DOI: 10.1007/s10272-014-0518-7

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Food Loss and Waste as an Economic and Policy Problem

Many international organisations, including the European Parliament, see reducing food loss and waste as a priority. They argue that this will increase the efficiency of resource use and have beneficial environmental effects. This paper asserts that the scale of the problem has been overstated and that many of the proposed policy solutions are unlikely to achieve the desired results. Indeed, attempts to reduce food loss and waste may ultimately decrease the efficiency of resource use.

Reduction of food loss and waste (FLW) ranks high on the agenda of many policy makers and academics. Thorough reviews are provided in Parlitt et al.[1] and by the FUSIONS (Food Use for Social Innovation by Optimising Waste Prevention Strategies) project,[2] in which a total of 221 publications are identified as relevant. The June 2014 publication by the High Level Panel of Experts on Food Security and Nutrition (HLPE) listed 207 publications relevant to the topic.[3] Most of these studies are commissioned by international or national organisations and are conducted by researchers from universities or collaborations of several project partners. A number of studies have been completed to highlight the magnitude of the problem, to initiate specific targets concerning the reduction of FLW, and to institute policies to meet the targets. The European Parliament is at the forefront of fighting against food waste. A resolution was approved by the Parliament's agriculture committee on 23 November 2011 that calls for the European Commission and member states to take "radical measures" to reduce waste – "from farm to fork"– by 50 per cent before 2025.[4]

1 J. Parfitt, M. Barthel, S. Macnaughton: Food waste within food supply chains: quantification and potential for change to 2050, in: Philosophical Transactions of the Royal Society B: Biological Sciences, Vol. 365, No. 1554, 2010, pp. 3065-3081.
2 FUSIONS: Reducing food waste through social interventions, FUSIONS Definitional Framework for Food Waste, Full Report, 2014.
3 HLPE: Food losses and waste in the context of sustainable food systems, Rome 2014.
4 EurActive: Parliament pushes to slash food waste in Europe, http://www.euractiv.com/cap/parliament-seeks-slash-food-waste-news-510225, 19 January 2012, accessed 1 September 2014.

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Furthermore, several other institutions also declared their intent to reduce food waste:

- A report by the Government Office for Science, London sets the target of halving the amount of food waste by the year 2050, which would be equal to 25 per cent of today's production.[5]
- The 2011 European Commission Resource Efficiency Roadmap sets a milestone of halving the disposal of edible food waste by 2020.[6]
- "In 2010 the World Economic Forum (WEF) announced its new vision for agriculture on the basis that agriculture contributes 30 per cent of global greenhouse gas emissions, provides 40 per cent of employment worldwide (and 70 per cent for the bottom billion) and accounts for 70 per cent of all water withdrawals."[7]
- The OECD has started to build a preliminary data set on food waste, which includes 34 OECD member countries and China.[8]
- The United Nations Environment Programme, the Food and Agriculture Organization of the UN (FAO), and partners started a global campaign on reducing food waste in January 2013. It aims to reduce food waste, provide an information-sharing portal for the various initiatives worldwide, and target food wasted by retail-

5 Foresight: The Future of Food and Farming, Final Project Report, The Government Office for Science, London 2011.
6 European Commission: Analysis associated with the Roadmap to a Resource Efficient Europe, Commission Staff Working Paper SEC(2011) 1067 final, Brussels 2011.
7 WEF, 2010, quoted by A.R. Davies: Food Futures: Co-designing Sustainable Eating Practices for 2050, in: EuroChoices, Vol. 12, No. 2, 2013, pp. 4-10.
8 OECD: Project on Food Waste, Food Chain Analysis Network meeting 20-21 June 2013, Paris 2013.

ers, consumers and hospitality industry along the supply chain.

Reduction of FLW may not only increase food availability on the national and global levels; it may also reduce the resources needed to produce and, hence, improve the world food situation. Moreover, less FLW could also contribute to positive climate effects. "In order to assess all the environmental benefits of food waste reduction initiatives, one must consider not only the fact that food waste treatment is reduced but that the food processing and other upstream steps of the life cycle are avoided too."[9]

The main objective of this article is to raise some scepticism concerning the potential contribution of the reduction of FLW to the stated objectives of policy makers and the media. This contribution to the literature starts with some contemplation of an adequate definition of FLW in line with the stated objectives. Given that the size of FLW plays an important role in the public debate, the paper investigates the rationale of aggregation and the evidence of the published numbers. Finally, some suggestions for further research will be presented.

