Outline of the Finnish system of certified carbon footprints of food products

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Abstract: *The basic structure of a system called Certified Footprints of Products (CFP system) is outlined in this discussion paper. The CFP system could produce strict and reliable data needed for generating product-oriented carbon footprints in Finland. Central parts of the CFP system are a national CFP programme, product category rules (PCRs), a chain or actor-wise monitoring plan, validation of the monitoring plan, and reporting and verification of data, and an ICT-system to support data sharing. The system is designed around activity-based monitoring data, and every actor would be responsible for data on its own activities. Linkages to existing environmental management systems are taken into account. The CFP system is still just a theoretical structure. It needs further development prior to full-scale introduction. For the food sector, a new architecture for data acquisition and quality assurance, development of existing mechanisms and consolidation of them in the CFP system are needed. Additional research is needed regarding emissions from agricultural production.*

Keywords: *food, carbon footprint, life cycle assessment, LCA, supply chain management, modularity*

Introduction

Carbon footprints of products have become an integral part of the climate change discussion. Different types of climate labels for food products have been increasingly and world wide appeared with a view to underline producer's corporate responsibility and to increase consumer's ability to make more climate friendly product choices by offering information on carbon footprint of the product or GHG emission reduction and/or compensation related to the product. Many of them are based on carbon footprint calculation as an application of life cycle assessment method. Existing carbon footprints of foods are based on various kinds of data production, data sources and calculation routines. Therefore they are not necessarily comparable with each other but they may all have own applications and niche.

Carbon footprints are often based on general data, i.e. not production specific primary data. General data sources can be scientific literature, databases or environmental extended input output (EEIO) models of national account, for example. Even though carbon footprints based on general data might be comparable on behalf of data quality they are not strict enough to incite production processes towards low-carbon direction the most effective way. Consumers are able to contribute carbon footprint of his or her consumption by choosing between different types of food, for example between pork and beef and carrots. This choice can be remarkable. However choice between products of different producers can also have impact on climate. There may be different kinds of production chains that include differences in production processes (Katajajuuri et al., 2007). That is important choice situation because consumers tend to maintain their consumer habits. In addition the main function of eating, nutrition, and food as a raw material of cooking have to be taken into account, and consumers are more easily be able to do it through choices among the same products than among all products or all food products. Only carbon footprint that is based on production chain specific primary data can form a delicate and dynamic tool that offers information for contributing to production processes of existing products.

Not only carbon labels but also various carbon bonus/credit systems for households are currently in use or under development in many countries (Perrels et al., 2009). In addition to the knowledge, they provide means and motivation to promote products and solutions with low greenhouse gas emissions. Comparability of carbon footprints is a very important issue regarding consumer information and feedback systems, in which climate impacts of consumer choices are reported to households at various aggregation levels (products/ product groups/all expenditures)(Hyvönen et al., 2009). This multi-level reporting requires comparability of products within the same product groups but also of products from different sectors and product groups. This could also be based on EEIO data or expert judgement, but eventually the more developed version of the reporting system needs a dynamic tool. This could in turn be based on recorded purchases, but the involved information details have to be assessed and elaborated to avoid supplying misleading information. In addition, steering impact would be insufficient in the same way that is described above. In order to enable a practicable and credible bonus system and comparable product-related information for consumers, development of the underlying product-related information system is critical.

This discussion paper outlines the proposal for the Finnish system of certified carbon footprints of products (the CFP system). The CFP system addresses the challenges of providing reliable, cost effective and up-to-date data to formulate a realistic and systematic information structure that represents the basis of a bonus system for households as well as product-related carbon footprint (Usva et al., 2009a).

Outline of the Certified Carbon Footprint of Products –system

The development of the CFP system was strongly supported by experiences in EU Emission Trade Scheme (EU-ETS) and empirical LCA-studies that have been conducted by MTT's LCA research group. In addition, relevant standards and specifications were incorporated. The most important standards and specifications were ISO 14040, 14044 (ISO 14040 series), 14025 (ISO 14020 series) and PAS 2050 (BSI 2008).

