattle reaching (5%) and commercial agriculture (32%) (Awuchi et al., 2020)

Pollutants – Synthetic pesticides (Kelthane, confidor, malathione and rogor) and Herbicide (EPA., 2011)

Land use – 50% of world habitat land is used for agriculture (Hannah and Max., 2020)

Green house gas emission – food production accounts for 30% of green house gas emission (Hannah and Max., 2020)

State wise Fertilizers used

Andra Pradesh	1138	679	474	2291	1977	1043	322	3342	980	490	212	1683
Bihar	688	368	245	1301	968	297	115	1380	1235	423	162	1821
Chattisgarh	498	298	208	1005	356	177	62	596	450	226	62	737
Goa	114	82	73	270	3	3	2	8	2	1	1	4
Gujarat	1247	450	456	2153	1183	417	133	1733	1296	382	114	1792
Haryana	807	339	202	1348	1021	370	38	1428	1070	303	38	1411
Himachal Pradesh	82	43	33	159	33	10	9	51	38	10	10	59
Jammu and Kashmir	95	57	29	181	66	29	5	100	51	171	11	79
Jharkhand	84	51	42	177	118	42	11	171	132	45	5	182
Karnataka	1043	655	651	2349	1216	787	333	2336	1018	560	283	1861
Kerala	227	164	349	740	136	66	100	301	79	34	62	175
Madhya Pradesh	1080	1181	449	2710	1062	751	80	1892	1673	894	116	2683
Maharastra	1745	1176	654	3575	1610	1012	400	3022	1561	898	482	2941
Orissa	313	177	176	666	323	136	56	515	348	151	75	574
Punjab	951	375	235	1561	1417	449	53	1918	1500	363	43	1906
Rajasthan	1335	742	130	2206	914	416	26	1356	1217	479	21	1918
Tamil Nadu	673	270	298	1241	685	316	264	1265	582	234	171	987
Telangana	-	-	-	-	-	-	-	-	987	370	122	1479
Uttar Pradesh	3210	1436	1085	5731	3067	1024	166	4258	3740	1227	206	5173
Uttarkhand	114	82	73	270	124	32	10	166	124	31	9	163
West Bengal	162	75	51	288	832	477	309	1617	790	461	349	1599

Ministry of Agriculture., 2020

Annual ground water extraction

State	Area under Irrigation (%)	Agriculture share in annual water extraction (%)	Stage of ground water extraction (%)
Andra Pradesh	49.8	86.5	33.3
Bihar	74.2	79.3	51.1
Chattisgarh	35.7	84.7	46.3
Goa	22.6	25.0	23.5
Gujarat	51.0	95.1	53.4
Haryana	91.2	90.2	134.6
Jharkhand	13.7	56.7	29.1
Karnataka	35.0	90.3	64.9
Kerala	20.0	43.8	51.7
Madhya Pradesh	48.6	91.4	56.8
Maharastra	23.6	91.9	55.0
Orissa	29.0	80.2	43.7
Punjab	98.5	96.9	164.4
Rajasthan	43.5	86.4	150.2
Tamil Nadu	56.1	92.2	82.9
Telangana	54.2	89.0	53.3
Uttar Pradesh	80.7	89.7	68.8
Uttarkhand	52.4	72.4	46.8
West Bengal	65.5	91.6	44.6
India	52.0	88.8	61.6

Ministry of Agriculture., 2020

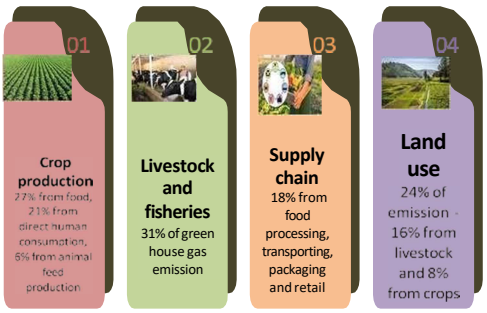
Green house gas emission

- **A carbon footprint is the total set of greenhouse gas emissions caused directly and indirectly by an individual, organization, event or product.**
- **Carbon footprint are measured in terms of tones of co2 equivalent (co2eq).**
- **A complete carbon footprint may include a number of types of green house gas., GWP is an index of global warming potency, with co2 defined as having a GWP of 1 and all other gases measured relative to co2.**

Green house gas	GWP
Carbon di oxide	1
Methane	25
Nitrous oxide	298
Hydroflurocarbons	124-14,800
Perfluorocarbons	7,500-12,200
Sulphur hexafluoride	22,800

IPCC., 2007

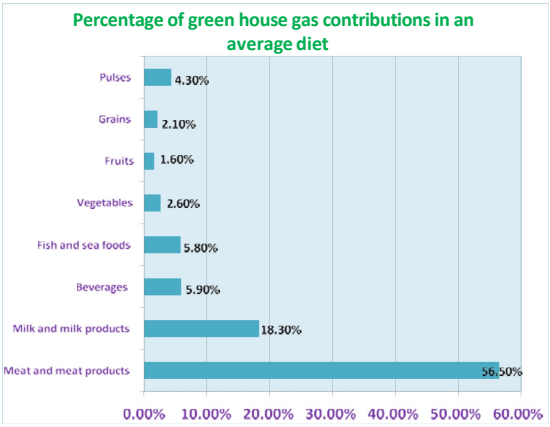
Four important elements to consider when quantifying food Green house gas emission



(Hannah and Max., 2020)

Effects of Green house gas emission

Percentage of green house gas contributions in an average diet



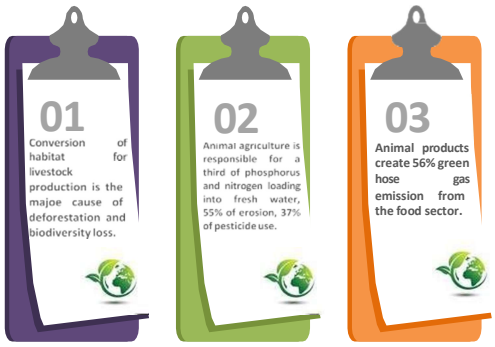
Requirement of water to produce 1 kg of meat

Water for grains about 6.5 kg of grain	Producing this volume of feed requires about 15,300 liters of water on average
Water for roughages about 36kg of roughages	
Water for drinking	Drinking and serving require about 155 liters of water on average
Water for serving	

FAO., 2019

Unsustainability of meat over consumption

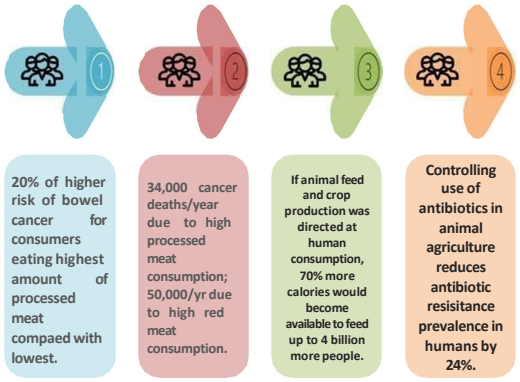
Environment



Niki *et al.*, 2020

Unsustainability of meat over consumption

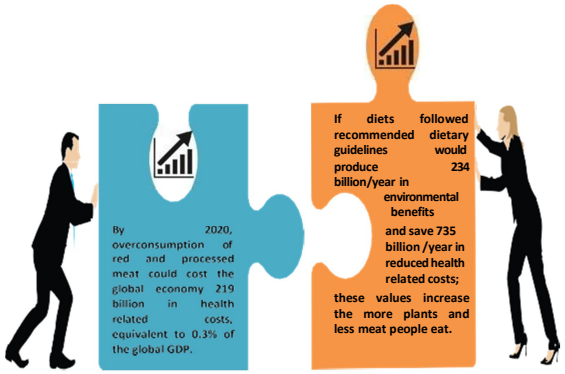
Social



Niki *et al.*, 2020

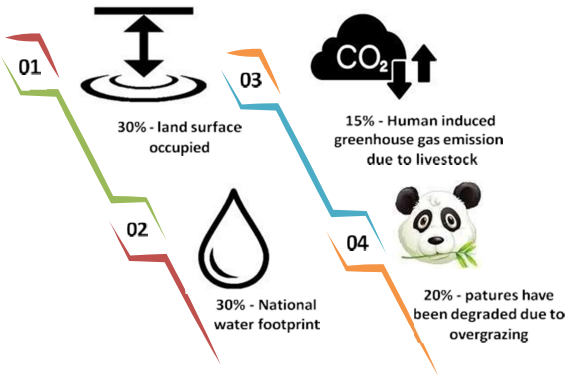
Unsustainability of meat over consumption

