EVALUATION OF ENVIRONMENTAL LOAD ON FRIUTS AND VEGETABLES CONSUMPTION AND ITS REDUCTION POTENTIAL

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ABSTRACT

This study estimated greenhouse gases (GHGs) and acidifying substances (ASs) emissions related to fruits and vegetables consumption in Japan based on lifecycle inventory analysis. We also evaluated reduction potential of GHGs and ASs considering the policies of producers and consumers.

Total GHGs emission from domestically produced fruits and vegetables in Japan (2003) was nearly 12.7 million t-CO_2eq in which 65% of the total was from production and 16% was from transportation. GHGs and ASs from greenhouse crops were higher than those from garden farming crops. Environmental efficiency using the proportion of nutrient content (vitamin C) to the GHGs considering cooking processes was relatively high in mandarin oranges and green peppers growing outside and cabbage. As for the reduction potential, we could evaluate up to 4.8% reduction in lifecycle(LC-) GHGs emission by optimizing transportation distance (consuming domestic products possibly).This result approximately equals to scenarios of substituting garden farming crops for 20% of greenhouse crops consumption, 20% reduction of food loss, and modal shift. Furthermore, reductions of 3.1% in LC-GHGs and 16.8% in LC-ASs by 20% deduction of fertilizers could be estimated.

INTRODUCTION

Recent fruits and vegetable consumption tends to year-round consumption. This causes increase of green house crops and extension of food mileage. These trends induce growth in energy use. Food loss, which also causes increase of environmental load, is seen as another problem. On the other hands, some countermeasures which have potential of envrionmental load reduction are proposed and partly implemented. The countermeasures can be classifyed those in agriculture stage, such like reduction of fertilizer, agrichemicals, those in distribution, such like modal shift, and those in consumption, such like local production for local consumption, food loss reduction. These effects have to be quantitatively evaluated to consider direction for realizing sustainable consumption.

This study aims to make inventory data of fruits and vegetables which are covering most of those produced and consumed in Japan. As to concider sustainability of food consumption, we also estimated environmental efficiency focusing on nutrient intake. Based on these result, we evaluated emission reduction potential of environmental load by various kinds of countermeasures in production, distribution, and consumption stage in the life cycle of fruits and vegetables consumption.

LIFECYCLE INVENTORY ANALYSIS

Methodology

In this study, we set system boundaries as 6 satages of life cycle: production, shipment, transportation, retailing, cooking in household, management of solid waste from agriculture, distribution, and household (Fig. 1). We assume purchace of fresh crops by household in inventory analysis, so we did not consider food processing and cooking in food service sector. We did not consider waste water treatment stage likewise.

We treated 14 kinds of vegetables and 10 kinds of fruits produced in Japan. These amount of production covers over 80% of Japanese fruits and vegetables production.

This study estimted direct and indirect emission from greenhouse gases (GHGs) and acidifying substances (ASs). We treated CO_2, CH_4, N_2O in GHG emission , and NOx, SOx, NH_3 in AS emission. This study utilizes hybrid LCA method (combination of I-O analysis [1] and process analysis) in production and shipment stage using production and shipment cost data and emission factor from Japanese I-O model. Process analysis is used in other stages.

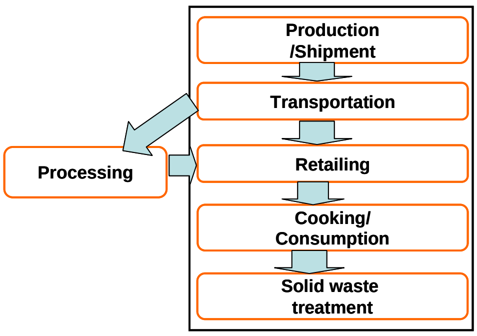

Fig. 1 System boudary

Results of inventory analysis

Fig. 2 shows major results about GHGs emission estimation of fruits and vegetabes produced in Japan. Emission from greenhouse crops exceed those from garden farming crops in case of tomatoes and green peppers. This difference comes from warming in winter greenhouse, in which mainly heavy fuel oil is used. Potatoes and onions embody low emission in production stage, however higher emission in transportation by long distance transportation.

Major results about ASs emission are shown in Fig. 3. In the case of ASs, crops with higher GHGs emission embody higher ASs emission in general. Some of crops which is treated more nitrogen fertilizer, such as spinach, garden farming peach, and garden farming grape, also emits more NOx and NH_3 than other crops.

