The nutritional footprint: an innovative management approach for the food sector

M. Lukas, A. Palzkill, H. Rohn & C. Liedtke
Wuppertal Institute for Climate, Environment and Energy GmbH, Germany

Abstract

The food and nutrition sector accounts for huge environmental impacts caused by production, processing, final consumption and waste treatment in private households or in out of home catering settings. Further, the field of nutrition inextricably links environmental and health aspects to each other. Thus, the domain of nutrition has to be considered intensively if environmental aspects and health considerations should be further investigated. However, a healthy and environmentally friendly diet is a criterion which remains quite abstract to the consumer. Against this background, the following research question is addressed: "How can environmental and health indicators be linked to each other?" For that reason a comprehensive concept is developed in this paper, the so-called *nutritional footprint*. The model is based on conceptual frameworks, such as the Hot Spot Analysis. Within a data assortment, relevant and available environmental data (e.g. material footprint or water consumption within the life cycle) is set in relation to available nutrition data (e.g. nutrient density or the classical calorie specifications). The paper shows that a nutritional footprint – as an assessment instrument – presents a way to communicate environmental and health issues together and provides a comprehensive and integrated perspective on quantitative and qualitative data. The concept developed in this paper is also available and useful for companies to expand their internal data and their external communication performance. Nonetheless, the current paper presents a first version on this concept, which has to be refined in cooperation with a leading fast food company in order to integrate the approach in their business.
Keywords: food, consumption, environmentally-friendly diet, nutritional footprint, environmental indicators, integrated indicators.

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1 Introduction

It becomes obvious that every kind of diet has a certain impact on the environment, has health-related effects and further, social and economic effects [1, 2]. Two of the biggest problems of western eating habits are related to the environmental and health damage they cause. On the one hand, so-called ‘prosperity diseases’ like obesity, hypertension or diabetes mellitus are increasingly common in many industrialized countries caused by eating too much sugar, fat and salt [3–5]. On the other hand, nutrition accounts for huge environmental impacts – not only caused by the high meat consumption and its high impact on climate change, but also its impact on land use patterns, water consumption or loss of biodiversity [6–10].

In consideration of the rising world population and the aspiration to guarantee prosperity for nine billion people (expected in 2050)which implies increasing environmental pressure on the ‘planetary boundaries’ [11] caused by rising resource use and land use patterns [12] a very urgent to profoundly change our food strategy and to promote environmentally friendly and resource-efficient diets is needed. However, the urgency of a transformation in eating habits does not automatically lead to its implementation.

Rather, a high level of uncertainty exists for consumers regarding the question what eco-friendly and healthy nutrition means in daily eating habits – apart from the difficulty that diets are not usually based on a model of rational decisions [13]. Looking at the production side, almost all companies consider only one dimension of environmental pressure. Food processing companies or food manufactures often try to manage their environmental impact by focusing on CO_2-Footprints, Eco-Indicators such as the Eco-Indicator 99 or comparable analyses like the Hot Spot Analysis (see: [6]), but disregard health impacts – or the other way around, focusing solely on the calorie amount.

However, the criteria of healthy and environmentally friendly diets often remain too abstract for consumers and producers, despite the currently emerging indicators for sustainability in the field of environmental sciences.

Here, whole diets or several products are compared with regard to their environmental impact in agricultural and other life cycle phases or by considering non-vegetarian, vegetarian or vegan diets [7, 8, 13]. In nutrition science normally foodstuffs and diets are historically compared with regard to calorie content, which is also a communication tool to consumers, more established than any environmental indicator so far [5, 7]. Only a few studies show an integrated concept and provide reliable and robust guidance with regard to both dimensions (for conceptual frameworks e.g. [7, 9, 12, 13]; for indicators e.g. [2, 8, 12]). As a matter of fact, it is argued that in the field of nutrition, environmental and health aspects can often be linked to each other, e.g. reduced meat consumption is considered to be healthy and environmentally friendly [7, 10, 14]. Aiming at the development of a holistic and integrated concept and a comprehensive indicator, this paper introduces the so-called nutritional footprint, which attempts to consider health and environmental issues in an integrated fashion (Fig. 1). Against this background, the following research questions are addressed: "*How can a healthy and environmentally friendly diet become more transparent to the consumer?*" and "*How can environmental and health indicators be linked to each other?*"

Figure 1: Combination of indicators to gain the nutritional footprint.

