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Measurement and Reduction of Food Loss and Waste – Reconsidered

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The number of recent publications on food loss and waste, and policy initiatives of governments and international organizations indicate the high priority of this topic. With this in mind, the methodology to measure food loss and waste has important implications for policy recommendations. The authors of this IAMO Policy Brief state that the many individual studies use different methodologies to quantify the size of waste with respect to metric measures and value for individual products and for the aggregate of food loss and waste. Most studies do not consider the costs incurred by reducing or redirecting food loss and waste. A recent publication has taken up the methodological problem (Bellamare et al., 2017). The authors of this IAMO Policy Brief investigate whether the proposed methodology solves the problem and can contribute to designing a rational policy to manage food loss and waste.

As an increasingly and globally recognized problem, food loss and waste (FLW) is of high interest to the public, politicians, and researchers from various fields. The available estimates find that almost one third or even more of the world's food production (1.3 billion tons) is lost or wasted, especially in the industrialized world. The United Nations aim to "halve per capita global food waste ... by 2030" (Delgado et al., 2017). However, the various concepts proposed in the literature to measure FLW produce varying results and the results are not sufficient for the design of a rational policy (Koester, 2017).

Hence, a study that takes up the methodology problem and aims at presenting a general method for quantifying FLW should be welcome. Bellemare et al. (2017) explore the topic of FLW with a focus on the measurement of food waste.

Bellemare et al. (2017) deserve credit for taking up the conceptual discussion and "proposing a more consistent and practical approach" to measuring FLW along the food supply chain (p. 1148). With this IAMO Policy Brief, we intend to move the discussion forward by examining the following propositions:

1. Bellemare et al. (2017) use quantity and value-based aggregates to measure FLW. Aggregation over quantities ignores the different nature of products. Values include other non-food products and services. Thus, both measures are inconsistent with most standard economic objectives that focus on food only.
2. Consistent definitions and measures of FLW need to specify the underlying objective to determine the optimal reduction of food waste and take into account the cost of reducing waste. Bellemare et al. (2017) state certain objectives, but do not derive their definitions and measure of FLW based on these.
3. The measure of FLW developed by Bellemare et al. (2017) and most other measures ignore the costs and risks of reducing FLW and thus may produce misleading results. The design of a rational policy has to take into account the outcome effect of the policy (reduction of FLW) and the economic costs involved.
4. Considering the costs and risks in a consistent measure and aggregate of FLW results in a different optimal level of FLW at potentially all stages of the food supply chain. To determine this optimum can be very costly, if not impossible due to lack of data.
5. The consideration of the costs and risks of preventing FLW will allow us to identify potentially efficient policy interventions.

Bellemare et al. (2017) focus their approach on food products along the supply chain. They propose to identify the quantities and values of FLW at each stage of the supply chain and aggregate them over

all stages. In contrast to other definitions, Bellemare et al. (2017) state "that 'food waste' is the difference between the amount of food produced and the sum of all food employed in any kind of productive use, whether it is used as food or nonfood" (p. 1152). Obviously, the authors do not aim at identifying 'only food' loss. Instead, they include in their estimate also non-food products that go to the landfill. Consequentially, the measurement leads to an overestimate of the waste of 'food only' in absolute terms. Moreover, the calculated percentage of FLW might be misleading as the proposed calculation of the size of food products includes per definition also non-food products. The definition of the authors implies that FLW is about resources that are not used. However, claiming it is always efficient to reduce waste is premature. The costs involved to reduce the not used resources may be higher than the benefit. A loss of resources may be unavoidable as part of the production process or it may be efficient if considering all resources used in the production of food and the reduction of food loss and waste.

Measuring and aggregating FLW

All studies in the field of FLW pretend to focus on 'food only' products. However, at all stages, food products are a combination of factors, food, and non-food products. The processing along the food value chain changes this combination and the raw product itself. Even if the product does not change, the factors incorporated into the product do. For instance, wheat at the producer level and at the wholesale level may physically be the same product, but at the wholesale level, the product incorporates additional transportation and storage costs. Thus, aggregation over quantities - even of physical equal products - often makes no sense at least for economic purposes. Further, focusing on 'food only' and single food items in the real sense is to some extent not possible and not effective.

Along the value chain, complementary products and services are added to the product, and the product itself is transformed in its physical form. Some of the raw product is taken off and directed to other uses, e.g. non-food uses. FLW studies focus on food and its value; if these studies do not exclude the value of the complementary products and services, the value of FLW is misspecified. Further, the exclusion of these products and services and the consideration of non-food parts of the original raw food material is very complex. In many cases, it may very well be impossible to separate all parts and values. Most value-based studies measure the value of all resources used in the production process up to the stage of the value chain where the loss or waste occurs. This approach overestimates the 'food only' value of FLW.