Economic



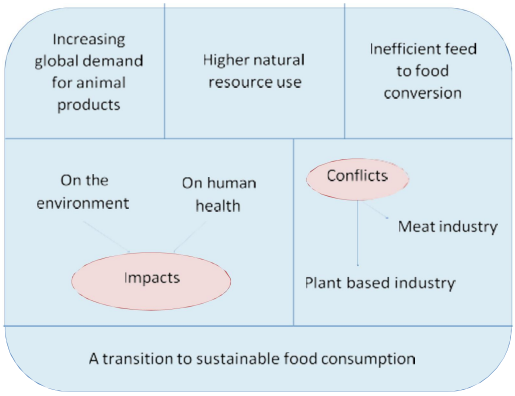
Niki *et al.*, 2020

Environmental impact of the livestock industry



Anoushka., 2021

Consumer acceptance of plant based meat substitutes



ICAR., 2022

Ethical perspectives of plant and animal based foods

Natural resource use and environmental outputs and outcomes

Outputs
Greenhouse gas emissions
Methane (CH4), co2 emissions
Land use
Water use
Chemical use

Inputs
Animals
Pasture or rangeland and water
Crops for feeds
Cropland, blue water and chemicals

Potential outcomes
Climate change
Land use change
Ecosystem disruption
Pollution (Air, Water and Soil)
Biodiversity

Reduced source used in meat and meat alternatives production could contribute to improvements in environmental outcomes important to justice, human rights and valuing the natural world lenses.

Social, cultural and economic inputs, outputs and outcomes

Inputs
Labor
Capital
Technology

Outputs
Income
Employment
Food

Potential outcomes
Nutrition and health
Sociocultural identities
Livelihoods, meaningful Work and wellbeing

Dietary change could have positive or negative effects on nutrition and health.
Changes to income and employment would impact livelihoods and human well being

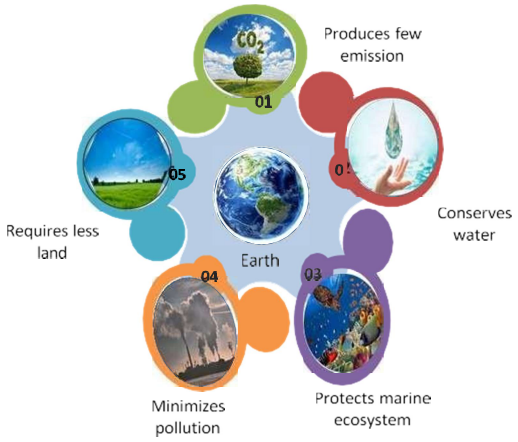
Potential non-human outcomes
Number of animals Raised for food
Conditions with Production system

Fewer animals would contribute to improvements in non-human outcomes important to animal rights and welfare lenses.

Valuing the natural world	Human rights
Value intrinsic of: Ecosystem, biodiversity and living things	Right to: health, food, fair wages, adequate standard of living, healthy and safe work conditions
Justice	**Animal rights and Animal welfare**
• Intergenerational justice • Economic justice • Health equity • Environmental justice • Equitable power and control	• Responsibility to provide a good life to animals in care. • Animal rights to not be raised for food.

Daniel *et al.*, 2022

Vegetarian – 5 Environmental Benefits



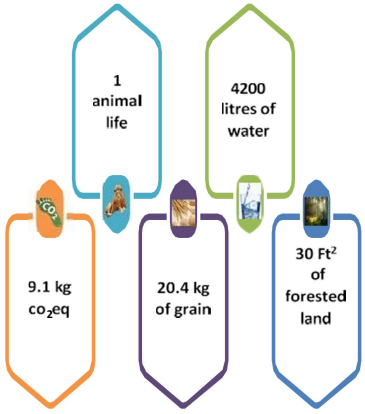
ICAR., 2022

Benefits of plant based food

Environment	Health	Economics
		
• Reduces an individuals • Water pollution • Air pollution • Carbon footprint	• Reduces the risks of heart disease • Obesity • Hypertension • Type 2 Diabetes	• Projected annual savings • In 2050 if everyone in the world goes for vegetation can save more than $258 billion

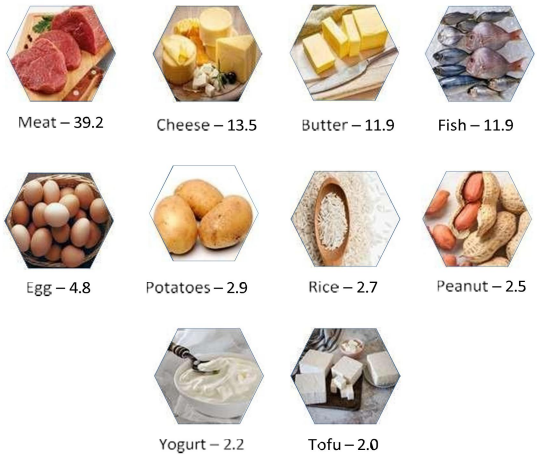
www.peta.org., 2022

Each day, Plant based diet saves



IPCC., 2015

10 common climate – damaging foods in India (KgCO2e/Kg of food)

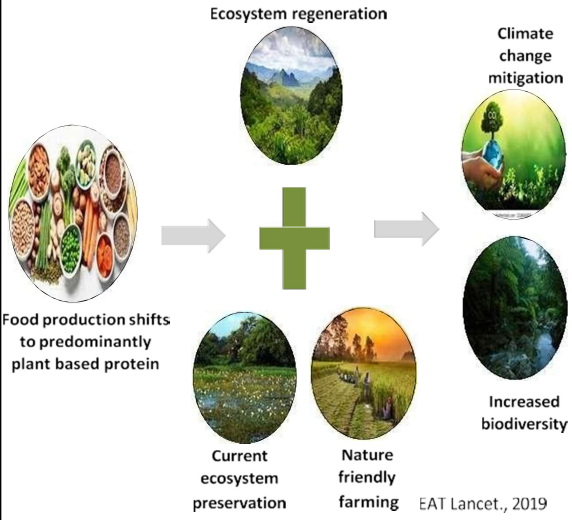


NRDC., 2020

Reducing food loss and waste to enhance Food security and Environmental Sustainability