2 The method of a nutritional footprint assessment

First, to delineate the relevant field of application, we assume that human health and the environment are inextricably linked. In the scientific community quantifiable comparisons of selected food items appear, whereas often the approach of the Material Input per Service Unit (MIPS) [15–19] concept is adapted or the assessment of life cycles (LCA) [20, 21] is realized. This shows that primarily environmental aspects are taken into consideration. Nonetheless, a 'food print approach' which considers both sides of the coin and which is therefore representing environmental indicators such as the 'ecological rucksack' and nutritional assessment is going to be a great opportunity to strengthen a holistic perspective on the production and consumption side. To define such an assessment tool, it becomes necessary to figure out the status quo. As a first step, the qualitative recommendations that exist with regard to nutrition and the environment and nutrition and health, respectively, have been screened. Both types of recommendations were monitored to gain an overview of the research field. The results are displayed in Table 1.

Table 1: Health and environmental recommendations (consumer perspective) (based on [2, 5, 7, 22]).

Dietary recommendations		**Recommendation of eco-friendly diet**	
Diet principles to be encouraged…	**Diet principles to be denied…**	**Diet principles to be encouraged…**	**Diet principles to be denied…**
• Fruit and vegetables • Whole grains • Fiber rich ingredients • Low fat dairy products • Vegetable oils	• Products high in fat and high intake of animal fats (e.g. meat, milk, eggs, butter) • Sugars and salt • Sweets • High-convenience-meals	• Mainly ovo-lacto-vegetal • Organically generated • Seasonal and regional products • Environmentally-friendly packed	• High-convenience-meals • A diet high in fish and meat • A non-seasonal and non-regional diet

The table shows the qualitative recommendations in both fields, which are dominant in the modern nutrition discourse in Germany, the left columns contain the classical recommendations announced by the German nutrition society (DGE) [5], established in the 1990s and then, whereas the right columns contain the deducted advice for an eco-friendly diet established at the turn of the century and in line with the concept of nutrition ecology [22]. The concept of nutrition ecology includes also the social perspective, but at this stage of work, we basically focus on environmental indicators.

Unfortunately, both concepts are qualitative and thus, it is not possible to calculate environmental and health-related impacts on their basis. Consequently, to put further develop the concept, health and environmental impacts have to be defined more precisely. Hence, numerical and measurable indicators, ideally based on empirical data, are needed. In the field of nutrition science, this type of quantitative data is available and easy to examine. The classical indicators of calorie content and nutrition density are suitable as a quantitative basis, due to their level of validity in science and, furthermore, consumers are familiar with them [4, 5, 24]. Including environmental indicators is slightly more difficult to realize. The data which is needed is directly or indirectly available from a multifaceted range of empirical research (e.g. [1, 2, 4, 8, 20, 25, 26]). Thus, a great amount of data is available for the screening and Table 2 presents the essential figures utilized for the development of a nutritional footprint concept.

Table 2: Combined consumer health and environmental indicators (based on Liedtke *et al.* [6] and Kuhndt *et al.* [23]; completed by Mancini *et al.* [1] and Acosta-Fernandez [10]).

Indicators to assess the health impact of diets	Indicators to assess the environmental impact and resource intensity of diets
• Nutrient density • Calorie content	• Abiotic and biotic material • Erosion and earth movement • Water consumption • Energy consumption • Land use and yield • Biodiversity • CO_2-equivalents

In the left column, the table displays the health impact criteria represented by the classical and well-known indicators of nutrition density and calorie content. Both indicators are directly measurable by means of quantitative methods. The right column shows the environmental indicators– based on resource efficiency indicators. Inspired by the MIPS methodology [1, 19], the indicators of abiotic and biotic resource use were adopted as well as the indicators of energy, water and erosion/earth movement. The indicator of CO_2-equivalents (used in LCA studies, see [20, 26]) was also integrated to gain a systematic view across all indicators. All indicators are also quantifiable. Other indicators such as land use/yield and biodiversity can be considered as qualitative in nature, at least when focusing on an industry or company level. Even though there is quantitative data for these factors at a global scale [3], it is not possible in the context of this paper to attempt down-scaling them to the level of individual companies.

