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Scenario analysis of greenhouse gases reduction by changing consumer's shopping behavior

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Abstract

Existing research shows that lifestyle changes and sustainable consumption play an important role in global warming mitigation. One way to alter consumer behavior and make it more environmentally responsible is to enhance communication between all stakeholders, that is, producers, retailers, and consumers. This paper evaluates the GHG reduction potential of changing daily shopping behavior through behavioral transformation. Behaviorally transformative actions in this context cover select foods and daily necessities, and are analyzed here from a life cycle assessment perspective. We developed multiple product selection scenarios to evaluate GHG emissions related to the purchase of daily commodities. Based on life cycle assessment, we estimated GHG emissions from production and distribution both in terms of current product selection and possible improved selection. Among other results, our study shows that due to seasonal consumption and energy conversion, greenhouse fruits and vegetables have high potential to reduce GHG emission. The GHG reduction potential of each individual commodity is not high because daily commodities consist of a number of goods. However, combinations of various actions can achieve a high reduction potential.

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Keywords: Type your keywords here, separated by semicolons ; Max 6 keywords

1. Introduction

Life style changes and sustainable consumption play important roles in global warming mitigation. UNEP [1] reports that approximately one third of life cycle GHG emissions from households (consisting of energy use and goods and service consumption) comes from food consumption. Thus, daily shopping choices are an important factor affecting GHG emission and its reduction in households. One way to shift consumer behavior in a more environmentally responsible direction is to increase communication between all stakeholders, that is, producers, retailers, and consumers. Scholars working on a research

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project entitled “Creating a Low-Carbon Production, Retail and Shopping System for Nagoya” have developed a communication platform that brings together producers, retailers, and consumers in Nagoya, Japan [2]. This project was aimed at changing consumer behavior in an environmentally friendly way by suggesting goods and lifestyle choices that would benefit both the environment and the consumers themselves. However, in order to be effective, such suggestions need to be very specific. It should also be possible to accurately quantify the GHG reduction potential of specific changes in consumer behavior.
This study seeks to evaluate the GHG reduction potential of changes in consumers’ daily shopping behavior. We have developed behaviorally transformative consumer actions covering select foods and daily necessities. We adopt a life cycle assessment (LCA) perspective to consider GHG emission in both the upstream and downstream sections of the supply chain.

2. Methods

2.1 Scenario development

There are innumerable types of products that people consume. For detailed quantification of the environmental burden caused by shopping behavior, we would need to apply the LCA criteria to every product, which is quite difficult. This study uses product selection actions pertaining to food and daily necessities because GHG emission related to this consumption accounts for 14% of the total GHG from household consumption in Japan (Table 1) [3]. We have selected particular actions and food/daily necessity items that can be expected to have a relatively large environmental load reduction effect, based on the criteria below:

Table 1. Percentage of life cycle CO_2 emission in the final consumption of households [3]

	Ratio %
Food	15
Housing	1
Fuel, light and water charges	49
(Electricity)	22
(Gas, manufactured and piped)	16
(Liquefied propane)	6
(Kerosene)	5
(Other fuel and light)	0
(Water and sewerage charges)	0
Furniture and household utensils	2
Clothing and footwear	2
Medical care	2
Transportation and communication	14
(Gasoline)	9
Education	1
Culture and recreation	5
Other consumption expenditure	12

(a) Items that previous studies have shown to cause a large share of current GHG emissions
(b) Items that are expected to have significant reduction potential from behavior modification
(c) Items with high purchase frequency (non-durable consumer goods)
(d) Items that can help reduce environmental load through appropriate product selection by consumers

While securing a sufficient coverage ratio of the total consumption for the prepared actions from the perspective of (a), actions that were deemed to be particularly important were included regardless of this. There are certain items where a number of past studies have shown marked differences in the emission effects, such as recycling of used paper (use of black liquor or evaluation of forest stocks) or organic farm products (to the extent of reduction of yield). These products have not been included in this study. We have selected actions that are centered mainly on food purchases (Table 2).

2.2 Estimation of GHG emission reduction

We use Formula 1 to estimate the GHG reduction potential in each action from the perspective of life cycle assessment. We do not intend to derive the potential of each product, but the total potential of product categories in each action. We have therefore derived the unit reduction potential (potential per

unit weight of food consumption) in order to stay as close as possible to the true average value of each item.

$$GHG\ reduction\ potential = \sum_i unit\ reduction\ potential * consumption\ quantity \quad (1)$$

Where *i*: item (e.g., tomatoes, spinach, apples, grapes)
The consumption quantity is the estimated quantity purchased by the household; we have used household budget statistics in Japan to reach this estimate. We calculate the unit GHG reduction potential as the average value of existing results, that is, the difference in GHG emission before and after the change in shopping behavior. The system boundary of LCA is "farm to store," including agricultural production, package manufacturing, transport from farm to consumption area, and all upstream processes related to utility and raw material production.