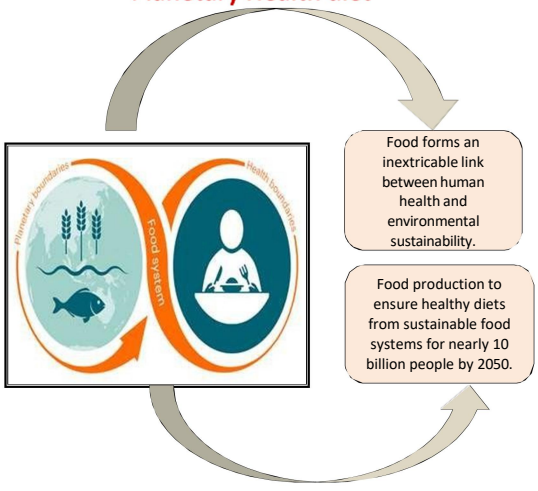
FAO., 2020

Healthy environment



EAT Lancet., 2019

Planetary Health diet



EAT Lancet., 2019

Planetary Health diet

The health of human civilization and the state of the natural systems on which it depends

The critical role that diets play in linking human health and environmental sustainability

Plant-based foods and with fewer animal source foods

Planetary health diet

2015 by the Rockefeller Foundation-*Lancet* Commission on planetary health to transform the field of public health

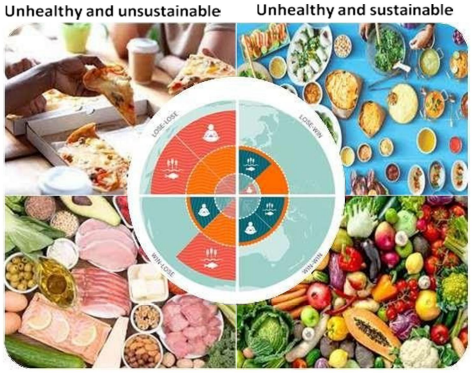
EAT Lancet., 2019

Scientific targets

Scientific targets define the safe operating space for food systems and are represented here by the orange ring. The wedges represent either dietary patterns or food production, and together they reflect various dietary patterns that may or may not meet scientific targets for human health and environmental sustainability.

Unhealthy and unsustainable

Unhealthy and sustainable



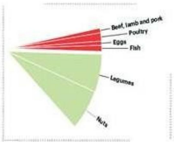
Healthy and unsustainable

Healthy and sustainable

EAT Lancet., 2019

Planetary Health plate

A planetary health plate should consist by volume of approximately half a plate of vegetables and fruits; the other half, displayed by contribution to calories, should consist of primarily whole grains, plant protein sources, unsaturated plant oils, and (optionally) modest amounts of animal sources of protein.



EAT Lancet., 2019

Planetary Health plate

Proteins should primarily be sourced from plants where possible, fish or alternative sources of omega-3 fatty acids several times per week, and with optional modest consumption of poultry and eggs alongside low intakes of red meat, if any, especially processed meat.

At least five servings of fruits and vegetables (500 grams) should be consumed per day excluding potatoes; 200 (100–300) grams of fruits and 300 (200–600) grams of vegetables per day.

At least 50 (0–75) grams of nuts and 75 (0–100) grams of legumes should be consumed per day including dry beans, lentils and peas.

Aim for no more than 98 grams of red meat (pork, beef or lamb), 203 grams of poultry and 196 grams of fish per week.

Fats should mostly come from unsaturated plant sources with low intakes of saturated fats and no partly hydrogenated oils; 40 (20–80) grams of unsaturated oils per day and no more than 11.8 grams of saturated oils per day.

Carbohydrates should primarily be sourced from whole grains with low intake of refined grains and less than 5% of energy from sugar.

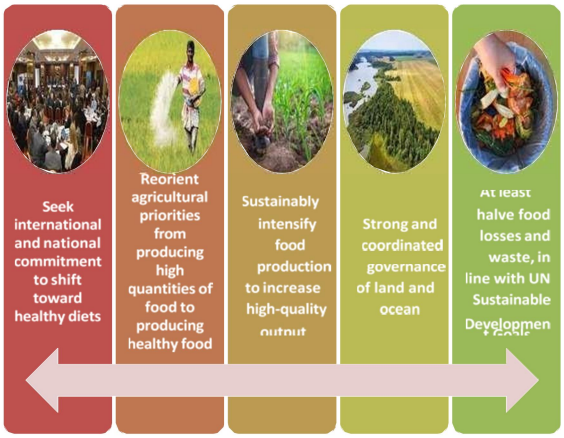
Consume 232 grams of whole grains per day including rice, wheat and corn, and at least 50 (0–100) grams of tubers or starchy vegetables per day including potatoes and cassava.

Moderate levels of dairy consumption are an option; around 250 (0–500) grams of dairy per day.

Earth system process	Control variable	Boundary (Uncertainty range)
Climate change	GHG emissions	5 Gt CO_2-eq yr^{-1} (4.7 – 5.4 Gt CO2-eq yr^{-1})
Land-system change	Cropland use	13 M km^2 (11–15 M km^2)
Freshwater use	Water use	2,500 km^3 yr^{-1} (1000–4000 km^3 yr^{-1})
Nitrogen cycling	N application	90 Tg N yr^{-1} (65–90 Tg N yr^{-1}) * (90–130 Tg N yr^{-1})**
Phosphorus cycling	P application	8 Tg P yr^{-1} (6–12 Tg P yr^{-1}) * (8–16 Tg P yr^{-1})**
Biodiversity loss	Extinction rate	10 E/MSY (1–80 E/MSY)

*Lower boundary range if improved production practices and redistribution are not adopted.
**Upper boundary range if improved production practices and redistribution are adopted and 50% of applied phosphorus is recycled.

Strategy to attain environmental sustainability



EAT Lancet., 2019

Estimated deaths prevented among adults by a global adoption of planetary health diet

Approach 1 Comparative risk	**19%**	**Or 11.1 million adult deaths/year**
Approach 2 Global burden of disease	**22.4%**	**Or 10.8 million adult deaths/year**
Approach 3 Empirical disease risk	**23.6%**	**Or 11.6 million adult deaths/year**

EAT Lancet., 2019

- Promote urban agriculture and community gardens
- Support biodiversity and ecosystem services

- Organizing public education campaigns targeting schools and households
- Developing a comprehensive food strategy and corresponding policies

Specific actions that policymakers can take to contribute to the Great Food Transformation

Embrace what works and innovate where more action is needed	• Enabling access to planetary health diets by increasing the affordability of healthy and sustainably produced foods •Designing public policies and innovations
Provide leadership and commitment	• Addressing the different socioeconomic and political drivers •Using the range of ministerial and departmental portfolios to ensure coherent food system actions.
Create novel governance arrangements	• Adopting a multi-sectoral approach through new partnerships in the food system •Working to establish international land use and ocean governance and management mechanisms.
Enable cost-effective financing	• Establishing financial incentives to help reduce food waste and food loss. • Create dedicated funding streams and programs that will support sustainable food system transformation.
Champion advocacy and education efforts	• Embedding healthy and sustainable food education into national school curricula. • Training and equipping food producers with both the knowledge and skills to deliver healthy and sustainable food

Specific actions that healthcare professionals can take to contribute to the Great Food Transformation

Conduct dietary assessments

Provide professional counsel

Support education and training

Change food procurement practices

Drive advocacy efforts

Specific actions that food service professionals can take to contribute to the Great Food Transformation





- Change culture by changing menus
- Emphasize the benefits of dietary shifts
- Work with suppliers and consumers
- Explore new foods and mix up menus
- Let plants take center stage
- Waste not, want not
- Lead with messaging around flavor
- Let plants take center stage
- Embrace cultural food influences
- Bring biodiversity to the table





Specific actions that farmers can take to contribute to the Great Food Transformation

- Adopt broad key principles
- Spare half of the Earth from agriculture
- Pick the right crop for the right spot
- Focus on applying specific practices
- Decrease greenhouse gas emissions
- Plant healthy and sustainable crops
- Reduce and reuse the nutrients
- Share the other half with nature






Specific actions that one can do to contribute to the Great Food Transformation

Choose health, sustainability and deliciousness

Prepare to increase, diversify and reduce

Embrace plants as a source of protein

Support regenerative farming practices

Dive into the breadth of options

Go easy on meat consumption

Approach food in moderation

Vote with every plate

Conclusion

- Food will be a defining issue of the 21st century.
- The global adoption of healthy diets from sustainable food systems would safeguard our planet and improve the health of billions
- The universal adoption of a planetary health diet would help avoid severe environmental degradation and prevent approximately 11 million human deaths annually.
- However, to safeguard the natural systems and processes that humanity depends on and that ultimately determine the stability of the Earth system will require no less than a Great Food Transformation.
- Unlocking its potential will catalyze the achievement.

