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DEVELOPING CRITERIA FOR TYPE III ECO-LABELING FOR FOOD PRODUCTS BASED ON MIPS-ANALYSIS

1. Introduction

According to ISO 14020 "The overall goal of environmental labels and declarations is, through communication of verifiable and accurate information, that is not misleading, on environmental aspects of products and services, to encourage the demand for and supply of those products and services that cause less stress on the environment, thereby stimulating the potential for market-driven continuous environmental improvement" [ISO, 1998].

The aims and objectives of environmental labels and declarations are: (a) To enable consumers to differentiate between products on the basis of environmental performance; (b) To raise general environmental awareness, *e.g.* via a label or associated marketing; (c) To raise consumer awareness of a product's specific environmental impact; (d) To identify the life cycle impact of groups of products, thus facilitating improvements in their environmental performance; (e) To contribute to a "responsible"/"quality" company/brand image; (f) To "reward" producers for improvements in the environmental performance of products; (g) To indicate best practice/future requirements and (h) To "shame" producers into improving the environmental performance of products, for example, via mandatory labels such as the EC Energy label.

Type III labels are currently in their infancy, although various forms of environmental product labels along Type III lines do exist. Hence, whilst Type III labeled products suffer from limited availability at present, this is likely to change rapidly, due to the growing interest from business and consumers. The non-selective nature of Type III labels, together with the potential development of label formats by industry groups, is likely to encourage cooperation and involvement from producers and hence product availability. However, in markets dominated by SMEs the cost intensive nature of Type III labels may restrict their use and hence the availability of labeled products. The paper argues that Type III labels can be used for food products.

2. Eco-labeling claims and type III labels

The current situation regarding environmental information on products is by no means uniform across the EU member states, the USA and Canada. There are varying degrees of development and control of labels and environmental claims regarding products, and differing levels of public environmental awareness and concern.

In general, however, the situation has traditionally consisted of:

a) Uncontrolled self-declared environmental claims;

b) Formal selective eco-labels (Type I) such as the EU Eco-label, Nordic Swan and German Blue Angel.

This dichotomy between uncontrolled environmental claims and Type I labels has created a number of problems, due to the proliferation of invalid claims, lack of recognition of formal eco-labels and both purchaser information overload and lack of valid and comparable information. Type I labels have often had to operate in isolation from other policy tools and against other environmental claims.

The International Standards Organisation (ISO) has developed standards for three types of environmental claims regarding a product, termed ISO Type I, II and III. The main elements of each type of claim can be described as shown in Table 1.

In line with ISO/TR 14025 environmental declarations on products consist of quantified environmental data on all significant forms of impact based on procedures and results from a life cycle study (ISO 14040 series) with additional, relevant information on environmental management systems or social aspects, if desired.

Type III claims are currently covered by an ISO Technical Report rather than an accepted international standard and hence there remains significant room for variability in how Type III claims are developed and managed. For example, Type III claims may be:

a) developed and self-declared by a producer; or

b) part of a programme in which an industrial sector or independent body develops the format (sets categories of parameters, minimum requirements, form of presentation) and involves third parties.

In both cases, the technical report establishes the requirement for all type III claims to undergo critical review (in accordance with ISO 14040) to verify the validity of the life cycle study and the content and format of the information presented to purchasers.

There are relatively few examples of Type III claims, however those which broadly follow the conditions of the technical report include the Canadian TerraChoice and Swedish Environmental Product Declaration systems.

Type III labels rely on a relatively high level of environmental awareness and understanding for their interpretation. However, if presented in formats aimed at individual consumers undertaking lengthy purchase decisions, they have the capacity to illustrate a product's specific environmental impact and describe to its global impact. Their wide coverage based on LCA is likely to raise awareness of less well known forms of impact. In addition, Type III eco-profiling labels are more likely to appear on products in the food sector and therefore to have a generally higher visibility in the market than Type I.

