Women As Catalysts for Sustainable Consumption: A Study of Household Practices and Carbon Footprint Reduction

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Abstract

This research delves into the significant role women play in driving sustainable consumption practices within households. By examining factors influencing women's decisions and identifying key barriers and opportunities, this study aims to empower women to become catalysts for a more sustainable future. The research highlights the impact of women's choices on energy consumption, food selection, waste management, and transportation, and explores strategies to promote sustainable behaviors. By understanding the complex interplay between women, household practices, and environmental sustainability, this research contributes to the development of effective policies and interventions to mitigate climate change.

Keywords: *Sustainable Consumption, Household Practices, Carbon Footprint, Energy Consumption, Climate Action.*

Introduction

The urgent need for action against the escalating global climate crisis is clear, as efforts to mitigate greenhouse gas emissions and shift towards a sustainable future become increasingly critical. Among the various strategies available to tackle this issue, a particularly promising approach focuses on household consumption. Households significantly contribute to overall carbon footprints and possess substantial potential for reducing their environmental impact by adopting sustainable practices. In this context, women, often the primary decision-makers regarding household consumption choices, play a pivotal role as catalysts for sustainable change.

This research investigates the complex relationship between women, household practices, and the reduction of carbon footprints. By analyzing the influence of women on household consumption patterns, the study seeks to identify opportunities to harness their impact in promoting sustainable behaviors. A variety of household practices will be explored, including energy usage, food selections, waste management, and transportation, to pinpoint specific areas where women can drive meaningful change.

Since the dawn of the 21st century, global greenhouse gas (GHG) emissions have steadily increased, largely due to rising emissions from China and other developing economies. This upward trend has led to heightened atmospheric concentrations of greenhouse gases, intensifying the natural greenhouse effect and posing serious risks to life on Earth.

As of 2023, global GHG emissions reached a record 53.0 Gt CO_2eq (not accounting for

Land Use, Land Use Change, and Forestry), reflecting a 1.9% increase—or 994 Mt CO2eq—compared to the previous year. Under the United Nations Framework Convention on Climate Change (UNFCCC), countries are working to develop national emissions inventories and implement strategies to curtail GHG emissions. Despite international climate agreements, fossil CO2 emissions, the primary contributor to global GHG totals, continue to rise. In this scenario, the EDGAR database provides independent estimates of GHG emissions for all nations, utilizing consistent methodologies aligned with IPCC guidelines and the most recent activity data. The latest update from EDGAR in September 2024 includes comprehensive data on GHG emissions from all anthropogenic sectors, encompassing Land Use, Land Use Change, and Forestry (LULUCF) through 2023.

Greenhouse Gases

Greenhouse gases (GHGs) are atmospheric gases that trap heat, playing a crucial role in regulating Earth's temperature. The main GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Each of these gases has a unique heat-trapping capacity, with methane and nitrous oxide being much more potent than carbon dioxide, though present in smaller quantities. Naturally occurring in Earth's atmosphere, GHGs are essential for maintaining temperatures suitable for life, as they prevent some of the Sun's heat from escaping back into space. However, this natural process has been intensified by human activities, especially the burning of fossil fuels, deforestation, and industrial processes.

Human-driven emissions have increased the concentration of these gases, amplifying the greenhouse effect and leading to climate change. Carbon dioxide, largely emitted by burning fossil fuels and deforestation, remains in the atmosphere for centuries, steadily warming the planet. Methane, released from agriculture and fossil fuel extraction, and nitrous oxide from fertilizers and waste treatment, are even more effective at trapping heat, despite shorter atmospheric lifetimes. Fluorinated gases, although present in trace amounts, have extremely high global warming potentials and are used in refrigeration, air conditioning, and industrial applications. Together, these gases disrupt Earth's energy balance, resulting in rising global temperatures, extreme weather patterns, and shifts in ecosystems.

Understanding the Greenhouse Effect

The greenhouse effect is a natural mechanism that keeps Earth warmer by trapping heat from the Sun. When solar energy reaches Earth's surface, it is absorbed and then released as infrared radiation. Greenhouse gases (GHGs) in the atmosphere capture some of this infrared radiation, keeping it from escaping into space and redirecting it back to Earth, which leads to further warming. Discovered in the 1820s, the greenhouse effect was later associated with GHGs and specific sources like coal burning, which amplify this effect. Human activities now release additional GHGs, disrupting balance between incoming solar energy and outgoing heat. This intensifies the greenhouse effect, contributing significantly to climate change.