Annexure VI

PLAGIARISM REPORT

Avinashilingam Institute for Home Science and Higher Education for Women
(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category A by MHRD)
Re-accredited with 'A++' Grade by NAAC.CGPA 3.65/4, Category I by UGC
Coimbatore – 641 043, Tamil Nadu, India

PLAGIARISM CHECK REPORT (THESES)

1.	Name of the Research Scholar	N. Komathy
2.	Roll No. and Year of Registration	20PHFDF001, 2021
3.	Department	Food Service Management and Dietetics
4.	Name of the Research Guide	Dr. R. Radha
5.	Title of the Thesis / Dissertation	Computation of nutritional footprint of food consumed by selected subjects and creating awareness on planetary health diet using the developed e-application
6.	Similarity Content (%) Identified	**5%**
7.	Software Used	Turnitin
8.	Date of Verification	22-11-2024

Note : The report is excluding 14 Consecutive words, Review of Literature and Quoted Materials.

Checked by :

22/11/24
Information Scientist

Research Scholar

22-11-24
Assistant Librarian

Research Guide

Date: 22-11-2024

Computation of nutritional footprint of food consumed by selected subjects and creating awareness on planetary health diet using the developed e-application

ORIGINALITY REPORT

5%	3%	3%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

Avinashilingam Institute For Home Science & Higher Education For Women

Certificate of Plagiarism Check for Thesis

Author Name	N Komathy
Course of Study	Doctor of Philosophy
Name of Guide	Dr. R. Radha
Department	Food Service Management and Dietetics
Acceptable Maximum Limit	10%
Submitted By	library@avinuty.ac.in
Paper Title	Computation of nutritional footprint of food consumed by selected subjects and creating awareness on planetary health diet using the developed e-application
Similarity	4%
Paper ID	2564388
Total Pages	90
Submission Date	2024-11-22 16:15:18

Signature of Student

Signature of Guide

Head of the Department

22.11.24

for University Librarian

Director of Post Graduate Studies

* This report has been generated by DrillBit Anti-Plagiarism Software

Annexure VII

PUBLICATIONS

Avinashilingam Institute for HomeScience and Higher Education for Women
(Deemed to be University Estd. u/s 3 of UGC Act 1956, Category 'A' by MHRD
Re-accredited with A++ Grade by NAAC. CGPA 3.65/4, Category I by UGC
Coimbatore - 641 043, Tamil Nadu, India

Appendix L2

(Item No 5 of Check List)

Details of Research Publications

S.No	Article	Journal	Other Details Vol/No/Page No/ Year	Published in UGC-CARE/ Scopus Indexed/ Web of Science
1	Comparison of nutritional footprint of selected food ingredients	Journal of Food, Agriculture and Environment	Vol. 21 (1): 22-25, 2023	UGC-CARE
2	Determination of Carbon Footprint of selected major cereals	Gujarat Agricultural University Research Journal	Vol. 48 (3): 177-184, 2023	UGC-CARE

*Proof of list of Journals from Internet to be attached along with copies of reprints.

Scholar : N.Komathy

Supervisor : Dr.R.Radha

2/7/24.

Checked By:

HoD/Dean of Respective School

The scholar Miss. Komathy, N (Reg. No. 20PHFDF001) has published her research articles in the following journals:

1. Journal of Food, Agriculture and Environment - indexed and active in UGC Care List Gp. I from June 2019 to present and
2. Gujarat Agricultural University Research Journal - indexed and active in UGC Care List Gp. I from June 2019 to present.

This may be considered.

01.07.2024.

WFL Publisher
Science and Technology
P L Box 48, FI-00981
Helsinki, Finland
e-mail: contact@wflpublisher.com

Journal of Food, Agriculture & Environment Vol. 21(1):22-25. 2023 *www.wflpublisher.com*

Comparison of nutritional footprint of selected food ingredients

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Received 30 October 2022, accepted 16 December 2022.

Abstract

The "Planetary Health Diet," which is presented by EAT-Lancet, is a healthy and environmentally friendly model diet that aims to promote the wellbeing of the entire global population. The Nutritional Footprint distils the findings from four key environmental and health indicators into a succinct conclusion. Therefore this study was carried out with the objective to compare the nutritional footprint between selected vegetables, fruits and non-vegetarian foods. Several food groups and various foods among the groups like chilli, tomato, brinjal, bittergourd in vegetable group, guava, banana, papaya and lemon among fruits and within the animal foods hen, goat, duck and beef were considered for the study. The health indicators like energy, proteins, fat and fibre were referred from Indian food composition table and the environmental indicators were identified as material footprint, carbon footprint, land use and water use were calculated. Hence, the nutritional footprint was calculated by the average of the sum of the nutritional and environmental footprint. The study results highlight nutritional footprint of beef was high among the selected food ingredients which were recommended rarely. Vegetables and fruits had low effect and recommended without any restrictions. This novel idea called the nutritional footprint has the potential to impact sustainable transformation procedures in the crucial field of nutrition.

Keywords: Food ingredients, health indicators, environmental indicators, nutritional footprint.

Introduction

Hawkes [1] underlines the fundamental transformation in the acquisition, preparation and consumption of food, in the established procedures for the animal husbandry and crop production; in the supply, processing and distribution of agricultural products. This has a significant negative influence on the ecosystem, including the global climatic system, biodiversity, and land and water resources [1].

There are a number of problems facing the world food system to maintain adequate nutritious food supply to individuals while reducing the negative consequences it has on the environment. One of the food system's major aims is to offer cost-effective, healthy food. The problem is to feed the rising population of approximately 9 billion by 2050 [2].

Global warming of 1.5°C over the past has shown that manmade carbon dioxide emissions have contributed substantially to climate change in the past. The IPCC Special Report shows that the sources of these emissions are spread across all areas of the economy[3]. The emission of pollutants from energy generation is particularly substantial followed by heating, industry, and the agri-food sector [4].

FAO [5]estimated that agricultural output alone accounts for around 10-12 per cent of greenhouse gas emission and it is continuing to increase. The percentage of total GHG emissions nevertheless differs from region to region. It accounts for almost 11% of the world GHG emissions. It is around 44% from Asia, 15% from Africa, 4% of Australia, 5% from Oceania, and 9% from North America and 17% from South America [5].

According to other research, GHG emissions from livestock products range from 0.8 to 2.4 kg CO_2eq kg per litre of milk, 1.7 to 6.6 kg CO_2eq kg^{-1} for eggs, 2.5 to 6.9 kg CO_2eq kg^{-1} for chicken meat, and 10 to 20 kg CO_2eq kg^{-1} for mutton and lamb [6]

Now, food poses a hazard to both people and the Earth. There is an urgent need for significant change in the world food system. The EAT-Lancet Commission gathered the world's scientists to focus on sustainable food production and healthy diets in order to address these urgent demands. Leading researchers in 37 fields, including public health, agribusiness, public administration, and sustainable development, came from 16 different nations [7].