Objectives for analyzing food waste

In the literature, most often we find the following two objectives: The reduction of FLW contributes to (1) food security (and the reduction of unethical behavior by avoiding food waste in some parts of the world while people suffer from hunger in other parts) or (2) the efficiency of resource use (or sustainable environments) (Koester, 2017; Kummu et al., 2012; Fusion, 2014).

The reduction of FLW can contribute to food security. In a world of growing populations and changing diets, FLW increases the pressure on the world's available resources, constituting a serious threat to food security, especially in developing countries. FLW has a direct impact on short-term food security, particularly on the availability of food. FLW has an indirect and long-term impact on food security through the efficient use of resources and environment. This impact can only be assessed if the methodology of quantification only focuses on 'food only' loss and not on loss of food and non-food as suggested by Bellemare et al. (2017). Moreover, the methodology for measurement should take into account that the quantity and the value of food on alternative stages of the supply chain is generally a joint product, including food, services and other by-products. Theoretically, it might be possible to separate the 'only food' part from the joint product 'food and by products', however, needed data are very specific and are generally not available in official data sources. Consequentially, available resources do not allow measuring the 'real' food loss or 'food only loss', not in quantitative or in monetary term. Moreover, the costs of making the reduced food quantities available have to be taken into consideration.

The second objective often stated for reducing FLW includes the efficiency of resource use or sustainable environments. In the long-term and under the same valuation of resources, both objectives may converge to a singular goal, namely long-term resource efficiency. Long-term resource efficiency maximizes the value of goods available for redistribution within or between societies (food security) under a sustainable environment. For Bellemare et al. (2017) FLW "is the difference between the amount of food produced and the sum of all food employed in any kind of productive use, whether it is food or nonfood" (p. 1152). If we assume that all uses are long-term efficient, this limiting perspective may be correct; however, inefficiencies in producing and using foods or other products can occur due to several factors, including lack of competition, policy regulations, specific cultural values, and market imperfections.

Costs and risks of reducing FLW

Although we can investigate some aspects of long-term resource efficiency using quantitative measures (technical efficiency), for the most part, a valuation of resources is necessary. Thus, quantitative measures of FLW are inappropriate. Bellemare et al. (2017) also favor value over quantity-based measures and suggest prices or marginal costs to valuing products (p. 1152). However, the suggested prices

for 'food only products' at the alternative stages of the supply chain do not express the marginal costs of 'food only', but food inclusive the by-products as part of the joint product.

Just focusing on the value of FLW ignores the costs and risks caused by saving or redirecting FLW. For instance, reducing FLW may demand investments in better machines or reducing FLW in the household may increase health risks for the consumer (Blichfeldt et al., 2015; Evans, 2012). As the result of a cost benefit analysis or a profit or utility maximization, the observed level of FLW can be long-term efficient. While most studies do not consider the costs and risks of reducing FLW, it is obvious that the findings presented by previous studies are not sufficient for a rational policy aiming at FWL reduction.

Measuring resource-based FLW (RFLW)

Throughout the value chain, goods and services are added to the food product and change the value of the combined product. Thus, FLW always leads to loss and waste of non-food resources. Nevertheless, in the following we focus on food products and include all resources added in the processing. Though some aspects discussed above would demand conceptual changes, we build on the concept of Bellemare et al. (2017) to illustrate the basic extensions. We consider environmental (external) effects that may vary for different products and across stages of the value chain. The costs to reduce FLW depend on the product, the stage of the value chain, and the measures to reduce FLW. In line with the framework of Bellemare et al. (2017), measures can have different starting points, e.g. reducing food loss, recovering food loss, diverting food use, and diverting food for consumption. Actual measures may have multiple effects at different starting points at different stages of the value chain. We assume that measures can be steered to change the FLW at particular starting points and at particular stages. The change in risk involved with the reduction in FLW also depends on the product, the stage, and the measure. Thus, the total value of FLW is a resource-based FLW; it is the sum of total value of wasted food-only and complementary products and services including its environmental effects minus the sum of total costs invested in preventing FLW and the risks involved with the reduction in FLW.