In the total of Japanese domestic products, 12.7 million t-CO_2eq of GHGs and 279 thousand t-SO_2eq of ASs are emitted in lifecycle of fruits and vegetables consumption. GHGs emission equals nearly 0.93% of all GHGs emission from Japan in 2003. 65 % of GHGs emission is from production stage, 16% is from transportation stage, 8% is from shipment stage. As for ASs, 93% of emission is from production stage, 4% from transportation stage.

ENVIRONMENTAL EFICIENCY

Fig. 4 shows environmental efficency focusing on nutrient intake. These indicators show GHGs emission per vitamin C intake, considering nutrient losses in cooking processes. Environmental efficiency is high in boiled cabbage, summer green pepper, and garden farming mandarin orange. Efficiency is low in greenhouse mandarin orange, strawberry, and winter tomato. Products with high environmental efficiency have rich vitamin C content like green peeer, oranges, or low emission in production stage like cabbage.

EMISSION REDUCTION POTENTIAL ESTIMATION

This study estimated emission reduction potential by making 7 scenarios shown in Table 1. Potential is calculated from result of inventory analysis and assumotion in each scenarios.

Results of potential estimation are shown in Fig. 5. We could evaluate up to 4.8% reduction in lifecycle GHGs emission by Local production & consumption scenario. This result approximately equals to scenarios of Consumption in season, 20% reduction of food loss, and

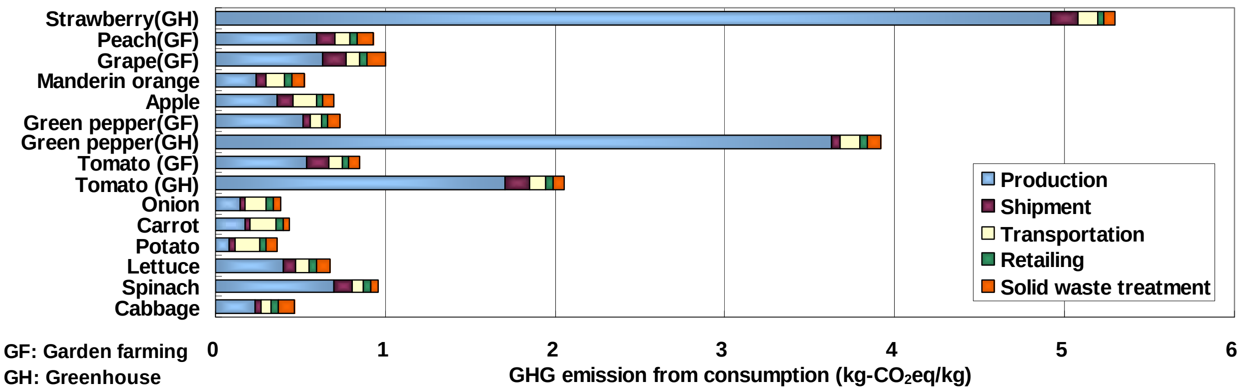

Fig.2 GHGs emission from fruits and vegetables consumption

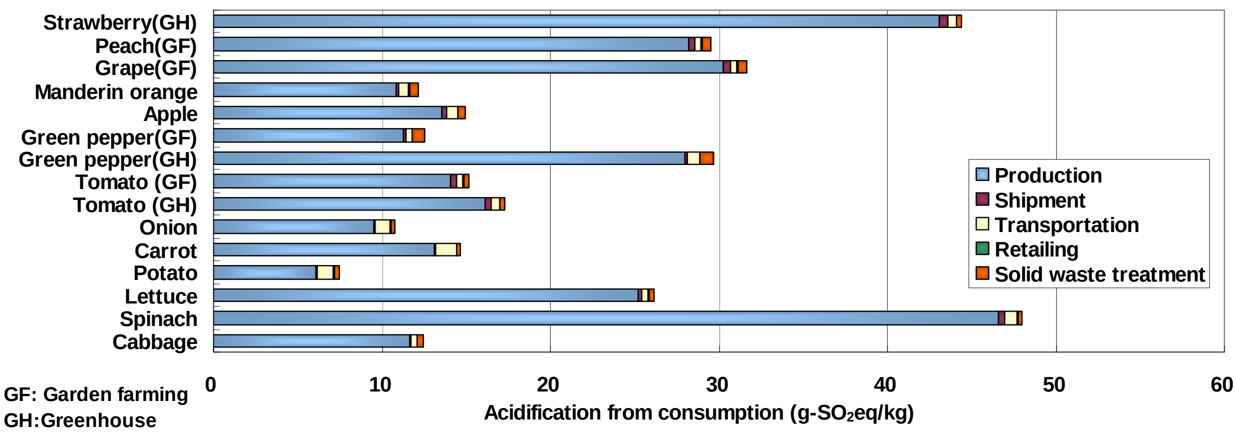

Fig.3 ASs emission from fruits and vegetables consumption

modal shift. In food loss reduction scenario, effect of GHGs reduction by holddown of excess production is higher than that by reduction of food waste. Energy saving of greenhouse scenario reduces most of GHGs in production stage. 25% to 44% of GHGs from greenhouse crop can be reduced. Fertilizer reduction is effective to reduce ASs emission.