The "Planetary Health Diet," which is presented by EAT-Lancet, is a healthy and environmentally friendly model diet that aims to promote the wellbeing of the entire global population. Sustainable food systems guidelines for healthy eating place a focus on increasing intake of fruits, vegetables, whole grains, and low-fat dairy products while reducing consumption of meat, fish, and eggs [8].

Sustainable healthy diets are "dietary patterns that support all aspects of people's health and wellbeing; have little stress on environment; are easily available, reasonably priced, safe, balanced, and are acceptable to their cultural contexts," according to the Food and Agriculture Organization (FAO) and World Health Organization (WHO)[9].

Therefore this study was carried out with the objective to compare the nutritional footprint between selected vegetables, fruits and non-vegetarian foods.

Methodology

Several food groups and various foods among the groups like chilli, tomato, brinjal, bittergourd in vegetable group, guava, banana, papaya and lemon among fruits and within the animal foods hen, goat, duck and beef were considered for the study.

Selection of indicators: Current scientific contributions that are pertinent to indicators of both health and the environment were examined in order to evaluate regularly used indicators. The objective was to choose a manageable amount of indications that are quantifiable, relevant, and simple to comprehend. By Lukas *et al.* [10], initial suggestions for the nutritional footprint have been made. The nutritional footprint summarises the findings of four indicators linked to health and four indicators connected to the environment into a conclusion that is simple to explain (Table 1).

Table 1. Nutritional footprint indicators.

Health indicators	Environmental indicators
Energy (kcal)	Material footprint (kg)
Protein (g)	Carbon footprint ($kgCO_2eq$)
Fat (g)	Land use (acre)
Fibre (g)	Water use (l)

Health indicators: The health indicators are energy, protein, fat and fiber of selected foods. These were referred from Indian Food Composition Table [11].

Environmental indicators: Four currently used indicators are combined to form the environmental footprint, which provides a comprehensive evaluation of environmental effect. The indicators are the carbon footprint, water use, land use, and material footprint. These variables have been computed. The next sections go over these in more depth.

Material footprint: A comparable indication was the "Material Footprint," which is based on the "MIPS principle" (Material Input Per Unit of Service). By weighing the raw materials utilised, the material footprint was determined. However, neither of the indicators yet takes into account the effects of land use or water consumption.

Carbon footprint: The total amount of greenhouse gases produced over the course of a product's life cycle is known as the "carbon footprint." Although the carbon footprint has gained popularity and is widely acknowledged in scientific and industrial circles, it must be augmented by utilising a thorough input indicator to analyse biotic and abiotic material fluxes over a longer time horizon [12]. The carbon footprint of the selected foods was calculated per year by using Formula (1):

Carbon footprint = Consumption of items / day (kcal/day) × 365 × Emission factor ($kgCO_2ekcal$) (1)

Whereas here, Consumption of items/day (kcal/day) = the energy in kcal of selected food items consumed by the subjects, the energy was calculated for each food items using IFCT nutritive value book[11] ; 365 = Number of days in a year; Emission factor = Adjusted daily emission factor for a particular harvested area.

Land use: The use of land can be measured using a variety of methods. Different land classifications (agricultural, urban, and natural land) are distinguished by some approaches [13, 14]. A straightforward model might be helpful for the nutrition-focused strategy: It includes all occupied land. All land types are equal, and the impacts of land usage are independent of the qualities of the land [15].

The land usage was calculated via a standard technique. Using a measuring tape, the land use was measured in acres.

Water use: All agricultural products need supplemental water in addition to the rain that falls naturally. Even completely rain-fed crops need water for crop spraying, but protected crops, on the other hand, need to be supplied with all the water they need to flourish. Water is necessary for livestock to drink, wash, and dip. There were litres of water used.

$$NF_{(H)} = \frac{\text{Carbohydrates} + \text{Protein} + \text{Fat} + \text{Fibre}}{4} \quad (2)$$

$$NF_{(E)} = \frac{\text{Material footprint} + \text{Carbon footprint} + \text{Land use} + \text{Water use}}{4} \quad (3)$$

Threshold levels of selected foods for nutritional footprint:

The integration of different indicators to one result: Separate averages of the four effect levels are computed for the environmental and health metrics (Formula 2 and 3). As a result, the indicators for health (Formula 2) and the environment (Formula 3) are each shown at one effect level.

$$NF = \frac{\text{Health indicators} + \text{Environmental indicators}}{2} \quad (4)$$

The two sets of indications are then fairly ranked against one another as a result of this stage. The calculation's final step involves adding both effect level sets together and calculating the average once more (Formula 4). To examine both indicator sets equally and to show the outcome as a single number, this step is completed.

As a result, the nutritional footprint (as stated in Formula 4) is the average of the total of the two calculating phases (Formula 2 and 3).

The result may also be categorised into three written levels in order to produce a qualitative ranking (Table 2). A"low," "medium," and "high" effect ranking can be determined. If the value is between 1 and 1.5, a low effect is obtained; between 1.5 and 2, a medium effect is obtained; and above 2, a large effect is considered. The nutritional footprint calculated is shown as a single value (for example, 1.75/medium effect), and a "low" effect level is generally advised whereas a "high" effect is only seldom advised.

Table 2. Qualitative ranking of nutritional footprint.

	Minimum value	**Maximum value**
Low	1	1.5
Medium	1.5	2
High	More than 2	

Results

Supporting health and lowering environmental stress are two objectives that are succinctly and clearly combined by the nutritional footprint. Table 3 presents the health indicators of selected food ingredients. It is abundantly clear that bittergourd contains most nutrients among the selected vegetables while banana contains high calories and protein whereas guava is a good source of fibre among fruits. Livestock is a good source of calories and protein, but very poor source of fibre.

Table 3. Health indicators of food ingredients.

Food ingredients	Energy (kcal)	Protein (g)	Fat (g)	Fibre (g)
Vegetables				
Chilli	29.00	2.90	0.60	6.80
Tomato	20.00	0.90	0.20	0.80
Brinjal	24.00	1.40	0.30	1.30
Bittergourd	60.00	2.10	1.00	1.70
Fruits				
Guava	51.00	0.90	0.30	5.20
Banana	116.00	1.20	0.30	0.40
Papaya	32.00	0.60	0.10	0.80
Lemon	57.00	1.00	0.90	1.70
Livestock				
Hen	109.00	25.90	0.60	0
Goat	118.00	21.40	3.60	0
Duck	130.00	21.60	4.80	0
Beef	410.00	79.20	10.10	0.50

Table 4 depicts the rank of nutrients and its average rank. According to the average of rank beef was a good source of nutrients when compared to other livestocks and vegetables and fruits. Chilli scored highest among the vegetables and guava scored highest among the fruits followed by banana, lemon and papaya.

Table 4. Rank of health indicators.

Food ingredients	Energy	Protein	Fat	Fibre	Average
Vegetables					
Chilli	1	1	1	3	1.5
Tomato	1	1	1	1	1
Brinjal	1	1	1	2	1.25
Bittergourd	1	1	1	2	1.25
Fruits					
Guava	2	1	1	3	1.75
Banana	3	1	1	1	1.5
Papaya	1	1	1	1	1
Lemon	2	1	1	2	1.5
Livestock					
Hen	3	2	1	1	1.75
Goat	3	2	1	1	1.75
Duck	3	2	1	1	1.75
Beef	3	3	3	1	2.5

Table 5 presents the environmental indicators of food. It was clear that the material footprint of brinjal was greater when compared to other food ingredients, carbon emission from livestock was higher and fruit cultivation required more land and the requirement of water for livestock was higher than other foods.

Table 6 highlights the rank of environmental indicators which show that among the foods, vegetable groups score higher for the material footprint whereas livestock score was higher for the carbon footprint, fruits scored higher for land use and the rank for water usage was higher for livestock.