Helpful guidance for assessing relevant data is provided by evaluation tools used in environmental management. The concept of the Hot Spot Analysis [6, 23] provides a sophisticated basis for dealing with a broad range of data. Therefore, adapted from the method of the Hot Spot Analysis [1, 23], the life cycle's phases raw material, production, use and waste treatment should be integrated in the analysis. Additionally, all qualitative or only indirectly measurable data (e.g. on biodiversity or land use) can be integrated as well. Bringing the concepts and methodologies together, the new concept suggests proceeding in three steps:

1. ***Estimation of health and environmental issues related to food products*** *(Screening empirical data)*
2. ***Allocation and evaluation of relevant indicators in the life cycle phases****(Ranking of all relevant indicators, ranges 1–3)*
3. ***Identification of results***
(Calculate and displayed as the nutritional footprint)

Step 1 evaluates relevant indicators to measure the health and environmental impact of food products, as explained earlier. A screening of large data sets has to be done in the preparation phase of the analysis. Therefore, the MIPS data, LCAs and other primary data have to be evaluated to estimate impacts throughout the different phases of a life cycle.

Subsequently, in **step 2**, the relevant data has to be selected and numerical values have to be assigned, in order to enable comparison. Building on the approach established in the Hot Spot Analysis, a range of numerical values from '1' to '3' has been defined [1, 23]. This range covers – very roughly – the different levels of impact a product may have, thus, an '1' stands for a minor environmental impact, whereas a '3' signifies a major environmental impact.

In order to illustrate the procedure, we will give an example with an imaginary product: First, an examination of data (e.g. LCAs or MIPS) is carried out. Within this data screening process, a great amount of relevant data is obtained, often with different ranges of e.g. proportion of land use. In order to retain the indicator 'land use', an average range is defined. Consequently, the newly obtained data has to be linked with existing data to rate the ranges. Similarly to the way that the Hot Spot Analysis refers to 'Hot Spots' [6, 23], we assign ranges to impacts, e.g. if a great amount of data is available and every study identifies the same points of action, due to a huge resource-intensity, these indicators are rated with a '3'. The health impact of foodstuff is evaluated in a similar way. For a high amount of calories and therefore a high percentage of the tolerable daily intake, the food products earn a higher rate, such as '2' or '3', the same was done with the nutrition density, but the other way around. If the nutrition density is high – which is considered to be proficient for a human diet – the indicator receives a lower rate such as '1' due to its positive impact. Nonetheless, in order to allow for a comparison of environmental and health-related indicators, they still need to be weighted. Thus, **step 3** comprises the identification of the nutritional footprint. This step includes a simple calculation, done by two calculation steps. First, all the data from each of the two indicator sets – health and environment – has to be summed up. Then, a typical calculation step has to be integrated: in order to give equal weight to the health and the environmental perspectives, the sum has to be divided by the amount of categories. Thus, both indicators earn the same status and can be summed up, to perform the last step and create the nutritional foot print. Fortunately, if numerical values are assigned as presented here, the method is suitable for all product groups, such as raw products, processed or high convenient foodstuffs. In the next section, two nutritional footprint calculation schemes are demonstrated to illustrate the methodical approach.

3 Results

The nutritional footprint can be seen as an assessment instrument that helps identifying the indicators of a product along its value chain (integrating all phases: raw material procurement, production, use and waste treatment) and which also includes the consumption perspective by using direct health indicators. To further refine the concept of the nutritional footprint and to apply the theory introduced in the second chapter, the results are presented in table 3. It shows the result of an analysis of two well-known and very different food

Table 3: The nutritional footprint of the products: Lettuce and beef *(conventional products)* (adapted from Mancini *et al*. [1] and Kuhndt *et al*. [23]).

Categories/ Products	Lettuce	Beef
Environmental/Resource Impact		
Abiotic	1	3
Biotic	2	3
Water consumption	2	3
Energy consumption	1	3
Erosion/earth movement	1	2
Land use and yield	1	3
Biodiversity	1	3
CO_2-equivalents	1	3
Average – environmental impact	1,25	2,88
Health Impact		
Calorie content	1	2
Nutrition density	1	2
Average – health impact	1	2
Nutritional footprint (overall amount/rounded)	2,3	4,9

products: lettuce and beef. The numerical values were allocated on a qualitative basis with the help of several quantitative environmental studies [11, 20, 25] and the nutritional data is based on a typical a nutrition table [24].

Table 3 presents the results of the allocation to display a nutritional footprint. It can be shown that lettuce has an overall nutritional footprint with the size of *2,3*, while the health and the environmental impact are equally large. Whereas in the case of beef, the environmental impact is relatively larger than the health impact and the overall nutritional footprint amounts to *4,9*.