The use of Type III claims in business-to-business communication will be optimised if it presents LCA-data in a uniform, standardised format using agreed sets of parameters. Without some form of agreed common format for product sectors, comparability between products will be restricted and the information requirements of consumers may not be met. There is no comparison of products inherent within the label type under ISO/TR 14025, although it does encourage "maximum comparability".

There was a strong message from environmental and consumer organisations that "as long as there is no third party certification in Type III schemes, they are not credible". Such certification would be facilitated by the quantifiable nature of Type III labels, but would have to cover a wide range of data and forms of impact compared to certification of other claim types.

Similarly, Type III claims must cover all forms of significant environmental impact and explain any notable trade-offs. In the case of Type III labels, market competition will be increased if it is possible to compare products via standardised parameters and measurement.

The effectiveness of Type III labels will be reduced if the range of products within one category varies considerably in the forms of their environmental impact, since then it may be difficult to gain consensus on standardised or agreed criteria and this would result in reduced comparability. Secondly, if there are trade-offs between various forms of en-

Table 1. Types of ISO environmental claims

Type I ISO 14024	Type II ISO 14021	Type III ISO/TR 14025
	KEY FEATURES	
pass/fail award system	text statement and/or logo	quantified information
third party grants licence	improvements should be quantified	may be presented in a variety of forms *e.g.* text, graphs, pictures
permission to use a label (typically a logo)	voluntary	
voluntary	avoid meaningless statements, *e.g.* 'environmentally friendly', 'sustainable'	
multi-issue, based on a product's life cycle impact	generally single issue, but may be multi-issue; must be significant according to ISO standards	multi-issue, based on Life Cycle study
criteria set and product assessed by third party	self-declared, no third party involvement	self-declared but must be peer reviewed according to an ISO technical report
	EXAMPLES	
A full list of Member State labels is accessible at http://europa.eu.int/comm/environment/ecolabel/link.htm Examples include: Blue Angel (Germany); Bra Miljoval (Sweden); EC Eco-label; Medio Ambiente (Spain); NFEnvironnement (France); Nordic Swan; Stichting Milieukeur (Netherlands)	Numerous examples exist such as: 'made from *x*% recycled material'	Volvo's product profile for its S80 passenger vehicle follows a Type III format ITT Flight: Environmental Product Declarations for all new products in line with ISO 14025 See Global Type III Environmental Declarations Network http://www.smsstandard.se/english/type3nw/index.asp

Source: Study on different types of Environmental Labelling, 2000.

vironmental impact, then Type III labels will require knowledgeable end users to avoid confusion and lack of understanding, since Type III labels contain no value judgments and producers are unlikely to explain these trade-offs if it jeopardises their competitiveness.

In any case, it is recommended that situations in which a product with a social claim competes against one with an environmental claim should be avoided. However, ideally all the elements of sustainable development need to be addressed, hence a product should meet both environmental and social criteria.

The basic prerequisites for Type III environmental declarations are to conform with the following standards [Swedish Environmental Management Council, 2000]:

– ISO 14020 on general principles for environmental labeling and declarations,

– ISO TR 14025 on Type III environmental declarations,

– ISO 14040–14043 on Life cycle assessment, LCA.

3. Life cycle assessment as a source of information for environmental declarations regarding a product

The environmental performance of a product or service shall be described based on a life cycle assessment (LCA). LCA is a technique for assessing the environmental aspects and potential impact of a product or service, by:

– definition of the goals and scope of the study,

– compiling an inventory analysis of the relevant inputs and outputs of the product system,

– evaluating the potential environmental impact associated with these inputs and outputs, and

– interpreting the results of the inventory analysis and impact assessment phases in relation to the objectives of the study.

The environmental performance declaration (EPD) shall contain information on resource use, emission of pollutants and the associated potential impact on the environment and on waste generation. The preparation of the underlying data for the description of environmental performance shall follow international standards on life cycle assessment (ISO 14040–14043), in particular, taking significant environmental aspects into account using a predetermined set of internationally accepted characterization factors.