Table 7 highlights the nutritional footprint of food ingredients which shows that the nutritional footprint of beef has high effect among the selected food ingredients which was recommended rarely. Foods like brinjal from vegetable group, guava and banana from fruits group and hen, goat and duck from livestock group have medium effect and recommended once in a week and other foods vegetables and fruits have low effect and are hence recommended without any restrictions for consumption.

Table 5. Environmental indicators of food ingredients.

Food ingredients	Material footprint (kg)	Carbon footprint ($kgCO_2eq$)	Land use (Acre)	Water use (l)
Vegetables				
Chilli	51.53 ± 1.26	251.12	0.034±0.012	10.12 ± 1.34
Tomato	20.25 ± 0.88	14,258.90	2.11±0.45	12.00 ± 0.11
Brinjal	120.38 ± 1.24	12,202.13	4.54±0.67	22.67 ± 1.24
Bittergourd	4.0 ± 1.21	18,306.51	4.62±0.79	26.72 ± 1.13
Fruits				
Guava	1.79±0.23	13,436.19		
Banana	8.64±1.67	21,518.06	5.46 ± 0.67	16.17 ± 1.18
Papaya	0.50±0.73	5,666.62	3.47 ± 0.34	13.23 ± 0.41
Lemon	0.12±0.04	346.79	1.46 ± 0.32	6.27 ± 0.78
Livestock				
Hen	10.32±0.64	1,210,642.95	1.34 ± 0.42	72.37 ± 1.76
Goat	15.00±0.00	643,728.6	1.23 ± 0.25	71.16 ± 0.87
Duck	6.45±1.78	619,928.77	1.11±0.012	80.79 ± 0.75
Beef	15.50±1.50	10,325.85	1.57±0.67	80.23±0.67

Table 6. Rank of environmental indicators.

Food ingredients	Material footprint	Carbon footprint	Land use	Water use	Average
Vegetables					
Chilli	2	1	1	1	1.25
Tomato	1	2	1	1	1.25
Brinjal	3	2	2	1	2
Bittergourd	1	2	2	1	1.5
Fruits					
Guava	1	2	2	1	1.5
Banana	1	2	2	1	1.5
Papaya	1	1	2	1	1.25
Lemon	1	1	1	1	1
Livestock					
Hen	1	3	1	3	2
Goat	1	3	1	3	2
Duck	1	3	1	3	2
Beef	1	3	1	3	2

Table 7. Nutritional footprint of food ingredients.

Food ingredients	Nutritional footprint	
Vegetables		
Chilli	1.5+1.25/2	1.3
Tomato	1+1.25/2	1.25
Brinjal	1.25+2/2	1.6
Bittergourd	1.25+1.5/2	0.8
Fruits		
Guava	1.75+1.5/2	1.6
Banana	1.5+1.5/2	1.5
Papaya	1+1.25/2	1.12
Lemon	1.5+1/2	1.25
Livestock		
Hen	1.75+2/2	1.8
Goat	1.75+2/2	1.8
Duck	1.75+2/2	1.8
Beef	2.5+2/2	2.25

Discussion

Non-vegetarian food items are evaluated as having a high and medium proportion of processed animal protein, which is considered to be quite resource-intensive, particularly the beef items [16-18]. The standard menu has a higher than average intake of calories and saturated fats, and it consumes less salt than the fitness menu does. Regardless of this fact, the standard menu has one of the highest water and material footprints. The fitness menu barely complies with the recommendations for a healthy lunch when seen from a nutritional stand point [19 -21]. Due to its extremely high calorie content, the standard menu does not comply with the criteria for a healthy lunch, whereas the fitness menu just barely does. Additionally, the environmental impact differs significantly in comparison. Therefore, while taking into account environmental factors, the fitness diet is the preferable option[22].

The typical UK diet has a 128% larger ecological footprint per tonne of food consumed than the healthier alternative (1.42 g ha per tonne compared to 0.62 g ha per tonne). High meat consumption (46% of the impacts), dairy products (9%), and alcoholic beverages (8% of the effects) accounted for the majority of the harmful consequences of the average person's diet in the UK. The huge area of land required for cultivating fodder and the energy utilised in production, processing, and distribution were the main causes of the high footprint of meat products. Contrarily, the ecological profile of the healthy fitness diet revealed a higher consumption of fruit, vegetables, cereals and a relatively low share of animal products. Despite having a lower percentage of meat in the healthy option—2% as opposed to 9% in the typical diet—meat still has the highest gootprint (16%) [23].

Conclusions

A novel idea called the nutritional footprint has the potential to impact sustainable transformation procedures in the crucial field of nutrition. The issue of how abstract environmental debates frequently are is addressed by this tool. In addition, unlike health problems, they frequently don't have any obvious direct application to the person. In the long term, the goals of influencing the change and transformation processes one way to assist the sustainable nutrition paradigm is to incorporate economic and social factors into the collection of indicators.

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ISSN 0250-5193

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Gujarat Agricultural Universities Research Journal

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GAU Research Journal **48** (3) : 177-184 (July 2023)

Determination of Carbon Footprint of Selected Major Cereals

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ABSTRACT

A significant portion of the global population relies on cereals, a family of grasses, as their primary source of food that provide essential nutrients and energy. However, 30% of greenhouse gas emissions worldwide are now attributable to the global food system as a whole. When food is grown, transformed, packaged, transported, sold, and consumed, greenhouse gas emissions are created. Methane, nitrous oxide, and carbon dioxide are the three primary greenhouse gases. Hence, this study aims to investigate the carbon footprint associated with the production and consumption of cereals in Coimbatore, a bustling city in Tamil Nadu, India. To determine the carbon footprint, all stages of cereal production including cultivation, water consumption, land use and transportation were considered. Primary data is collected through surveys and secondary data from scientific literature, government reports, and databases. The carbon footprint of the foods was determined per year. The study result highlights that rice (1252.01 $kgco_2e/yr$)have a high carbon footprint when compared to other cereals followed by Italian millet (860.48$kgco_2e/yr$) which have high negative impact on environment whereas tender maize (100.35$kgco_2e/yr$) emits less carbon compared to others and has low impact on environment. By providing a comprehensive analysis of the carbon footprint of cereals in Coimbatore, this study helps to create awareness on the importance of sustainable agricultural practices. Legislators, cultivators, and other partners in the cereal supply chain may use the insightful information it provides to adopt focused actions aimed at reducing emissions and enhancing environmental sustainability.

Keywords : Carbon footprint, Cereals, Cultivation, Water consumption, Land use and Transportation

INTRODUCTION

A significant amount of dietary energy and nutrients are obtained from cereals and cereal products, which are staple foods in the majority of human diets in both developed and developing nations (McKevith, 2004; Kushi*et al*., 2009; McIntosh, 2001). They make up over 75% of carbohydrates, mostly starches, and 6-15% protein. Globally, they account for more than 50% of the energy supply (WHO, 2003). The fact that cereal production, which totals around 2600 million tons annually, is the primary factor affecting global food security further supports the significance of cereals and cereal products (FAO, 2018).

Xu*et al*., (2021) opines that grains constitute an essential part of the world's food systems and a vital source of nourishment for millions

of people. However, there are environmental costs associated with the production and use of grains, chiefly in the form of carbon footprint and greenhouse gas (GHG) emissions. It's essential to comprehend and deal with cereals' carbon footprint in order to create sustainable farming methods and slow down global warming.

The Food and Agriculture Organization (FAO, 2018) estimates that 14% of the world's greenhouse gas emissions are related to agriculture, particularly the production of cereals. This covers emissions from changing land use, fertilization, crop cultivation, processing, shipping, and packing, among other phases of the grain production cycle. Significant volumes of methane (CH_4), nitrous oxide (N_2O), and carbon dioxide (CO_2) are released during these operations. These gases are powerful contributors to climate change (Patie*t al*., 2017; Mohapatra *et al*., 2017).