When implementing all of 7 scenarios, it is able to reduce 22.7 % of GHGs and 22.4% of ASs.

CONCLUSUION

This study estimated GHGs and ASs emission related to Japanese fruits and vegetables consumption. We also evalate emission reduction potential by various countermeasures. These results should be valuable as basic data and analysis for consideration for sustainable consumption of food.

REFERENCES

[1] Center for Global Environmental Research National Institute for Environmental Studies: Embodied Energy and Emission Intensity Data for Japan Using Input-Output Tables (3EID), http://www-cger.nies.go.jp/publication/D031/index.html, (2007)

Table 1 Emission reduction scenarios

scenario	overview
Local production & consumption	Optimizing domestic transportation distance
Modal shift	Shifting 50% of over 500km truck transportation to railway
Consumption in season	Substituting garden farming crops for 20% of greenhouse crops consumption
Food loss reduction	Reducing 20% of food loss in household
Fertilizer reduction	Reducing 20% of fertilizer in agricultural production
Energy saving in greenhouse	Converting bunker A boiler for Heating to heat pump system
Food recycling	Recycling all food waste (50% for composting, 50% for energy recovery by methane fermentation)

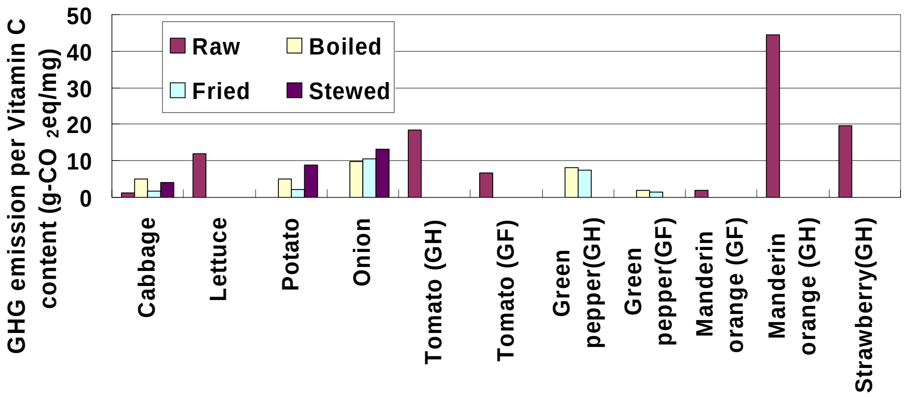

Fig. 4 Environmental efficiency focusing on nutrient intake

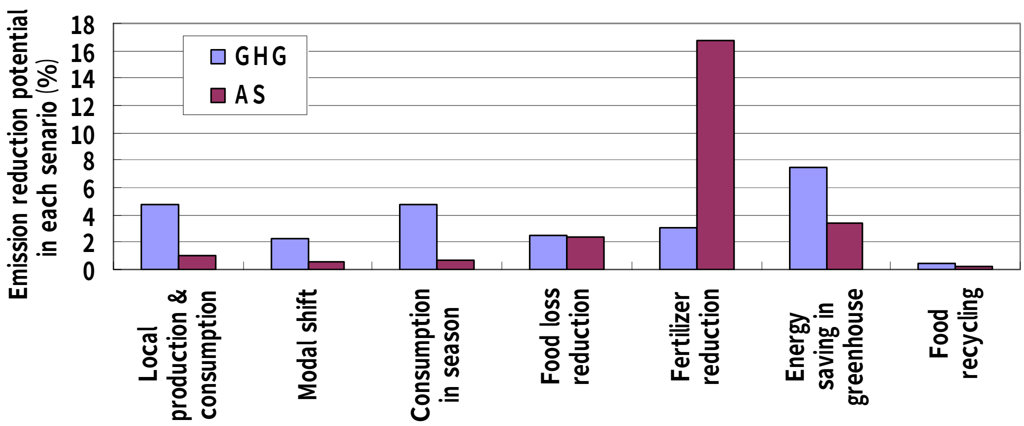

Fig. 5 Emission reduction potential based on seven scenarios