Definition of food loss and waste

There is no consensus on the definition of FLW.[10] Over 100 different definitions of "food loss" and "food waste" have been collected by FUSIONS.[11] The HLPE proposes the following definition: FLW is a "decrease, at all stages of the food chain from harvest to consumption, in mass, of food that was originally intended for human consumption, regardless of the cause."[12] This is in line with the definition used in most studies and in particular with that of the FAO.[13]

While researchers are of course free to decide upon a specific definition, there may be a direct relationship between the selected definition, the achievement of a stated objective and the measure used to estimate the extent of FLW. Hence, the main objectives stated in some studies and summarised by the HLPE are presented in the following. The objectives of reduction of FLW are indirectly revealed by the HLPE survey,[14] but completely in line with the mainstream papers in this field. According to the HLPE:

> FLW impact food security and nutrition by three main ways. First, a reduction of global and local availability of food. Second, a negative impact on food access, for those involved in harvest and post-harvest operations and who face FLW-related economic and income losses, and for consumers due to the contribution of FLW to tightening the food market and raising prices of food. Third, a longer-term effect on food security results from the unsustainable use of natural resources on which the future production of food depends.[15]

HLPE concludes that FLW impacts the sustainable food system in all three dimensions: economic, social and environmental. Even if not clearly stated, the objectives of reducing FLW seem to be:

- to improve food security and reduce unethical behaviour by avoiding food waste in some parts of the world while people suffer from hunger in other parts;[16]
- to improve the efficiency of resource use;[17]
- to contribute to a sustainable environment.[18]

It seems questionable whether one definition may allow for the quantification of the impact of specific policy interventions with respect to the achievement of the stated objectives. It may even be that the data collected in line with the chosen definition will be insufficient to assess the achievements of the objective.

Food security

The chosen definition will lead to an overestimation of FLW and its contribution to the food security objective for two reasons. First, some of the food included in FLW according to this definition could or should not be reduced,

9 European Commission: Final Report, Preparatory study on Food Waste across EU 27, Technical Report No. 54 2010, Brussels 2010.
10 OECD, op. cit.
11 FUSIONS, op. cit.
12 HLPE, op. cit.
13 J. Gustavson, C. Cederberg, U. Sonesson, R. Van Otterdijk, A. Meybeck: Global food losses and food waste, FAO, Rome 2011.
14 Ibid.
15 Ibid, p. 12.
16 See e.g. M. Kranert, G. Hafner, J. Barabosz, H. Schuller, D. Leverenz, A. Kölbig, F. Schneider, S. Lebersorger, S. Scherhaufer: Ermittlung der weggeworfenen Lebensmittelmengen und Vorschläge zur Verminderung der Wegwerfrate bei Lebensmitteln in Deutschland, ISWA, Stuttgart 2012; M. Bond, T. Meacham, R. Bhunnoo, T.G. Benton: Food waste within global food systems, A Global Food Security Report, Global Food Security Programme, Swindon 2013.
17 See e.g. FAO: Food wastage footprint: impacts on natural resources, Rome 2013; B. Lipinski, C. Hanson, R. Waite, T. Searchinger, J. Lomax, L. Kitino: Reducing Food Loss and Waste, Working Paper, Installment 2 of "Creating a Sustainable Food Future", World Resources Institute, Washington, D.C. 2013; and General Accounting Office: Food Waste: An Opportunity to Improve Resource Use. Comptroller General of the United States, Washington, D.C. 1977.
18 See e.g. M. Kummu, H. de Moel, M. Porkka, M. Siebert, S. Varis, P.J. Ward: Lost food, wasted resources: global food supply chain losses and their impacts on freshwater, cropland and fertilizer use, in: Science of the Total Environment, Vol. 438, 2012, pp. 477-489; FAO, op. cit.

as any reduction would not actually contribute to the stated policy objectives. These include:

- Food products which necessarily shrink during storage time. Some of this loss is unavoidable and due to the seasonality of agricultural products.

- Agricultural products which had been planned for consumption but which were left in the field due to high harvesting costs or lack of demand due to specific consumer preferences (e.g. small-sized potatoes).