It is essential to take into account every step of the manufacturing process, from seed to plate, in order to fully assess the carbon footprint of cereals. Changes in land use, especially the conversion of grasslands and forests to croplands, release a significant amount of CO_2 into the atmosphere. Commonly employed in cereal farming, synthetic fertilizers increase emissions of N_2O, a gas with a far greater warming potential than CO_2. Furthermore, the carbon footprint is increased by energy-intensive procedures related to transportation, automation, and irrigation (Yongchange*t al*., 2018).

Balafoutis*et al*., (2017) highlighted that lowering the carbon footprint of cereals necessitates a multifaceted strategy that includes advancements in technology, sustainable agricultural methods, and alterations in consumer behaviour. Important tactics for reducing emissions include promoting precision agricultural practices, minimizing fertilizer usage, implementing renewable energy sources, and enhancing supply chain effectiveness. Positive change may also be sparked by educating customers on the carbon footprint of cereals and promoting sustainable consumption practices. Therefore, the purpose of this study is to look into the carbon footprint related to the production and consumption of grains in Coimbatore, Tamil Nadu, India's busy metropolis.

MATERIALS AND METHODS

Selection of samples

According to Pingali., (2017),for a substantial proportion of the world's population, grains are important sources of nutritional value and dietary energy. These are adaptable crops that work well in a variety of climates and environments, making them appropriate for a wide range of geographical locations and cultural contexts. Furthermore, cereals are frequently inexpensive, the mainstay of daily meals, and a major weapon in the fight against hunger and malnutrition, particularly in poor nations. Totally 12 cereals that are often found in Coimbatore, such as Rice (*Oryza Sativa*), Wheat (Triticum Aestivum),

Maize (*Zea Mays*), Italian millet (*Setaria Italica*), Sorghum (*Sorghum Bicolor*), Pearl millet (*Pennisetum Glaucum*), Barley (*Hordeum Vulgare*), Proso millet (*Panicum Miliaceum*), Finger millet (*Eleusine Coracana*), and Little millet (*Panicum Sumatrense*)have been chosen as the dietary category for the carbon footprint calculation.

Carbon footprint

The total quantity of greenhouse gas produced over a product's life cycle is known as its "carbon footprint." The Carbon Footprint has gained popularity and acceptance in scientific and industrial domains; however, since it is an output indicator pertaining to a single environmental effect, it must be complemented by the use of an all-encompassing input indicator to analyze biotic and abiotic material flows in a more comprehensive manner (Schmidt, 2008).

The data regarding the places where cereals are received for sales were collected. By using that data, distance from that place to Coimbatore was estimated and also data about the mode of transport, irrigation methods, such as fertiliser used, watering methods, harvesting methods, mode of vehicles used during the process and total yield of foodwere collected as secondary data.

Primary data is collected through surveys and secondary data from scientific literature, government reports, and databases. The carbon footprint of cereals and grains was determined for a year. The total emission factor of irrigation and transport for cereals and grains were applied in the carbon footprint formula.

The carbon footprint of the food ingredients were calculated per year by using the formula,

Carbon footprint = Consumption of items / day (kcal/day) × 365 × Emission factor ($kgco_2ekcal$)

(Formula - 1)

Whereas here,

Consumption of items / day (kcal/day)	-	The energy in kcal of selected food items consumed by the subjects, the energy was calculated for each food items using IFCT nutritive value book (2017).
365	-	Number of days in a year
Emission factor	-	Adjusted daily emission factor for a particular harvested area

RESULTS AND DISCUSSION

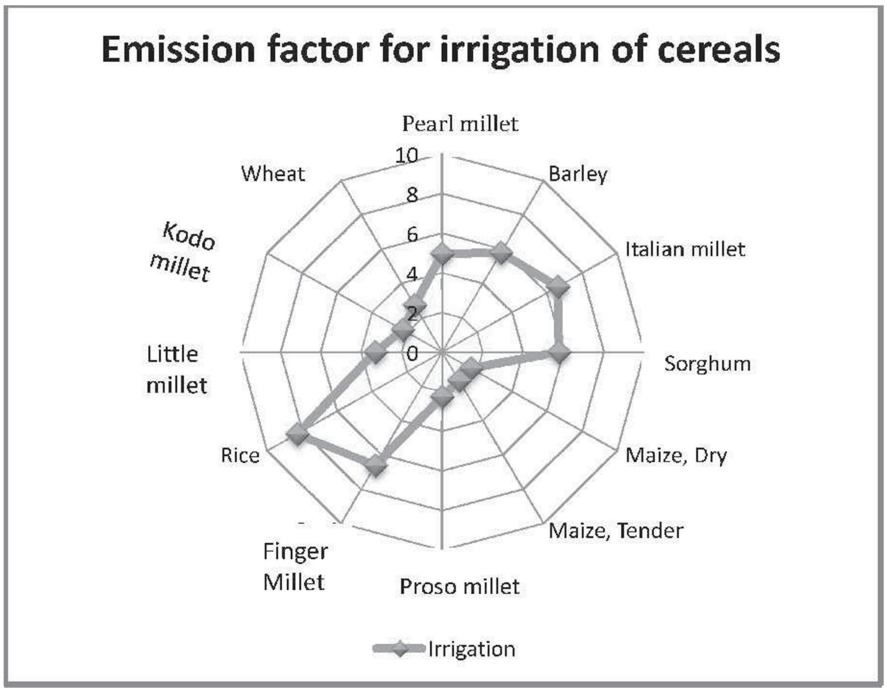

FIGURE I : Emission factor for irrigating the cereals

Figure I presents emission factor for irrigating the cereals and highlighted that the emission factor for irrigation of maize was lower and emits less carbon when compared to others and emission factor for irrigation of rice was higher and emits more carbon during irrigation when compared to others.

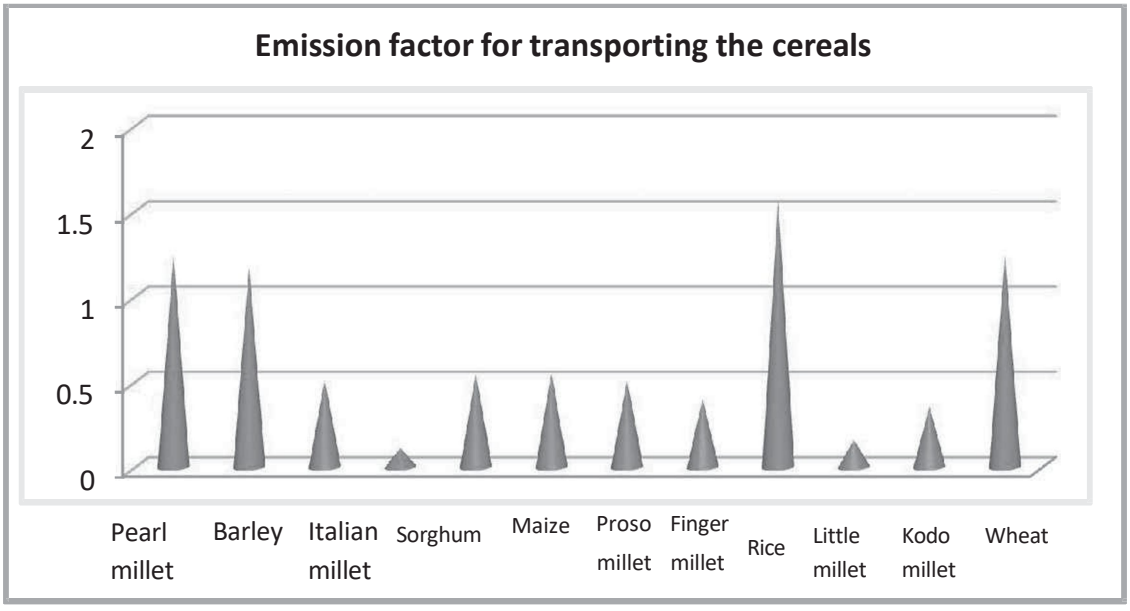

FIGURE II : Emission factor for transporting the cereals

Figure II provides Emission factor for transporting the cereals. It shows that the emission factor of jowar was lower and the emission factor of rice was higher followed by wheat than others.