Greenhouse Gas Emissions in the Atmosphere

Greenhouse gas (GHG) emissions in the atmosphere have reached record levels, largely driven by human activities. According to the Global Carbon Project, atmospheric CO_2 levels exceeded 417 parts per million (ppm) in 2023, a significant increase from pre-industrial levels of about 280 ppm. Carbon dioxide, accounting for roughly 76%

of total GHG emissions, is primarily emitted from burning fossil fuels and deforestation. Methane (CH_4) emissions, responsible for approximately 16% of global GHGs, have surged, largely from agriculture, waste management, and fossil fuel extraction. Methane levels reached around 1,900 parts per billion (ppb) in 2022, the highest recorded, with a warming potential over 25 times that of CO_2. Nitrous oxide (N_2O) emissions, making up about 6% of GHGs, continue to rise, driven by agricultural practices, particularly fertilizer use.

The rising levels of GHGs are pushing global temperatures upward, leading to extreme weather events and impacting ecosystems. According to the Intergovernmental Panel on Climate Change (IPCC), GHG emissions need to decline by about 45% from 2010 levels by 2030 to limit warming to 1.5°C above pre-industrial levels. However, emissions remain on an upward trajectory, with the World Meteorological Organization reporting that 2023 saw the highest annual increase in methane since records began in the 1980s. Current trends indicate that without rapid and widespread emission reductions, global temperatures could exceed 2°C, heightening risks of severe climate impacts, including heatwaves, intense storms, and biodiversity loss.

Greenhouse Gas Emissions Contribution from Households: A Global and Indian Perspective

Households are significant contributors to global greenhouse gas (GHG) emissions, accounting for approximately 20% to 25% of total emissions worldwide. The primary sources of these emissions include energy consumption for heating and cooling, electricity usage, transportation, and waste generation. According to the Intergovernmental Panel on Climate Change (IPCC), the residential sector contributed around 7.1 Gt CO2eq in 2020, reflecting a steady increase from previous years due to rising energy demands, particularly in developing regions.

In 2023, global GHG emissions reached an all-time high of 53.0 Gt CO2eq, with household activities representing a substantial portion of this total. Specifically, the United States Environmental Protection Agency (EPA) estimates that the residential sector in the U.S. alone was responsible for about 18% of total national GHG emissions, largely due to the reliance on fossil fuels for heating, electricity, and appliances. Furthermore, a study by the International Energy Agency (IEA) found that worldwide energy demand in the residential sector grew by 3% in 2021, which directly correlated with increased emissions.

In India, the household sector contributes significantly to national GHG emissions, accounting for approximately 24% of the total emissions. According to the India State of Forest Report 2021, the total GHG emissions from households reached 1.53 Gt CO2eq in 2020, marking a 15% increase from 2018 levels. This rise is attributed to various factors, including urbanization, increasing energy consumption, and changes in lifestyle.

A major source of household emissions in India is the reliance on biomass and fossil fuels for cooking and heating. According to the National Sample Survey Office (NSSO), around 65% of Indian households still depend on solid fuels, such as wood, coal, and dung cakes, leading to high emissions of carbon dioxide and methane. The transition to cleaner energy sources is critical, as the Ministry of Power projects that India's electricity consumption will increase by 7% annually over the next decade, which could further elevate household emissions unless sustainable practices are adopted.

Transportation also contributes significantly to household emissions in India. The Transportation Research and Injury Prevention Program (TRIPP) estimates that the household transportation sector emitted approximately 0.2 Gt CO2eq in 2020, with a projected increase as urban mobility continues to expand. Additionally, waste management remains a pressing issue, with household waste contributing significantly to methane emissions in landfills. The Central Pollution Control Board (CPCB) reported that around 62 million tons of waste is generated annually in urban India, with an estimated 20% of this waste being organic, leading to significant methane emissions when not properly managed.

Objectives

- Identify key household practices that women influence and that significantly contribute to reducing a household's carbon footprint.

- Understand the factors that motivate women to adopt sustainable consumption behaviors within their households.

- Explore the barriers that prevent women from adopting sustainable consumption behaviors in their households.

- Develop strategies to empower women to become even more effective catalysts for sustainable consumption.