In Figure 1 a scheme of CFP system and its linkages to standards and environmental management systems is described. The CFP system is linked to environmental management systems to emphasize practicality of system for producers alongside with effectiveness of steering mechanism and reliability of information. However, until now CFP system is just a theoretical structure and it needs to be further developed and introduced through application and interaction between different actors.

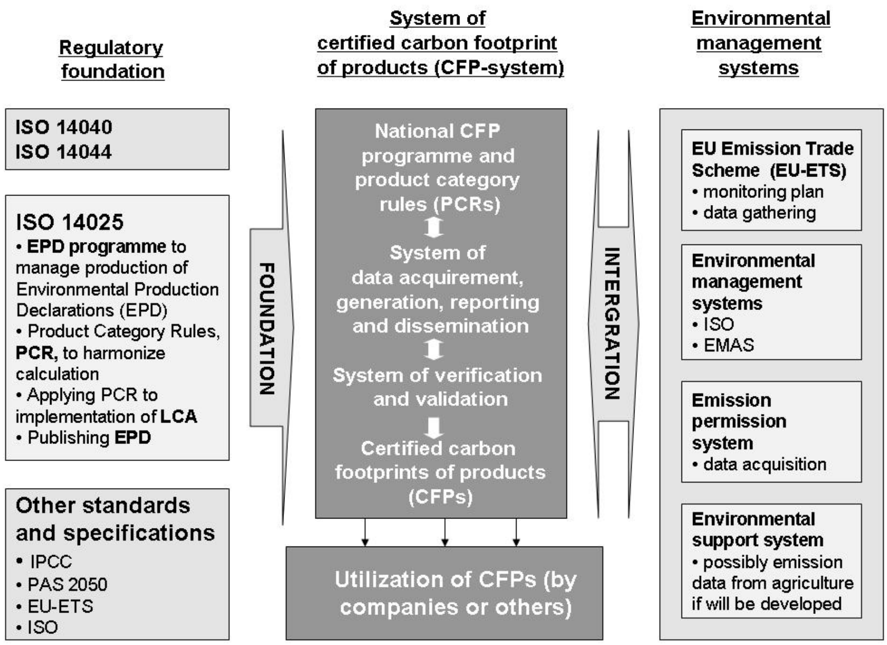

Figure 1. CFP system linkages to the international regulatory foundation and environmental management systems in Finland.

The CFP system aims to provide representative, reliable and up-to-date information on carbon footprints of products (for different uses where comparable information is needed). It really should provide information at product level. To be feasible it should be cost-effective to society and producers. It should be acceptable, flexible and user-friendly for producers. The system should allow for gradual improvement of resolution, scope and accuracy of information within the system.

Key elements of the CFP system are 1) utilisation of real monitored process-based activity data, 2) calculation rules at three levels, and 3) procedures for validation, verification and data dissemination. To tackle some challenges important for food products concept of voluntary emission guarantees and a ceiling level for total product emissions are introduced.

Utilisation of real monitored process-based activity data

The use of real process-based data means that data from every significant activity of (most) stages of the supply chain are based on real activity data (i.e. used materials, energy, land etc.) and emission monitoring (as far as it is possible and sensible). The overall production system of any product consists of numerous dynamic processes and streams. Consequently the resulting complexity and information volume make the collection of activity-based data challenging and expensive. Therefore, indirect emission factors (defaults) and not-so-accurate database values or values from literature (secondary data) are widely used in LCA and carbon footprint calculations. However, most manuals for LCA and carbon calculation including ISO 14040 (ISO 14040 series) and PAS 2050 (BSI 2008), for example, prefer primary (activity) data to secondary data. Selection between primary and secondary data depends on various things, including time scale, expenses and cooperation within production chain. Basically from a point of view of consumer choice, things that make difference from production chain to another are those of which calculation should be based on primary data. However, emission monitoring of primary production of food is still under development, and so is also emission modelling. Despite of emission data origin, primary data regarding activity data should always be used if achievable. Supporting primary activity data production is a main task for the proposed CFP system, and accordingly represents a fundamental challenge for data management (database) in the CFP system.

