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PROCEEDINGS

8TH INTERNATIONAL CONFERENCE ON

LIFE CYCLE ASSESSMENT IN THE AGRICULTURE-FOOD SECTOR



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Please cite this publication as:

Corson, M.S., van der Werf, H.M.G. (Eds.), 2012. Proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012), 1-4 October 2012, Saint Malo, France. INRA, Rennes, France.

Please cite a paper or abstract in this publication as:

Proust, V.L.G.E.M., 2012. In search of lost time, in: Corson, M.S., van der Werf, H.M.G. (Eds.), Proceedings of the 8th International Conference on Life Cycle Assessment in the Agri-Food Sector (LCA Food 2012), 1-4 October 2012, Saint Malo, France. INRA, Rennes, France, p. 20-25.

ISBN 978-2-7466-5740-3



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Product-Oriented Environmental Management System (POEMS) in the agri-food sector: main results of the EMAF project

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ABSTRACT

In this paper the main results of the Eco-Management for Food Project (co-funded by the Italian Ministry of Education, University and Research - PRIN No. 2008TXFBYT) are presented. Within the EMAF project, a Product-Oriented Environmental Management System (POEMS) framework that is specifically tailored for the agri-food industry, is being designed and implemented. It has a modular structure as it is made up of a set of complementary tools: an Integrated Quality and Environmental Management System; a simplified Life Cycle Assessment methodology; guidelines for product environmental communication. Finally, this paper describes the main results of the POEMS framework implementation to different pilot food companies, in order to verify the effective functioning and to highlight the strong and weak points of the POEMS model and of its individual fundamental elements.

Keywords: POEMS, Integrated Management Systems, Simplified LCA, Environmental Product Labels, Agri-Food Supply Chain

1. Introduction

Product-Oriented Environmental Management System (POEMS) is a new framework designed to bring together traditional environmental management systems and tools oriented towards environmental product performances. It is “*a systematic approach to organizing a firm in such a way that improving the environmental performance of its products across their product life cycles becomes an integrated part of operations and strategy*” (de Bakker et al., 2002). Despite there still being no standard reference and few studies available in literature – mainly in manufacturing industries and only one first attempt (Ardente et al., 2006) in the agri-food sector – a growing number of organisations are experiencing the need to integrate environmental management systems standards with those addressed to the environmental evaluation of products, shifting attention from system/process to product/service.

In this context, the definition of a POEMS framework specifically tailored for the agri-food industry is the core target of the Eco-Management for Food (EMAF) Project (co-funded by the Italian Ministry of Education, University and Research - PRIN 2008TXFBY), that sets out to define, test and disseminate innovative environmental management tools in order to improve the sustainability and competitiveness of agri-food companies. The choice of this particular sector is mainly due to its economic importance in the European Union, as well as the considerable amount of natural resources used and environmental pollutants released by this industry; indeed, the Environmental Impact of Products - EIPRO study (Tukker et al., 2006), conducted by the European Commission, showed that among the products consumed in Europe, food and beverages are the ones which are associated with major environmental impacts, in a life cycle perspective.

2. Methods

Within the EMAF project, the POEMS framework has a modular structure resulting from the integration of complementary environmental management tools: the underlying basis is an Integrated Quality and Environmental Management System (ISO 9001 and ISO 14001/EMAS), while the product orientation is provided by a Simplified Life Cycle Assessment and a suitable environmental product label or declaration chosen following Guidelines for the Environmental Product Communication.

The innovative character of the EMAF project has a double dimension connected to the fact that each environmental management tool included in this study is developed in its methodological structure and then applied in pilot firms, both with a single and an integrated approach, offering to agri-food organisations a “modular” format that refers to each tool separately and to the POEMS in general. In this way, whatever the starting point of the firms is and whatever their targets are, they will find an answer and a strategy via which they may formulate their own route to eco-compatibility. In the following a synthesis of the single environmental management tools of which the POEMS model is made up is presented with a brief description of their methodological structure and the main results of their implementation to different pilot food companies,

in order to verify the effective functioning and to highlight the strong and weak points of the POEMS model and of its individual fundamental elements.