It should be noted here that a '*2*' is the lowest value and a '*6*' is the highest value to be achieved. A '*2*' stands for a 'good' product with little harmful impact on human health and the rate of '*6*'stands for 'worse product' with high impacts on health and the environment. Therefore the lowest value which is available is about: '1'(*Environmental Impact=1 + Health Impact=1*) and the highest value is about '6' (*Environmental Impact=3 + Health Impact=3*).

Clearly, the nutritional footprint displays a difference between both products as regards their overall impact, which is a similar result as compared to other studies of health and environmental impacts of these products[4, 7, 20, 25, 27].Considering the health impact, the meat product will be positioned with a medium impact, due to its origin as animal product but with no higher impact due to their small processing level. To clarify the basic approach of the assessment of the nutritional footprint and to deepen the understanding at that stage, the example of the *'nutritional footprint of beef'* is shortly summarized.

First – to meet **step 1** – within every life-cycle phase of beef, data was screened to meet all environmental (see: abiotic and biotic material; erosion and earth movement; water consumption; energy consumption; land use and yield; biodiversity; CO_2-equivalents)and health indicators (see: nutrition density and calorie intent). Based on screening relevant environmental studies, the relevant environmental indicators [1, 25, 26] were chosen, in order to meet **step 2** of the method. Health indicators were screened and calculated with the help of relevant scientific data, too [24].

To illustrate the scoring system in step 2, we would like to present an example, namely the indicators'CO_2-equivalents' or several resource-intensity indicators. Several studies in which life cycle assessments have been performed, produced a wide range of varying final results [4, 5, 7, 20, 25]. However, this variance is due to geographical differences or other varieties, and if all results are compared e.g. with foodstuff from vegetable origin, the results overall remain relatively high. Furthermore, all studies stated that the emission of CO_2or the overall resource-intensity had to be reduced. Seeing these recommendations, the present analysis considers the indicator $CO_2$with a '3'.

Thus, step two has been completed. Finally, in **step 3** the two aspects were summed up and divided by their number of categories and lastly summed up with each other to present the nutritional footprint.

4 Conclusion and outlook

A nutritional footprint is a transparent concept to assess environmental and health impacts of food products by combining quantitative and qualitative indicators. The tool seems to be a good opportunity to include two significant features which so far have not been compared directly, health and environmental indicators on foodstuff. Numerous studies show that foodstuffs based on animal products are connected to higher resource consumption than those based on vegetable origins (e.g. [7, 15, 22]), which can also be concluded from the application shown in this paper. Additionally, the concept of the nutritional footprint allows for the integration of health aspects in an assessment tool which was mainly designed to analyse environmental impacts. The tool provides an understandable tool to help and guide the consumer towards a healthy and eco-friendly diet. Furthermore, companies could address their resource-efficiency potential of food products with the help of this method. With respect to the current discussion about sustainable development of companies, a nutritional footprint can also be considered as an efficient and flexible management tool to improve internal information systems, precisely because this indicator includes more than one aspect of sustainable development.

The first step is done: the concept has been created to stimulate the debate about the relation and links between ecological and health indicators. Up to now, the connection was obvious but not qualified and accessible. Yet, a larger amount of data and the further investigation of typical indicators is necessary and essential.

Furthermore, and due to the early development state of this concept, the life cycle phases were not to be weighted, even if the Hot Spot Analysis contains this process step. Thus, a refining process including this step has to be carried out in the near future. Further, the method provides a great opportunity to mix quantitative and qualitative data to integrate also more ‘soft indicators’ such as biodiversity into the assessment. However, in the long term, the qualitative assessment should play only a subordinated role and the quantitative assessment has to be focused.