The CFP system is based on responsibility of producers for balance area data generation. It is vital for improving environmental performance of product. In our experience on LCA studies of food products, downstream actors (e.g. farm) are not necessarily enthusiastic about giving information on their activities if upstream actor (food processing industry) asks initial data for LCA calculation. It does not mean that downstream actors are not interested in improving their environmental performance but it may prove that improving product chain performance based on that kind of data production structure is not as effective as it could be. We are convinced that if actor is responsible for information of its activities from the start, and respectively it is recognized that they actually own that information, starting point for co-operation to improve environmental impacts of product are much better. The starting point is more equal and respective.

Calculation rules at three levels

Calculation rules for data production have to be harmonised at three levels to promote reliable Certified Carbon Footprints of Products that are comparable at product level. They form a hierarchy where the upper level determining the lower level. In the CFP system the tools for calculation rules at different levels are 1) CFP Programme, 2) Product category rules, PCR, and 3) the Chain Monitoring Plan. Thinking behind the CFP programme and PCR are based on ISO 14025 Sandard (ISO 14020 series) on environmental declaration, while the concept of Chain Monitoring Plan has received influence from EU-ETS (EC, 2007).

The CFP Programme

The CFP Programme represents the uppermost level of calculation rules for CFPs in the CFP system. It can be established nationally as The National CFP Programme or alternatively Finnish activities might be channelled into the Swedish International EPD® -system, for example. It must be stressed that national EPD programmes (including the proposed CFP Programme) should represent an intermediate phase, the ultimate goal being able to compare carbon footprints of different products from the same category globally. This requires an international (or at least at EU level) EPD or CFP programme and internationally accepted PCRs. Anyway, CFP Programme should adopt the definition of the EPD programme that is described in the ISO 14025 standard. There are functions in addition to the calculation logic, including management of PCR preparation and the data confidentiality system. Regarding calculation rules, the CFP Programme would prepare, maintain and communicate general content of PCRs, i.e. the overall principles for development of PCRs.

The precision required for harmonisation of calculation rules at the CFP programme level has to be determined through a transparent development process in the national (or international) CFP programme. The CFP Programme is the forum where details of regulations could be discussed without sector boundaries. The CFP Programme would establish procedures and content for developing the PCRs for different product groups.

Product Category Rules

Calculation rules are to be described and defined at the sector-specific level in PCRs, within the limits of the CFP Programme. The main issues to be addressed at PCR level, according the ISO14025 standard, are listed in Figure 2. The content of some of these may be defined already at the CFP Programme level, but some of them are product group specific. They are logically dealt with at the PCR level, although some represent challenges for a new procedural tool for the upper level rules, like *the guaranteed level of emission* and *the ceiling level of a product.*

There are some special issues for food products that have to be taken into account while rules are set. The most critical ones are 1) variability in emission over time, 2) timing of emissions, 3) predetermined parameters for reporting LCA data, and 4) allocation of material and energy flows and releases.