- Products planned for human consumption but fed to animals due to specific consumer preferences (e.g. some vegetables or cereals). It may be argued that humans could eat this food, but this "loss" contributes to the production of animal-originated food.

- Food that has gone uneaten due to health reasons (e.g. the fat of a rumpsteak).

- Food donations to feed the poor. It is obvious that this so-called loss is not a real loss, as it is used for human consumption.

Second, this definition of FLW conveys the perception that the quantified amount could be made available for human consumption without taking into account the costs needed to reduce FLW. Take the example of storage loss; better storage could follow from investment in storage capacities. This may not have been done so far because potential investors may not have been convinced of the profitability or they may not have had access to credit or had the knowledge, willingness, and capability to take the risk. A similar argument may be valid for loss during transport. Another important point is the loss in retail shops and in households. Shops would occur less FLW if they were to stock up several times per day and if households were to buy their food daily from these shops. However, while this would certainly lead to less FLW, there would be higher costs for the retail shops and households. The impact on resource efficiency is not at all clear. However, traders and consumers have likely decided on a method that from their point of view is cost efficient.

Efficiency of resource use

The FLW definition is also ill-suited to investigate the efficiency of resource use. Food at different stages of the value chain is a joint product; it includes the raw agricultural food product and complementary services and processing costs, as well as other added product items. Resources used to offer a specific final food item differ significantly across the whole set of food products. Some goods can only be delivered after including complementary processing costs and others only include services. However, even if some food goods offered in retail shops only include services, the value of these services may vary significantly; it may be a product which was shipped long distances from abroad or which had to be stored for a long period. Neglecting the complementary services, added material and processing costs in collecting data in line with the chosen definition of FLW does not allow one to draw conclusions about the efficiency of resource use.

Sustainability

There seems to be wide agreement that sustainability has three dimensions – economic, social, and long-term viability, including resource use and biodiversity. The question is whether a reduction of FLW as defined above is likely to contribute to sustainability. It has already been shown that data collected in line with the definition above do not provide useful information on efficient resource use. Hence, the reduction of FLW might not necessarily contribute to the first dimension of sustainability.

It is also unclear whether it contributes to the two other dimensions. Less FLW does not imply that the living standards of the most vulnerable in our society or worldwide will be positively affected. Of course, less FLW does imply that more food will be available on our planet. However, there is no guarantee that those who currently suffer from a lack of food would gain. The main cause of starvation in poor countries is not a lack of food availability but rather a lack of purchasing power among the poor. The improved availability of food may help some people, but reducing FLW is not a targeted measure to help the poor.

The open question is whether reducing FLW contributes positively to the third dimension of sustainability, long-term viability and biodiversity. One may argue that using a smaller amount of resources to produce food improves sustainability. However, the data collected in line with the definition of FLW do not offer clear information on such positive effects. The reduction of FLW may be highly positive, negative or neutral with respect to sustainability. Take the case of replacing imported food by producing it domestically and storing it part of the season in order to feed the population all year round. It may well be that importing specific food items for some periods during the year contributes to more sustainability than producing these food items in the season and storing them for the rest of the year. There is no clear relationship between the reduction of FLW and a positive contribution to sustainability.

Methods for quantification of FLW

It is understandable that all available studies present a measurement of the FLW for individual products at different stages of the value chain and an aggregation of the FLW of individual products. Such information is needed if one wants to know whether the issue is of sufficient importance to necessitate a policy response. "The usual approach to metrics is to assess FLW in mass, generally the most easily accessible and comparable data at all levels of analysis."[19] A few studies transform the quantities into calories,[20] basing their quantification on the same FAO data set as the studies measuring mass, while very few studies use monetary units as a measure.[21] The focus of the following discussion will be on the measurement of FLW in tonnes.[22]

Table 1 serves for structuring the discussion. First, the stage of the food chain in which FLW has to be quantified is an important factor. Second, the kind of food to be measured must also be taken into account; the food item under consideration can be a homogeneous product, such as a specific type of egg, or an item which is not homogeneous, such as a mix of eggs from organic and conventional food producers. Finally, there may be an aggregate of food products including all types of food aggregated in tonnes. For clarification of the problems involved, the individual cases will be discussed in sequence.