Major Sources of Greenhouse Gas Emissions

- **Energy Production**: The largest source of GHGs, accounting for about 73% of global emissions, primarily through burning fossil fuels (coal, oil, and natural gas) for electricity, heating, and transportation.

- **Transportation**: Vehicles, ships, and airplanes that rely on fossil fuels release substantial carbon dioxide and other pollutants, contributing around 16% of global emissions.

- **Industry**: Industrial processes, including cement production, chemical manufacturing, and steel production, produce approximately 21% of emissions. Emissions stem from both energy use and chemical reactions involved in production.

- **Agriculture**: Livestock farming, rice cultivation, and soil management practices are major sources of methane and nitrous oxide, which contribute nearly 18% of total emissions globally. Livestock, in particular, emit methane through digestive processes.

- **Forestry and Land Use**: Deforestation, land degradation, and land-use changes release stored carbon from trees and soil, accounting for about 11% of global emissions. Forests act as carbon sinks, so their destruction reduces Earth's capacity to absorb CO_2.

- **Waste Management**: Organic waste in landfills decomposes anaerobically, emitting methane. Waste treatment and disposal, including wastewater treatment, add about 3% to global emissions.

- **Residential and Commercial Buildings**: The use of fossil fuels for heating, cooking, and other energy needs in buildings contributes around 6% of GHG emissions, with a rising demand for electricity adding further indirect emissions.

- **Fluorinated Gases**: These synthetic gases, used in refrigeration, air conditioning, and industrial applications, have a high global warming potential, despite being emitted in smaller quantities compared to other GHGs.

Table1: Summarizing the carbon footprint of various household equipment's in India

Equipment	Carbon Footprint (kg CO2e/year)
Air Conditioner (1.5 ton, 8 hours/day)	2,000 - 3,000
Refrigerator (250L, 24 hours/day)	300 - 500
Washing Machine (Fully Automatic, 5 washes/week)	200 - 300
Electric Water Heater (50L, 2 hours/day)	600 - 800
Electric Oven (1 hour/day)	100 - 200
Microwave Oven (30 minutes/day)	50 - 100
LED Lighting (10 bulbs, 5 hours/day)	50 - 100
Incandescent Lighting (10 bulbs, 5 hours/day)	200 - 300

The table provides a snapshot of the carbon footprint associated with various household appliances in India. Air conditioners, due to their high energy consumption, contribute significantly to emissions, followed by electric water heaters. Refrigerators and washing machines, while less intensive, still have a notable impact. Electric ovens and microwave ovens, while less frequently used, can add to the overall household carbon footprint. The choice of lighting, with LED bulbs being significantly more energy-efficient than incandescent ones, can also influence the overall environmental impact of a household. Understanding these differences can empower individuals to make informed choices about appliance usage and energy efficiency, contributing to a more sustainable lifestyle.

Major Household activities contribute to greenhouse gas (GHG) emissions through various daily practices and resource uses

- **Energy Use for Cooking and Heating**: A significant number of households rely on biomass (such as firewood, cow dung, and crop residue) and kerosene for cooking, which release CO_2, CH_4, and other pollutants. Adoption of liquefied petroleum gas (LPG) has grown, but traditional fuels remain prevalent, especially in rural areas.

- **Electricity Consumption**: Households that use electricity generated from fossil fuel-powered plants contribute indirectly to CO_2 emissions. Major sources of electricity demand include lighting, appliances, and increasingly, air conditioning in urban areas.

- **Waste Management**: Improper waste disposal and open burning of household waste emit CH_4, CO_2, and other GHGs. Limited recycling and waste segregation further contribute to emissions from landfill decomposition.

- **Water Use and Treatment**: Energy-intensive water pumping for irrigation and household use indirectly contributes to GHG emissions, especially in areas where groundwater extraction is common. Additionally, wastewater treatment releases N_2O and CH_4 emissions.

- **Transportation**: Personal vehicles, especially two-wheelers, are a significant source of CO_2 emissions in urban areas. As private vehicle ownership rises, emissions from fossil fuel use in transport are increasing.

- **Construction and Home Improvements**: Home construction and renovations often involve cement and steel, both of which are carbon-intensive materials. The shift toward concrete homes also impacts household carbon footprints.

- **Consumption of Goods and Services**: The demand for consumer goods, from electronics to fashion, has grown significantly in recent years. Manufacturing, packaging, and transporting these goods contribute

indirectly to household-related GHG emissions.