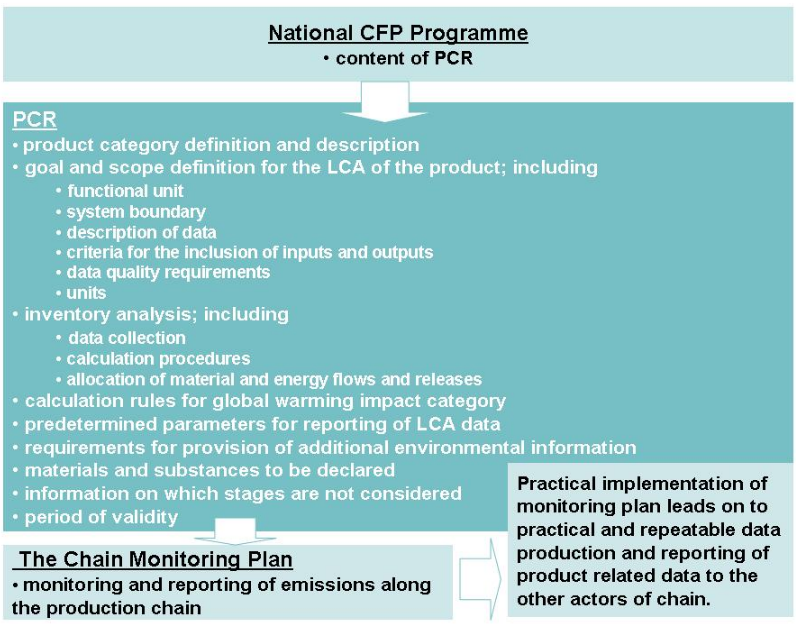

Figure 2. Outline of levels for calculation rules and rule content at different levels. Formulation of CFP Programme and PCR based on ISO 14025 and formulation of The Chain Monitoring Plan is based on the EU-ETS structure.

Variability in emissions over time

LCA calculation and reporting is often followed a year after initiation. In agricultural production annual harvest represents a natural time span, but yields can differ considerably over the years. Therefore, greenhouse gas emissions for agricultural products (derived from yield) vary substantially among harvests. In Finland, using the same input level, crop yield can vary considerably from one year to another. Input level is decided in advance (in relation to yield expectations), and product emission is mainly determined by conditions during the season. Consumer preference therefore cannot influence emissions. Regarding global warming, agricultural production is the most critical phase in food production and annual variation in production considerably influences life cycle results for final food production. Consumers are not able to appreciate advantages from global warming that can occur in a production chain not linked to agriculture, because the global warming effects are confounded with yield level changes. Using a longer time span can obviate this problem. The mean value of three harvests fluctuates far less than annual values, but the use of *a voluntary guaranteed level* may be yet more stable and therefore more consumer-friendly. In a voluntary guaranteed level the producer asserts that emissions of production do not exceed a certain level.

Timing of emissions

The carbon footprint of a product should be in a line with actual emissions released during its production. However, it is not always clear when emissions occur. For example, methane emissions from landfills occur after the product has been produced and consumed. In some cases the emissions occur before production has begun. In Finland the pH of the soil in agricultural fields must be kept optimal for production by liming. Lime application causes CO_2 emissions when $CaCO_3$ decomposes. Liming is normally carried out in every fourth or fifth year and the field produces four or five crops during that period. Thus emissions associated with liming should be divided evenly over all yields.

Predetermined parameters for reporting LCA data

The aim is that primary data are preferred for calculating CFP. However, primary data are not always to hand or are not always even necessary. Some predetermined parameters (secondary data) for exiguous emissions need to be taken into account. However, the nature of exiguous emissions has to be defined at the PCR level in addition to the predetermined parameters.

Allocation

Allocation is needed when the production system generates more than one product, or is not based on linearity of raw material inputs and outputs. During allocation, inputs and outputs are channelled into products using described procedures. Allocation has stimulated scientific discussion and there is not consensus for the way it should be done. ISO 14040 standards and PAS2050 both emphasise avoidance of allocation by dividing a unit process into two or more sub-processes and collecting input-output data for the sub-processes, or expanding the product system to include the additional functions related to the co-products. When allocation cannot be avoided, ISO 14040 standard suggests the use of physical allocation and PAS 2050 the use of economic allocation.

Traditionally LCA studies are geared towards production or administrative requirements, but product oriented carbon footprints are supposed to guide consumers, although the rationality of allocation can differ from the consumers' point of view. It has to be considered carefully what the effects of different allocation procedures have on consumers, and accordingly how consumer choice influences production. This needs further research and consideration, and it makes sense to define allocation principles for calculation rules even at the CFP Programme level. The decisions on allocation procedures represent one of the most important stages in a LCA study and can influence the results considerably. Results from different methods of calculation would be comparable and allocation principles can be specified in the PCR.

The Monitoring Plan

In the CFP system, the most detailed level of calculation rules is at the chain monitoring plan level. In an ideal situation the production chain represents the basis of the Chain Monitoring Plan, for which *the continual data collection* and *the (annual) emission calculation* is described in detail using balance area definition. Alternatively, the monitoring plan can be made separately for particular organisations, modules, cells and production networks.