The Hot Spot Analysis [6, 23] includes an additional step to validate the gained results with the help of relevant stakeholders. Within these workshops the values and ranges have to be discussed. At this point, we would like to deviate from the concept of the Hot Spot Analysis, in order to focus on the further development and to scale up the indicators. But so far it is difficult to trace indicators such as biodiversity along the entire life cycle. Finally, a nutritional footprint is an assessment tool, which enables the user to gain a detailed overview and to use this instrument to compare different impacts of food stuffs relatively easily. Further, we conclude with a short outlook on necessary steps to further develop the concept:

- *Scalability of all indicators has to be achieved – therefore ‘soft indicators’, such as biodiversity, have to be developed in quantitative figures along the life cycle (using and following the concepts of the SIFO, EEA and ETC/STP[28, 29])*

- *Integration of additional measurable and well-known health indicators (such as 'salt content' of food products and the 'daily intake')*
- *Integration of additional measurable and well-known environmental indicators (such as 'water footprint')*
- *Integration of additional social indicators(such as the social indicators from the Sustainability and Social Hot Spot Analysis [30])*
- *A well-founded and empirically fused weighting method for the nutritional footprint - both within the several indicators of environment and health, and between these criteria*

5 Outlook

At the moment we are working together with a leading fast food company and try to examine the relevance of the concept and the possibilities to integrate parts of the concept in their business processes. All in allit seems to be possible in the future to expand the concept into a sophisticated assessment and communication tool. However, the concept has another important mission: to stimulate the debate on the communication tools which integrate health and environmental indexes. Until now a level of sufficient transparency has not been reached. Every company and every consumer have to evaluate which products are suitable in production and daily consumption processes, with regard to health and environmental aspects, therefore the nutritional footprint is reliable. Another essential aspect is related to the question: *"Prospectively, what is more important in 'daily nutrition' the health or the environmental issues?"* a request which has also been reflected by several studies [7, 8]. And finally, we are aware that aspects such as cultural heritage, food quality and culinary skills are other key aspects determining sustainable dietary patterns and healthy diets, which are also essential elements of the debate, as well as an appropriate nutrition education, even if they could not be considered in the current state of work.

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References

[1] Mancini, L., Lettenmeier, M., Rohn, H., Liedtke, C.: *Application of the MIPS method for assessing the sustainability of production–consumption systems of food*. Journal of Economic Behaviour. 81. pp. 779-793. 2012.
[2] Koerber, K.v., Kretschmer, J.: *Zukunftsfähige Ernährung*. ERNO 1 (1). pp. 39-46. 2000.
[3] Fernstrom M., Reed, K., Rahavi, E., Dooher, C.*: Communication strategies to help reduce the prevalence of non-communicable diseases: Proceedings from the inaugural IFIC Foundation Global Diet and Physical Activity*

Communications Summit. Nutrition Reviews. Vol. 70 (5). pp. 301–310. 2012. Online http://onlinelibrary.wiley.com/doi/10.1111/j.1753-4887.2012.00480.x/pdf.

[4] Barker, M., Lawrence, W., Robinson, S., Baird, J.: *Food labelling and dietary behaviour: bridging the gap. Public Health Nutrition*. 15. pp. 758-759. 2012.

[5] German Nutrition Society: Healthy eating and drinking with the 10 rules of the German Nutrition Society. 2011. Online. http://www.dge.de/modules.php?name=Content&pa=showpage&pid=15.

[6] Liedtke, C., Baedeker, C., Kolberg, S., Lettenmeier, M.: *Resource intensity in global food chains: the Hot Spot Analysis*. British Food Journal 112. No.10. 2010.

[7] Wirsam, B., Leitzmann, C.: *Klimaeffiziente Ernährung*. Ernährungsumschau 1/11. pp. 26-29. 2011.

[8] Marlow, H., Hayes, W.K., Soret, S., Carter, R., Schwab, E., Sabaté, J.: *Diet and the environment: does what you eat matter?* Am J Clin Nutr 89. 1699S-1703S. 2009.

[9] Leuenberger, M., Jungbluth, N., Büsser, S.: *Environmental impact of canteen meals: comparison of vegetarian and meat based recipes*. International Conference on LCA in the Agri-Food, Italy. 2010. Online. http://www.esu-services.ch/fileadmin/download/leuenberger-2010-meals-LCAfood.pdf.

[10] Acosta-Fernandez, J. (2009): *Identifikation prioritärer Handlungsfelder für die Erhöhung der gesamtwirtschaftlichen Ressourcenproduktivität in Deutschland.*Wuppertal: Wuppertal Institut.

[11] Rockström, J. *et al. A safe operating space for humanity*. Nature 461, Nr. 7263. pp. 472–475. 2009.

[12] Bringezu, S., O'Brien, M., Schütz, H.: *Beyond biofuels: assessing global land use for domestic consumption of biomass; a conceptual and empirical contribution to sustainable management of global resources*. Land use policy. 29. Issue 1. pp. 224-232. 2012.