- **Agricultural Practices (for Rural Households)**: Many rural households engage in small-scale farming and livestock rearing, which can produce CH_4 and N_2O emissions through manure management, rice paddies, and fertilizer use.

Key household practices women often adopt that contribute to carbon footprint reduction

Energy Conservation

Women often play a pivotal role in promoting sustainable household practices. By adopting efficient appliance usage, water conservation techniques, and mindful temperature control, women can significantly reduce their household's carbon footprint. These practices not only contribute to environmental sustainability but also lead to cost savings and improved overall well-being.

Sustainable Food Choices

Women play a crucial role in promoting sustainable consumption practices within households. By embracing dietary shifts towards plant-based options or reducing meat consumption, women can significantly lower their carbon footprint. Additionally, prioritizing local and seasonal food choices reduces transportation emissions and supports local economies. By implementing mindful food practices like meal planning, proper storage, and composting, women can effectively minimize food waste and its associated environmental impact. These conscious choices empower women to become catalysts for a more sustainable future.

Sustainable Transportation

To reduce carbon emissions and improve air quality, individuals can adopt sustainable transportation practices. Opting for active transportation like walking and cycling or utilizing public transport systems can significantly lower greenhouse gas emissions. Additionally, carpooling and ride-sharing can reduce the number of vehicles on the road, leading to reduced traffic congestion and lower emissions. For those who rely on personal vehicles, choosing eco-friendly options like electric or hybrid vehicles can further minimize environmental impact.

Waste Reduction and Recycling

Women play a pivotal role in promoting sustainable household practices. By embracing principles like reducing, reusing, and recycling, they minimize waste generation and conserve resources. Additionally, composting food scraps helps reduce landfill emissions and create nutrient-rich soil. Opting for sustainable packaging choices, such as minimal packaging and reusable or recyclable options, further contributes to environmental sustainability.

Sustainable Cleaning Practices

By adopting natural cleaning practices, such as using DIY cleaning solutions and minimizing water usage, individuals can significantly reduce their environmental impact. Natural cleaning products not only avoid harmful chemicals but also reduce plastic waste associated with conventional cleaning products. Water-efficient cleaning methods further contribute to sustainability by conserving precious resources. These simple yet effective practices can empower individuals to make a positive difference in their homes and communities.

Factors Influencing Women's Adoption of Sustainable Consumption Behaviors

Socio-economic Factors

The adoption of sustainable household practices by women is influenced by various factors. Lower-income households may prioritize affordability over sustainability, while higher education levels can lead to greater environmental awareness. Additionally, occupations that emphasize sustainability can influence personal choices. Access to information on sustainable products and practices is crucial, as is the consideration of lifestyle choices such as urban or rural living, family size, and housing type, which can impact consumption patterns.

Cultural Factors

Cultural, social, and religious factors significantly influence women's consumption habits. Traditional values and beliefs often dictate specific consumption patterns, while social norms and peer pressure can sway choices towards popular trends. Moreover, religious teachings and practices may shape attitudes towards consumption and environmental responsibility, further impacting women's decisions and behaviors.

Educational Factors

Environmental education, consumer education, and skill development are crucial components of sustainable living. By understanding environmental issues, consumers can make informed choices about products and services. Additionally, acquiring practical skills empowers individuals to adopt sustainable practices in their daily lives, such as reducing waste, conserving energy, and growing their own food.

Global GHG Emission Trends

- In 2022, global human-driven GHG emissions reached 53.8 gigatons of CO_2 equivalent (Gt CO_2e), reflecting a 62% rise since 1990. The decade from 2010 to 2019 saw an average annual emission rate of 56 Gt CO_2e, marking the highest decadal average recorded and nearly 10 Gt CO_2e above the previous decade (2000–2009).

- Fossil fuel combustion represented the majority share, contributing 73% of global human-caused GHG emissions. In 2023, global CO_2 emissions from energy sources set a new record at 37.2 Gt, reflecting a 52% increase since 2000. Current projections suggest these energy-related CO_2 emissions could increase by another 15% between 2022 and 2050.

- Fluorinated gases (F-gases), containing fluorine compounds such as hydrofluorocarbons (HFCs), are currently the fastest-growing category of GHGs, with F-gas emissions rising by 5.5% in 2022. Methane (CH_4) emissions increased by 1.8%, while nitrous oxide (N_2O) emissions rose by 0.9% in the same year.