Validation of methods, verification of data and data dissemination

Validation refers to the comparative process that revises the consistency between background guidance and a more specific monitoring plan. The monitoring plan contains all the methods used for generating quantitative product-specific emission estimates based on various transparently identified data sources. Verification is a compliance checking process that addresses correctness of numbers used and validity of applied monitoring and calculation methods in relation to the monitoring plan. Areas of validation of methods and verification of data in the CFP system are illustrated in Figure 3.

The Monitoring Plan should conform to the CFP validating system. In this case each company in the production chain produces data on its own activities (balance areas) according to the Monitoring Plan. This is the basis of *modularity* in the CFP system**.** The use of information modules as a source of LCA data of products is already introduced in the ISO 14025 standard. The results of annual emission calculations, as well as methods for continual data collection and other relevant procedures, are described in the annual specific emission report, to document verification. After verification, the results of monitoring are entered into an emission database and then used in commercial consumer-oriented ICT applications. *The voluntary emission guarantee of balance area* and *the ceiling level of product* are the published results of the emission calculation if it falls under the voluntary emission guarantee value or ceiling level of product (Hongisto et al., 2008). If calculation value for balance area is not under the voluntary emission guarantee value or ceiling level of product, a new increased guarantee value can/must be defined, e.g. based on findings in the verification procedure. The decision regarding shifting the guaranteed level can be made after the verification statement is ready. Outline of links in The Monitoring Plan and other key elements of CFP system are described in figure 3.

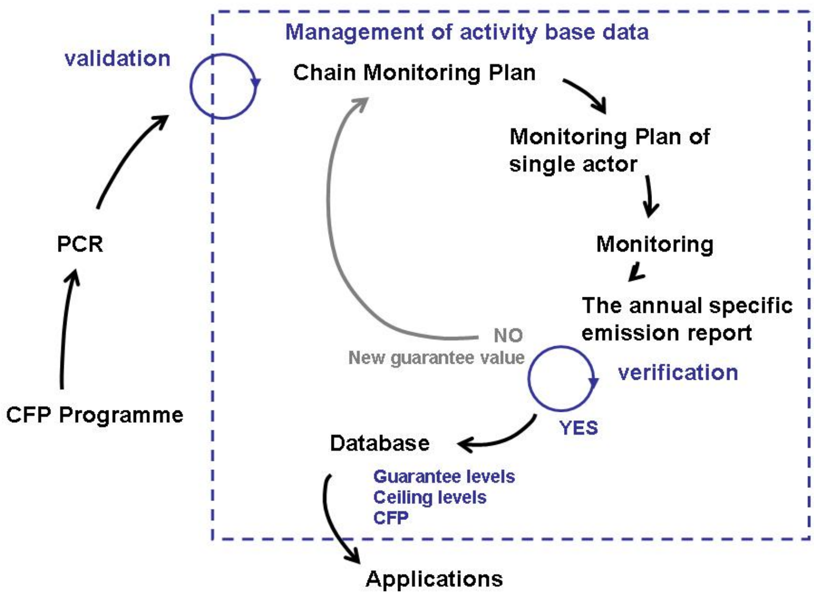

Figure 3. Outline of links in The Monitoring Plan and other key elements of CFP system.

The CFP system for carbon data acquirement, calculation and verification requires a systematic approach and a highly sophisticated ICT-infrastructure to support its operations. In addition to managing and publishing PCRs and CFPs (i.e. the ceiling level), infrastructure is needed for dissemination of the voluntary guarantee levels from business-to-business and to support emission and climate impact calculation. Dissemination of the voluntary guarantee levels from business-to-business needs an emission database, in which they could be published as the Public Voluntary Guarantees and the Ceiling Level of Products.

