Estimating the GHG emissions mitigation effects of â€œbuying local foodâ€• through a life cycle analysis: the case study of Japanese seven regions

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Greenhouse gas (GHG) emissions from food system accounted for 34% of the global GHG emissions in 2020. To mitigate the GHG emissions from the food system, it is crucial to focus on food supply chains including cultivation of agricultural products, transportation, packaging, sales, and disposal and make a policy toward a greener food system. The concept of â€œfood milesâ€• which represents how far the food traveled before it reaches the final consumers, penetrated Japanese society and â€œbuying local foodâ€• has been promoted to reduce GHG emissions in the transportation stage through decreasing the food miles.
On the other hand, we should note that the existing food trade network reflects the comparative advantage of regions due to its geographic feature. Hence, the production shift to local food can offset the GHG emissions reduction effect in transportation stage through the increase of intermediate input for food production. However, there are few studies that consider the net effect of buying local food in a country.

This study investigates the impact of buying local food on life cycle CO2 emissions associated with cultivation and transportation of food in Japanese seven regions (i.e., Hokkaido, Tohoku, Kanto, Kansai, Chugoku, Shikoku, Kyushu). We focus on major five vegetables (i.e., radish, onion, cabbage, carrot, and Chinese cabbage) which are widely produced and consumed in Japan. The novelty of this study is that we estimated the detailed intermediate input structure of agriculture sector by the seven regions based on the income and expenditure survey to agricultural enterprise. We consider twelve intermediate input including energy, fertilizer, agricultural chemicals, farm machine, land improvement, packaging. For energy input, we used different input coefficients for open cultivation and intensive cultivation (indoor cultivation) which requires extra energy input to control the temperature in the facilities.

To calculate the direct and indirect CO2 emissions in cultivation, we use CO2 emission coefficients based on the environmentally-extended input-output table of Japan (3EID) published by National Institute for Environmental Studies. Finally, CO2 emissions in cultivation stage are calculated by multiplying the embodied CO2 emission coefficient row vector with the estimated input coefficient column vector.

We found that the embodied CO2 emissions intensity of food cultivation are significantly varies among regions. The intensity was lowest in Hokkaido (4.4kg-CO2/thousand JPY) and was the highest in Shikoku region (7.3 kg-CO2/thousand JPY). For Hokkaido which has a vast land, the share of open cultivation was the highest among the regions.

For calculating the CO2 emissions in transportation stage, we constructed food transportation network matrix using food trade data published by wholesales market in each region and CO2 emissions intensity for unit truck transportation published by truck association of Japan. In Japan, more than 90% of domestic food transportation are covered by truck transportation. We considered the transportation share and the intensity of private and industry trucks respectively. We found the total CO2 emissions from transporting the five vegetables focused on this study was 480 kt-CO2. Food transports from Hokkaido to Kanto region which including Tokyo was the largest contributor, it accounted for 15% of the total emission. It was followed by that from Hokkaido to Kansai region including the second largest city and that from Hokkaido to Kyushu region which is the longest travel from Hokkaido.

Based on the results, we investigated the CO_2 mitigation effect of the buying local food by the case of shifting from cultivation in Hokkaido to Kanto. Specifically, we set a scenario of substituting vegetables produced in Kanto for those imported from Hokkaido to Kanto and change substitution rate between 1% and 50%. The results show that the purchase shift decreased the life-cycle CO_2 emissions. However, even in the scenario of an extreme shift with the substitution rate of 50%, the reduction effect was only 4% of the total CO_2 emission. Therefore, to mitigate the life cycle CO_2 emissions from the food system effectively, policy makers should focus on the other CO_2 mitigation policies such as restructuring the transportation network or shifting transportation by trucks to that by railway or shipping which have lower CO_2 emission intensities.