Table 2 Actions on shopping behavior changes

Scenario	Commodity	Assumption
Local production/consumption	Vegetables	13 items; minimizing of the total transportation distance from farm to consumption area within Japan
Seasonal production/consumption	Vegetables	13 items; 20% reduction of unseasonal consumption, maintaining the constant total consumption of vegetables
Choice of products reducing the use of chemical fertilizers	Rice Vegetables	14 items; 50% and > 90% reduction in the use of chemical fertilizers on vegetables and rice respectively
Reduction of food packaging	Meat	Moving from sale of food on trays (material: PSP) to sale without trays (material: HDPE)

3. Results and discussion

Figure 1 shows the estimated results of the GHG reduction effect for each scenario covered in this study. In the scenario relating to vegetables, the reduction potential was 149–410 kt-CO_2 eq. This is about 3.4%–4.4% of the life cycle GHG emission of the items in each action. The purchased quantity of rice farmed in an environmentally sound way is less than that of vegetables. However, the emission reduction rate of 9.5% for rice in this category is higher than that for vegetables. Rice therefore has a slightly higher reduction potential than vegetables (220 kt-CO_2eq). The reduction effect of doing away with the PSP plastic used in meat trays would be greater than the increase in emission due to the use of alternative plastic (HDPE). This would result in a net reduction of 209 kt-CO_2eq. Overall, the total reduction effect from all scenarios is 1,181 kt-CO_2eq. When compared to the CO_2 emission due to household consumption as estimated by RISTEX, this reduced figure is equivalent

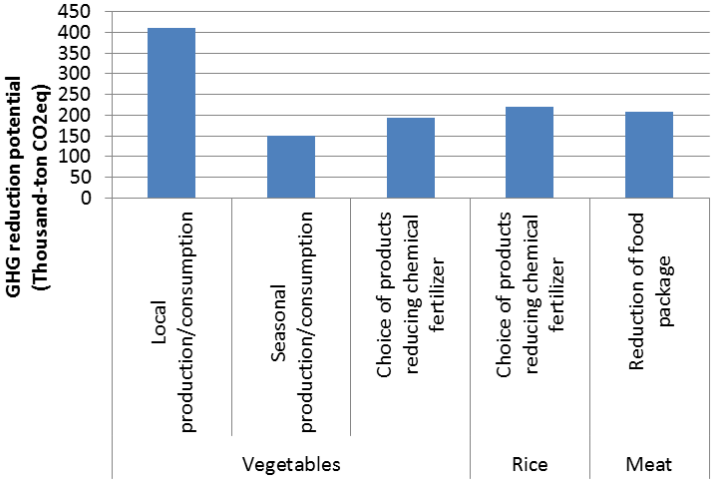

Fig.1 GHG emission potential by scenario

to the emissions from the annual final consumption of roughly 130,000 households. However, considering the reduction rate, we observed that actions in small numbers do not cause a substantial reduction. A feasible proposal for changing consumer behavior with a view to meaningful reduction of GHG emissions must assess combinations of numerous actions covering a large number of items and product life cycles. Here, we estimate the potential while assuming that all consumers will take action. In practice, however, to correctly model the effect of behavior changes, critical factors that facilitate changes in behavior, such as price or convenience, must also be considered during implementation.
The GHG reduction potential of different products varies according to country or region, depending on the production/distribution environment and prevalent food consumption patterns. To promote efficient environment-friendly actions, while simplified estimations can be used, both evaluation and implementation should be region-specific. Development of region-specific scenarios and estimation methods requires shorter research time and lower costs, and helps provide consumers with more precise decision-making support.

4. Conclusion

In this study, as a preliminary step to proposing changes in shopping behavior through communication between retailers and consumers, we have estimated the GHG reduction potential of behavior change in four scenarios. The results show that there will be a reduction effect from such change. However, in order to achieve a substantial reduction in emission, it is necessary to examine a larger number of actions. Various reduction efforts by producers/distributors would be required in each product life cycle stage, and the information provided in this regard needs to be very specific. To promote low carbon consumption activity, it is necessary to undertake further qualitative and quantitative examination of emission effects, and appropriate communication, using information that is supported by adequate data. Robust reduction efforts are also required from all the individuals and businesses in the production and consumption chain.

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Biography

Dr. Naoki Yoshikawa is Assistant Professor at the College of Science and Engineering, Ritsumeikan University. He has recently worked on an R&D project entitled “Creating a Low-Carbon Production, Retail and Shopping System for Nagoya.”