Implementing of the CFP system in the Finnish food sector

For implementing the CFP system for the food sector the entire data production and sharing system has to be created from scratch. Fortunately the Finnish food sector has a tradition of studying environmental impacts using the life cycle approach (Usva et al. 2009b; Kurppa et al., 2009; Saarinen et al., 2009), so that extensive extended data production may possibly be initiated sooner and faster than in many other sectors.

Food sectors, like other sectors, are faced with the challenge of trying to get carbon data for production chains of imported raw materials and products. The main imported flows relate to soy and other vegetable oil seeds and raw fodder materials, but minor material flows are various. The use of conservative defaults represents an important solution at least for the beginning. In practice all those involved have to put significant effort into extending data acquisition to cover imported material flows.

Fundamental sector-specific issues that need to be dealt with in implementing CFP in the food sector are related to the nature of emissions from agricultural production, as well as the characteristics and structure of food sector and feature of food products.

Emissions from agricultural production

In general N_2O and CH_4 emissions are the most significant sources of greenhouse gases from food production. CO_2 dominates the overall CO_2 equivalent emissions in the other sectors. Most N_2O and CH_4 emissions for food products originate from agricultural production and are material, activity and condition dependent. Most impacts of agricultural production originate from biological processes. They are not easy to measure and scientific knowledge about them is expanding. Furthermore, land-use and land-use change impacts on CO_2 emissions are high and have been neglected in past food LCA studies. Therefore, representative estimates for environmental impacts of agricultural production are not easy to get, even in principle.

The (conservative) defaults for N_2O and CH_4 emission sources are maybe the only possibility for now for calculating the carbon footprint of the food products. Such default values should be defined in PCRs or other sector-specific documents. In the beginning the default values should be as extensive as possible, to cover the most important emission sources. However, from now more specific default values for different situations have to be defined.

Variation in technology used by producers is significant for GHG emissions – this is true not only for agricultural producers but also for small industries. Perhaps the most marked example is energy source choice during greenhouse production. Energy consumption dominates total greenhouse gas emissions for greenhouse products, and the footprint of a greenhouse product can be decreased by 90% by changing the energy source from fossil fuels to renewables. Generally, the scales of potential variability for various technological processes are largely unknown (because of a lack of comparable LCA results). This variability could be defined by use of activity base data in modelling and calculation, sharing and comparing information on them. Regarding agricultural production, research and development work (in relation to data acquisition, monitoring, modelling and sharing) is needed before this kind of technology sensitive activity data become available. This relates to progress in traceability for food. The reference scales of variability can also be produced from a more theoretical basis, for instance by using demonstrative precision-farming systems, facilitated by equipment for energy use measurement or varying production practises. This needs support from research, and could be the first step towards large-scale production of CFPs. The reference scales could then be used by various producers to define their ceiling levels for emissions. By improving the efficacy of energy use they can then move into a better position, or by changing the technology, move to a new (better) scale of reference.

Structure of food sector – Consumption of food

Food consumption has diversified and there are currently countless people involved and numerous daily purchasing situations in the sector. Consumers make decisions between products on a daily basis, either in the context of public catering or private purchase. Food represents a major material flow in public procurement. The popularity of eating out is increasing. Carbon footprints of products have to be comprehensive and easily available, which is possible using a flexible, cost-efficiency system in conjunction with consumer demand and political pressure. Such issues constitute the core starting points for the creation of the CFP system, and should be kept in mind when the system is to be implemented.

Food consumption, both private and public, is governed by many efficient driving forces, including nutritional requirement, culture, economics, social issues, and environmental impacts. Potential changes in food consumption are influenced by many drivers in addition to those related to climate impacts. These represent a challenge, especially for developing a steering mechanism and data production. Definition of the functional unit is an issue that has to be solved at the PCR level. The primary option for a functional unit related to food is CO_2-eqv per kg or litre, but the next step considers the functions of food in relation to their carbon footprint. This is crucial regarding public catering and other catering services (a serving or nutrition service as a final product) (Kurppa et al., 2009; Saarinen et al., 2009; Virtanen et al, 2010). However, the basic data production for raw materials constituting a serving(s) should be based on the functional unit of a kg or litre also in these cases.