The EPD system is based on the same type of "chain of parties" as established for introducing and implementing an environmental management system according to ISO 14001 and EMAS. This means that companies and organisations carry out analyses of the environmental performance of a product or a service in accordance with a predetermined procedure for collecting, compiling and analyzing information based on a LCA, following the ISO 14040–14043 standards and supplemented with some further requirements as specified.

Impact assessment includes an analysis of the use of non-renewable and renewable resources with and without energy content and electricity consumption.

Potential environmental impact can be described based on pollutant emissions, whose effects are converted using so-called characterisation factors to a unified scale and added together. The declaration of environmental performance shall present resource use, pollutant emissions and their subsequent potential environmental impact. It should be possible to add information of an explanatory nature. The presentation of this information shall be divided into two parts – one for the manufacturing phase and one for the use phase. It is important to note that the same information and criteria are to be used for different products and processes, including food production.

The manufacturing phase represents the part of the life cycle that includes life cycle phases from raw material extraction and energy generation to the end product leaving the factory gate ("from cradle to gate").

Different forms of resource use and pollutant emissions usually have different potential environmental impact within so-called impact categories. Resource use can be classified as non-renewable resources, renewable resources and electricity consumption.

Pollutant emissions can be expressed in terms of potential environmental impact, such as [Swedish Environmental Management Council, 2000]:

– emission of greenhouse gases (expressed as the sum of global warming potential, GWP, 100 years),

– emission of ozone-depleting gases (expressed as the sum of ozone-depleting potential in CFC 11-equivalents, 20 years),

– emission of acidifying gases (expressed as the sum of acidifying potential in mol H^+/g max),

– emission of gases that contribute to the creation of ground-level ozone (expressed as the sum of ozone-creating potential, ethene-equivalents),

– emission of substances into water contributing to oxygen depletion (expressed as the sum of oxygen consumption potential in g O_2/g max).

Such a declaration can also include a list of toxic materials and waste generation, classified into hazardous and other waste.

The use phase in an environmental declaration on a product represents the part of the life cycle that includes the life cycle phases from distribution of the product leaving the factory gate to final waste handling ("from gate to grave"). The information required is usually of a more general nature than that included in the production phase and usually consists of more generic data and average values, unless more specific and detailed data is available.

Information regarding the use phase should be based on a well-defined functional unit that should be accurately described. This information should preferably be divided into resource use and pollutant emission as for the production phase. Resource use for food products should be based on well-documented data and tests, and a detailed specification of background data and data sources should be given. Such an emphasis could be explained by the growing concern of both producers and consumers with regard to food safety within the whole supply chain.

4. Application of material-flow based indicators within life cycle assessment

There are various internationally harmonised classification systems for environmental indicators, such as the pressure-state-response (PSR) framework of the OECD [http://www.oecd.org] or the extended Driving Forces-Pressures-State-Impact-Response (DPSIR) system of the European Union. These indicators identify and describe socio-economic activities, which cause pressure on the environment. However, their ability to provide information on real environmental impact is very limited [EEA, 1999].

A large number of resource-use indicators can be derived from economy-wide material flow accounts, providing a comprehensive description of the biophysical metabolism of societies. These indicators can be grouped into (a) input, (b) output and (c) consumption indicators and have been developed through international co-operations over the last 5–10 years.

The main indicators in each indicator group are based on the recommendations in a methodological guide [Spangenberg et al., 1998].

Any assessment of the environmental sustainability of consumer goods and services must be carried out "from the cradle to the grave", or back to the cradle in the case of recycled goods, if misperceptions due to only partial consideration of the total life-cycle impact are to be avoided in the future. Hence, assessments of ecological effectiveness must evaluate all material flows set into motion by people: each use of a natural resource, be it water for drinking or cooling, minerals for industrial production or construction, land for agriculture or air for breathing, inevitably increases the entropy of the overall system.