[13] Macdiarmid, J. *et al*.: *Sustainable diets for the future: can we contribute to reducing greenhouse gas emissions by eating healthy diet?* Am J Clin Nutr. 96. 632-639. 2012.

[14] Clonan, A., Holdsworth, M.: *The challenges of eating a healthy and sustainable diet?* Am J Clin Nutr. 96. pp. 459-460. 2012.

[15] [Lettenmeier, M., Göbel, C., Liedtke, C., Rohn, H., Teitscheid, P.: *Material Footprint of a sustainable nutrition system in 2050. Need for dynamic innovations in Production, consumption and politics.* In: Proceedings in food system dynamics and innovation in food networks. University Bonn. 2012

[16] Rohn, H., Lettenmeier, M., Pastewski, N.: *Identification of Technologies, Products and Strategies with High Resource Efficiency Potential: Results of a Cooperative Selection Process.* eds. R. Bleischwitz; P.J.J. Welfens; Z. Zhang: International Economics of Resource Efficiency, Physica-Verlag: Heidelberg, pp. 335-347. 2011.

[17] Kotakorpi, E.; Lähteenoja, S.; Lettenmeier, M.: Household MIPS. Natural resource consumption of Finnish households and its reduction. The Finnish Environment 43en/2008. Ministry of the Environment: Helsinki, Finland. 2008.

[18] Kaiser, C., Rohn, H., Ritthoff, M.: Wie viel Natur kostet unsere Nahrung? – Ein Beitrag zur Materialintensität ausgewählter Produkte aus Landwirtschaft und Ernährung. Wuppertal Institut Papers. Forthcoming.

[19] Rohn, H., Pastewski, N., Lettenmeier, M.: *Ressourceneffizienz von ausgewählten Technologien, Produkten und Strategien – Ergebniszusammenfassung der Potenzialanalysen.*Paper 1.4. 2010. Online. http://ressourcen.wupperinst.org/downloads/MaRess_AP1_4.pdf

[20] de Vries, M., de Boer, I.J.M.: *Comparing environmental impacts for livestock products: A review of life cycle assessments*. Livestock Science 128 (2010) 1–11. 2010.

[21] Williams, A.G., Audsley, E., Sandars, D.L.: *Determining the environmental burdens and resource use in the production of agricultural and horticultural commodities.* Main reports Defra Research Project ISO205, Bedford. Cranfield University and Defra. 2006.

[22] Leitzmann, C.: *Nutrition ecology: the contribution of vegetarian diet*. Am J Clin Nutr 78. 657S-659S. 2003.

[23] Kuhndt, M. *et al*. (2002): *Hot Spot Analysis in practice – a case study focusing on MNC,* confidential report.

[24] Souci, S., Fachmann, W., Kraut, H.: *Food Composition and Nutrition Tables.*7th edition. Medpharm: Stuttgart. 2008.

[25] Hoekstra, A.Y.: *The hidden water resource use behind meat and dairy.*2012. Online: http://www.waterfootprint.org/Reports/Hoekstra-2012-Water-Meat-Dairy.pdf

[26] Hirschfeld, J., Weiß, J., Preidl, M., Korbun, T.: *Klimawirkungen der Landwirtschaft in Deutschland*. IÖW. 2008. Online. www.foodwatch.de /foodwatch/content/e10/e17197/e17201/e17220/IOEW_Klimawirkungen_der_Landwirtschaft_SR_186_08_ger.pdf

[27] Liedtke, C., Welfens, J. *et al*.: *Mut zur Nachhaltigkeit: LerneinheitKonsum*. Bildung für nachhaltige Entwicklung. 2008.

[28] Stø, E., Gordley, D., Throne-Holst, H., Strandbakken, P.: *Political tools for sustainable consumption: Single or multi-dimensional indicators?* European Society for Ecological Economics. 2010. Online: http://www.esee2011.org/registration/fullpapers/esee2011_5249ee_1_1304952788_4289_2200.pdf

[29] ETC/SCP: *Progress in Sustainable Consumption and Production in Europe Indicator-based Report*. 2011.

[30] Bienge, K., Geibler, J.v., Lettenmeier, M.: *Sustainability Hot Spot Analysis: A streamlined life cycle assessment towards sustainable food chains.* Conference proceedings of the 9th European International Farming System Association Symposium, Vienna, 2010.