Structure of food sector – Production of food

The food production sector consists of a range of actors, the majority of which are small and middle-sized enterprises (SMEs). On the other hand, there are some major participants in the food sector, mostly in secondary production and trade. It is likely that generation of carbon data will tend to be channelled through these central players, several of which have already been very active in environmental management issues. One impending challenge is the participation of other actors in PCR and data production with respect to their own carbon footprints. Broad participation in PCR production is important for producing a comprehensive set of rules that can be applied throughout the production chain. It is to everyone’s advantage that this is made possible. Data production, in turn, it will incur extra costs and inconveniences. In some cases some of the chain actors might reap most economic benefits (downstream actors), while other actors have to defray the main costs (upstream actors). Development activities and costs are expected to be directed at agricultural primary production, but the downstream actors (brand owners) might easily benefit from the lower purchase prices, increased competition and possibly higher value of more climate-friendly marketed end products. Attempts should be made to avoid such a situation for pursuing justification and acceptability. The system should promote total sustainability and corporate responsibility, and it should be fair and attractive for small actors too.

One of the first steps in developing agricultural data production for the CFP system could be to integrate it into the prevailing EU Agri-Environmental Schemes (European Commission a), taking account of the potential growing conditions in the future (European Commission b). Such an environmental support system requires farmers to produce comprehensive information about their production, which is related to political aims and tools. The environmental aims and tools regarding agriculture evidently need to be considered in relation to climate impacts and should include the challenges associated with product-oriented environmental data production. If the incentive were to be linked to an agri-environmental scheme, the support could be directed to the appropriate stakeholders, in contrast to what might occur were a standard trading system to operate.

In terms of the purchase of raw materials from the food industry, the growing challenge is that industrial suppliers (and trade regarding own labels) are in constant flux, and often change rapidly. Use of imported materials makes data acquisition more difficult, which is a basic challenge for manufactures and highlights the importance of traceability as the primary task to encourage business responsibility. Purchase processes of manufactures should be actively developed to be more supportive of traceability. In principle, a product with an untraceable production chain could not be included in the CFP system.

Conclusions

The outline of the CFP system aims at catalysing the uptake of reliable carbon footprint generation in Finland for a broad range of products. It is still a theoretic framework without implementation. The proposed CFP system guarantees reliability of information and aims to keep the costs of information management within tolerable limits. The EU Emission Trade System (EU-ETS) includes the energy sector and some other heavy industry sectors. Despite the EU-ETS sectors' large share in total emissions, the EU-ETS on its own is not sufficient to mitigate climate change. Consumption in its widest sense has to be taken into account in the steering mechanisms. Accordingly, decision makers, including consumers and other purchasers, need information on the climate impacts of products in order to make informed decisions.

The vision of the certified carbon footprint data production system was developed because only the product based traceable data makes the differences between products and might influence competition situation in practice. We suppose the illustrated system incite producers to initiate efforts to produce desired information and in the longer run activate practical GHG emission mitigation efforts. To communicate improvements data has to be acquired from the real production chain and traceable streams. From this perspective any common default values are not operative and should be replaced with monitored data whenever possible. The need for good quality data and a cost-effective (tools, ICT-system) production of it in the long-run is evident. 3rd party verification system is needed to guarantee the reliability of data. To minimise additional costs it is necessary to integrate the data production system into the international standards, guidelines and practices and into the existing data collection and verification systems (e.g EU-ETS). Tailoring of the used data sources on a sector specific level is necessary to improve cost efficiency of CFP-system.

The outlined CFP system was designed in conjunction with an envisaged feedback system for households. That feedback system informs households individually about the cumulated greenhouse gas emissions of their purchases over time. A pilot version of the feedback system was developed and tested in the Climate Bonus project. The CFP system is able to produce information on carbon footprints of products of which the purchases are to be reported in the feedback system. Yet, the CFP system can just as well be used for carbon labelling, eco-design, and development of production processes with the aim to lower their carbon footprints.