Case 1: If one only wants to know the quantity of a specific food item, e.g. organically produced eggs, discarded at the producer stage, the aggregation seems straightforward. However, the question is whether this information can be of value for policymaking. From an economic point of view, a product has to be defined in physical terms (e.g. potatoes), in time (potatoes at a specific date) and in space (potatoes produced at a specific location and offered at a specific location). This information is needed if policy makers want to know the economic value of the specific FLW and the costs to be incurred for avoiding or reducing it.

Table 1
Overview: problems of aggregation

Stage of value chain	Homogeneous agricultural food products	Set of agricultural food products
Producer stage	Case 1	Case 3
Any other stage	Case 2	Case 4

Source: Author's account.

Case 2: The error may be even larger if the FLW is measured along the value chain and if it is implicitly assumed that the quantities can be aggregated independently of the stage at which the loss occurred. One kilogram of potatoes wasted after harvest has a lower value than the waste of one kilogram of potatoes just before the next harvest. If the potato waste is late in the season and has travelled a long route from producer to consumer, transport costs and storage costs have been wasted in addition to the value of the resources dissipated at the end of the harvest. Seasonal and spatial production and consumption may lead to measurement errors.

The FLW of one kilogram at the end of the food chain is more costly than at the beginning for two reasons. First, by the time it reaches the end of the chain, some services (trading, storing, screening) have been added to the raw product. Second, the waste of one kilogram at a higher stage of the value chain is more costly because the raw material has been reduced along the chain due to storage and other losses. Hence, policy makers may be badly informed if they only see the total loss of a specific food product aggregated along the value chain.

Case 3: While it is convenient to have a simple method for aggregating different types of food, it makes no sense to simply aggregate the weight of such diverse products as beef and vegetables. Certainly, wastage of relatively cheap food, such as vegetables and potatoes, is greater in mass than wastage of higher quality products, such as beef. But one kilogram of beef contains more calories than one kilogram of vegetables, and moreover, the production of one kilogram of beef consumes many more resources than the production of one kilogram of vegetables. The aggregated figure does not provide information on how many people could be fed if there were no FLW, how many resources have been wasted and how sustainability could be improved by avoiding FLW.

Case 4: Agricultural food products change in quality during the journey from the first stage of the food chain to the last one. Complementing services and other food

19 HLPE, op. cit.

20 M. Kummu, op. cit.; B. Lipinski et al., op. cit.; C.F. Buzby, H.F. Wells, J. Hyman: The estimated amount, value, and calories of postharvest food losses at the retail and consumer levels in the United States of America, EIB-121, U.S. Department of Agriculture, Economic Research Service, Washington, D.C. 2014.

21 J.C. Buzby et al, op. cit.; J.C. Buzby, J. Hyman: Total and per capita value of food loss in the United States, in: Food Policy, Vol. 37, No. 5, 2012, pp. 561-570; WRAP: The food we waste, Banbury 2008.

22 See also U. Koester: Total and per capita value of food loss in the United States – Comments, in: Food Policy, Vol. 41, 2013, pp. 63-64; and U. Koester: Discarding food vs. starving people – Inefficient and immoral?, IAMO Policy Brief No. 7, Halle (Saale) 2012.

items differ across agricultural food products. The aggregation of these very dissimilar economic goods along the supply chain necessarily leads to measurement errors. Unfortunately, it is not known how much the final aggregated figure overvalues the FLW because processing, storage and other costs are not known. The information can also not be used for a reasonable estimate of inefficiency of resource use or as the potential for improving sustainability.

Apart from failing to provide reliable estimates of the impact of FLW, studies have thus far not taken into account the costs arising from attempts to prevent FLW. Hence, the figures are too unreliable to be used to institute a rational policy.

Tasks for further research

Global studies might have been important for creating awareness, but this awareness is somewhat biased; moreover, the studies do not provide detailed information for designing a targeted policy response.

Further research is needed to accurately identify FLW – defined separately with respect to the individual objective, as discussed above. It would be helpful to identify whether there is a market or policy failure, how it could be addressed via specific policy instruments and what the cost-benefit ratio would be. Based on the available studies, the research could focus on the farm/retail stage in developing countries and on the retail/consumer stage in developed countries.