3. Results and discussion

3.1. Integrated Quality and Environmental Management System: the structural basis of POEMS

An Integrated Management System (IMS) is based on the combination of separate Management Systems (MSs) in order to plan, realise, control, audit and improve systematically a wide array of company performance, related principally to quality, environment, health and safety. During the last few decades, researchers have discussed IMS in a multitude of theoretical and empirical studies, focusing on different perspectives and addressing important aspects concerning possible strategies, methodologies and degree of the integration process (Salomone, 2008; Bernardo et al., 2009). Strategies refer to the selection and implementation sequence of sub-systems, while methodologies cover the implementation phases and steps; the degree concerns the level of integration that the organisation intends to achieve (Karapetrovic, 2004; Ørgensen et al., 2008).

The multitude of theoretical approaches found in the existing literature on the integration of MSs, lead to the conclusion that there is not a “one size fits all” methodology on which to build an integrated structure. Every integration process depends on the specific characteristics of the organisations involved, particularly in reference to dimension, number of pre-existent MSs, and sector features.

Within the EMAF project it was of primary importance to design a methodology for IMS implementation - which forms the backbone of POEMS -, covering Quality Management System (QMS) and Environmental Management System (EMS), focused on the agri-food sector, and testing its application in a specific pilot firm.

The proposed IMS model has to be seen as a flow of activities, schematized for simplicity in three progressive but different steps of integration, on the basis of the compatibility and complementarity between the requirements of the standards. The IMS model proposed is characterised by an innovative operational value because its approach focuses specifically on the agri-food sector. It has been applied to a pilot company and permits its continuous adaptation in accordance to the specific needs of SMEs.

The model proposes a multi-step progressive approach related to the following phases. The “first level” is “strategic”, identifying the principles, objectives, policies and values useful to the continuous improvement of quality and environmental performance; the “second level” involves aspects linked to the “systemic implementation” of the IMS, by a synergic management of resources and a full analysis of the results achieved in each of the areas considered; the “third level”, however, has a “unifying” nature, aiming at the complete integration and synergies among all the organisational managerial and cultural aspects.

During the integration process in the pilot company some strong points, clustering in internal and external, have emerged (Zeng, et al., 200□) The former are: a focus on a holistic approach and underpinning relationships; the harmonisation of capabilities linked to the early use of formalised MSs; a reduction in unnecessary documents and bureaucracy; improvements in organisational efficiency and effectiveness. The external strong points are principally related to: the worldwide growing diffusion of multiple MSs in the agri-food sector and the need to enhance their synergies; the increasing use of best business practices due to strong competition on the global market; widespread adoption of tools for continuous improvement and benchmarking. The internal weak points, which arose during the implementation process, are: the need for an aptitude to change among employees and management; the difficulties in re-allocation of roles, responsibilities and skills; finally, the need of resources for training, knowledge sharing and dissemination. The lack of market information on IMS approaches pursued in managerial and organisational processes and difficulties in fostering IMS adoption as a tool for creating value on the market are the most important barriers which emerged in the external context.

3.2. Simplified Life Cycle Assessment: the environmental assessment of agri-food products

Life Cycle Assessment (LCA) has been increasingly used to identify and assess the environmental impacts of a variety of goods and services. In the framework of the EMAF project, existing LCA studies and review papers on food supply chains were analysed to report the current state-of-the-art and identify critical issues. More in detail, the purpose of such a review was to identify: a) the main methodological issues in the food sector and how they have been dealt with, b) whether there could be a tendency for some environmental impacts to be more affected than others, and c) whether there were specific stages in products' life cycles that seem to be more impacting than the others. All the above purposes were related to identifying the information necessary for selecting a simplified tool that could be suitable to be implemented in this field.

Subsequently, a literature review of simplified LCA approaches followed resulting in several papers focusing on a variety of products/sectors (a few ones related directly or indirectly to the food sector). Most papers highlighted that the need to simplify an LCA lies within the time and cost parameters (especially for SMEs) of carrying out a full LCA. In addition, simplified methods were recognised to be useful in the early product design phases, when limited information is available. Finally, these methods were recognised to be helpful in green procurement, for example for identifying the minimum technical specifications based on environmental characteristics. Based on the previous outcomes, a set of criteria were identified for the selection of the most suitable simplified tool among those reviewed: a) ISO-compliance, b) broad focus (a number of impact categories to be considered, not just one, like, e.g. in Carbon Footprint), c) user-friendly interface, d) limited data requirement or adaptability to existing databases, e) relevance to life cycle steps identified in our food LCA review, and f) ease of integration with EPD, POEMS and other communication tools.