Traceability for different goods is becoming increasingly sought after, especially in the food sector. The outlined CFP system is in harmony with the rising demand for traceability thanks to the use of activity-based data and the requirement for chain data management. However, it requires an effort and continued commitment from all those involved in the entire production chain.

References

BSI (2008) PAS 2050:2008 – Specification for the assessment of the life cycle greenhouse gas emissions of goods and services.

EC (2007) COMMISSION DECISION (2007/589/EC). Establishing guidelines for the monitoring and reporting of greenhouse gas emissions (MRG2) pursuant to Directive 2003/87/EC of the European Parliament and of the Council.

European Commission (a). Agriculture and environment: Introduction. European Comsission, Agriculture and Rural development. *Offical web-page.* http://ec.europa.eu/agriculture/envir/index_en.htm Visited at 23 April 2010.

European Commission. (b). Climate change: The challenges for agriculture. European Comsission, Agriculture and Rural development. *Fact sheet.* http://ec.europa.eu/agriculture/publi/fact/climate_change/2008_en.pdf. Visited at 23 April 2010.

Hongisto M., Perrels A.,Nissinen A.,Katajajuuri J. M. and K. Hyvönen (2008) Miten kotitaloudet voisivat seurata ja ohjata kulutuksensa ilmastovaikutusta? *Ympäristö ja Terveys* 39,10, 42–45. (in Finnish) (How households could follow and steer climate impacts of their consumption?)

Hyvönen K., Saastamoinen M., Timonen P., Kallio A., Hongisto M., Melin M., Södergård C. and A. Perrels (2009) Kuluttajien näkemyksiä kotitalouden ilmastovaikutusten seuranta- ja palautejärjestelmästä – Climate Bonus hankeraportti (WP5), *VATT Tutkimukset* 143:4 (in Finnish) (Views of consumers about climate information and feedback system – Climate Bonus project report (WP5))

ISO 14020 series. Environmental labels and declarations – General principles

ISO 14040 series. Environmental management – Life cycle assessment – Principles and framework

ISO 14065. Greenhouse gases – Requirements for greenhouse gas validation and verification bodies for use in accreditation of other forms of recognition

Katajajuuri J-M. (2007) *Experiences and Improvement Possibilities - LCA Case Study of Broiler Chicken Production*, In: 3rd International Conference on Life Cycle Management, Zurich, Switzerland, 27–29 August 2007, 6 p.

Kurppa, S., Grönroos J., Hyvärinen H., Katajajuuri J-M., Kauppinen T., Mäkelä J., Nissinen A.,Nousiainen J., Saarinen M., Usva K., Viinisalo M. and Y. Virtanen (2009) *Environmental impacts on a lunch plate – challenges to interpret the LCA results?* Proceedings of Future of the Consumer Society Conference, 28–29 May 2009, Tampere, Finland.

Perrels, A., Hongisto M., Hyvönen K., Katajajuuri J.M. and A. Nissinen (2009) A quick scan of climate policy services and underlying data system approaches – Climate Bonus project report (WP1), *VATT Research Reports* 143:1

Saarinen M., Mäkelä J., Viinisalo M., Kurppa S. and A. Nissinen (2009) *Application of lunch plate model for communication of environmental impacts of the consumer's food choices.* Proceedings of Future of the Consumer Society Conference, 28–29 May 2009, Tampere, Finland.

Usva K., Hongisto M., Saarinen M., Katajajuuri J.M., Nissinen A., Perrels A., Nurmi P., Kurppa S. and Koskela S. (2009a) Towards certifies carbon footprints of products – a road map for data production – Climate Bonus project report (WP3), *VATT Research Reports* 143:2

Usva, K., Saarinen, M., Katajajuuri, J-M., Kurppa, S. (2009b) Supply chain integrated LCA approach to assess environmental impacts of food production in Finland. *Agricultural and Food Science* 18, 3-4: 460-476.

Virtanen, Y., Kurppa, S., Saarinen, M., Mäenpää, I. and J. Grönroos (2010) Carbon footprint of food – an approach from national level and from a food portion. Proceedings of IFSA 2010 Symposium, 4–7 June 2010, Vienna, Austria.