There is not yet an appropriate measure for aggregating FLW for separate products along the supply chain, and it is not yet clear how different products, such as meat or potatoes, could be aggregated at various stages of the supply chain. Multiple methods might be necessary, depending on the information needed in order to design policies for the individual objectives.

Research is needed to demonstrate how reduced FLW could produce the desired effects or how this could be done efficiently. Moreover, there is a need for evidence on how costly it may be to reduce FLW and to achieve the stated policy objectives.

Policy activities

Government intervention in any economic activity is always based on a value judgement. An actual situation is compared with a desired situation, and the intervention is supposed to close the gap. Concerning the selection of instruments, a government may be constrained by the established order of the economy and, thus, by the role of the government and the role of markets.[23]

In investigating measures to reduce food loss and waste, several criteria should be considered. There might be a need for government intervention if there is a lack of *incentive compatibility*. The term indicates that individual actions are based on incentives, but if the private (market) incentives do not lead to socially acceptable consequences, incentive compatibility is not warranted. Hence, a lack of incentive compatibility may be a necessary condition for governmental interference in a market economy.

However, it is by itself not a sufficient condition. Intervention may lead to negative side-effects, including administrative costs, such as the costs of monitoring and enforcement, as well as economic costs. Such economic costs occur if, for example, food is fed to animals and is therefore, according to the present definition, categorised as a loss. If this category of food loss is reduced, there will either be a reduction in animal production (meat, milk or eggs) or other feed will have to be used. A similar case prevails if the government reduces "waste" that has been donated to charity for the poor. Reducing this food loss would likely lead to increased suffering among the poor. Such economic costs may generally arise if governments interfere in the name of reducing food loss. Accepting some food loss and waste can be economically efficient given the present state of information, technology and consumer preferences.

Reducing FLW throughout the value chain

FLW at the farm level

Farmers could reduce food loss and waste by forgoing the screening of raw products like potatoes or vegetables at the farm and instead selling the total quantity to retailers or consumers. However, they would surely discover that they were only able to sell their products at lower prices or not at all, thus yielding a lower profit. It may be in farmers' profit interests to accept some food loss and use it – whenever possible – to feed animals. The same consideration applies to farmers who prefer to accept some harvest loss on their land because the efforts required to prevent this loss would reduce farm profit.

Some farmers may have to accept losses due to inadequate technologies for cultivation and harvesting. Investment to reduce these losses might be profitable for farmers

23 For a more detailed discussion, see U. Koester, J. Empen, T. Holm: Reduction of FLW in Europe and Central Asia, Synthesis Report prepared for Food and Agriculture Organization of the United Nations, Regional Office for Europe and Central Asia (REU), Budapest 2013.

and even for society at large, but farmers may suffer from credit constraints that prevent them from making the necessary investments. Governments could consider supporting access to credit. However, the best alternative would not be to grant credit subsidies but rather to provide banks with some safeguarding of credit that is to be used to reduce food loss or waste.

The most efficient way to reduce FLW at the farm level might be to avoid lower yields due to insects, rodents, inadequate seeds, cultivation and fertiliser use.[24] Seed producers could contribute to lower FLW if they offered seeds that produced more homogeneous products, such as potatoes of the same size and wheat that can consistently be used for bread production instead of being used as feed wheat. Educating farmers might be a good strategy in some countries. However, it may take a long time to achieve progress.

FLW at the wholesale and stock keeper level

Wholesale traders and stock keepers could try to reduce FLW by shortening the period of time between buying and selling. Stockpiling for some period of time reduces the weight of most agricultural products and introduces the danger of loss due to insects, rodents and other animals, or natural decay and loss of quality. Moreover, hazardous climate conditions may reduce the food volume and lower the quality. Wheat that was stocked as bread-wheat may be used as feed-wheat and thus increase food loss. This loss is an unavoidable side effect of a functioning supply chain. Of course, it may be that losses are too high from an economic point of view, mainly because vertical markets are not well integrated.

Governments could reduce losses at this step of the supply chain by providing adequate public and merit goods that improve the functioning of markets. The risk for market agents will be lower if they have access to hedging possibilities. Hence, if the government of a specific country moves towards free and predictable trade, traders may be able to hedge on futures markets in other countries. The result would be less risk as well as less FLW. Governments in some countries could also support the establishment of additional wholesale markets and collection centres and, thus, cut food losses. Provision of market information and schemes for the classification of products may also be effective in reducing food losses.