Subsequently, a number of decision-making tools for assisting the selection were identified, namely: i) Delphi Method, ii) Analytical Hierarchy Process, iii) Multi-Criteria Decision Making (MCDM) and iv) Rough Sets Theory. It was finally decided to use the MCDM method, after having consulted a number of experts in the domain, according to which a set of weights were assigned to the above criteria by a group of experts. The tools found in the literature are being evaluated by some experts and tool developers themselves through the application of three of the methodologies of the Multi-Attribute Utility Theory family, namely SMART (Barron and Barrett, 1996), Mszros and Rapsk (Meszaros and Rapcsak, 1996) and Entropy Optimisation (Lofti and Fallahnejad, 2010). The results of the simplified LCA will be compared to those of a full LCA. In the meantime, the collection of data (necessary for both types of LCA) was performed at two small winemaking firms in the region of Abruzzo, in Italy. The data collection and the early steps of the tool application demonstrated that performing a simplified LCA may require limited time and resources. Furthermore, simplified tools have clear and easy to understand calculation and visualisation methods and are considered to be suitable for effective communication of the environmental performance of products and services. The user friendliness along with the Life Cycle Thinking orientation are characteristics that simplified LCA tools normally offer, as well. When it comes to opportunities that can make such tools more easily adopted, those can include a proactive approach as regards the strategic management of the environmental variable, a sensitivity of the management to environmental issues and an interest for eco-labelling initiatives on the side of the market.

On the other hand, such tools are characterised by their difficulty in incorporating the methodological differences across firms and sectors. Moreover, a reduced scope and an increased subjectivity are issues that can be considered as weaknesses of simplified LCA tools. As far as external threats are concerned, they are mostly connected to a general lack of environmental awareness by the firms combined with a central focus on short-term problems, mainly due to the pressure by the market. In addition, the fact that a general rule for Small and Medium-sized Enterprises (SMEs) being that environmental management tools are not perceived as an opportunity has to be taken into consideration. In parallel, a tendency for lack of time and/or willingness of the technical staff and the management for data collection was identified. Finally, the fact that environmental issues are often perceived as constraints and source of additional and often unknown (or hidden) costs has to be noted, as well (Masoni et al., 2004). The next steps of the research group include the finalisation of both the full and the simplified LCA implementations for various types of wine in the two firms involved and a comparison of their results in order to assess the robustness of the selected simplified tool.

3.3. Guidelines for product environmental communication: the market orientation

The agri-food production based on more sustainable processes enhances the importance of the relationship of trust between producers and consumers and requires communication tools by which provides useful information, related to the respect of the environmental resources, to consumers. Specific environmental tools may respond to these needs, tools that can orient agri-food firms toward more sustainable production processes and that can attribute to products an objective, recognizable and marketable environmental value (Lo Giudice and Clasadonte, 2010).

Due to the great amount of different environmental communication and labelling systems, a framework of guidelines has been proposed for supporting firms in the choice of the most appropriate environmental communication system, with regards to their productive peculiarities, the environmental impacts, the territorial characteristics and the type of the target market.

The main characteristics of the guidelines can be synthesized as follows: consistency with the provisions of series ISO 14020 and ISO 14063 standards; general character, i.e. all organisations can apply them regardless of size, sector, location; transparency and completeness, to be easily used as a tool for decision making.

The framework (characterised by a clear, credible and transparent language) has a structure based on iterative procedural steps suitable for different kinds of stakeholders whose degree of involvement in the communication process is taken into account.

The proposed guidelines provide the following index:

- Introduction (state of the art, existing labels);
- Principles of environmental communication (terms and definitions, reference standards);
- Goal and scope (voluntary tools of certification, assessment of the business needs, system boundaries, involved stakeholders, markets of references);
- Environmental communication policy (planning of the environmental communication activity, identification of the business tools);
- Environmental communication strategy (involved business resources);
- Measurement of environmental impacts (questionnaires, input-output flow analysis, flowcharts iterative models, decision support systems, identification of indicators of organisations performance, best available techniques, prevention strategies, more appropriate labeling identification);
- Reporting (documentation, logos);
- Environmental Communication (revision policies - audit, cost analysis, potential benefits, description of chosen tool, potential integration with other enterprise management tools, identification of target-audience, final recommendations).

The guidelines have been applied to a pilot company operating in the pasta chain located in eastern Sicily to test their effectiveness and highlight the strong and weak points. The flowcharts and iterative steps of the approach proposed allowed to analyse the firms characteristics and the features of the reference chain, guiding the management to adopt one of the most popular used tool of environmental communication for products: the Environmental Product Declaration (EPD). To this scope, starting with the Product Category Rules (PCR) existing for the area analysed, the assessment of environmental impacts of the production process of the pilot company was made using the methodology of Life Cycle Assessment (LCA), which highlighted the agricultural phase as the most impactful throughout the production cycle (Lo Giudice et al., 2011).