For simplification, any potential interrelationships between products and stage are ignored here. The optimal RFLW derived from our conceptual framework indicates the marginal value of the food and resources involved that are recovered (not wasted) and any additional marginal external effects need to be equal to the marginal costs of resources necessary to reduce the RFLW. In addition, the change in risk needs to be valued for each product and each supply chain stage. Therefore, effective measures require that the value of RFLW and the extra environmental cost savings due to waste that is not going to the landfill exceed the costs and risks of reducing RFLW.

Recommendations

Discussions on FLW need to consider the costs and the risks of reducing FLW, the value of FLW is only one side of the coin. Further, food products always include non-food resources. Thus, a resource based approach to FLW is more appropriate; policies which focus on the reduction of the total volume of FLW are likely ineffective. Policies to reduce FLW should focus on areas where the value of resource based FLW likely exceeds the costs and risks of reduction. Prices should reflect external or environmental effects to induce long-term efficient behavior. We especially need to screen state regulations; state regulations often overvalue risks and undervalue costs, which reveals great potential to use resources more efficiently. Consumer preferences are not static; they change over time and are easily influenced. Some studies have suggested that concerns about foodborne illnesses and a desire to eat fresh food are prominent reasons for generating food waste for many households (Lanfranchi et al., 2016; Neff et al., 2015; Qi and Roe, 2016). Further, a lack of information causes inefficient behavior. Public information campaigning may inform consumers and influence our preferences toward more resource-efficient consumer behavior. Finally, we may support research in various fields to develop new ideas and technologies for more resource efficient production, consumption, and storage of (food) products.

Further Information

Literature

Bellemare, M. F., Çakir, M., Peterson, H. H., Novak, L., Rudi, J. (2017): On the Measurement of Food Waste. *American Journal of Agricultural Economics*, 99(5), 1148–1158. URL: doi:10.1093/ajae/aax034 (Accessed: 1 July 2018).

Blichfeldt, B. S., Mikkelsen, M., Gram, M. (2015): When it Stops Being Food. *Food, Culture & Society*, 18(1), 89–105. URL: doi:10.2752/175174415X14101814953963 (Accessed: 1 July 2018).

Delgado, L., Schuster, M., Torero, M. (2017): Reality of Food Losses: A New Measurement Methodology.

Evans, D. (2012): Beyond the Throwaway Society: Ordinary Domestic Practice and a Sociological Approach to Household Food Waste. *Sociology, 46*(1), 41–56. URL: doi:10.1177/0038038511416150 (Accessed: 1 July 2018).

FAO. (2011): Global food losses and food waste – Extent, causes and prevention.

Fusions (2014): Reducing food waste through social interventions, FUSIONS Definitional Framework for Food Waste, Full Report. URL: www.eu-fusions.org/index.php/publications (Accessed: 1 July 2018).

HLPE. (2014): Food losses and waste in the context of sustainable food systems. In *A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security.* Rome.

Koester, U. (2012): Discarding food vs. starving people - Inefficient and immoral? *IAMO Policy Brief No. 7,* Halle (Saale).

Koester, U. (2017): Food Loss and Waste as an Economic and Policy Problem. In: Schmitz, A., P.L. Kennedy and T.G. Schmitz (eds). World Agricultural Resources and Food Security (Vols. 1-0, Vol. 17, pp. 275–288). Emerald Publishing Limited. URL: doi:10.1108/S1574-871520170000017018 (Accessed: 1 July 2018).

Kummu, M., de Moel, H., Porkka, M., Siebert, S., Varis, O., Ward, P. J. (2012): Lost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use. *Science of The Total Environment*, 438, 477–489. URL: doi:10.1016/j.scitotenv.2012.08.092 (Accessed: 1 July 2018).

Lanfranchi, M., Calabrò, G., De Pascale, A., Fazio, A., Giannetto, C. (2016): Household food waste and eating behavior: empirical survey. *British Food Journal*, 118(12), 3059–3072. URL: doi:10.1108/BFJ-01-2016-0001 (Accessed: 1 July 2018).

Neff, R. A., Spiker, M. L., Truant, P. L. (2015): Wasted Food: U.S. Consumers' Reported Awareness, Attitudes, and Behaviors. *PLOS ONE*, 10(6), e0127881. URL: doi:10.1371/journal.pone.0127881 (Accessed: 1 July 2018).

Qi, D., Roe, B. E. (2016): Household Food Waste: Multivariate Regression and Principal Components Analyses of Awareness and Attitudes among U.S. Consumers. *PLOS ONE, 11*(7), e0159250. URL: doi:10.1371/journal.pone.0159250 (Accessed: 1 July 2018).

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