The total material flow is considered as an appropriate measure of potential impact. The reduction of material flow is a necessary, although not in all cases sufficient, means of reducing the pressure of the human species on the global environment in a safe manner.

The goal of reducing material flow is proactive, in that it does not refer to individual symptoms of environmental damage caused by some branch of the economy, but to the overall impact on the system, thereby trying to prevent future damage, as well as reducing the current potential for environmental damage.

A standardised methodology, delivering meaningful, transparent and reproducible information about the total material flow involved in production, use and disposal or recycling of a certain product or service is based on Material Intensity Analysis (MAIA or MIA) developed at Wuppertal Institute, Germany. The concept of resource-efficiency measurement or MIPS (material input per unit of service) was introduced to measure material inputs (MI) at all levels (product, company, national economy, region including all "ecological rucksacks", *i.e.* the total mass of material flow involved in making a product or providing a service over its whole life cycle. If we apply the MIPS-concept for EPD purposes, the MI should be referred to as total material flow calculated as tonnes of materials of different categories required for making the labeled product within its life cycle. In order to guarantee reproducibility, a number of individual standards and conventions are being introduced and are currently being compiled in the MAIA handbook. So-called MI-values have already been obtained for food products in Germany and Finland [http://www.wupperinst.org].

MIPS is analogous to standard efficiency measures in that it has the same structure of a balance between inputs and results, but it is very different in that it links two well-distinguished objectives (environmental preservation on one hand and well-being on the other) and constitutes an intermediate objective expressing the extent to which they are (or must be) reconciled. The lower the MIPS, the greater the amount of services obtainable from a given level of use of natural resources and/or the lower the level of use necessary to obtain a given level of services. Therefore, MIPS can serve as a criteria for comparing the eco-efficiency of various products.

Finally, these indicators should lead to action: the substitution of a certain amount (including "rucksacks") of any specific material with a lesser amount of another one, while delivering an equivalent service, is regarded as a key task for innovative research in new and improved materials.

The "ecological rucksack" results directly from the listing and accounting of all materials used in providing a final product or service. It is defined, in general, as the sum of all materials which are not physically included in the product, but which were necessary for production, use, recycling and disposal. Thus, by definition, the "ecological rucksack" results from the life-cycle-wide material input (MI) minus the mass of the product itself. Ecological rucksacks are calculated by integrating the five main categories of material flow.

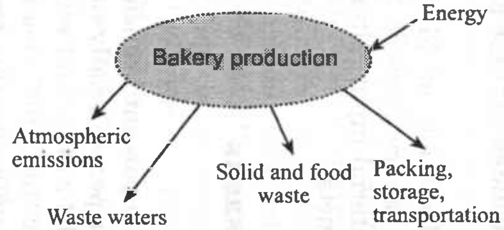
Besides all the materials involved in the life cycle of a product or service, all materials consumed indirectly in the production, packaging, operation or use (washing agents, water, fuels, etc.), maintenance (paints, cleaners, etc.) and repair (spare parts, etc.) of the product under consideration are included in the determination of MI. In addition, all materials necessary for the production or operation and disposal of an output, in terms of materials consumed for energy generation and also the share of infrastructure (such as transport, extraction, production, and disposal installations), including all the inputs necessary for their construction, operation, maintenance and destruction, should be included in these calculations.

The next chapter describes results of the calculation of MIPS, MI-value "ecological rucksack" for the production of bakery goods in St. Petersburg. The values presented can be used as material input criteria for both Type I and Type III labeling of such products.

5. MIPS, MI-values and "ecological rucksacks" of Russian bakery goods

At present the bakery industry is one of the most important branches of the food industry, providing numerous products for people's daily consumption. A special emphasis should be placed on the safety, and especially environmental safety, of bakery goods as their "hygienic" cleanliness directly affects the health of consumers. Usually by the term "safety" we understand the high quality of goods and/or the absence of toxic and cancerogenic substances, as well as other negative influences of products on human organisms when the consumption of a product does not exceed the recommended daily amount. The concept of environmental safety is wider and covers not only the safety of food consumption, but also the safety of raw materials used in production, production itself, as well as storage and utilization of food products. To confirm that a company worries about its consumers, the quality of its own products and the environment, it could launch an eco-labeling process in addition to the obligatory certification process.