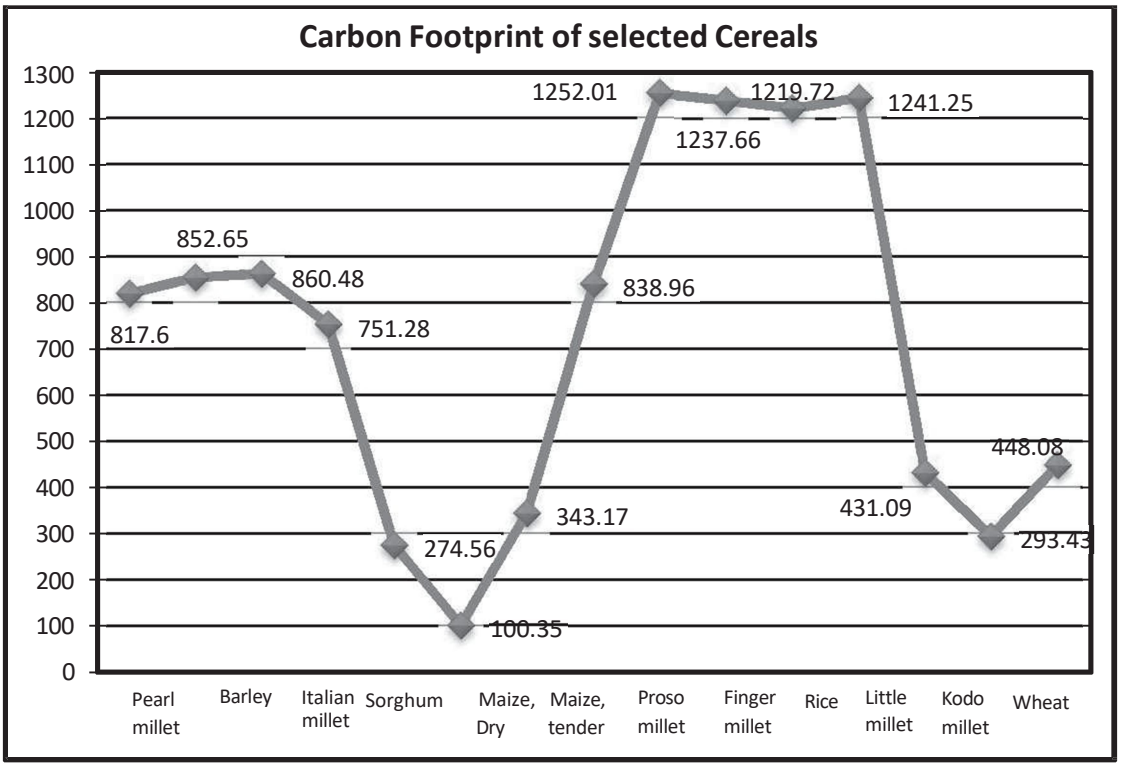

FIGURE III : Carbon Footprint of selected Cereals

The data elucidated in figure III reveals that the carbon footprint of parboiled milled rice was higher compared to all the other cereals followed by raw milled rice and which was clear that these cereals have high negative impact on environment and should be consumed in lesser quantity. And also shows that tender maize have lesser carbon footprint and less impact on environment which can be recommended in higher quantity.

DISCUSSION

The findings indicate that each package of 4 kilogramme of polished rice has a 7.7 $kg^{-6}CO$ eq_2carbon impact. Production of raw materials has a significant impact, particularly regarding methane emissions from paddy fields (Yoshikawa., 2010).

Agricultural activities are responsible for more than 10% of the anthropogenic emissions of CH_4, with rice fields making up the majority of these releases (Scheehle and Kruger, 2006). In continuous flooding settings, the carbon emission in rice varies between 21.96 and 60.96 Tg C yr^{-1} due to variations in urea doses, as reported by Pathak*et al*. (2012).

Blengini and Busto (2009) estimated rice has

a 2.90 kg CO_2-e kg^{-1} yield carbon footprint from sowing to the farm to gate. The Intergovernmental Panel on Climate Change (IPCC, 2007) estimates that Egypt's rice fields produce between 20 and 100 Tg annually on average to global emissions. This amounts to around 5–20% of total CH_4 emissions originating from human activities. Measurements were taken in paddy fields in the US, Spain, Italy, China, India, Australia, Japan, and Thailand (IPCC, 1997).The primary contributors to this carbon footprint are the methane produced by flooded rice (67%) and the deforestation brought on by the continuous use of 149 000 hectares of hillside slash-and-burn land for rice farming (29%) (Bockel*et al*., 2010).

As to a research conducted by Cheng *et al*. (2011), the average carbon intensity in China changed between 1993 and 2007 for cultivated lands, ranging from 0.64 tCE ha/yr to 0.92 tCE ha/yr, and between 1993 and 2007 for total production, which was 0.11 tCE t/yr.

In addition to other pollutants including carbon monoxide (CO), particulate matter (PM), and dangerous polycyclic aromatic hydrocarbons (PAHs), burning rice residue is another source of emissions that generates carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (Lemieux *et al*., 2004).

CONCLUSION

The carbon footprint of cereals, encompassing the entire production chain from cultivation to consumption, is a significant environmental concern in the context of sustainable agriculture and climate change mitigation. This article has provided insights into the factors contributing to the carbon footprint of cereals.Efforts to reduce the carbon footprint of cereals require a multi-pronged approach. Sustainable farming practices play a crucial role in emissions reduction. Precision agriculture techniques, such as optimized nutrient management and water conservation, can minimize the use of synthetic fertilizers and irrigation-related emissions. Conservation tillage and soil carbon sequestration practices can further contribute to mitigating emissions. Innovation in post-harvest processes, such as adopting renewable energy sources for processing and transport, utilizing sustainable packaging materials, and shortening supply chains, can also help reduce emissions. These steps not only lower the carbon footprint but also promote overall resource efficiency and resilience in the cereal industry.

Consumer choices and behaviour have a significant impact on the carbon footprint of cereals. By making informed decisions, such as opting for sustainably produced cereals, reducing food waste and supporting local and seasonal produce, consumers can contribute to emissions reduction. Policy interventions and industry initiatives are crucial for driving systemic change. Government regulations can incentivize sustainable farming practices; promote renewable energy adoption, and support research and development for low-carbon technologies. Industry collaborations, certification schemes, and labelling initiatives can further encourage sustainable practices across the cereal supply chain.

While progress has been made in understanding and addressing the carbon footprint of cereals, further research is

needed to refine measurement methodologies, evaluate regional variations, and assess the effectiveness of mitigation strategies. Additionally, ongoing monitoring and assessment of the carbon footprint of cereals will be essential to track progress and inform future sustainability efforts. In conclusion, mitigating the carbon footprint of cereals is essential for achieving sustainable agriculture and combating climate change. By implementing sustainable farming practices, adopting innovative technologies, promoting responsible consumption, and enacting supportive policies, it is possible to reduce emissions and create a more resilient and environmentally friendly cereal industry. Collectively, these efforts will contribute to a more sustainable and climate-resilient future.

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