- Since 2005, China has surpassed the United States as the largest annual emitter of anthropogenic CO_2. In 2022, China's per capita CO_2 emissions were double the global average, while U.S. per capita emissions were triple the global average.

- There are stark disparities in emissions between income groups globally. The wealthiest 10% of the population accounted for 48% of emissions, with two-thirds of this group living in developed nations. In contrast, the poorest 50% of the population contributed only 12% of global emissions.

- CO_2 emissions from non-OECD countries are expected to grow by 1.0% per year, while those from OECD countries are projected to rise by 0.2% annually. However, per capita emissions in OECD countries are still anticipated to be 2.2

times higher than in non-OECD countries by 2050.

Reducing greenhouse gas (GHG) emissions from household activities in India

- **Switching to Cleaner Cooking Fuels**: Promoting alternatives like LPG, electric stoves, and biogas over traditional biomass fuels (such as wood, cow dung, and crop residues) can substantially cut down household CO_2 and CH_4 emissions. Programs like the Pradhan Mantri Ujjwala Yojana (PMUY) encourage LPG usage, yet broader expansion and affordability measures are necessary to ensure clean cooking access for all.

- **Increasing Energy Efficiency in Lighting and Appliances**: Replacing incandescent bulbs with LED lights and supporting energy-efficient appliances can lower electricity demands, reducing CO_2 emissions from fossil-fuel-driven power sources. The UJALA scheme, which offers affordable LEDs, has made substantial progress toward this goal.

- **Enhancing Waste Management**: Households can mitigate GHG emissions by segregating waste and composting organic materials instead of burning them or sending them to landfills, where decomposition releases CH_4. Community waste collection and awareness initiatives can promote effective waste segregation and composting at the household level.

- **Improving Water Use Efficiency**: Reducing water consumption and using water-saving fixtures decrease the energy required for water pumping and treatment. Households can adopt low-flow faucets, efficient garden irrigation, and rainwater harvesting practices.

- **Encouraging Public and Non-Motorized Transport**: Decreasing reliance on private vehicles by opting for public transport, cycling, and walking can significantly reduce CO_2 emissions from the transportation sector. Expanding public transit systems and introducing bike-sharing options can help households lower their transportation-related carbon footprint.

- **Adopting Solar and Renewable Energy Solutions**: Encouraging the use of rooftop solar panels and solar water heaters can reduce household reliance on grid electricity, thereby decreasing CO_2 emissions from fossil-fuel-based power plants. Subsidies and incentives for residential solar adoption make these solutions more affordable.

- **Promoting Sustainable Consumption**: Educating households on sustainable purchasing practices—such as avoiding single-use plastics, choosing local and seasonal foods, and selecting eco-friendly products—can lower emissions associated with the production, packaging, and transportation of goods.

- **Encouraging Efficient Use of Construction Materials**: Households can reduce GHG emissions by choosing eco-friendly building materials and energy-efficient designs in home construction and renovations. Green construction materials and methods help reduce the carbon footprint in household building projects.

- **Reducing Agricultural Emissions (in Rural Households)**: For rural households engaged in farming, sustainable practices like organic farming, optimized fertilizer application, and proper livestock waste management can help minimize CH_4 and N_2O emissions in agriculture.

Findings of the Study

- Women often play a significant role in household decision-making, particularly regarding energy consumption, food choices, waste management, and transportation.

- Household practices, such as energy consumption, food choices, waste management, and transportation, contribute significantly to individual and collective carbon footprints.

- Women can act as catalysts for sustainable consumption by adopting eco-friendly practices within their households, such as energy efficiency, reducing food waste, and choosing sustainable transportation options.

- Factors like socio-economic status, cultural norms, education, and access to information influence women's willingness and ability to adopt sustainable practices.

- Barriers such as lack of awareness, affordability, and infrastructure constraints hinder women's efforts to adopt sustainable practices.

- Strategies like education and awareness campaigns, policy interventions, and community initiatives can empower women to make informed choices and drive sustainable consumption.

Research Outcome

The research highlights the crucial role of women in driving sustainable consumption within households. By making informed choices about energy use, food selection, waste management, and transportation, women can significantly reduce their carbon footprint. However, factors like socioeconomic status, cultural norms, and access to information influence their ability to adopt sustainable practices. To empower women as catalysts for change, it is essential to address barriers such as lack of awareness and affordability, and implement strategies like education and awareness campaigns. By doing so, we can harness the potential of women to create a more sustainable future.

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