24 The approach chosen in L. Kitinoja: Identification of Appropriate Postharvest Technologies for Improving Market Access and Incomes for Small Horticultural Farmers in Sub-Saharan Africa and South Asia, World Food Logistics Organization Grant Number 52198, Alexandria 2010 could serve as a model. This project focused on only one stage of the food supply chain. It aimed at improving the income of small farmers and introduced measures based on a cost-benefit analysis.

FLW at the retailer level

Food retailers are able to collect fairly accurate information about the daily flow of their inventory, thus minimising food loss. However, they must generally keep surplus quantities of food available to ensure that they do not run out of any particular product, which would cost them both sales and the trust of their customers. This necessarily results in some FLW. Alternatively, a retailer could decide to order food items several times daily, but in order to do so, the retailer would have to devote more resources to purchasing and storing food items. The delivery company would also have to use more resources, as transport and labour costs would increase with the frequency of deliveries. Consequently, pursuing less FLW would lead to a higher volume of complementary services.

Retailers may have to accept losses – in particular in developing or transition countries – because they do not have adequate storage facilities or because the velocity of trade flows is too slow to enable multiple deliveries per day. Retailers also have to accept some level of FLW due to the low quality of produce delivered to them (see the above section on the farm level). Some countries do not have quality testing systems and corresponding classification systems. Hence, some quantities of fresh food, such as fruits and vegetables, bought by the retailer cannot be sold. Improving the functioning of markets, setting up wholesale markets and improving retailers' access to credit could help to reduce FLW.

Policy makers could significantly reduce FLW at the retail level if consumers were better informed of the meaning of terms such as "best before date", "expiration date" or "sell-by date". Customers prefer to stay on the safe side and buy products whose dates are not close to the ones specified on the packages. The use of descriptions that are less misleading would help, as would the provision of better retail forecasting information. For example, bakeries and shops selling bakery products in Germany take advantage of a new sales forecasting method that offers daily forecasts for individual retail shops based on weather forecast, calendar day, special events and other variables. A non-representative survey found that bakeries using these forecasts have reduced the loss of their bakery products by about 20 per cent.

FLW at the household level

The situation is similar at the household level. If consumers bought food products daily, they could reduce food loss in households. However, there are transaction costs associated with buying food daily, and hence, the consumer may prefer to buy food once a week and accept that some food loss will occur due to loss of freshness.

FLW in private households is high in developed countries. Indeed, reducing FLW at this level would yield the highest aggregated gain along the supply chain.[25] While policy makers could appeal to people to change their handling of food, there is not much indicating that such appeals would lead to significant effects. Most people react to incentives and not to appeals. However, it is likely that some households are not well informed about the meaning of the "best before date" and on how to use leftover food for the preparation of meals. Furthermore, consumers need to be informed about the best storing practices and new technologies to maximise storability (e.g. new refrigerators).

FLW in restaurants

To avoid being accused of skimping on portion size, many restaurants serve overly large portions. An alternative could be to offer consumers the option to order large, normal or small portions. However, restaurant owners have likely considered this alternative and opted for the approach that is most profitable for them, namely offering only large portions and accepting some FLW.

One important determinant of food loss in restaurants is specific legislation in some countries. It is understandable that food that has already been served to one table cannot be used to serve another table, even if cooked again or even if the first customer did not touch the food, e.g. bread or rolls. However, it has been against the law to feed leftover food to animals in Germany since 2006 and in Switzerland since 2011. It might be of interest to learn whether this legislation has led to the improved health of animals.

Summary

Reducing FLW ranks high on the agenda of many policy makers and international organisations. There are many publications which convey the message that there is a great potential to save food, thereby contributing to food security, increased efficiency of resource use and positive environmental effects. It is argued in this paper that the evidence has not been well investigated. First, the definition of FLW is not adequate and is ill-suited for instituting policies meant to contribute to the three objectives above. Second, the methods used for aggregating loss and waste are questionable. Third, the total quantity of FLW highlighted in the media and used to rationalise policy activities is misleading. Targeted policies to reduce food loss and waste, which take into account the costs as well as the benefits of action, could be beneficial.

25 L. Kitinoja, op. cit., p. 49.