The application of the guidelines, despite the initial lack of knowledge by the company of different communication tools and the difficult involvement of stakeholders within the sector, led to: identify the most appropriate tool for environmental assessment; increasing interest in environmental communication tools, such as trademarks and statements; increase the knowledge of suppliers, distributors and consumers about corporate environmental performance. However, it was found that there are still some open issues of fundamental importance, such as: the lack of knowledge on distributors/consumers of these tools; the limited financial resources in the hands of companies; the limited availability of PCR, in the agri-food sector, relating to the EPD system; the uncertainty on the possible application of the Ecolabel in food products.

3.4. Product-Oriented Management System: the complete framework

Pursuing the goals of EMAF project, a literature review of previous methodological and applicative studies of POEMS was performed in order to identify the most appropriate methodological solutions for the agri-food industry; the information gathered allowed us to define key issues that were then translated in the following POEMS model requirements: a) fundamental structure composed of a management system conforming to ISO 14001 or to the EMAS Regulation, integrated with ISO 9001 and other possible management systems typical of the agri-food sector; b) methodology based on the Deming Cycle, fully exploiting the iterative character of the cycle in order to pursue continuous improvement of both the methodological structure and environmental and product performance; c) product orientation ensured by the integration of a Simplified Life Cycle Assessment methodology suitable for organisations in the agri-food production chain, which can be used to evaluate different cultivation methods, production technologies and alternative materials; d) ability to transform the environmental measures taken into commercial advantages in the best possible way for the organisation, thanks to the use of guidelines that can support firms in their choice of the most suitable form of environmental message, closely linked to the product; e) simplification of certain operational aspects and reduction of "bureaucracy"; f) general character, making it applicable to any type of activity in the agri-food sector, whatever the organisation's size, nature and position in the agri-food supply chain; g) modular structure, as it is composed of a collection of management tools that can be applied, individually or as an integration of two or more elements, on the basis of organisations' specific requirements and of the objectives they aim to reach. The POEMS framework is synthetically illustrated in Fig. 1.