One of the bakeries situated in the Central District of St. Petersburg was selected as the object of study [Kopyltsova and Sergienko, 2004]. There is a boiler-house using natural gas for the production of steam for the technological needs of the bakery. The bakery owns several automobiles and lorries. The bakery specializes in the production of various bakery and confectionery goods. The product chain of the bakery goods is shown in Fig. 1.

Material Input		Production	**Usage and Utilizaion**
Abiotic raw material	Biotic raw material		Consumption of: – Wheat bread ; – Bread from rye and wheat flour; – Long loaf. Waste utilization
– Salt; – Drinking water; – Technical water; – Natural gas; – Energy; – Packing materials	– Flour; – Yeast; – Sugar; – Fats, oils		

Environmental requirements

1. Decrease of environmental risks related to natural resources' usage by means of organic agriculture development. 1.1. Usage of grain produced in environmentally safe regions with fertilizer which do not consist of toxic substances dangerous for consumers' health. 1.2. Usage of nutrition additives, which do not contain toxic substances and pesticides. 2. Decrease of environmental risks associated with water contamination by means of sewage clean-up. 3. Decrease of environmental risks associated with technological processes by means of cleaner production development. 3.1. Saving of packaging materials. 3.2. Re-usage and recycling of waste.	Decrease of material input	– Abiotic raw material; – Biotic raw material	Information for consumers regarding environmentally friendly usage of products and waste The mark on the products should convey the information about eco-labeled food advantages
	Decrease of waste waters discharge	– Suspended substances; – Fats; – COD; BOD	
	Decrease to the atmosphere air emmisions	– Organic substances (hydrocarbons, alcohol, etc.) – Inorganic substances (oxides, ammonia, alcohol, etc.)	
	Decrease	– Food waste; – Solid waste; – Packing waste	

Fig. 1. Life cycle stages and environmental requirements of bakery goods
Source: Kopyltsova and Sergienko, 2004.

While producing bakery goods various forms of harmful environmental impact may occur, due to atmosphere emissions, sewage, waste and noise.

The output of bakery goods is calculated as the amount of final goods, produced from flour and other raw materials according to a given recipe using 100 kg of flour. There are norms for the output of each product.

Therefore, inputs and losses of flour, raw materials, semi-finished products, as well as final goods, influence the output of bakery goods during their production, storage and transportation. All the inputs and losses are to be calculated for every type of bakery goods.

The packaging is designed for preservation of the quality and appearance of goods, improvement of sanitary and hygienic conditions during the transportation and sale of bakery goods. The wrapping materials must satisfy definite physical-chemical properties. One obligatory requirement for packaging materials is their physiological harmlessness, for example, absence of substances affecting the smell and/or flavor of goods, or changing themselves due to the influence of food materials.

The dividing of a product's life cycle into separate components allows us to analyze the food chain in detail, beginning with those components, which can be the most carefully described. Step by step, additional information should be obtained and the new components of the life cycle investigated. At this stage of the examination of the product's life cycle, special emphasis is placed on the input of raw materials and production output.

The method of investigation of material flow was based on the MIPS-concept and cove-red all natural and processed inputs, the main and additional raw materials and energy sources. The results obtained are shown in Table 2 in a format convenient for MI-calculation.

Since there were no available data on MI-factors for yeast, in order to take it into account, we use the factor 1 t/t. Also, information on the packaging materials was not available; this should also be added to the calculation sheet.

The data on the output of main products were taken from the sales department of the bakery. As to the data on emissions and sewage they were taken mainly from the documentation of the environmental department. Data on waste was not available at the time of the study, however, they will be clarified and analyzed later on. The total amount of bakery goods is 5472.6 t/year.