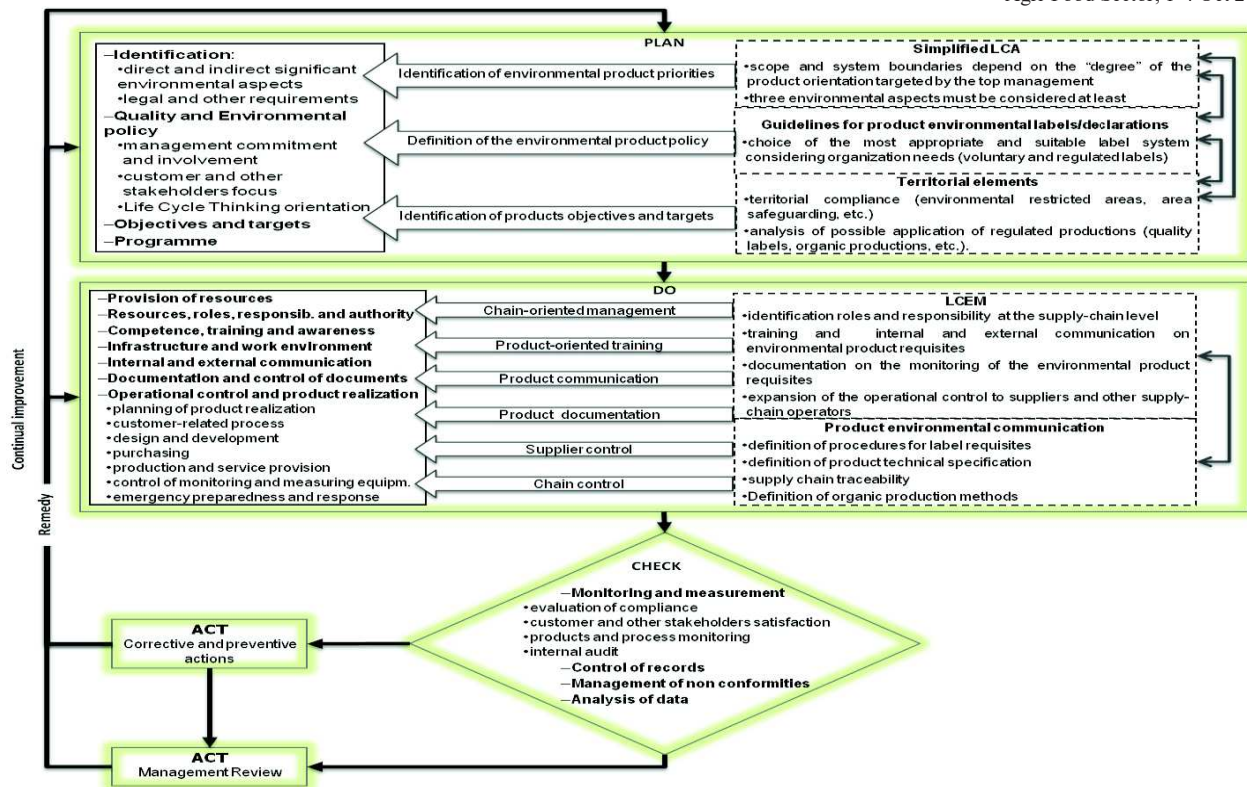


Figure 1. The POEMS framework (EMAF, 2012)

The model was developed from a traditional EMS (ISO14001 standard), integrated with a QMS (ISO 9001 and ISO 9004 standards), and is based on the PDCA cycle. It allows the collection of external customers' and other stakeholders' expectations concerning the product requirements (that is a key issue in ISO 9001 standard but not in the ISO 14001 one). In the PLAN phase, the product-orientation of IMS is guaranteed by the inclusion of a Simplified-LCA (of one or more products), and by the consideration of territorial elements (e.g. land protection; regulated quality brands; organic production) that allows the collection of data and information useful for the evaluation of improvements in the environmental performances of products. This information flow lets to change the initial environmental review so as to take into account the environmental impacts of products and the interaction with the other actors of the supply-chain. In the DO phase, the framework is completed with the inclusion of a Life Cycle Environmental Management strategy in order to improve the decision-making process by deploying a range of information useful to the supply-chain sustainability, the definition of the appropriate product documentation and the preparation of the chosen environmental product label or declaration. Finally, the framework continues with the phases of CHECK and ACT.

In order to verify the effective functioning of the POEMS model, its application in pilot companies, operating in two different agri-food supply chains, has already been started up. The two supply chains were chosen in order to involve firms operating in important Italian sectors, from an economic and/or environmental point of view, but with very different characteristics and problems: the olive oil and the roasted coffee industries. During the POEMS implementation in the pilot companies some strong and weak points have emerged; they can all be summarized in the following main issues: even if the model demonstrated the robustness of its general and iterative character and a reduction of "bureaucracy", the need for a huge quantity of data and the necessity of defining common goals and implementing joint efforts with the other actors of the supply chain, in the real practice, hinder the full implementation of a POEMS. Indeed, firms are reluctant to collect information from other actors and in the agri-food organisations a limited co-operation across the supply chain still persists. This resistance to change should be faced up with proper information and training activities in order to struggle the lack of a supply chain management perspective.

4. Conclusion

The innovative character of the POEMS model is determined by the integration approach of tools that are generally analysed as "independent" tools, while in the EMAF project they are closely related to each other. The adoption of an IMS, made up of a QMS and an EMS, represents a fundamental step in the transition from a conventional to a more sustainable business practice in agri-food organisations. At the same time, it

represents only the starting point towards the complex pathway for the improvement of the global performance of agri-food products and processes, in accordance to the environmental sustainability perspective. Such a vision, indeed, requires the adoption of an array of tools, aiming at a POEMS as the final target. The other tools to be integrated are a Simplified LCA and a proper product environmental communication tool. Indeed, the product-orientated approach allowed by a Simplified LCA methodology, specifically suited for agri-food SMEs, and guidelines for supporting firms in the choice of the most appropriate environmental communication system, are deemed as highly necessary for a successful POEMS framework: they may assure the market orientation essential to counter the erroneous firm's conviction that environmental management tools are not a business opportunity. In fact, the applicative phase of EMAF project (that is still in progress) has highlighted that various important factors affecting the application of each environmental management tool are widespread in many organization of the agri-food sector; these factors include the lack of market information, the understanding and awareness of environmental issues, the difficulty to consider these tools as instruments for creating value in the market, and the limited co-operation across supply chains. This means that cultural and structural changes and continual improvement are the imperatives that should be properly managed in order to directly connect POEMS and its single components with the challenges of transforming the sustained efforts into effective business opportunities.

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