Finally, the MIPS was calculated by

$$MIPS = \frac{MI_1 + MI_2 + M_3}{\text{Materialoutputor} \, S}$$

Table 2. Material input: raw materials, heat and power energy

Material/Component	Weight of goods, t	MI-factor, t/t	Material input (MI), t	Explanatory notes
RAW MATERIALS				
Flour	3,911.5	2	7,823.0	Bakery information
Yeast	29.9	1	29.9	
Salt	58.6	1.2	70.3	
Granulated sugar	130.4	6.6	860.4	
Margarine	84.4	4.8	405.0	
Vegetable oil	5.9	4.8	28.5	
Drinking water	1,101.0	0.01	11.0	
Technical water	88,410.6	0.01	884.1	
Total (MI1)	93,732.3		10,112.2	
HEAT ENERGY				
Natural gas	58,515	1.3	76,069.5	Bakery
Total (MI2)			76,069.5	
POWER ENERGY				
Electricity network (FIN)	11 117.9	0.41	4,558.0	Calculation
Total (MI3)			4,558.0	

Source: authors' own research.

where S is considered as a unit of a marketable product such as 1 ton of bakery goods.

$$MIPS = \frac{10{,}112.2\ t + 76{,}069.5\ t + 4{,}558.0\ t}{5{,}472.6\ t} =$$

$$= 16.6\ t/t \text{ or } 16.6\ kg/kg \text{ of bakery goods.}$$

Thus, the MI-factor for 1 kg of bakery goods is 16.6 kg. The so-called “ecological rucksack” of 1 kg of bakery goods “weighs”

“Ecological rucksack” = MI – 1 kg = 16.6 kg – 1 kg = 15.6 kg.

Taking into account one loaf of bread, whose average weight is 0.7 kg, we obtain

The “ecological rucksack” of one loaf of bread =
= 15.6 kg · 0.7 kg = 10.9 kg.

In order to compare the data obtained with those available from the Wuppertal Institute, Germany, we need to calculate material input of just renewable resources.

$$MIPS_{renewables} = \frac{9,146.8\ t}{5,472.6\ t} = 1.7 \text{ or } 1.7 \text{ kg/kg}$$

In Germany the corresponding MI-factor for bread and confectionery goods is 2.2.

6. Conclusions

1. The results obtained show that material input of renewable resources per kg of bakery goods is equal to 1.7 kg/kg, which is in agreement with those available from the Wuppertal Institute, Germany, since the corresponding MI-factor for bread and confectionery goods is equal to 2.2 kg/kg. The full consumption of natural resources, including nonrenewable resources amounts to 16.6 kg/kg. Therefore, bread is a quite "heavy" product from the point of view of using natural resources. However, this is due to the considerable consumption of natural gas in its production. We think that the life cycle-oriented approach based on material flow calculations for all kinds of natural resources gives figures that are more reliable for environmental decision-making and specifically for eco-labeling purposes.

2. Clearly, the data used for the calculations need to be clarified and a lot of additional information should be collected. Certainly, the Russian MI-factors for materials are required. However, the approach itself is useful for environmental decision-making at company level.

3. The findings of the research carried out show that information obtained from analysis of the product life cycle could be generalized by means of the concept of MIPS. A lot of data on material and energy flow inputs could be represented in the form of a single indicator or criterion. Such a criterion could describe the environmental quality of the product and thus serve as additional evidence for eco-labeling purposes.

4. MI-values or MIPS-criteria can be used for material flow evaluation based on LCA both for Type I and Type III eco-labeling.

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Web-sites

A List of Member State labels – http://europa.eu.int/comm/environment/ecolabel/link.htm

Global Type III Environmental Declarations Network – http://www.smsstandard.se/english/type3nw/index.asp

Organisation for Economic Cooperation and Development – http://www.oecd.org

Wuppertal Institute – http://www.wupperinst.org